Rico-Argentine Site
Removal Action Work Plan

September 2021

Administrative Settlement Agreement and Order on Consent

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ACRONYMS AND ABBREVIATIONS

AECOM	AECOM Technical Services, Inc.
amsl	above mean sea level
Anaconda	Anaconda Company
AOC	administrative settlement agreement and order on consent
Atlantic Richfield	Atlantic Richfield Company
CDOT	Colorado Department of Transportation
CDPHE	Colorado Department of Public Health and Environment
CDPS	Colorado Discharge Permit System
CEPCO	Crystal Exploration and Production Company
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CHC	Charles H. Carpenter
CQAP	Construction Quality Assurance Plan
CWD	Constructed Wetlands Demonstration
EE/CA	Engineering Evaluation and Cost Analysis
EPA	United States Environmental Protection Agency
EWD	Enhanced Wetlands Demonstration
FCS	Flow Control Structure
FSP	Field Sampling Plan
gpm	gallons per minute

H_2S	hydrogen sulfide gas
HASP	Health and Safety Plan
HDS	high density sludge
HMWMD	Hazardous Materials and Waste Management Division
HWTT	Horizontal Wetland Treatment Train
IDF	Interim Drying Facility
MOB	manganese-oxidizing bacteria
NPDES	National Pollutant Discharge Elimination System
OM&M	operations, maintenance, and monitoring
POTD	potentially dissolved
QAPP	Quality Assurance Project Plan
QA/QC	quality assurance/quality control
QCP	Quality Control Plan
RAMCO	Rico Argentine Mining Company
RAWP	Removal Action Work Plan
SAP	Sampling and Analysis Plan
SCM	Site Conceptual Model
Site	Rico-Argentine Site
SLT	St. Louis Tunnel
SPCC	Spill Prevention, Control and Countermeasure
SRB	sulfate-reducing bacteria
STA	Small Tracts Act
SWMP	Stormwater Management Plan
UAO	Unilateral Administrative Order for Removal Action
USFS	United States Forest Service
USGS	United States Geological Survey
VCUP	Voluntary Cleanup and Redevelopment Program
VWTT	Vertical Wetland Treatment Train

EXECUTIVE SUMMARY

This Removal Action Work Plan (RAWP) is for the Rico-Argentine Site (Site), located in Rico, Colorado (see Figure 1). This RAWP has been prepared as an attachment to the Administrative Settlement Agreement and Order on Consent (AOC); Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Docket Number [ ]; United States Environmental Protection Agency (EPA) 2021 and is intended to describe the removal action tasks necessary to fulfill the requirements of the AOC.

The AOC supersedes and replaces in its entirety the Unilateral Administrative Order for Removal Action, Docket Number CERCLA-08-2011-0005 (UAO), which EPA issued to Atlantic Richfield Company (Atlantic Richfield) on March 17, 2011, and under which Atlantic Richfield has implemented certain removal action tasks consistent with the National Contingency Plan, including but not limited to: a) management of precipitation solids in the settling ponds including partial removal of solids from the upper ponds; b) construction of an on-site solids repository; c) investigation of actions to stabilize the adit opening and consolidate adit flows; d) development of a design for appropriate hydraulic controls at or near the adit opening to manage flows entering the treatment system; e) construction of hydraulic controls at or near the adit opening to manage flows; f) development of a design for an expanded treatment system for the St. Louis Tunnel adit discharge, including upgrades to pond embankments and hydraulic structures; and g) construction of a water treatment system to address the adit discharge. The AOC provides for completion of the removal action work tasks initiated under the UAO, including: 1) enhanced hydraulic controls; 2) expanding the water treatment system to full size; and 3) additional removal of pond solids and solids management.

Attachments to this RAWP include the *Performance Evaluation and Technology Selection Report* (Appendix A), which details the water treatment removal action alternatives analysis; the *Draft Water Treatment Performance Criteria* (Appendix B), which describes the draft performance criteria for water treatment; and *Previous Removal Action Task Status and Site Investigations* (Appendix C), which summarizes the status of completed and ongoing removal action tasks and deliverables.

The Site is located approximately 0.75 miles north of the northern boundary of the Town of Rico in Dolores County, Colorado. The Site consists of an adit, known as the St. Louis Tunnel (SLT), associated underground mine-workings, and a series of settling ponds located downgradient of the SLT adit. Mining activities at the Site began in the early 1900s and continued intermittently through approximately 1977; exploration work ceased in approximately 1983.

Lime treatment of SLT adit discharge was initiated in 1984 under a National Pollutant Discharge Elimination System (NPDES) permit. The property and NPDES permit were transferred to Rico Development Company (RDC) in 1986, and water treatment continued until approximately 1996. The NPDES permit expired in 1999 and has not been renewed. The SLT is inaccessible due to a tunnel collapse in 1996, resulting in the formation of several debris plug(s).

In 2011, EPA issued the UAO for Removal Action to Atlantic Richfield and an associated RAWP, attached as Appendix 3 to the UAO (EPA, 2011a, 2011b). The UAO presented a list of actions required in accordance with the 2011 RAWP. The required actions included the following:

- Hydraulic Controls
  - Investigation of actions that can be feasibly implemented at the collapsed SLT portal to stabilize the adit opening and consolidate adit flows;
  - Development of a preliminary 30% design for appropriate hydraulic controls at or near the adit opening to manage flows entering the treatment system; and
  - Construction, as appropriate, of hydraulic controls at or near the adit opening to manage flows.
- Water Treatment

- Development of preliminary 30% design for an expanded treatment system for the SLT adit discharge; and
  - Construction of a water treatment system to address adit discharge.
- Solids Management
  - Management of precipitation solids in the settling ponds downstream of the SLT portal, including partial removal of solids from the upper ponds (Ponds 11, 12, 14, 15, and 18); and
  - Construction of an on-site solids repository in accordance with the siting requirements of Colorado Hazardous Materials and Waste Management Division (HMWMD) and Dolores County.

Further site characterization, source water controls, treatability testing, and alternative evaluations were performed pursuant to the 2011 UAO. Removal action activities under the UAO also included removal of pond solids from the St. Louis Ponds System; strengthening of pond dikes/berms; routing and management of stormwater; construction of a solids repository; installation of two relief wells and a flow control structure as adit hydraulic controls; and installation, operation, and monitoring of pilot-scale and demonstration-scale constructed-wetlands treatment systems.

Categories of work that remain include the analysis, design, and construction of: a) an expanded full-scale water treatment system to remove hazardous substances from the SLT discharge; b) additional hydraulic control measures for the collapsed area of the SLT adit; and c) ongoing solids management (collectively, the Water Treatment System as presented in the AOC); and d) the operation and monitoring of the SLT Water Treatment System and associated infrastructure.

Based upon data collected during operation of the Constructed Wetland Demonstration (CWD) and the Enhanced Wetland Demonstration (EWD) treatment systems, a number of removal action alternatives were considered and analyzed for a full-scale water treatment system, as described in Appendix A - Performance Evaluation and Technology Selection Report. The alternatives evaluated were: 1. No Further Action; 2. Expanded Constructed Wetlands; and 3. High-Density Sludge Lime Treatment. These alternatives were primarily evaluated for effectiveness, implementability, and cost. Based upon this comparative analysis, the design and application of a full-scale Expanded Constructed Wetlands Treatment System was selected as the recommended removal action alternative.

Management of precipitation solids from the Expanded Constructed Wetlands Treatment System components and from the partial removal of solids from the upper St. Louis Ponds System[1] during construction will be outlined in a Solids Management Plan. Solids will be managed on-site, as necessary, and placed in the constructed Solids Repository.

A significant amount of data regarding Adit Hydraulic Controls has been collected since the installation of two relief wells intersecting the SLT in 2016. The flow and water level data from the two relief wells and other monitoring locations confirm that the apparent hydraulic conductivity of the collapsed features within the SLT is decreasing over time. A design package will be developed and implemented for the installation of an additional relief well and construction of surface infrastructure and piping connected to the Expanded Constructed Wetlands Treatment System.

[1] All but 2 feet of Pond 18 solids were excavated conventionally by mechanical method and placed in an interim drying facility constructed over the inactive Ponds 16/17 area in 2011. The two feet were left in place to retard the downward seepage of pond water through any calcine tailings present and into the underlying predominantly coarse-grained alluvium deposits. Ponds 15, 12, 11, and 14 solids were dredged and conveyed to interim storage in Pond 13 during 2012, 2013, 2014 respectively, again leaving approximately 2 feet of solids in place (for the same reason).

1 INTRODUCTION

This Removal Action Work Plan (RAWP) is for the Rico-Argentine Site (Site), located in Rico, Colorado. This RAWP has been prepared as an attachment to the Administrative Settlement Agreement and Order on Consent (AOC); Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Docket Number [ ]; United States Environmental Protection Agency (EPA) 2021 and is intended to describe the removal action tasks necessary to fulfill the requirements of the AOC.

The AOC supersedes and replaces in its entirety the Unilateral Administrative Order for Removal Action, Docket Number CERCLA-08-2011-0005 (UAO), which EPA issued to Atlantic Richfield Company (Atlantic Richfield) on March 17, 2011, and under which Atlantic Richfield has implemented certain removal action tasks consistent with the National Contingency Plan, including but not limited to: a) management of precipitation solids in the settling ponds including partial removal of solids from the upper ponds; b) construction of an on-site solids repository; c) investigation of actions to stabilize the adit opening and consolidate adit flows; d) development of a design for appropriate hydraulic controls at or near the adit opening to manage flows entering the treatment system; e) construction of hydraulic controls at or near the adit opening to manage flows; f) development of a design for an expanded treatment system for the St. Louis Tunnel adit discharge, including upgrades to pond embankments and hydraulic structures; and g) construction of a water treatment system to address the adit discharge. The AOC provides for completion of the removal action work tasks initiated under the UAO, including: 1) enhanced hydraulic controls; 2) expanding the water treatment system to full size; and 3) additional removal of pond solids and solids management.

This RAWP includes the following elements:

- Introduction;
- Site characterization;
- Removal action objectives;
- Removal action tasks;
- Removal action work to be performed; and
- Removal action schedule.

Attachments to this RAWP include the *Performance Evaluation and Technology Selection Report* (Appendix A), which details the water treatment removal action alternatives analysis; the *Draft Water Treatment Performance Criteria* (Appendix B), which describes the draft performance criteria for water treatment; and *Previous Removal Action Task Status and Site Investigations* (Appendix C), which summarizes the status of completed and ongoing removal action tasks and deliverables. The ensuing sections discuss the following: site description and background; land use/ownership; and previous removal action tasks.

1.1 Site Description and Background

The Site was the location of historic mining and mineral processing operations. It consists of an adit known as the St. Louis Tunnel (SLT), associated historic underground mine workings, and a series of settling ponds downgradient of the SLT adit. Historically, the adit continuously drained water with elevated concentrations of metals, which eventually discharged to the Dolores River after traveling through the settling ponds.

The metals on-site are considered “hazardous substances” as defined by Section 101(14) of (CERCLA, 42 U.S.C. § 9601(14). Consequently, the EPA issued a UAO in 2011 that required Atlantic Richfield to conduct a removal action to abate endangerment to the public health, welfare, or the environment that may be presented by the actual or threatened release of hazardous substances at or from the Site (EPA, 2011a). Since the order was issued, Atlantic Richfield has been conducting work pursuant to the 2011 RAWP (EPA, 2011b) attached as Appendix 3 to the UAO for Removal Action.

1.1.1 Site Location

The Site is located approximately 0.75 miles north of the northern boundary of the Town of Rico in Dolores County, Colorado. The Site lies at an average elevation of 8,800 feet above mean sea level (amsl) at the base of Telescope Mountain (the lower portion of which immediately adjacent to the SLT is known as Charles H. Carpenter [CHC] Hill) in a relatively flat area adjacent to the Dolores River. This location is in the SW ¼ of Section 24 and the NW ¼ and SW ¼ of Section 25, T 40 N, R 11 W within the United States Geological Survey (USGS) Rico 7.5-minute Topographic Quadrangle.

1.1.2 Site Access

The Site is accessed via a gravel road from State Highway 145 from Telluride (28 miles) to the north and from Cortez (49 miles) to the south as shown on Figure 1. Due to avalanche paths to the east of the Site, the main access road is closed during the winter when avalanche hazards exist, and the Site is accessed via the dikes to the west throughout the St. Louis Ponds System (Ponds System). The typical active-work season for the Site runs from approximately May through October.

1.1.3 Climate

The climate is characterized as semi-arid with long, cold snowy winters and short, moderately wet, and warm summers. Monthly and annual climatic data has been compiled by the Colorado Climate Center at Colorado State University for Rico Station ID 057014 from 1893 through 1993. The mean annual temperature is 39°F. The warmest months are June, July, and August with monthly mean temperatures of about 55°F, and the coldest months are December, January, and February with monthly mean temperatures of about 7°F. The mean annual precipitation in the Rico area is about 27 inches with most precipitation occurring as snowfall in the fall, winter, and early spring.

1.1.4 Facilities/Features

The ensuing sections discuss the following key Site features and facilities: SLT, the Ponds System, demonstration-scale constructed wetlands systems, on-site repositories, and decommissioned treatment structures.

1.1.4.1 St. Louis Tunnel

The SLT extends approximately 5,000 feet east into the base of CHC Hill in the north-central portion of the Site. Based on historical geologic mapping and photographs, it is inferred that the intact portions of the tunnel are seven to eight feet high and nine to ten feet wide. Borrow material had been excavated from the area covering the SLT, causing a collapse of the roof and walls of the tunnel. Adit discharge continues to flow out of the obstructed adit and pools behind the debris plugs, which were identified by pressure transducers installed in tunnel monitoring wells and relief wells. To help alleviate the water pressure behind the debris plugs, two relief wells (RW-2A and RW-2B) were installed in 2016 to allow adit discharge from the SLT to be conveyed in a controlled method to the water treatment system and Ponds System.

The Flow Control Structure (FCS) was installed in 2017 to detain water that could be released during a potential debris plug breach. The FCS would detain much of the water in the tunnel behind the structure and divert overtopping flows to various on-site structures (i.e., Solids Repository and Pond 12) to contain an initial breach.

1.1.4.2 Ponds System

A series of constructed ponds occupy most of the central and southern portions of the Site along the valley floor on the eastern bank of the Dolores River and about 80 acres along the flood plain. Historically, the ponds were used for settling of solids in connection with lime treatment of the adit discharge, resulting in a lime-precipitation metals sludge in some of the ponds. There are 19 ponds on-site, but only eight are actively receiving water discharged from the demonstration-scale constructed wetlands treatment systems, as shown on Figure 2. Discharge from the SLT flows through the demonstration-scale constructed wetlands treatment systems (constructed under the UAO) or the active ponds (Ponds 5–9, 11, 12, and occasionally 15) and discharges to the Dolores River from an outfall (DR-6) at Pond 5.

The demonstration-scale constructed wetlands treatment systems consist of the Constructed Wetland Demonstration (CWD), which includes the area formerly occupied by Pond 19, and the Enhanced Wetlands Demonstration (EWD), which includes the area formerly occupied by Pond 14 and Pond 18. Pond 15 is maintained dry and has been utilized, as needed, for additional settling when demonstration-scale constructed wetlands treatment systems are bypassed for maintenance or during times of high turbidity, while relief well maintenance was conducted. Pond 10 is fed by groundwater and is not in the current flow path. Ponds 16 and 17 currently serve as the solids Interim Drying Facility (IDF), and Pond 13 provides additional storage for precipitated solids. Ponds 11, 12, and 15 are referred to as the Upper Ponds, which have larger volumes and contain varying amounts of precipitated lime treatment metals-bearing solids. Ponds 5–9 are referred to as the Lower Ponds and contain little to no treatment solids, except for Pond 9. Over time, the Lower Ponds have become a series of naturalized wetlands with abundant vegetation and wildlife. Ponds 1–4 do not currently receive water discharged from the SLT but are fed by geothermally influenced groundwater. Solids management removal action tasks that have been conducted since the issuance of the UAO in 2011 are discussed in Section 1.4. Table 1 summarizes the current estimated volumes of precipitated solids located throughout the Site.

Table 1. *Estimated Volume of Precipitated Solids at Rico-Argentine Site*

Pond	Estimated Solids Volume (cy)
Online/Active Ponds	
11	1,900
12	1,300
15	2,900
Offline/Inactive Ponds	
13	25,500[1]

Notes:
1. Volume shown includes solids and incidental calcines temporarily placed in Pond 13 during removals from various ponds.

Placement of significant volumes of waste rock and other grading material in the central and northern portions of the Site resulted in ground elevations well above the original floodplain surface. Currently, the active channel and floodplain of the Dolores River are confined to the western portion of the historic 100-year floodplain (in some locations up to the 500-year floodplain) by contiguous dikes constructed along the east bank of the river adjacent to and upgradient of Pond 11 (AECOM Technical Services, 2012). However, Ponds 1 through 9 are within the 100-year floodplain, because the dikes are not sufficiently elevated downstream of Pond 11 and not present downgradient of Pond 5. Flood dike upgrades that have been performed to date are discussed in Section 1.4.

1.1.4.3 Demonstration-Scale Constructed Wetlands Treatment Systems

The two demonstration-scale constructed wetlands treatment systems constructed under the UAO are the CWD and the EWD. Water from the SLT is pre-treated with aeration and a coagulant to raise pH and aid precipitation of oxidized iron hydroxide, collected in a Parshall flume (DR-3), and then directed to either the CWD or the EWD, which can treat a maximum of 60 and 550 gallons per minute (gpm), respectively, for a total maximum treatment capacity of 610 gpm. Excess flow is diverted around the demonstration-scale constructed wetlands treatment systems and is sent directly to Pond 12. The CWD consists of two separate treatment trains that can each treat up to a maximum of 30 gpm. These are referred to as the Vertical Wetland Treatment Train (VWTT) and the Horizontal Wetland Treatment Train (HWTT).

After coagulation addition, the SLT water that is directed towards the VWTT flows into a settling basin to allow for floc formation and coagulated solids settling. Next, water flows through a vertical-flow anaerobic biotreatment cell filled with organic media, which utilizes sulfate-reducing bacteria (SRB) to remove dissolved metals via sulfide precipitation. Finally, the water flows through an aeration cascade to strip excess sulfide and increase dissolved oxygen before flowing into Pond 12. If directed towards the HWTT after coagulation, the SLT water flows into a settling basin. Then, water flows through a surface-flow wetland and subsequently a horizontal-subsurface-flow anaerobic wetland filled with organic media and rock matrix support that utilizes SRB to remove dissolved metals via sulfide precipitation. The effluent then flows through an aeration channel and finally through a limestone rock drain, which utilizes manganese-oxidizing bacteria (MOB) for manganese removal before discharging to Pond 12.

In the EWD, water first enters a settling basin for solids settling. Water flows by gravity to a manganese removal cell, which utilizes MOB and then into a vertical flow anaerobic biotreatment cell filled with organic media, which utilizes SRB to remove dissolved metals via sulfide precipitation. Biotreatment cell effluent is fed into an aeration cascade and then discharged into Pond 12.

Treated water from the three wetlands treatment trains flows into Pond 12, where it is allowed to mix with any pre-treated SLT discharge from the wetland's diversion as well as any stormwater runoff from the Site. Pond 12 gravity-flows into the remaining ponds in the Ponds System and then eventually discharges to the Dolores River from Pond 5 at the DR-6 outfall.

1.1.4.4 On-site Repositories

There are two repositories on-site - the Soil Lead Repository and the Solids Repository.

The Soil Lead Repository occupies approximately 2.6 acres at the base of the CHC Hill in the north-central portion of the Site. The repository accepts soils with elevated lead concentrations removed from the Town of Rico under the Colorado Department of Public Health and Environment (CDPHE) Voluntary Cleanup and Redevelopment Program (VCUP). The permitted repository has a capacity at full build-out of 40,000 cubic yards. Roughly 10,000 cubic yards of soils from yard removals during 2005 to 2019 have been placed in the repository. The repository was built with a geosynthetic clay liner and an overlying leachate collection system that discharges to the Ponds System. Although located at the Site, the Soil Lead Repository was not constructed and is not being operated as part of a removal action activity pursuant to the UAO (or AOC).

A Solids Repository was constructed to provide an on-site management area for existing lime treatment metal-bearing pond solids generated from historic water treatment operations and removed during past/future water treatment system construction, as well as future water treatment generated solids. Solids previously removed from various ponds are currently stored in the IDF (former Ponds 16 and 17), and offline Pond 13, which are both isolated from the Ponds System. The Solids Repository provides capacity for disposal of all existing on-site precipitated treatment solids, estimated to be 31,000 cubic yards in-place in the repository, secured within an engineered, compacted starter dike. Additional capacity for other water treatment related solids from the Site is potentially available by stacking such materials above the starter dike crest elevation. Stacking these materials could add up to 32,000 cubic yards of storage for a maximum repository capacity of approximately 63,000 cubic yards. Since construction, the repository has been managed in an empty state and no solids have been placed in the repository. If future solids management requires repository expansion, the repository could be expanded to the west and could potentially have a maximum build-out capacity of approximately 365,000 CY.

1.1.4.5 Decommissioned Treatment Structures
Remnants of the former lime treatment operations remain on-site, including a metal treatment building and adjacent steel lime silo. The building now houses coagulant storage tanks, a laboratory used for calibration and storage of sampling equipment, and the Site telemetry system.

1.2 History
Mining in the Rico area began in 1869 and continued sporadically for over a century. Historical mining activities are described by Ransome (1901) and McKnight (1974). The St. Louis Smelting and Refining Company drove the SLT into the base of Telescope Mountain beginning in the 1930s and connected it via a northwest-running crosscut tunnel (Northwest Crosscut) to mine workings located to the northwest in CHC Hill and Telescope Mountain to drain those workings so they could be mined. A crosscut to the southeast connects the tunnel with and drains other workings.

In 1944, the Rico Argentine Mining Company (RAMCO) purchased the SLT from St. Louis Smelting and Refining Company, which later underwent various mergers and became a division of Crystal Exploration and Production Company (CEPCO).

In 1955, a sulfuric acid plant was constructed and began operations at the Site. Roasting of pyrite ore to produce sulfuric acid resulted in the generation of calcine residues. The calcine residues were primarily disposed of in Ponds 16 and 17 and the bottom of Pond 15.

RAMCO ceased most mining operations in 1971 and mine workings beneath Silver Creek were allowed to flood. All mining activities by RAMCO ended in 1976-1977 and exploration work ceased in 1978.

In 1980, the Anaconda Company (Anaconda) acquired RAMCO’s assets in Rico, including the Site and pre-existing National Pollutant Discharge Elimination System (NPDES) permit (EPA, 2011b). Anaconda conducted exploration drilling at several locations in and around the Site in the 1980s; however, the depth and hot geothermal waters encountered made mining challenging and uneconomic, and no further exploration or development occurred. Anaconda never produced ore or operated milling facilities in Rico. Anaconda was merged into an Atlantic Richfield subsidiary in 1977, which later merged with Atlantic Richfield in 1981.

In 1983, water from the Blaine Mine on Silver Creek was redirected to the SLT, and the Blaine Tunnel became zero discharge. A slaked-lime addition plant was constructed and began operating in 1984 to treat the discharge from the SLT adit to achieve permitted water quality standards at the outfall (DR-6) into the Dolores River. The lime caused some of the metals to precipitate and form a lime metal-bearing precipitate sludge in the bottom of the settling ponds. It is believed in about 1996, the portal area of the SLT collapsed. In 1996, active treatment of the discharge was discontinued (EPA, 2011a).

Atlantic Richfield sold its Rico properties including the Site to Rico Development Corporation in May 1988 under a Purchase and Sale Agreement; the NPDES permit was also transferred at this time. Rico Development Corporation sold its property holdings in April of 1994. The NPDES permit expired in 1999 and has not been renewed.

1.3 Land Use/Ownership
Atlantic Richfield has acquired much of the real property immediately surrounding the SLT portal, Solids Repository, and demonstration-scale constructed wetlands treatment systems, which are located north of and outside the Town of Rico boundary. In October 2013, Atlantic Richfield submitted a Small Tracts Act (STA) application to the United States Forest Service (USFS) to acquire three mineral survey fraction tracts of USFS lands in the vicinity of the SLT. Conveyance of these three tracts to Atlantic Richfield occurred on December 3, 2015. On December 12, 2014, Atlantic Richfield acquired additional property at the Site occupied by the Solids Repository and portions of the Ponds System lying immediately to the east of the Dolores River. Remaining portions of the Ponds System located just to the east of the parcel acquired in 2014 are on property currently owned by the USFS, some of which Atlantic Richfield is currently seeking to obtain through a second pending STA application.

Land use at the Site is and will remain restricted to the CERCLA response actions, including water treatment and solids management. An unimproved access road enters the Site on its southern boundary, immediately east of the Dolores River and passes through the SLT project area. Owners of property north of the Site occasionally use this road to reach their property.

1.4 Previous Removal Action Tasks

In 2011, EPA issued a UAO for Removal Action to Atlantic Richfield and an associated RAWP, attached as Appendix 3 to the UAO (EPA, 2011a, 2011b). The UAO presented a list of actions required to be performed in accordance with the 2011 RAWP. The required actions generally included the following:

- Hydraulic Controls
  - Investigation of actions that can be feasibly implemented at the collapsed SLT portal to stabilize the adit opening and consolidate adit flows;
  - Development of a preliminary 30% design for appropriate hydraulic controls at or near the adit opening to manage flows entering the treatment system; and
  - Construction, as appropriate, of hydraulic controls at or near the adit opening to manage flows.
- Water Treatment
  - Development of preliminary 30% design for a treatment system for the SLT adit discharge; and
  - Construction of a water treatment system to address adit discharge.
- Solids Management
  - Management of precipitation solids in the settling ponds downstream of the SLT portal, including partial removal of solids from the upper ponds (Ponds 11, 12, 14, 15, and 18); and
  - Construction of an on-site solids repository in accordance with the siting requirements of Colorado Hazardous Materials and Waste Management Division (HMWMD) and Dolores County.

Other investigations and related activities related to the tasks described in the 2011 RAWP were completed prior to the issuance of the UAO, as described in Section 4.0 of the 2011 RAWP.

The 2011 RAWP presented specific tasks, subtasks, and deliverables related to the removal action tasks. Appendix C presents the status of each of these tasks and the relevant deliverables. The removal action work that has been conducted since the issuance of the UAO can be summarized as follows:

- Pre-Design and Ongoing Site Monitoring
  - A Sampling and Analysis Plan (SAP) for ongoing surface water, groundwater, and SLT discharge was established to further characterize the seasonal water quality, water levels and flow rates (Atlantic Richfield Company, 2014a).
- Hydraulic Controls
  - After a series of adit and source water control investigations and hydraulic control alternative evaluations, the following adit hydraulic control measures were implemented in accordance with the *St. Louis Tunnel Hydraulic Controls Interim Risk Reduction Measures Work Plan (*Atlantic Richfield Company, 2016): two relief wells (RW-2A and RW-2B) were drilled and installed in 2016, and the FCS was constructed downstream of the adit in 2017.
- Water Treatment
  - Technology screening and a series of treatability studies were performed. A pilot-scale test wetland was constructed and operated in 2013. Based on the successful results of the pilot-scale test wetland, a larger demonstration-scale constructed wetlands system consisting of the CWD and later EWD was designed and constructed to treat SLT

discharge. Operations began in 2014 (CWD) and 2015 (EWD) and continue to the present.

- Solids Management
    - A series of solids management removal action tasks were conducted 2011–2015.
        - In 2011, all but two feet of solids were removed from Pond 18 and placed in the IDF, which was constructed over the former Ponds 16/17 area. The two feet were left in place to retard the downward seepage of pond water into the underlying predominantly coarse-grained alluvium deposits.
        - In 2012, dike improvements were made to Pond 13 to increase solids storage capacity. Solids were then dredged from Ponds 15 (in 2012), and Ponds 11 and 12 (in 2013) and conveyed to interim storage in Pond 13, again leaving approximately two feet of solids in place for seepage control. Solids were removed from Pond 14, with an initial removal in 2014 and final removal in 2015 along with final solids removal of Pond 18 during the EWD construction.
        - The Solids Repository was constructed in 2014–2015.
- Flood Dike Upgrades
    - Flood dike upgrades performed in 2012 included reconstruction of the Pond 15/18 revetment to address two seeps, construction of the Pond 9 revetment, and placement of additional riprap as needed along the flood dike. An additional dike raise in the Pond 18 area and Pond 11 hydraulic structure improvements were performed during 2016 as an ancillary measure to the Interim Risk Reduction Measures.

Additionally, stormwater control measures were also implemented during construction and maintenance activities to mitigate acceleration of erosion and sedimentation, and to control, minimize, and prevent the release of impacted soils entrained in stormwater discharges. The remaining removal action work is further discussed in this RAWP.

2 SITE CHARACTERIZATION

The following sections discuss the source of contamination and the Site Conceptual Model (SCM).

2.1 Site Geology

The geology on-site consists of occasionally exposed bedrock and unconsolidated natural deposits (colluvium and alluvium) typical of mountain-valley terrain. Various surficial historic mining/mineral processing related by-products and fill materials are also present on-site.

The underlying bedrock is primarily comprised of the Middle Pennsylvanian Age Lower Member of the Hermosa Formation. Some volcanic intrusions of Late Cretaceous to early Tertiary age hornblende latite porphyry are present but are sparse and relatively insignificant to the context of the Site. The Hermosa Formation is locally exposed in the slopes above the Site on CHC Hill and is covered by an estimated 340 feet of talus/colluvium at the former SLT portal location. The volcanic intrusions are seen on the lower slopes of CHC Hill and were encountered during the drilling of the SLT (Atlantic Richfield Company, 2013). The average depth to bedrock on-site is 150–175 feet. The Lower member of the Hermosa Formation is comprised of alternating layers of sandstone, siltstone, shale, conglomeratic shale, and limestone or dolomite (Pratt, et al., 1969). Most of the ore was extracted from massive sulfide replacement deposits in the limestone beds (McKnight, 1974). Minerals of economic importance in the area included pyrite, sphalerite, galena, and chalcopyrite.

Colluvial deposits are extensive on the lower mountain slopes of CHC Hill. Penetrations of these deposits by mine workings on-site indicate an apparent thickness of several hundred feet. The colluvium typically consists of a wide range of crudely sorted grain sizes, from fines to large boulders, up to occasional rock blocks greater than 25 feet.

Underlying the relatively flat-bottomed Dolores River valley are alluvial deposits. Borings on-site have identified three alluvial zones:

1. Upper Coarse Alluvium – Typically gravel and gravelly sand ranging from 30 to 50 feet thick;
2. Fine Alluvium – Typically consists of sand with some scattered gravel and gravel lenses ranging from 70 to 90 feet thick; and
3. Lower Coarse Alluvium – Typically consist of gravel and gravelly sand and is approximately 40 feet thick.

Fill materials such as soil and riprap have been placed in a variety of locations around the Site, including at the base of CHC Hill, embankments impounding the Ponds System, and covering the prior floodplain of the Dolores River in the northern portion of the Site.

2.2 Surface Water

Site surface water system components include: 1) the SLT adit discharge; and 2) stormwater including spring run-on and runoff. This section provides a brief description of each Site surface water component as well as the downgradient Dolores River directly to the west of the Site.

The SLT discharge originates as infiltrating precipitation that migrates along joints, fractures, and faults and collects in the mine workings that drain into the SLT. As shown in Figure 3, the primary mine workings contributing to the drainage from the SLT include: the workings draining through the Northwest Crosscut, including the Mountain Springs and Wellington workings; the workings draining through the Southeast Crosscut, including the Blaine, Argentine, and 517 Shaft workings; and the 145 Raise. Groundwater is present in the underground mine workings as a result of infiltration of precipitation (rainfall and snowmelt) through natural discontinuities (i.e., joints, fractures and faults) that serve locally as high conductivity pathways (relative to the intact bedrock) from the surface to the workings. Air is also abundantly present within the workings primarily via mine features open at the surface (i.e., adits, tunnels, and shafts) at various locations, and secondarily from natural discontinuities, both of which connect the underground workings to the surface. Dissolution of mineralized rock present in the open, natural discontinuities and mine workings occurs due to oxidation reactions resulting from contact of the groundwater (referred to herein as SLT adit discharge once it is intercepted by open mine workings) with susceptible ore minerals in the oxygenated environment.

Weathering and oxidation of the ore and associated minerals release metals and sulfate that originate from the ore minerals. The key contaminants are cadmium, copper, iron, manganese, lead, and zinc due to the mineralogy of the local ores and the geochemistry of these metals. Acidity is also produced by oxidation processes, particularly pyrite oxidation. This, in turn, enhances metals and sulfate release; however, acid is neutralized by limestone in bedrock and in resulting colluvium and alluvium. As a result, iron precipitates from solution and lead and copper are adsorbed by the iron oxides, or precipitate as other mineral phases. Cadmium, manganese, and zinc require higher pH conditions for adsorption, so tend to remain dissolved and be transported further downgradient by surface water and/or groundwater. Historical analytical data indicate that the Northwest Crosscut contributes most of the zinc, cadmium, and manganese loading in the SLT discharge (Atlantic Richfield Company, 2014b). The presence of limestone in bedrock neutralizes acidity to a circumneutral pH, resulting in partial reduction of some metals concentrations by precipitation or adsorption. Geochemically, the concentrations of metals in the adit discharge vary depending on seasonal changes in moisture conditions within the mine workings. Little moisture is needed initially during atmospheric oxidation, which results in formation of secondary, more soluble minerals. In the winter, less water infiltrates into and moves through the mine workings due to frozen surface and near-surface conditions. As a result, metal salts accumulate on the walls of the mine workings above the actively flowing adit discharge. When thawing occurs in the spring, a flush of infiltrating water moves through the mine workings and dissolves the accumulated and concentrated salts. As a result, metals concentrations are typically higher in the spring to early summer.

SLT discharge has been continuously monitored since 2011. Based on the monitoring results, SLT discharge varies seasonally with a base-flow of approximately 400-600 gpm during the late summer, fall, and winter. During the early spring, a sharp increase in SLT discharge occurs with observed peak flows ranging from 900-1250 gpm in the May-June timeframe. SLT discharge tapers off gradually to base-flow over the summer months. The peak flow and highest metals concentrations in the adit discharge do not precisely coincide with the seasonal onset of high runoff water flows in the Dolores River, but follow by up to about a month due to the time required for melt water to infiltrate soils, move through fractured bedrock, enter mine workings, and flow from the SLT.

A portion of SLT discharge flows from two relief wells (RW-2A and RW-2B), and the remainder of the flow passes through a series of three inferred debris plugs consisting of loose colluvial material, fractured bedrock, and wooden timber debris from collapsed tunnel supports, and then daylights at the collapsed SLT portal.

All SLT discharge is routed through the Ponds System. Up to approximately 610 gpm of base-flow water is treated through the demonstration-scale constructed wetlands system (discussed in Section 1.1.4.3). Any SLT discharge not treated by demonstration-scale constructed wetlands is diverted to the Ponds System for solids settling. Demonstration-scale constructed wetlands effluent and diverted flows are allowed to mix in the Ponds System before eventually discharging to the Dolores River.

Stormwater and spring runoff from the Site are collected in the Site stormwater control measures and directed to the Ponds System with eventual discharge to the Dolores River. The Site has a Stormwater Management Plan (SWMP), which is updated annually and continues to be used to meet the substantive requirements of the CDPHE General Construction Stormwater Permit and for stormwater control on-site during and after removal action construction. The SWMP is discussed in further detail in Section 5.3.1.1.

Directly west of the Site is a mile-long reach of the Dolores River, which flows from north to south. This reach of river is located near the headwaters and therefore experiences significant seasonal variation in flows due to spring snowmelt and stormwater runoff. Historically, water samples and flow measurements were collected at five locations on the Dolores River. In 2014, the flow measurement locations were reduced to two locations upstream and downstream of the treated Ponds System discharge to the river. Water quality samples continue to be collected at all five locations.

2.3 Groundwater

The Site has an extensive system of 49 monitoring wells or piezometers. Groundwater elevations have been measured periodically since 2002 with more frequent data from November 2011 to present. Most of the groundwater wells were intentionally screened within the upper alluvium with the remainder screened in colluvium or one of the other overburden materials. The changes in groundwater elevation are generally consistent with the seasonal variations of flow in the Dolores River. The primary direction of groundwater flow beneath the Site is from north to south, parallel to the gradient of the valley floor with a local component of flow toward the river.

Some adit discharge seeps into underlying colluvium and into groundwater near and just downgradient of the SLT opening and from unlined portions of the Ponds System. Prior removal action tasks (i.e., removal of ponds from the Ponds System and installation of lined ponds for demonstration-scale constructed wetlands treatment system construction and installation of relief wells intersecting the SLT) have decreased the head levels in the adit and the amount of seepage to groundwater.

2.4 Precipitation Solids

Lime was used to treat the metals laden SLT discharge from 1984 to 1996. The treated water flowed into the Ponds System where the metals precipitated and sludge settled before discharging to the Dolores River. As a result, solids have accumulated in the upper ponds. The *Initial Solids Removal Plan* (Atlantic Richfield Company, 2011), submitted pursuant to the requirements of the 2011 RAWP, summarized a precipitation solids inventory performed in 2001. Since 2011, solids have been removed from Pond 18, Pond 14, and partially from Pond 15, Pond 12, and Pond 11, as a part of previous removal action work discussed in Section 1.4. After solids removals were performed, the precipitation solids inventory was updated. As discussed in Section 1.1.4.2, current volumes of solids are provided in Table 1.

3 REMOVAL ACTION OBJECTIVES

The primary removal action tasks necessary to fulfill the requirements of the AOC are: 1) hydraulic controls, 2) water treatment, and 3) solids management. The tasks and objectives are provided below.

3.1 Hydraulic Controls

Two relief wells were installed in 2016 to provide hydraulic control of water pooled within the SLT and to reduce the potential for an uncontrolled release of adit discharge from the SLT. However, a reduction in debris plug permeability over time has been observed through monitoring of outflows through the relief wells and debris plug combination. As a result, additional hydraulic controls are needed to:

1. Provide enhanced and redundant capacity in control of water levels within the SLT;
2. Minimize the potential for an uncontrolled release of adit discharge from the SLT;
3. Manage and convey flows to the full-scale Expanded Constructed Wetlands Treatment System; and
4. Provide metering of flow and maintain water quality for water treatment.

3.2 Water Treatment

Based on the successful results of the pilot-scale and demonstration-scale constructed wetlands and the *Performance Evaluation and Technology Selection Report* (see Appendix A), an Expanded Constructed Wetlands Treatment System to treat SLT water will be designed and constructed. Additional passive wetlands treatment capacity will enable year-round treatment of the 10-year to 25-year recurrence period for SLT flows. Water treatment objectives include:

1. Reduce key contaminants loading to the Dolores River to improve water quality;
2. Reduce metals concentrations to achieve agreed-upon performance criteria;
3. Treat base flows and freshet flows up to the 25-year recurrence period (design permitting);
4. Provide safe, reliable, year-round / all-weather operations; and,
5. Minimize waste production and energy usage.

The water treatment removal action alternatives evaluation is described in Appendix A - *Performance Evaluation and Technology Selection Report*.

3.3 Solids Management

Initial solids removals have been performed for Ponds 11, 12, and 15, and final solids removals have been performed for Ponds 14 and 18. Ponds 14 and 18 final solids removals were conducted as part of the construction of the EWD. Solids are currently stored in the IDF and Pond 13.

The objectives of Solids Management removal action task include the following:

1. Management of precipitation solids as necessary from the Expanded Constructed Wetlands footprint to achieve hydraulic residence times and accommodate water treatment flow rates;
2. Manage precipitation solids currently present in the IDF and Pond 13; and
3. Manage potential future solids from water treatment, including solids removal and drying.

4 PLANNED REMOVAL ACTION TASKS

The planned removal action tasks for hydraulic controls, water treatment, and solids management are provided in the following sub-sections.

4.1 Hydraulic Controls

Hydraulic control options will continue to be used to manage flows and minimize potential for uncontrolled release from the SLT. Construction of a third relief well, RW-3A, will provide hydraulic control and redundancy to the existing system configuration. This work will be described further in an Adit Hydraulic Controls Work Plan.

4.2 Water Treatment

Water treatment alternatives have been evaluated as described in the *Performance Summary and Technology Selection Report* (see Appendix A). Based on a number of factors, including influent chemistry, relatively stable year-round temperatures, and other site-specific considerations (i.e., limited winter access, high elevation, avalanche hazard, etc.), the Expanded Constructed Wetlands best meets the water treatment removal action objectives. The demonstration-scale constructed wetlands have provided excellent discharge water quality following commissioning, while allowing for a reduced on-site presence during the winter, especially during periods of high or extreme avalanche danger. Additionally, solids generation is considerably lower with a constructed wetland than with High Density Sludge (HDS) Lime Treatment, and consumable requirements are greatly reduced. Capital and operations, maintenance, and monitoring (OM&M) cost estimations also support the selection of this alternative.

The selected water treatment removal action is the Expanded Constructed Wetlands Treatment System. Additional wetland components and infrastructure will be designed and constructed as part of the Expanded Constructed Wetlands buildout. This work will be described further in a Water Treatment System Work Plan.

4.3 Solids Management

Continued management of the remaining solids in the St. Louis Ponds System, future water treatment-generated solids, IDF solids, Pond 13 solids, solids in the Solids Repository, and calcines encountered in the construction zone will be required. A Solids Management Plan detailing how existing and future water treatment generated solids are to be managed will be developed. Precipitation solids will be removed as necessary from the Expanded Constructed Wetlands footprint to complete construction of the Expanded Constructed Wetlands. Calcines will be removed where necessary to complete construction of the Expanded Constructed Wetlands and otherwise will not be excavated or managed. The Solids Management Plan will include specific details such as removal requirements, interim drying locations, placement locations, placement thicknesses, placement grades, and cover material specifications.

5 REMOVAL ACTION WORK TO BE PERFORMED

The removal action work to be performed is listed sequentially below. Removal action work to be performed primarily includes a) continued water quality, surface water flow, and groundwater level monitoring; b) the analysis, design, and construction of hydraulic control measures for the collapsed area of the SLT adit; c) the analysis, design, and construction of a full-scale water treatment system, to remove hazardous substances from the SLT discharge; d) solids management; and e) the operation and monitoring of the Water Treatment System, adit hydraulic controls, and associated infrastructure. The following removal action tasks will be performed.

5.1 Pre-Construction Water Quality, Surface Water Flow, and Groundwater Level Monitoring

Flow data and water quality samples will continue to be collected from the SLT discharge and outfall flumes, select locations within the Ponds System, and select locations in the Dolores River. Water level and water quality samples will continue to be collected from on-site groundwater monitoring wells. This monitoring will be conducted in accordance with the May 15, 2014 *Sampling and Analysis Plan for Surface Water and Groundwater* (Atlantic Richfield Company, 2014a) (as amended by Atlantic Richfield's January 22, 2018 letter reducing the sampling frequency from three times to twice annually) and the May 15, 2014 *Quality Assurance Project Plan for Surface Water and Groundwater* (Atlantic Richfield Company, 2014c). Monitoring will be performed during the peak flow (May/June) and moderate to low flow (October/November) timeframes. Water quality and flow monitoring will be conducted under the above plans until the Monitoring and Field Sampling Plan for Removal Action Construction (described further in Section 5.3.1.3) has been submitted and approved by EPA.

5.2 Adit Hydraulic Controls Work Plan

5.2.1 Relief Well - RW-3A

A draft design package for the installation of an additional relief well (RW-3A) will be prepared and submitted to EPA. This draft design will provide increased relief well capacity to allow for additional tunnel head control during freshet conditions to minimize the potential for an uncontrolled release of adit discharge from the SLT. The additional relief well is anticipated to include a horizontal relief well including surface completion, valves and piping, and a concrete protective well house. RW-3A is planned to be installed sufficiently in-by of the existing relief wells so that alternatives for additional adit hydraulic controls can be further evaluated and eventually constructed if deemed necessary. The draft relief well design package will include the following:

- Design criteria;
- Conceptual construction drawings;
- Sizing calculations; and
- Proposed construction schedule.

Following EPA review and approval of the draft design, a final relief well design package will be prepared. The final relief well design package will include the following:

- Construction drawings;
- Technical specifications;
- Sizing calculations;
- Project plans including a Technical Execution Plan detailing the proposed drilling implementation; and
- Construction schedule.

Following EPA review and approval of the final design, the work specified by the final design will be implemented in accordance with the schedule provided.

Following installation of RW-3A, additional monitoring and data collection is anticipated to monitor and adjust head levels within the SLT.

5.2.2 Construction Completion Report

Following completion of the relief well construction, a Construction Completion Report will be prepared to document the work performed. The Construction Completion Report will include the following:

- As-built drawings signed and stamped by a professional engineer;
- Technical variances;
- Quality control documents;
- Material submittals;
- Field reports; and
- Construction photograph logs.

5.3 Water Treatment System Work Plan

5.3.1 Expanded Constructed Wetlands

A draft water treatment design package will be prepared and submitted to EPA. This design will include means for improved solids management, redundancy to allow for maintenance, and improved capacity to allow treatment during freshet conditions. The expanded system is anticipated to include additional settling basins, an additional biotreatment cell, an additional aeration cascade, and a rock drain. Construction will require excavation of residual sediments, installation of liners, and reconstruction of site berms, as needed. Additional construction items such as treatment flow routing infrastructure, installation of media, and safety structures will be included. The draft water treatment design package will include the following:

- Design criteria;
- Revised draft performance criteria (as identified in Appendix B);
- Conceptual drawings;
- Sizing calculations; and
- Proposed construction schedule.

Following EPA review and approval of the draft design, a final water treatment design will be prepared. The final water treatment system design will include the following:

- Construction drawings;
- Technical specifications;
- Project plans as described in Sections 5.3.1.1through 5.3.1.3;
- Final performance criteria; and
- Construction schedule.

The project plans that will be included in the final water treatment design package submittal are further described in the Sections below.

Following EPA review and approval of the final design, the work specified by the final design (Removal Action Construction) will be implemented in accordance with the schedule provided.

5.3.1.1 Stormwater and Erosion Control Plan

The SWMP is updated annually and continues to be used to meet the substantive requirements of the CDPHE General Construction Stormwater Permit and for stormwater control on-site during and after removal action construction. The primary objective of the SWMP is to identify control measures that, when implemented, will meet the terms and conditions of the permit, by minimizing or reducing stormwater pollution of waters of the State of Colorado.

Non-affected waters coming from the north of the Site are intercepted and directed towards the Dolores River via site grading and stormwater controls. Non-affected stormwater that enters the Site from the east is routed to the Ponds System via stormwater controls. Affected stormwater from on-site, including from the IDF, is routed to Pond 12 for settling in the Ponds System via stormwater controls. The demonstration-scale constructed wetlands treatment systems have stormwater controls incorporated in their design/construction to prevent stormwater from entering the treatment components. All stormwater collected throughout the demonstration-scale constructed wetlands treatment systems is routed to Pond 12 for settling.

Atlantic Richfield's contractors will administer and manage the Site SWMP for continued monitoring of past and present construction activities in accordance with the requirements of Colorado Discharge Permitting System (CDPS). The SWMP addresses the limits of disturbance for the Site. The SWMP has been prepared in accordance with good engineering, hydrologic, and pollution control practices. It is intended to be a dynamic document that will continue to be updated as needed to address planned development, new disturbances, and other changes needed to manage stormwater and protect surface water quality.

Control measures will be implemented during construction and maintenance activities to mitigate acceleration of erosion and sedimentation, and to control, minimize, and prevent the release of impacted soils entrained in stormwater discharges. The selection of erosion and sediment control measures are contingent upon site specific conditions (e.g., construction, vegetation, precipitation, and evaporation). Control measures will be installed according to the Colorado Department of Transportation *Erosion Control and Stormwater Quality Field Guide* (CDOT, 2011).

Once the removal action construction activities have been completed for the Site, the SWMP will be used for long-term stormwater management. These activities will include maintaining the erosion-control measures installed as described in the SWMP. Also, a uniform vegetative cover will be established with an individual plant density of at least 70 percent of pre-disturbance levels, or equivalent permanent, physical erosion reduction methods will be employed once site activities have been completed and are ready for stabilization.

Spill prevention and response is also discussed in the SWMP. Through proper training and observant on-site personnel, spills can be prevented. Refueling equipment poses the risk of spilling fuel on-site and efforts will be made to perform this task away from any drainages or waterways. In the event a spill does occur, appropriate measures will be performed to minimize and eliminate the spill and/or damages and notification to the proper people will be executed as described in the SWMP. Contractors planning to refuel on-site will also be required to prepare a Spill Prevention, Control and Countermeasures Plan (SPCC) for their specific operations.

5.3.1.2 Construction Quality Assurance/Quality Control Plan

A Construction Quality Assurance Plan (CQAP) Plan or a Quality Control Plan (QCP) will be prepared as part of the final water treatment design. Specific tasks require quality assurance and quality control (QA/QC) to help ensure construction meets the specifications and the intent of the design. Anticipated tasks and means of QA/QC are listed below:

- Earthwork: surveying, grade checking, soil proctor and compaction, gradations, Atterberg Limits, and field density testing;
- Water Conveyance: surveying, grade checking, leak testing, materials verification, and grouting;
- Concrete Work: compressive strength and shear strength, slump, air content, and concrete placement;
- Liner Installation: materials, installation, welding seams and appurtenances, survey, grade checking, soil proctor, and compaction; and

- Soil Capping and Revegetation: cover materials and amendments, cover thickness, gradations, soil proctor and compaction, placement methods, seed mix, and seeding.

5.3.1.3 Monitoring and Field Sampling Plan

The Monitoring and Field Sampling Plan (FSP) will guide monitoring and sampling of surface water, groundwater, and water treatment systems during Removal Action Construction including the Water Treatment System shakedown period (see Section 5.3.2 for information on the shakedown period). The FSP will be prepared as part of the final water treatment design. The *Quality Assurance Project Plan (QAPP) for Surface Water and Groundwater*, *Rico-Argentine Mine Site – Rico Tunnels Operable Unit OU01*, *Rico*, *Colorado* dated May 15, 2014 (Atlantic Richfield Company, 2014c) will be updated and resubmitted as part of the FSP. A select number of surface water locations and groundwater wells will be monitored and sampled during Removal Action construction. It is anticipated that a number of groundwater wells will be abandoned and/or destroyed during Removal Action construction.

All sampling events will include collection of field parameters (e.g., pH, temperature, specific conductance, oxidation-reduction potential, dissolved oxygen) as well as analytical samples. The FSP will identify the monitoring parameters and frequencies.

The following parameters, at a minimum, will continue to be monitored during Removal Action Construction:

- Total SLT flow;
- Relief well flow(s), if applicable (and debris plug flow, if any);
- Water elevations/head pressures, if applicable;
- SLT water parameters (pH, turbidity, specific conductance, temperature, etc.);
- Effluent water parameters (pH, turbidity);
- Treatment flow rates at selected system points;
- Flocculant/chemical injection rates and concentrations;
- Aerator performance, if applicable;
- H_2S concentrations at selected locations;
- Site weather; and
- Web-based live cameras on specific site features.

The analyte lists for surface water, groundwater, and water treatment system water quality samples will be included in the FSP. The analyte lists may include alkalinity, anions, total cyanide, hardness, total metals, dissolved metals, potentially dissolved (POTD) metals, nutrients, total dissolved solids, total sulfide, total suspended solids, and total organic carbon. Field analyses may include sulfide and ferrous iron at select locations.

Sondes (measuring pH, specific conductance, temperature, oxidation reduction potential, dissolved oxygen, turbidity, and water level (select locations)) may be utilized to continuously monitor water quality throughout the Site and treatment system. Data will be uploaded to a remote server.

5.3.2 Water Treatment Shakedown

Following the completion of the Expanded Constructed Wetlands construction activities, a water treatment shakedown period will begin. The shakedown period will last for at least two years and include at least one freshet to review whether the Expanded Constructed Wetlands is functioning and performing as designed or if modifications to the system will need to be performed and noted in as-builts and appropriate project plans. Evaluation of system performance against performance criteria specified in the Expanded Constructed Wetlands Final Design will occur during system operation. Sampling is anticipated to continue to be performed at selective surface water sampling locations and groundwater sampling locations to monitor concentrations of contaminants of concern via water movement as necessary for performance criteria refinement and update. Sampling locations and monitoring requirements will be developed as part of the FSP (Section 5.3.1.3). Removal Action Construction shall be considered complete after the shakedown period when it is determined that the Expanded Constructed Wetlands and adit hydraulic controls are achieving design criteria and EPA provides written certification in accordance with the AOC.

5.3.3 Construction Completion Report

Following the water treatment shakedown period, a Construction Completion Report will be prepared to document the work performed. The Construction Completion Report will include the following:

- As-built drawings signed and stamped by a professional engineer;
- Technical variances;
- Quality control documents;
- Material submittals;
- Field reports; and
- Construction photograph logs.

5.3.4 Operations Plan

The Operations Plan will guide operations, inspections, monitoring, and maintenance of the Water Treatment System for a period of no less than ten (10) years following completion of Removal Action Construction (including shakedown) . The Operations Plan will be developed to ensure personnel understand how and why systems are operated, and to maintain system integrity, function, safety, and compliance. Inspections of the designed facility will be completed as required to maintain safe, reliable operations. The Operations Plan will include safe operating limits, corrective actions, troubleshooting, and relevant equipment manuals for each section of the treatment train and adit hydraulic controls. In addition to describing normal operating procedures for the Water Treatment System, the Operations Plan will include a description of procedures to be used for managing SLT discharge during bypass, upset, and planned maintenance events.

Operational protocols aside, there are a number of unknowns associated with operating a constructed wetland of this configuration and magnitude that can affect performance of the biological system and would benefit from continued deliberate extended evaluation. Such unknowns run the spectrum from media life and regeneration capacity, to biological evolution and response to changing system conditions, to optimization of hydraulic controls and degassing/oxidation technologies. Many of the evaluations take years to complete; media life being one aspect of the technology that may require seven or move years of monitoring, given that most wetland systems depend on media lasting between seven and ten years. The Operations Plan will identify certain evaluations of the Water Treatment System components that are critical to optimization of performance, protectiveness, operational efficiency, and safe reliable operations. Example evaluations include:

- Methods and techniques to regenerate media;
- Prediction of media life;
- Hydraulic controls optimization;
- Improved solids settling; and
- Improved mass removal of metals.

The Operations Plan will provide monitoring and sampling requirements to be implemented following Expanded Constructed Wetlands construction and certification including quality assurance requirements. The Operations Plan will update, as necessary, the performance criteria set forth in the Expanded Constructed Wetlands Final Design. Compliance water quality samples are anticipated to be collected at the frequency set in the Operations Plan once the Expanded Constructed Wetlands Treatment System has been commissioned and operations initiated. This sampling will be completed to confirm that the reductions of metals concentrations from the mine discharge to the final discharge to the Dolores River are meeting the Site performance criteria summarized in Appendix B and revised during the Expanded Constructed Wetlands design and Operations Plan development.

Additional wetlands unit operations focused sampling will be conducted throughout the Expanded Constructed Wetlands Treatment System at a frequency yet to be determined for diagnostic purposes. This sampling will be conducted to monitor water treatment system performance throughout the system. All sampling events will include collection of field parameters (e.g., pH, temperature, specific conductance, oxidation-reduction potential, dissolved oxygen) as well as analytical samples. The Operations Plan will identify the monitoring parameters and frequencies. The Operations Plan will be developed and submitted following completion and certification of Removal Action Construction.

5.4 Solids Management Plan

A Solids Management Plan will be developed and detail how existing and future water treatment generated solids will be managed. The Solids Management Plan will describe how remaining solids in the St. Louis Ponds System, future treatment generated solids, IDF solids, Pond 13 solids, solids in the Solids Repository, and calcines encountered in the construction zone will be managed. Solids and sludges resulting from operation of the existing treatment system and those generated through construction will be managed similarly. Pond solids will be removed as necessary from the Expanded Constructed Wetlands footprint to complete construction. Calcines will be removed as necessary or managed to complete construction of the Expanded Constructed Wetlands but otherwise left in place. The Solids Management Plan will include specific details such as removal requirements, interim drying locations, placement locations, placement thicknesses and grades, and cover material specifications. This plan will be implemented in conjunction with the CDPHE-approved *Rico-Argentine Solids Repository Engineering Design and Operations Plan*, dated October 3, 2014 (Atlantic Richfield Company, 2014d).

5.5 Health and Safety Plan

The Health and Safety Plan (HASP) prepared under the UAO has been resubmitted and will be used for future removal action activities. All removal action tasks will be performed in accordance with the HASP. A resubmission of the HASP is not required.

5.6 Historic Preservation Plan

Archeological assessments have been completed at the Site in connection with the Small Tract Act land acquisitions. A cultural resource inventory completed in 2018 identified a segment of the Enterprise branch of the Rio Grande Southern Railroad Grade. This segment is located to the east of the main site access road. Additional inventory of this segment was completed in 2019 at the request of the USFS. There are no other historical places on the Rico-Argentine Site that were designated for preservation. Given these evaluations, historic preservation and mitigation plans are not anticipated to be required unless the identified segment of the Enterprise branch of the Rio Grande Southern Railroad Grade is affected by the proposed design.

5.7 Post-Removal Site Control Plan

90 days prior to the expiration of the operations and monitoring period defined in the Operations Plan, a Post-Removal Site Control Plan will be submitted to EPA for approval. The Post-Removal Site Control Plan will detail continuing operations and monitoring for the Water Treatment System, adit hydraulic controls, and Solids Repository in accordance with the Operations Plan and Solids Management Plan and in a manner that maintains effectiveness and integrity of the systems.

6 REMOVAL ACTION SCHEDULE

The Draft Removal Action Schedule is presented in Figure 4. This schedule is based on existing information and may change depending on acquisition of new data, unanticipated design/construction issues, and/or regulatory requirements that have not been considered.

7 REFERENCES

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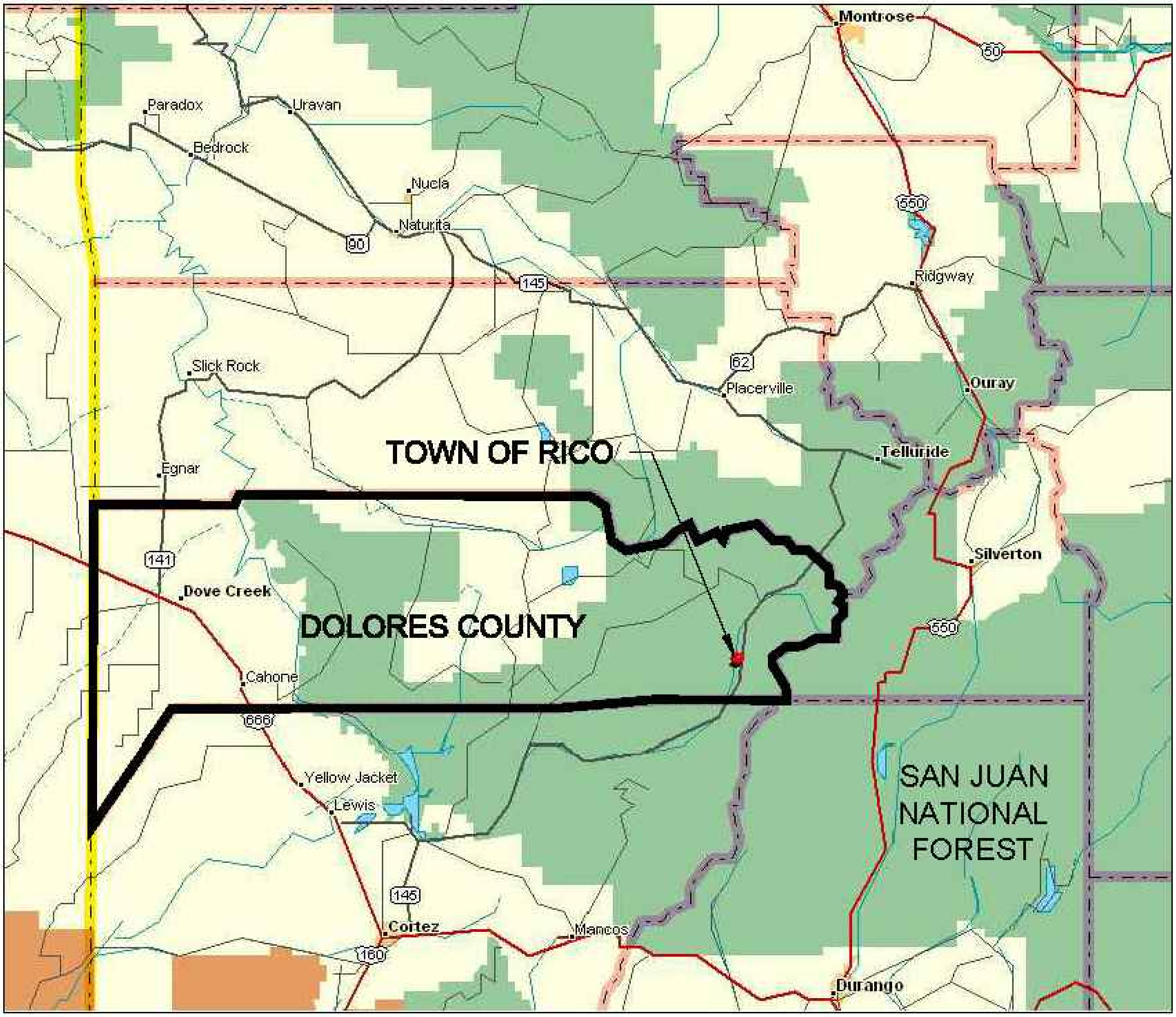
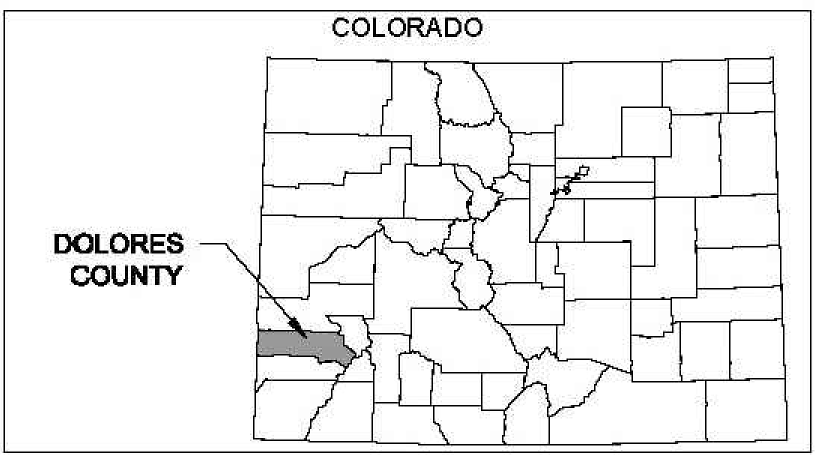
Figures





Copper Environmental Consulting A PRISM SPECTRUM COMPANY	4/17/2020		**Figure 1**
	Atlantic Richfield Company	**Rico - Argentine Mine Site** **Dolores County, Colorado**	**Site Location**
	Project: 70817.20		

Apr 21, 2020 - 12:08pm Patricia
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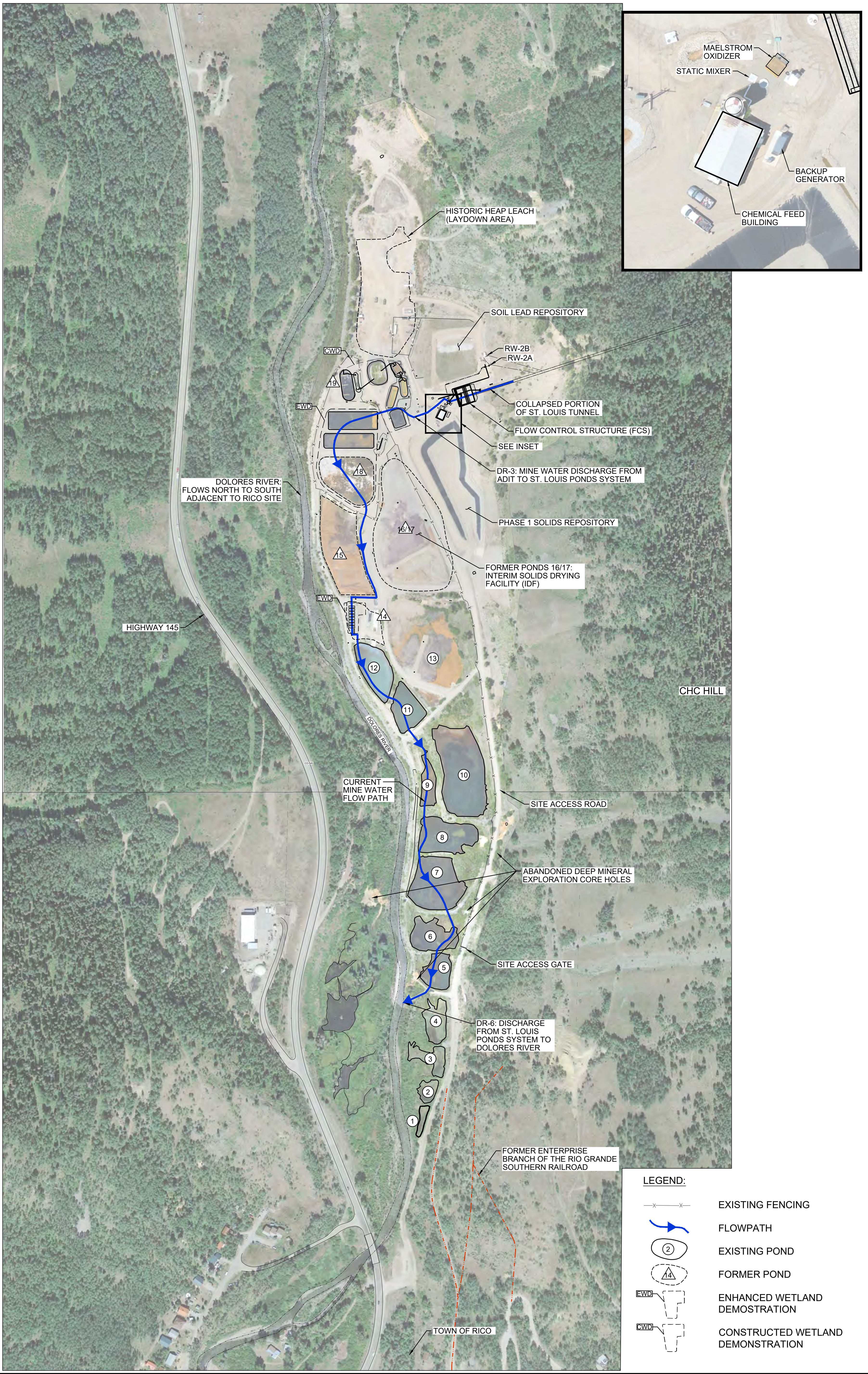

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4/17/2020

Atlantic Richfield Company

Project: 70817.20

N W E S

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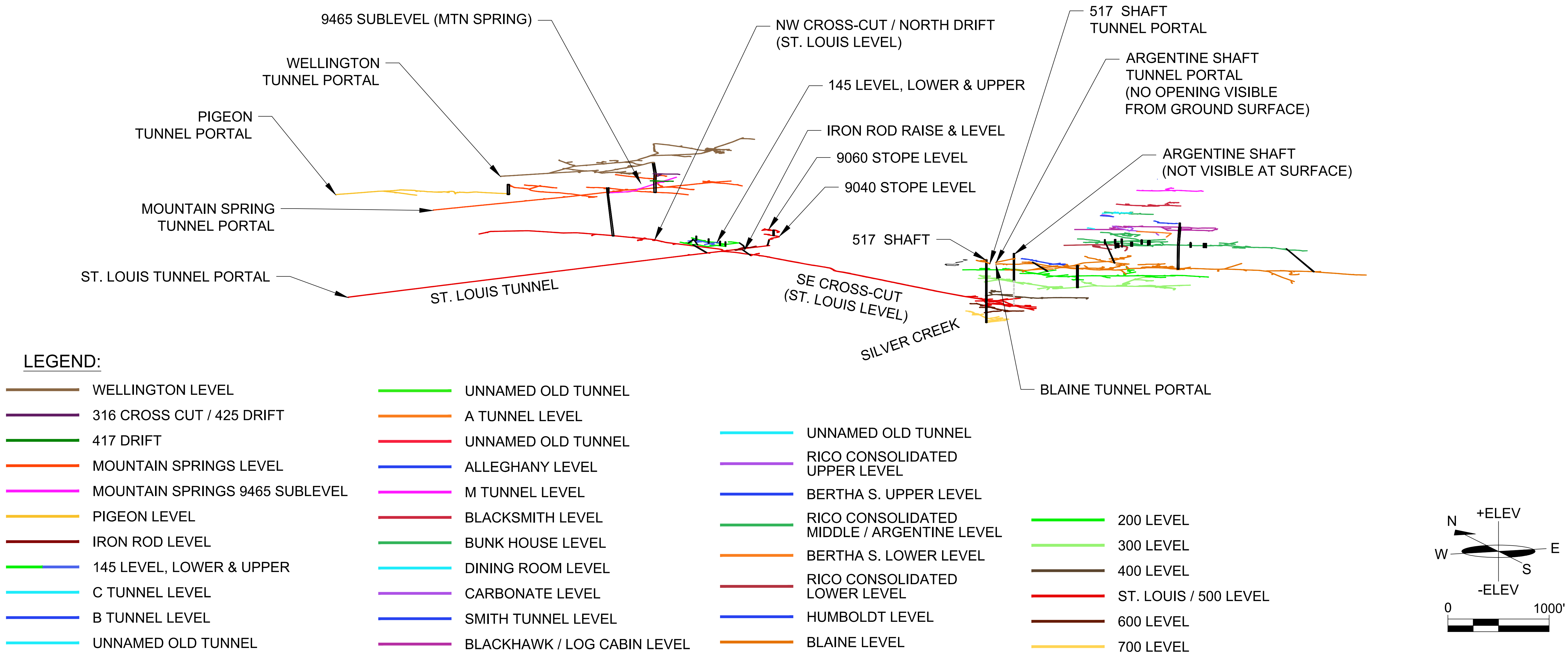
Rico - Argentine Mine Site
Dolores County, Colorado

Figure 2

Site Features

NOTES:
1. ALL MINE WORKINGS TRACED FROM "comp_Plan.tif", MAP #77 OF AECOM IMAGE INVENTORY, EXCEPT THE FOLLOWING:
   A. ARGENTINE SHAFT TUNNEL PER MAP #2, "scan02.tif", OF AECOM IMAGE INVENTORY. ("ARGENTINE MINE AND ST. LOUIS TUNNEL", DRAWN 5-21-55, P.L.J.)
   B. 517 SHAFT PER MAP #8, "scan08.tif", OF AECOM IMAGE INVENTORY. ("USGS/McKNIGHT PROFESSIONAL PAPER 723, PLATE 3")
   C. SILVER CREEK, BRIDGES & BUILDING FOOTPRINTS AT ARGENTINE TAILINGS PER ANDERSON ENGINEERING GROUND SURVEY, DATED AUGUST 2, 2011.
   D. ST. LOUIS SOUTHEAST CROSS CUT PER MAP #57, "00120110602202157.PDF", OF AECOM IMAGE INVENTORY. ("ST. LOUIS LEVEL, SHEET No. 2", DATED DEC. 1959 BY RT)
2. ALL LOCATIONS/DIMENSIONS APPROXIMATE ONLY.
3. ALL MINE LEVELS SHOWN AT SINGLE ELEVATION AND SEPARATED VERTICALLY PER USGS/McKNIGHT PROFESSIONAL PAPER 723 EXCEPT FOR LEVEL 700, WHICH IS SHOWN 100-FT BELOW 600 LEVEL.
4. NO EVIDENCE FOUND TO DATE ON HISTORIC MINE MAPS OF 517 SHAFT EXTENDING TO GROUND SURFACE.
5. ONLY SUGGESTIONS THAT ARGENTINE SHAFT EXTENDS BELOW 300 LEVEL ARE ON USGS/McKNIGHT PROFESSIONAL PAPER 723, PLATE 3, NOTATION ON MAP F (400 LEVEL) & MAP G (500 LEVEL): "ARGENTINE SHAFT (PROJECTED)". NOT SHOWN AT ALL ON MAP H (600 LEVEL); AND ON "ST. LOUIS LEVEL, SHEET No. 2", DATED DEC. 1959 BY RT.
6. FULL EXTENTS OF SOME LEVELS NOT SHOWN, AND INTERCONNECTIONS OF UPPER WORKINGS UNKNOWN AT THIS TIME.



Copper Environmental Consulting
A PRISM SPECTRUM COMPANY

Date: SEPTEMBER 2014

Atlantic Richfield Company

Rico - Argentine Mine Site
Dolores County, Colorado

Figure 3

Mine Workings Overview

Figure 4: *Removal Action Schedule*

Schedule	Submittal Due or Work to be Completed (or Started as Noted)
<u>Water Treatment System</u>	
Adit Hydraulic Controls	
Relief Well RW-3A Draft Design	2021
Relief Well RW-3A Final Design	2021
Relief Well RW-3A Construction	2021/2022
Construction Completion Report	90 Days after Adit Hydraulic Controls Construction Completion
Water Treatment	
Water Treatment Draft Design	180 Days after AOC Effective Date
Water Treatment Final Design (includes CQAP, SWMP, and Monitoring and Field Sampling Plan)	180 Days after Draft Design Approval
Water Treatment Construction – Start	Next Field Season following Final Design Approval
Water Treatment Construction (including Water Treatment System Shakedown Period) – Completion	Next 4 Field Seasons following Final Design Approval (Shakedown Period of at least two years and including at least one freshet)
Construction Completion Report	90 Days after Water Treatment Construction – Completion
Solids Management	
Develop Solids Management Plan	90 Days after AOC Effective Date
Final Solids Removals from Water Treatment Footprint	Next 2 Field Seasons following AOC Effective Date
Operations Plan	90 Days after Water Treatment Construction – Completion
Post-Removal Site Control Plan	90 Days prior to the Completion of the Operations and Monitoring Period

Rico-Argentine Site
Removal Action Work Plan
Appendix A: Performance Evaluation and Technology Selection Report

September 2021

Administrative Settlement Agreement and Order on Consent

TABLE OF CONTENTS

LIST OF FIGURES

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LIST OF ATTACHMENTS

ACRONYMS AND ABBREVIATIONS

AECOM	AECOM Technical Services, Inc.
ARAR	Applicable or Relevant and Appropriate Requirement
Atlantic Richfield	Atlantic Richfield Company
CDPHE WQCD	Colorado Department of Public Health and Environment Water Quality Control Division
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CWD	Constructed Wetland Demonstration
EPA	United States Environmental Protection Agency

EWD	Enhanced Wetlands Demonstration
gal	gallons
gpm	gallons per minute
H_2S	hydrogen sulfide
HDS	high density sludge
HWTT	Horizontal Wetland Treatment Train
M	million
N/A	not applicable
NPDES	National Pollutant Discharge Elimination System
NPV	net present value
OM&M	operations, maintenance, and monitoring
ORP	oxidation reduction potential
Ponds System	St. Louis Ponds System
RAWP	Removal Action Work Plan
s.u.	standard units
Site	Rico-Argentine Site
SIMOPs	simultaneous operations
SLT	St. Louis Tunnel
UAO	Unilateral Administrative Order for Removal Action
USFS	Unites States Forest Service
VWTT	Vertical Wetland Treatment Train
Water Treatment System	preferred full-scale water treatment alternative for the for the St. Louis Tunnel adit discharge

EXECUTIVE SUMMARY

This Performance Evaluation and Technology Selection Report describes the removal action alternatives considered and the evaluation process used in identifying the preferred full-scale water treatment alternative for the for the St. Louis Tunnel (SLT) adit discharge (the Water Treatment System) at the Rico-Argentine Site (Site). Treatment system alternatives selected for evaluation were: 1) No Additional Action, 2) Expanded Constructed Wetlands, and 3) Lime Treatment with High Density Sludge (HDS). This document outlines the alternatives considered, the selection criteria used for decision making, and the rationale behind selection of the most applicable and effective removal action treatment alternative.

Based on its projected effectiveness, implementability, environmental impacts, and relative costs, the full-scale build-out of the Expanded Constructed Wetlands is the preferred water treatment alternative. The selected water treatment system will be an expansion of the existing demonstration-scale constructed wetlands treatment systems. It will provide improved solids management, increased hydraulic capacity, reduced maintenance, and redundancy to allow for continuous and effective water treatment.

1 INTRODUCTION

This *Performance Evaluation and Technology Selection Report* describes the removal action alternatives considered and the evaluation process used in identifying the preferred full-scale water treatment alternative for the for the St. Louis Tunnel (SLT) adit discharge (the Water Treatment System) at the Rico-Argentine Site (Site). The removal action treatment alternative selected in this report will be designed and constructed as part of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) removal action approved by the United States Environmental Protection Agency (EPA) for the Site, as documented in the December 21, 2010 Action Memorandum for the Site.

The SLT adit discharge is comprised of groundwater impounded within the underground workings of the Rico-Argentine Mine system and water infiltrating and flowing through the interconnected mine workings within Telescope Mountain and Dolores Mountain at the Site. The water contacts sulfidic mineralized rock and picks up metals and acidity prior to discharging from the SLT adit. Historically, the adit surface water discharge had been channelized through a series of settling ponds prior to discharge to the Dolores River. Some of those ponds are still involved in the current treatment process and are referred to as the St. Louis Ponds System (Ponds System). The Site location, layout, major features, and an overview of mine workings are shown on Figures 1 through 4, respectively.

Earlier response actions, investigations performed pursuant to the 2011 *Unilateral Administrative Order* (UAO) *for Removal Action* (Docket No. CERCLA-08-2011-0005) (EPA, 2011), and experience gained from designing, constructing, and operating the demonstration-scale wetland treatment systems provided supporting information for the comparative analysis summarized in this Report.

Although the Action Memorandum documented approval of a “time-critical removal action” for the SLT discharge, the alternatives evaluation process described in this Report used procedures and evaluation criteria generally consistent with those described in EPA’s *Guidance on Conducting Non-Time-Critical Removal Actions Under CERCLA* (EPA, 1993). This is because removal action activities completed to date under the 2011 UAO, including ponds solids management as well as construction and operation of demonstration scale wetland treatment system components, have addressed many of the site conditions underlying EPA’s initial determination that the removal action should be classified as time-critical. As the removal action transitions to the design and build-out of a full-scale water treatment system, the approach set forth in the 1993 EPA Guidance lends itself well to the identification and analysis of treatment system alternatives.

Detailed information about Site history, location, access, land use and ownership, climate, topography, geology, and Site features (including the SLT, demonstration wetland systems, Ponds System, stormwater controls, and repositories) is provided in the [February] 2021 *Rico-Argentine Mine Site Removal Action Work Plan* (2021 RAWP). Site characterization information, including measured SLT discharge flow rates, appears in Section 2 of the 2021 RAWP. This *Performance Evaluation and Technology Selection Report* is Appendix A to the 2021 RAWP. Performance criteria for the SLT water treatment system are provided in Appendix B to the 2021 RAWP. Previous investigations and removal action activities performed under the UAO are described in Appendix C to the 2021 RAWP.

2 WATER TREATMENT REMOVAL ACTION OBJECTIVES AND BASIS OF DESIGN

2.1 Water Treatment Objectives

As stated in the 2021 RAWP, the objectives of the water treatment removal action are to:

1. Reduce key contaminants loading to the Dolores River to improve water quality;
2. Reduce metals concentrations to achieve agreed-upon performance criteria;
3. Treat base flows and freshet flows up to the 25-year recurrence period (design permitting);
4. Provide safe, reliable, year-round / all-weather operations; and,
5. Minimize waste production and energy usage.

2.2 Basis of Design for Water Treatment System

The *Water Treatment System Basis of Design* will include the following elements: operational conditions, influent flow rate, influent chemical compositions, and proposed performance criteria.

Operational conditions for the water treatment system include: a 30-year design life; 24 hours/day, 7 days/week, 365 days/year operation; maximum utilization of passive operations; use of proven processes for operations; utilization of existing infrastructure wherever possible, including on-site waste management infrastructure; and minimizing the environmental footprint.

Maximum influent flow-rate conditions are based on hydrologic modelling of the peak SLT adit discharge flows. The model's framework is referred to as the "tank model." This model analogizes watershed basins to calculations based on tanks of water. These tanks of water simulate how a watershed might react. The main hydrologic input is precipitation. The ultimate output is the final base SLT discharge flow. The hydrologic output from these theoretical tanks is intended to replicate and forecast historic hydrographs and flow data for the basin of interest.

Based on the model, the predicted 10-year recurrence interval flow (Log Pearson Type III) for the SLT discharge is 1,150 gallons per minute (gpm). The predicted 25-year recurrence interval flow (Log Pearson Type III) is 1,250 gpm. The maximum observed flow rate since continuous flow monitoring was installed in 2011 at DR-3 is 1,250 gpm. The water treatment system will be sized for a peak influent flow rate of 1,150 to 1,250 gpm. The minimum influent flow rate is 400 gpm based on historical data collected at DR-3. Figures 5 and 6 provide the model output and the DR-3 hydrograph, respectively.

Influent composition based on DR-3 analytical data is shown in Table 1.

3 ANALYSIS OF REMOVAL ACTION ALTERNATIVES

The analysis of technology alternatives includes review of site characterization data, development of alternatives, and evaluation of alternatives for effectiveness, implementability, environment, and cost.

3.1 Preliminary Alternate Treatment Technology Screening

Technology alternatives previously considered and screened during preliminary evaluations were described in the *Preliminary Water Treatment Technology Screening Report* (Atlantic Richfield Company, 2011). Technologies were divided into three categories: biological treatment (microbial mats, sulfide reducing bioreactors, and constructed wetlands), chemical treatment (anoxic limestone drains, electrocoagulation, ion exchange, lime treatment with lagoon settling, conventional lime treatment, and sulfide precipitation), and physical treatment (electrodialysis, evaporation ponds, and reverse osmosis). The following alternatives were not retained for consideration:

- Microbial mats;
- Sulfate reducing bioreactors;
- Anoxic limestone drains;
- Electrocoagulation;
- Conventional lime treatment;
- Chemical sulfide precipitation;
- Electrodialysis;
- An evaporation ponds system; and
- Reverse osmosis.

Technologies that were retained for further consideration and on-site testing were: ion exchange, lime treatment with lagoon settling, lime treatment with high density sludge (HDS), and constructed wetlands. Bench scale testing of ion exchange treatment using multiple resins was completed at the Site in 2013. A lime treatment with lagoon settling system operated at the Site from 1984-1996. A pilot scale constructed wetlands system was trialed at the Site in 2012-2013. A separate investigation in 2012 evaluated the effectiveness of in-situ chemical treatment as an alternative to SLT water treatment. Performance results for these various technologies and systems are summarized in the following sections.

3.1.1 Ion Exchange

Ion exchange utilizes highly engineered resins to remove similarly sized and charged dissolved contaminants from water. The resin can be regenerated when resin capacity is spent. Resin regeneration produces waste with highly concentrated dissolved metals, which require proper handling and transport to an appropriate facility for disposal. Some metal contaminants may be difficult to remove with this method, and competing ions can make the process inefficient, possibly requiring an additional polishing step to meet treatability goals.

Bench scale testing was completed in 2013 for several resins and tested water collected from the Blaine, 517 Shaft, AT-2, and the SLT discharge (collected at DR-3). Results for the SLT discharge found that several resins had effective removal of cadmium and zinc but were generally not effective for arsenic or copper removal. Some resins were effective for manganese removal while others were not. Additional information on testing results and the resins that were trialed are discussed in the *Ion Exchange Test Results Technical Memorandum* (AECOM, 2013).

Based on the results of the 2013 bench-scale testing, ion exchange was eliminated from further consideration as a removal action treatment alternative.

3.1.2 Lime Treatment with Lagoon Settling and with HDS

Lime treatment with lagoon settling applies lime to the water causing the pH to increase and resulting in precipitation of heavy metals. Lime treatment with HDS uses a similar approach for pH neutralization but replaces lagoon settling with a flocculation and clarification step that generates a more manageable high-density sludge.

A lime treatment with lagoon settling system was operated at the Site during the 1980s and 1990s under a National Pollutant Discharge Elimination System (NPDES) permit. The system dosed the SLT adit discharge with slaked lime and a flocculant. Lime solids precipitated out and accumulated in the Ponds System. Table 2 summarizes the effluent parameters monitored during the operation of this system. Only a limited pool of parameters were recorded.

A preliminary assessment of the effluent monitoring results revealed inconsistent performance of the SLT lime treatment with lagoon settling system, particularly for cadmium, copper, and lead (Table 2). Atlantic Richfield currently operates HDS systems at several other acid-mine drainage sites. Those systems are generally performing well, although operating conditions at the other sites are not directly comparable to those at the Site.

Because lime treatment with HDS is a proven technology and offers several advantages over lime treatment with lagoon settling, including improved solids management efficiency; higher quality, denser solids; reduced footprint requirements; and improved operational control, it was retained for further consideration as a removal action treatment alternative.

3.1.3 Constructed Wetlands

A pilot-scale constructed wetland system was installed and trialed at the Site from December 2012 to September 2013. Pilot testing results are presented in the *St. Louis Tunnel Discharge Constructed Wetland Pilot Scale Test Completion Report* (Atlantic Richfield Company, 2013). The pilot test system utilized a limestone rock drain for manganese removal and an anerobic subsurface flow wetland for cadmium and zinc removal. It was tested at flow rates between 1.5-6 gpm. The aerobic rock drain effectively reduced dissolved manganese concentrations by greater than 99%. As much as 85% of dissolved cadmium and 65% of dissolved zinc were removed through the rock drain, and as much as 95% of dissolved cadmium and more than 99% of dissolved zinc entering from the rock drain was removed by the wetland cell. Successful removal of the target metals during the pilot test led to the design and implementation of the Constructed Wetland Demonstration (CWD) and Enhanced Wetland Demonstration (EWD) systems.

Decreased hydraulic conductivity in the wetland cell was observed at higher flows and was likely caused by accumulation of particulate iron, suspended and precipitated solids, and mobilization of fine sediment during flow increases. Gravitational settling of influent particulate iron was also observed in the rock drain, leading to the recommendation for adding settling ponds prior to treatment cells for the future demonstration systems.

Based on the pilot testing results and the positive performance of subsequently constructed demonstration-scale wetlands, expanded constructed wetlands technology was retained for further consideration as a removal action treatment alternative.

3.1.4 In-Situ Chemical Treatment

A treatability study to assess the effectiveness of in-situ chemical treatment was conducted in 2012 and 2013. The study involved injecting alkaline solutions into the 517 Shaft to precipitate metals in the source water before it reaches the SLT. While some metals reduction was observed at the SLT discharge, results indicated that much of the chemical treatment was not reaching the SLT due to poor mixing within the 517 Shaft. In-situ treatment at the 517 Shaft also was generally ineffective in reducing metals concentrations reaching the SLT from other portions of the underground workings, including those entering the SLT from the NW crosscut. In-situ treatment also required ongoing injection and monitoring, presenting a potential safety risk in winter due to access restrictions and avalanche hazards. Additionally, there were concerns over the accumulation of metals precipitates in the underground workings over time and the potential for an uncontrolled release of those solids during a high-flow event.

Based on the results from the treatability study, in-situ chemical treatment was not retained for further consideration as a removal action treatment alternative (Atlantic Richfield Company, 2014).

3.2 Retained Alternative Treatment Technologies for Comparative Evaluation

Based on the technology screening described above, three alternatives were retained for further evaluation: No Additional Action, Lime Treatment – High Density Sludge, and Expanded Constructed Wetlands.

3.2.1 No Additional Action

The No Additional Action alternative assumes that no additional improvements would be made at the Site and that the current demonstration-scale systems would continue to be operated "as-is" and maintained with the current operations, maintenance, and monitoring (OM&M). The existing demonstration-scale wetland systems and ponds would be utilized to treat the SLT adit discharge. Required sampling and OM&M tasks would be performed as necessary, including solids management. Aluminum chlorohydrate (or another coagulant/flocculant) would continue to be applied at the static mixer to aid in settling. Once the coagulant has been added, the water management would remain consistent with the current water treatment process. Flow rates that exceed the capacity of the wetland systems (610 gpm total) would be routed around the wetlands systems to Pond 12 for retention settling before discharge to the Dolores River. The process flow diagram for the No Additional Action alternative is presented in Figure 7.

The No Additional Action alternative would require minimal year-round staffing for monitoring and maintenance activities. Coagulant delivery would not be required during the winter months, eliminating the need for winter road maintenance and site access across avalanche routes. Solids generation would require regular maintenance. Any significant maintenance activities, such as media replacement (currently estimated at a 10-year life) or dredging solids (1-2 times per year), would require routing flow around the treatment systems for extended periods of time due to lack of redundancy in the design. This alternative would require minimal additional infrastructure construction.

3.2.2 Lime Treatment – High Density Sludge

Lime treatment with HDS would require construction of a new treatment plant and sludge dewatering facility. The SLT adit discharge would be dosed with lime and mixed in a reactor with recycled sludge from the clarifier. Then a polymer flocculant would be applied to the lime treated water and solids would be settled and collected in the clarifier. A multistage system may be required. This water would be discharged from the clarifier to the Ponds System or directly to the Dolores River. Solids would be recycled or wasted to containers for dewatering, neutralization, and disposal in the Solids Repository. Depending on design and performance criteria, it may be necessary to add a polishing step to the HDS effluent. Due to the limited size of the Solids Repository and the large quantities of treatment solids that would be generated, it is likely that stacking of treatment solids or construction of additional repository capacity would be needed (*see* 2021 RAWP, Section 1.1.4.4). Additional site infrastructure would be required, including a large, heated building, electrical utility upgrades, and significant road improvements to allow for year-round access and winter deliveries of consumables. The process flow diagram for Lime Treatment – High Density Sludge alternative is presented in Figure 7.

To handle system upsets and routine maintenance, an influent equalization/storage pond would need to be constructed. This pond would be sized to hold a minimum of 3.5 days (6.3 million gallons) of influent at the maximum flow rate described in Section 3.2. Operations would likely require a year-round presence on-site with clarifier clean-out and other major maintenance items occurring in the later part of the field season when SLT discharge has decreased from freshet levels and the Site remains easily accessible.

3.2.3 Expanded Constructed Wetlands Treatment System

A full-scale constructed wetlands treatment system would require expansion of the EWD system, providing increased hydraulic capacity, redundancy, and improved solids management. Additional system components would be added for redundancy to allow for continuous water treatment during higher spring flows, while performing needed maintenance and solids management. These would include settling basins, a biotreatment cell, rock drains, aeration cascades, and an expanded operations building with aeration and coagulation addition.

This alternative would incorporate the best performing components from the existing demonstration-scale constructed wetlands and add additional units to increase the hydraulic capacity and improve system performance. The system would be operated similarly to the current operations but at a larger scale. SLT flows that exceed the capacity of the expanded constructed wetland treatment system (in excess of 1,150-1,250 gpm) would still undergo aeration and coagulant addition, but they would be routed around the biotreatment steps to the Ponds System for retention settling prior to discharge to the Dolores River. With the expansion of system capacity, the duration, frequency, and amount of these re-routing episodes would be reduced. The process flow diagram for the Expanded Constructed Wetlands alternative is presented in Figure 8.

3.3 Comparative Evaluation of Alternatives

Treatment system alternatives were comparatively evaluated using the following primary criteria: effectiveness, implementability, environment, and costs. Effectiveness considers protectiveness of human health and the environment and the ability of the alternatives to achieve removal action objectives. Implementability considers the technical and administrative feasibility of each system and the availability of resources during and following implementation of the system. Environment considers waste production, energy usage, emissions, biodiversity, and footprint. Costs considers estimated capital and operations costs expressed as the net present value (NPV) expected for each alternative.

The results of the comparative analysis are summarized in Table 3 and Table 4 and discussed in the following sections.

3.3.1 Effectiveness

The effectiveness of an alternative is determined by assessing how successfully the alternative satisfies the removal action objectives and basis of design as outlined in Section 2. This evaluation includes discussion of protectiveness of human health and the environment by removal of contaminants. A ranking matrix comparing the effectiveness of alternatives meeting removal action objectives is presented in Table 5.

3.3.1.1 Ability to Achieve Contaminant Removal

Treatment and removal of metals from the SLT discharge are the main objectives for the treatment system. Treatment success for the alternatives is evaluated based on the ability to remove key contaminants. Treatment system effectiveness was evaluated based in part on an analysis of estimated metals mass removals and by comparing predicted effluent metals concentrations to the water quality based effluent limitations, antidegradation based average concentrations, and non-impact limits presented in the 2008 *Water Quality Assessment* (WQA) prepared by the Colorado Department of Public Health and Environment Water Quality Control Division (CDPHE WQCD, 2008).[1]

No Additional Action

Aside from the initial implementation stage, the three existing demonstration-scale systems under the No Additional Action alternative have been successful in reducing metal loading to the Dolores River and have generally been able to remove contaminants from the SLT water below the treatability goals. Spring runoff freshet episodes occur in most, but not all years, typically lasting from late spring through early summer. As explained further below, the resulting sharp increase in SLT discharge flow and contaminant loading may exceed the treatment capacity of the existing demonstration-scale systems, occasionally resulting in increased metals concentrations in the treatment system effluent. When flow exceeds the 610 gpm capacity of the three demonstration-scale systems, the excess water is routed directly to Pond 12 for retention settling. From Pond 12, the water flows through Ponds 11, 9, 8, 7, 6, and 5 before discharging to the Dolores River.

During low flow, non-freshet conditions, the EWD system is able to consistently meet treatability goals for aluminum, arsenic, cadmium, copper, iron, lead, manganese, nickel, and zinc. The increased flow and metals loading experienced during the freshet can exceed the removal capacity of the EWD system for aluminum, arsenic, manganese, and zinc. The EWD system has an average mass removal rate of greater than 98% for aluminum, cadmium, copper, iron, and lead. Average mass removal rates for other metals are: 93.3% for arsenic, 74.2% for

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[1] Effluent limitations from the 2008 WQA and mass removal targets were not identified as chemical-specific Applicable or Relevant and Appropriate Requirements (ARARs) in the 2010 Action Memorandum.

manganese, 80.0% for nickel, and 90.4% for zinc. These removal rates translate into the following average total mass removals for the EWD system: 3,190 lbs/year for aluminum, 3.8 lbs/year for arsenic, 52.6 lbs/year for cadmium, 684 lbs/year for copper, 27,493 lbs/year for iron, 46.1 lbs/year for lead, 3,977 lbs/year for manganese, 9.7 lbs/year for nickel, and 8,460 lbs/year for zinc. Table 6 presents the annual mass removal rates for metals through the EWD from 2016 to August 2020. Solids accumulation in the system components over time may reduce metals removal effectiveness, resulting in the eventual need for media replacement.

The CWD Horizontal Wetlands Treatment Train (HWTT) is reliably able to remove most contaminants below the treatability goals during both low and high flows with the exception of aluminum and arsenic. The limestone rock drain in the HWTT has demonstrated success for efficient manganese removal with total manganese removal efficiency of greater than 96% through the HWTT system since 2016, including during freshet events. The CWD Vertical Wetlands Treatment System (VWTT) successfully removes cadmium, copper, iron, lead and zinc below treatability goals for both low and high flow periods. Increased loading during freshet flows creates difficulties with meeting treatability goals for aluminum, arsenic, manganese, and occasionally zinc.

Consistently meeting treatability goals for all metals year-round for the No Additional Action alternative is difficult due to limited capacity and removal efficiencies during periods of high metals loading as shown in historical data. Removal efficiency plots and historical influent/effluent contaminant concentrations for the demonstration-scale systems are provided in Attachment A. Attachment A plots contain monthly flow-volume average influent, effluent, and efficiency data for the EWD since the first complete year of operation (2016) to present. Horizontal lines in Attachment A represent the effluent limits presented in the 2008 WQA (CDPHE WQCD, 2008).

The plots show a consistently high rate of removal for most metals of interest for most of the year. During years when a freshet occurs, an increase in flow and metal concentrations is observed. The sudden, large increase in metal concentrations in the SLT discharge – particularly manganese and zinc – can affect the removal of some metals by the constructed wetland system for a short duration, generally during the May-August timeframe. Due to the passive and biotic nature of the EWD, sudden concentration changes of the influent waters can stress the system and reduce the removal efficiency of the treatment cells in the EWD. This is expressed by a dip in removal efficiency and an increase in effluent concentrations in the plots in Attachment A. Most metals, however, stay below the appropriate treatability goals during the freshet and return to higher removal efficiencies post-freshet.

Lime Treatment – High Density Sludge

Based on past performance of the lime-treatment-with-lagoon-settling system at the Site during the 1980s and 1990s and experience with lime treatment systems at other acid mine drainage sites, it is expected that lime treatment with HDS would achieve the treatability goals for most contaminants with some notable exceptions. Aluminum, cadmium, and manganese are present in the SLT discharge at levels well above the treatability goals and would be difficult to remove with a single-stage HDS system. Similar metal removal issues observed during operation of the lime treatment with lagoon settling technology (Section 3.1.2, and Table 2) would likely also affect the performance of an HDS system. Manganese and cadmium require a higher pH (in the range of 10-11 standard units [s.u.]) than the standard HDS system pH setpoint (typically 9-9.5

s.u.) to precipitate from the solution. Operating at a high enough pH required to meet treatability goals for cadmium and manganese would necessitate a finishing step for pH adjustment of the effluent prior to discharge. Additional polishing may also be needed to achieve desired removal rates for aluminum (which has increasing solubility as pH rises above ~7.5 s.u.) and total dissolved solids. Bench testing using SLT discharge water would be needed to evaluate the performance of process equipment, such as the clarifier, and to determine what pH adjustment and additional polishing steps are required.

Seasonal variations in SLT flow rate due to the freshet would be managed by collecting SLT discharge in an equalization pond to allow for controlled influent flow to the system. The capacity of the equalization pond would be limited by the available footprint (potential capacity of approximately 6.3 Mgal, or approximately 3.5 days of retention at 1,200 gpm SLT discharge) and may not be sufficient to accommodate the full SLT discharge at all times. Additionally, seasonal changes in metals loading during freshet conditions would require adjustments to raw materials dosing and possibly residence time or mixing conditions.

It is possible that during freshet periods there would be a reduction of efficiency across the system from increased metals loading and suspended solids that could result in failure to meet treatability goals for some metals (such as aluminum, cadmium, and manganese). Prior lime treatment with lagoon settling on the Site resulted in some discharge concentrations above the treatability goals for cadmium, copper, lead, and mercury (manganese and aluminum were not analyzed). Although lime treatment with lagoon settling is a different treatment approach, the basis of the lime treatment technology is similar, and freshet conditions would likely result in similar difficulties removing these metals from the SLT discharge utilizing Lime Treatment with HDS alternative.

Expanded Constructed Wetlands

The Expanded Constructed Wetlands design would add additional components to the existing EWD system to address the limitations described above for the No Additional Action alternative. Hydraulic capacity and residence time limitations for contaminant removal efficiencies would be resolved with additional settling basins and an additional biotreatment cell and aeration cascade, allowing the system to better handle the higher flows and metals loadings experienced during the freshet. The Expanded Constructed Wetlands system would also include the addition of limestone rock drains for manganese removal due to the success of this component in the existing HWTT.

With these design improvements, the Expanded Constructed Wetlands would be expected to meet the treatability goals for the vast majority of the year and effectively reduce metals loading to the Dolores River. However, SLT discharge flows during unusually high-water years could still exceed the hydraulic and treatment capacities of the system. Additionally, system effectiveness would likely decline slightly over time due to solids accumulation within the components as the matrix approaches the end of its lifespan. These effects could be mitigated through proactive solids management and maintenance-oriented system design. Flow above the design capacity of the Expanded Constructed Wetlands (greater than 1,150-1,250 gpm) would continue to be routed around the biotreatment cells to the Ponds System.

The Expanded Constructed Wetlands alternative would achieve greater metals removal and further improve water quality in the Dolores River, as compared to the No Additional Action alternative.

3.3.1.2 Protectiveness

Protectiveness evaluations consider how reliably an alternative supports the removal action objectives. In this section, alternatives were evaluated for longevity of the system and components, flexibility, system control, and time to implement the technology.

<u>*No Additional Action*</u>

Some integrity risk exists for the No Additional Action alternative. The demonstration-scale systems have limited hydraulic capacity and lack redundancy. Flow in excess of 610 gpm during high flow/freshet periods or system downtime result in routing portions of flows around certain treatment components. All flow that is routed around process units is discharged to Pond 12 for retention settling prior to reaching the Dolores River. Aside from freshet conditions, the risk for process upsets that could affect water quality is considered low. However, the semi-passive control and long residence time of the systems would make upsets challenging and time consuming to resolve. Wetland systems are not easily modified and have an inherent lag in response to process changes, which may make it difficult to meet some treatability goals, especially at maximum flows. The nature of the wetlands systems also reduces system flexibility, as most modifications or system upgrades would likely require substantial planning, construction, and time to implement. Some flexibility with flow management and residence time is achievable through the addition or removal of boards to/from effluent manholes.

Semi-passive control of the system means that minimal equipment is required for operation, which reduces the likelihood of critical equipment or instrumentation failures. The expected lifespan of the component media matrices is currently being evaluated but is anticipated to be approximately 10 years before replacement would be required. Water quality sondes require frequent calibration and some probes (specifically pH/Oxygen Reduction Potential [ORP]) need replacement on a regular basis.

<u>*Lime Treatment – High Density Sludge*</u>

The use of process controls and equipment allows for tight control of the process and immediate responses to system upsets. There would be an increased risk of process upsets as compared to other alternatives due to the higher opportunity for equipment or instrumentation failure that may temporarily affect effluent water quality. Equipment failure could result in extended downtime and the temporary inability to treat water until repairs could be made or a replacement could be procured. However, an equipment-based active treatment system allows for system flexibility, as timely modifications could be made with minimal interruption to treatment.

An HDS treatment system would have a relatively long design life overall, but individual equipment and components would require replacement as necessary to maintain performance. For example, equipment life could last as long as 20+ years for tanks and reactors or as little as a few months for some instrumentation (such as pH probes). Installation and shakedown for system performance evaluation is anticipated to take multiple field seasons; however, bench testing would be necessary to properly design and size equipment, which would delay construction. The Lime Treatment with HDS plant consists of a smaller footprint than the existing wetlands treatment systems, although some pond capacity would still be required for temporary storage and equalization, as noted above.

Expanded Constructed Wetlands

Many of the same risks, mitigations, and benefits would be experienced with the Expanded Constructed Wetlands alternative as with the No Additional Action alternative, including semi-passive system control, process upset management, flexibility, and longevity. However, design and implementation of the Expanded Constructed Wetlands utilizes lessons learned from the demonstration-scale systems to mitigate additional risks and improve system integrity and redundancy. Additional settling basins, as well as an additional biotreatment cell, aeration cascade, and dual rock drains, would increase hydraulic capacity and create system redundancy to allow maintenance to be conducted without routing flow around the treatment system, providing superior protection and increasing system flexibility. As with the demonstration system, the semi-passive design of the system tends to create a challenge for timely recovery from process upsets.

The expected lifespan of the component media matrices is approximately 10 years before replacement would be required. Design of the Expanded Constructed Wetlands would address maintenance difficulties for settled solids removal experienced during operation of the demonstration-scale systems, which is expected to extend the lifespan of the matrix media. Water quality sondes would similarly require frequent calibration and replacement of some probes.

The Expanded Constructed Wetlands would require two field seasons for construction, followed by inoculation of the new system components and a shakedown period for system performance evaluation. This alternative likely requires the full available footprint of the Site, including removal of some existing upper ponds for new construction. The final tie-in of the new components to the existing EWD system as well as the conversion of the manganese removal cell would require downtime of the EWD treatment system and may temporarily affect effluent water quality.

3.3.2 Implementability

Implementability is a measure of technical and administrative feasibility of the alternatives, implementation and operational risk, logistics considerations, and the availability of materials, services, and resources to implement and operate the technology.

The fact that water treatment systems similar to the No Additional Action, Lime Treatment – High Density Sludge, and Expanded Constructed Wetlands alternatives are operating at other locations has been considered in the implementability evaluation. These similar water treatment systems, constructed and operated at the other sites include the following:

1. Constructed Wetlands Systems including above-ground and below-ground wetlands/biochemical reactors:
    a. Empire Mine, Colorado (settling pond and aerobic wetlands);
    b. ASARCO’s West Fork site, Missouri (settling pond, two anaerobic wetlands cells, a rock filter, and an aeration pond);
    c. Aspen Seep Bioreactor at the Leviathan Mine Site, California (two bioreactors and two settling ponds);
    d. Burleigh Tunnel, Colorado (anaerobic compost constructed wetlands system); and
    e. Captain Jack Mill, Colorado (in-situ bioreactor).

2. Lime Treatment – HDS Systems:
    a. High Density Sludge Treatment System at the Leviathan Mine Site, California;
    b. Horseshoe Bend Water Treatment Plant, Montana;
    c. Leadville Mine Drainage Tunnel, Colorado; and
    d. Gladstone Interim Water Treatment Plant, Colorado (non-HDS system).

3.3.2.1 Technical and Administrative Feasibility

Technical feasibility analyzes the potential for technical difficulties associated with each alternative that could cause delays in implementation or successful operations, including reliability of the technology, complexity of operations, maintenance, control systems, raw materials required, and Site-specific factors.

Administrative and regulatory factors for each alternative include items such as securing permits (if required), meeting non-environmental laws, impacts on adjoining properties, easements required (if any), and complying with regulatory requirements.

Atlantic Richfield owns much of the real property immediately surrounding the SLT portal, Solids Repository, and demonstration-scale constructed wetlands treatment systems, which are located north of and outside the Town of Rico boundary. Atlantic Richfield is also in the process of acquiring additional United States Forest Service (USFS) property associated with the Ponds System.

Site-specific characteristics will affect the design and operation of each treatment system option. Considerations include weather, terrain, the available footprint, winter operation and access (including avalanche hazards), and remoteness of the Site.

No Additional Action

The No Additional Action alternative results in low implementation risk since it requires minimal operations staff and intervention due to a mostly passive style treatment system. Some cells are not adequately designed for maintenance and require labor-intensive work to mobilize equipment for solids removal. Solids generation and management has been an ongoing issue with the demonstration-scale constructed wetlands. Solids accumulation in cells requires frequent maintenance and shortens the anticipated life expectancy of the components. Solids carryover/settling occurs in units downstream of the settling basins, resulting in frequent maintenance requirements and reducing efficiency of downstream cells. Settling basins also require multiple cleanouts per year. Solids currently can be disposed of on-site. Minimal intervention is required during winter months, which reduces risks due to winter conditions and avalanche hazards for site personnel. No winter deliveries of coagulant are required as sufficient storage is available on-site. The passive style treatment with constructed wetlands systems requires minimal utilities and consumables. Consumables include aluminum chlorohydrate coagulant (and potentially flocculant) and sampling supplies.

Lime Treatment – High Density Sludge

Construction of a Lime Treatment with HDS plant would require an array of skilled labor to complete, including masons, pipefitters, mechanics, electricians, automation experts, and general construction labor. Due to the remote location of the site, procuring contractors from outside locations would be necessary. Delivery of large equipment pieces may also take additional logistical time and coordination, as the only access to the Site is via a two-lane mountain highway, and special permits would be required for any transportation of wide or oversized loads. The Lime Treatment with HDS alternative would require construction of a new operations building to house process equipment for protection from winter conditions. Construction includes significant civil work with large heavy equipment, electrical, placement and assembly of process equipment and piping, and construction of equalization ponds. Large equipment would require permitted lifts for placement. Solids removal from Pond 15 and other components would also be necessary.

The Lime Treatment with HDS alternative would require a team of operators and maintenance personnel for year-round treatment. Additional expected maintenance includes annual system deep cleaning and pump rebuilds, daily inspections and calibrations, and regular intervals of various system component testing. Safe site access would require frequent snow removal from the main access road and off-site placement, avalanche hazard mitigation and monitoring, and increased traffic on winding mountain roads via Colorado Highway 145. Poor weather conditions may put delivery and operations staff at risk during travel and result in delivery and/or treatment delays. Winter access to raw materials delivery would also be unreliable and risky for travel, which may require large on-site storage capacity and materials handling logistics to stock up materials before winter to avoid weather- and travel-related delays.

Given temperature extremes at the Site, a heated building rated for heavy snow loads would be required to contain the system and prevent freezing during winter months. Due to the cost of the major equipment pieces, redundancy would be costly to achieve, and maintenance requirements would result in process down time. SLT discharge during periods of downtime would either be captured in equalization ponds or require temporary routing around the treatment plant. There would be a competing need for space for the HDS treatment system and backup treatment/storage in case of an upset condition. Certain scenarios could result in additional periods of non-compliance (such as inability to deliver reagents to the Site due to weather). HDS produces a dense sludge that is purged from the system and requires dewatering prior to disposal. As a result of the limited size of the Solids Repository, a second phase of the Solids Repository would need to be constructed for solids disposal over the 30-year project life. Off-site disposal could be required after 30 years. The Lime Treatment with HDS alternative would require the second phase of the Solid Repository be constructed much earlier (in about half the time) when compared to the Expanded Constructed Wetlands alternative. Utilities costs would be significant due to power required to run various equipment such as the clarifier, pumps, and mixers, as well as lime and flocculant delivery systems.

Expanded Constructed Wetlands

Construction of an Expanded Constructed Wetland**s** system would require a array of skilled labor to complete, including masons, pipefitters, electricians, and automation experts, but would primarily rely on general construction resources for excavation, solids removal, placement of liners, installation of HDPE piping, and civil work with heavy equipment. Less electrical would be required as compared to Lime Treatment with HDS and would primarily consist of power and telemetry for coagulant storage and dosing, water quality sondes, water level and flow, hydrogen sulfide (H_2S) gas monitors, and aeration. No equipment requiring special transportation permitting would need to be procured, with the possible exception of coagulant storage tanks. However, there would likely be significant traffic to and from the Site for delivery of borrow and other construction materials. Solids removal from Pond 15 and other components would also be necessary.

Expansion of the constructed wetlands would be designed to include redundancy to allow for routine maintenance without routing flow around the treatment system during base-flow conditions. Additional system components for the Expanded Constructed Wetlands design would require a significant footprint in an area with limited available land. However, minimal utilities would be required for this system. Consumable deliveries would not be required over the winter as adequate consumables storage would be available on-site. Overall solid and other waste generation, transportation, and disposal for expansion of the constructed wetlands would be comparatively low. Solids settling and accumulation would occur in the settling basins and would require periodic cleanout and maintenance. Solids would be disposed of on-site. New system components would be designed with maintenance capabilities in mind based on lessons learned from the existing demonstration-scale systems to reduce time, risks, and costs associated with current solids management requirements.

The Expanded Constructed Wetlands would be suited for the Site because of the comparatively low base metal contaminant levels, the circumneutral nature of the SLT discharge water, and a considerably reduced OM&M profile. Minimal operations staff would be required, and little intervention would be required during the winter months. No winter deliveries of coagulant would be required, as sufficient storage would be available on-site to stock the product prior to winter weather.

The Expanded Constructed Wetlands alternative would be expected to perform better than the demonstration-scale constructed wetland systems (CWD and EWD), as it would be designed with increased hydraulic capacity and have improved system performance by maintaining and using the best performing components from the existing systems. Periodic solids removals from settling basins and periodic media replacements would be required to maintain effectiveness. Year-round effectiveness would be maintained by including redundancy in the final design, which is intended to allow for routine maintenance without routing flow around the treatment system.

3.3.2.2 Implementation Safety Risk

There are general health and safety concerns with construction work at the Site that require proper safety management to reduce risk, such as biological elements, physical demands, high altitude, working around water and slippery slopes, and extreme and/or changing weather conditions. Construction for all alternatives will be scheduled during the spring to fall field season as much as possible to avoid hazards associated with the harsh winters in Rico. Additionally, special precautions will be taken to properly acclimate new workers to the high altitude at the Site. Weather will be monitored daily, and work will be ceased and rescheduled when weather, such as heavy rain or lightening, begins to create hazardous conditions. A water truck will be utilized when necessary to spray down roads to mitigate fugitive dust generated by implementation activities. All activities will be performed in accordance with health and safety plans and risk assessments. Safety risks associated with implementation were considered for each alternative as discussed in this section.

No Additional Action

The No Additional Action alternative operates the existing demonstration wetland systems and therefore requires no implementation tasks, as the implementation has already been completed.

Lime Treatment – High Density Sludge

Implementation of a Lime Treatment with HDS plant would require a wide array of skilled labor and significant construction that would involve the use of large, heavy equipment and simultaneous operations (SIMOPs) that would necessitate careful planning and execution. Civil and general construction would be required for construction of the plant building to house the equipment. Transportation, unloading, and installation of large or heavy equipment may require special permitting and scheduling for delivery via the two-lane highway. SIMOPS and increased traffic and personnel on-site would create a risk of collisions and would necessitate traffic control and spotters. The use of cranes and competent operators would be necessary for unloading deliveries and installation of large equipment pieces. Erection of the process equipment and piping would require working from heights and the use of scaffolding or manlifts. Installation of the system piping, electrical, and controls must be completed by competent and licensed personnel to ensure safety and functionality. Much of this work would involve energy isolation, hot work precautions, pinch point hazards, and working at heights. Additionally, assembly of internal components inside process equipment (such as the clarifier rake or reactor agitator) may necessitate entry into confined space. Chemical hazards exist for set up and delivery of the initial flocculant and lime stores as well as from possible dust or contact with solids removal from existing ponds to install the operations building, equalization pond, and sludge drying bed. Tear down and disposal of the historic lime silo and contents would create a lime dust exposure and demolition hazard. Fugitive dusts from construction and traffic would require mitigation by wetting roads and excavation sites as necessary. Additional hazards include pressure testing of piping, overhead utilities, and testing and assembly of rotating equipment.

Expanded Constructed Wetlands Treatment System

Most of the construction and implementation of the Expanded Constructed Wetlands system components could be completed by general construction companies. Competent and licensed personnel would be necessary for installation of electrical, instrumentation, and controls but on a far smaller scale than for Lime Treatment with HDS. Construction of the Expanded Constructed Wetlands would require significant civil work using large, heavy equipment. Additionally, the Site would receive significant traffic from materials deliveries. The increased traffic, SIMOPs, and number of construction personnel working on the site could create collision and struck by hazards that would necessitate monitoring and traffic control measures to reduce risk, such as spotters and SIMOPs coordination. The main hazards associated with construction of wetlands cells are excavation and engulfment if shoring of slopes is not completed properly. Engulfment hazards would also exist when dumping component media into new cells. Long stick excavators and long reach equipment would be utilized as necessary during media placement to avoid the need for equipment to enter component cells. Additional hazards include working around water near existing components, working near H_2S exclusion zones, laying and pressure testing of piping, and working near overhead utilities. Inoculation of the new biotreatment cell would be completed by mixing in media (which includes manure, metals precipitates, and bacteria) from the existing biotreatment cell, and safe hygiene practices and PPE would be utilized to prevent exposure. Construction of the new biotreatment cells and conversion of the manganese removal cell to a settling basin would require the removal of existing settled solids and used media. Solids would be disposed of in the Solids Repository, but potential exposure risk would exist during removal and transport of the solids. Tear down and disposal of the historic lime silo and contents would create a lime dust exposure and demolition hazard. Excavation and traffic would also introduce a dust hazard due to the existence of metals, calcines, and waste rock from historic operations and could be mitigated by wetting roads and materials as necessary to control fugitive dust. Initial startup of the Expanded Constructed Wetlands system would produce a temporary increase in H_2S generation as the biotreatment cell becomes anerobic but could be controlled and mitigated by closely monitoring the system and managing residence time of the cell.

3.3.2.3 OM&M Safety Risk

There are general health and safety concerns of OM&M field work at the Site that require proper safety management, such as biological elements, physical demands, high altitude, working around water and slippery slopes, and extreme and/or changing weather conditions associated with the Site.

No Additional Action

The No Additional Action alternative continues the current operations of the EWD and CWD treatments systems without modification. The existing OM&M tasks would continue to be performed, including water quality sampling, equipment maintenance, solids removal, chemical delivery and handling, inspections, and general site maintenance. Maintenance activities that have potential for chemical exposure include handling and storage of coagulant (aluminum chlorohydrate), settled solids removal from system components, calibration of sondes, on-Site laboratory testing, and H_2S off-gassing from some system components. Safety management procedures and physical barriers are in place to protect operators from H_2S exclusion zones; however, some activities do require controlled access to these areas. Solids removal activities require labor intensive equipment mobilization and have the potential risk for injury.

Minimal staff intervention is necessary for OM&M, especially during the winter, which reduces operational and safety risk by means of limiting staff exposure. Periodic winter access would still be required and would introduce environmental hazards including travel to and from the Site, working in cold weather and navigating over deep snow conditions and through existing avalanche paths.

Lime Treatment – High Density Sludge

Lime Treatment with HDS utilizes an active treatment plant that relies on process equipment, automation and controls, and competent staff to continuously operate. OM&M activities would include regular inspections and maintenance of equipment and instrumentation, sludge/solids management, chemical delivery and handling, and general Site maintenance (including snow removal in winter). OM&M tasks for Lime Treatment with HDS require handling of flocculant and lime, which pose chemical exposure risk to site personnel. Lime is a corrosive substance that can be dangerous to human health or the environment by means of exposure or loss of containment. Storage and handling of lime on Site would require rigorous safety management. The automated sludge recycle and wasting system for the clarifier largely eliminates solids exposure risk during operations. However, personnel would need to sample and manage disposal of dewatered solids. High risk potential maintenance tasks would require competent skilled technicians for performing lock-out tag-out and activities (such as tank cleaning) that require confined space entry.

Utilizing Lime Treatment with HDS would necessitate year-round full-time staffing and require safe access to the Site for personnel and deliveries in the winter. Possible risks to human health during winter operations include working in cold conditions, access to the Site through avalanche paths, and travel on snow- or ice-covered mountain roads. Frequent monitoring and mitigation for avalanche prevention and regular snow removal from the main access road and site access roads (i.e., access to sludge drying bed) would be necessary to reduce risk.

Expanded Constructed Wetlands

Again, many of the same risks, mitigations, and benefits would be experienced with the Expanded Constructed Wetlands alternative as with the No Additional Action alternative, including the potential for chemical exposure, working in winter conditions, semi-passive system control, process upset management, solids management, and minimal staffing or intervention required. However, design and implementation of the Expanded Constructed Wetlands would utilize lessons learned from the demonstration-scale systems to mitigate additional risks and improve system integrity. New settling basins would be designed to facilitate solid removal and reduce risk of injury by limiting labor intensive tasks and reducing exposure to solids. Components that generate H_2S would be designed to minimize accumulation zones (such as installing open-air hydraulic control structures to allow gas to dissipate).

3.3.2.4 Availability and Logistics

The availability and logistics assessment addresses personnel and technical requirements, off-site waste disposal, laboratory analysis needs, and access to equipment and supplies. Lack of equipment availability, skilled labor, or logistic roadblocks may impact the time required to implement technologies. The ability to prevent or minimize downtime due to maintenance and operations procurement needs may also impact the implementability of the alternatives.

Logistics and availability of services and materials are an inherent challenge at the Site due to the remote mountain location and seasonal inclement weather. Rico is a small town with a population of approximately 250 people and limited services. A single two-lane highway connects the Town of Rico to larger city centers with significant elevation change between cities. Driving can be especially hazardous and difficult during winter months due to ice and snow, which may affect the ability for the site to receive equipment, raw materials, or skilled services. Hiring competent staff for implementation and especially for post-construction operations and maintenance is challenging, and recruitment may not be a timely process for all prospective alternatives.

No Additional Action

The No Additional Action alternative would operate the current treatment system and require staff of approximately five for year-round operation. During field season, which typically runs from May to October, field staff typically work 50 hours per week to perform OM&M and other project tasks. The semi-passive operation of the system allows OM&M tasks to be limited during winter months, and the Site is only accessed on a bi-weekly basis or as needed. The No Additional Action alternative does not include any additional improvements that would create availability or logistics concerns for implementation. Solids are currently disposed of on-site and do not require off-site disposal. Raw materials and supplies can be sourced as needed utilizing current vendors and suppliers. Materials are available for procurement most of the year. Raw materials and supplies required for Site operation include aluminum chlorohydrate, biotreatment cell media, clean water, and diesel. These materials are procured regularly, depending on the consumption rate on Site. Currently, coagulant is procured every 3-6 months. Biotreatment cell media is predicted to be procured every 10 years. Site access is sufficient for delivering and receiving raw materials when needed. The No Additional Action alternative is expected to be unavailable for treatment for several short periods during the year when maintenance activities such as solids removals from the settling basins occur. Additionally, when biotreatment cell media requires replacement, the system would be unavailable for an extended period of time (possibly up to two months while media is replaced).

Lime Treatment – High Density Sludge

Lime Treatment with HDS would require a year-round staff of approximately six to operate, including staff that would require technical skills for maintenance and/or electrical to address system issues in a timely manner. Staff requirements assume 40 hours per week to operate year-round. Procuring and retaining a qualified team in a remote area may be difficult to achieve. Additional expected operational maintenance includes annual system deep cleaning and pump rebuilds, daily inspections and calibrations, and regular intervals of testing various system components. Many of these maintenance items would require down time to perform, limiting the percent availability of the system to treat water. A more frequent maintenance schedule requiring extended periods of downtime could potentially allow for exceedances, especially during periods of poor influent water quality (freshet) unless a fully redundant system is available.

This treatment option would require several consumables, including flocculant and lime that would require year-round delivery. Winter access for raw materials delivery would also be unreliable and risky for travel, which may require large on-site storage capacity and materials handling logistics to stock up materials before winter to avoid weather- and travel-related delays. Delivery of large equipment pieces may take additional logistical time and coordination as the only access to the site is via a two-lane mountain highway. The Site access road may also require additional maintenance and/or re-routing to accommodate more frequent deliveries and avalanche mitigation for winter Site access, which would require major construction and additional non-removal action design changes to the Site.

Expanded Constructed Wetlands

The Expanded Constructed Wetlands treatment system would require a staff of approximately four for year-round operation. During field season, which typically runs from May to October, field staff would typically work 10-hour days Monday through Friday to perform OM&M tasks. The semi-passive operation of the system allows OM&M tasks to be limited during winter months and the Site would only be accessed on a bi-weekly basis or as needed. Required consumables would include aluminum chlorohydrate coagulant (potentially additional flocculant) and sampling supplies and are available as needed via current suppliers to the Site. Solids would be disposed of on-site.

Logistical concerns are nearly equivalent to the No Additional Action alternative. Procurement of consumables such as coagulant and diesel is similar, but biotreatment cell media life is expected to be vastly improved due to improvements in solids management design. Due to system redundancy, this alternative is anticipated to have minimal downtime and be available for treatment of water year-round, even when settling basin cleanouts and/or biotreatment cell media replacement occurs.

3.3.3 Environment

The environmental impact of each alternative regarding waste production, energy usage, emissions, biodiversity, and overall footprint was evaluated. Treatment alternatives that produce minimal waste, reduce energy consumption, minimize the overall footprint and maintain a sustainable environmental impact are favored over other alternatives.

No Additional Action

Under No Additional Action waste production, energy usage, emissions and the footprint would remain unchanged from current Site operations. The footprint of the systems consumes a large percentage of the Site, including the Ponds System. However, the semi-passive and natural feel of the wetlands and Ponds System have shown to positively impact biodiversity in the area, as wildlife has become established in the Ponds System. The rate of waste produced on Site (sludge, etc.) is not expected to increase significantly over time, and the Solids Repository has the capacity to accept all generated solids over the design life of the project. The energy usage on Site is minimal as the system is semi-passive and requires limited equipment for operations. Emissions would not be expected to increase following the implementation of the No Additional Action alternative.

Lime Treatment – High Density Sludge

Lime Treatment with HDS is dependent on the addition of lime and various coagulants, flocculants, and other water treatment solutions. These treatment materials add additional mass to waste produced by the water treatment system. Although producing denser sludge/waste materials than other treatment alternatives, waste production would significantly increase. Additional waste disposal facilities may be required. HDS sludge treatment would require active water treatment, with energy demands required for various pumps, monitoring systems, and dosing systems. Energy usage would be high in the winter months as the plant would require an enclosed heated building to prevent freezing of lines and equipment. Emissions would not be expected to increase. The energy consumption and energy demand footprint with this technology would be much larger than the semi-passive water treatment alternatives discussed in this report. The Lime Treatment with HDS plant would consist of a smaller physical footprint than the existing wetlands treatment systems and would effectively reduce the amount of land needed for operation of the Site. However, active treatment would increase operations activity and traffic at the Site, which may negatively impact biodiversity in the immediate area as noise and traffic may force established wildlife to seek new habitations.

Expanded Constructed Wetlands

Waste production is estimated to be directly proportional to the load treated from the SLT. Off-Site disposal would not be necessary as the Solids Repository has sufficient capacity to dispose of all generated solids over the project life. The energy use on Site would be low, as the semi-passive nature of the treatment technology takes advantage of gravity to move and distribute water throughout the treatment system instead of pumps. This alternative would require the largest footprint and a majority of the available space on the Site would be utilized in the design. However, the semi-passive and natural feel of wetlands and the Ponds System would be expected to positively impact biodiversity in the area over time as with the existing demonstration wetlands systems. Depending on future design, passive aeration techniques may be possible and eliminate the current active aeration treatment step. Gravity based passive systems allow for a small carbon/environmental footprint.

3.3.4 Cost

Capital investment, ongoing OM&M costs, and NPV have been estimated for each alternative and are presented in Table 7. High capital costs or consumables and operational costs may render some systems less favorable and impact the overall sustainability of the systems for long-term operation. Cost of closure was not considered due to the need for perpetual treatment at the Site.

3.3.4.1 Capital Costs

Capital investment costs estimated for each system include direct equipment and construction costs and indirect construction costs (administration, safety, engineering design, quality assurance, and oversight) for water treatment. Non-water treatment related infrastructure including hydraulic controls, an improved access road and avalanche/rock fall protections and shelters are not accounted for in the capital investment costs. Capital associated with solids repository construction are not included in the capital cost estimates but are accounted for in the NPV calculations. NPV calculations are provided on a consistent 30-year project life including design, construction, and OM&M.

No Additional Action

The No Additional Action alternative assumes that the existing systems would be operated as-is with no additional improvements or investment. Therefore, no capital investment would be required for this scenario.

Lime Treatment – High Density Sludge

The capital investment required for implementation of an HDS Lime Treatment system is estimated at $12.2 million (M). Required infrastructure would contribute to more than half the capital cost and include, but not be limited to, converting existing ponds into influent equalization ponds and a solids drying bed, constructing an influent pump station, and constructing a large, heated building to contain the full system and structures for housing utilities and power stations. Demolition of some existing structures and solids removal from existing ponds would be required. An HDS plant would require the purchase of a significant amount of process equipment, instruments, electrical, piping, and controls to operate. However, much of this equipment would retain value and be considered recoverable capital.

Expanded Constructed Wetlands

The capital investment required for implementation of the Expanded Constructed Wetlands system is estimated at $9.1M. This estimate includes solids removal from existing ponds within the new system footprint and construction of system components (settling basins, biotreatment cell, rock drains, and aeration cascade), instruments/telemetry, and piping. The existing EWD treatment system would also require some modification to be integrated into the full-scale system. The cost estimate of the expanded system includes structural costs for constructing a larger chemical feed building and installing and purchasing aeration and flocculation equipment.

3.3.4.2 OM&M Cost

OM&M costs were estimated for the 30-year design life of the systems based on previous experience at similar sites and available information. OM&M costs include sampling frequency, required manpower, raw materials, solids management and disposal, utilities, and many other considerations. Estimates also include matrix replacement costs adjusted to an annual basis for the No Additional Action and the Expanded Constructed Wetlands alternatives (assuming a 10-

year matrix life). As the Site is expected to treat SLT discharge water in perpetuity, OM&M costs are especially significant for evaluating the best fit for long-term operation.

No Additional Action

The No Additional Action alternative assumes the continuation of annual maintenance activities that are currently being performed at the Site and are expected to cost $2M annually at a cost of $6.35/1,000 gallons of treated water. Periodic replacement of biotreatment cell media, rock drain media, and wetlands plant matrix would be necessary due to solids buildup in the system. The cost for replacing these media is included on an annualized basis in the estimate assuming a 10-year replacement cycle. Annual OM&M costs include, but are not limited to, solids management, chemicals (flocculant/coagulant, analytical solutions), stormwater control, replacement equipment/instruments and oversight. The semi-passive nature of the system means that little equipment, maintenance and associated costs would be required for operation. There would be no need for a dedicated maintenance team on-site, and minimal full-time staffing would be required to run the system (Site currently treats water 24/7 with full time staff members working Monday through Friday day shift only).

Lime Treatment – High Density Sludge

The Lime Treatment with HDS alternative is an active treatment plant and the OM&M costs are estimated at $2.6M annually at a cost of $7.56/1,000 gallons of treated water. Lime Treatment with HDS depends on a large quantity of electrical components, programming, instrumentation, and process equipment to operate which would require periodic replacement or refurbishing. Regular maintenance, calibrations and sampling are essential to keep the system optimized and operating efficiently. As such, a dedicated on-site maintenance staff may be required to maintain equipment and address issues timely. Other maintenance activities include, but are not limited to, descaling clarifiers and other equipment, solids management and disposal of sludge waste, and raw materials costs (lime, analytical chemicals, flocculant, etc.). A critical equipment inventory would need to be maintained on-site so that critical spare parts are immediately available when needed to prevent downtime. Lime Treatment with HDS is an active treatment system and would have increased staffing needs as compared to the semi-passive wetlands alternatives to monitor equipment and system automation.

Expanded Constructed Wetlands

OM&M for the Expanded Constructed Wetlands is estimated to cost $1.95M annually at a cost of $5.67/1,000 gallons of treated water. OM&M requirements are very similar to the No Additional Action alternative. Periodic replacement of biotreatment cell media, rock drain media and wetlands plant matrix would be necessary due to solids buildup in the system. The cost for replacing these media is included on an annualized basis in the estimate assuming a 10-year replacement cycle. As with the No Additional Action alternative, annual OM&M costs include, but are not limited to, solids management, chemicals (flocculant/coagulant, analytical solutions), stormwater control, replacement equipment/instruments and oversight. The semi-passive nature of the system means that little equipment, maintenance and associated costs would be required for operation. There would be no need for a dedicated maintenance team on-site and minimal full-time staffing is required to run the system. Expected OM&M costs are reduced as compared to the No Additional Action alternative as the CWD systems would no longer be operated or maintained. Redundancy in the Expanded Constructed Wetlands system would also allow for maintenance to be conducted without needing to route flow around the treatment system.

3.3.4.3 Net Present Value

Estimated NPV is calculated on a pre-tax basis with a 7.0% discount rate and a 2.0% inflation rate over 30 years. These calculations are shown in Table 7. The calculations return a NPV of -$31.85M (at a cost of $3.37/1,000 gals treated water) for No Additional Action, -$53.0M (at a cost of $5.14/1,000 gals treated water) for the Lime Treatment with HDS system, and -$36.9M (at a cost of $3.58/1,000 gals treated water) for the Expanded Constructed Wetlands. NPV for all alternatives is shown as a deficit as the Site does not generate revenue as a result of implementation of the treatment system. NPV for the Expanded Constructed Wetlands costs approximately 15% more as compared to the No Additional Action alternative. However, the NPV of the Lime Treatment with HDS system is nearly 70% more than the No Additional Action alternative due to the cost of capital and OM&M expenditures over the design life of the system.

4 RECOMMENDED REMOVAL ACTION ALTERNATIVE

Based on the evaluation presented in this report, the Expanded Constructed Wetlands is the preferred removal action. The Expanded Constructed Wetlands would: 1) reduce key contaminants loading to the Dolores River to improve water quality; 2) best achieve the objective of meeting agreed upon performance criteria; 3) treat base flows and freshet flows up to a 25-year recurrence period (design permitting); 4) provide safe, reliable, year-round / all-weather operations; and 5) minimize waste production and energy usage.

The expansion of the EWD to implement the Expanded Constructed Wetlands system would reliably increase mass removal from the SLT discharge and reduce metals loading to the Dolores River. The demonstration-scale constructed wetlands have proven that wetlands treatment is viable for the Site and is especially amenable to the circumneutral pH and stable year-round temperatures of the SLT adit discharge. The EWD system has an average mass removal of greater than 98% for aluminum, cadmium, copper, iron, and lead, with removals of 93.3% for arsenic, 74.2% for manganese, 80.0% for nickel, and 90.4% for zinc. Mass removal efficiency percentages and total removals for the life of the EWD system are listed in Table 6, and efficiency plots are available in Attachment A. Seasonal increases in flow and metals loading associated with the freshet stress the demonstration-scale systems and result in difficulties meeting treatability goals, particularly for manganese and zinc. The Expanded Constructed Wetlands alternative would mitigate this issue by incorporating rock drains and increasing treatment capacity into the wetland system design. The rock drain in the HWTT has been able to effectively remove manganese and zinc to below treatability goals even during freshet periods. The improved removal efficiencies of the Expanded Constructed Wetlands would be protective of the environment by consistently reducing metals below treatability goals in most conditions and the design would have the capacity to treat influent flows up to the 25-year recurrence with the construction of the new treatment components for added capacity and redundancy.

The Expanded Constructed Wetlands is also the preferred alternative due to the protectiveness to human health and the environment by providing safe and reliable year-round operation. Wetlands treatment is considered a semi-passive system and requires minimal operations personnel as compared to Lime Treatment with HDS, especially during winter months. A reduced on-site presence required during the winter as compared to Lime Treatment with HDS allows for elimination or significant reduction of risk for exposure to avalanche hazards. Winter consumables delivery via trucks, such as coagulant delivery, would not be required for this alternative. The wetlands system would also be protective of the environment because minimal equipment and energy would be needed for operations as compared to the Lime Treatment with HDS system. Minimal equipment would improve reliability, as the system would not be as dependent on critical equipment, and downtime resulting from equipment failures could be easily avoided. Solids and waste generation would be considerably lower with a constructed wetland than for Lime Treatment with HDS, and the existing Solids Repository would have the capacity for disposal of all generated solids over the project life. Design improvements to facilitate solid removal from system components would reduce risk of injury by limiting labor intensive tasks and reducing exposure to solids. Although this alternative would require the largest on-site footprint for treatment, it does not include an off-site footprint, and adequate space would be available on-site to accommodate the design and the semi-passive nature of the system. Natural type features would lessen the impact to the surrounding environment. Wetlands blend well into the natural environment, and the existing Ponds System has positively influenced biodiversity and wildlife habitat.

Capital and OM&M cost estimations support selection of this alternative with significantly lower costs per 1,000 gallons of treated water ($3.58/1,000 gal NPV) when compared to the Lime Treatment – HDS alternative ($5.14/1,000 gal NPV).

Experiential knowledge and lessons learned from the pilot and demonstration-scale wetlands systems would inform the Expanded Constructed Wetlands design to produce a robust, safe, and effective treatment system that would reliably meet removal action objectives and provide protection of human health and the environment, protective integrity, and reduction of risk for the Site.

5 REFERENCES

Atlantic Richfield Company, 2011. *Preliminary Water Treatment Screening Report, Rico-Argentine Mine Site*, submitted by Atlantic Richfield Company to US EPA, dated November 29, 2011.

Atlantic Richfield Company, 2013. *St. Louis Tunnel Discharge Constructed Wetland Pilot Scale Test Completion Report, Rico-Argentine Mine Site – Rico Tunnels Operable Unit OU01, Dolores County, Colorado*, submitted by Atlantic Richfield Company to US EPA, dated November 4, 2013.

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CDPHE WQCD, 2008. *Water Quality Assessment Mainstem of the Dolores River St. Louis Tunnel Discharge*, dated October 2008.

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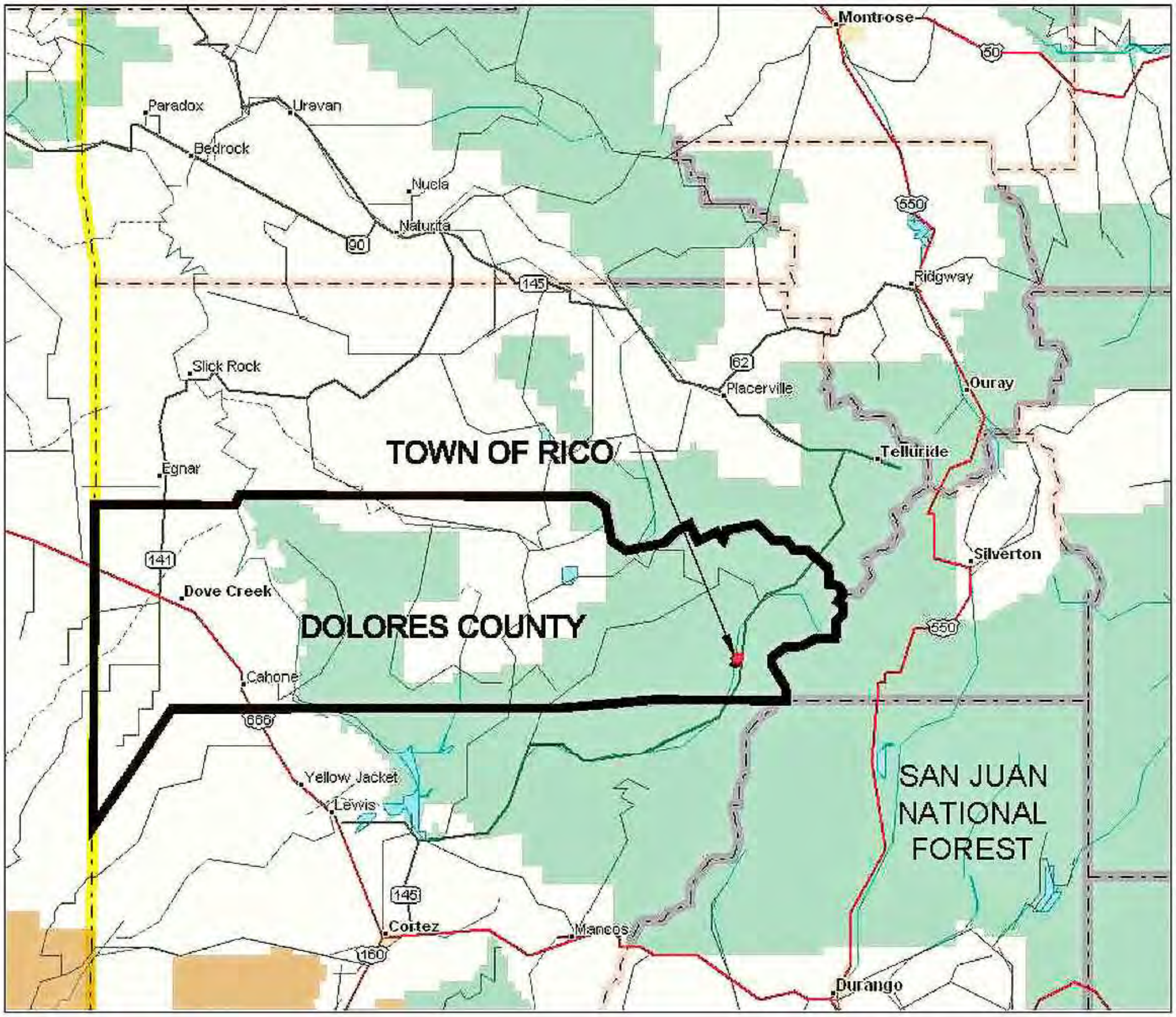
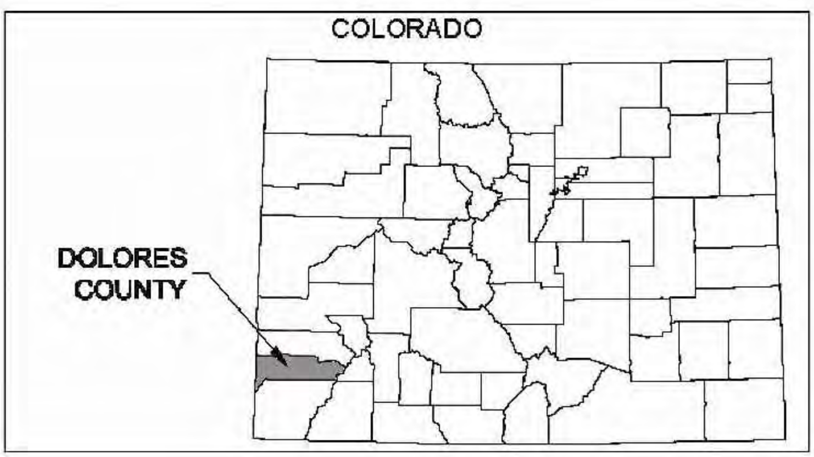
EPA, 2011. *Unilateral Administrative Order for Removal Action, U.S. EPA Region 8, CERCLA Docket No. CERCLA-08-2011-0005,* dated March 23, 2011.

Figures





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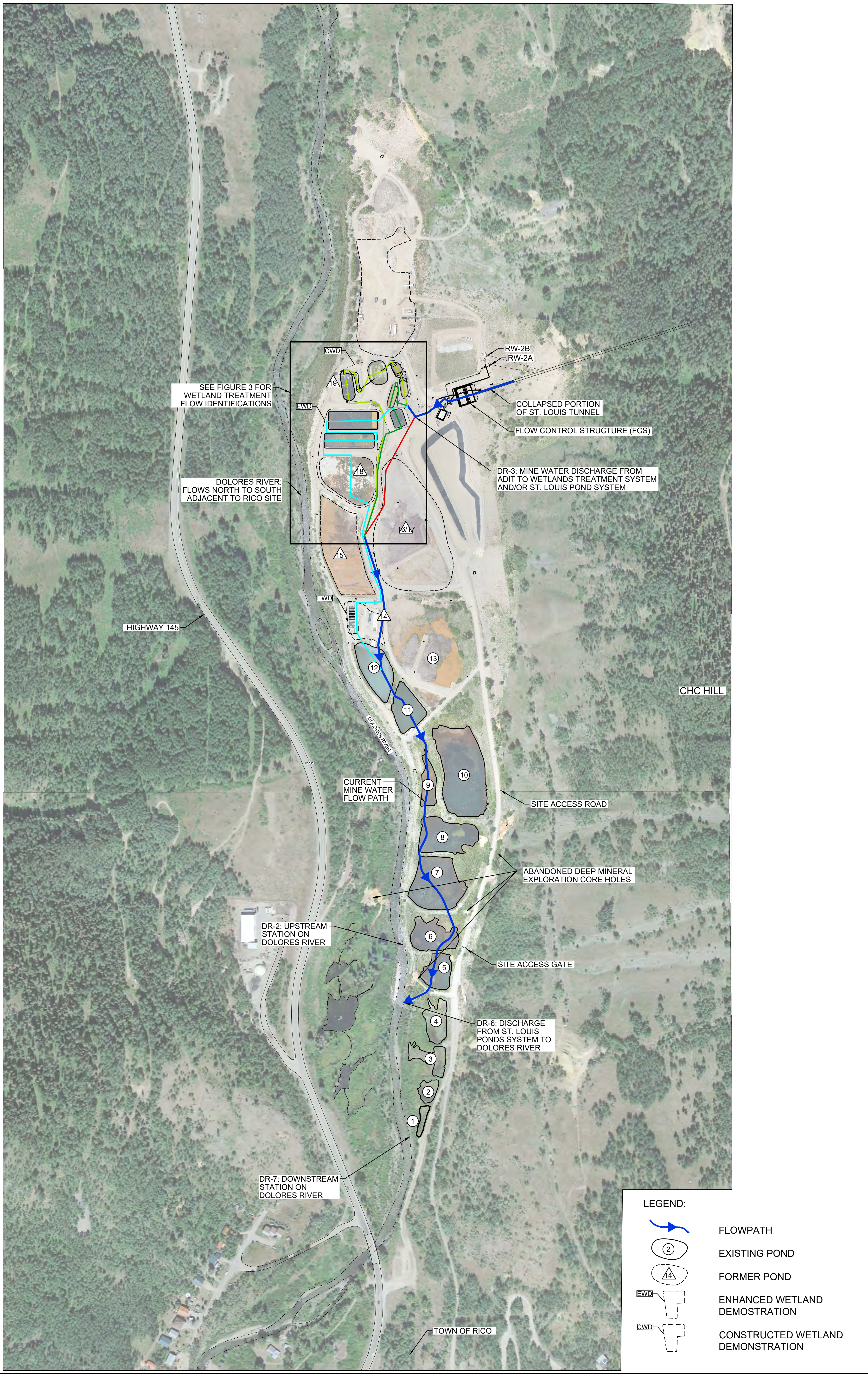
Copper Environmental Consulting A PRISM SPECTRUM COMPANY	7/21/2020 Atlantic Richfield Company Project: 70817.20	**Rico - Argentine Mine Site** **Dolores County, Colorado**	**Figure 1** **Site Location**



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7/21/2020

Atlantic Richfield Company

Project: 70817.20

Rico - Argentine Mine Site
Dolores County, Colorado

Figure 2

Site Features

Patricia F
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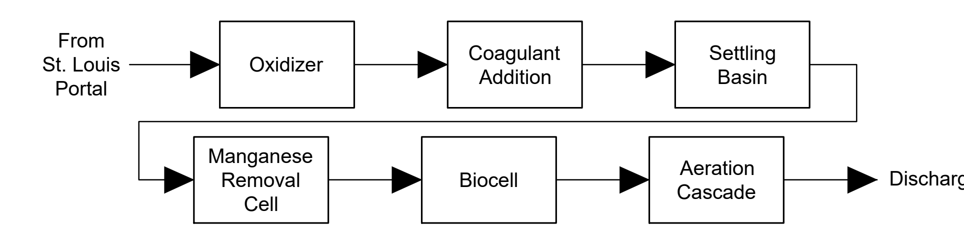
Jan 08, 2021 - 6:03pm

LEGEND:

- ST. LOUIS TUNNEL DISCHARGE FLOWPATH
- WETLANDS TREATMENT SYSTEM BYPASS
- ENHANCED WETLAND DEMONSTRATION FLOWPATH
- CONSTRUCTED WETLAND DEMONSTRATION FLOWPATH (HWTT)
- CONSTRUCTED WETLAND DEMONSTRATION FLOWPATH (VWTT)
- ENHANCED WETLAND DEMONSTRATION
- CONSTRUCTED WETLAND DEMONSTRATION
- SOLIDS REPOSITORY
- SOIL LEAD REPOSITORY
- RELIEF WELL
- FLOW CONTROL STRUCTURE LOCATION



ENHANCED WETLANDS DEMONSTRATION (EWD)

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TITLE:
MAJOR FEATURES

PROJECT:
Rico - Argentine Mine Site
Dolores County, Colorado

FIGURE 3

Patricia
Jan 08, 2021 - 12:30pm
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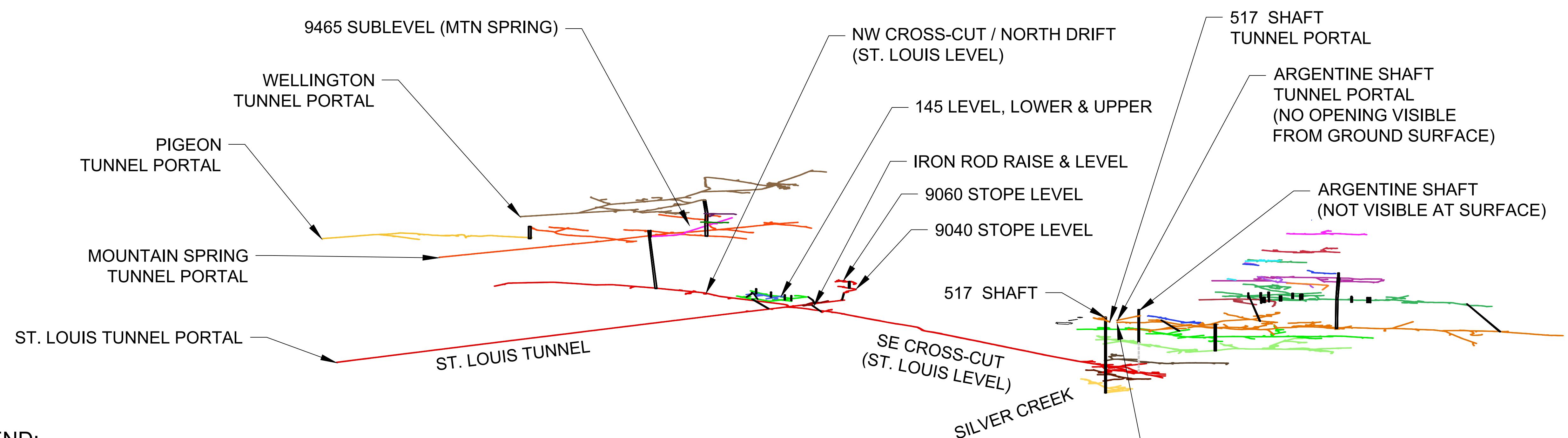
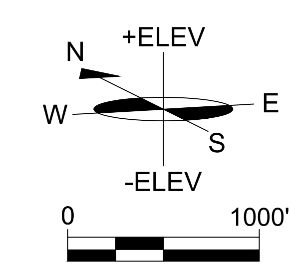
NOTES:

1. ALL MINE WORKINGS TRACED FROM "comp_Plan.tif", MAP #77 OF AECOM IMAGE INVENTORY, EXCEPT THE FOLLOWING:
   A. ARGENTINE SHAFT TUNNEL PER MAP #2, "scan02.tif", OF AECOM IMAGE INVENTORY. ("ARGENTINE MINE AND ST. LOUIS TUNNEL", DRAWN 5-21-55, P.L.J.)
   B. 517 SHAFT PER MAP #8, "scan08.tif", OF AECOM IMAGE INVENTORY. ("USGS/McKNIGHT PROFESSIONAL PAPER 723, PLATE 3")
   C. SILVER CREEK, BRIDGES & BUILDING FOOTPRINTS AT ARGENTINE TAILINGS PER ANDERSON ENGINEERING GROUND SURVEY, DATED AUGUST 2, 2011.
   D. ST. LOUIS SOUTHEAST CROSS CUT PER MAP #57, "00120110602202157.PDF", OF AECOM IMAGE INVENTORY. ("ST. LOUIS LEVEL, SHEET No. 2", DATED DEC. 1959 BY RT)
2. ALL LOCATIONS/DIMENSIONS APPROXIMATE ONLY.
3. ALL MINE LEVELS SHOWN AT SINGLE ELEVATION AND SEPARATED VERTICALLY PER USGS/McKNIGHT PROFESSIONAL PAPER 723 EXCEPT FOR LEVEL 700, WHICH IS SHOWN 100-FT BELOW 600 LEVEL.
4. NO EVIDENCE FOUND TO DATE ON HISTORIC MINE MAPS OF 517 SHAFT EXTENDING TO GROUND SURFACE.
5. ONLY SUGGESTIONS THAT ARGENTINE SHAFT EXTENDS BELOW 300 LEVEL ARE ON USGS/McKNIGHT PROFESSIONAL PAPER 723, PLATE 3, NOTATION ON MAP F (400 LEVEL) & MAP G (500 LEVEL): "ARGENTINE SHAFT (PROJECTED)". NOT SHOWN AT ALL ON MAP H (600 LEVEL); AND ON "ST. LOUIS LEVEL, SHEET No. 2", DATED DEC. 1959 BY RT.
6. FULL EXTENTS OF SOME LEVELS NOT SHOWN, AND INTERCONNECTIONS OF UPPER WORKINGS UNKNOWN AT THIS TIME.



LEGEND:

- WELLINGTON LEVEL
- 316 CROSS CUT / 425 DRIFT
- 417 DRIFT
- MOUNTAIN SPRINGS LEVEL
- MOUNTAIN SPRINGS 9465 SUBLEVEL
- PIGEON LEVEL
- IRON ROD LEVEL
- 145 LEVEL, LOWER & UPPER
- C TUNNEL LEVEL
- B TUNNEL LEVEL
- UNNAMED OLD TUNNEL
- UNNAMED OLD TUNNEL
- A TUNNEL LEVEL
- UNNAMED OLD TUNNEL
- ALLEGHANY LEVEL
- M TUNNEL LEVEL
- BLACKSMITH LEVEL
- BUNK HOUSE LEVEL
- DINING ROOM LEVEL
- CARBONATE LEVEL
- SMITH TUNNEL LEVEL
- BLACKHAWK / LOG CABIN LEVEL
- UNNAMED OLD TUNNEL
- RICO CONSOLIDATED UPPER LEVEL
- BERTHA S. UPPER LEVEL
- RICO CONSOLIDATED MIDDLE / ARGENTINE LEVEL
- BERTHA S. LOWER LEVEL
- RICO CONSOLIDATED LOWER LEVEL
- HUMBOLDT LEVEL
- BLAINE LEVEL
- 200 LEVEL
- 300 LEVEL
- 400 LEVEL
- ST. LOUIS / 500 LEVEL
- 600 LEVEL
- 700 LEVEL



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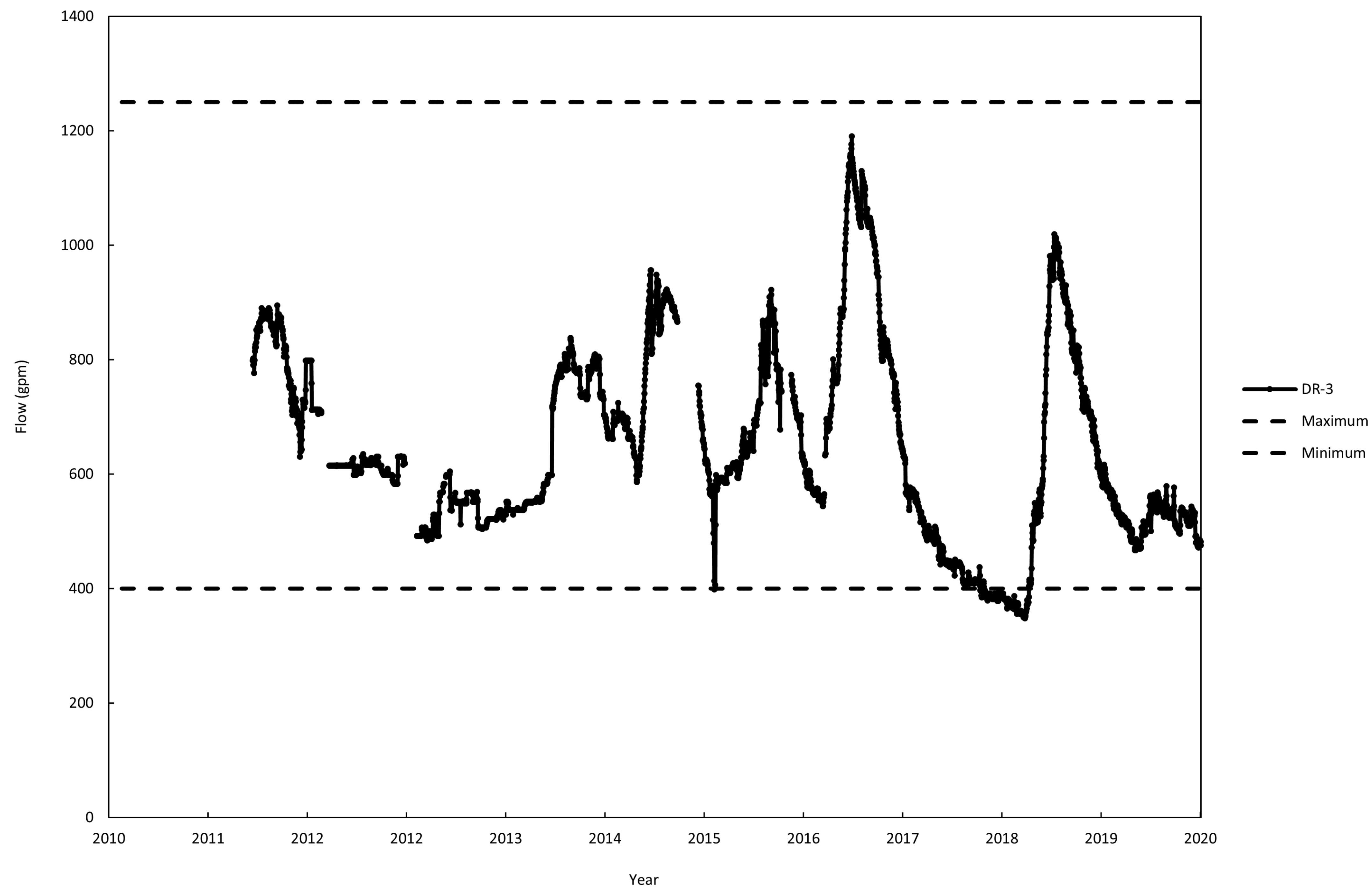
Date: SEPTEMBER 2014

Atlantic Richfield Company

Rico - Argentine Mine Site
Dolores County, Colorado

Figure 4

Mine Workings Overview



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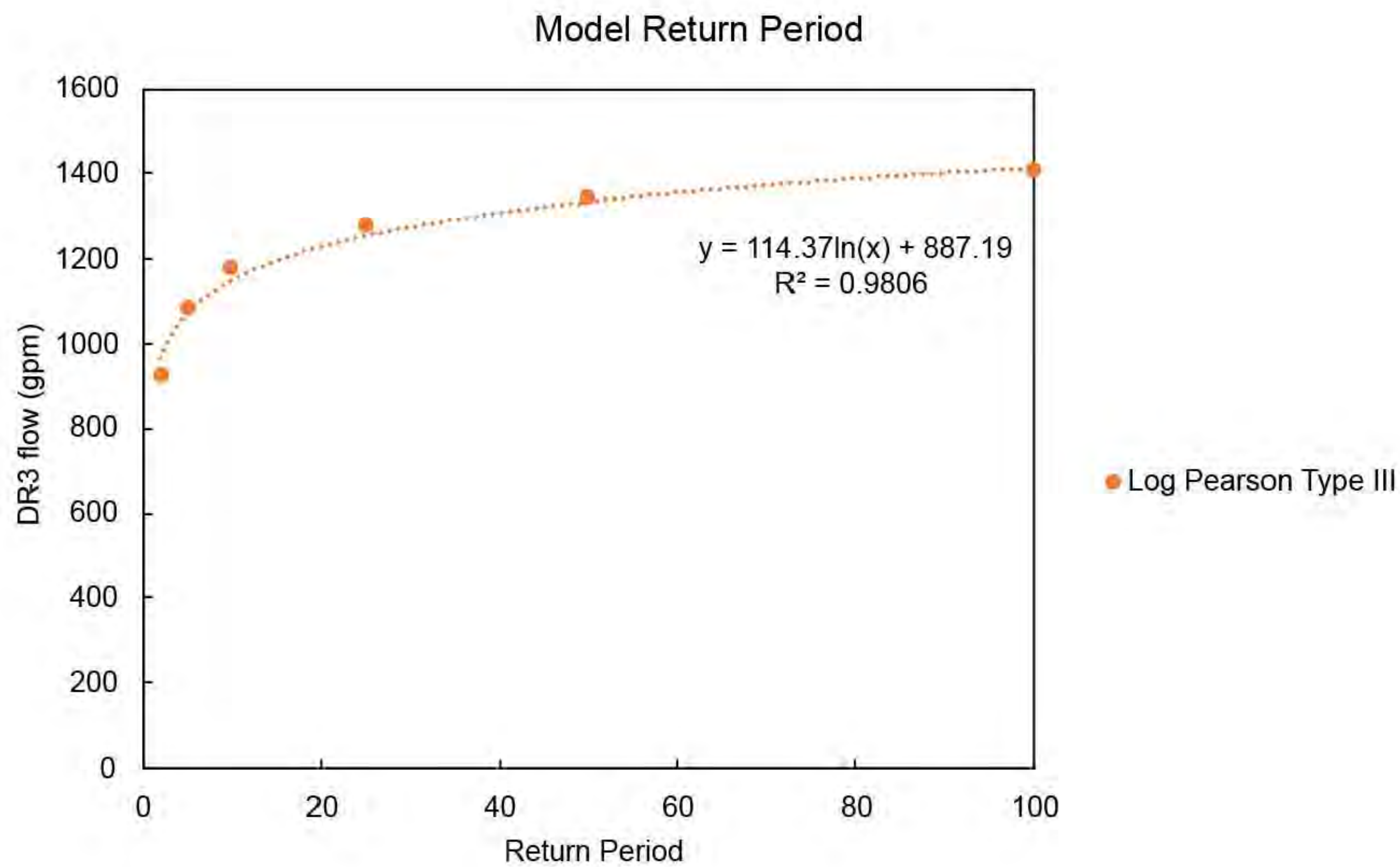
Atlantic Richfield Company

TITLE:
DR-3 Hydrograph (2011-2020)

PROJECT:
Rico - Argentine Mine Site
Dolores County, Colorado

FIGURE
5

Event Year	Modeled DR3 Flow (gpm) Log Pearson Type III
5	1071
10	1151
15	1197
20	1230
25	1255
50	1335
75	1381
100	1414
85%tile	942



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Atlantic Richfield Company

TITLE: Hydrologic Model Output

PROJECT: Rico - Argentine Mine Site
Dolores County, Colorado

FIGURE 6

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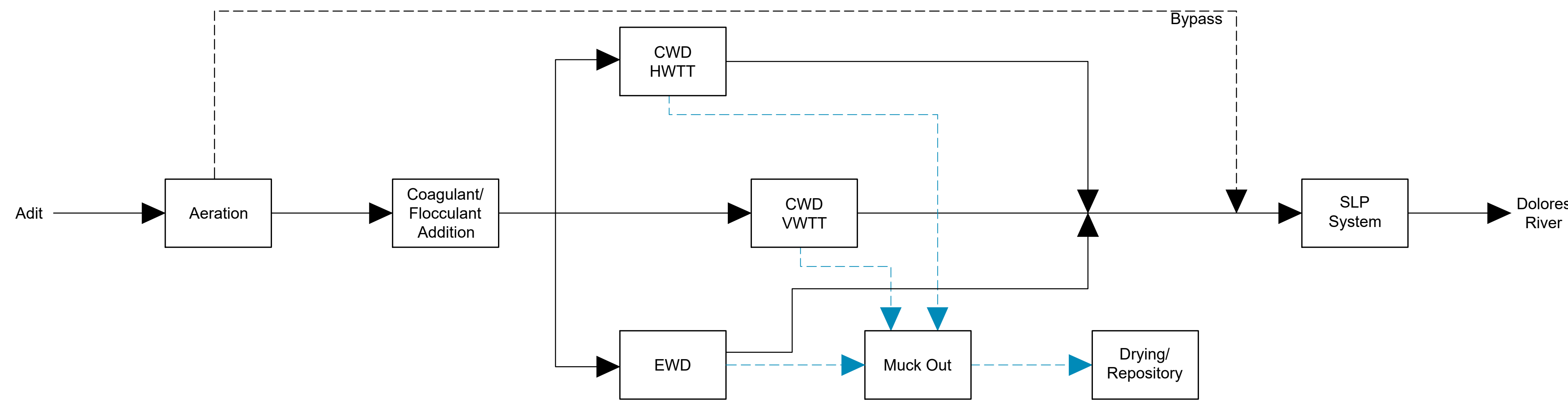
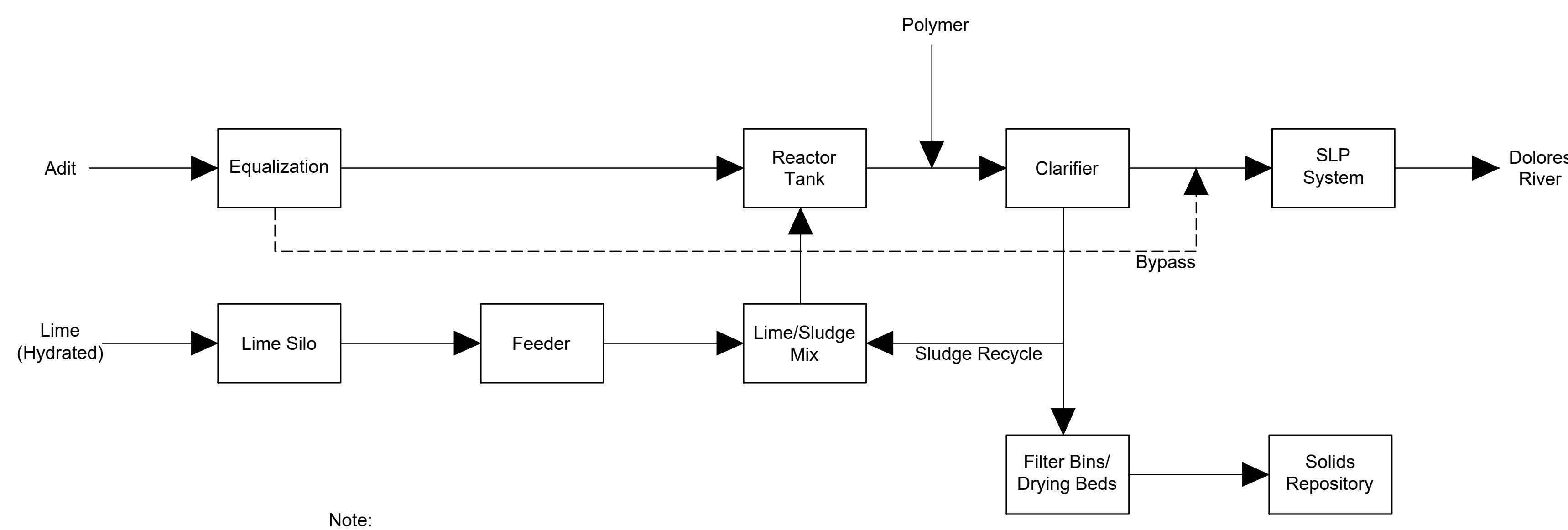


NO ADDITIONAL ACTION

(CURRENT CONFIGURATION)



Note:
Lime - HDS Alternative may require additional polishing/pH adjustment.

LIME - HDS

LEGEND:

FLOW / MATERIAL STREAM (SOLID)

TEMPORARY/MAINTENANCE STREAM (DASHED)

UNIT PROCESS

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Atlantic Richfield Company

TITLE:
PROCESS FLOW DIAGRAMS:
No Additional Action, Lime Treatment - High-Density Sludge

PROJECT:
Rico - Argentine Mine Site
Dolores County, Colorado

FIGURE
7

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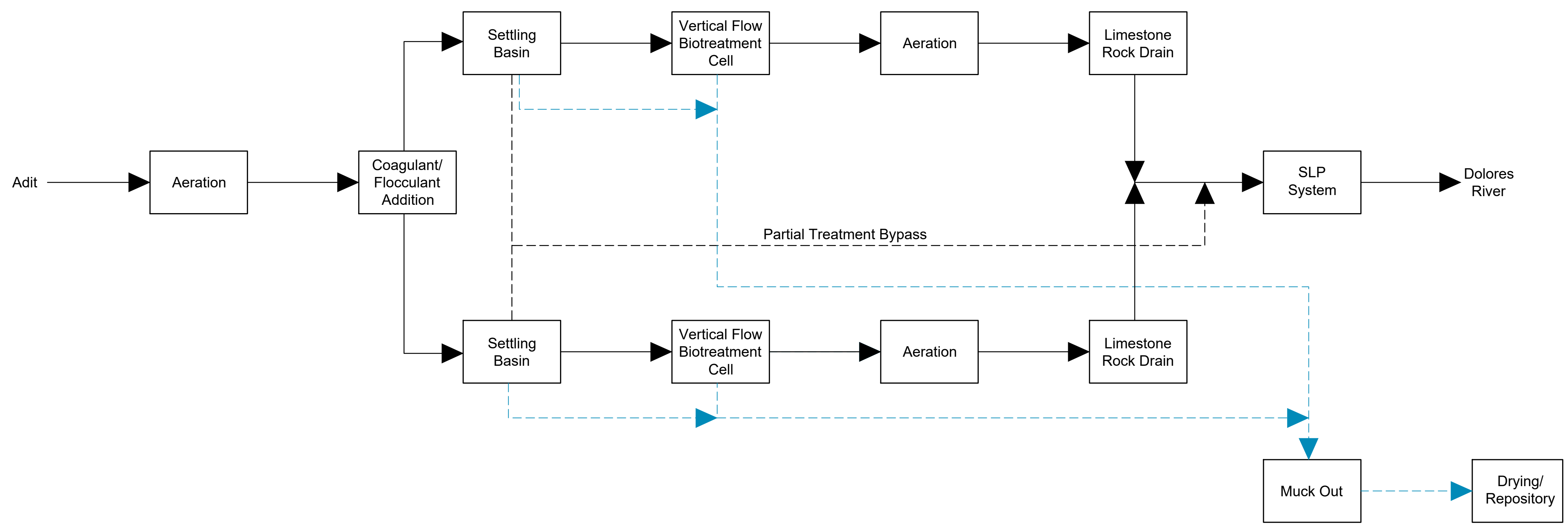

EXPANDED CONSTRUCTED WETLANDS

LEGEND:

FLOW / MATERIAL STREAM (SOLID)

TEMPORARY/MAINTENANCE STREAM (DASHED)

UNIT PROCESS

NO:	DATE	CADD	CHECK	APP'D	ISSUE / REVISION DESCRIPTION
0	07/21/20	PAF	SPB	KWP	PRELIMINARY REVIEW

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Atlantic Richfield Company

TITLE: PROCESS FLOW DIAGRAM: Expanded Constructed Wetlands

PROJECT: Rico - Argentine Mine Site, Dolores County, Colorado

FIGURE 8

Jan 08, 2021 - 6:00pm Patricia F
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Tables

Table 1. *Ranges of Contaminant Concentrations in SLT Discharge Water for both Freshet and Non-Freshet Conditions Rico-Argentine Site*

Parameter	Non-Freshet Min	Non-Freshet Max	Freshet Min	Freshet Max
Temperature (°C)	11.1	20.6	15.2	22.5
pH (s.u.)	6.27	7.48	5.63	7.4
Aluminum, Total (µg/L)	163	2190	218	6460
Aluminum, Dissolved (µg/L)	<4	762	12.6	5440
Arsenic, Total (µg/L)	<0.5	5.9	<0.5	4.2
Arsenic, Dissolved (µg/L)	<0.5	1.6	<0.5	2.2
Cadmium, Total (µg/L)	13.8	34.9	16.5	151
Cadmium, Dissolved (µg/L)	10.0	34.2	13.2	150
Calcium, Total (mg/L)	194	270	192	311
Copper, Total (µg/L)	27.6	343	24	2570
Copper, Dissolved (µg/L)	2.5	148	2.7	2370
Iron, Total (µg/L)	2510	24100	2250	30500
Iron, Dissolved (µg/L)	<50	9120	<50	15600
Lead, Total (µg/L)	1.3	29.5	1.4	59.7
Lead, Dissolved (µg/L)	<0.1	14.6	<0.1	21.7
Magnesium, Total (mg/L)	17.4	21.8	17.6	26.2
Manganese, Total (µg/L)	1530	3530	1530	6760
Manganese, Dissolved (µg/L)	1590	3210	1540	6910
Nickel, Total (µg/L)	3.6	7.9	3.2	16.2
Nickel, Dissolved (µg/L)	3.5	7.6	3.8	20.0
Potassium, Total (mg/L)	1.46	19.3	1.56	5.42
Sodium, Total (mg/L)	8.2	14.3	7.16	38
Zinc, Total (µg/L)	2320	6290	3170	25500
Zinc, Dissolved (µg/L)	1400	6290	2500	24800
Alkalinity (mg/L as $CaCO_3$)	78.8	155	<20	121
Sulfate (mg/L)	485	994	519	908
Chloride (mg/L)	<1	40.2	<1	<1

Notes:

1. Data collected from 1979 to May 2020 at DR-3/DR-3A sampling locations and Demonstration-Scale Wetlands Treatment System influent sampling locations.
2. Freshet determined by pH decrease and specific conductance increase in the April-July timeframe.
3. Non-detect values reported as less than Reporting Limit.

Table 2. *Historical Lime Treatment with Lagoon Settling Effluent Water Quality Summary*
Rico-Argentine Site

Parameter	Unit	Effluent Value[1]		
		Minimum[2]	**Flow-Volume Average[3]**	**Maximum[4]**
Cd, Total	µg/L	0.20	4.73	179.1
Cu, Total	µg/L	0.346	13.52	75.0
Pb, Total	µg/L	0	6.29	160.0
Hg, Total	µg/L	0.050	0.10	0.4
pH	s.u.	6.37	7.41	9.4
Ag, Total	µg/L	0.087	1.93	100.0
TDS	mg/L	735	1015	1878
TSS	mg/L	0.05	4.1	60
Zn, Total	mg/L	0.015	0.57	2.6
Flow	gpm	440	747	1736

Notes:

1. Monthly effluent values were digitized for compilation from scanned documents, with a somewhat incomplete period of record from October 1984 – July 1996.
2. Minimum value recorded in historical documents.
3. Flow volume average is calculated using the recorded flow measurements and the appropriate effluent concentration for each constituent.
4. Maximum value recorded in historical documents.

Table 3. *Advantages and Disadvantages of Removal Action Alternatives*
Rico-Argentine Site

	No Additional Action	Lime Treatment – HDS	Expanded Constructed Wetland
Advantages	• Low capital cost. • Generally meet standards during non-freshet period at current designed flow rate of 610 gpm.	• Generally meet treatability study goals. • Best process control and response to system upsets. • Can be designed to better handle anticipated flows and metal loadings but would still require equalization/storage ponds. • Reduced sludge volume vs. other active treatment methods. • Possibly easier solids management vs. other active treatment methods. • No replacement of media required. • No H_2S gas generation.	• Generally meet treatability study goals. • High mass removal rates of cadmium and manganese. • Lower OM&M cost. • Much less support labor required. • Lower safety risk during winter (avalanche risk, etc.) given lower winter support hours. • No chemical deliveries required in winter. • No harsh chemicals used. • Chemical neutralization of discharge not required. • Viewed favorably by EPA; EPA has a stated policy to consider “green remediation” aspects in Superfund. • SLT water well-suited to wetland treatment (near-neutral pH, relatively low metals concentrations, relatively constant composition much of the year, generation of sulfide enables cadmium, copper, and zinc removal in neutral pH range).

Table 3. *Advantages and Disadvantages of Removal Action Alternatives (Continued)*
Rico-Argentine Site

	No Additional Action	Lime Treatment – HDS	Expanded Constructed Wetland
Disadvantages	• Standards not met part of year. • Small H_2S gas generation may present a minor HSSE risk. H_2S areas are gated to prevent unauthorized entry and accidental exposure. Probably more frequent replacement of media required due to more frequent media plugging. • No redundancy, thus significant maintenance would likely result in bypass of treatment system. • Slow response to system upsets.	• Much more complicated mechanical, electrical, and control systems than other wetland approaches. • Need for lime deliveries year-round (remote location and site access, mountain driving, severe winter weather). • Increased cost for maintenance and consumables. • Increased year-round staffing (remote location, severe weather, avalanche hazard). • Handling and HSSE issues associated with lime. • Potential difficulties with meeting cadmium and manganese treatability study goals, requiring high pH target and downward pH adjustment for discharge. • More sludge produced than wetland system. • Regulators less likely to grant waivers. • Regulators publicly demonstrate a bias away from lime treatment in Colorado due to experiences at Gold King, Argo Tunnel, Summitville, etc.	• Small H_2S gas generation may present a minor HSSE risk. H_2S areas are gated to prevent unauthorized entry and accidental exposure. • System cannot be easily modified if needed. • Replacement interval of media not well understood. • Less active process control. • More time required to recover from upsets. • May need relief from performance criteria during freshet period via waiver or seasonal goals. • Requires larger footprint than other alternatives.

__Table 4.__ Comparative Analysis of Removal Action Alternatives
Rico-Argentine Site

Treatment Alternative	Evaluation Criteria										
	Effectiveness			Implementability				Environment			Cost
	Contaminant Removal	Protectiveness/ Permanence	Time	Technical Feasibility	Implementation Safety Risk	OM&M Safety Risk	Availability/ Logistics	Waste Management	Energy Usage/ Emissions	Biodiversity/ Footprint	Total Cost
No Additional Action	Effective but limited hydraulic and removal capacity	Current system unable to treat high flows (610 gpm maximum) and directs excess flow around treatment components; Moderate to high risk of regulatory exceedances	N/A	System continues with current success	N/A	Mild chemical exposure (coagulant, settled solids) and H_2S generation risk	5 FTEs, 50hr/week during field season, biweekly or as needed during winter	Organic media replacement required (~10-year media life)	Semi-passive treatment and minimal equipment requires low energy	Large footprint for wetlands and Pond System	Lowest capital cost ($0M)
	High flows or metals loading may overwhelm system (freshet)	Semi-passive system reduces likelihood of equipment or instrument failures		Uncertainty of operability during high flows or during system maintenance, risk for exceedances		Working near water	Suppliers established for consumables	Sufficient capacity for waste disposal in Solids Repository	Minimal emissions generated	Naturalistic and semi-passive system promotes biodiversity and wildlife benefits	Moderate OM&M cost ($6.35/1,000 gal treated)
	HWTT rock drain successful in Mn and Zn removal	Clogging and fouling of existing components can reduce efficiency		Pre-freshet maintenance limited between snowmelt and freshet		Maintenance required year-round	Infrequent deliveries required for raw materials and no winter delivery necessary	No off-site waste footprint required			High potential long-term costs
	Not able to treat up to 25-year recurrence flow (current max 610 gpm)	Semi-passive system creates lag in response to process changes and time to resolve upsets		Clogging of media, media life uncertain		Limited winter on-site activities and Site access required	Maintenance downtime could limit system availability	Unknown rock media replacement frequency			NPV cost of $3.20/1,000 gal treated
		System not easily modified, some flexibility exists for residence time and flow				Solids removal work is labor intensive and not efficient					

Table 4. *Comparative Analysis of Removal Action Alternatives (Continued)*
Rico-Argentine Site

Treatment Alternative	Evaluation Criteria										
	Effectiveness			Implementability				Environment			Cost
	Contaminant Removal	Protectiveness/ Permanence	Time	Technical Feasibility	Implementation Safety Risk	OM&M Safety Risk	Availability/ Logistics	Waste Management	Energy Usage/ Emissions	Biodiversity/ Footprint	Total Cost
Lime Treatment - HDS	Effective when in operation but may struggle with removal efficiency at periods of high metals loading	Solids/Scale Management have greater potential to cause integrity losses in vessels and pipes	Multiple field seasons anticipated for construction and shakedown	Proven approach for mine water	Skilled labor required for piping, electrical, controls, etc.	More hazardous chemicals required (flocculant, lime)	6 FTEs, 40hr/week year-round	Significant increase in solids/sludge generation	High energy usage due to process equipment	Smaller footprint required	Highest capital cost ($12.2M)
	Removal of Al, Cd, and Mn may prove difficult	High turnover of some equipment (instruments such as pH/ORP probes)	Bench/pilot testing for design could postpone implementation	Need polishing treatment for some metals and TDS	Chemical exposure risk for lime and floc system and clean out of existing ponds for new infrastructure (settled solids and fugitive dust)	Process plant hazards, working near water, confined space in tanks	Frequent deliveries year-round for raw materials	Sufficient capacity for 30-year waste disposal in Solids Repository (eventually fills)	High energy usage in winter for heated ops building and freeze protection	Noise and traffic could negatively impact biodiversity and wildlife	Highest OM&M cost ($7.56/1,000 gal treated)
	Additional stages may be required for polishing	Tight process control allows for immediate process changes and quick response to upsets		Need bench/pilot scale testing for design	High SIMOPs risk and traffic control risk	Lime truck deliveries required year-round (winter truck access required)	Maintenance downtime could limit system availability	Potential for off-site waste footprint	Minimal emissions generated	Smaller on-site footprint could allow naturalization of unused land	High potential long-term costs
	Equalization pond can provide consistent flow rates	System depends on multiple pieces of critical equipment and failures could result in extended downtime		Pre-freshet maintenance limited between snowmelt and freshet	Working at heights (scaffolding), energy isolation, working near water, confined space entry, pinch points, hot work, rotating equipment, overhead utilities, pressure testing of piping	Significant maintenance as compared to wetlands required year-round	Recruiting qualified staff could be challenging	Difficulty managing solids waste during winter operations		Off-site footprint required in future for solids disposal	NPV cost of $4.92/1,000 gal treated
	Seasonal variations in meals loading may require frequent process adjustments			Sludge stabilization may be required	Transportation, delivery off-loading and lifting for installation risk for large scale equipment	Full time on-site winter staff required for operations and maintenance					
	Able to treat 25-year recurrence flow				Demolition of historic lime silo, potential lime dust exposure	Snow removal for Site access roads and avalanche hazards					

Table 4. *Comparative Analysis of Removal Action Alternatives (Continued)*
Rico-Argentine Site

Treatment Alternative	Evaluation Criteria										
	Effectiveness			Implementability				Environment			Cost
	Contaminant Removal	Protectiveness/ Permanence	Time	Technical Feasibility	Implementation Risk	OM&M Risk	Availability/ Logistics	Waste Management	Energy Usage/ Emissions	Biodiversity/ Footprint	Total Cost
Expanded Constructed Wetlands	Effective, able to meet criteria with few exceptions	Increased capacity and redundancy reduces downtime for maintenance and increased flexibility	Two field seasons anticipated for construction	Proven technology at the Site based on pilot and demonstration wetlands performance	Primarily requires general contractors and fewer specialty skilled labor	Mild chemical exposure (coagulant, settled solids) and H_2S generation risk	4 FTEs, 50hr/week during field season, biweekly or as needed during winter	Organic media replacement required (~10-year media life)	Semi-passive treatment and minimal equipment requires low energy	Large footprint required	Moderate capital cost ($9.1M)
	Improved redundancy, hydraulic capacity, and metals removal capacity from No Additional Action	Semi-passive system reduces likelihood of equipment or instrument failures		Clogging of media, media life uncertain	Chemical exposure risk for new chemical feed system and clean out of existing ponds for new infrastructure (settled solids, fugitive dust)	Working near water	Could use same vendors as currently utilized for the Site	Sufficient capacity for waste disposal in Solids Repository	Minimal emissions generated	Naturalistic and semi-passive system promotes biodiversity and wildlife benefits	Lowest OM&M cost ($5.67/1,000 gal treated)
	All SLT discharge receives at least partial treatment even when capacity of wetlands is exceeded	Semi-passive system creates lag in response to process changes and time to resolve upsets		Pre-freshet maintenance limited between snowmelt and freshet	High SIMOPs risk and traffic control risk	Maintenance is required year-round	Infrequent deliveries required for raw materials and no winter delivery necessary	No off-site waste disposal footprint required			Lower long-term cost than Lime - HDS
	Able to treat 25-year recurrence flow	System not easily modified, some flexibility exists for residence time and flow			Excavation, engulfment, working near water, working near H_2S zones, overhead utilities, pressure testing of piping	Limited winter on-site activities and Site access required	System redundancy prevents downtime for maintenance	Unknown rock media replacement frequency			NPV cost of $3.42/1,000 gal treated
					Biotreatment cell media inoculation and H_2S generation	Improved, less labor-intensive solids removal and maintenance design versus No Additional Action					
					Demolition of historic lime silo, potential lime dust exposure						

Abbreviations:
FTE - full-time equivalent
H_2S – hydrogen sulfide
gal – gallons
M - million
N/A – not applicable
ORP – oxidation reduction potential
SIMOPS – simultaneous operations
TDS – total dissolved solids

Table 5. *Removal Action Objectives Comparison Matrix*
Rico-Argentine Site

Treatment Alternative	Remove key contaminants loading to the Dolores River to improve water quality	Reduce metals concentrations to agreed-upon performance criteria	Treat base and freshet flows up to 25-year recurrence period (design permitting)	Provide safe reliable year-round operations	Minimize waste production and energy usage	Total Ranking Value
No Additional Action	1	1	1	2	3	**8**
Lime Treatment - HDS	2.5	2.5	3	1	1	**10**
Expanded Constructed Wetlands	2.5	2.5	2	3	2	**12**

Risk Ranking:

Lowest/Best	3
	2.5
Moderate/Good	2
	1.5
Not Desirable/Worst	1

Table 6. *Enhanced Wetland Demonstration Annual Mass Removal Efficiencies*
Rico-Argentine Site

Pollutant	2016 Efficiency (%)	2017 Efficiency (%)	2018 Efficiency (%)	2019 Efficiency (%)	2020 Efficiency (%)	Average (%)	Annual Mass Removal Average (pounds)[3]
Aluminum, Total	99.8%	99.8%	98.9%	98.3%	99.6%	99.3%	3,190
Arsenic, Total	95.7%	92.7%	89.7%	93.0%	94.9%	93.3%	3.8
Cadmium, Total	94.6%	99.4%	99.4%	99.4%	99.4%	98.4%	52.6
Copper, Total	99.9%	100.0%	99.6%	99.8%	99.9%	99.8%	684
Iron, Total	99.7%	99.2%	99.3%	98.0%	99.1%	99.0%	27,493
Lead, Total	99.6%	99.6%	99.3%	99.6%	99.5%	99.5%	46.1
Manganese, Total	69.3%	63.9%	82.5%	71.6%	84.1%	74.2%	3,977
Nickel, Total	75.9%	88.4%	83.6%	46.7%	81.6%	80.0%	9.7
Zinc, Total	82.9%	95.1%	97.8%	80.0%	97.3%	90.4%	8,460
Average EWD Flow Rate[2] (gpm)	495	475	420	495	510	480	-

Notes:

1. Annual mass removal efficiency calculated as a percentage removal of influent load (EWD treated flow).
2. Average EWD Flow Rate calculated from EWD flow measurements at FE-07.
3. Average EWD Mass Removal calculated for 2016-2019.

Table 7. *Estimated Costs for Removal Action Alternatives*
Rico-Argentine Site

Treatment Alternative	Estimated Total Capital Cost [1]	Estimated Annual Operations and Monitoring Cost [2]	Estimated Annual Operations and Monitoring Cost on 1,000 Gallons Treated Basis [3]	Estimated Net Present Value [4]	Estimated Net Present Value on 1,000 Gallons Treated Basis [5]
No Additional Action	$ -	$ 2,000,000	$ 6.35/1,000 gallons treated	- $ 31,850,000	- $ 3.37/1,000 gallons treated
Lime Treatment – HDS	$ 12,200,000	$ 2,600,000	$ 7.56/1,000 gallons treated	- $ 53,000,000	- $ 5.14/1,000 gallons treated
Expanded Constructed Wetland	$ 9,100,00	$ 1,950,000	$ 5.67/1,000 gallons treated	- $ 36,900,000	- $ 3.58/1,000 gallons treated

Notes:

1. Includes direct equipment and construction costs and indirect construction costs (administration, safety, engineering design, quality assurance, and oversight). Does not include treatment solids repository costs any alternative. These costs are included in the Net Present Value calculation.
2. Includes costs for labor, materials, equipment, analytical services, utilities, and other direct and indirect costs. Includes matrix replacement costs adjusted to an annual basis for the No Additional Action and the Expanded Constructed Wetlands alternatives. Assumes 10-year life of matrix for No Additional Action and Expanded Constructed Wetlands alternatives.
3. Cost on 1,000 gallons treated basis based on current treatment capacity of approx. 600 gpm (315 million gallons per year) for No Additional Action. Cost on per 1,000 gallons treated basis based on complete treatment of average annual DR-3 flow from 2011-2020 of 655 gpm (344 million gallons per year) for Expanded Constructed Wetland and Lime-Treatment HDS.
4. Estimated Net Present Value calculated for a 30-year period on a pre-tax basis with an 7.0% discount rate and a 2.0% inflation rate.
5. Cost on 1,000 gallons treated basis based on current treatment capacity of approx. 600 gpm (315 million gallons per year) for 30 years for No Additional Action. Cost on per 1,000 gallons treated basis based on complete treatment of average annual DR-3 flow from 2011-2020 of 655 gpm (344 million gallons per year) for 30 years for Expanded Constructed Wetland and Lime Treatment – HDS.

Attachment A: Enhanced Wetland Demonstration Efficiency Plots

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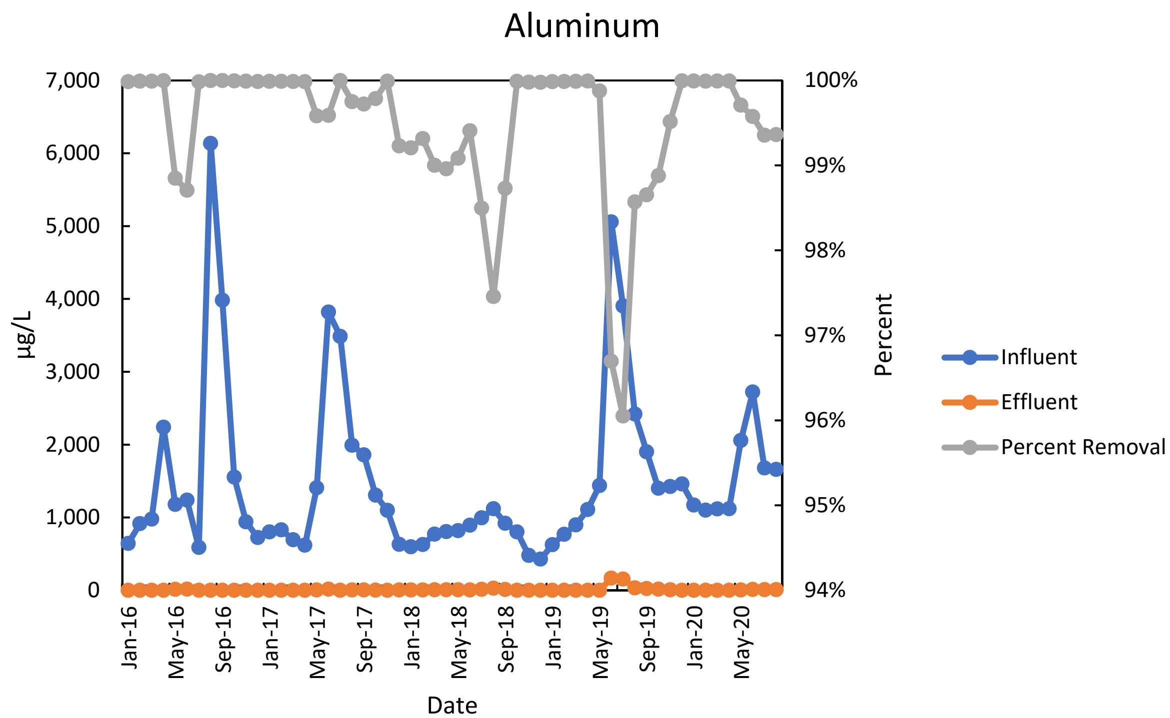
ENHANCED WETLAND DEMONSTRATION (EWD) MONTHLY FLOW-VOLUME AVERAGE EFFICIENCY PLOTS

The below plots contain monthly flow-volume average influent, effluent, and efficiency data for the EWD since the first complete year of operation (2016) to present (2020). All concentration data plotted is the total fraction of the element of interest.

The plots show a steady removal of most metals of interest for most of the year. Flows to the EWD system have generally been maintained around 400-500 gpm, depending largely on the magnitude of the St. Louis Tunnel discharge and the Site maintenance schedule for EWD components. When influent flow exceeds the EWD design capacity, the excess flow is routed to Pond 12 for retention settling prior to being released to the Dolores River. Effluent concentrations shown in the plots and used for removal efficency calculations are for samples taken directly from the EWD effluent, before mixing with bypass and other treatment systems on Site (CWD).

During years when a freshet is occuring, increases in flow and metals concentrations are observed. The sudden, large increase in metal concentrations can affect the removal of some metals for a short duration, as expressed in the below plots as a significant increase in influent concentrations during the May-August timeframe. Due to the passive and biotic nature of the EWD, sudden concentration changes of the influent waters can stress the system and reduce the removal efficiency of the treatment cells in the EWD. This is expressed by a dip in removal efficiency and an increase in effluent concentrations in the plots. Most metals stay below the appropriate treatability goal concentrations during the freshet and resolve back to normal removal efficiencies post-freshet.

The freshet at the Site is characterised by a sharp increase (three to four times the low flow concentration) of influent manganese and zinc concentrations. The EWD was not initially designed to treat such large concentrations of manganese and zinc, which can result in a sudden but short decrease in removal efficiency as the increased metal load stresses the biotic processes. Looking forward, an additional treatment step to target additional manganese and zinc removal (such as a rock drain) should be considered.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4,000
3,000
2,000
1,000
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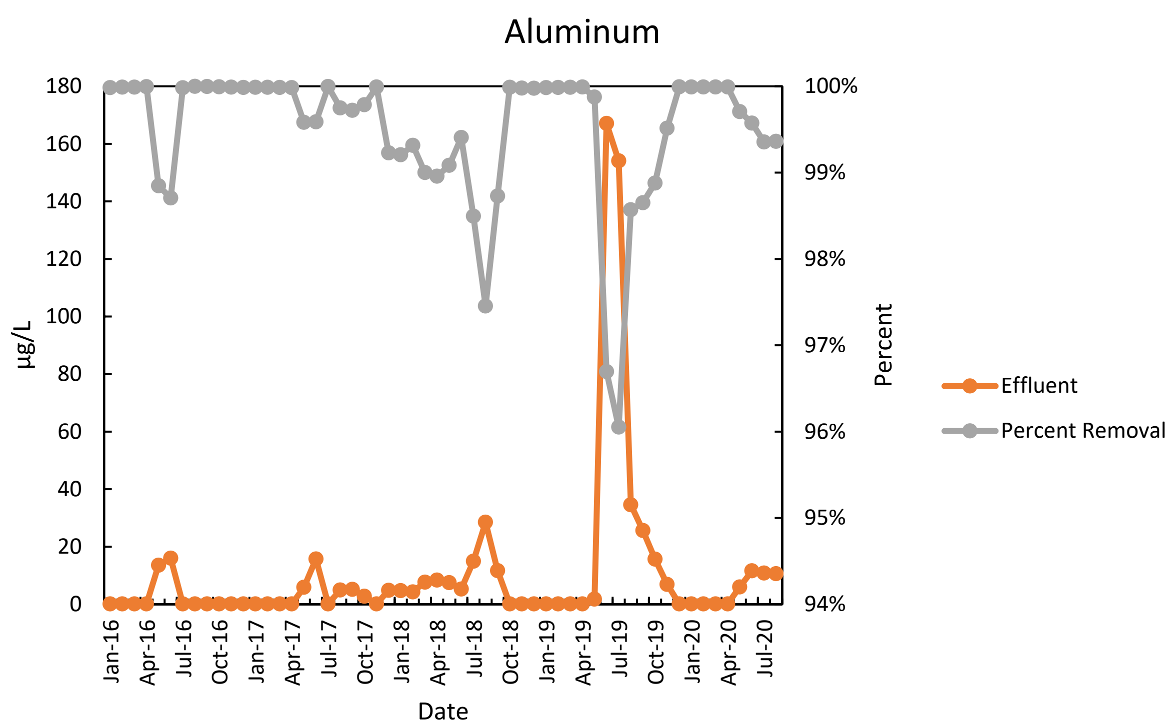
µg/L
100%
99%
98%
97%
96%
95%
94%
Percent
Jan-16
May-16
Sep-16
Jan-17
May-17
Sep-17
Jan-18
May-18
Sep-18
Jan-19
May-19
Sep-19
Jan-20
May-20
Date
Influent
Effluent
Percent Removal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Percent
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Jul-16
Oct-16
Jan-17
Apr-17
Jul-17
Oct-17
Jan-18
Apr-18
Jul-18
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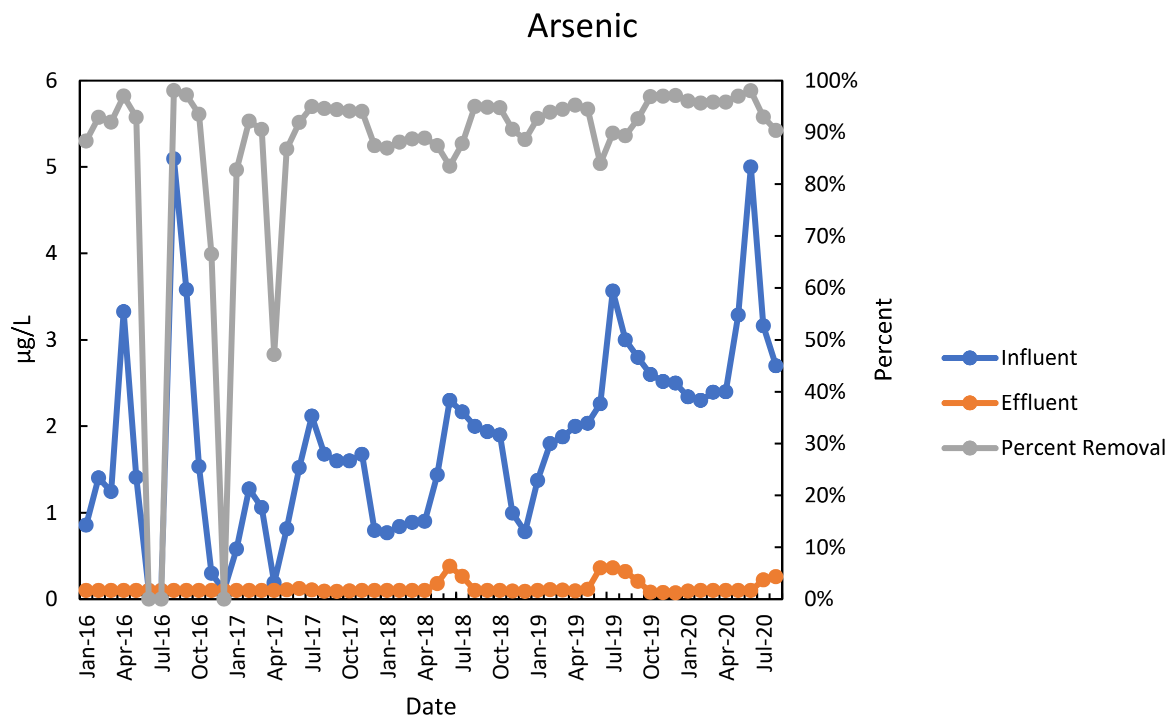
Apr-19
Jul-19
Oct-19
Jan-20
Apr-20
Jul-20
Date
Effluent
Percent Removal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5
4
3
2
1
0
µg/L
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80%
70%
60%
50%
40%
30%
20%
10%
0%
Percent
Jan-16
Apr-16
Jul-16
Oct-16
Jan-17
Apr-17
Jul-17
Oct-17
Jan-18
Apr-18
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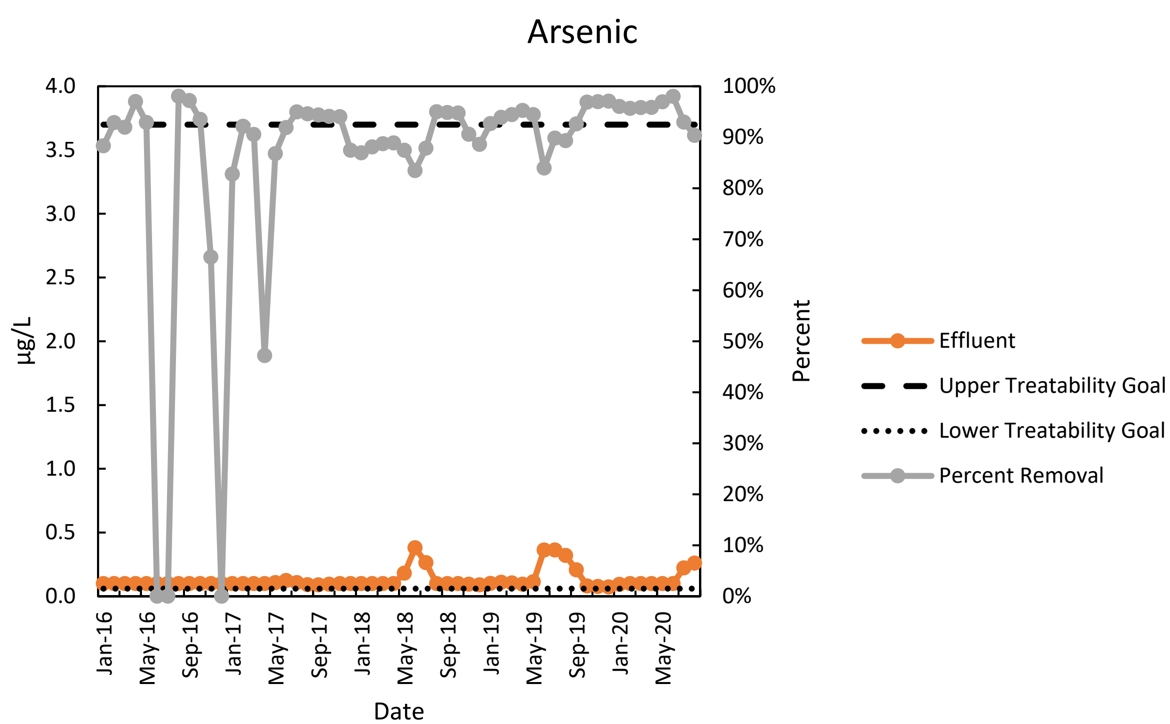
Date
Influent
Effluent
Percent Removal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3.0
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1.5
1.0
0.5
0.0
µg/L
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90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Percent
Jan-16
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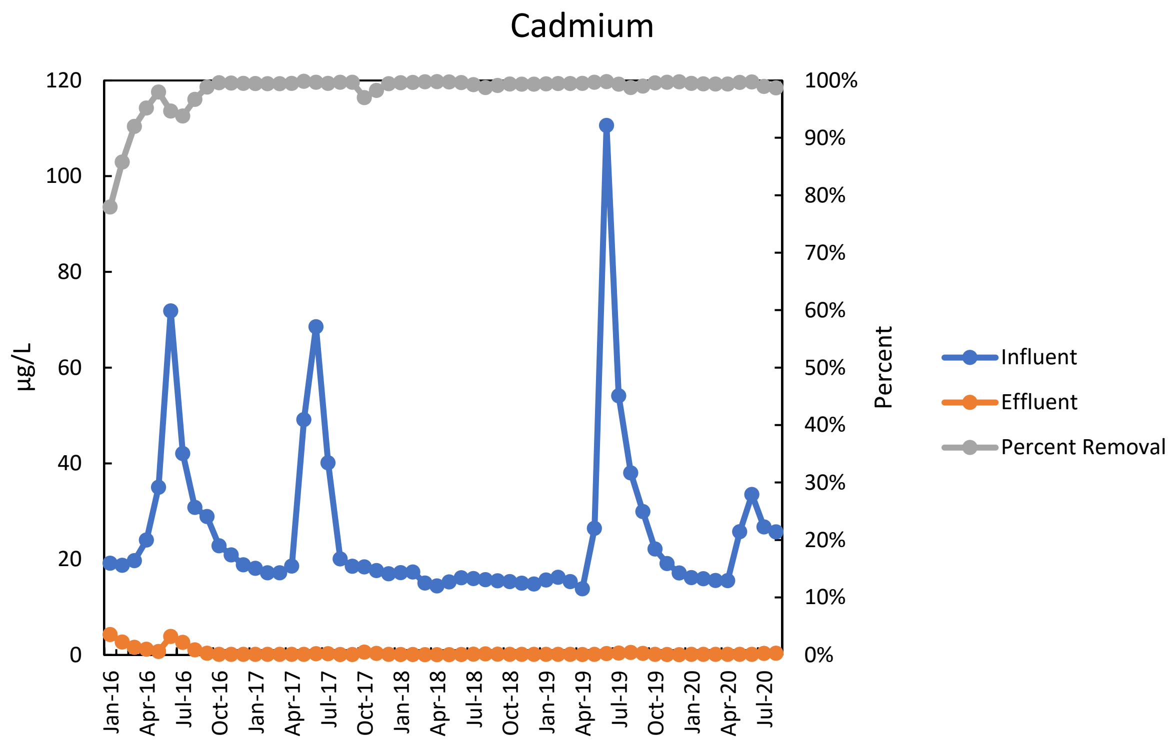
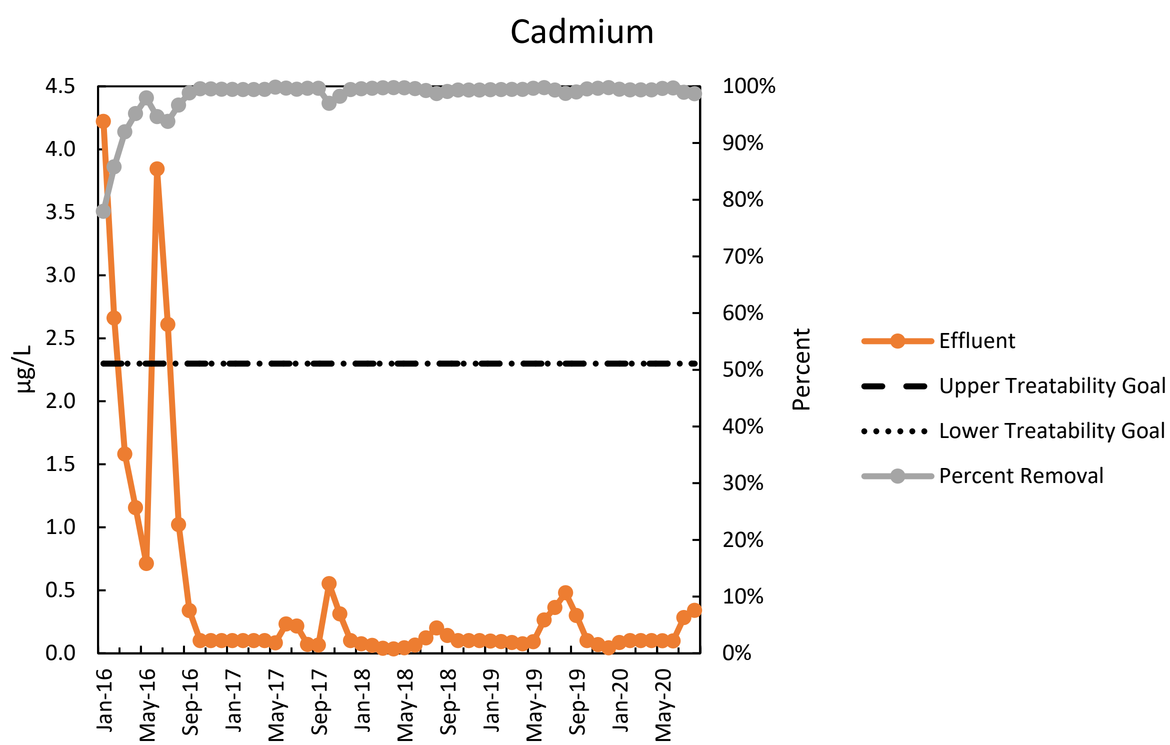
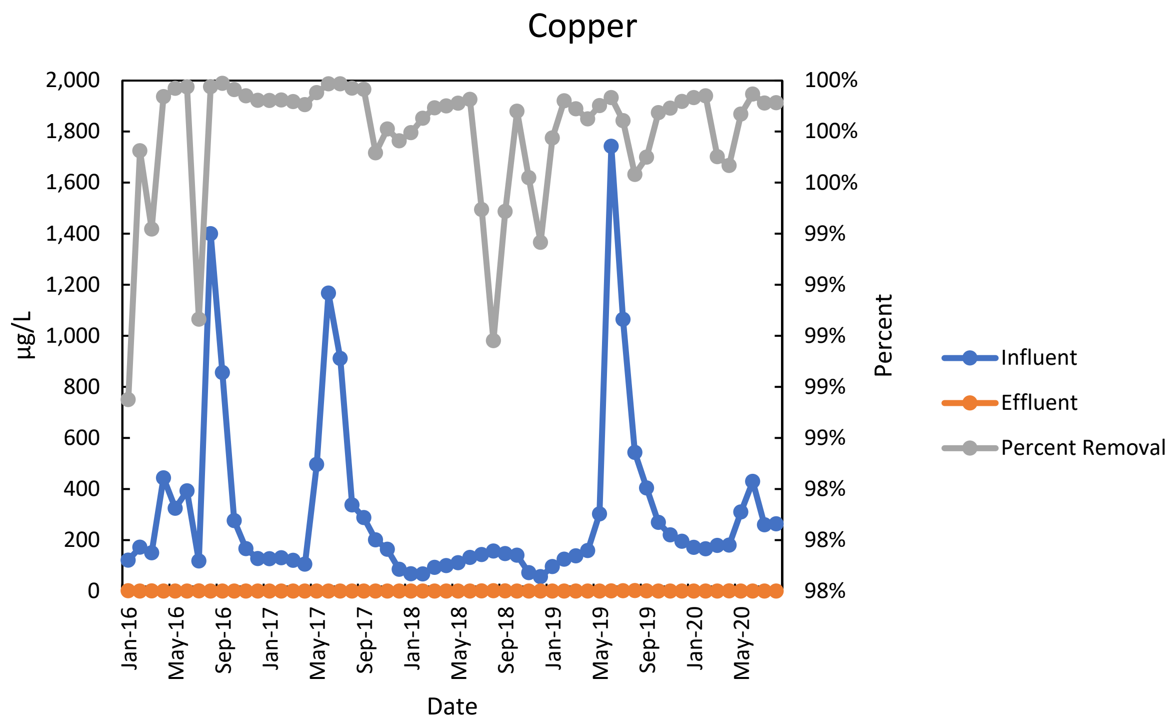
Jan-17
May-17
Sep-17
Jan-18
May-18
Sep-18
Jan-19
May-19
Sep-19
Jan-20
May-20
Date
Effluent
Upper Treatability Goal
Lower Treatability Goal
Percent Removal


Cadmium
µg/L
Percent
Influent
Effluent
Percent Removal


Cadmium
µg/L
Percent
Effluent
Upper Treatability Goal
Lower Treatability Goal
Percent Removal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May-16
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Jan-17
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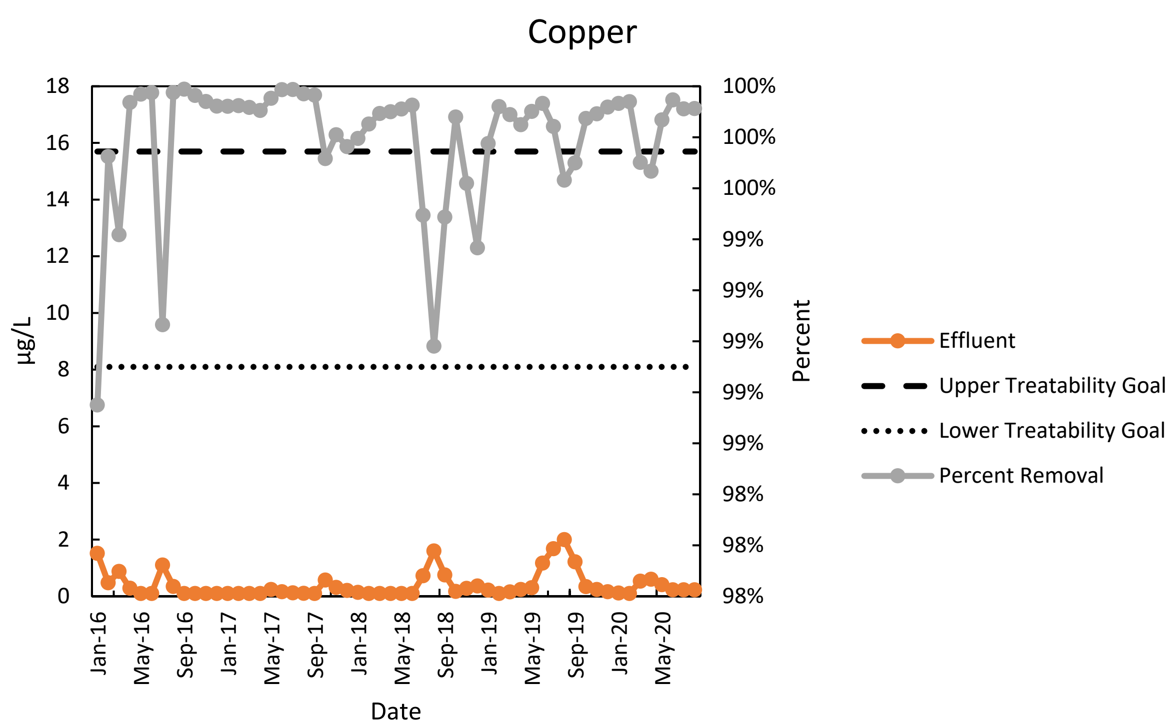
Jan-20
May-20
Date
Influent
Effluent
Percent Removal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10
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6
4
2
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µg/L
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100%
100%
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99%
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98%
98%
Percent
Jan-16
May-16
Sep-16
Jan-17
May-17
Sep-17
Jan-18
May-18
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May-19
Sep-19
Jan-20
May-20
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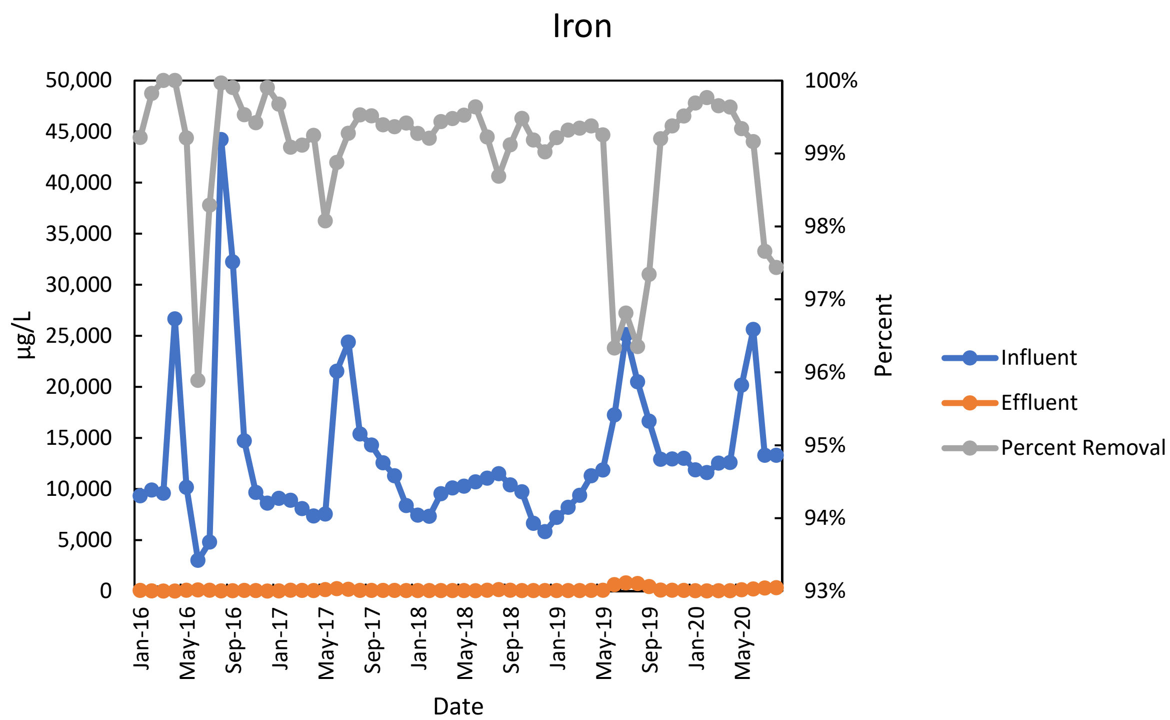
Effluent
Upper Treatability Goal
Lower Treatability Goal
Percent Removal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5,000
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93%
Percent
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Sep-16
Jan-17
May-17
Sep-17
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May-19
Sep-19
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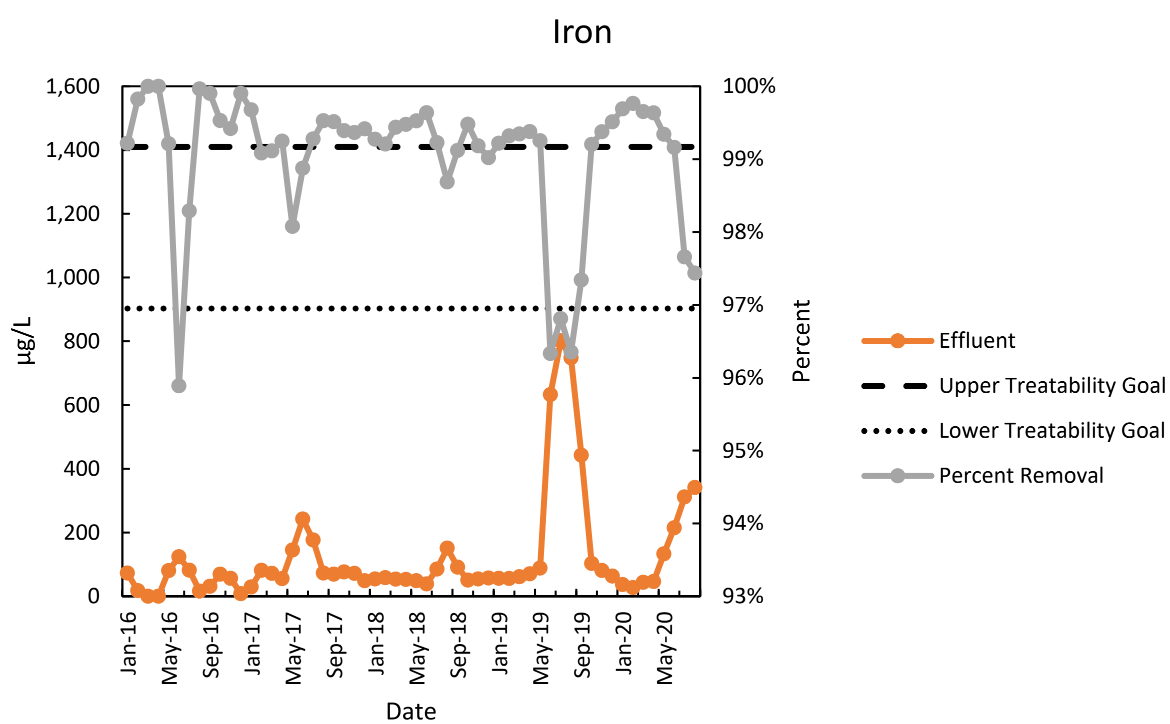
May-20
Date
Influent
Effluent
Percent Removal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400
200
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93%
Percent
Jan-16
May-16
Sep-16
Jan-17
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Sep-17
Jan-18
May-18
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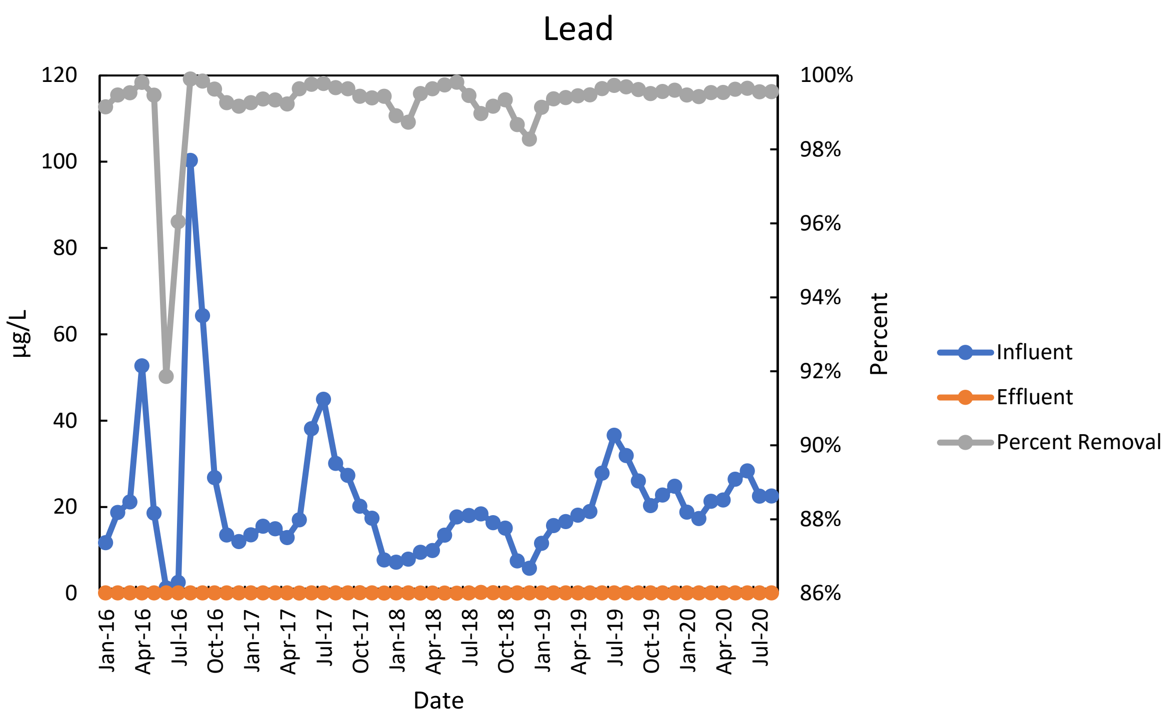
May-19
Sep-19
Jan-20
May-20
Date
Effluent
Upper Treatability Goal
Lower Treatability Goal
Percent Removal



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Jan-18
Apr-18
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Jul-20
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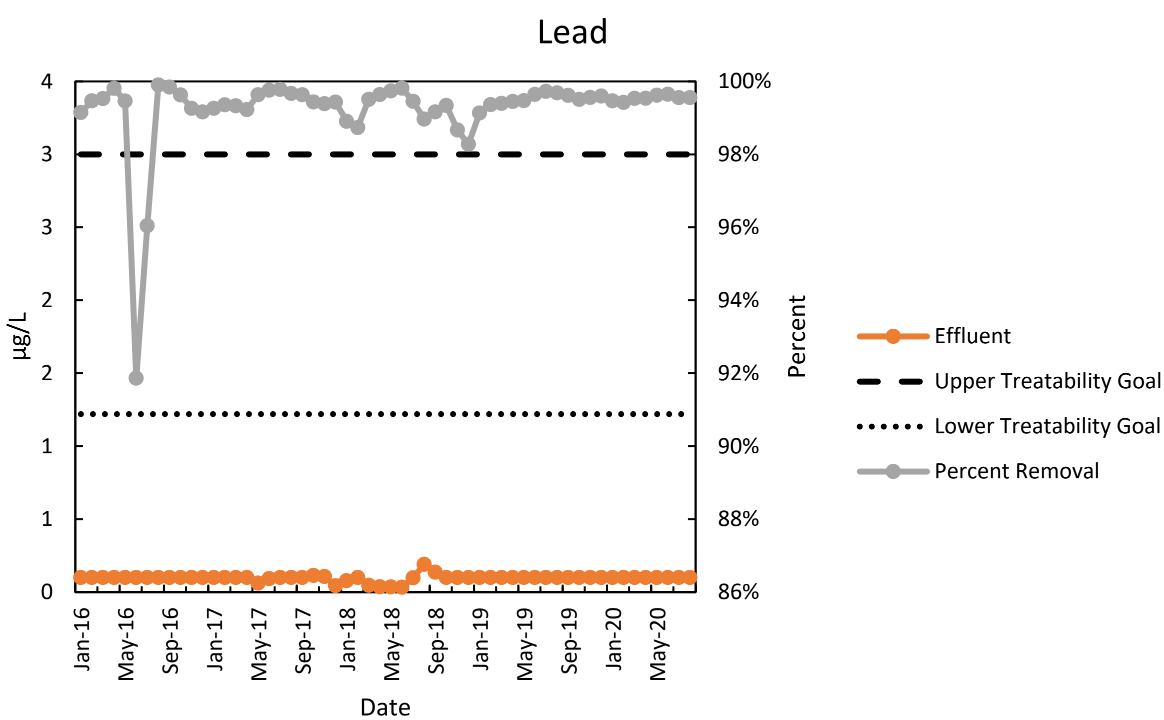
Influent
Effluent
Percent Removal



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Jan-16
May-16
Sep-16
Jan-17
May-17
Sep-17
Jan-18
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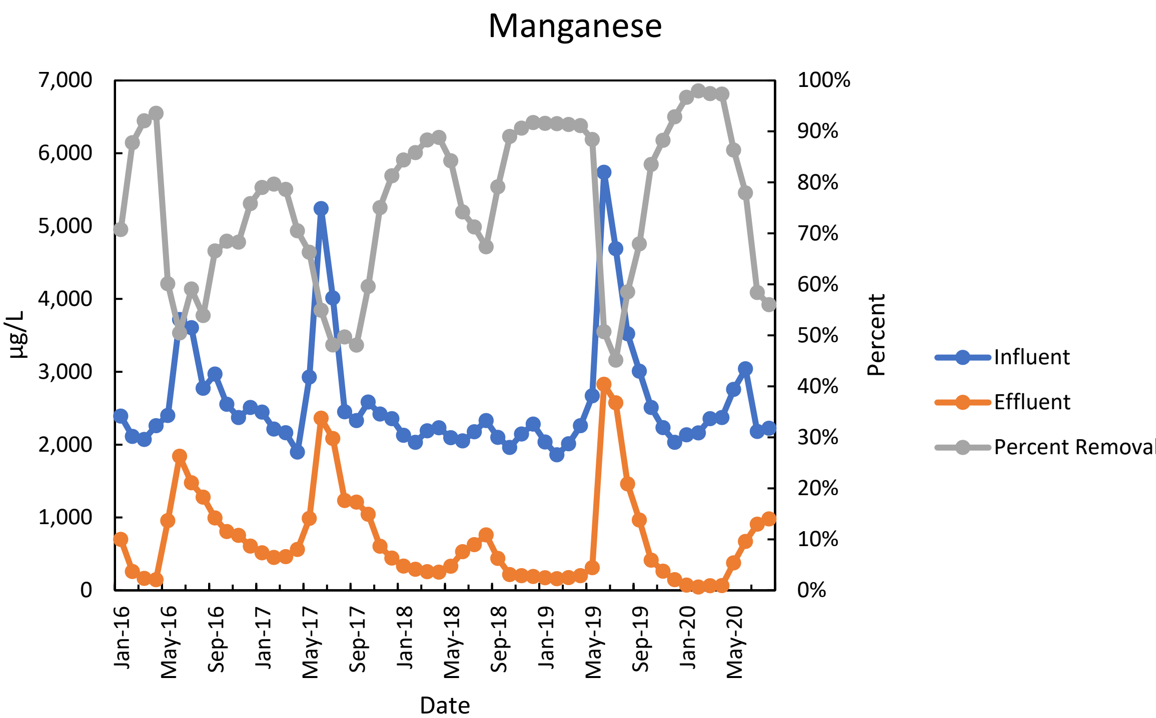
May-19
Sep-19
Jan-20
May-20
Date
Effluent
Upper Treatability Goal
Lower Treatability Goal
Percent Removal



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Jan-17
May-17
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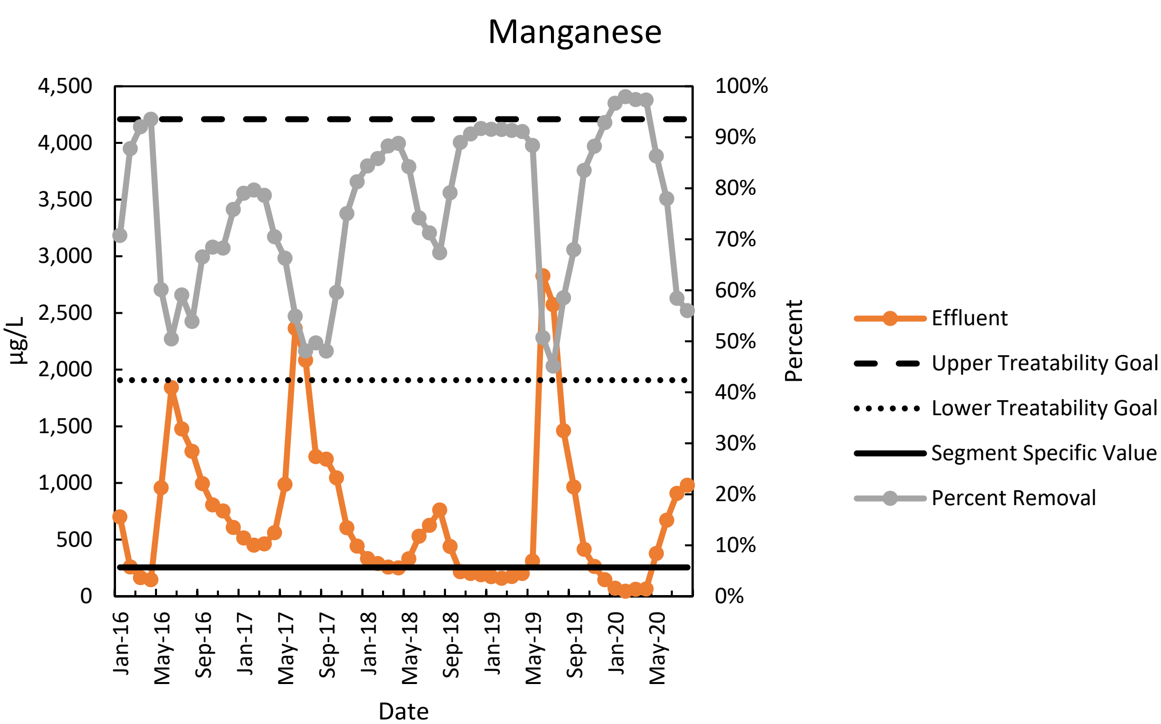
May-20
Date
Influent
Effluent
Percent Removal



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Jan-16
May-16
Sep-16
Jan-17
May-17
Sep-17
Jan-18
May-18
Sep-18
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Sep-19
Jan-20
May-20
Date
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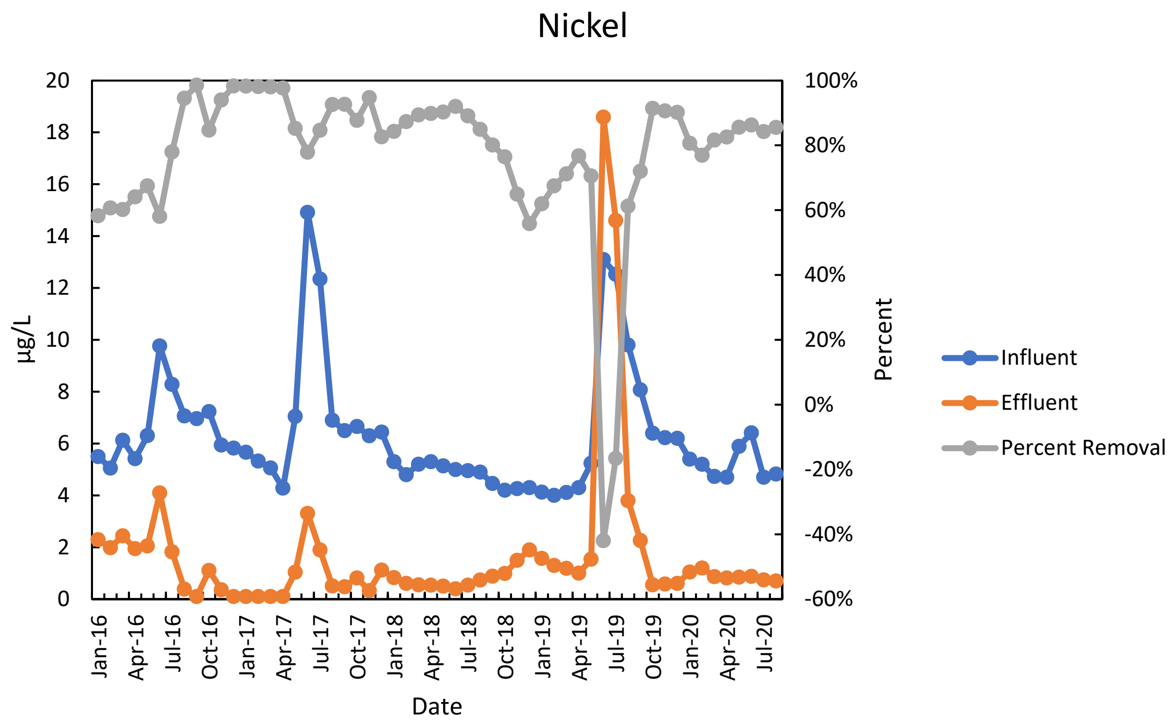
Upper Treatability Goal
Lower Treatability Goal
Segment Specific Value
Percent Removal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µg/L
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Effluent
Percent Removal
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-60%
-40%
-20%
0%
20%
40%
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80%
100%
Jan-16
Apr-16
Jul-16
Oct-16
Jan-17
Apr-17
Jul-17
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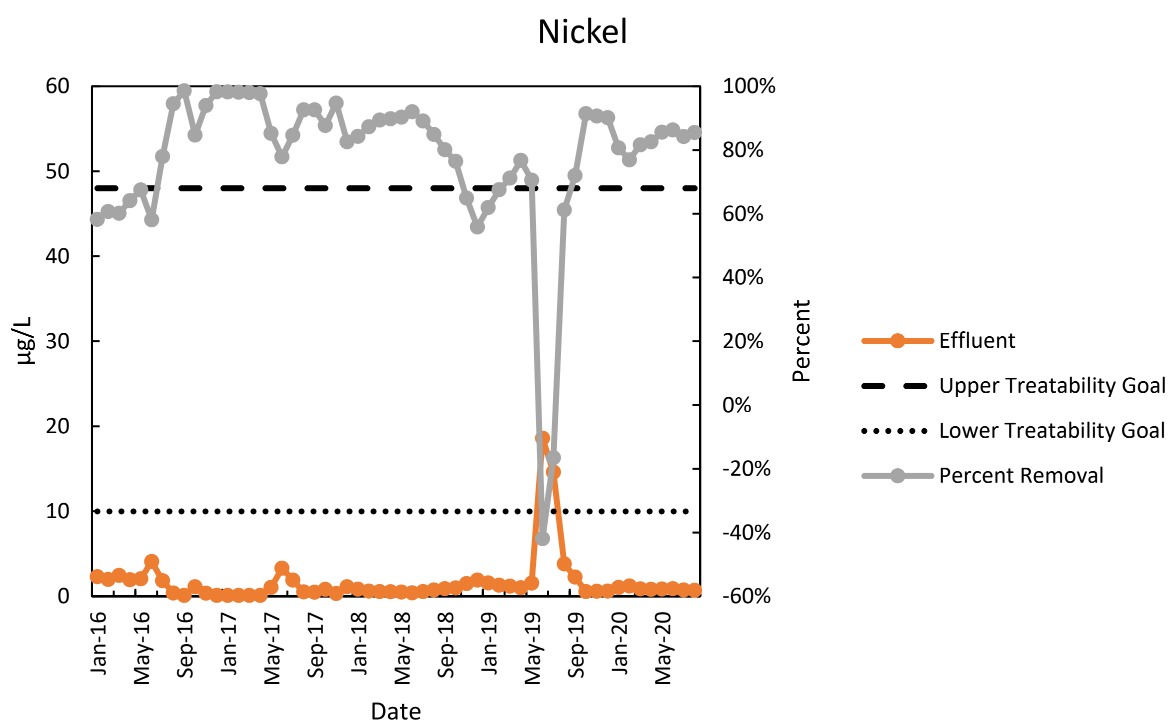
Jul-20


Nickel
µg/L
Percent
Date
Effluent
Upper Treatability Goal
Lower Treatability Goal
Percent Removal
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10
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40
50
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-40%
-20%
0%
20%
40%
60%
80%
100%
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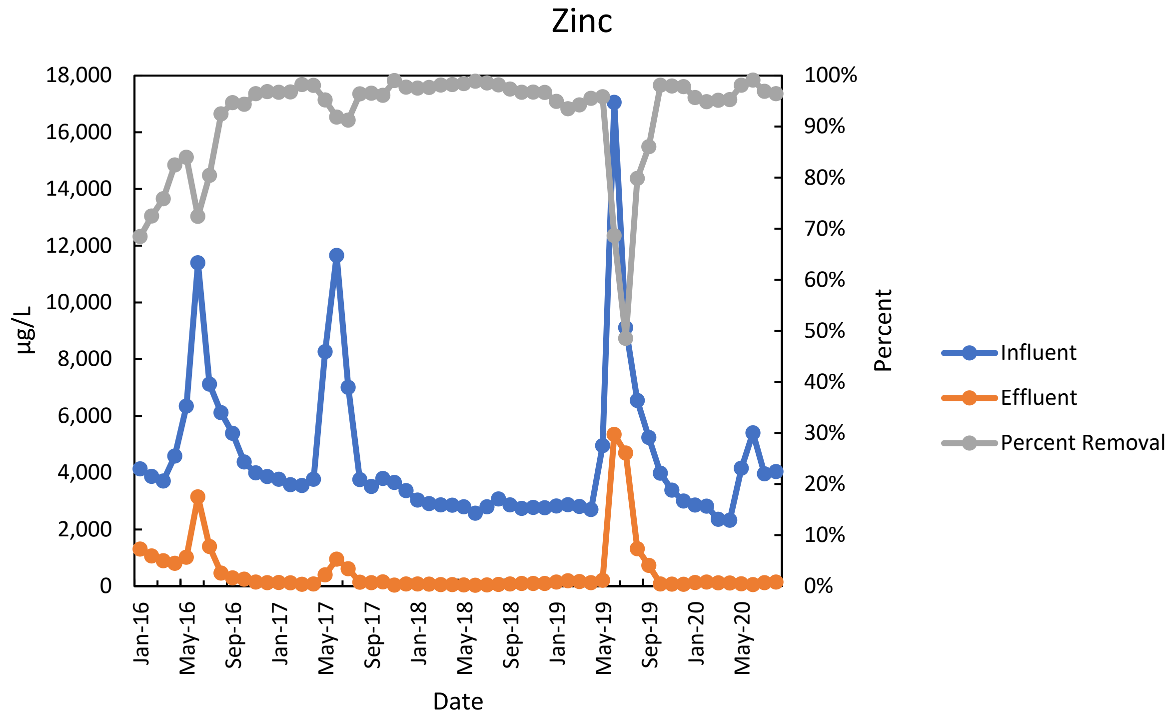
Sep-19
Jan-20
May-20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µg/L
Percent
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10,000
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6,000
4,000
2,000
0
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Jan-16
May-16
Sep-16
Jan-17
May-17
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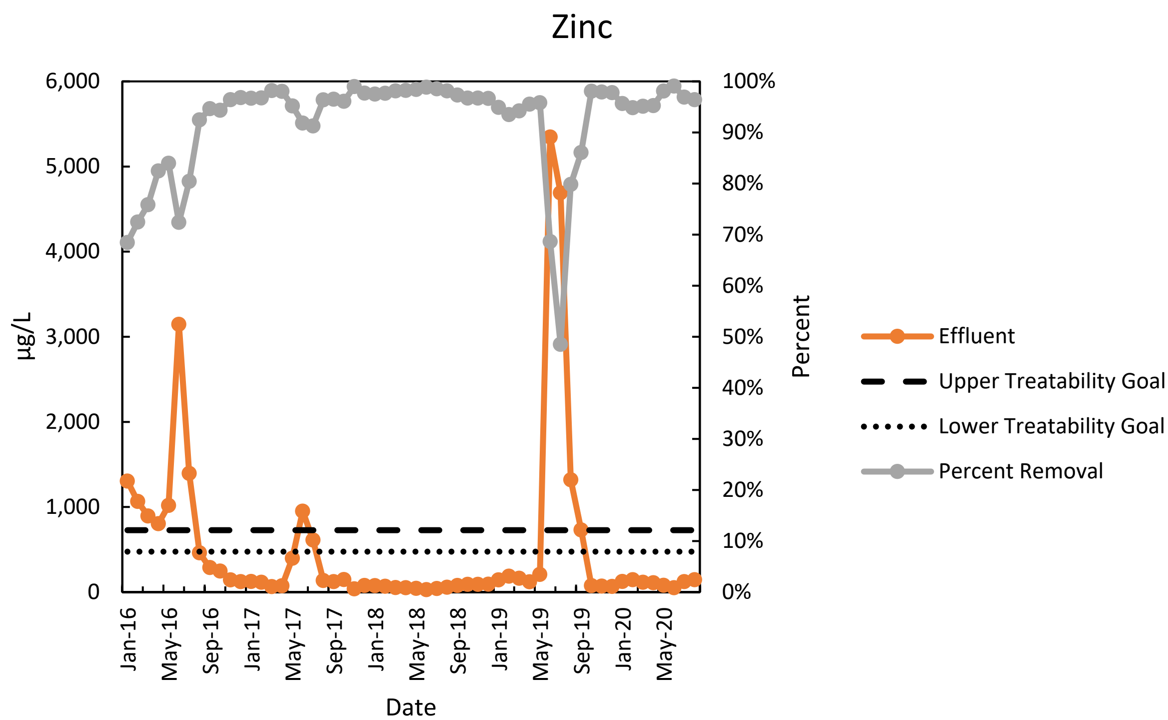
Influent
Effluent
Percent Removal


Zinc
µg/L
Percent
Date
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5,000
4,000
3,000
2,000
1,000
0
100%
90%
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60%
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May-16
Sep-16
Jan-17
May-17
Sep-17
Jan-18
May-18
Sep-18
Jan-19
May-19
Sep-19
Jan-20
May-20
Effluent
Upper Treatability Goal
Lower Treatability Goal
Percent Removal

Rico-Argentine Site

Removal Action Work Plan

Appendix B: Water Treatment Performance Criteria

September 2021

Administrative Settlement Agreement and Order on Consent

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1.0 INTRODUCTION AND BACKGROUND

1.1 Purpose

This Water Treatment Performance Criteria document for the Rico-Argentine Site (hereafter referenced as the Site) establishes Removal Action (RA) performance criteria for water treatment. These criteria will be applied to treated water that flows from the St. Louis Tunnel (SLT) and interconnected mine workings that ultimately discharge to the Dolores River. This document has been prepared as an appendix to the Administrative Settlement Agreement and Order on Consent (AOC) Removal Action Work Plan (RAWP) (EPA 2021).

1.2 Background

The Site is located approximately 0.75 miles north of the northern boundary of the Town of Rico in Dolores County, Colorado. The Site description and background are detailed in the AOC RAWP to which this document is appended.

As detailed in the Performance Evaluation and Technology Selection Report (Appendix A of the AOC RAWP), the selected water treatment system for water that flows from the SLT is an expansion of the current demonstration-scale constructed wetlands treatment systems (Expanded Constructed Wetlands Treatment System).

The current demonstration-scale treatment system discharges to Pond 12 in the St. Louis Ponds System. It is anticipated that the Expanded Constructed Wetlands Treatment System may discharge to Pond 9 (see Figure 1). Treated water currently flows through the St. Louis Ponds System, and subsequently to the Dolores River at sampling location DR-6 (see Figure 1). The discharge is to segment COSJDO03 of the Dolores River as identified in the Code of Colorado Regulations (Water Quality Control Commission Regulation # 34; CDPHE, 2020a). The segment is described as the "*Mainstem of the Dolores River from a point immediately above the confluence with Horse Creek to a point immediately above the confluence with Bear Creek*".

2.0 DEVELOPMENT OF PERFORMANCE CRITERIA

The performance criteria set forth in this appendix were developed to satisfy the objectives and requirements of the removal action. Under the 2011 Unilateral Administrative Order (UAO) (Docket No. CERCLA-08-2011-0005, March 17, 2011), Atlantic Richfield was required to develop a preliminary design for and construct a new treatment system for the SLT discharge. The Removal Action Work Plan appended to the UAO states that *"The objective of this task … is to provide a water management system that provides a sustainable approach to managing the St. Louis Tunnel discharge that is protective of the Dolores River and complies with the associated Applicable or Relevant and Appropriate Requirements (ARARs)."* Under the AOC, Atlantic Richfield must include final performance criteria in the SLT Water Treatment System Final Design. Further, following construction and shakedown of the SLT water treatment system, performance criteria will be updated, as necessary, and provided in the Operations Plan (see AOC § 23). Evaluation of system performance against the performance criteria will occur during system operation per this plan.

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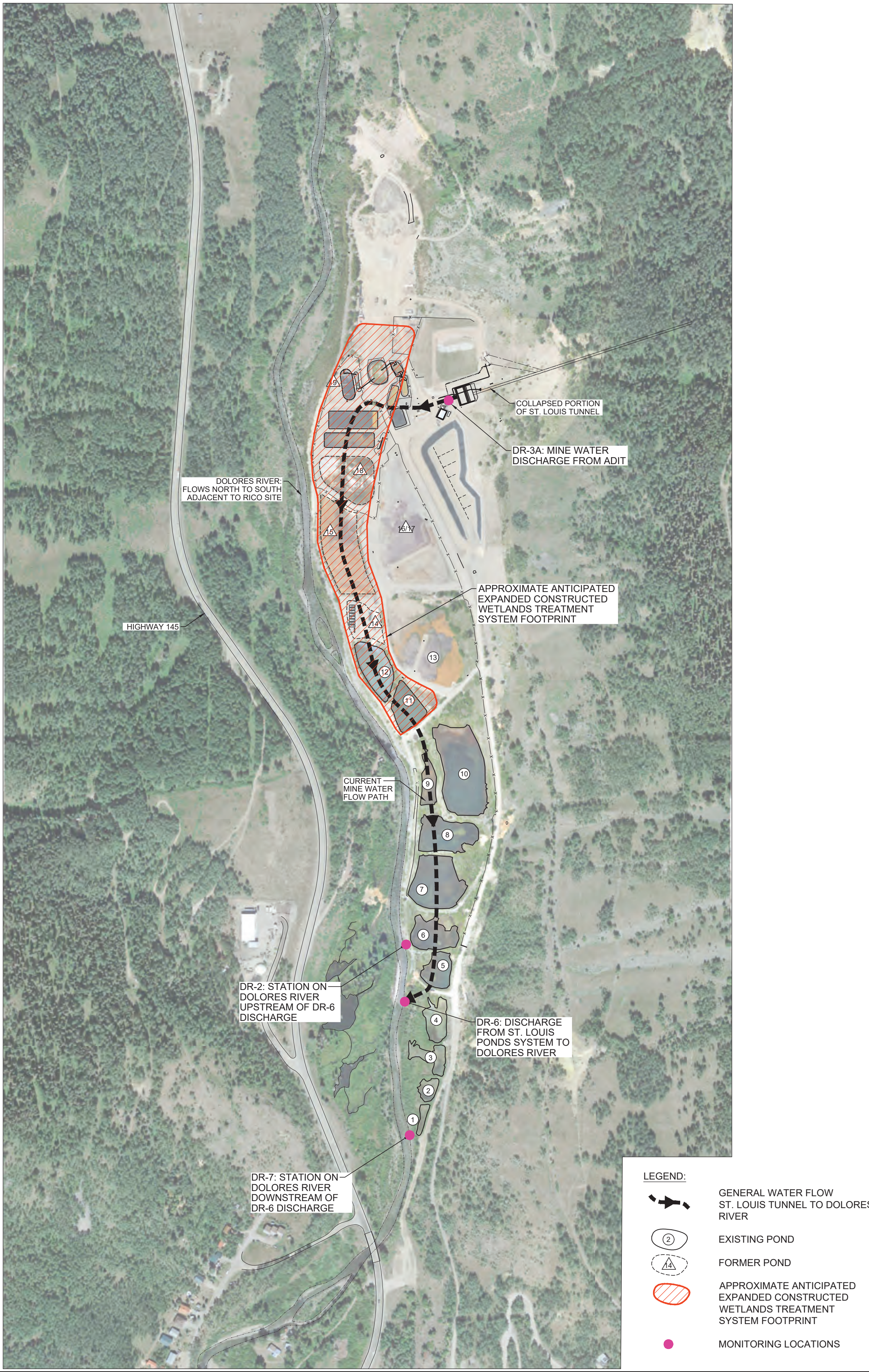

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Copper Environmental Consulting
A PRISM SPECTRUM COMPANY

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Atlantic Richfield Company

Project: 70817.20

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Rico - Argentine Mine Site
Dolores County, Colorado

Figure 1

Rico Site Layout and Selected Monitoring Locations

2.1 Site-Specific Water Treatment Aspects

Factors considered in developing the performance criteria for the SLT Water Treatment System include:

- **Limited Available Area for Water Treatment System and Other Site Infrastructure.** The Site consists of a comparatively small flood plain between the Dolores River and the adjoining Telescope Mountain.
- **Freshet vs. Non-freshet Conditions.** Relatively short-term, yet potentially severe, freshet conditions (high flow and high metals concentrations) associated with spring runoff complicate water treatment design and operation, because there are technical and practical limitations to the design of the treatment system that govern effectiveness, including sizing, flow and hydraulic retention time requirements, along with the ability of biological treatment systems to handle rapidly changing conditions (e.g. pH, metals concentrations, solids, etc.). Freshet conditions can be highly variable year-to-year. Weak freshets in three of the last four years have made it difficult to implement necessary studies to optimize a final design for freshet conditions.
- **Maximum Design Flow.** As the source of SLT water is infiltrated rain or snowmelt, there may be infrequent extreme freshet flow years where the peak SLT flow will exceed the maximum treatment system design flow. While modeling has indicated that the statistical average recurrence interval of such years will be 25 years or more, in those extremely high flow years, there will be periods in which the portion of SLT flow above the treatment system design flow may be diverted around a portion of the treatment system and be blended with treated effluent through the St. Louis Ponds System prior to discharge. The 25-year recurrence period is a statistical correlation; actual conditions may result in such flows more, or less often than once every 25 years. It is anticipated that all SLT flow will receive treatment for suspended solids, and that the portion above the maximum design flow will be diverted around the biocell, aeration cascade, and rock drain process steps. In these instances, there may be a time lag in biocell response as it returns to normal operating conditions.
- **Winter Access and Conditions, with Associated Health and Safety Considerations.** The Site is relatively remote and encounters prolonged and harsh winter conditions along with known avalanche hazards.

2.2 Performance Criteria Considerations

The SLT waters will flow through the Expanded Constructed Wetlands Treatment System, the St. Louis Pond System, and subsequently to the Dolores River. Colorado Regulation No. 34.6(4) establishes classifications and water quality standards for streams in the San Juan and Dolores River Basins. The receiving stream segment #COSJDO03 is classified for Agriculture, Cold Water Aquatic Life 1, Class E Recreation, and Water Supply uses. These uses determine water quality standards for physical and biological, inorganic, and metal parameters, which are specified in Colorado Department of Public Health and Environment Water Quality Control Commission 5 CCR 1002-34 Regulation No. 34, Classifications and Numeric Standards for San Juan River and Dolores River Basins; Appendix 34-1 contains Stream Classifications and Water Quality Standards Tables (current version, effective date 06/30/2020) as provided in Table 1.

Table 1*. Water Quality Standards for Dolores River Segment COSJDO03*

Physical and Biological		
Temperature (°C)	DM CS-I Jun-Sept 21.7 Oct-May 13.0	MWAT CS-I Jun-Sept 17.0 Oct-May 9.0
	acute	chronic
Dissolved Oxygen (mg/l) D.O. (spawning)	--	6.0 (minimum) 7.0 (minimum)
pH	6.5-9.0	--
chlorophyll a (mg/m^2)	--	150
E.coli chronic colonies/100 ml	--	126
Inorganic (mg/l)		
	acute	chronic
Ammonia	TVS	TVS
Boron	--	0.75
Chloride	--	250
Chlorine	0.019	0.011
Cyanide	0.005	--
Nitrate	10	--
Nitrite	0.05	--
Phosphorus	--	0.11
Sulfate	--	250 (WS)
Sulfide	--	0.002
Metals (µg/l)		
	acute	chronic
Aluminum	--	TVS
Arsenic	340	--
Arsenic, total recoverable	--	0.02-3.0*
Beryllium	--	--
Cadmium	TVS	TVS
Cadmium, total recoverable	5.0	--
Chromium +3	TVS	TVS
Chromium +3, total recoverable	50	--
Chromium +6	TVS	TVS
Copper	TVS	TVS
Iron	--	300 (WS)
Iron, total recoverable	--	1000
Lead	TVS	TVS
Lead, total recoverable	50	--
Manganese	TVS	TVS/255
Mercury	--	0.01(t)
Molybdenum, total recoverable	--	150
Nickel	TVS	TVS
Nickel, total recoverable	--	100
Selenium	TVS	TVS
Silver	TVS	TVS
Uranium	--	--
Zinc	TVS	TVS

Notes:
"--": No standard specified in Reg. 34 for segment COSJDO03.

All metals are dissolved unless otherwise noted. Compliance for dissolved constituents determined by potentially dissolved analyses.
*Arsenic(chronic) = temporary hybrid standard with expiration date of 12/31/2024
CS-I = cold stream tier one
DM = daily maximum temperature
mg/l = milligrams per liter
MWAT = maximum weekly average temperature
t = total
TVS = table value standard (CDPHE 6/30/20, Section 34.6)
µg/l = micrograms per liter
WS = water supply

In developing performance criteria for the SLT Water Treatment System, it is important to consider the relevant regulatory framework. In Colorado, water quality standards are used to derive effluent limitations for industrial discharges permitted in accordance with the Colorado Discharge Permit System Regulations, Regulation 61, 5CCR 1002-61. Because the SLT Water Treatment System will be designed, constructed, and operated as part of a CERCLA removal action, it will not be subject to a Colorado Discharge Permit System (CDPS) discharge permit (*see* 42 U.S.C.§ 9621(e)). Accordingly, water quality-based effluent limits will not be established for the discharge. Even so, numeric water quality standards for segment #COSJDO03, and numeric effluent limitations based on those standards, may be considered potential ARARs for the removal action. Under CERCLA, however, attainment of ARARs is only required to the extent practicable considering the exigencies of the situation and other appropriate site-specific factors. *See* 40 C.F.R. § 300.415(j).

Based on this regulatory framework, Atlantic Richfield requested in November 2018 that staff with the Colorado Water Quality Control Division (the "Division") develop preliminary effluent limitations (PELs) for the SLT Water Treatment System discharge. The Division offers a fee-based service to identify PELs for a potential discharge to state waters, which may be used by entities to plan and design the wastewater management and treatment processes to meet these objectives. At the time Atlantic Richfield submitted its PEL application in early 2018, it had not yet been determined whether post-construction operation of the SLT Water Treatment System would require issuance of a CDPS permit or remain subject to a CERCLA AOC.

The Division delivered its PEL document to Atlantic Richfield on March 24, 2020. A copy of the PEL document is enclosed as Attachment 1. It included multiple sets of PELs for the SLT discharge based on the following discharge scenarios: direct discharge to the Dolores River at a design flow of 1.74 MGD, non-seasonal; direct discharge to the Dolores River at a design flow of 1.74 MGD, May 1 – August 31; direct discharge to the Dolores River at a design flow of 1.44 MGD, September 1 – April 30; and discharge to wetlands at a design flow of 1.74 MGD, non-seasonal. The calculated PELs for certain constituents were substantially lower than concentrations that have been determined to be achievable for the SLT Water Treatment System, at least during freshet conditions.

Independent of the Division's PEL process, Atlantic Richfield performed an evaluation of potential SLT discharge effluent limitations using the methods prescribed in Regulation 61. The comparative analysis of Atlantic Richfield's and the Division's PELs is summarized in Attachment 2. As explained in the Attachment, Atlantic Richfield's input assumptions and methodologies differed from CDPHE's in certain material respects, including:

- Table Value Standards (TVS) for metals based on in-stream hardness;
- Dolores River low-flow calculations; and
- Selected in-stream segment standards.

These differences resulted in several discrepancies in the calculated PELs.

Atlantic Richfield's evaluation also highlighted the overly strong conservative nature of the PEL calculation process for this specific situation. For example, the PEL document calculations for chronic standards were based on a Design Flow of 2.7 cubic feet per second (CFS) and a Dolores River flow of 5.4 CFS (the 30E3 chronic low flow), or a ratio of Dolores River flow to Design Flow of 2.0. Historical flow records indicate that this ratio has only been approached in two periods in the last ten years as shown in Figure 2 below, and that generally much more assimilative capacity is available. These two periods were during the extremely dry winters of 2017-2018 and 2018-2019, with associated low Dolores River flows. Over the last ten years, the ratio has been higher than 3.0 for 98.6% of the time and above 4.0 for 96.4%. All else being equal (hardness, background concentration, etc.), flow ratios of 3.0 and 4.0 result in increases of 33% and 66%, respectively, over calculated water quality-based effluent limits in the Division's PEL. The conclusion from Atlantic Richfield's evaluation was that exceeding a PEL at end-of-pipe would not necessarily translate into an exceedance of instream water quality standards.

In addition to the evaluation of potential SLT discharge effluent limitations, Atlantic Richfield thoroughly evaluated the hydrologic and chemical conditions of the SLT discharge and other site-specific considerations in connection with the preparation of the Performance Evaluation and Technology Screening Report (Appendix A of AOC RAWP).

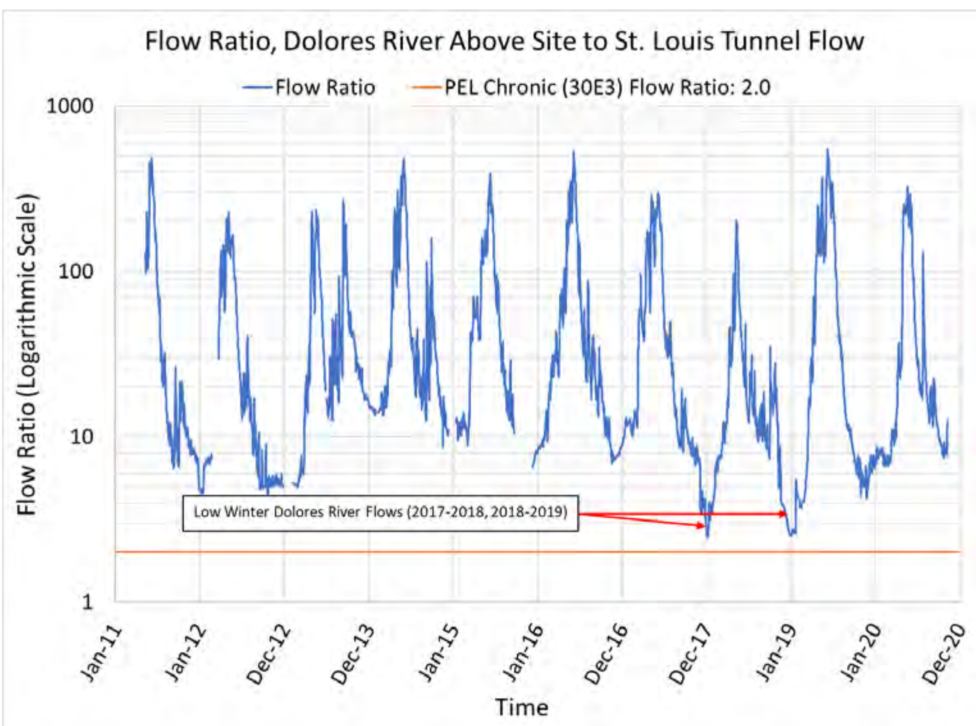

Figure 2. *Dolores River to St. Louis Tunnel Discharge Flow Ratio*

The evaluation identified several factors that affect the practicability of attaining the calculated PELs for the SLT discharge, including:

- CDPHE regulations require the use of “Design Flow” (i.e., maximum flow) in combination with biologically-based, statistically-low Dolores River flows to calculate PELs. However, this condition does not occur at the Site, since SLT flows mimic River flows; high flows from the SLT occur in years with high Dolores River flows, and low SLT flows occur in years with low Dolores River flows, as both originate largely from precipitation and melting of snowpack. Further, Figure 3 below illustrates that the maximum monthly average SLT flow occurs in mid-summer (July/August), and the minimum Dolores River flow occurs in mid-winter (January/February). Therefore, the Dolores River actual assimilative capacity is not realistically reflected in the PEL calculations, and results in unrealistically restrictive PEL values.
- Passive and semi-passive systems have distinct advantages in the Site’s alpine setting and provide effective treatment; but, unlike active systems, they can require time to respond to process/operational changes, and to recover from upsets.
- Due to limited space availability and the potential for occasional very high flow years exceeding the treatment system design capacity, there will be rare occasional need to temporarily route a small portion of inthe SLT flow around the biological portions of the treatment process (biotreatment cell(s) and limestone-based rock drain(s)) directly to the St. Louis Ponds System below the Expanded Constructed Wetlands Treatment System. This will occur only in very wet freshet seasons, anticipated to occur on the order of 25-year recurrence intervals or more. Such routing of SLT flows will also occur during media changeouts and maintenance periods when treatment cells are taken out of service. Flows will still be treated with a settling aid (flocculant and/or coagulant) and solids with appurtenant metals settled in the treatment system settling basins. In these instances, there may be a time lag in biocell response as it returns to normal operating conditions.
- Inherent in the passive system design is a need to occasionally (estimated between 7 and 15 years) replace organic media and limestone media in portions of the Expanded Constructed Wetlands Treatment System. During replacement and the subsequent three-to-six-month biocell startup periods to reestablish bacterial populations, it is anticipated that metals removal effectiveness may be temporarily reduced. As the expanded treatment system will contain process cells in parallel and possibly in series, operational flexibility will exist, and best efforts will be made to minimize the conditioning period and any possible reductions in treatment capacity during media conditioning or replacements.
- Freshet conditions in particular pose a significant challenge by combining rapidly changing conditions of influent flow and metals load. This is mitigated to a degree by the presence of generally increased Dolores River flow during freshet periods for increased assimilative capacity.

Atlantic Richfield’s evaluation confirmed that PELs may be attainable at certain times under certain conditions; but, attainment will not be technically practicable at all times under all conditions, particularly during freshet episodes. As a result, water quality-based effluent limitations were not selected as appropriate performance criteria for the SLT Water Treatment System.

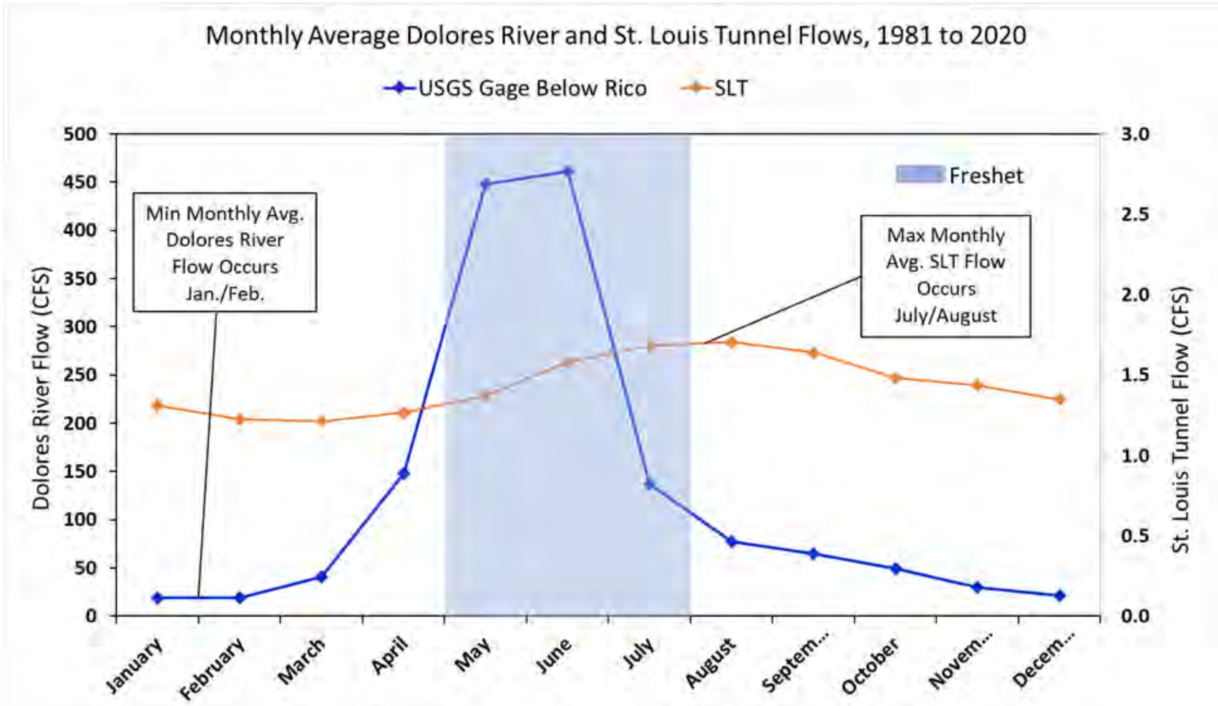

Figure 3. *Monthly Average Dolores River and St. Louis Tunnel Flows*

2.3 Performance Criteria

Instead of numeric water quality-based effluent limitations derived using the methods described in the PEL document, the performance criteria for the SLT Water Treatment System will be based on mass removal efficiencies for the following metal constituents: aluminum, cadmium, copper, iron, lead, manganese, and zinc; these metals are considered “Key” as they commonly flow from the SLT at concentrations exceeding standards. The values in the “Annual Minimum” column in Table 2, shaded in green, are the performance criteria for these Key metal constituents.

Table 2. *Performance Criteria for Key Constituents (Flow-Weighted Minimum and Average, Annual Basis)*

Analyte	Annual Minimum	Annual Average
Aluminum	98.3%	99.3%
Cadmium	94.6%	98.4%
Copper	99.6%	99.8%
Iron	98.0%	99.0%
Lead	99.3%	99.5%
Manganese	63.9%	74.2%
Zinc	80.0%	90.4%

Note: Green-shaded column presents performance criteria.

These criteria were developed based on the observed performance of the Enhanced Wetland Demonstration (EWD) system over the five-year operating period of 2016 through 2020. Details on how these criteria were developed are provided in Attachment 3.

Data collected to monitor the performance of the EWD system since startup in late 2015 show that the mass removal for most Key constituents has been greater than 90% based on monthly and annual averages. As the design for the Expanded Constructed Wetlands Treatment System has yet to be developed, using EWD performance data provides a reasonable basis for evaluating the future performance of the expanded system. The EWD has a design capacity of 550 gallons per minute (gpm). Five full years of operational data is available. The Expanded Constructed Wetlands Treatment System performance is anticipated to be at least as efficient as the EWD.

Improved performance relative to the EWD is anticipated with the expanded system due to 1) improved system design to handle freshet periods in most years; and 2) the likely inclusion of a limestone-based rock drain, which should result in improved manganese removal as well as provide some additional polishing of other metals concentrations, since the manganese dioxide collected in the rock drain is a known, effective sorbent. The benefits to performance from these enhancements cannot be verified pre-final design. Final performance criteria will be provided with the final design, and any necessary changes will be provided in the Operations Plan, post-shakedown.

The percent removals provided in Table 2 will result in substantial mass of metals removed from flows entering the Dolores River by the expanded treatment system. Table 3 presents projected minimum and average annual mass removal values, corresponding to the percent removal values shown in Table 2 and projected annual metal mass loads (based on average 2016 to 2020 SLT discharge mass loadings) that the expanded system will receive. These are the projected masses of Key metal constituents that will be captured and removed by the Expanded Constructed Wetlands Treatment System.

Table 3. *Expanded Constructed Wetlands Treatment System Projected Average Minimum and Annual Mass Removals for Key Constituents*

Analyte	Projected Minimum Mass Removal (lb.)	Projected Annual Mass Removal (lb.)
Aluminum	4,567	4,613
Cadmium	71.3	74.2
Copper	986	988
Iron	37,452	37,834
Lead	64.0	64.1
Manganese	4,759	5,526
Zinc	10,690	12,079

Metals removal from SLT water via treatment directly leads to decreased metals concentrations in the Dolores River. The relationship between percent metal removal and Dolores River metals concentrations is complex since background concentrations in the river can be variable and the Dolores River and SLT flow rates are variable. As both Dolores River and SLT flows are ultimately based on precipitation and snowmelt, their flows tend to vary similarly on a seasonal and annual basis, with the Dolores River flow peaking approximately one to two months prior to the SLT reaching its peak flow.

To provide information on the relationship of the current EWD system treatment with instream Dolores River water quality, Attachment 4 provides water quality data measured at monitoring location DR-7, downstream of the Site discharge. Plots of each Key metal constituent (along with sulfate) are presented from 2011 to October 2015 (pre-EWD period) and from November 2015 to the present (EWD operating period) to provide perspective of the effect of the EWD operation on the Dolores River water quality. As can be seen in Attachment 4, cadmium, copper, manganese, and zinc concentrations have shown a decrease at DR-7 since the EWD startup, while other constituents such as aluminum, iron, and lead have shown little change since their removal is primarily by settling, which was occurring prior to the EWD startup. Table 4 presents a summary of the comparison of measured water quality at DR-7 with instream Dolores River chronic water quality standards since the EWD startup in November 2015. Key metals concentrations have met the water quality standards during all non-freshet sampling events, with the exception of manganese; manganese met TVS standards in all sampling events; but exceeded the Water Supply standard in 6 of 17 samples. Several metal exceedances occurred during freshet sampling events, when flows exceeded the 550 gpm design capacity of the EWD. Testing performed in August and November 2020, during non-freshet conditions, demonstrated the absence of acute and chronic toxicity at monitoring location DR-7 (Atlantic Richfield, 2021.)

***Table 4**. Summary of DR-7 Water Quality Data vs. Dolores River Segment Chronic Water Quality Standards Since EWD Startup in November 2015*

Key Constituent	# of Segment Standard Exceedances	Total # of Samples[2]	Comments
Aluminum	3	12	For all three exceedances (during 2017, 2019, and 2020 freshets), aluminum also exceeded TVS standards in the Dolores River upstream of the Site. Further, in the 2019 freshet the aluminum concentration was lower at DR-7 than at DR-2, indicating improved aluminum concentration below the Site discharge.
Cadmium	1	17	Exceeded TVS standard during 2017 freshet.
Copper	0	17	
Iron	0	17	
Lead	1	17	For the single exceedance (during the 2019 freshet), the lead concentration also exceeded TVS standards in the Dolores River upstream of the Site. The lead concentration was lower at DR-7 than at DR-2, indicating improved lead concentration below the Site discharge.
Manganese	0 6	17 17	No exceedances of TVS standard; Exceeded Water Supply Standard.
Sulfate	1	17	Exceeded Water Supply standard during winter 2020 with low Dolores River flow; prior years sampling occurred in the fall months.
Zinc	2	17	Exceeded TVS standard during 2017 and 2019 freshets.

Notes:
[1] Exceedances of Dolores River Segment (#COSJDO03) Chronic Standards as provided in Table 1. Total metals analyses used for all metals for conservatism (rather than potentially dissolved analyses).
[2] Number of samples collected since EWD startup in November 2015 to December 2020.

The Key metal constituents discussed above are of primary concern at the Site. Other constituents, such as sulfate, arsenic, and minor constituents including boron, chloride, and others, are of less concern at the Site and are described below.

<u>Sulfate:</u> Sulfate treatment was not a goal for any of the treatability studies conducted. A small amount of sulfate is removed in the demonstration systems, producing sulfide for subsequent metals precipitation and removal. Sulfate concentration in the SLT flow is not significantly changed by either of the current demonstration systems and will not be significantly changed by the Expanded Constructed Wetlands Treatment System. Sulfate measurements at monitoring location DR-7 presented in Attachment 4 show that sulfate concentrations have been below the segment Water Supply standard of 250 mg/L nearly 100% of the time, before and after the operation of the demonstration systems. Since no significant treatment will occur, and sulfate concentrations in the Dolores River have complied with the Water Supply standard nearly all the time regardless, no performance criterion is proposed for sulfate.

Arsenic: Arsenic is a unique case, in that it currently has a “hybrid” temporary modification of the standard in effect until at least December 31, 2024. This temporary modification consists of a chronic total recoverable arsenic standard of 0.02 to 3.0 µg/L. The first number in the temporary modification range (0.02 ug/L) is the health-based standard in the applicable river segment to protect combined exposure from drinking water and fish consumption. The second value in the range (3.0 µg/l) is the technology-based achievable effluent value to be monitored at end-of-pipe. As described in CDPHE, 2020a: *“Control requirements, such as discharge permit effluent limitations, shall be established using the first number in the range as the ambient water quality target, provided that no effluent limitation shall require an “end-of-pipe” discharge level more restrictive than the second number in the range.”* Total recoverable arsenic concentrations measured at the discharge to the Dolores River (sample location DR-6) have been well below the 3.0 µg/L technology-based achievable effluent value in all sampling events since 2011 (both pre- and post-EWD startup), with a maximum measured value of 0.59 µg/L. As the discharge has been well below the arsenic standard for all sampling events since 2011, including the period prior to EWD startup in November 2015, no performance criterion is proposed for arsenic.

Minor Constituents: Minor constituents for which standards exist for Dolores River segment COSJDO03 include ammonia, boron, chloride, phosphorus, sulfide, chromium-III, chromium-VI, mercury, molybdenum, nickel, selenium, and silver. Site data collected has shown these to be well below standards, and no performance criteria are necessary.

2.4 Performance Evaluation Approach

To evaluate system performance, samples and flow measurements will be taken from the sampling locations representing the SLT flow (treatment system influent) and the St. Louis Ponds outfall to the Dolores River. These correspond to current sampling locations DR-3A and DR-6, respectively, as indicated on Figure 1. Flow rate and concentration data will be used to calculate an annual percent mass removal for each Key metal constituent, as described below.

The percent-removal performance criteria for the Key constituents in Table 2 are based on the calculated annual calendar-year values from EWD system performance from 2016 through 2020. Performance of the Expanded Constructed Wetlands Treatment System will be evaluated by calculation of annual percent removal values for each Key constituent, based on measurements made throughout the calendar year, and comparing them to the Table 2 performance criteria. Calculations will be made using the following general equations, which use zinc (Zn) as an example. Additional detail is provided below.

$$Annual\ \%\ Zn\ Mass\ Removal = \left\{1 - \frac{\sum Zn\ Mass_{DR-6}}{\sum Zn\ Mass_{DR-3A}}\right\} x\ 100\%$$

Where:

$\sum Zn\ Mass_{DR-6}$ = sum of DR-6 Zn mass increments through the calendar year

$$= (Zn\ Mass_{DR-6})_{Jan} + (Zn\ Mass_{DR-6})_{Feb} + (Zn\ Mass_{DR-6})_{Mar} + \cdots + (Zn\ Mass_{DR-6})_{Dec}$$

$\sum Zn\ Mass_{DR-3A}$ = sum of DR-3A Zn mass increments through the calendar year

$$= (Zn\ Mass_{DR-3A})_{Jan} + (Zn\ Mass_{DR-3A})_{Feb} + (Zn\ Mass_{DR-3A})_{Mar} + \cdots + (Zn\ Mass_{DR-3A})_{Dec}$$

and

$(Zn\ Mass_{DR\text{-}6})_{Jan}$ = January Zn mass at DR-6
$(Zn\ Mass_{DR\text{-}6})_{Feb}$ = February Zn mass at DR-6
$(Zn\ Mass_{DR\text{-}6})_{Mar}$ = March Zn mass at DR-6
.
.
$(Zn\ Mass_{DR\text{-}6})_{Dec}$ = December Zn mass at DR-6

and

$(Zn\ Mass_{DR\text{-}3A})_{Jan}$ = January Zn mass at DR-3A
$(Zn\ Mass_{DR\text{-}3A})_{Feb}$ = February Zn mass at DR-3A
$(Zn\ Mass_{DR\text{-}3A})_{Mar}$ = March Zn mass at DR-3A
.
.
$(Zn\ Mass_{DR\text{-}3A})_{Dec}$ = December Zn mass at DR-3A

Zn mass increments for DR-6 and DR-3A will be calculated for each time increment by the following equations:

DR-6 Zn mass increment = (DR-6 Zn concentration representing time increment) x (average DR-6 flow over time increment) x (duration of time increment)

DR-3A Zn mass increment = (DR-3A Zn concentration representing time increment) x (average DR-3A flow over time increment) x (duration of time increment)

Time increments will be monthly or biweekly (every two weeks), as discussed further below. If additional samples are obtained within a given time increment, the results of all samples will be averaged for use in the calculation. DR-6 and DR-3A flow rates will be monitored continuously and will be averaged over the length of the time increment. Using this information, percent removal over time increments can be calculated.

During base-flow periods (approximately July through April), site experience has shown that monthly time increments are adequate since metal concentrations and flow rates are relatively steady and change slowly. Site experience has also shown that the freshet period (generally May through June) can involve more rapid concentration changes, and therefore, shorter time increments may be needed to define the mass increments more accurately. The same mass increment equations will be used, but with shorter duration of time increments. While subject to refinement in the future and to real-time observations, collection of DR-3A and DR-6 samples at biweekly intervals from May through June should provide this definition. Therefore, the time increments utilized in the DR-6 and DR-3A mass increment equations above will be biweekly during May and June, and one month in the other months of the year. Depending on circumstances, additional samples may be taken within particular time increments, and if so, will be averaged to provide the metal concentration for the time increment.

As an example to illustrate the percent removal calculation for a given month, using the month of January as the time increment and calculating zinc mass removal:

$$January\ \%\ Zn\ Mass\ Removal = \left\{1 - \frac{January\ Zn\ Mass_{DR-6}}{January\ Zn\ Mass_{DR-3A}}\right\} x\ 100\%$$

Where:

January Zn $Mass_{DR\text{-}6}$ = (January DR-6 Zn concentration) x (average DR-6 flow over January) x (January duration)

January Zn $Mass_{DR\text{-}3A}$ = (January DR-3A Zn concentration) x (average DR-3A flow over January) x (January duration)

The remaining months other than May and June would be calculated similarly. May and June will differ in that they will have biweekly time and mass increments that will be summed for each of those months.

Percent mass removals will be calculated and reported monthly for each Key constituent. Performance will be evaluated by comparison of the calculated annual percent removal values to the Table 2 performance criteria at the end of the calendar year as discussed in Section 3.0. There may be months of the year where calculated monthly percent removal values are below the Table 2 performance criteria values, which are annual values. This phenomenon is expected during particularly notable freshet events.

Best efforts will be made to conduct the sampling on a monthly basis during base flow; however, there may be periods (particularly in winter) when there may be health and safety issues associated with access to the Dolores River and Site that may preclude sampling.

Unusual Conditions:

Unusual conditions may occur, such as periods in which full water treatment is not occurring due maintenance or media changeouts, or occasions when the SLT flow temporarily exceeds the Expanded Constructed Wetlands Treatment System maximum design flow. During any periods in which full water treatment is not occurring, such as for maintenance or media changeouts, no performance evaluation sampling will occur.

Rerouted or partially treated flow effects, (above the design capacity), which adversely influence the effluent data will be subtracted to properly reflect system performance. Such effects might include excess metals load due to excess flows over and above the engineered design capacity of the treatment system, for example. As shown below for zinc as an example, the percent removal calculation will be modified to subtract the mass associated with the SLT flow above the maximum design flow from both the DR-6 mass and DR-3A mass in the percent removal equations. This mass can be thought of as "excess" mass associated with the flow beyond which the treatment system was designed to treat, and by subtracting it from the DR-3A and DR-6 mass increments, it is removed from consideration. This equation will be used in the annual percent removal calculation for any time increment in which the SLT flow exceeds the maximum design flow. Note that if the DR-3A flow is equal to or less than the maximum design flow, this "excess mass" is zero, and the equation becomes identical to the previously shown equation.

$$Excess\ SLT\ Flow\ Conditions: \%\ Zn\ Mass\ Removal = \left\{1 - \frac{\sum(Zn\ Mass_{DR-6} - Zn\ Mass_{Excess})}{\sum(Zn\ Mass_{DR-3A} - Zn\ Mass_{Excess})}\right\} x\ 100\%$$

Where:

$Zn\ Mass_{Excess}$ = (DR-3A Zn concentration) x [(DR-3A flow) – (maximum design flow)] x (time duration)

∑: indicates summation of time increments for which SLT flow exceeds maximum design flow

3.0 PERFORMANCE EVALUATION AND REPORTING

Evaluation of the Expanded Constructed Wetlands Treatment System against performance criteria along with associated reporting will be conducted throughout the RA periods. Per the AOC, the RA periods consist of: 1) RA Construction, including shakedown, 2) Operations, and 3) Post-Removal Site Control. Monitoring and reporting for each period will be conducted according to the appropriate documents as specified in the AOC and the RAWP.

Monitoring will include:

- Continuous flow measurement and recording at locations DR-3A and DR-6, and
- Analytical samples for aluminum, cadmium, copper, iron, lead, manganese, and zinc obtained at DR-3A and DR-6 at a monthly frequency from January through April and July through December, and at a biweekly frequency during May and June.

Reporting will be performed monthly and will include calculated percent removals for aluminum, cadmium, copper, iron, lead, manganese, and zinc for the month. The December monthly report of each year will include calculated annual percent removals for aluminum, cadmium, copper, iron, lead, manganese, and zinc for the calendar year, and compared to the Table 2 performance criteria.

4.0 REFERENCES

Atlantic Richfield, 2021. Whole Effluent Toxicity (WET) Testing Data Summary and Analysis Report, March 2021.

CDPHE, 2020a. Water Quality Control Commission, Regulation No. 34 – Classifications and Numeric Standards for San Juan River and Dolores River Basins, 5 CCR 1002-34. Current effective date 6/30/2020.

CDPHE, 2020b. PEL 230051, Rico-Argentine Mine Site, Preliminary Effluent Limits, March 24, 2020.

CDPHE, 2020c. Water Quality Control Commission, Regulation No. 31 – The Basic Standards and Methodologies for Surface Water, 5 CCR 1002-31. Current effective date 6/30/2020.

Attachment 1

PEL 230051, Rico-Argentine Mine Site, Preliminary Effluent Limits

(Dated March 24, 2020)

Anthony Brown
Atlantic Richfield Company
4 Centerpointe Drive, 2nd Floor, Suite 200
La Palma, CA 90623-1066

TO: Anthony Brown

FROM: WQCD: Erin Scott, 303-692-3506, erin.scott@state.co.us

DATE: March 24, 2020

Re: PEL 230051, Rico-Argentine Mine Site, Preliminary Effluent Limits

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The Water Quality Control Division (Division) of the Colorado Department of Public Health and Environment has prepared, per your request, the Preliminary Effluent Limits (PELs) for the Rico-Argentine wastewater treatment facility. These effluent limits were developed as detailed in the attached document, for planning in the development of appropriate treatment.

Due to the nature of the facility, seasonal design flows were requested, as follows;

Rico-Argentine Mine- May 1-August 31	1.74 MGD	2.7 CFS
Rico-Argentine Mine- Sept 1- April 30	1.44 MGD	2.2 CFS

Further, three discharge scenarios were requested, as follows;

- A discharge scenario direct to the Dolores River, and
- A discharge scenario to the "naturalized wetlands" below Pond 14, (Prior to entering the Dolores river) and
- A discharge scenario through the "naturalized wetlands/beaver ponds" (Prior to entering the Dolores river) then out outfall 009

The PELs developed for this facility are based on the water quality standards for the receiving stream identified in the PEL application, narrative water quality standards, technology based limitations established in the *Regulations for Effluent Limitations* (Regulation No. 62), and any applicable federal Effluent Limitation Guidelines (ELGs) developed specific to this industry type. The water quality standard based limitations presented in this PEL may be incorporated into a CDPS permit contingent on analyses conducted during permit development. The technology based limitations will also be incorporated into the permit unless a more stringent limitation is applied.

As explained in the attached document, the water quality based limitations have been developed based on the current and/or next effective water quality standards for the receiving stream, the ambient water quality of the receiving stream, the calculated low flows, the stated effluent flows of the facility, and where necessary the antidegradation regulations, mixing zone policies, and any designation of a receiving stream by the US Fish and Wildlife Service as habitat for federally listed threatened and endangered (T&E) fish. A determination of which PELs ultimately apply in a permit will be dependent on decisions regarding treatment, pollutants of concern, chemical usage, receiving streams, design flows, or other information presented to the Division at the time of permit application.

The division notes that currently the series of treatment ponds are located along the Dolores River, and seep into the Dolores river alluvium. The division advises Atlantic Richfield to line the ponds, as compliance points in a final permit may be different from those proposed by Rico in the PEL application if the ponds remained unlined. For example, compliance points may be designated by the division prior to entering the ponds, or may be designated within the ponds themselves prior to seeping through the alluvium, rather than in the currently piped locations. Compliance points will be discussed, evaluated, and determined during the permitting process.

Note that, as requested, this PEL was drafted for seasonal considerations for the Dolores River. However, the dilution ratio in both seasons is 3:1, and only minimal differences in WQBELs result from a seasonal analysis with a 2:1 ratio. Therefore, the division retains the discretion to issue a permit without seasons, based on the critical (low flow) condition as directed in Regulation 31, and permit limitations may be based on a non-seasonal discharge permit. Therefore, permit limitations based on a non-seasonal evaluation with the following effluent flow was also developed.

Rico-Argentine Mine	1.74 MGD	2.7 CFS

This non-seasonal evaluation also facilitated the development of the antidegradation evaluation, which is not a seasonal concept, and seasonal ADBELs are not applicable.

The following tables contain a summaries of the limitations that have been developed in this PEL for this facility. Note that for a discharge into either wetland scenario, the WQBELs and ultimate permit limits are the same.

The Rico-Argentine mine will be expected to meet the limitations for these parameters upon commencement of permit coverage.

Table 1
Preliminary Effluent Limits for the Rico Argentine Mine
Discharge to the Dolores River
at a Design Flow of 1.74 MGD (Non-Seasonal)

Effluent Parameter	Effluent Limitations Maximum Concentrations			
	30-Day Average	7-Day Average	Daily Maximum	2-Year Average
Effluent Flow (MGD)	1.74			
Temp Daily Max (°C) June-Sept			21.7	
Temp Daily Max (°C) Oct-May			13	
Temp MWAT (°C) June-Sept		17		
Temp MWAT (°C) Oct-May		9		
pH (su)			6.5-9.0	
TSS (mg/l)	30	45		
Oil and Grease (mg/l)			10	

Al, TR (µg/l)	103		22229	37
Sb, PD (µg/l)	17			2.7
As, TR (µg/l)	0.06			
As, PD (µg/l)			793	119
Be, TR (µg/l)	12			2.3
Cd, TR (µg/l)			12	3.5
Cd, PD (µg/l)	2.3		7.7	
Cr+3, TR (µg/l)			117	19
Cr+3, PD (µg/l)	411		2459	63
Cr+6, Dis (µg/l)	33		37	5.1
Cu, PD (µg/l)	20		61	
CN, WAD (µg/l)			12	1.8
Fe, Dis (µg/l)	772			
Fe, TR (µg/l)	1410			
Pb, TR (µg/l)			117	18
Pb, PD (µg/l)	13		336	
Mn, Dis / PD (µg/l)*	539		8918	
Mo, TR (µg/l)	478			76
Hg, Tot (µg/l)	0.03			0.0054
Ni, TR (µg/l)	300			45
Ni, PD (µg/l)	80		2061	
Se, PD (µg/l)	13		42	3.4
Ag, PD (µg/l)	0.06		17	
U, TR (µg/l)	50			7.5
U, PD (µg/l)	10305		12831	1545
Zn, PD (µg/l)	707		731	
B, Tot (mg/l)	2.3			0.33
Chloride (mg/l)	745			112
Sulfate (mg/l)	642			
Sulfide as H2S (mg/l)	0.006			0.0009
SAR pass/fail **	Pass/Fail			
EC (dS/m)	4.4			
Thallium, TR (µg/l)	0.72			11
Radium 226+228(pC/l)	15			2.3
WET, chronic				
Static Renewal 7 Day Chronic *Pimephales promelas*			NOEC or IC25 $\geq$ 33	
Static Renewal 7 Day Chronic *Ceriodaphnia dubia*			NOEC or IC25 $\geq$ 33	

*Manganese- 30 day average is in 'dissolved' form, daily maximum in 'potentially dissolved' form
** SAR limit is calculated using the actual measured EC value (30-day average) of the effluent and substituting this value in to the following equation to solve for SAR. The equation for determining the SAR limit is: SAR = (7.1 * EC) – 2.48

Table 2 Preliminary Effluent Limits for the Rico Argentine Mine Discharge to the Dolores River at a Design Flow of 1.74 MGD (May 1- August 31)				
Effluent Parameter	**Effluent Limitations Maximum Concentrations**			
	30-Day Average	**7-Day Average**	**Daily Maximum**	**2-Year Average**
Effluent Flow (MGD)	1.74			
Temp Daily Max (°C) June-Sept			21.7	
Temp Daily Max (°C) Oct-May			13	
Temp MWAT (°C) June-Sept		17		
Temp MWAT (°C) Oct-May		9		
pH (su)			6.5-9.0	
TSS (mg/l)	30	45		
Oil and Grease (mg/l)			10	
Al, TR (µg/l)	114		51763	37
Sb, PD (µg/l)	24			2.7
As, TR (µg/l)	0.087			
As, PD (µg/l)			1851	119
Be, TR (µg/l)	17			2.3
Cd, TR (µg/l)			27	3.5
Cd, PD (µg/l)	3.3		18	
Cr+3, TR (µg/l)			272	19
Cr+3, PD (µg/l)	594		5737	63
Cr+6, Dis (µg/l)	48		87	5.1
Cu, PD (µg/l)	20 (NIL)		139	
CN, WAD (µg/l)			27	1.8
Fe, Dis (µg/l)	1087			
Fe, TR (µg/l)	1410 (NIL)			
Pb, TR (µg/l)			272	18
Pb, PD (µg/l)	19		782	
Mn, Dis / PD (µg/l)*	768		20777	
Mo, TR (µg/l)	690			76
Hg, Tot (µg/l)	0.043			0.0054
Ni, TR (µg/l)	430			45
Ni, PD (µg/l)	80 (NIL)		4809	
Se, PD (µg/l)	18		98	3.4
Ag, PD (µg/l)	0.06 (NIL)		40	
U, TR (µg/l)	73			7.5
U, PD (µg/l)	14884		29938	1545
Zn, PD (µg/l)	1018		1696	
B, Tot (mg/l)	3.3			0.33
Chloride (mg/l)	1075			112
Sulfate (mg/l)	903			
Sulfide as H2S (mg/l)	0.0087			0.0009
SAR pass/fail **	Pass/Fail			
EC (dS/m)	5.5			
Thallium, TR (µg/l)	1			11
Radium 226+228(pC/l)	22			2.3
WET, chronic				
Static Renewal 7 Day Chronic *Pimephales promelas*			NOEC or IC25 ≥ 23***	

Static Renewal 7 Day Chronic *Ceriodaphnia dubia*			NOEC or IC25 ≥ 23***	

* Manganese- 30 day average is in 'dissolved' form, daily maximum in 'potentially dissolved' form
** SAR limit is calculated using the actual measured EC value (30-day average) of the effluent and substituting this value in to the following equation to solve for SAR. The equation for determining the SAR limit is: SAR = (7.1 * EC) – 2.48
*** The IWC for May - August is 23 %. The IWC for the season September - April is 29 %. If the frequency of WET testing is quarterly in a permit, the IWC for the quarter will be set to the most stringent month during that quarter

Table 2
Preliminary Effluent Limits for the Rico Argentine Mine
Discharge to the Dolores River
at a Design Flow of 1.44 MGD (Sept 1- April 30)

Effluent Parameter	Effluent Limitations Maximum Concentrations			
	30-Day Average	7-Day Average	Daily Maximum	2-Year Average
Effluent Flow (MGD)	1.44			
Temp Daily Max (°C) June-Sept			21.7	
Temp Daily Max (°C) Oct-May			13	
Temp MWAT (°C) June-Sept		17		
Temp MWAT (°C) Oct-May		9		
pH (su)			6.5-9.0	
TSS (mg/l)	30	45		
Oil and Grease (mg/l)			10	
Al, TR (µg/l)	107		25106	37
Sb, PD (µg/l)	19			2.7
As, TR (µg/l)	0.069			
As, PD (µg/l)			896	119
Be, TR (µg/l)	14			2.3
Cd, TR (µg/l)			13	3.5
Cd, PD (µg/l)	2.6		8.7	
Cr+3, TR (µg/l)			132	19
Cr+3, PD (µg/l)	473		2779	63
Cr+6, Dis (µg/l)	38		42	5.1
Cu, PD (µg/l)	20 (NIL)		68	
CN, WAD (µg/l)			13	1.8
Fe, Dis (µg/l)	879			
Fe, TR (µg/l)	1410 (NIL)			
Pb, TR (µg/l)			132	18
Pb, PD (µg/l)	15		379	
Mn, Dis / PD (µg/l)*	617		10073	
Mo, TR (µg/l)	551			76
Hg, Tot (µg/l)	0.035			0.0054
Ni, TR (µg/l)	345			45
Ni, PD (µg/l)	80 (NIL)		2329	
Se, PD (µg/l)	14		48	3.4
Ag, PD (µg/l)	0.06 (NIL)		19	
U, TR (µg/l)	58			7.5
U, PD (µg/l)	11866		14497	1545
Zn, PD (µg/l)	813		825	
B, Tot (mg/l)	2.6			0.33
Chloride (mg/l)	857			112

Sulfate (mg/l)	731			
Sulfide as H2S (mg/l)	0.0069			0.0009
SAR pass/fail **	Pass/Fail			
EC (dS/m)	4.4			
Thallium, TR (µg/l)	0.83			11
Radium 226+228(pC/l)	17			2.3
WET, chronic				
Static Renewal 7 Day Chronic *Pimephales promelas*			NOEC or IC25 ≥ 29***	
Static Renewal 7 Day Chronic *Ceriodaphnia dubia*			NOEC or IC25 ≥ 29***	

* Manganese- 30 day average is in 'dissolved' form, daily maximum in 'potentially dissolved' form
** SAR limit is calculated using the actual measured EC value (30-day average) of the effluent and substituting this value in to the following equation to solve for SAR. The equation for determining the SAR limit is: SAR = (7.1 * EC) – 2.48
*** The IWC for May - August is 23 %. The IWC for the season September - April is 29 %. If the frequency of WET testing is quarterly in a permit, the IWC for the quarter will be set to the most stringent month during that quart

Table 2
Preliminary Effluent Limits for the Rico Argentine Mine Discharge to Wetlands into the Dolores River at a Design Flow of 1.74 MGD

Effluent Parameter	Effluent Limitations Maximum Concentrations			
	30-Day Average	7-Day Average	Daily Maximum	2-Year Average
Effluent Flow (MGD)	1.74		Report	
Temp Daily Max (°C) June-Sept			21.7	
Temp Daily Max (°C) Oct-May			13	
Temp MWAT (°C) June-Sept		17		
Temp MWAT (°C) Oct-May		9		
pH (su)			6.5-9.0	
TSS (mg/l)	30	45		
Oil and Grease (mg/l)			10	
Al, TR (µg/l)	87		10071	13
Sb, PD (µg/l)	5.6			0.84
As, TR (µg/l)	0.02			0.003
As, PD (µg/l)			340	51
Be, TR (µg/l)	4			0.6
Cd, TR (µg/l)			5	
Cd, PD (µg/l)	1.2		5.7	
Cr+3, TR (µg/l)			50	7.5
Cr+3, PD (µg/l)	137		1773	21
Cr+6, Dis (µg/l)	11		16	1.7
Cu, PD (µg/l)	20		50	
CN, WAD (µg/l)			5	0.75
Fe, Dis (µg/l)***	772			
Fe, TR (µg/l)	1000			
Pb, TR (µg/l)	9.9		50	
Pb, PD (µg/l)	11		281	
Mn, Dis / PD (µg/l)	255		4738	

Mo, TR (µg/l)	160			24
Hg, Tot (µg/l)	0.01			0.0015
Ni, TR (µg/l)	100			15
Ni, PD (µg/l)	80		1513	
Se, PD (µg/l)	4.6		18	1.1
Ag, PD (µg/l)	0.81		22	0.15
U, TR (µg/l)***	50			7.5
U, PD (µg/l)	6915		11070	1037
Zn, PD (µg/l)	428		564	
B, Tot (mg/l)	0.75			0.11
Chloride (mg/l)	250			38
Sulfate (mg/l)***	642			
Sulfide as H2S (mg/l)	0.002			0.0003
SAR pass/fail ***	Pass/Fail			Report
EC (dS/m) ***	4.4			
Thallium, TR (µg/l)	0.24			0.036
Radium 226+228 (pCi/l)	5			0.75
WET, chronic				
Static Renewal 7 Day Chronic *Pimephales promelas*			NOEC or IC25 ≥ 100	
Static Renewal 7 Day Chronic *Ceriodaphnia dubia*			NOEC or IC25 ≥ 100	

* Manganese- 30 day average is in 'dissolved' form, daily maximum in 'potentially dissolved' form
** SAR limit is calculated using the actual measured EC value (30-day average) of the effluent and substituting this value in to the following equation to solve for SAR. The equation for determining the SAR limit is: SAR = (7.1 * EC) – 2.48
*** Based on the Delores River

Preliminary Effluent Limitations
The Dolores River or the "Naturalized" Wetlands to the Dolores River
ATLANTIC RICHFIELD CO., THE RICO-ARGENTINE MINE
Erin Scott
March 2020

Table of Contents

I. Preliminary Effluent Limitations Summary

Table A-1 includes summary information related to this PEL. This summary table includes key regulatory starting points used in development of the PEL such as: receiving stream information; threatened and endangered species; 303(d) and Monitoring and Evaluation listings; low flow and facility flow summaries; and a list of parameters evaluated.

Table A-1
PEL Summary

Facility Information

Facility Name	Design Flow (max 30-day ave, MGD)	Design Flow (max 30-day ave, CFS)
Rico-Argentine Mine- May 1-August 31	1.74	2.7
Rico-Argentine Mine- Sept 1- April 30	1.44	2.2
Rico-Argentine Mine (non-seasonal)	1.74	2.7

Receiving Stream Information

Receiving Stream Name	Segment ID	Designation	Classification(s)
S1. The Dolores River	COSJDO03	Reviewable	COLD CLASS 1 RECREATION E AGRICULTURE WATER SUPPLY
S2 The Wetlands to the Dolores River	COSJDO05A	Reviewable	COLD CLASS 1 RECREATION E AGRICULTURE WATER SUPPLY

Low Flows (cfs)

Receiving Stream Name	1E3 (1-day)	7E3 (7-day)	30E3 (30-day)	Ratio of 30E3 to the Design Flow (cfs)
S1. The Dolores River (May 1- Aug 31)	12	12	9	3:1
S1. The Dolores River (Sept 1- April 30)	3.6	4.1	5.4	3:1
S1. The Dolores River (non-seasonal)	3.6	4.1	5.5	2:1
S2. The Wetlands	0	0	0	0:1

Regulatory Information

T&E Species	303(d) (Reg 93)	Monitor and Eval (Reg 93)	Existing TMDL	Temporary Modification(s)	Control Regulation
Yes or No	None	None	No	Arsenic (chronic) = hybrid, Exp 12/31/2024	None

Pollutants Evaluated

Metals, Chloride, Boron, Cyanide, Temp, Radionuclides, SAR, EC

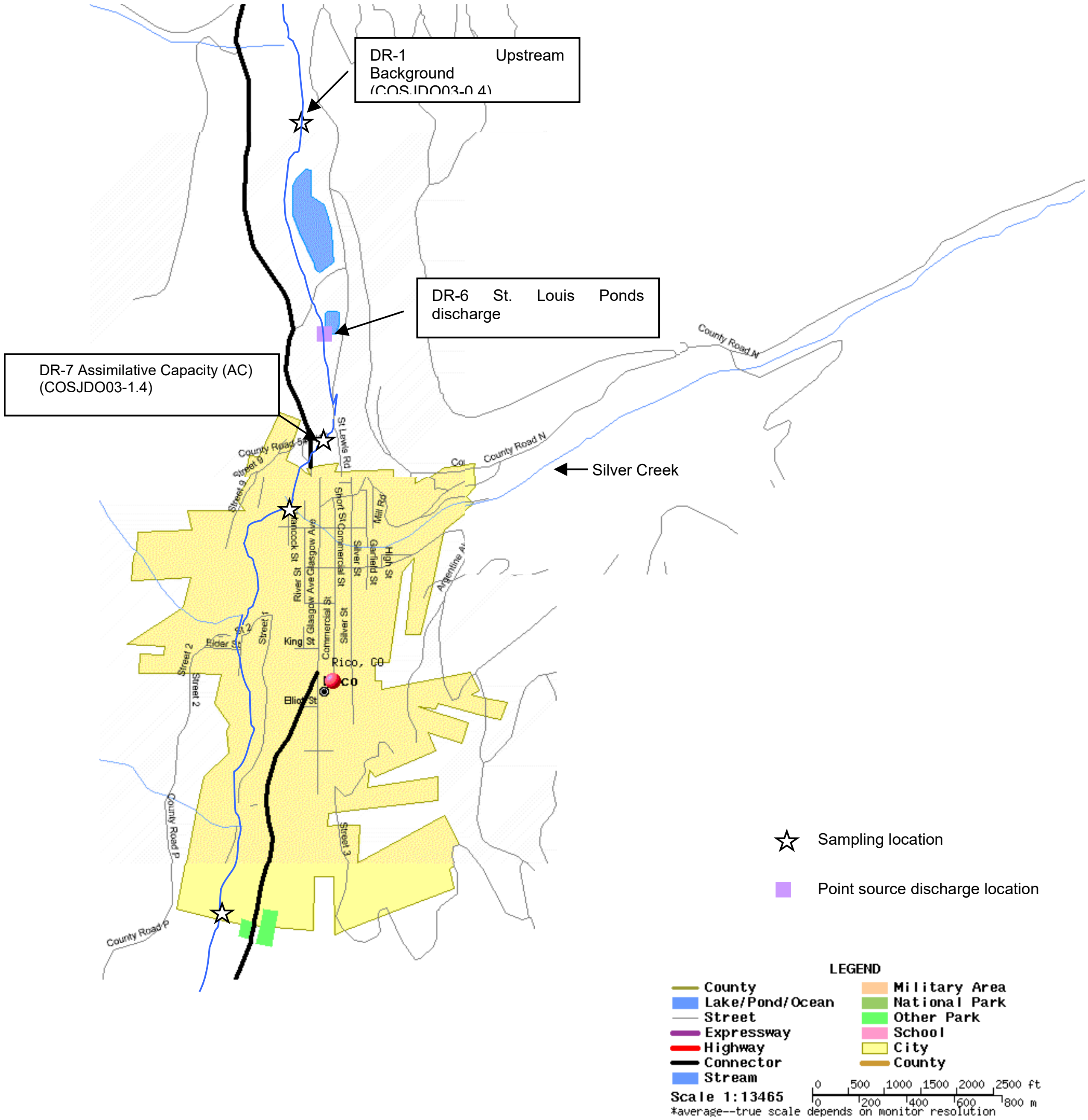
II. Introduction

The Preliminary Effluent Limitations (PEL) of the Dolores River near the Rico-Argentine Mine site, located in Dolores County, is intended to determine the assimilative capacities available for pollutants found to be of concern. This PEL describes how the water quality based effluent limits (WQBELs) are developed. These parameters may or may not appear in the permit with limitations or monitoring requirements, subject to other determinations such as reasonable potential analysis, evaluation of federal effluent limitation guidelines, implementation of state-based technology based limits, mixing zone analyses, 303(d) listings, threatened and endangered species listing, or other requirements as discussed in the permit rationale.

Figure A-1 contains a map of the study area evaluated as part of this PEL.

4300 Cherry Creek Drive S., Denver, CO 80246-1530 P 303-692-2000 www.colorado.gov/cdphe/wqcd

Figure 1 - WQA Study Area



The Rico Tunnel discharges to the Dolores River, which is stream segment COSJDO03. This means the San Juan Basin, Dolores Sub-basin, Stream Segment 03. This segment is composed of the "Mainstem of the Dolores River from a point immediately above the confluence with Horse Creek to a point immediately above the confluence with Bear Creek". Stream segment 03 is classified for Cold Class 1, Recreation E, Water Supply and Agriculture. Note that the downstream segment is over 12 steam miles away with several major tributaries between the discharge location and the next stream segment. Further, the downstream segment is not impaired, and has less stringent TVS standards, due to the higher hardness on the segment (station 914 in Stoner).

A second option under this PEL is to discharge into "naturalized" wetlands, which are non-constructed wetlands that then flow into the Dolores river. The wetlands are in stream segment COSJDO05A. The segment is composed of the "All tributaries to the Dolores and West Dolores rivers including all wetlands, from the source to a point immediately below the confluence with the West Dolores river." Stream segment 05A is classified for Cold Class 1, Recreation E, Water Supply and Agriculture.

The Rico (also known as the St. Louis) Tunnel discharge is located north of the Town of Rico, upstream of the confluence with Silver Creek. The discharge flows from the tunnel through a series of settling ponds before discharging to the Dolores River. It should be noted that the discharge from the tunnel was previously covered under a permit held by the Rico Development Corporation. Due to the dissolution of the Rico Development Corporation and other circumstances in 1996, the operation and maintenance of the tunnel pond treatment system was abandoned and the expired permit was never renewed. Thus, the Rico Tunnel has been discharging mine drainage for the past 10 years with only passive settling of naturally precipitated metals as the flow passed through the pond system. Figure A-1 on the following page contains a map of the study area evaluated as part of this WQA.

Information evaluated as part of this assessment includes data gathered from the Atlantic Richfield Company and its consultants, the Town of Rico, WQCD, Colorado Division of Water Resources (DWR), U.S. Environmental Protection Agency (EPA), U. S. Geological Survey (USGS), and the local water commissioner. The actual data used in the assessment consist of the best information available at the time of preparation of this WQA package.

III. Water Quality Standards

Narrative Standards

Narrative Statewide Basic Standards have been developed in Section 31.11(1) of the regulations, and apply to any pollutant of concern, even where there is no numeric standard for that pollutant. Waters of the state shall be free from substances attributable to human-caused point source or nonpoint source discharges in amounts, concentrations or combinations which:

for all surface waters except wetlands;

(i) can settle to form bottom deposits detrimental to the beneficial uses. Depositions are stream bottom buildup of materials which include but are not limited to anaerobic sludge, mine slurry or tailings, silt, or mud; or (ii) form floating debris, scum, or other surface materials sufficient to harm existing beneficial uses; or (iii) produce color, odor, or other conditions in such a degree as to create a nuisance or harm existing beneficial uses or impart any undesirable taste to significant edible aquatic species or to the water; or (iv) are harmful to the beneficial uses or toxic to humans, animals, plants, or aquatic life; or (v) produce a predominance of undesirable aquatic life; or (vi) cause a film on the surface or produce a deposit on shorelines; and for surface waters in wetlands;

(i) produce color, odor, changes in pH, or other conditions in such a degree as to create a nuisance or harm water quality dependent functions or impart any undesirable taste to significant edible aquatic species of the wetland; or (ii) are toxic to humans, animals, plants, or aquatic life of the wetland.

In order to protect the Basic Standards in waters of the state, effluent limitations and/or monitoring requirements for any parameter of concern could be put in CDPS discharge permits.

Standards for Organic Parameters and Radionuclides

Radionuclides: Statewide Basic Standards have been developed in Section 31.11(2) and (3) of The Basic Standards and Methodologies for Surface Water to protect the waters of the state from radionuclides and organic chemicals.

In no case shall radioactive materials in surface waters be increased by any cause attributable to municipal, industrial, or agricultural practices or discharges to as to exceed the following levels, unless alternative site-specific standards have been adopted. Standards for radionuclides are shown in Table A-2.

Table A-2
Radionuclide Standards

Parameter	Picocuries per Liter
Americium 241*	0.15
Cesium 134	80
Plutonium 239, and 240*	0.15
Radium 226 and 228*	5
Strontium 90*	8
Thorium 230 and 232*	60
Tritium	20,000

*Radionuclide samples for these materials should be analyzed using unfiltered (total) samples. These Human Health standards are 30-day average values.

Organics: The organic pollutant standards contained in the Basic Standards for Organic Chemicals Table are applicable to all surface waters of the state for the corresponding use classifications, unless alternative site-specific standards have been adopted. These standards have been adopted as “interim standards” and will remain in effect until alternative permanent standards are adopted by the Commission. These interim standards shall not be considered final or permanent standards subject to antibacksliding or downgrading restrictions. Although not reproduced in this PEL, the specific standards for organic chemicals can be found in Regulation 31.11(3).

In order to protect the Basic Standards in waters of the state, effluent limitations and/or monitoring requirements for radionuclides, organics, or any other parameter of concern could be put in CDPS discharge permits.

The aquatic life standards for organics apply to all stream segments that are classified for aquatic life. The water supply standards apply only to those segments that are classified for water supply. The water + fish standards apply to those segments that have a Class 1 aquatic life and a water supply classification. The fish ingestion standards apply to Class 1 aquatic life segments that do not have a water supply designation. The water + fish and the fish ingestion standards may also apply to Class 2 aquatic life segments, where the Water Quality Control Commission has made such determination.

Because the receiving water is classified for Cold Class 1, with a water supply designation, the water supply, water + fish, and aquatic life standards apply to this discharge.

Salinity and Nutrients

Nutrients
Total Phosphorus and Total Inorganic Nitrogen: Regulation 85, the Nutrients Management Control Regulation has been adopted by the Water Quality Control Commission and became effective September 30, 2012. This regulation contains requirements for phosphorus and Total Inorganic Nitrogen (TIN) concentrations for some point source dischargers. Limitations for phosphorus and TIN may be applied in accordance with this regulation.

Salinity: Regulation 61.8(2)(l) contains requirements regarding salinity for any discharges to the Colorado River Watershed. For industrial dischargers and for the discharge of intercepted groundwater, this is a no-salt discharge requirement. However, the regulation states that this requirement may be waived where the salt load reaching the mainstem of the Colorado River is less than 1 ton per day, or less than 350 tons per year. The Division may permit the discharge of salt upon a satisfactory demonstration that it is not practicable to prevent the discharge of all salt. See Regulation 61.8(2)(l)(i)(A)(1) for industrial discharges and 61.8(2)(l)(iii) for discharges of intercepted groundwater for more information regarding this demonstration.

In addition, the Division's policy, Implementing Narrative Standards in Discharge Permits for the Protection of Irrigated Crops, may be applied to discharges where an agricultural water intake exists downstream of a discharge point. Limitations for electrical conductivity and sodium absorption ratio may be applied in accordance with this policy.

Temperature
Temperature shall maintain a normal pattern of diurnal and seasonal fluctuations with no abrupt changes and shall have no increase in temperature of a magnitude, rate, and duration deemed deleterious to the resident aquatic life. This standard shall not be interpreted or applied in a manner inconsistent with section 25-8-104, C.R.S.

Segment Specific Numeric Standards
Numeric standards are developed on a basin-specific basis and are adopted for particular stream segments by the Water Quality Control Commission. The standards in Table A-3a have been assigned to stream segments COSJDO03/5A. Additionally, the parameters in Table A-3b are also being evaluated as they are parameters of concern for this facility type. These parameters are being included based on the numeric standards in Regulation 31.

Table A-3a

In-stream Standards for Stream Segment COSJDO03 & COSJDO05A

Physical and Biological
Dissolved Oxygen (DO) = 6 mg/l, minimum (7 mg/l, minimum during spawning)
pH 6.5- 9.0
E. coli chronic = 126 colonies/100 ml
Temperature June-Sept = 17° C MWAT and 21.7° C DM

Temperature Oct-May = 9° C MWAT and 13° C DM
Inorganic
Total Ammonia acute and chronic = TVS
Chlorine acute = 0.019 mg/l
Chlorine chronic = 0.011 mg/l
Free Cyanide acute = 0.005 mg/l
Sulfide chronic = 0.002 mg/l
Boron chronic = 0.75 mg/l
Nitrite acute = 0.05 mg/l
Nitrate acute = 10 mg/l
Chloride chronic = 250 mg/l
Sulfate chronic = For WS, the greater of ambient water quality as of January 1, 2000 or 250 mg/l
Metals
Total Recoverable Aluminum acute and chronic = TVS
Dissolved Arsenic acute = 340 µg/l
Total Recoverable Arsenic chronic = 0.02 µg/l*
Dissolved Cadmium acute and chronic = TVS
Total recoverable Cadmium acute = 5 ug/l
Total Recoverable Trivalent Chromium acute = 50 µg/l
Dissolved Trivalent Chromium acute and chronic = TVS
Dissolved Hexavalent Chromium acute and chronic = TVS
Dissolved Copper acute and chronic = TVS
Dissolved Iron chronic WS = The greater of ambient water quality as of January 1, 2000, or 300 µg/l
Total Recoverable Iron chronic = 1000 µg/l
Dissolved Lead acute and chronic = TVS
Total Recoverable Lead acute = 50 ug/l
Dissolved Manganese chronic WS = The greater of ambient water quality as of January 1, 2000 or 50 µg/l
Dissolved Manganese acute and chronic = TVS & 255 ug/l
Total Recoverable Molybdenum chronic = 160 µg/l
Total Mercury chronic = 0.01 µg/l
Dissolved Nickel acute and chronic = TVS
Total Recoverable Nickel chronic = 100 ug/l
Dissolved Selenium acute and chronic = TVS
Dissolved Silver acute and chronic = TVS
Dissolved Zinc acute and chronic = TVS
Dissolved Uranium acute and chronic = TVS
Total Uranium = 16.8-30 ug/l

*Beginning 01/01/2025- A temporary modification for chronic total recoverable arsenic, which is equal to 'current conditions', with an expiration date of 12/31/2024 is applicable. The Water Quality Control Commission's regulations state that current conditions be maintained and existing uses protected during the duration of a temporary modification.

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Table A-3b Additional Standards Being Evaluated Based on Regulation 31
Total Recoverable Beryllium chronic = 4 ug/l
Dissolved Antimony chronic = 5.6 ug/l
Total Recoverable Thallium chronic = 0.24 ug/l

Water Supply- Dissolved Iron, Dissolved Manganese, and Sulfate

The standard for dissolved manganese, dissolved iron, and sulfate for water supply segments is the greater of the ambient water quality as of January 1, 2000, or 50 µg/l, 300 ug/l, and 250 mg/l, respectively. Per division practice, ambient water quality as of January 1, 2000, is the 85th percentile of data as listed in the Assessment unit database from January 1995 to December 1999 if there are at least 10 data points. If there are less than 10 data points from January 1995 to December 1999, then the date range expands from January 1995 to December 2004 to capture 10 data points.

For all parameters, there were 8 data points, and so the period of record is January 1995 to December 1999. For dissolved iron, the ambient water quality was 109 ug/l, so the standard is 300 ug/l. For dissolved manganese, the ambient water quality was 195 ug/l, so the value of 195 ug/l is the water supply standard. For sulfate, the ambient water quality was 120 mg/l, so the standard is 250 mg/l.

Table Value Standards and Hardness Calculations

Standards for metals are generally shown in the regulations as Table Value Standards (TVS), and these often must be derived from equations that depend on the receiving stream hardness or species of fish present. The Classification and Numeric Standards documents for each basin include a specification for appropriate hardness values to be used. Specifically, the regulations state that:

> The hardness values used in calculating the appropriate metal standard should be based on the lower 95% confidence limit of the mean hardness value at the periodic low flow criteria as determined from a regression analysis of site-specific data. Where insufficient site-specific data exists to define the mean hardness value at the periodic low flow criteria, representative regional data shall be used to perform the regression analysis. Where a regression analysis is not appropriate, a site-specific method should be used.

Dolores River
Hardness data for The Dolores River near the point of discharge of were insufficient to conduct a regression analysis based on the low flow. Therefore, the Division's alternative approach to calculating hardness was used, which involves computing a mean hardness.

The mean hardness was computed to be 212 mg/l based on sampling data from sampling location DR-7, Dolores river just below the settling ponds system. This hardness value and the formulas contained in the TVS were used to calculate the in-stream water quality standards for metals, with the results shown in Table A-4a.

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Table A-4a

TVS-Based Metals Water Quality Standards for PEL 230051- Dolores River

Parameter	*In-Stream Water Quality Standard*			*TVS Formula: Hardness (mg/l) as CaCO3 =* 212
Aluminum, Total Recoverable	Acute	9572	µg/l	$e^{(1.3695(\ln(hardness))+1.8308)}$
	Chronic	87	µg/l	$e^{(1.3695(\ln(hardness))-0.1158)}$
Cadmium, Dissolved	Acute	3.3	µg/l	$[1.136672-0.041838\ln(hardness)]e^{(0.9151(\ln(hardness))-3.6236)}$
	Chronic	0.75	µg/l	$[1.101672-0.041838\ln(hardness)]e^{(0.7998(\ln(hardness))-4.4451)}$
Trivalent Chromium, Dissolved	Acute	1054	µg/l	$e^{(0.819(\ln(hardness))+2.5736)}$
	Chronic	137	µg/l	$e^{(0.819(\ln(hardness))+0.5340)}$
Hexavalent Chromium, Dissolved	Acute	16	µg/l	Numeric standards provided, formula not applicable
	Chronic	11	µg/l	Numeric standards provided, formula not applicable
Copper, Dissolved	Acute	27	µg/l	$e^{(0.9422(\ln(hardness))-1.7408)}$
	Chronic	17	µg/l	$e^{(0.8545(\ln(hardness))-1.7428)}$
Lead, Dissolved	Acute	145	µg/l	$[1.46203-0.145712\ln(hardness)][e^{(1.273(\ln(hardness))-1.46)}]$
	Chronic	5.6	µg/l	$[1.46203-0.145712\ln(hardness)][e^{(1.273(\ln(hardness))-4.705)}]$
Manganese, Dissolved	Acute	3835	µg/l	$e^{(0.3331(\ln(hardness))+6.4676)}$
	Chronic	255*	µg/l	Numeric Water Supply Standard, formula not applicable
Nickel, Dissolved	Acute	884	µg/l	$e^{(0.846(\ln(hardness))+2.253)}$
	Chronic	98	µg/l	$e^{(0.846(\ln(hardness))+0.0554)}$
Selenium, Dissolved	Acute	18.4	µg/l	Numeric standards provided, formula not applicable
	Chronic	4.6	µg/l	Numeric standards provided, formula not applicable
Silver, Dissolved	Acute	7.4	µg/l	$\frac{1}{2} e^{(1.72(\ln(hardness))-6.52)}$
	Chronic	0.27	µg/l	$e^{(1.72(\ln(hardness))-10.51)}$
Uranium, Dissolved	Acute	5499	µg/l	$e^{(1.1021(\ln(hardness))+2.7088)}$
	Chronic	3435	µg/l	$e^{(1.1021(\ln(hardness))+2.2382)}$
Zinc, Dissolved	Acute	272	µg/l	$0.978e^{(0.8525(\ln(hardness))+1.0617)}$
	Chronic	589	µg/l	$e^{(2.140(\ln(hardness))-5.084)}$

*Numeric Aquatic Life Standard Per Regulation 36. Note that a Water Supply Standard also applies

The Wetlands

Hardness data for The Wetlands was provided by Atlantic Richfield, and corresponds to Rico sampling location DR-6.

The mean hardness was computed to be 797 mg/l based on robust sampling data from DR-6 with 70 data points. The *Basic Standards and Methodologies for Surface Water* indicates that hardness must be capped at 400 mg/l when determining in-stream metal water quality standards using the equations in the TVS. This maximum hardness value and the formulas contained in the TVS were used to calculate the in-stream water quality standards for metals, with the results shown in Table A-4b.

Table A-4b
TVS-Based Metals Water Quality Standards for PEL 230051- The Wetlands

Parameter	***In-Stream Water Quality Standard***			***TVS Formula: Hardness (mg/l) as CaCO3 =*** **400**
Aluminum, Total Recoverable	Acute	10071	µg/l	$e^{(1.3695(\ln(hardness))+1.8308)}$
	Chronic	87	µg/l	$e^{(1.3695(\ln(hardness))-0.1158)}$
Cadmium, Dissolved	Acute	5.7	µg/l	$[1.136672-0.041838\ln(hardness)]e^{(0.9151(\ln(hardness))-3.6236)}$
	Chronic	1.2	µg/l	$[1.101672-0.041838\ln(hardness)]e^{(0.7998(\ln(hardness))-4.4451)}$
Trivalent Chromium, Dissolved	Acute	1773	µg/l	$e^{(0.819(\ln(hardness))+2.5736)}$
	Chronic	231	µg/l	$e^{(0.819(\ln(hardness))+0.5340)}$
Hexavalent Chromium, Dissolved	Acute	16	µg/l	Numeric standards provided, formula not applicable
	Chronic	11	µg/l	Numeric standards provided, formula not applicable
Copper, Dissolved	Acute	50	µg/l	$e^{(0.9422(\ln(hardness))-1.7408)}$
	Chronic	29	µg/l	$e^{(0.8545(\ln(hardness))-1.7428)}$
Lead, Dissolved	Acute	281	µg/l	$[1.46203-0.145712\ln(hardness)][e^{(1.273(\ln(hardness))-1.46)}]$
	Chronic	11	µg/l	$[1.46203-0.145712\ln(hardness)][e^{(1.273(\ln(hardness))-4.705)}]$
Manganese, Dissolved	Acute	4738	µg/l	$e^{(0.3331(\ln(hardness))+6.4676)}$
	Chronic	255*	µg/l	$e^{(0.3331(\ln(hardness))+5.8743)}$
Nickel, Dissolved	Acute	1513	µg/l	$e^{(0.846(\ln(hardness))+2.253)}$
	Chronic	168	µg/l	$e^{(0.846(\ln(hardness))+0.0554)}$
Selenium, Dissolved	Acute	18.4	µg/l	Numeric standards provided, formula not applicable
	Chronic	4.6	µg/l	Numeric standards provided, formula not applicable
Silver, Dissolved	Acute	22	µg/l	$\frac{1}{2} e^{(1.72(\ln(hardness))-6.52)}$
	Chronic	0.81	µg/l	$e^{(1.72(\ln(hardness))-10.51)}$
Uranium, Dissolved	Acute	11070	µg/l	$e^{(1.1021(\ln(hardness))+2.7088)}$
	Chronic	6915	µg/l	$e^{(1.1021(\ln(hardness))+2.2382)}$
Zinc, Dissolved	Acute	467	µg/l	$0.978e^{(0.8525(\ln(hardness))+1.0617)}$
	Chronic	2293	µg/l	$e^{(2.140(\ln(hardness))-5.084)}$

*Numeric Aquatic Life Standard Per Regulation 36. Note that a Water Supply Standard also applies

Total Maximum Daily Loads and Regulation 93 – Colorado's Section 303(d) List of Impaired

Waters and Monitoring and Evaluation List

This stream segment is not listed on the Division's 303(d) list of water quality impacted streams and is not on the monitoring and evaluation list.

IV. Receiving Stream Information

Low Flow Analysis

The Colorado Regulations specify the use of low flow conditions when establishing water quality based effluent limitations, specifically the acute and chronic low flows. The acute low flow, referred to as 1E3, represents the one-day low flow recurring in a three-year interval, and is used in developing limitations based on an acute standard. The 7-day average low flow, 7E3, represents the seven-day average low flow recurring in a 3 year interval, and is used in developing limitations based on a Maximum Weekly Average Temperature standard (MWAT). The chronic low flow, 30E3, represents the 30-day average low flow recurring in a three-year interval, and is used in developing limitations based on a chronic standard.

To calculate low flows, a flow gage measurement immediately upstream of the site should be used. However, there were no flow gages immediately upstream of the site, and so a downstream gage station was used. To determine the upstream low flows available to the Rio-Argentine mine, daily flow at location DR-3 (St. Louis Tunnel discharge at adit entrance) was subtracted from the daily flow measured from USGS Station 09165000 (Dolores River Below Rico, CO). For any day that was missing flow data at location DR-3, the flow for that day was set to the monthly maximum flow that was recorded.

Next, a watershed ratio was calculated from the USGS gage station approximately 4-5 miles downstream of the discharge. The area above the USGS gage is 106 square miles and the area above the discharge is 72.2 square miles, resulting in a watershed ratio of 0.68.

Two seasonal periods of record were analyzed, using a period of record from May 11, 2011, to July 31, 2018, as that was the period of record for flow data provided by the facility for location DR-3. The annual 1E3, 7E3, and 30E3 low flows were calculated using U.S. Environmental Protection Agency (EPA) DFLOW software. The output from DFLOW provides calculated acute and chronic low flows for each month. Based on the low flow analysis described above, the upstream low flows available to the facility were calculated and are presented in Table A-5a.

The low flow during May 1- August 31, is 12 cfs (1E3 and 7E3), and 9 cfs (30E3). The low flow during the season, September 1- April 30 is 3.6cfs (1E3), 4.1 cfs (7E3), and 5.4 cfs (30E3).

Table A-5a

Low Flows for Dolores River at the Rico-Argentine Mine Site

Low Flow (cfs)	*Annual*	*Jan*	*Feb*	*Mar*	*Apr*	*May*	*Jun*	*Jul*	*Aug*	*Sep*	*Oct*	*Nov*	*Dec*
1E3 Acute	3.6	3.6	5.3	5.9	17	42	13	12	13	7.3	6.6	6.7	3.7
7E3 Chronic	4.1	4.1	5.2	5.7	12	36	13	13	12	7.3	6.7	6.7	4.1

Table A-5a

Low Flows for Dolores River at the Rico-Argentine Mine Site

30E3 Chronic	5.4	5.4	5.4	5.7	7.6	23	16	16	9	7.4	6.8	6.2	5.4

May 1-August 31- The ratio of the low flow of the Dolores River to the effluent flow of 1.74 MGD is 3:1

September 1- April 30- The ratio of the low flow of the Dolores River to the effluent flow of 1.44 MGD is 3:1

Non-Seasonal- The ratio of the low flow of the Dolores River to the effluent flow of 1.74 MGD is 2:1

During the months of March, April, May, and August, the acute low flow calculated by DFLOW exceeded the chronic low flow. In accordance with Division standard procedures, the acute low flow was thus set equal to the chronic low flow for these months.

WETLANDS
For discharge to the "naturalized" wetlands (COSJDO05A), the division automatically assumes that no mixing occurs during times of low flow until, and unless, a mixing zone has been submitted to the division and approved. The low flow information is summarized in Table A-5b.

Table A-5b

Low Flows for the "Naturalized" Wetland at the Rico-Argentine Mine Site

Low Flow (cfs)	*Annual*	*Jan*	*Feb*	*Mar*	*Apr*	*May*	*Jun*	*Jul*	*Aug*	*Sep*	*Oct*	*Nov*	*Dec*
1E3 Acute	0	0	0	0	0	0	0	0	0	0	0	0	0
7E3 Chronic	0	0	0	0	0	0	0	0	0	0	0	0	0
30E3 Chronic	0	0	0	0	0	0	0	0	0	0	0	0	0

The ratio of the low flow of wetlands to the Rico-Argentine design flow is 0:1.

Mixing Zones

The amount of the available assimilative capacity (dilution) that may be used by the permittee for the purposes of calculating the WQBELs may be limited in a permitting action based upon a mixing zone analysis or other factor. These other factors that may reduce the amount of assimilative capacity available in a permit are: presence of other dischargers in the vicinity; the presence of a water diversion downstream of the discharge (in the mixing zone); the need to provide a zone of passage for aquatic life; the likelihood of bioaccumulation of toxins in fish or wildlife; habitat considerations such as fish spawning or nursery areas; the presence of threatened and endangered species; potential for human exposure through drinking water or recreation; the possibility that aquatic life will be attracted to the effluent plume; the potential for adverse effects on groundwater; and the toxicity or persistence of the substance discharged.

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Unless a facility has performed a mixing zone study during the course of the previous permit, and a decision has been made regarding the amount of the assimilative capacity that can be used by the facility, the Division assumes that the full assimilative capacity can be allocated. Note that the review of mixing study considerations, exemptions and perhaps performing a new mixing study (due to changes in low flow, change in facility design flow, channel geomorphology or other reason) is evaluated in every permit and permit renewal.

If a mixing zone study has been performed and a decision regarding the amount of available assimilative capacity has been made, the Division may calculate the water quality based effluent limitations (WQBELs) based on this available capacity. In addition, the amount of assimilative capacity may be reduced by T&E implications.

For this facility, 100% of the available assimilative capacity for the receiving stream (not applicable to the wetlands) may be used as the facility has not yet performed a mixing zone study, and the discharge is not to a T&E stream segment, and is not expected to have an influence on any of the other factors listed above. Note, however, this facility will be required to complete a mixing zone analysis for a discharge into the Dolores River, per the Colorado Mixing Zone guidance.

Ambient Water Quality

The Division evaluates ambient water quality based on a variety of statistical methods as prescribed in Section 31.8(2)(a)(i) and 31.8(2)(b)(i)(B) of the *Colorado Department of Public Health and Environment Water Quality Control Commission Regulation No. 31*, and as outlined in the Division's Policy for Characterizing Ambient Water Quality for Use in Determining Water Quality Standards Based Effluent Limits (WQP-19). Ambient water quality is evaluated in this PEL analysis for use in determining assimilative capacities and in completing antidegradation reviews for pollutants of concern, where applicable.

The Dolores River- To conduct an assessment of the ambient water quality upstream of the Rico site, data were gathered from sampling location DR-1, submitted by the permittee, and located just upstream from the facility settling ponds. The period of record varied from parameter to parameter, but was generally October 1999 through May 2018. These data are summarized in Table A-6.

Table A-6

Ambient Water Quality for The Dolores River

Parameter	*Number of Samples*	*15th Percentile*	*50th Percentile*	*85th Percentile*	*Mean*	*Maximum*	*Chronic Stream Standard**	*Notes*
Al, TR (µg/l)	50	15	79	358	190	1780	87	
Sb, Dis (µg/l)	44	0	0	0	0	0	5.6	2
As, TR (µg/l)	60	0	0	0	0.089	1.1	0.02	2
As, Dis (µg/l)	64	0	0	0	0.042	1	340	2
Be, TR (µg/l)	44	0	0	0	0	0	4	2
Cd, TR (µg/l)	65	0	0	0	0.0074	0.26	5	2
Cd, Dis (µg/l)	40	0	0	0	0.0065	0.2	0.75	2
Cr, TR (µg/l)	74	0	0	0.72	0.29	2.2	50	2
Cr, Dis (µg/l)	35	0	0.69	1.4	0.83	4.2	NA	2
Cu, Dis (µg/l)	40	0	0.68	1.7	0.83	3.5	17	2

CN, Tot (µg/l)	71	0	0	0	0.0003	0.0073	5	2
Fe, Dis (µg/l)	76	0	0	64	30	423	300	2
Fe, TR (µg/l)	74	0	87	370	242	2320	1000	2
Pb, TR (µg/l)	65	0	0.1	0.64	0.3	2.7	50	2
Pb, Dis (µg/l)	40	0	0.045	1.7	2.6	34	5.6	2
Mn, Dis (µg/l)	39	8.7	13	23	16	51	195	
Mo, TR (µg/l)	33	0.7	0.87	1	0.85	1.6	160	
Hg, Tot (µg/l)	69	0	0	0	0.0003	0.009	0.01	2
Ni, TR (µg/l)	60	0	0	0.74	0.31	2.8	100	2
Ni, Dis (µg/l)	40	0	0	0.88	0.35	3.1	98	2
Se, Dis (µg/l)	39	0	0.32	0.57	0.27	1	4.6	2
Ag, Dis (µg/l)	40	0	0	0.043	0.017	0.16	0.27	2
U, TR (µg/l)	1	0	0	0	0	0	30	2
U, Dis (µg/l)	1	0.25	0.25	0.25	0.25	0.25	3435	
Zn, Dis (µg/l)	40	0	1.8	6.7	4.3	31	240	2
B, Tot (mg/l)	0	0	0	0	0	0	0.75	2
Chloride (mg/l)	49	0	1.1	2.6	1.3	5.7	250	2
Sulfate (mg/l)	64	14	38	54	36	76	250	
Sulfide as H_2S (mg/l)	45	0	0	0	0	0	0.002	2
Thallium, TR (µg/l)	46	0	0	0	0.061	2.8	0.24	2
Hardness as $CaCO_3$ (mg/l)	70	98	221	312	212	410	NA	4
Note 2: Sample results were below detection levels, zero was used in accordance with the Division's approach for summarizing & averaging.								
Note 3: The ambient water quality exceeds the water quality standards for these parameters.								
Note 4: Hardness data collected downstream at DR-7								
*When there is no chronic standard, the acute standard is shown								

V. Facility Information and Pollutants Evaluated

Facility Information

The Rico-Argentine Mine site is located upstream of the confluence with Silver Creek and the Town of Rico in Dolores County. The discharge is made up of mine drainage emanating from the mountain, which is routed through a series of 11 settling ponds before discharging to the Dolores River. Flow rates into (and out of) the ponds are dependent upon regional precipitation patterns and natural hydrogeologic processes. The design capacity of the facility is seasonal, as follows;

Rico-Argentine Mine- May 1-August 31	1.74 MGD	2.7 CFS
Rico-Argentine Mine- Sept 1- April 30	1.44 MGD	2.2 CFS

According to the PEL application, wastewater treatment is accomplished using "aeration, coagulation addition, settling, and bio-treatment including manganese polishing." This treatment is through a series of ponds. The technical analyses that follow include assessments of the assimilative capacity based on these effluent discharge scenarios.

The Rico-Argentine mine is the sole known point source contributor to the Dolores river in this area. No other individual permit point sources were identified as dischargers to the Dolores river in this area. Note that due to the intermittent nature of stormwater discharges, and that these types of discharges do not typically occur at low flow conditions, they are not considered in this PEL.

The Naturalized Wetlands

Due to the in-stream low flow of zero, the assimilative capacities during times of low flow are not affected by nearby contributions. Therefore, modeling nearby facilities in conjunction with this facility was not necessary.

Pollutants of Concern

Pollutants of concern may be determined by one or more of the following: facility type; effluent characteristics and chemistry; effluent water quality data; receiving water quality; presence of federal effluent limitation guidelines; or other information. Parameters evaluated in this PEL may or may not appear in a permit with limitations or monitoring requirements, subject to other determinations such as a reasonable potential analysis, mixing zone analyses, 303(d) listings, threatened and endangered species listings or other requirement as discussed in a permit rationale.

There are no site-specific in-stream water quality standards for TSS and oil and grease for this receiving stream. Thus, assimilative capacities were not determined for these parameters. The applicable limitations for these pollutants can be found in Regulation No. 62 and will be applied in the permit for the facility.

The following parameters were identified by the Division as pollutants to be evaluated for this facility:

- Temperature
- SAR and EC
- Metals and Cyanide
- Radionuclides

According to the *Classifications, Standards, and Designations of Regulation 36*, stream CODJDO03/5A are designated a water supply. Thus, the dissolved iron, dissolved manganese (water supply), sulfate standard(s) are further evaluated as part of this PEL for the Dolores river. Note that the aquatic life TVS standard for dissolved manganese also remains applicable and is evaluated below.

Note that for the wetland, no surface intakes and no wells expected to be supplied by hydrologically connected groundwater are evaluated for this receiving water. For this reason, the sulfate, dissolved iron, and dissolved manganese standard for the wetland are not evaluated as part of this analysis. However, the water supply uses on the Dolores river are still applicable for a discharge into the wetlands, and limits based on the Dolores river for water supply are applied. Also note that the aquatic life TVS standard for dissolved manganese on the wetland remains applicable and is evaluated below.

VI. Determination of Water Quality Based Effluent Limitations (WQBELs)

Technical Information

Note that the WQBELs developed in the following paragraphs, are calculations of what an effluent limitation may be in a permit. The WQBELs for any given parameter, will be compared to other potential limitations (federal Effluent Limitations Guidelines, State Effluent Limitations, or other applicable limitation) and typically the more stringent limit is incorporated into a permit. If the WQBEL is the more stringent limitation, incorporation into a permit is dependent upon a reasonable potential analysis.

In-stream background data and low flows evaluated in Sections II and III are used to determine the assimilative capacity of the Dolores River near the Rico-Argentine mine for pollutants of concern, and to calculate the WQBELs. For all parameters except ammonia, it is the Division's approach to calculate the WQBELs using the lowest of the monthly low flows (referred to as the annual low flow) as determined in the low flow analysis. For ammonia, it is the standard procedure of the Division to determine monthly WQBELs using the monthly low flows, as the regulations allow the use of seasonal flows.

The Division's standard analysis consists of steady-state, mass-balance calculations for most pollutants and modeling for pollutants such as ammonia. The mass-balance equation is used by the Division to calculate the WQBELs, and accounts for the upstream concentration of a pollutant at the existing quality, critical low flow (minimal dilution), effluent flow and the water quality standard. The mass-balance equation is expressed as:

$$M_2 = \frac{M_3 Q_3 - M_1 Q_1}{Q_2}$$

Where,

Q_1 = Upstream low flow (1E3 or 30E3)
Q_2 = Average daily effluent flow (design capacity)
Q_3 = Downstream flow ($Q_1 + Q_2$)
M_1 = In-stream background pollutant concentrations at the existing quality
M_2 = Calculated WQBEL
M_3 = Water Quality Standard, or other maximum allowable pollutant concentration

The "Naturalized" Wetlands

When Q_1 equals zero, Q_2 equals Q_3, and the following results: $M_2 = M_3$

Because the low flow (Q_1) for the "naturalized wetlands" is zero, the WQBELs for the pollutants of concern are equal to the in-stream water quality standards for this discharge location.

A more detailed discussion of the technical analysis is provided in the pages that follow.

The Dolores River

The upstream background pollutant concentrations used in the mass-balance equation will vary based on the regulatory definition of existing ambient water quality. For most pollutants, existing quality is determined to be the 85th percentile. For metals in the total or total recoverable form, existing quality is determined to be the 50th percentile.

For temperature, the highest 7-day mean (for the chronic standard) of daily average stream temperature, over a seven consecutive day period will be used in calculations of the chronic temperature assimilative capacity, where the daily average temperature should be calculated from a minimum of three measurements spaced equally through the day. The highest 2-hour mean (for the acute standard) of stream temperature will be used in calculations of the acute temperature assimilative capacity. The highest 2-hour mean should be calculated from a minimum of 12 measurements spaced equally through the day.

Calculation of WQBELs

Using the mass-balance equation provided in the beginning of Section VI, the acute and chronic low flows set out in Section IV, ambient water quality as discussed in Section IV, and the in-stream standards shown in Section III, the WQBELs for were calculated. The data used and the resulting WQBELs, M_2, are set forth in the tables below. Where a WQBEL is calculated to be a negative number and interpreted to be zero or When the ambient water quality exceeds the in-stream standard, the Division standard procedure is to allocate the water quality standard to prevent further degradation of the receiving waters.

Temperature:

The Dolores River

A WQBEL for temperature can only be calculated if there is representative data, in the proper form, to determine what the background Maximum Weekly Average Temperature and Daily Maximum ambient temperatures are. As this data is not available at this time, the temperature limitation will be set at the water quality standard and will be revisited in the future when representative temperature data becomes available.

Total Recoverable Uranium Ranges: Because total uranium assimilative capacities are calculated based on a range of standards, *The Basic Standards and Methodologies for Surface Water* requires further evaluation. Specifically, the regulations state that "Control requirements, such as discharge permit effluent limitations, shall be established using the first number in the range as the ambient water quality target, provided that no effluent limitation shall require an "end-of-pipe" discharge level more restrictive than the second number in the range."

For the Dolores river, because the WQBEL for total recoverable uranium has been calculated to be less than the second number in the range of standards, the second standard (as shown in Table A-3a) would instead be substituted as the WQBEL pursuant to the regulations.

WQBELS- THE DOLORES RIVER

Table A-7a

Chronic WQBELs- The Dolores River
May 1- August 30
Effluent Flow: 1.74 MGD (2.7 CFS)

Parameter	Q_1 (cfs)	Q_2 (cfs)	Q_3 (cfs)	M_1	M_3	M_2	Notes
Temp MWAT (°C) June-Sept	9	2.7	11.7	NA	17	***17***	
Temp MWAT (°C) Oct-May	9	2.7	11.7	NA	9	***9***	
Al, TR (µg/l)	9	2.7	11.7	79	87	***114***	
Sb, Dis (µg/l)	9	2.7	11.7	0	5.6	***24***	
As, TR (µg/l) – Beginning 01/01/2025	9	2.7	11.7	0	0.02	***0.087***	
Be, TR (µg/l)	9	2.7	11.7	0	4	***17***	

Cd, Dis (µg/l)	9	2.7	11.7	0	0.75	***3.3***	
Cr+3, Dis (µg/l)	9	2.7	11.7	0	137	***594***	
Cr+6, Dis (µg/l)	9	2.7	11.7	0	11	***48***	
Cu, Dis (µg/l)	9	2.7	11.7	1.7	17	***68***	
Fe, Dis (µg/l)	9	2.7	11.7	64	300	***1087***	
Fe, TR (µg/l)	9	2.7	11.7	87	1000	***4043***	
Pb, Dis (µg/l)	9	2.7	11.7	1.7	5.6	***19***	
Mn, Dis (µg/l)	9	2.7	11.7	23	195	***768***	WS
Mn, Dis (µg/l)	9	2.7	11.7	23	255	***1028***	AL
Mo, TR (µg/l)	9	2.7	11.7	0.87	160	***690***	
Hg, Tot (µg/l)	9	2.7	11.7	0	0.01	***0.043***	
Ni, TR (µg/l)	9	2.7	11.7	0.88	100	***430***	
Ni, Dis (µg/l)	9	2.7	11.7	0.88	98	***422***	
Se, Dis (µg/l)	9	2.7	11.7	0.57	4.6	***18***	
Ag, Dis (µg/l)	9	2.7	11.7	0.043	0.27	***1***	
U, TR (µg/l)	9	2.7	11.7	0	16.8	***73***	
U, Dis (µg/l)	9	2.7	11.7	0.25	3435	***14884***	
Zn, Dis (µg/l)	9	2.7	11.7	6.7	240	***1018***	
B, Tot (mg/l)	9	2.7	11.7	0	0.75	***3.3***	
Chloride (mg/l)	9	2.7	11.7	2.6	250	***1075***	
Sulfate (mg/l)	9	2.7	11.7	54	250	***903***	
Sulfide as H2S (mg/l)	9	2.7	11.7	0	0.002	***0.0087***	
Radium 226+228 (pCi/l)	9	2.7	11.7	0	5	***22***	
Thallium, TR (µg/l)	9	2.7	11.7	0	0.24	***1***	

WS= Water Supply/AL= Aquatic Life

Table A-7b
Chronic WQBELs – The Dolores River
September 1- April 30
Effluent Flow 1.44 MGD (2.2 CFS)

Parameter	***Q_1 (cfs)***	***Q_2 (cfs)***	***Q_3 (cfs)***	***M_1***	***M_3***	***M_2***	***Notes***
Temp MWAT (°C) June-Sept	5.4	2.2	7.6	NA	17	***17***	
Temp MWAT (°C) Oct-May	5.4	2.2	7.6	NA	9	***9***	
Al, TR (µg/l)	5.4	2.2	7.6	79	87	***107***	
Sb, Dis (µg/l)	5.4	2.2	7.6	0	5.6	***19***	
As, TR (µg/l) – Beginning 01/01/2025	5.4	2.2	7.6	0	0.02	***0.069***	
Be, TR (µg/l)	5.4	2.2	7.6	0	4	***14***	
Cd, Dis (µg/l)	5.4	2.2	7.6	0	0.75	***2.6***	
Cr+3, Dis (µg/l)	5.4	2.2	7.6	0	137	***473***	
Cr+6, Dis (µg/l)	5.4	2.2	7.6	0	11	***38***	
Cu, Dis (µg/l)	5.4	2.2	7.6	1.7	17	***55***	
Fe, Dis (µg/l)	5.4	2.2	7.6	64	300	***879***	
Fe, TR (µg/l)	5.4	2.2	7.6	87	1000	***3241***	
Pb, Dis (µg/l)	5.4	2.2	7.6	1.7	5.6	***15***	

Mn, Dis (µg/l)	5.4	2.2	7.6	23	195	***617***	WS
Mn, Dis (µg/l)	5.4	2.2	7.6	23	255	***824***	AL
Mo, TR (µg/l)	5.4	2.2	7.6	0.87	160	***551***	
Hg, Tot (µg/l)	5.4	2.2	7.6	0	0.01	***0.035***	
Ni, TR (µg/l)	5.4	2.2	7.6	0	100	***345***	
Ni, Dis (µg/l)	5.4	2.2	7.6	0.88	98	***336***	
Se, Dis (µg/l)	5.4	2.2	7.6	0.57	4.6	***14***	
Ag, Dis (µg/l)	5.4	2.2	7.6	0.043	0.27	***0.83***	
U, TR (µg/l)	5.4	2.2	7.6	0	16.8	***58***	
U, Dis (µg/l)	5.4	2.2	7.6	0.25	3435	***11866***	
Zn, Dis (µg/l)	5.4	2.2	7.6	6.7	240	***813***	
B, Tot (mg/l)	5.4	2.2	7.6	0	0.75	***2.6***	
Chloride (mg/l)	5.4	2.2	7.6	2.6	250	***857***	
Sulfate (mg/l)	5.4	2.2	7.6	54	250	***731***	
Sulfide as H2S (mg/l)	5.4	2.2	7.6	0	0.002	***0.0069***	
Radium 226+228 (pCi/l)	5.4	2.2	7.6	0	5	***17***	
Thallium, TR (ug/l	5.4	2.2	7.6	0	0.24	***0.83***	

WS= Water Supply/AL= Aquatic Life

Table A-7c
Acute WQBELs - The Dolores River
May 1- August 31
Effluent Flow 1.74 MGD (2.7 CFS)

Parameter	***Q_1 (cfs)***	***Q_2 (cfs)***	***Q_3 (cfs)***	***M_1***	***M_3***	***M_2***
Temp Daily Max (°C) June-Sept	12	2.7	14.7	NA	21.7	***21.7***
Temp Daily Max (°C) Oct-May	12	2.7	14.7	NA	13.0	***13***
Al, TR (µg/l)	12	2.7	14.7	79	9572	***51763***
As, Dis (µg/l)	12	2.7	14.7	0	340	***1851***
Cd, TR (µg/l)	12	2.7	14.7	0	5	***27***
Cd, Dis (µg/l)	12	2.7	14.7	0	3.3	***18***
Cr, TR (µg/l)	12	2.7	14.7	0	50	***272***
Cr+3, TR (µg/l)	12	2.7	14.7	0	50	***272***
Cr+3, Dis (µg/l)	12	2.7	14.7	0	1054	***5738***
Cr+6, Dis (µg/l)	12	2.7	14.7	0	16	***87***
Cu, Dis (µg/l)	12	2.7	14.7	1.7	27	***139***
CN, Free (µg/l)	12	2.7	14.7	0	5	***27***
Pb, TR (µg/l)	12	2.7	14.7	0.1	50	***272***
Pb, Dis (µg/l)	12	2.7	14.7	1.7	145	***782***
Mn, Dis (µg/l)	12	2.7	14.7	23	3835	***20777***
Ni, Dis (µg/l)	12	2.7	14.7	0.88	884	***4809***
Se, Dis (µg/l)	12	2.7	14.7	0.57	18.4	***98***

Ag, Dis (µg/l)	12	2.7	14.7	0.043	7.4	***40***
U, Dis (µg/l)	12	2.7	14.7	0.25	5499	***29938***
Zn, Dis (µg/l)	12	2.7	14.7	6.7	317	***1696***

Table A-7d
Acute WQBELS- The Dolores River
September 1 - April 30
Effluent Flow 1.44 MGD (2.2 CFS)

Parameter	***Q_1 (cfs)***	***Q_2 (cfs)***	***Q_3 (cfs)***	***M_1***	***M_3***	***M_2***
Temp Daily Max (°C) June-Sept	3.6	2.2	5.8	NA	21.7	***21.7***
Temp Daily Max (°C) Oct-May	3.6	2.2	5.8	NA	13.0	***13***
Al, TR (µg/l)	3.6	2.2	5.8	79	9572	***25106***
As, Dis (µg/l)	3.6	2.2	5.8	0	340	***896***
Cd, TR (µg/l)	3.6	2.2	5.8	0	5	***13***
Cd, Dis (µg/l)	3.6	2.2	5.8	0	3.3	***8.7***
Cr, TR (µg/l)	3.6	2.2	5.8	0	50	***132***
Cr+3, TR (µg/l)	3.6	2.2	5.8	0	50	***132***
Cr+3, Dis (µg/l)	3.6	2.2	5.8	0	1054	***2779***
Cr+6, Dis (µg/l)	3.6	2.2	5.8	0	16	***42***
Cu, Dis (µg/l)	3.6	2.2	5.8	1.7	27	***68***
CN, Free (µg/l)	3.6	2.2	5.8	0	5	***13***
Pb, TR (µg/l)	3.6	2.2	5.8	0.1	50	***132***
Pb, Dis (µg/l)	3.6	2.2	5.8	1.7	145	***379***
Mn, Dis (µg/l)	3.6	2.2	5.8	23	3835	***10073***
Ni, Dis (µg/l)	3.6	2.2	5.8	0.88	884	***2329***
Se, Dis (µg/l)	3.6	2.2	5.8	0.57	18.4	***48***
Ag, Dis (µg/l)	3.6	2.2	5.8	0.043	7.4	***19***
U, Dis (µg/l)	3.6	2.2	5.8	0.25	5499	***14497***
Zn, Dis (µg/l)	3.6	2.2	5.8	6.7	317	***825***

WQBELS- THE DOLORES RIVER- NON SEASONAL

Table A-7e

Chronic WQBELs- The Dolores River Non-Seasonal
Effluent Flow: 1.74 MGD (2.7 CFS)

Parameter	***Q_1 (cfs)***	***Q_2 (cfs)***	***Q_3 (cfs)***	***M_1***	***M_3***	***M_2***	***Notes***
Temp MWAT (°C) June-Sept	5.4	2.7	8.1	NA	17	***17***	
Temp MWAT (°C) Oct-May	5.4	2.7	8.1	NA	9	***9***	
Al, TR (µg/l)	5.4	2.7	8.1	79	87	***103***	
Sb, Dis (µg/l)	5.4	2.7	8.1	0	5.6	***17***	
As, TR (µg/l) –Beginning 01/01/2025	5.4	2.7	8.1	0	0.02	***0.06***	
Be, TR (µg/l)	5.4	2.7	8.1	0	4	***12***	
Cd, Dis (µg/l)	5.4	2.7	8.1	0	0.75	***2.3***	
Cr+3, Dis (µg/l)	5.4	2.7	8.1	0	137	***411***	
Cr+6, Dis (µg/l)	5.4	2.7	8.1	0	11	***33***	
Cu, Dis (µg/l)	5.4	2.7	8.1	1.7	17	***48***	
Fe, Dis (µg/l)	5.4	2.7	8.1	64	300	***772***	

Fe, TR (µg/l)	5.4	2.7	8.1	87	1000	***2826***	
Pb, Dis (µg/l)	5.4	2.7	8.1	1.7	5.6	***13***	
Mn, Dis (µg/l)	5.4	2.7	8.1	23	255	***719***	AL
Mn, Dis (µg/l)	5.4	2.7	8.1	23	195	***539***	WS
Mo, TR (µg/l)	5.4	2.7	8.1	0.87	160	***478***	
Hg, Tot (µg/l)	5.4	2.7	8.1	0	0.01	***0.03***	
Ni, TR (µg/l)	5.4	2.7	8.1	0	100	***300***	
Ni, Dis (µg/l)	5.4	2.7	8.1	0.88	98	***292***	
Se, Dis (µg/l)	5.4	2.7	8.1	0.57	4.6	***13***	
Ag, Dis (µg/l)	5.4	2.7	8.1	0.043	0.27	***0.72***	
U, TR (µg/l)	5.4	2.7	8.1	0	16.8	***50***	
U, Dis (µg/l)	5.4	2.7	8.1	0.25	3435	***10305***	
Zn, Dis (µg/l)	5.4	2.7	8.1	6.7	240	***707***	
B, Tot (mg/l)	5.4	2.7	8.1	0	0.75	***2.3***	
Chloride (mg/l)	5.4	2.7	8.1	2.6	250	***745***	
Sulfate (mg/l)	5.4	2.7	8.1	54	250	***642***	
Sulfide as H2S (mg/l)	5.4	2.7	8.1	0	0.002	***0.006***	
Radium 226+228 pCi/l	5.4	2.7	8.1	0	5	***15***	
Thallium, TR (ug/l	5.4	2.7	8.1	0	0.24	***0.72***	

AL=Aquatic Life/WS=Water Supply

Table A-7f
Acute WQBELs – The Dolores River Non-Seasonal
Effluent Flow 1.74 MGD (2.7 CFS)

Parameter	***Q_1 (cfs)***	***Q_2 (cfs)***	***Q_3 (cfs)***	***M_1***	***M_3***	***M_2***	***Notes***
Temp Daily Max (°C) June-Sept	3.6	2.7	6.3	NA	21.7	***21.7***	
Temp Daily Max (°C) Oct-May	3.6	2.7	6.3	NA	13.0	***13***	
Al, TR (µg/l)	3.6	2.7	6.3	79	9572	***22229***	
As, Dis (µg/l)	3.6	2.7	6.3	0	340	***793***	
Cd, TR (µg/l)	3.6	2.7	6.3	0	5	***12***	
Cd, Dis (µg/l)	3.6	2.7	6.3	0	3.3	***7.7***	
Cr, TR (µg/l)	3.6	2.7	6.3	0	50	***117***	
Cr+3, TR (µg/l)	3.6	2.7	6.3	0	50	***117***	
Cr+3, Dis (µg/l)	3.6	2.7	6.3	0	1054	***2459***	
Cr+6, Dis (µg/l)	3.6	2.7	6.3	0	16	***37***	
Cu, Dis (µg/l)	3.6	2.7	6.3	1.7	27	***61***	
CN, Free (µg/l)	3.6	2.7	6.3	0	5	***12***	
Pb, TR (µg/l)	3.6	2.7	6.3	0.1	50	***117***	
Pb, Dis (µg/l)	3.6	2.7	6.3	1.7	145	***336***	
Mn, Dis (µg/l)	3.6	2.7	6.3	23	3835	***8918***	
Ni, Dis (µg/l)	3.6	2.7	6.3	0.88	884	***2061***	
Se, Dis (µg/l)	3.6	2.7	6.3	0.57	18.4	***42***	
Ag, Dis (µg/l)	3.6	2.7	6.3	0.043	7.4	***17***	
U, Dis (µg/l)	3.6	2.7	6.3	0.25	5499	***12831***	
Zn, Dis (µg/l)	3.6	2.7	6.3	6.7	317	***731***	

THE WETLANDS

Table A-7g
Chronic WQBELs – The Wetlands, Segment COSJDO05A

Parameter	*Q_1 (cfs)*	*Q_2 (cfs)*	*Q_3 (cfs)*	*M_1*	*M_3*	*M_2*
Temp MWAT (°C) June-Sept	0	2.7	2.7	NA	17	***17***
Temp MWAT (°C) Oct-May	0	2.7	2.7	NA	9	***9***
Al, TR (µg/l)	0	2.7	2.7	0	87	***87***
Sb, Dis (µg/l)	0	2.7	2.7	0	5.6	***5.6***
As, TR (µg/l)	0	2.7	2.7	0	0.02	***0.02***
Be, TR (µg/l)	0	2.7	2.7	0	4	***4***
Cd, Dis (µg/l)	0	2.7	2.7	0	1.2	***1.2***
Cr+3, Dis (µg/l)	0	2.7	2.7	0	137	***137***
Cr+6, Dis (µg/l)	0	2.7	2.7	0	11	***11***
Cu, Dis (µg/l)	0	2.7	2.7	0	29	***29***
Fe, TR (µg/l)	0	2.7	2.7	0	1000	***1000***
Pb, Dis (µg/l)	0	2.7	2.7	0	11	***11***
Mn, Dis (µg/l)	0	2.7	2.7	0	255	***255***
Mo, TR (µg/l)	0	2.7	2.7	0	160	***160***
Hg, Tot (µg/l)	0	2.7	2.7	0	0.01	***0.01***
Ni, TR (µg/l)	0	2.7	2.7	0	100	***100***
Ni, Dis (µg/l)	0	2.7	2.7	0	168	***168***
Se, Dis (µg/l)	0	2.7	2.7	0	4.6	***4.6***
Ag, Dis (µg/l)	0	2.7	2.7	0	0.81	***0.81***
U, TR (µg/l)	0	2.7	2.7	0	16.8	***30***
U, Dis (µg/l)	0	2.7	2.7	0	6915	***6915***
Zn, Dis (µg/l)	0	2.7	2.7	0	428	***428***
B, Tot (mg/l)	0	2.7	2.7	0	0.75	***0.75***
Chloride (mg/l)	0	2.7	2.7	0	250	***250***
Sulfide as H2S (mg/l)	0	2.7	2.7	0	0.002	***0.002***
Radium 226+228 pCi/l	0	2.7	2.7	0	5	***5***
Thallium, TR (ug/l)	0	2.7	2.7	0	0.24	***0.24***

Table A-7h
Acute WQBELs – The Wetlands, Segment COSJDO05A

Parameter	*Q_1 (cfs)*	*Q_2 (cfs)*	*Q_3 (cfs)*	*M_1*	*M_3*	*M_2*
Temp Daily Max (°C) June-Sept	0	2.7	2.7	NA	21.7	***21.7***
Temp Daily Max (°C) Oct-May	0	2.7	2.7	NA	13.0	***13***
Al, TR (µg/l)	0	2.7	2.7	0	10071	***10071***
As, Dis (µg/l)	0	2.7	2.7	0	340	***340***
Cd, TR (µg/l)	0	2.7	2.7	0	5	***5***
Cd, Dis (µg/l)	0	2.7	2.7	0	5.7	***5.7***
Cr, TR (µg/l)	0	2.7	2.7	0	50	***50***
Cr+3, TR (µg/l)	0	2.7	2.7	0	50	***50***
Cr+3, Dis (µg/l)	0	2.7	2.7	0	1773	***1773***
Cr+6, Dis (µg/l)	0	2.7	2.7	0	16	***16***
Cu, Dis (µg/l)	0	2.7	2.7	0	50	***50***
CN, Free (µg/l)	0	2.7	2.7	0	5	***5***

Pb, TR (µg/l)	0	2.7	2.7	0	50	***50***
Pb, Dis (µg/l)	0	2.7	2.7	0	281	***281***
Mn, Dis (µg/l)	0	2.7	2.7	0	4738	***4738***
Ni, Dis (µg/l)	0	2.7	2.7	0	1513	***1513***
Se, Dis (µg/l)	0	2.7	2.7	0	18.4	***18***
Ag, Dis (µg/l)	0	2.7	2.7	0	22	***22***
U, Dis (µg/l)	0	2.7	2.7	0	11070	***11070***
Zn, Dis (µg/l)	0	2.7	2.7	0	564	***564***

Whole Effluent Toxicity (WET) Testing

The Water Quality Control Division has established the use of WET testing as a method for identifying and controlling toxic discharges from wastewater treatment facilities. WET testing is being utilized as a means to ensure that there are no discharges of pollutants "in amounts, concentrations or combinations which are harmful to the beneficial uses or toxic to humans, animals, plants, or aquatic life" as required by Section 31.11 (1) of the Basic Standards and Methodologies for Surface Waters. The requirements for WET testing are being implemented in accordance with Division policy, Implementation of the Narrative Standard for Toxicity in Discharge Permits Using Whole Effluent Toxicity (Sept 30, 2010). Note that this policy has recently been updated and the permittee should refer to this document for additional information regarding WET.

In-Stream Waste Concentration (IWC) – Where monitoring or limitations for WET are deemed appropriate by the Division, the chronic in-stream dilution is critical in determining whether acute or chronic conditions shall apply. In accordance with Division policy, for those discharges where the chronic IWC is greater than 9.1% and the receiving stream has a Class 1 Aquatic Life use or Class 2 Aquatic Life use with all of the appropriate aquatic life numeric standards, chronic conditions will normally apply. Where the chronic IWC is less than or equal to 9.1, or the stream is not classified as described above, acute conditions will normally apply. The chronic IWC is determined using the following equation:

IWC = [Facility Flow (FF)/(Stream Chronic Low Flow (annual) + FF)] X 100%

The flows and corresponding IWC for the appropriate discharge point are:

Receiving Water/Season	Chronic Low Flow, 30E3 (cfs)	Facility Design Flow (cfs)	IWC, (%)
The Dolores River May 1- Aug 31	9	2.7	23
The Dolores River Sept 1- Ap 30	5.4	2.2	29
The Dolores River- Non Seasonal	5.4	2.7	33
The Wetlands	0	2.7	100

The Dolores River

The IWC for the season May through August is 23 %, which represents a wastewater concentration of 23% effluent to 77 % receiving stream. The IWC for the season September through April is 29 %, which represents a wastewater concentration of 29 % effluent to 71 % receiving stream. These IWCs correlate to chronic WET testing. Note that if the frequency of WET testing is quarterly in a permitting action, the IWC for the quarter will be set to the most stringent month during that quarter.

In the event a non-seasonal permit is applied, The IWC is 33%, which represents a wastewater concentration of 33% effluent to 67% receiving stream. This IWC correlates to chronic WET testing.

The Wetlands
The IWC is 100 %, which represents a wastewater concentration of 100% effluent to 0 % receiving water. This IWC correlates to chronic WET testing.

Agricultural Use Parameters (SAR and EC):

Section 31.11(1)(a)(iv) of *The Basic Standards and Methodologies for Surface Waters* (Regulation No. 31) includes the narrative standard that State surface waters shall be free of substances that are harmful to the beneficial uses or toxic to humans, animals, plants, or aquatic life. The interpretation of these conditions (i.e., "no harm to plants" and "no harm to the beneficial uses") and how they were to be applied in permits were contemplated by the Division as part of an Agricultural Work Group, and culminated in the most recent policy entitled *Implementing Narrative Standards in Discharge Permits for the Protection of Irrigated Crops* (hereafter the Ag Policy)

Based on available information, the water in **The Dolores River,** downstream from the town of Rico is used for irrigation water. At the confluence of Bear Creek and the Dolores river, several fields are irrigated for grass hay. The evaluation of the suitability (i.e., quality) of irrigation water is complex and involves the detailed understanding of the interactions of plant tolerances, soil types, and agricultural management practices. Irrigation water has two properties – salinity and sodicity – that can have concurrent impacts on the irrigated crop beneficial use. The Division has thus determined that two parameters, specifically electrical conductivity (EC) and sodium absorption ratio (SAR), are the best parameters to regulate in discharge permits to control levels of salts to minimize both the loss of irrigated crop yield and the sodium hazard.

In order to establish "standards" and limits for EC and SAR, the Division must: (1) determine the most sensitive crop usually grown in the area downstream from the discharge and determine the corresponding EC of irrigation water (EC_w) threshold value for no reduction in yield below100%; and (2) determine the SAR based on the EC_w value, with consideration of existing water quality, to prevent the exceedance of the SAR.

Electrical Conductivity: The electrical conductivity (EC) is also known as specific conductance, conductance, conductivity, or specific conductivity. Crops have varying sensitivity to electrical conductivity. Studies have established the maximum conductivity in the water in the root zone that will result in no reduction of crop yield. This value is referred to as the EC saturation extract or EC_e. However, the EC_e is not the same as the EC of the irrigation water (EC_w). The EC_w is the maximum conductivity in the irrigation water that will result in no reduction in crop yield.

Common crop EC_w thresholds are reproduced from the Ag Policy, and are summarized in Table A-9a. Note that other EC_w are listed in tables in appendixes to the Ag Policy.

Table A-9a **Maximum EC_w That Will Not Reduce The 100% Yield of Selected Irrigated Crops**	
Common Colorado Crops	***Irrigation Water Electrical Conductivity (EC_w)***
Beans	0.7
Onion	0.8
Corn (grain)	1.1
Potato	1.1
Corn (silage)	1.2
Alfalfa	1.3
Orchard Grass	1.5
Wheat	4.0
Sugarbeet	4.7
Barley	5.3

The EC_w that is used in the development of permit limits is determined based on the most sensitive of the EC_w's for the crops grown in the area. Based on available information, for waters originating from **The Dolores River** and used for crop irrigation, orchard grass was determined to be the most sensitive crop.

For **the Dolores River**, the EC limit is calculated using the mass balance equation found at the beginning of Section IV of this analysis. The data used and the resulting calculations of the EC limit, M_2, are set forth in the table below. Note that in accordance with the Ag Policy, the EC limit will be imposed as a chronic (30-day average) limit and therefore chronic low flows were used together with 85th percentile EC concentrations when calculating the limit.

May 1- August 31

Parameter	***Q_1 (cfs)***	***Q_2 (cfs)***	***Q_3 (cfs)***	***M_1***	***M_3***	***M_2***
EC (dS/m)	9	2.7	11.7	0.3	1.5	***5.5***

September 1- April 30

Parameter	***Q_1 (cfs)***	***Q_2 (cfs)***	***Q_3 (cfs)***	***M_1***	***M_3***	***M_2***
EC (dS/m)	5.4	2.2	7.6	0.3	1.5	***4.4***

Note that in Figure A-2 at an EC value of 0.36 or less, the SAR must be 0. In order to achieve a 0 SAR, any treatment process would have to eliminate all sodium, which is virtually impossible. Therefore, a minimum EC at 0.36 will be instigated in the permit.

SAR – SAR means Sodium Adsorption Ratio, which is a representation of the relative proportion of sodium cations to calcium and magnesium cations (also known as the "sodium hazard"). The equation for SAR follows:

$$SAR = \frac{Na^{+}}{\sqrt{\frac{Ca^{++} + Mg^{++}}{2}}}$$

The values for sodium (Na^+), calcium (Ca^{++}) and magnesium (Mg^{++}) in this equation are expressed in units of milliequivalents per liter (meq/l). Generally, data for sodium, calcium and magnesium are reported in terms of mg/l, which must then be converted to calculate the SAR. The conversions are:

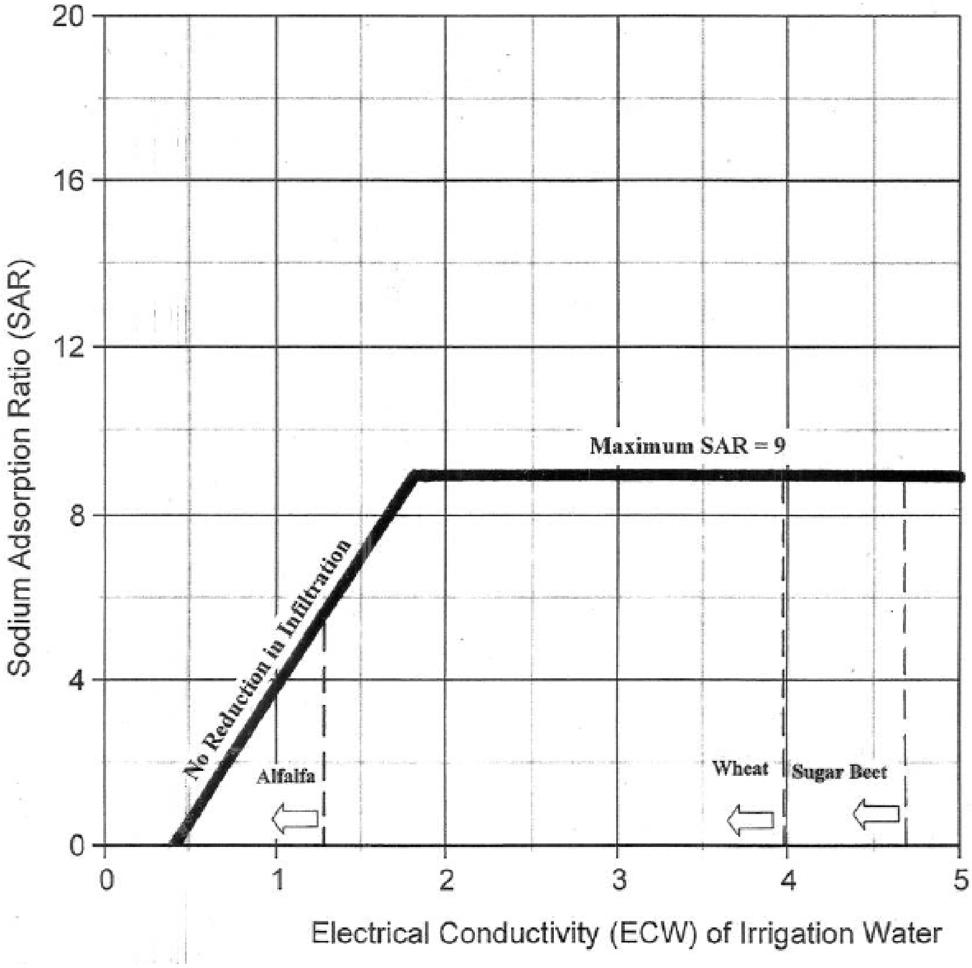
$$\text{meq/l} = \frac{Concentration\ in\ mg/l}{Equivalent\ weight\ in\ mg/meq}$$

Where the equivalent weights are determined based on the atomic weight of the element divided by the ion's charge:

Na^+ = 23.0 mg/meq (atomic weight of 23, charge of 1)
Ca^{++} = 20.0 mg/meq (atomic weight of 40.078, charge of 2)
Mg^{++} = 12.15 mg/meq (atomic weight of 24.3, charge of 2)

The SAR standard is established using the SAR/EC equation, shown graphically in Figure A-2, which is reproduced herein from the Ag Policy. Since the allowable SAR value is tied to the actual EC of the effluent, the EC/SAR equation (SAR = (7.1 * EC) – 2.48) will be the SAR limit in the permit, however the allowable SAR of the effluent will be capped at the value above or 9, whichever is less. Due to the effect of bicarbonate on the available calcium and magnesium, limitations may be expressed as adjusted SAR, which accounts for bicarbonate in the effluent. This is applicable if bicarbonate in the effluent is 150 mg/l or greater.

Figure A-2: Relative Rate of Water Infiltration as Affected by EC_w and SAR with Modification to Show Upper Limit for SAR = 9



VII. Antidegradation Evaluation

As set out in *The Basic Standards and Methodologies for Surface Water*, Section 31.8(2)(b), an antidegradation analysis is required except in cases where the receiving water is designated as "Use Protected." Note that "Use Protected" waters are waters "that the Commission has determined do not warrant the special protection provided by the outstanding waters designation or the antidegradation review process" as set out in Section 31.8(2)(b). The antidegradation section of the regulation became effective in December 2000, and therefore antidegradation considerations are applicable to this PEL analysis.

According to the *Regulation No. 34- Classifications and Numeric Standards for San Juan River and Dolores River Basins*, stream segments COSJDO03/5A are Undesignated (Reviewable). Thus, an antidegradation review is required for this segment if new or increased impacts are found to occur.

DOLORES RIVER WATER SUPPLY – Dissolved Iron, Dissolved Manganese, and Sulfate

The Water Quality Control Commission completed a final action for *The Basic Standards and Methodologies for Surface Water, Regulation 31* which became effective January 1, 2017. The final action exempts dissolved iron, dissolved manganese, and sulfate from antidegradation consideration on the basis that this level of protection extends to standards that protect "fishable/swimmable" uses, and not water supply uses. Dissolved iron, dissolved manganese and sulfate are based on secondary Safe Drinking Water Act criteria and are not surrogates for any swimmable criteria, and are therefore exempt from further antidegradation review. This WQA has been developed in conformance with the preliminary final action, as any permitting action based on this WQA would take effect just prior to the effective date of this regulation.

Introduction to the Antidegradation Process

The antidegradation process conducted as part of this Preliminary Effluent Limitations is designed to determine if an antidegradation review is necessary and if necessary, to complete the required calculations to determine the limits that can be selected as the antidegradation-based effluent limit (ADBEL), absent further analyses that must be conducted by the facility.

As outlined in the *Antidegradation Significance Determination for New or Increased Water Quality Impacts, Procedural Guidance* (AD Guidance), the first consideration of an antidegradation evaluation is to determine if new or increased impacts are expected to occur. This is determined by a comparison of the newly calculated WQBELs verses the existing permit limitations in place as of September 30, 2000, and is described in more detail in the analysis. Note that the AD Guidance refers to the permit limitations as of September 30, 2000 as the existing limits.

If a new or increased impact is found to occur, then the next step of the antidegradation process is to go through the significance determination tests. These tests include: 1) bioaccumulative toxic pollutant test; 2) temporary impacts test; 3) dilution test (100:1 dilution at low flow) and; 4) a concentration test.

As the determination of new or increased impacts, and the bioaccumulative and concentration significance determination tests require more extensive calculations, the Division will begin the antidegradation evaluation with the dilution and temporary impact significance determination tests. These two significance tests may exempt a facility from further AD review without the additional calculations.

Note that the antidegradation requirements outlined in *The Basic Standards and Methodologies for Surface Water* specify that chronic numeric standards should be used in the antidegradation review; however, where there is only an acute standard, the acute standard should be used. The appropriate standards are used in the following antidegradation analysis.

Significance Tests for Temporary Impacts and Dilution

The ratio of the chronic (30E3) low flow to the design flow is less than the 100:1 significance criteria. Therefore this facility is not exempt from an AD evaluation based on the dilution significance determination test, and the AD evaluation must continue.

For the determination of a new or increased impact and for the remaining significance determination tests, additional calculations are necessary. Therefore, at this point in the antidegradation evaluation, the Division will go back to the new or increased impacts test. If there is a new or increased impact, the last two significance tests will be evaluated.

New or Increased Impact and Non Impact Limitations (NILs)

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To determine if there is a new or increased impact to the receiving water, a comparison of the new WQBEL concentrations and loadings verses the concentrations and loadings as of September 30, 2000, needs to occur. If either the new concentration or loading is greater than the September 2000 concentration or loading, then a new or increased impact is determined. If this is a new facility (commencement of discharge after September 30, 2000) it is automatically considered a new or increased impact.

Note that the AD Guidance document includes a step in the New or Increased Impact Test that calculates the Non-Impact Limit (NIL). The permittee may choose to retain a NIL if certain conditions are met, and therefore the AD evaluation for that parameter would be complete. As the NIL is typically greater than the ADBAC, and is therefore the chosen limit, the Division will typically conclude the AD evaluation after determining the NIL. Where the NILs are very stringent, or upon request of a permittee, the Division will calculate both the NIL and the AD limitation so that the limitations can be compared and the permittee can determine which of the two limits they would prefer, one which does not allow any increased impact (NIL), or the other which allows an insignificant impact (AD limit).

The non impact limit (NIL) is defined as the limit which results in no increased water quality impact (no increase in load or limit over the September 2000 load or limit). The NIL is calculated as the September 2000 loading, divided by the increased design flow (if applicable), and divided by a conversion factor of 8.34. If there is no change in design flow, or if there is a decrease in design flow, then the NIL is equal to the September 2000 permit limitation.

If the facility was in place, but did not have a limitation for a particular parameter in the September 2000 permit, the Division may substitute an implicit limitation. Consistent with the First Update to the AD Guidance of April 2002, an implicit limit is determined based on the approach that specifies that the implicit limit is the maximum concentration of the effluent from October 1998 to September 2000, if such data is available. If this data is unavailable, the Division may substitute more recent representative data, if appropriate, on a case by case basis. Note that if there is a change in design flow, the implicit limit/loading is subject to recalculation based on the new design flow. For parameters that are undisclosed by the permittee, and unknown to the Division to be present, an implicit limitation may not be recognized. Note that there is not a current permit for the St. Louis Tunnel discharge.

This facility was in place and discharging to the Delores River prior to September 30, 2000 (CO0029793), and therefore the new or increased impacts test must be conducted. The design flow of this facility has decreased from 2.6 MGD (4 cfs) during the AD period, to 1.74 MGD (2.7 cfs).

<u>NILs- TR Cadmium and TR Lead</u>
For total recoverable cadmium and total recoverable lead, the limitations of September 2000, 0.4 ug/l and 9.9 ug/l, respectively, were used in the evaluation of new or increased impacts. The remaining permit limits were in 'total recoverable' form, and not in the current 'dissolved' form so could not be used for NILs.

<u>Implicit NILs</u>
For total recoverable arsenic, dissolved arsenic, potentially dissolved Cadmium, chloride, Dissolved trivalent and hexavalent chromium, potentially dissolved copper, cyanide, total recoverable iron, potentially dissolved lead, potentially dissolved manganese, potentially dissolved nickel, potentially dissolved selenium, potentially dissolved silver, and potentially dissolved zinc, data prior to 2000 were either not available, or very limited (data was available for dissolved Mn only prior to 2000), as the permit limitations and monitoring at that time was in 'total' form. Therefore,

data from October 1999 through January 2006 were determined to be representative of the AD period, and were used to determine the implicit limitations. This period of record is representative because there were no water quality changes to the watershed nor were there any changes to the effluent quality since before September 30, 2000. The data summary for the implicit NILs based on this data is shown below. Note, the standard deviation is included simply to show the variability in the data, and because this was shown in the previous 2008 WQA.

Parameter	Count	Min of Monthly Avg's	Max of Monthly Avg's	Std. Dev. of Monthly Avg's
Arsenic, TR (µg/l)	2	<0.5	0	0
Arsenic, Dis (µg/l)	4	<2	0	0
Cadmium, Pd (ug/l)	18	1.8	84.8	19.16576949
Chromium, Dis (µg/l)	5	<0.1	0	0
Copper. Pd (ug/l)	18	<10	20.4	7.491424291
Cyanide, Tot (mg/l)	7	<0.005	0	0
Iron, TR (µg/l)	30	<20	1410	453.4167981
Lead, Pd (ug/l)	18	<0.1	32	7.409031849
Manganese, Pd (ug/l)	18	312	4110	868.8688763
Mercury, Tot (µg/l)	13	<0.0002	0.0004	0.000149786
Nickel, Pd (ug/l)	14	<18.6	80	21.20128547
Selenium, Pd (ug/l)	15	<8	0.9	0.28149262
Silver, Pd (ug/l)	17	<1	0.06	0.014552138
Zinc, Pd (ug/l)	17	410	14500	3399.145005
Chloride (mg/l)	5	<8	0.9	0.402492236

<u>No Data</u>
For total recoverable aluminum, potentially dissolved antimony, total recoverable beryllium, total recoverable trivalent chromium, total recoverable molybdenum, total recoverable nickel, total recoverable uranium, potentially dissolved uranium, boron, sulfide, radium 226+228, strontium and thallium, there are no effluent data available and therefore, the Division will calculate the ADBACs.

<u>Calculation of Loadings for New or Increased Impact Test</u>

The equations for the loading calculations are given below. Note that the AD requirements outlined in *The Basic Standards and Methodologies for Surface Water* specify that chronic numeric standards should be used in the AD review; however, where there is only an acute standard, the acute standard should be used. Thus, the chronic low flows will be used later in this AD evaluation for all parameters with a chronic standard, and the acute low flows will be used for those parameters with only an acute standard.

$$\text{Previous permit load} = M_{permitted}\ (mg/l) \times Q_{permitted}\ (mgd) \times 8.34$$
$$\text{New WQBELs load} = M_2\ (mg/l) \times Q_2\ (mgd) \times 8.34$$

Where,

$M_{permitted}$ = September 2000 permit limit (or implicit limit) **(mg/l)**
$Q_{permitted}$ = design flow as of September 2000 **(mgd)**
Q_2 = current design flow (same as used in the WQBEL calculations)
M_2 = new WQBEL concentration **(mg/l)**
8.34 = unit conversion factor

Table A-10 shows the results of these calculations and the determination of a new or increased impact.

Table A-10a

Determination of New or Increased Impacts- The Dolores River

Pollutant	*Sept 2000 Permit Limit*	*Sept 2000 Permit Load (lbs/day)*	*NIL or Implicit NIL*	*New WQBEL*	*New WQBEL Load (lbs/day)*	*New or Increased Impact*
As, TR (µg/l)	NA	NA	0	0.06	0.00087	Yes
As, Dis (µg/l)	NA	NA	0	793	12	Yes
Cd, TR (µg/l)	0.4	0.0087	0.4	12	0.17	Yes
Cd, Dis (µg/l)	NA	NA	85	2.3	0.033	No
Cr+3, Dis (µg/l)*	NA	NA	0*	411	6	Yes
Cr+6, Dis (µg/l)*	NA	NA	0*	33	0.48	Yes
Cu, Dis (µg/l)	NA	NA	20	48	0.7	Yes
CN, Tot (µg/l)	NA	NA	0	12	0.19	Yes
Fe, TR (µg/l)	NA	NA	1410	2826	41	Yes
Pb, TR (µg/l)	9.9	0.21	9.9	150	2.2	Yes
Pb, Dis (µg/l)	NA	NA	32	13	0.19	No
Mn, Dis (µg/l)	NA	NA	4110	719	10	No
Hg, Tot (µg/l)	NA	NA	0.0004	0.03	0.00044	Yes
Ni, Dis (µg/l)	NA	NA	80	292	4.2	Yes
Se, Dis (µg/l)	NA	NA	0.9	13	0.19	Yes
Ag, Dis (µg/l)	NA	NA	0.06	0.72	0.01	Yes
Zn, Dis (µg/l)	NA	NA	14500	707	10	No
Chloride (mg/l)	NA	NA	0.9	745	10811	Yes

*Data based on the unspeciated (total) form of dissolved chromium

As shown in Table A-10a, there are no new or increased impacts to the receiving stream based on the new WQBELS for dissolved cadmium, dissolved lead, dissolved manganese and dissolved zinc, and for these parameters the AD evaluation is complete and the WQBELs are the final result of this PEL.

For the remaining parameters in the table above, there are new or increased impacts and in accordance with regulation, the permittee has the option of choosing either the NIL's or ADBAC's. Normally, the Division would assign the NILs as permit limitations, or prescribe monitoring to determine the appropriate implicit limitations as necessary, however, in this case, the NILs are very stringent for some parameters and for purposes of this PEL, the Division will calculate the ADBACs for comparison.

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Table A-10b Determination of New or Increased Impacts- The Wetlands						
Pollutant	***Sept 2000 Permit Limit***	***Sept 2000 Permit Load (lbs/day)***	***NIL or Implicit NIL***	***New WQBEL***	***New WQBEL Load (lbs/day)***	***New or Increased Impact***
As, TR (µg/l)	NA	NA	0	0.02	0.00029	Yes
As, Dis (µg/l)	NA	NA	0	340	4.9	Yes
Cd, TR (µg/l)	0.4	0.0087	0.4	5	0.073	Yes
Cd, Dis (µg/l)	NA	NA	85	1.2	0.017	No
Cr+3, Dis (µg/l)	NA	NA	0*	137	2	Yes
Cr+6, Dis (µg/l)	NA	NA	0*	11	0.16	Yes
Cu, Dis (µg/l)	NA	NA	20	29	0.42	Yes
CN, Tot (µg/l)	NA	NA	0	13	0.19	Yes
Fe, TR (µg/l)	NA	NA	1410	1000	15	No
Pb, TR (µg/l)	9.9	0.21	9.9	50	0.73	Yes
Pb, Dis (µg/l)	NA	NA	32	11	0.16	No
Mn, Dis (µg/l)	NA	NA	4110	255	3.7	No
Hg, Tot (µg/l)	NA	NA	0.0004	0.01	0.00015	Yes
Ni, Dis (µg/l)	NA	NA	80	168	2.4	Yes
Se, Dis (µg/l)	NA	NA	0.9	4.6	0.067	Yes
Ag, Dis (µg/l)	NA	NA	0.06	0.81	0.012	Yes
Zn, Dis (µg/l)	NA	NA	14500	428	6.2	No
Chloride (mg/l)	NA	NA	0.9	250	3628	Yes

*Data based on the unspeciated (total) form of dissolved chromium

As shown in Table A-10b, there are no new or increased impacts to the receiving stream based on the new WQBELS for dissolved cadmium, total recoverable iron, dissolved lead, dissolved manganese and dissolved zinc, and for these parameters the AD evaluation is complete and the WQBELs are the final result of this PEL.

For the remaining parameters in the table above, there are new or increased impacts and in accordance with regulation, the permittee has the option of choosing either the NIL's or ADBAC's. Normally, the Division would assign the NILs as permit limitations, or prescribe monitoring to determine the appropriate implicit limitations as necessary, however, in this case, the NILs are very stringent for some parameters and for purposes of this PEL, the Division will calculate the ADBACs for comparison.

The final two significance determination tests (bioaccumulative and concentration) need to be applied, to determine if AD limits are applicable. For the bioaccumulative test, the determination of the baseline water quality (BWQ), the baseline water quality loading (BWQload), the threshold load (TL) and the threshold load concentration (TL conc) needs to occur. For the concentration test, the BWQ, significant concentration thresholds (SCT) and antidegradation based average concentrations (ADBACs) need to be calculated. These calculations are explained in the following sections, and each significance determination test will be performed as the necessary calculations are complete. The AD low flow may also need to be calculated when determining the BWQ for an existing discharger (as of Sept 2000) when upstream water quality data are used.

Determination of Baseline Water Quality (BWQ)

The BWQ is the ambient condition of the water quality as of September 30, 2000. The BWQ defines the baseline low flow pollutant concentration, and for bioaccumulative toxic pollutants, the baseline load. The BWQ is to take into account the influence of the discharger if the discharge was in place prior to September 30, 2000. In such a case, data from a downstream location should be used to determine the BWQ. If only upstream data is available, then a mass balance equation may be applied, using the facilities effluent data to determine the BWQ. If the discharge was not present prior to September 30, 2000, then the influence of that discharge would not be taken into account in determining the BWQ. If the BWQ has already been determined in a previous PEL AD evaluation, it may not need to be recalculated as the BWQ is the water quality as of September 30, 2000, and therefore should not change unless additional data is obtained or the calculations were in error.

Dolores River, BWQ-Previous WQA

The BWQ concentrations were correctly determined for the Dolores River for dissolved hexavalent chromium (based on unspeciated dissolved chromium data), total recoverable trivalent chromium (based on unspeciated total chromium data), dissolved copper, cyanide, total recoverable iron, dissolved nickel, dissolved selenium, and dissolved silver potential pollutants of concern as part of a previous WQA (2008). These are summarized in Table A-11a.

Table A-11a

Dolores River- BWQ Concentrations Based on Previous Determinations

Pollutant	*BWQ (µg/l)*
Cr+6, Dis	0.05
Cr+3, Trec	0.54
Cu, Dis	1.24
CN, Free	0
Fe, Trec	250
Ni, Dis	0
Se, Dis	0.92
Ag, Dis	0

For the remaining parameters, consistent with Division procedures, the BWQ concentrations should be established so that it can be used as part of an antidegradation review.

Dolores River, BWQ (remaining parameters)

This discharger was in place as of September 30, 2000, and therefore the BWQ will include the influence of the discharger. Data collected at DR-7 (the same as sampling location COSJDO03-1.4, 2008 WQA) located just downstream from the pond outfall, were determined to be representative of fully mixed condition downstream from the facility, without other influences, and thus the data were used to determine the BWQ concentrations. Since the data were collected downstream of the discharge, it takes into account the contribution of the facility.

Currently, it is the Division's approach to evaluate five years of ambient water quality data, if available, for the five years prior to September 30, 2000, when determining the BWQ. However, due to very limited data (between 1-4 data points) available during the timeframe of September 30, 1995 through September 30, 2000, the period of record was expanded, from April 1998 through January 2006 for most pollutants. Although these data were not collected during the five years prior to September 2000, the Division has determined that, absent data available during the AD period, the available data are considered representative of the BWQ during the AD period. There have been no water quality changes to the watershed during this time, nor have there been any changes to the effluent quality since before September 2000. Using an expanded period of record, with a more robust data set more accurately characterizes the baseline water quality. Data for total recoverable aluminum, total recoverable beryllium and total recoverable thallium were not available during the AD timeframe, and data closest to the AD period was from April 2011 through February 2014. Data for potentially dissolved antimony was available from March 2012 through February 2014. Data for total recoverable molybdenum was available from June 2012 through February 2014. Data for sulfide was available from June 2012 through May 2018. A longer data set in the instance of sulfide was deemed acceptable as all data was non-detect. Absent data available during the AD period, the available data are considered representative of the BWQ during the AD period. For the remaining parameters, there is no ambient water quality data available from any timeframe (e.g. Radium 226+228 pCi/l).

These ambient water quality data are summarized in Table A-11b. The BWQ concentrations based on these data, represented by the 50th percentile for total recoverable metals and total metals, and the 85th percentile for dissolved metals and other pollutants, are summarized in Table A-11c. Note that in some cases samples were available in potentially dissolved and dissolved on the same day. In those instances, the potentially dissolved values were used in determining the BWQ.

Table A-11b

Ambient Water Quality Data Summary for AD Period- Dolores River

Parameter	*No. of Samples*	*15th Percentile*	*50th Percentile*	*85th Percentile*	*Mean*	*Location*
Al, TR (µg/l)	32	17	61	317	153	Downstream
Sb, Dis (µg/l)	21	0	0	0.083	0.045	Downstream
As, TR (µg/l)	4	0	0.25	0.78	0.38	Downstream
Be, TR (µg/l)	30	0	0.2	0.2	0.11	Downstream
Cd, TR (µg/l)	4	0.75	0.9	1	0.88	Downstream
Cr, TR (µg/l)	12	0	0	0.62	0.31	Downstream
Cr, Dis (µg/l)	4	0	0	0.11	0.05	Downstream
Pb, TR (µg/l)	6	0.075	0.15	0.8	0.53	Downstream
Mo, TR (µg/l)	20	0.96	1.8	2.8	1.9	Downstream
Hg, Tot (µg/l)	11	0	0.0003	0.00085	0.001	Downstream
Ni, TR (µg/l)*	16	0	0	0	0	Downstream
Chloride (mg/l)	4	0	0.55	1.2	0.6	Downstream
Sulfide as H2S (mg/l)	30	0	0	0	0	Downstream
Thallium, TR (ug/l)	32	0	0	0	0	Downstream

*dissolved data used in the absence of total data

Table A-11c

BWQ Concentrations for Potential Pollutants of Concern Based on Downstream Ambient Water Quality Concentrations- Dolores River

Pollutant	*BWQ*	*WQS*
Al, TR (µg/l)	61	87
Sb, Dis (µg/l)	0.083	5.6
As, TR (µg/l)	**0.25**	0.02
Be, TR (µg/l)	0.2	4

Cd, TR (µg/l)	0.9	5
Cr+3, Dis (µg/l)	0.11	137
Pb, TR (µg/l)	0.15	50
Mo, TR (µg/l)	1.8	160
Hg, Tot (µg/l)	0.0003	0.01
Ni, TR (µg/l)	0	100
Se, Dis (µg/l)	0.92	4.6
Chloride (mg/l)	1.2	250
Sulfide as H2S (mg/l)	0	0.002
Thallium, TR (ug/l)	0	0.24

In cases where the BWQ concentration exceeds the water quality standard, the calculated BWQ concentration must then be set equal to the water quality standard. This occurred for total recoverable arsenic.

The Wetlands, BWQ

This discharger was in place as of September 30, 2000, and therefore the BWQ will include the influence of the discharger. Data collected at DR-6 (the St. Louis settling pond outfall) located at the last treatment pond were determined to be representative of the wetlands water quality with the influence of the discharge, during the AD period. Thus the data were used to determine the BWQ concentrations for a discharge into the wetlands. Since the data were collected at the end of the treatment of the discharge, it takes into account the contribution of the facility.

Currently, it is the Division's approach to evaluate five years of ambient water quality data, if available, for the five years prior to September 30, 2000, when determining the BWQ. However, due to very limited data (between 1-4 data points) available during the timeframe of September 30, 1995 through September 30, 2000, the period of record was expanded, from October 1999 through January 2006 for most pollutants. Although these data were not collected during the five years prior to September 2000, the Division has determined that, absent data available during the AD period, the available data are considered representative of the BWQ during the AD period. There have been no water quality changes to the watershed during this time, nor have there been any changes to the discharge since before September 2000. Using an expanded period of record, with a more robust data set more accurately characterizes the baseline water quality. Data were available for arsenic, cadmium, chromium, copper, iron, lead, manganese, mercury, chloride, cyanide,nickel, selenium, silver and zinc. For the remaining parameters, there is no ambient water quality data available.

These ambient water quality data are summarized in Table A-11d. The BWQ concentrations based on these data, represented by the 50th percentile for total recoverable metals and total metals, and the 85th percentile for dissolved metals and other pollutants, are summarized in Table A-11e.

Table A-11d

Ambient Water Quality Data Summary for AD Period- The Wetlands

Parameter	*Number of Samples*	*15th Percentile*	*50th Percentile*	*85th Percentile*	*Mean*	*Location*	*Notes*
As, TR (µg/l)	7	0	0	0.14	0.2	Effluent	1
As, Dis (µg/l)	5	0	0	0.56	0.28	Effluent	

Cd, TR (µg/l)	15	8	11	17	18	Effluent	
Cr, TR (µg/l)	15	0	0.0016	0.2	0.093	Effluent	
Cr, Dis (µg/l)	5	0	0	0	0	Effluent	
Cu, Dis (µg/l)	38	0	3.1	12	5.3	Effluent	
CN, Tot (µg/l)	7	0	0	0	0	Effluent	
Pb, TR (µg/l)	15	0.5	1.1	2	1.4	Effluent	
Hg, Tot (µg/l)	13	0	0	0.0003	0.00011	Effluent	
Ni, TR (µg/l)	29	0	0	7.3	2	Effluent	2
Ni, Dis (µg/l)	29	0	0	7.3	2	Effluent	
Se, Dis (µg/l)	29	0	0	0.48	0.24	Effluent	
Ag, Dis (µg/l)	37	0	0	0.03	0.015	Effluent	
Chloride (mg/l)	5	0	0	0.36	0.18	Effluent	

Note 1: Dissolved values included due to a lack of total data
Note 2: dissolved nickel data used in the absence of total data

Table A-11e

BWQ Concentrations for Potential Pollutants of Concern Based on Downstream Ambient Water Quality Concentrations- The Wetlands

Pollutant	*BWQ*	*WQS*
As, TR (µg/l)	0	0.02
As, Dis (µg/l)	0.56	340
Cd, TR (µg/l)	11	5
Cr, TR (µg/l)	0.0016	50
Cr+3, TR (µg/l)	0.0016	50
Cr+3, Dis (µg/l)	0	137
Cu, Dis (µg/l)	12	29
CN, Tot (µg/l)	0	5
Pb, TR (µg/l)	1.1	50
Hg, Tot (µg/l)	0	0.01
Ni, TR (µg/l)	0	100
Ni, Dis (µg/l)	7.3	168
Se, Dis (µg/l)	0.48	4.6
Ag, Dis (µg/l)	0.03	0.81
Chloride (mg/l)	0.36	250

Note that the AD requirements outlined in *The Basic Standards and Methodologies for Surface Water* specify that chronic numeric standards should be used in the antidegradation review; however, where there is only an acute standard, the acute standard should be used. Chronic standards were available for all pollutants except total recoverable trivalent chromium, total recoverable cadmium, total recoverable lead, and total recoverable nickel.

Bioaccumulative Significance Test

For mercury, the bioaccumulative significance test can now be completed with some minor additional calculations for the baseline water quality load (BWQload), the threshold load (TL), the new load based on the WQBELs, and the threshold load concentration (TL conc). These terms are defined by the following equations:

BWQload = BWQ (from Table A-11a or e) * AD low flow (chronic) * 8.34
Threshold Load (TL) = 0.1 * BWQload
Threshold Load Concentration (TL Conc) = TL ÷ new design flow ÷ 8.34
WQBEL Load = new WQBEL (concentration) * new design flow * 8.34

The discharge is considered to be insignificant if the new load (WQBEL load) is less than the threshold load (TL), or if the new WQBEL (concentration) is less than the TL Conc. The results of the calculations and the comparisons are shown in Table A-12.

Table A-12

Bioaccumulative Significance Test

Parameter	Threshold Load Concentration (TL Conc)	Threshold Load (TL)	WQBEL Conc	WQBEL Load
Mercury, Total (Delores)	$2.1X10^{-6}$	0.00003	0.00003 mg/l	0.00044
Mercury, Total (Wetlands)	0	0	0.00001 mg/l	0.00015

For mercury, the threshold load is less than the WQBEL load and the TL Conc is less than the WQBEL Concentration. The antidegradation review for this parameter will continue with the calculation of the SCT and ADBACs, in the same manner as the other non-bioaccumulative toxic pollutants.

Significant Concentration Threshold

The SCT is defined as the BWQ plus 15% of the baseline available increment (BAI), and is calculated by the following equation:

$$SCT = (0.15 \times BAI) + BWQ$$

The BAI is the concentration increment between the baseline water quality and the water quality standard, expressed by the term (WQS – BWQ). Substituting this into the SCT equation results in:

$$SCT = 0.15 \times (WQS-BWQ) + BWQ$$

Where,
WQS = Chronic standard or, in the absence of a chronic standard, the acute standard
BWQ = Value from Table A-11a, e, or c

When the BWQ concentration is equal to zero, the following equation results: $SCT = 0.15 \times WQS$

Determination of the Antidegradation Based Average Concentrations

Antidegradation based average concentrations (ADBACs) are determined for all parameters except ammonia, by using the mass-balance equation, and substituting the SCT in place of the water quality standard, as shown in the following equation:

$$ADBAC = \frac{SCT \times Q_3 - M_1 \times Q_1}{Q_2}$$

Where,

Q_1 = Upstream low flow (1E3 or 30E3 based on either the chronic or acute standard)
Q_2 = Current design capacity of the facility
Q_3 = Downstream flow (Q_1 + Q_2)
M_1 = Current ambient water quality concentration (From Section III)
SCT = Significant concentration threshold

Wetlands
When Q_1 is equal to zero, Q_2 equals Q_3, and therefore the following equation results: *ADBAC = SCT*

The ADBACs were calculated using the SCTs, and are set forth in Table A-13a.

Table A-13a

SCTs and ADBACs – The Dolores River

Pollutant	Q_1(cfs)	Q_2 (cfs)	Q_3 (cfs)	M_1	SCT	ADBAC
Al, TR (µg/l)	5.4	2.7	8.1	79	65	37
Sb, Dis (µg/l)	5.4	2.7	8.1	0	0.91	2.7
As, TR (µg/l)	5.4	2.7	8.1	0	0.02	0.06
As, Dis (µg/l)	3.6	2.7	6.3	0	51	119
Be, TR (µg/l)	5.4	2.7	8.1	0	0.77	2.3
Cr+3, TR (µg/l)	3.6	2.7	6.3	0	8	19
Cr+3, Dis (µg/l)	5.4	2.7	8.1	0	21	63
Cr+6, Dis (µg/l)	5.4	2.7	8.1	0	1.7	5.1
CN, Free (µg/l)	3.6	2.7	6.3	0	0.75	1.8
Fe, TR (µg/l)	5.4	2.7	8.1	87	363	915
Pb, TR (µg/l)	3.6	2.7	6.3	0.1	7.6	18
Mo, TR (µg/l)	5.4	2.7	8.1	0.87	26	76
Hg, Tot (µg/l)	5.4	2.7	8.1	0	0.0018	0.0054
Ni, TR (µg/l)	5.4	2.7	8.1	0	15	45
Ni, Dis (µg/l)	5.4	2.7	8.1	0.88	15	43
Se, Dis (µg/l)	5.4	2.7	8.1	0.57	1.5	3.4
Ag, Dis (µg/l)	5.4	2.7	8.1	0.043	0.041	0.037
U, TR (µg/l)	5.4	2.7	8.1	0	2.5	7.5
U, Dis (µg/l)	5.4	2.7	8.1	0.25	515	1545
B, Tot (mg/l)	5.4	2.7	8.1	0	0.11	0.33
Chloride (mg/l)	5.4	2.7	8.1	2.6	39	112
Sulfide as H2S (mg/l)	5.4	2.7	8.1	0	0.0003	0.0009
Thallium, TR (µg/l)	5.4	2.7	8.1	0	0.036	0.11
Radium 226+228(pC/l)	5.4	2.7	8.1	0	0.75	2.3

FOR SCT > ADBAC: Based on these calculations, the ambient water quality exceeds the SCT for total recoverable aluminum and dissolved silver. Where an assimilative capacity is calculated to be less than the standard, the Division standard procedure is to allocate the water quality standard, which in this case is the SCT, to prevent degradation of the receiving stream.

Table A-13b
SCTs and ADBACs - The Wetlands

Pollutant	Q_1*(cfs)*	Q_2 *(cfs)*	Q_3 *(cfs)*	M_1	*SCT*	*ADBAC*
Al, TR (µg/l)	0	2.7	2.7	0	13	13
Sb, Dis (µg/l)	0	2.7	2.7	0	0.84	0.84
As, TR (µg/l)	0	2.7	2.7	0	0.003	0.003
As, Dis (µg/l)	0	2.7	2.7	0	51	51
Be, TR (µg/l)	0	2.7	2.7	0	0.6	0.6
Cd, TR (µg/l)	0	2.7	2.7	0	5	5
Cr+3, TR (µg/l)	0	2.7	2.7	0	7.5	7.5
Cr+3, Dis (µg/l)	0	2.7	2.7	0	21	21
Cr+6, Dis (µg/l)	0	2.7	2.7	0	1.7	1.7
Cu, Dis (µg/l)	0	2.7	2.7	0	15	15
CN, Tot (µg/l)	0	2.7	2.7	0	0.75	0.75
Pb, TR (µg/l)	0	2.7	2.7	0	8.4	8.4
Mo, TR (µg/l)	0	2.7	2.7	0	24	24
Hg, Tot (µg/l)	0	2.7	2.7	0	0.0015	0.0015
Ni, TR (µg/l)	0	2.7	2.7	0	15	15
Ni, Dis (µg/l)	0	2.7	2.7	0	31	31
Se, Dis (µg/l)	0	2.7	2.7	0	1.1	1.1
Ag, Dis (µg/l)	0	2.7	2.7	0	0.15	0.15
U, Dis (µg/l)	0	2.7	2.7	0	1037	1037
B, Tot (mg/l)	0	2.7	2.7	0	0.11	0.11
Chloride (mg/l)	0	2.7	2.7	0	38	38
Sulfide as H2S (mg/l)	0	2.7	2.7	0	0.0003	0.0003
Thallium, TR (ug/l)	0	2.7	2.7	0	0.036	0.036
Radium 226+228 (pCi/l)	0	2.7	2.7	0	0.75	0.75

Concentration Significance Tests

The concentration significance determination test considers the cumulative impact of the discharges over the baseline condition. In order to be insignificant, the new or increased discharge may not increase the actual instream concentration by more than 15% of the available increment over the baseline condition. The insignificant level is the ADBAC calculated in Tables A-13a and A-13b above. If the new WQBEL concentration (or potentially the TL Conc for bioaccumulatives) is greater than the ADBAC, an AD limit would be applied. This comparison is shown in Tables A-14a for the Dolores River and A-14b for the Wetlands.

Table A-14a
Concentration Significance Test- The Dolores River

Pollutant	*New WQBEL*	*ADBAC*	*Concentration Test Result*
Al, TR (µg/l)	103	37	Significant
Sb, Dis (µg/l)	17	2.7	Significant
As, TR (µg/l)	0.06	0.06	Insignificant
As, Dis (µg/l)	793	119	Significant

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Be, TR (µg/l)	12	2.3	Significant
Cr+3, TR (µg/l)	117	19	Significant
Cr+3, Dis (µg/l)	411	63	Significant
Cr+6, Dis (µg/l)	33	5.1	Significant
CN, Free (µg/l)	12	1.8	Significant
Fe, TR (µg/l)	2826	915	Significant
Pb, TR (µg/l)	150	18	Significant
Mo, TR (µg/l)	478	76	Significant
Hg, Tot (µg/l)	0.03	0.0054	Significant
Ni, TR (µg/l)	300	45	Significant
Ni, Dis (µg/l)	292	43	Significant
Se, Dis (µg/l)	13	3.4	Significant
Ag, Dis (µg/l)	0.72	0.037	Significant
U, TR (µg/l)	50	7.5	Significant
U, Dis (µg/l)	10305	1545	Significant
B, Tot (mg/l)	2.3	0.33	Significant
Chloride (mg/l)	745	112	Significant
Sulfide as H2S (mg/l)	0.006	0.0009	Significant
Thallium, TR (ug/l)	0.72	0.11	Significant
Radium 226+228 (Pci/l)	15	2.3	Significant

For total recoverable arsenic, the WQBELs are equal to the ADBAC and therefore, the concentration test results in an insignificant determination. The WQBELs are the final result of this PEL for this parameter and AD limitations are not necessary. For the remaining parameters, the WQBELs are greater than the ADBACs and therefore, the concentration test results in a significance determination, and the antidegradation based effluent limitations (ADBELs) must be determined.

Table A-14b

Concentration Significance Test – The Wetlands

Pollutant	*New WQBEL*	*ADBAC*	*Concentration Test Result*
Al, TR (µg/l)	87	13	Significant
Sb, Dis (µg/l)	5.6	0.84	Significant
As, TR (µg/l)	0.02	0.003	Significant
As, Dis (µg/l)	340	51	Significant
Be, TR (µg/l)	4	0.6	Significant
Cd, TR (µg/l)	5	5	Insignificant
Cr+3, TR (µg/l)	50	7.5	Significant
Cr+3, Dis (µg/l)	137	21	Significant
Cr+6, Dis (µg/l)	11	1.7	Significant
Cu, Dis (µg/l)	29	15	Significant
CN, Free (µg/l)	5	0.75	Significant
Pb, TR (µg/l)	50	8.4	Significant
Mo, TR (µg/l)	160	24	Significant
Hg, Tot (µg/l)	0.01	0.0015	Significant
Ni, TR (µg/l)	100	15	Significant
Ni, Dis (µg/l)	168	31	Significant
Se, Dis (µg/l)	4.6	1.1	Significant
Ag, Dis (µg/l)	0.81	0.15	Significant

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U, Dis (µg/l)	6915	1037	Significant
B, Tot (mg/l)	0.75	0.11	Significant
Chloride (mg/l)	250	38	Significant
Sulfide as H2S (mg/l)	0.002	0.0003	Significant
Thallium, TR (ug/l)	0.24	0.036	Significant
Radium 226+228 (pCi/l)	5	0.75	Significant

For total recoverable cadmium, the WQBEL is equal to the ADBAC and therefore, the concentration test results in an insignificant determination. The WQBELs are the final result of this PEL for this parameter and AD limitations are not necessary.

For the remaining parameters, the WQBELs are greater than the ADBACs and therefore, the concentration test results in a significance determination, and the antidegradation based effluent limitations (ADBELs) must be determined.

Antidegradation Based Effluent Limitations (ADBELs)

The ADBEL is defined as the potential limitation resulting from the AD evaluation, and may be either the ADBAC, the NIL, or may be based on the concentration associated with the threshold load concentration (for the bioaccumulative toxic pollutants). ADBACs, NILs and TLs have already been determined in the AD evaluation, and therefore to complete the evaluation, a final comparison of limitations needs to be completed.

Note that ADBACs and NILs are not applicable when the new WQBEL concentration (and loading as evaluated in the New and Increased Impacts Test) is less than the NIL concentration (and loading), or when the new WQBEL is less than the ADBAC.

Where an ADBAC or NIL applies, the permittee has the final choice between the two limitations. A NIL is applied as a 30-day average (and the acute WQBEL would also apply where applicable) while the ADBAC would be applied as a 2 year rolling average concentration. For the purposes of this PEL, the Division has made an attempt to determine whether the NIL or ADBAC will apply. The end results of this AD evaluation are in the tables below, including any parameter that was previously exempted from further AD evaluation, with the final potential limitation identified (NIL, WQBEL or ADBAC).

Table A-15a

Final Selection of WQBELs, NILs, and ADBACs- The Dolores River

Pollutant	*NIL*	*New WQBEL*	*ADBAC*	*Chosen Limit*
Al, TR (µg/l)	NA	103	37	ADBAC
Sb, Dis (µg/l)	NA	17	2.7	ADBAC
As, TR (µg/l)	0	0.06	0.06	WQBEL
As, Dis (µg/l)	0	793	119	ADBAC
Be, TR (µg/l)	NA	12	2.3	ADBAC
Cd, TR (µg/l)	0.4	12	3.5	ADBAC
Cd, Dis (µg/l)	85	2.3	NA	WQBEL
Cr+3, TR (µg/l)	NA	117	19	ADBAC
Cr+3, Dis (µg/l)	0	411	63	ADBAC
Cr+6, Dis (µg/l)	0	33	5.1	ADBAC

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Cu, Dis (µg/l)	20	48	7.4	NIL
CN, Tot (µg/l)	0	12	1.8	ADBAC
Fe, TR (µg/l)	1410	2826	915	NIL
Pb, TR (µg/l)	9.9	150	18	ADBAC
Pb, Dis (µg/l)	32	13	NA	WQBEL
Mn, Dis (µg/l)	4110	719	NA	WQBEL*
Mo, TR (µg/l)	NA	478	76	ADBAC
Hg, Tot (µg/l)	0.0004	0.03	0.0054	ADBAC
Ni, TR (µg/l)	NA	300	45	ADBAC
Ni, Dis (µg/l)	80	292	43	NIL
Se, Dis (µg/l)	0.9	13	3.4	ADBAC
Ag, Dis (µg/l)	0.06	0.72	0.037	NIL
U, TR (µg/l)	NA	50	7.5	ADBAC
U, Dis (µg/l)	NA	10305	1545	ADBAC
Zn, Dis (µg/l)	14500	707	NA	WQBEL
B, Tot (mg/l)	NA	2.3	0.33	ADBAC
Chloride (mg/l)	0.9	745	112	ADBAC
Sulfide as H2S (mg/l)	NA	0.006	0.0009	ADBAC
Thallium, TR (µg/l)	NA	0.72	0.11	ADBAC
Radium 226+228(pC/l)	NA	15	2.3	ADBAC

*Note that the AD analysis was completed on the aquatic life value, the water supply WQBEL of 539 ug/l still applies

NILs
For dissolved copper, total recoverable iron, and dissolved silver the NILs have been established for this facility. The NILs were selected as they are less stringent than the ADBACs. NILs are implemented as 30-day averages. However, the facility has the final choice between the NILs and ADBACs, and if the ADBAC is preferred, the permit writer should be contacted.

ADBACs
For total recoverable aluminum, potentially dissolved antimony, dissolved arsenic, total recoverable beryllium, total recoverable cadmium, total recoverable and dissolved trivalent chromium, dissolved hexavalent chromium, cyanide, total recoverable lead, total recoverable molybdenum, total mercury, potentially dissolved selenium, total recoverable and dissolved uranium, boron, chloride, sulfide, total recoverable thallium, and radium 226+228 the ADBACs have been established for this facility. The ADBACs were selected as they are less stringent than the the NILs, or perhaps due to the application as a two-year rolling average. However, the facility has the final choice between the NILs and ADBACs, and if the ADBAC is preferred, the permit writer should be contacted.

WQBELs
As shown in Table A-14, there are no new or increased impacts to the receiving stream based on the new WQBELS for dissolved cadmium, dissolved lead, dissolved manganese and dissolved zinc, and for these parameters the WQBELs are the final result of this PEL.

Table A-15b

Final Selection of WQBELs, NILs, and ADBACs- The Wetlands

Pollutant	*NIL/Implicit NIL*	*New WQBEL*	*ADBAC*	*Chosen Limit*
Al, TR (µg/l)	NA	87	13	ADBAC

Sb, Dis (µg/l)	NA	5.6	0.84	ADBAC
As, TR (µg/l)	0	0.02	0.003	ADBAC
As, Dis (µg/l)	0	340	51	ADBAC
Be, TR (µg/l)	NA	4	0.6	ADBAC
Cd, TR (µg/l)	0.4	5	5	WQBEL
Cd, Dis (µg/l)	85	1.2	NA	WQBEL
Cr+3, TR (µg/l)	NA	50	7.5	ADBAC
Cr+3, Dis (µg/l)	0	137	21	ADBAC
Cr+6, Dis (µg/l)	0	11	1.7	ADBAC
Cu, Dis (µg/l)	20	29	15	NIL
CN, Tot (µg/l)	0	5	0.75	ADBAC
Fe, TR (µg/l)	1410	1000	NA	WQBEL
Pb, TR (µg/l)	9.9	50	8.4	NIL
Pb, Dis (µg/l)	32	11	NA	WQBEL
Mn, Dis (µg/l)	4110	255	NA	WQBEL
Mo, TR (µg/l)	NA	160	24	ADBAC
Hg, Tot (µg/l)	0.0004	0.01	0.0015	ADBAC
Ni, TR (µg/l)	NA	100	15	ADBAC
Ni, Dis (µg/l)	80	168	31	NIL
Se, Dis (µg/l)	0.9	4.6	1.1	ADBAC
Ag, Dis (µg/l)	0.06	0.81	0.15	ADBAC
U, Dis (µg/l)	NA	6915	1037	ADBAC
Zn, Dis (µg/l)	14500	428	NA	WQBEL
B, Tot (mg/l)	NA	0.75	0.11	ADBAC
Chloride (mg/l)	0.9	250	38	ADBAC
Sulfide as H2S (mg/l)	NA	0.002	0.0003	ADBAC
Thallium, TR (ug/l)	NA	0.24	0.036	ADBAC
Radium 226+228 (pCi/l)	NA	5	0.75	ADBAC

NILs
For dissolved copper, total recoverable lead, and dissolved nickel the NILs have been established for this facility. The NILs were selected as they are less stringent than the ADBACs. NILs are implemented as 30-day averages. However, the facility has the final choice between the NILs and ADBACs, and if the ADBAC is preferred, the permit writer should be contacted.

WQBELs
For total recoverable cadmium, dissolved cadmium, total recoverable iron, dissolved lead, dissolved manganese, and dissolved zinc, there are no new or increased impacts to the receiving stream based on the new WQBELS, and for these parameters the WQBELs are the final result of this PEL.

ADBACs
For the remaining parameters, the ADBACs have been established for this facility. The ADBACs were selected as they are less stringent than the NILs, or perhaps due to the application as a two-year rolling average. However, the facility has the final choice between the NILs and ADBACs, and if the ADBAC is preferred, the permit writer should be contacted.

VIII. Technology Based Limitations

Regulations for Effluent Limitations

Regulation No. 62, the Regulations for Effluent Limitations, includes effluent limitations that apply to all discharges of wastewater to State waters, with the exception of storm water and agricultural return flows. These regulations are applicable to the discharge from the proposed discharge.

Table A-16 contains a summary of the applicable limitations for pollutants of concern at this facility.

Table A-16
Regulation 62 Based Limitations

Parameter	***30-Day Average***	***7-Day Average***	***Instantaneous Maximum***
TSS	30 mg/l	45 mg/l	NA
pH	NA	NA	6.0-9.0 s.u.
Oil and Grease	NA	NA	10 mg/l

IX. References

Regulations:

The Basic Standards and Methodologies for Surface Water, Regulation 31, Colorado Department Public Health and Environment, Water Quality Control Commission, effective January 31, 2018.

Classifications and Numeric Standards for San Juan River and Delores River Basins, Regulation No. 34, Colorado Department Public Health and Environment, Water Quality Control Commission, effective June 30, 2019

Regulations for Effluent Limitations, Regulation 62, CDPHE, WQCC, July 30, 2012.

Nutrients Management Control Regulation, Regulation 85, Colorado Department Public Health and Environment, Water Quality Control Commission, effective September 30, 2012.

Colorado's Section 303(d) List of Impaired Waters and Monitoring and Evaluation List, Regulation 93, Colorado Department Public Health and Environment, Water Quality Control Commission, effective March 30, 2012.

Policy and Guidance Documents:

Antidegradation Significance Determination for New or Increased Water Quality Impacts, Procedural Guidance, Colorado Department Public Health and Environment, Water Quality Control Division, December 2001.

Memorandum Re: First Update to (Antidegradation) Guidance Version 1.0, Colorado Department Public Health and Environment, Water Quality Control Division, April 23, 2002.

Colorado Mixing Zone Implementation Guidance, Colorado Department Public Health and Environment, Water Quality Control Division, effective April 2002.

Policy for Conducting Assessments for Implementation of Temperature Standards in Discharge Permits, Colorado Department Public Health and Environment, Water Quality Control Division Policy Number WQP-23, effective July 3, 2008.

Implementing Narrative Standards in Discharge Permits for the Protection of Irrigated Crops, Colorado Department Public Health and Environment, Water Quality Control Division Policy Number WQP-24, effective March 10, 2008.

Policy for Characterizing Ambient Water Quality for Use in Determining Water Quality Standards Based Effluent Limits, Colorado Department Public Health and Environment, Water Quality Control Division Policy Number WQP-19, effective May 2002.

4300 Cherry Creek Drive S., Denver, CO 80246-1530 P 303-692-2000 www.colorado.gov/cdphe/wqcd

Attachment 2

Comparison of CDPHE PEL to Atlantic Richfield Evaluation

Comparison of CDPHE PEL to Atlantic Richfield Evaluation

Introduction

In November of 2018, Atlantic Richfield Company (Atlantic Richfield) submitted a Preliminary Effluent Limits (PEL) application to the Colorado Department of Public Health & Environment (CDPHE) for the Rico St. Louis Tunnel (SLT) discharge based on assumptions of design flow and discharge location for a future expanded Rico water treatment system. CDPHE submitted the PEL document to Atlantic Richfield in March 2020 (CDPHE, 2020b). Upon receiving the PEL document from the State, the data, assumptions, and provided PELs were evaluated by Atlantic Richfield. This evaluation resulted in differences between the State's PELs and Atlantic Richfield's PEL analysis. The PEL values and basis for selection of these values from the Water Quality-Based Effluent Limitations (WQBELs), Antidegradation Based Average Concentrations (ADBAC), and Non-Impact Limit (NIL) values for both the PEL and Atlantic Richfield's evaluations are provided in Table 2-1. Key differences are noted for the following items, and these are discussed in more detail below.

- Table Value Standards (TVS) for metals based on in-stream hardness;
- Dolores River low-flow calculations; and
- Selected in-stream segment standards.

Table 2-1. *Final Selection of WQBELs, NILs, and ADBACs - The Dolores River*

	CDPHE Values[1]				**Atlantic Richfield Values**			
Pollutant	**NIL**	**NEW WQBEL**	**ADBAC**	**Chosen Limit**	**NIL**	**NEW WQBEL**	**ADBAC**	**Chosen Limit**
Al, TR (µg/l)	NA	103	**37**	ADBAC	162	**90**	65	***WQBEL***
Sb, Dis (µg/l)	NA	17	**2.7**	ADBAC	0.3	17	**2.7**	ADBAC
As, TR (µg/l)	0	**0.06**	0.06	WQBEL	0	**0.06**	0.06	WQBEL
As, Dis (µg/l)	0	793	**119**	ADBAC	1.4	989	**150**	ADBAC
Be, TR (µg/l)	NA	12	**2.3**	ADBAC	0.32	12	**1.8**	ADBAC
Cd, TR (µg/l)	0.4	12	**3.50**	ADBAC	82.2	**15**	4.16	***WQBEL***
Cd, Dis (µg/l)	85.0	**2.3**	NA	WQBEL	R	R	R	R
Cadmium, Dissolved[2] (Updated CO Standard) (Acute, cold) (µg/l)	85.0	**8.44**	NA	WQBEL	84.8	**14.0**	4.3175	WQBEL

Table 2-1. *Final Selection of WQBELs, NILs, and ADBACs - The Dolores River*

	CDPHE Values[1]				**Atlantic Richfield Values**			
Pollutant	**NIL**	**NEW WQBEL**	**ADBAC**	**Chosen Limit**	**NIL**	**NEW WQBEL**	**ADBAC**	**Chosen Limit**
Cadmium, Dissolved[2] (Updated CO Standard) (Chronic) (µg/l)	85.0	**3.79**	NA	WQBEL	84.8	**4.75**	3.0	WQBEL
Cr^{+3}, TR (µg/l)	NA	117	**19**	ADBAC	1.6	145	**23.1**	ADBAC
Cr^{+3}, Dis (µg/l)	0	411	**63**	ADBAC	0	525	**78**	ADBAC
Cr^{+6}, Dis (µg/l)	0	33	**5.1**	ADBAC	0	32	**3.9**	ADBAC
Cu, Dis (µg/l)	**20**	48	7.4	NIL	**20**	63	10.26	NIL
CN, Tot (µg/l)	0	12	**1.8**	ADBAC	0	15	**2.18**	ADBAC
Fe, TR (µg/l)	**1410**	2826	915	NIL	**1410**	2800	907	NIL
Pb, TR (µg/l)	9.9	150	**18**	ADBAC	4.4	145	**22.1**	ADBAC
Pb, Dis (µg/l)	32	**13**	NA	WQBEL	32	**23**	4.0	WQBEL
Mn, Dis (µg/l)	4110	**719 (539)**	NA	WQBEL[3]	4210	**720**	NA	WQBEL[4]
Mo, TR (µg/l)	NA	478	**76**	ADBAC	18.2	444	**70**	ADBAC
Hg, Tot (µg/l)	0.0004	0.03	**0.0054**	ADBAC	0.0004	0.0297	**0.0056**	ADBAC
Ni, TR (µg/l)	NA	300	**45**	ADBAC	8.4	297	**45**	ADBAC
Ni, Dis (µg/l)	**80**	292	43	NIL	**80**	375	52	NIL
Se, Dis (µg/l)	0.9	13	**3.4**	ADBAC	1.39	12.7	**3.5**	ADBAC
Ag, Dis (µg/l)	**0.06**	0.72	0.037	NIL	0.27	5.94	**0.891**	***ADBAC***
U, TR (µg/l)	NA	50	**7.5**	ADBAC	NA	89	**13.4**	ADBAC
U, Dis (µg/l)	NA	10305	**1545**	ADBAC	NA	14415	**2162**	ADBAC
Zn, Dis (µg/l)	14500	**707**	NA	WQBEL	14500	**939**	NA	WQBEL

Table 2-1. *Final Selection of WQBELs, NILs, and ADBACs - The Dolores River*

	CDPHE Values[1]				Atlantic Richfield Values			
Pollutant	**NIL**	**NEW WQBEL**	**ADBAC**	**Chosen Limit**	**NIL**	**NEW WQBEL**	**ADBAC**	**Chosen Limit**
B, Tot (mg/l)	NA	2.3	**0.33**	ADBAC	NA	2.23	**0.334**	ADBAC
Chloride (mg/l)	0.9	745	**112**	ADBAC	0.9	738	**109**	ADBAC
Sulfide as H2S (mg/l)	NA	0.006	**0.0009**	ADBAC	0.077	**0.0059**	0.0009	***WQBEL***
Thallium, TR (µg/l)	NA	0.72	**0.11**	ADBAC	NA	0.713	**0.107**	ADBAC
Radium 226+228(pC/l)	NA	15	**2.3**	ADBAC	NA	14.85	**2.23**	ADBAC

Notes:
Bolded values are the chosen numeric limit values.
Bolded and Italicized indicate that the chosen limit differs between CDPHE and Atlantic Richfield.
R = Dissolved cadmium standards for acute and chronic water quality standards have been revised and listed in the following rows.
[1] Values as presented in Table A-15a of the 2020 CDHPE PEL.
[2] Cadmium standards updated in Regulation 31 on June 30, 2020.
[3] Note that the AD analysis was completed on the aquatic life value, the water supply WQBEL of 539 ug/l still applies.
[4] WQBEL were determined using the Site-specific standard of 255 ug/L.

NILs were established by determining the maximum daily averages from statistical analysis of the analytical data collected at the discharge location DR-6. Both WQBELs and ADBACs were established by using the chronic in-stream standards including the hardness based TVS with chronic low flow values in mass balance equations. However, ADBACs also took into consideration the baseline water quality of this stream segment. Chronic water quality standards were used in the calculations along with the chronic annual low flow value unless there was not a chronic water quality standard listed. When this was the case, the acute water quality standard was used with the acute annual low flow value. The recommended chosen limit values are bolded for the CDPHE as well as Atlantic Richfield. Note the differences between chosen limit values due to flow rates and hardness values used in the calculations.

If there are NIL, WQBEL and ADBAC values listed for a parameter, it is likely that the middle value is chosen for the limit. And if there are only two values, then it is likely that the lesser of the two limits is chosen. However, when the New WQBEL is greater than the NIL or the ADBAC, then the comparison is between the NIL and ADBAC. According to the PEL, "*the permittee has the final choice between the two limitations. A NIL is applied as a 30-day average (and the acute WQBEL would also apply where applicable) while the ADBAC would be applied as a 2-year rolling average concentration.*"

TVS-Based Metals and Hardness

In Regulations 31 and 34, several metal standards are listed as TVS and are hardness-based standards. As provided in PEL document Table A-4A – *TVS-Based Metals Water Quality Standards for PEL 230051- Dolores River,* CDPHE calculated in-stream hardness based on a mean hardness using DR-7 data and cited a lack of data for not utilizing a linear regression analysis. A linear regression utilizing paired flow and hardness data is the preferred approach, and several other methods are mentioned in the regulations. One of these methods is using the mean of the hardness during the low flow season established in the permit. The value that CDPHE calculated was 212 mg/L $CaCO_3$. Analysis by Atlantic Richfield shows that hardness is a clear function of Dolores River flow and thus calculated an in-stream hardness based on the linear regression analysis method using DR-7 hardness data and statistically-low flow data from DR-G, which produced a value of 290 mg/L $CaCO_3$.

The relationship between hardness and flow rates at the DR-7 location is shown on the plot in Figure 2-1. A "power" trendline fits DR-7 data with high hardness values (above 300 mg/L $CaCO_3$) being measured at low flow rates (<10 cfs) and lower hardness values (200 mg/L $CaCO_3$) being measured at higher flow rates (>25 cfs).

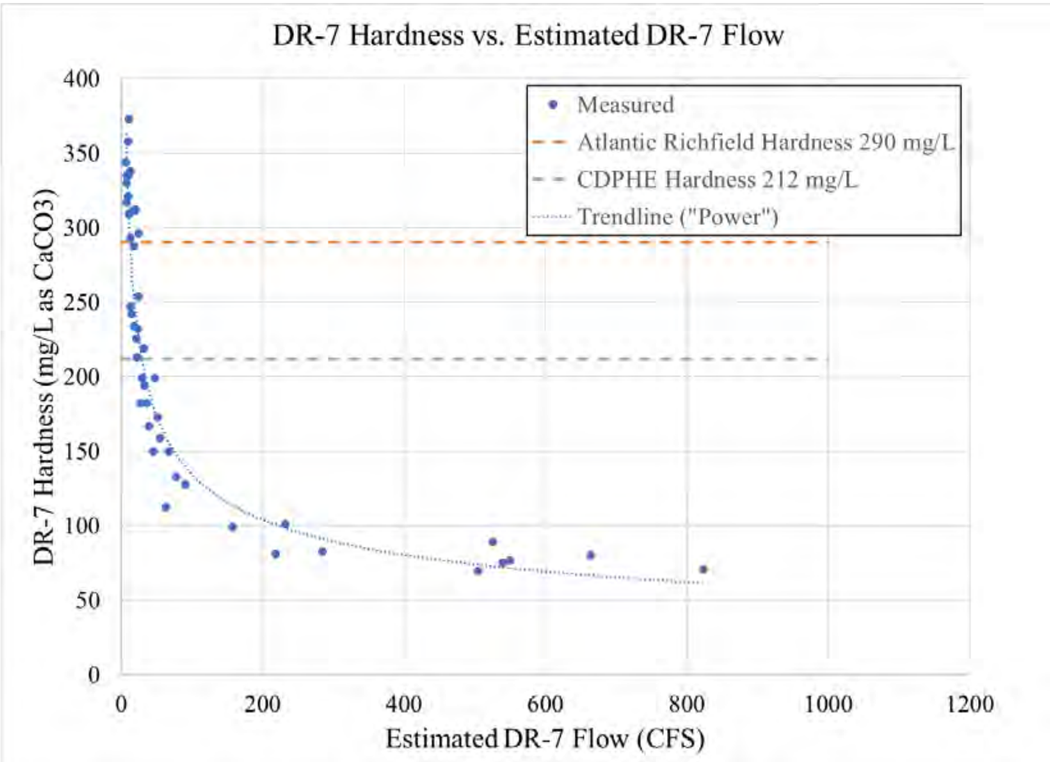

Figure 2-1. *Hardness and flow rate measurements at DR-7 demonstrate the relationship between low flows and high hardness values as well as high flows and low hardness values. The calculated TVS hardness values are also shown.*

Showing the CDPHE 1E3 (acute) and 30E3 (chronic) low flow rates (see Figure 2-2) results in expected corresponding hardness values greater than 300 mg/L $CaCO_3$ which supports the calculated hardness value of 290 mg/L $CaCO_3$ in this analysis. As the hardness value is used in the equations for the TVS, the greater the hardness value, the higher the TVS. The TVS values are used when determining the water quality-based effluent limits (WQBELs).

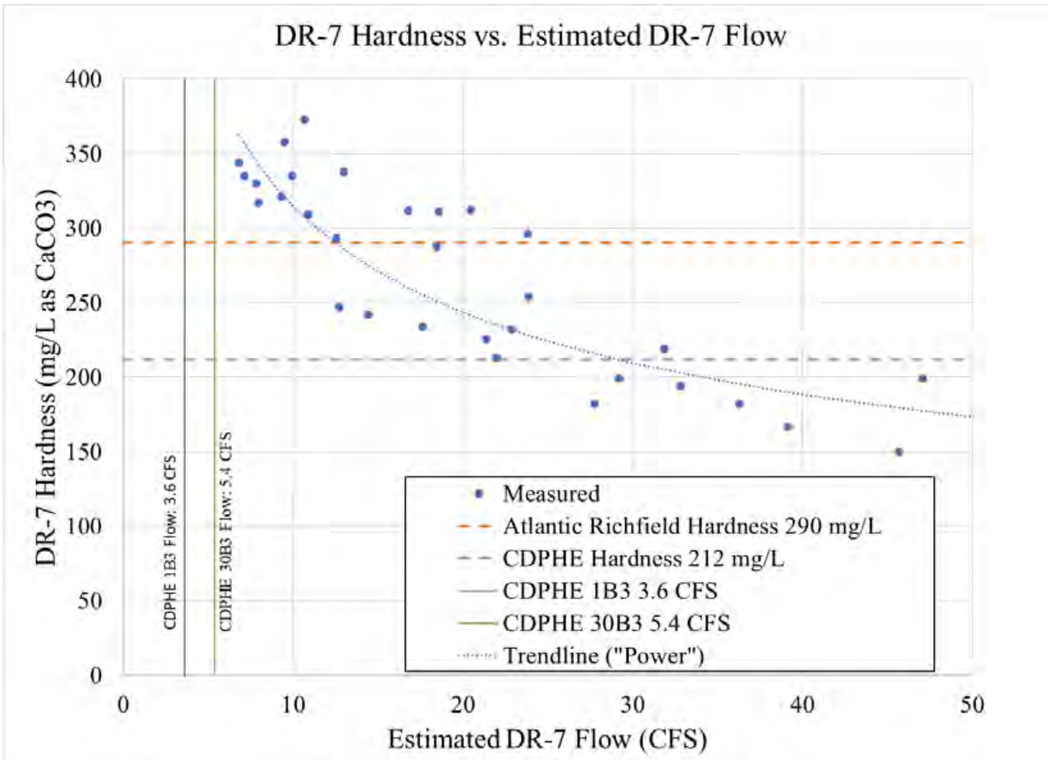

Figure 2-2. *Hardness and flow rate measurements at DR-7 with the CDPHE low flow values for 1E3 (acute) and 30E3 (chronic) as well as the calculated hardness values shown.*

<u>Dolores River Low Flow Calculations</u>

The Dolores River low flow values in the CDPHE PEL Table A-5a - *Low Flows for Dolores River at the Rico-Argentine Mine Site* were based on the following method for estimating Dolores River flow above the Site: starting with the daily DR-G flow (from USGS gage 09165000 located below the town of Rico), the daily DR-3 flow was subtracted, and the remainder was multiplied by a watershed ratio of 0.68. This ratio represents the relative area of the watershed above the Site discharge (72.2 square miles) compared to the watershed area above the USGS gage (106 square miles). The estimated Dolores River flow values above the Site were then used in the EPA DFLOW low flow program to calculate “biologically based” monthly low flows. Atlantic Richfield was unable to replicate the CDPHE values using this method.

The following tables (Tables 2-2 and 2-3) show the annual and monthly Dolores River low flow rates determined by the CDPHE and Atlantic Richfield, respectively. The annual rates use the lowest monthly flow value over the twelve-month period. The annual chronic (30E3) and acute (1E3) low flow values were used to determine the water quality-based effluent limits (WQBELs). Larger annual low flow values will produce larger WQBELs. There is less than a two percent difference between the State and Atlantic Richfield’s annual chronic (30E3) low flow values with the larger value shown in CDPHE's table. There is a difference of approximately 45% between the CDHPE and Atlantic Richfield annual acute low flow values with the higher value shown in Atlantic Richfield's table. Generally, chronic effluent limits would be more restrictive, so the difference in acute low flow values may not be significant.

Table 2-2. *CDPHE Low Flow Calculated Values for the Dolores River at the Rico-Argentine Mine Site*

Low Flow (cfs)	***Annual***	***Jan***	***Feb***	***Mar***	***Apr***	***May***	***Jun***	***Jul***	***Aug***	***Sept***	***Oct***	***Nov***	***Dec***
1E3 Acute	3.6	**3.6**	5.3	5.9	17	42	13	12	13	7.3	6.6	6.7	3.7
7E3 Chronic	4.1	**4.1**	5.2	5.7	12	36	13	13	12	7.3	6.7	6.7	**4.1**
30E3 Chronic	5.4	**5.4**	**5.4**	5.7	7.6	23	16	16	9	7.4	6.8	6.2	**5.4**

Note: *Bolded values highlight which months had the lowest flow value(s) that were used for the annual low flow value.*

Table 2-3. *Atlantic Richfield Low Flow Calculated Values for the Dolores River at the Rico-Argentine Mine Site*

Low Flow (cfs)	***Annual***	***Jan***	***Feb***	***Mar***	***Apr***	***May***	***Jun***	***Jul***	***Aug***	***Sep***	***Oct***	***Nov***	***Dec***
1E3 Acute	5.2	**5.2**	5.4	6.0	16	71	21	15.6	12	7.2	6.5	6.2	5.3
7E3 Chronic	5.2	**5.2**	5.6	6.3	21	91	25	17.7	12	7.2	6.7	6.6	5.4
30E3 Chronic	5.3	**5.3**	5.6	7.8	68	194	58	25.0	17	9.1	7.4	6.7	6.1

Note: *Bolded values highlight which months had the lowest flow value(s) that were used for the annual low flow value.*

All 1E3 acute values, the 7E3 chronic annual value, and the 30E3 chronic values, except the value for February, used the DFLOW program to determine the low flows. (Because February has less than 30 days, the DFLOW program cannot provide 30E3 values.) The 7E3 monthly values and the 30E3 chronic February values were unable to be determined using the DFLOW program so the USGS Integrated Design Flow (IDF) program was used to determine these low flows.

<u>In-Stream Segment Standards</u>

The segment standards for manganese, molybdenum and cadmium differ between the PEL and the Atlantic Richfield evaluation due to classification assumptions and changes to the State regulations. The values identified by Atlantic Richfield are believed to be correct as discussed below.

<u>Manganese</u>

The Site discharges to Dolores River Segment COSJDO03, which is classified for Water Supply (WS), and therefore the WS regulations apply for sulfate, iron, and manganese. Regulation 34, Section 38 presents "Statement of Basis, Specific Statutory Authority and Purpose; September 10, 2012 Rulemaking; Final Action November 5, 2012; Effective Date March 30, 2013".

In Section 34.38(G), the regulation states that "*A site-specific manganese standard of 255 ug/L was added to Dolores Segment 3. This value was calculated as the 85th percentile of available data from 1/1/1995 – 12/31/2012 and is expected to be representative of conditions on January 1, 2000, consistent with 31.11(6)*."

Section 31.11 referenced in the 34.38(G) rulemaking effort contains "Basic Standards Applicable to Surface Water of the State", and further, Section 31.11(6) contains the Water Supply standard. There are two key points.

1. Section 31.11(6) states that *"Except where the Commission adopts or has adopted a different standard on a site-specific basis…"* and goes on to describe the Water Supply standard. Section 34.38(G) clearly states that a site-specific manganese standard of 255 µg/L was adopted for Dolores Segment 3 and references the Water Supply standard in Section 31.11(6).
2. Section 34.38(G) further states that the 255 µg/L value*"… is expected to be representative of conditions on January 1, 2000, consistent with Section 31.11(6)."* This statement specifically references the Water Supply standard. Section 31.11(6) states that the less restrictive of the following two options shall apply:
    - Existing quality as of January 1, 2000; or
    - 50 µg/L (dissolved), for manganese.

The CDPHE PEL document does not reference or acknowledge this and calculates a dissolved manganese standard based on the 85th percentile of data as listed in the Assessment unit database from January 1995 to December 1999. The data is not presented and is not readily available. The value calculated is 195 µg/L.

For segment COSJDO03, the current version of Regulation 34 shows "WS" for the sulfate chronic standard and for the dissolved iron chronic standard. For manganese it does not show "WS" at all, it shows "TVS/255". The 255 ug/L site specific value for Segment COSJDO03 identified in Section 34.38(G) about the Water Supply standard (31.11(6)) is the correct value for the manganese Water Supply standard in that segment and was used in the PEL evaluation provided in Table 2-1.

Cadmium

The dissolved cadmium standard has been updated since Atlantic Richfield received the PEL. In December 2019, the Water Quality Control Commission (WQCC) approved new cadmium hardness-based water quality standards that took effect on June 30, 2020. The Atlantic Richfield evaluation used the updated dissolved cadmium standard (see Table 2-1), which results in less restrictive values than previously determined for the chronic standard at all hardness values as well as for the acute (cold) standard when hardness is greater than 45 mg/L.

Molybdenum

The segment standard for molybdenum is different between the PEL and the Atlantic Richfield analysis. PEL document Table A-3a **–** *In-stream Standards for Stream Segment COSJDO03 & COSJDO05A* lists the total recoverable molybdenum chronic standard as 160 ug/L; however, State Regulation 34 lists the in-stream standard as 150 ug/L. The 150 µg/L value specified in State Regulation 34 was used in the Atlantic Richfield evaluation (see Table 2-1).

Attachment 3

Supporting Information for Percent Removal Calculations

Supporting Information for Percent Removal Calculations

This attachment provides additional information supporting Table 2, which presents performance criteria based on calculated annual minimum and annual average percent removal values for constituents of interest observed during operation of the Enhanced Wetland Demonstration (EWD) at the Site, over the years of 2016 through 2020. The EWD has been operated as a treatability study.

Atlantic Richfield Company (Atlantic Richfield) measures the EWD treatment flow continuously and obtains samples of the EWD influent and effluent streams regularly (at least bimonthly, and more frequently during freshet periods). Atlantic Richfield also regularly samples intermediate points within the overall EWD process to monitor system health and to learn about its operation.

To facilitate mass-based percent removal calculations, each constituent influent and effluent mass was first compiled on a daily basis. In doing this, the continuous flow measurement was averaged over each day to produce a daily average flow rate value. Since influent and effluent samples are taken at discrete points in time, each influent and effluent sample was assumed to represent a constant influent or effluent composition from the sample date until the next influent or effluent sample was obtained, at which time the new sample dataset would represent the composition until the next subsequent sample dataset was obtained.

Percent removal calculations were developed using the total constituent mass entering the EWD and total constituent mass leaving the EWD, over the time period represented by the analytical sample. A formula illustrating the general percent removal calculation is illustrated below:

$$\%\ Mass\ Removal = \left\{1 - \frac{Mass_{Effluent}}{Mass_{Influent}}\right\} x\ 100\%$$

Where:

$Mass_{Effluent}$ = (Effluent concentration) x (average EWD flow for time period) x (time)
$Mass_{Influent}$ = (Influent concentration) x (average EWD flow for time period) x (time)

To produce a daily-basis percent removal, the daily masses were used explicitly. To produce a monthly-basis percent removal, the daily masses were summed for each calendar month. To produce a yearly-basis percent removal, the daily masses were summed for each calendar year. The values in Table 2 represent calculated EWD percent removal values for the constituents of interest for the calendar years of 2016 through 2020. The values in the “Annual Minimum” column are the minimum calendar-year percent removals observed over the 2016 through 2020 timeframe. The values in the “Annual Average” column are the average percent removals observed over the timeframe.

Figures 3-1 through 3-5 present monthly-basis average influent and effluent concentrations and percent removal for aluminum, cadmium, iron, manganese, and zinc for the calendar years of 2016 through 2020. There are several aspects in these figures that warrant discussion:

1. There are rapid increases and subsequent decreases in the constituents for some calendar years. These tend to coincide with the gray shaded areas, which represent the May 1st to July 31st timeframe each year. This is the general timeframe of the freshet period, where

there is a rise and fall in metals concentrations along with a rise and gradual drop in St. Louis Tunnel flow. The behavior generally tends to lag the Dolores River runoff hydrograph by three to six weeks.

2. The increases in concentrations during the freshet period vary from year to year. This is due to a number of factors including the water content of the snowpack, the rate of melting, the previous year's freshet, and others. As an example, it can be seen in Figure 3-5 that there were distinct increases in zinc concentration during the 2016, 2017, and 2019 freshets; there was no zinc concentration increase in 2018 as it was a very dry preceding winter; and there was only a small increase in 2020, again due to a relatively dry preceding summer/fall.
3. Some constituents show a decrease in percent removal during the freshet periods (e.g., zinc and manganese). In general, percent removals were quite high between freshet periods. The EWD design did not include provisions for effective treatment during strong freshets, as this aspect was not well-understood at the time of the EWD design.
4. Outside of the freshet periods, the influent metals concentrations (blue line) tend to be relatively low and to change relatively slowly, conditions that are very amenable to effective treatment.

The annual minimum and average percent removal values appearing in Table 2 utilized the same data set as illustrated in Figures 3-1 through 3-5 but were summed over each calendar year to develop results on a yearly basis, rather than the monthly basis in the figures below.

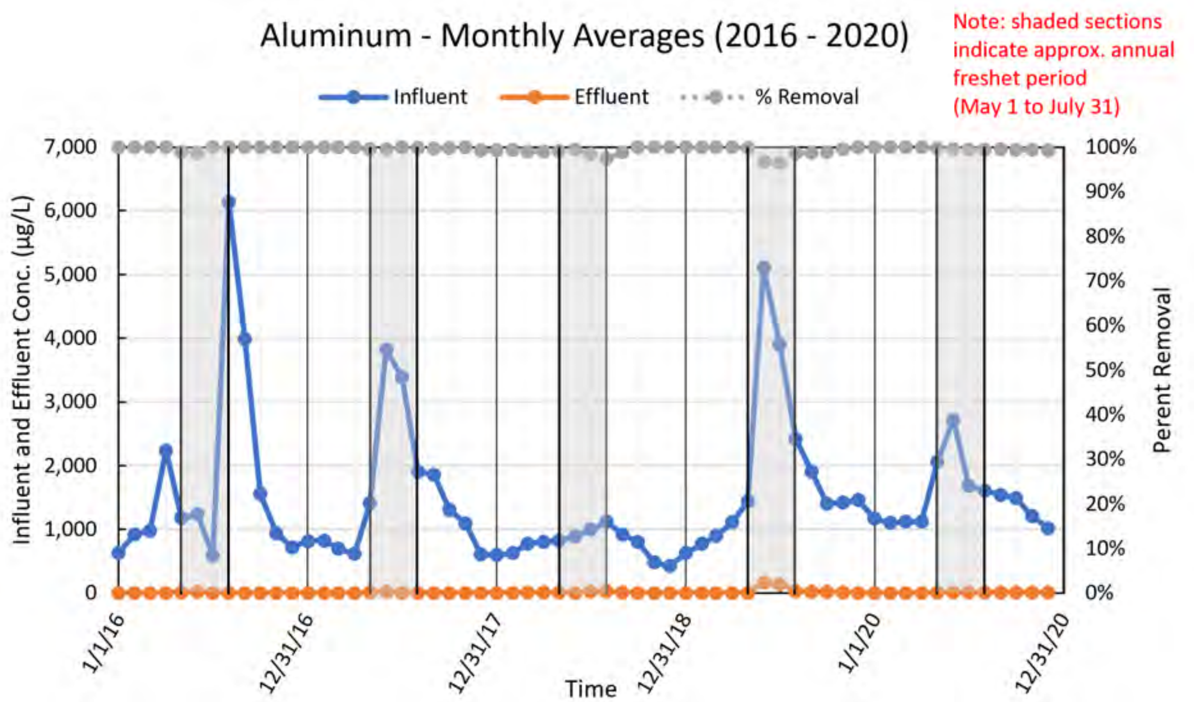

Figure 3-1. *Aluminum Monthly Average Influent, Effluent, and Percent Removal for EWD System from 2016 through 2020*

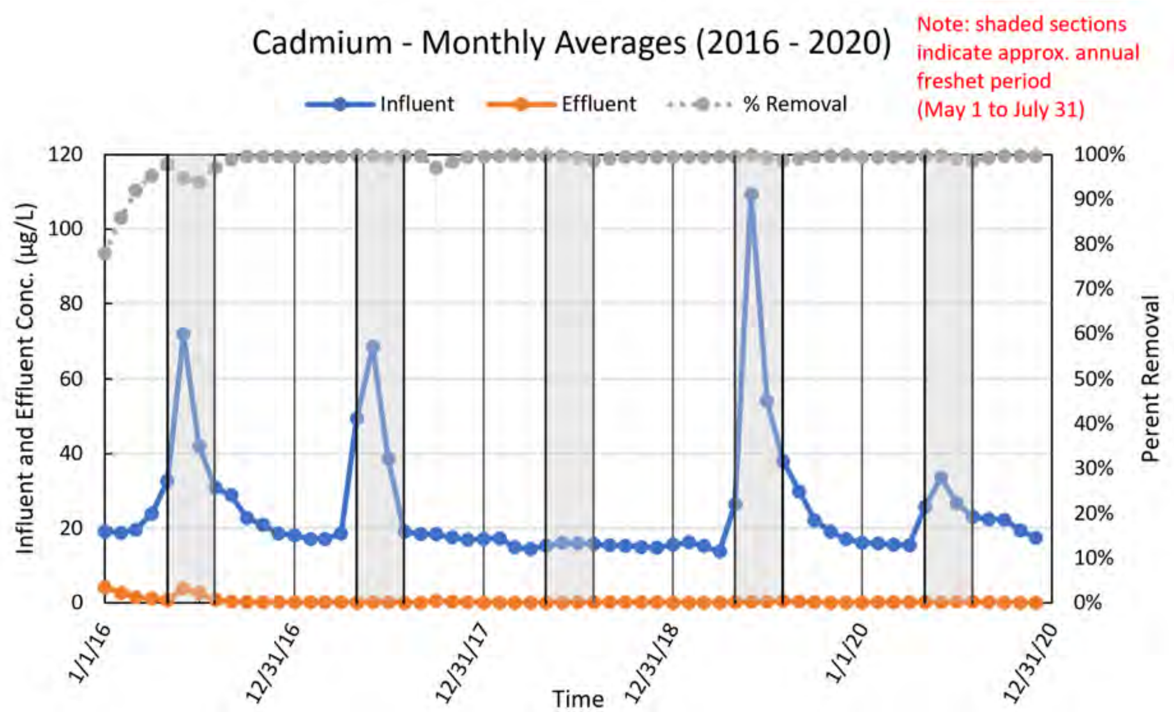

Figure 3-2*. Cadmium Monthly Average Influent, Effluent, and Percent Removal for EWD System from 2016 through 2020*

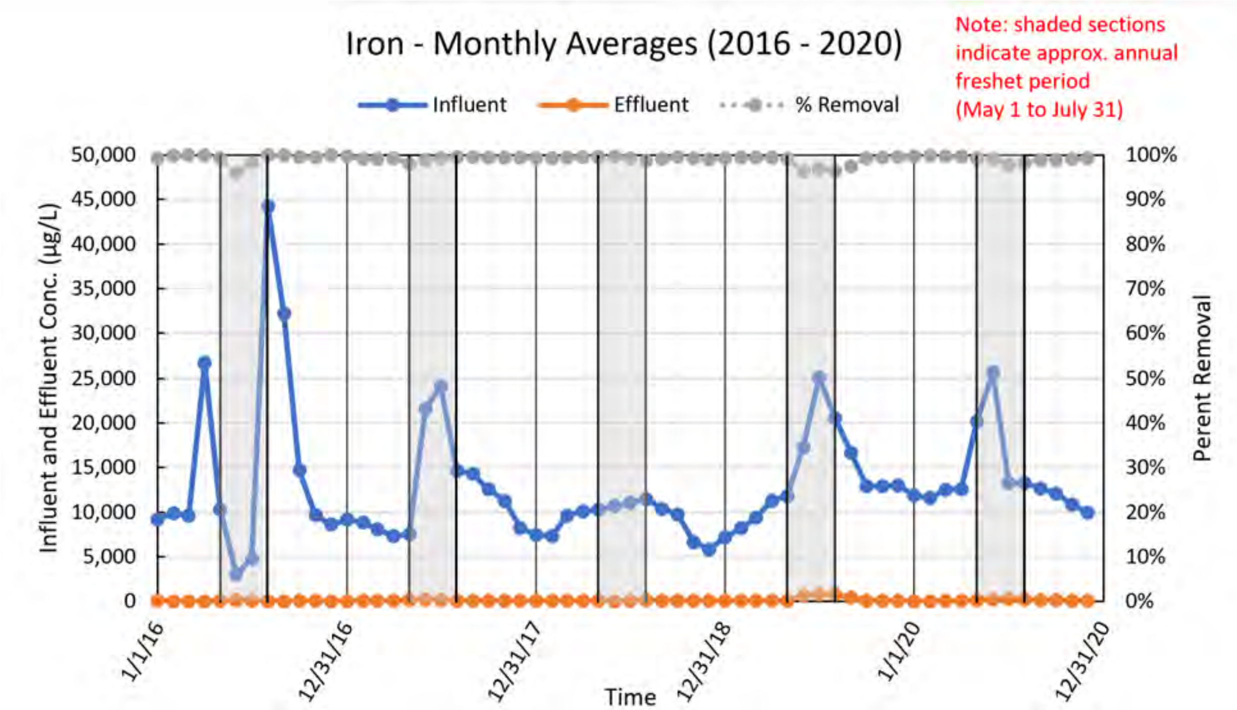

Figure 3-3. *Iron Monthly Average Influent, Effluent, and Percent Removal for EWD System from 2016 through 2020*

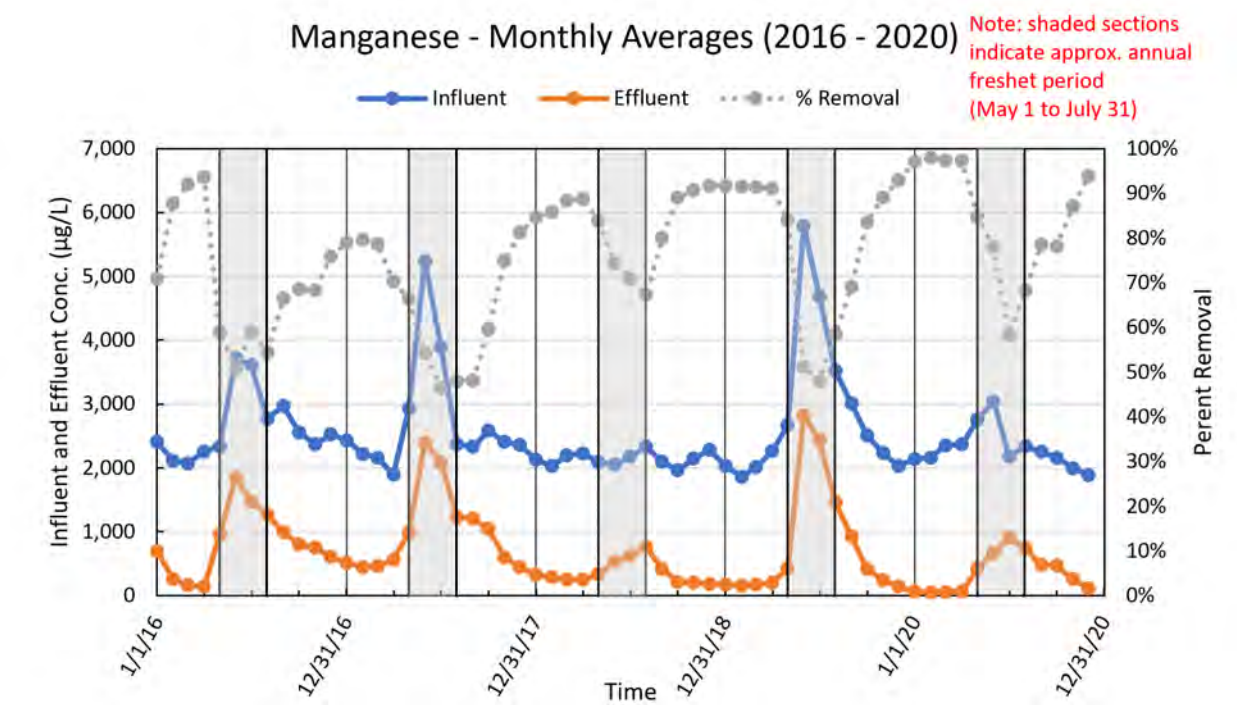

Figure 3-4. *Manganese Monthly Average Influent, Effluent, and Percent Removal for EWD System from 2016 through 2020*

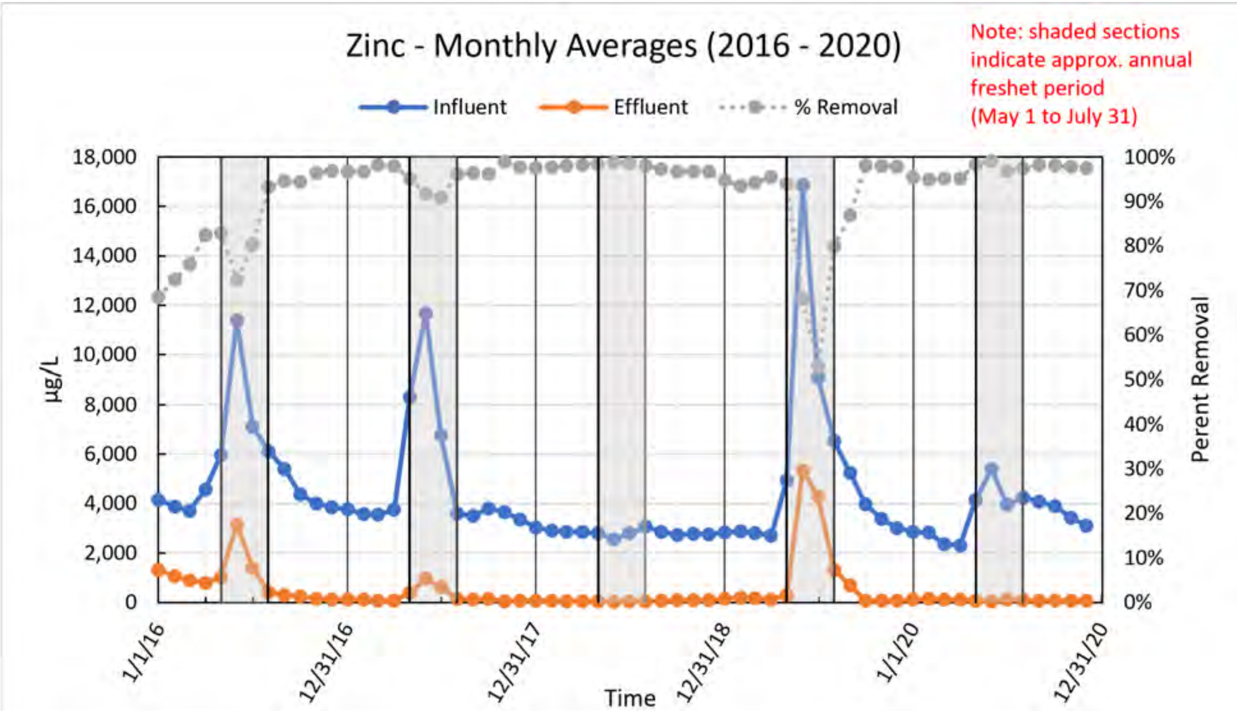

Figure 3-5. *Zinc Monthly Average Influent, Effluent, and Percent Removal for EWD System from 2016 through 2020*

Attachment 4

Comparison of Measured Dolores River Water Quality to Applicable Water Quality Standards

Comparison of Measured Dolores River Water Quality to Applicable Water Quality Standards

This attachment discusses measured water quality in the Dolores River downstream of the Site wetland treatment system discharge compared with applicable CDPHE Water Quality Control Division water quality standards.

The Enhanced Wetland Demonstration (EWD) system became operational in late 2015 and has operated continuously to the present. The system was constructed and operated as a treatability study, and the system design basis was 550 gallons per minute (gpm). During periods of St. Louis Tunnel (SLT) base flow, the EWD (along with the two smaller treatability study systems known collectively as the Constructed Wetland Demonstration [CWD]) has treated all of the SLT flow. During periods with SLT flow above approximately 600 gpm, the portion of flow above 600 gpm has been routed around the treatability study systems to the St. Louis Ponds for settling. After entering the ponds, this routed water would mix with the treated water, and the mixed waters would flow through the ponds and ultimately to the Dolores River. In addition to high-flow periods, flow was also routed around the treatment system during relatively brief maintenance periods, such as to remove settled solids from settling basins.

The following plots present data from samples obtained from sampling location DR-7, which is located in the Dolores River downstream of the St. Louis Ponds discharge location DR-6. These locations are shown on Figure 1 of the parent document. A mixing zone analysis performed in accordance with CDPHE's Colorado Mixing Zone Implementation Guidance, confirmed that the DR-6 discharge mixes fully with the receiving water at a point in the Dolores River upstream of DR-7 (Atlantic Richfield, 2008).

The following figures compare measured data from DR-7 to State of Colorado chronic standards for Dolores River segment COSJDO03 as presented in Regulation No. 34 – Classifications and Numeric Standards for San Juan River and Dolores River Basins (5 CCR 1002-34, effective date June 30, 2020). These include hardness-based chronic standards for aluminum, cadmium, copper, lead, and zinc; the chronic total iron standard; water supply standards for iron, sulfate, and manganese; and the current temporary hybrid chronic standard for total arsenic. Note that compliance with the hardness-based standards (with the exception of aluminum) are to be demonstrated using potentially dissolved analyses; these figures used total analyses. This is conservative, as total analyses should be equal to or greater than potentially dissolved analyses.

The figures present data from 2011 through 2020. Startup of the EWD is shown as November 1, 2015. The shaded areas represent the approximate freshet periods for 2016 through 2020 (May 1 through July 31) for reference. Figure 4-1 presents Dolores River flow at the United States Geological Survey (USGS) gage below Rico (09165000) along with hardness measured at DR-7, for reference, as it shows how hardness (and therefore hardness-based water quality standards) is strongly affected by Dolores River flow; hardness is diluted during high flow runoff periods and considerably higher during base flow periods.

The subsequent figures, Figures 4-2 through 4-10, show that conditions in the Dolores River downstream of the Rico discharge have consistently met the segment chronic standards since the EWD startup in late 2015, with only a few exceptions observed during freshet conditions. The following briefly summarizes the comparison of measured data with chronic water quality standards for the segment, for each Key constituent. Table 4-1 presents a summary of the comparison.

***Table 4-1**. Summary of DR-7 Water Quality Data vs. Dolores River Segment Chronic Water Quality Standards Since EWD Startup in November 2015*

Key Constituent	# of Segment Standard Exceedances[1]	Total # of Samples[2]	Comments
Aluminum	3	12	For all three exceedances (during 2017, 2019, and 2020 freshets), aluminum also exceeded TVS standards in the Dolores River upstream of the Site. Further, in the 2019 freshet the aluminum concentration was lower at DR-7 than at DR-2, indicating improved aluminum concentration below the Site discharge.
Cadmium	1	17	Exceeded TVS standard during 2017 freshet.
Copper	0	17	
Iron	0	17	
Lead	1	17	For the single exceedance (during the 2019 freshet), the lead concentration also exceeded TVS standards in the Dolores River upstream of the Site. The lead concentration was lower at DR-7 than at DR-2, indicating improved lead concentration below the Site discharge.
Manganese	0 6	17 17	No exceedances of TVS standard; Exceeded Water Supply Standard.
Sulfate	1	17	Exceeded Water Supply standard during winter 2020 with low Dolores River flow; prior years sampling occurred in the fall months.
Zinc	2	17	Exceeded TVS standard during 2017 and 2019 freshets.

Notes:
[1] Exceedances of Dolores River Segment (#COSJDO03) Chronic Standards as provided in Table 1. Total metals analyses used for all metals for conservatism (rather than potentially dissolved analyses).
[2] Number of samples collected since EWD startup in November 2015 to December 2020.

- Aluminum (Figure 4-2) has exceeded the chronic segment standard three times, during the 2017, 2018, and 2019 freshets. However, data collection at the Site has shown that the background total aluminum tends to be very high during the runoff period from upstream sources such as clays. Total aluminum data from sample location DR-2 upstream of the Site are included in Figure 4-2. These data indicate that the source of elevated aluminum concentrations at DR-7 are from upstream, and that total aluminum concentrations above the Site have exceeded standards for each freshet for which data was available. Further, in the 2019 freshet the aluminum concentration was lower at DR-7 than at DR-2, indicating improved aluminum concentration below the Site discharge.

- Cadmium (Figure 4-3) exceeded the chronic segment standard once, during the 2017 freshet.
- Copper (Figure 4-4) has had no exceedances relative to the chronic segment standard throughout the EWD operation.
- Iron (Figure 4-5, Figure 4-6) has had no exceedances relative to both the chronic and Water Supply segment standards throughout the EWD operation.
- Lead (Figure 4-7) exceeded the chronic segment standard once, during the 2019 freshet. Similar to the aluminum discussion above, data collection at the Site have shown elevated lead concentrations from upstream sources, possibly sorbed to particulate iron or aluminum. Total lead concentrations measured at location DR-2 above the Site are included in Figure 4-7. The total lead value measured above the segment chronic TVS during the 2019 freshet can be seen to be due to high concentrations in the Dolores River above the Site. The lead concentration was lower at DR-7 than at DR-2, indicating improved lead concentration below the Site discharge.
- Manganese (Figure 4-8) has exceeded the segment Water Supply standard of 255 µg/L six times. It should be noted that the EWD system does not include a limestone-based rock drain for manganese removal, as is anticipated for the future Expanded Constructed Wetlands Treatment System. There have been no exceedances of the chronic table value standard (TVS) for manganese.
- Sulfate (Figure 4-9) exceeded the segment Water Supply standard once, during low winter flows in the Dolores River in 2020. Prior sampling events have occurred in the fall months, with increased Dolores River flows.
- Zinc (Figure 4-10) exceeded the segment chronic standard twice, once each during the 2017 and 2019 freshets.

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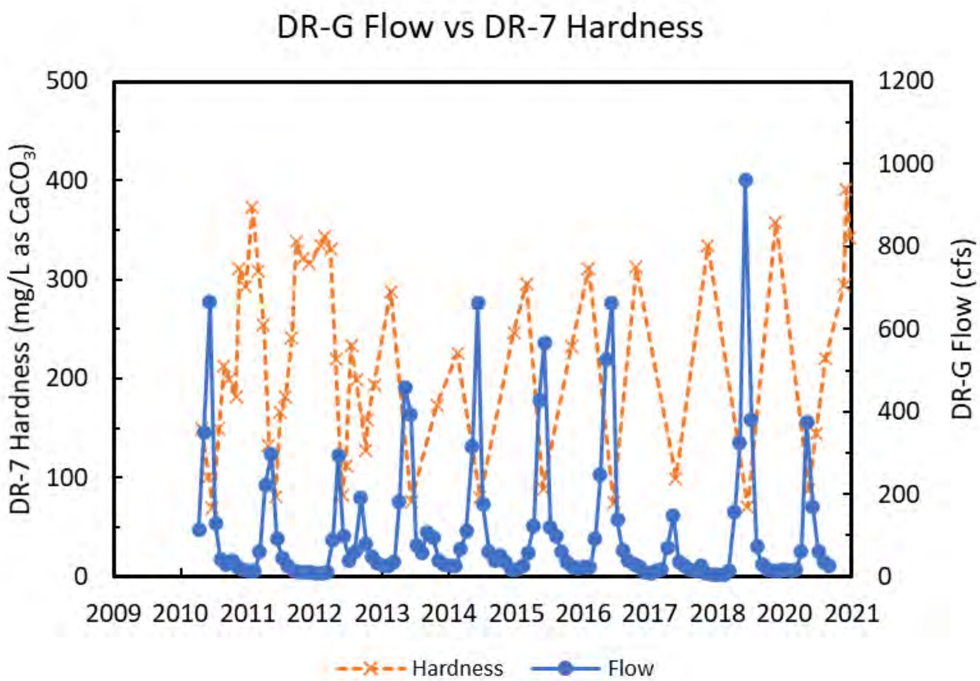

Figure 4-1. *Flow at DR-G (USGS Gage 09165000) with Hardness Measured at DR-7*

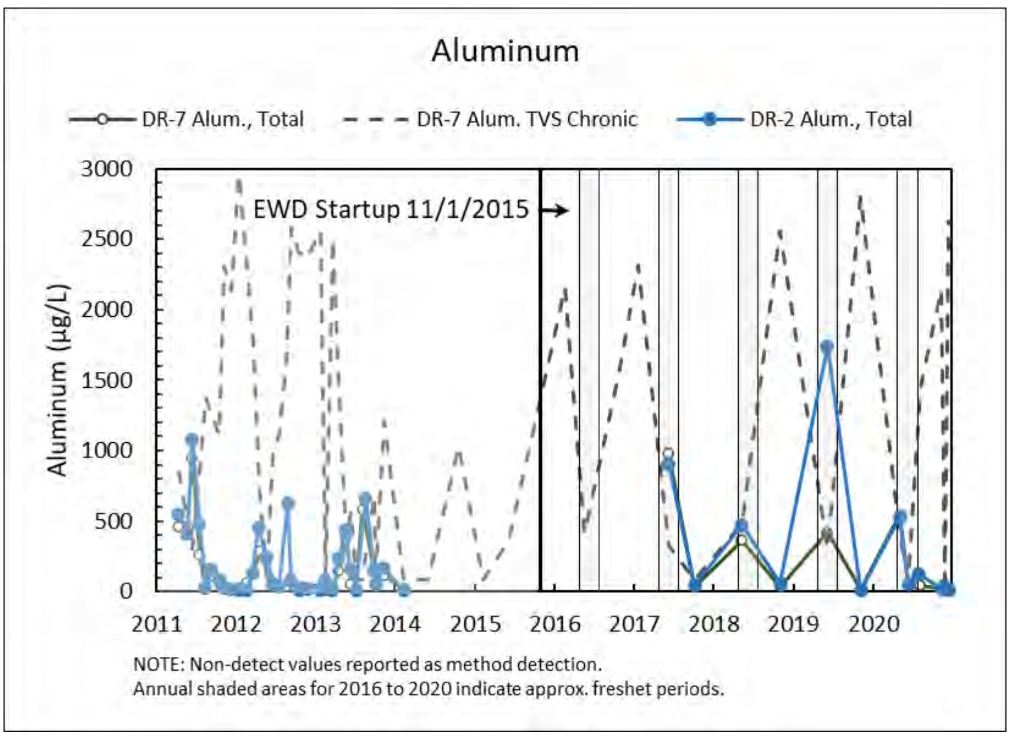

Figure 4-2. *Total Aluminum Measured at DR-7 and DR-2 Compared to Chronic TVS Standard at DR-7*

Figure 4-3. *Total Arsenic Measured at DR-6 Compared to Temporary Chronic Hybrid Standard*

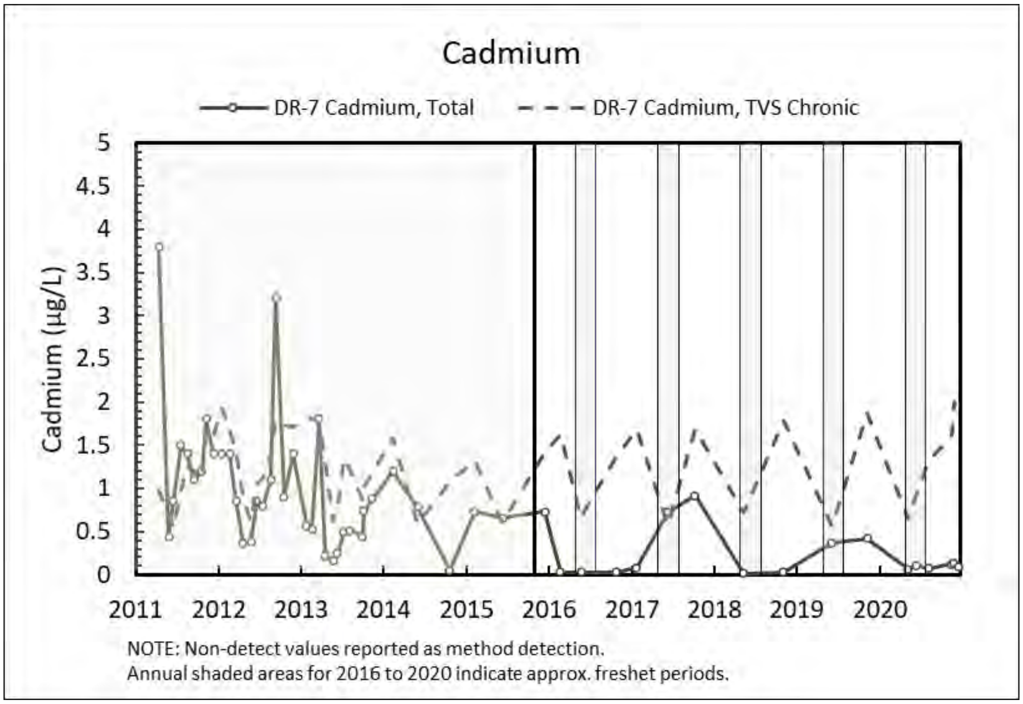

Figure 4-3. *Total Cadmium Measured at DR-7 Compared to Chronic TVS Standard*

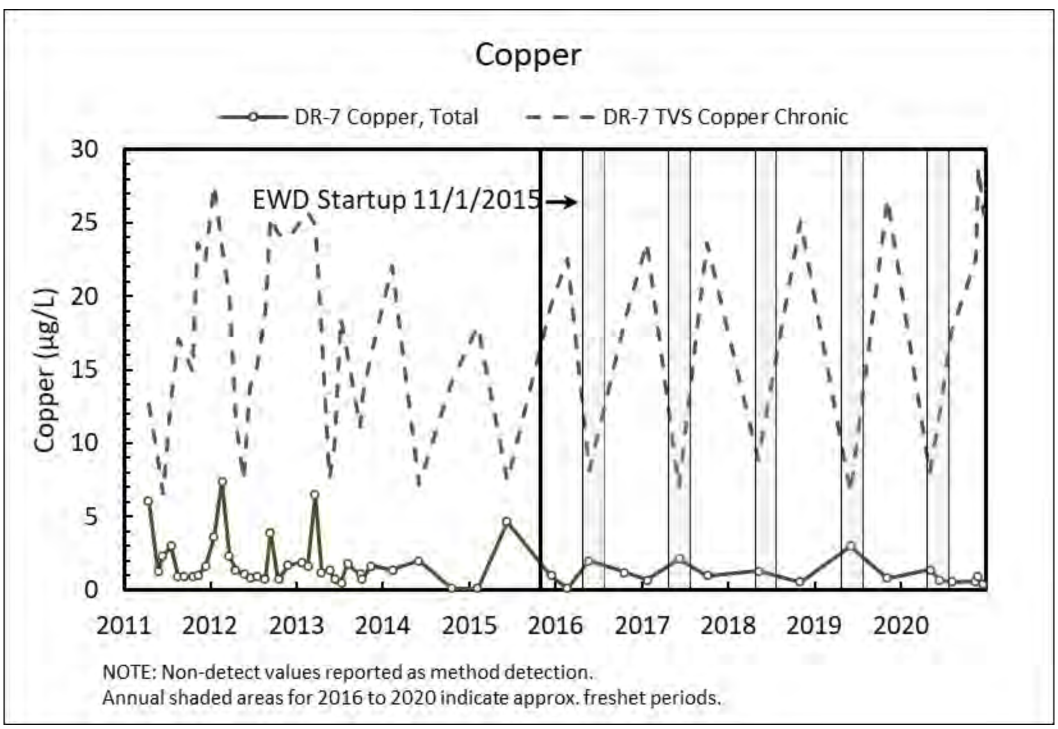

Figure 4-4. *Total Copper Measured at DR-7 Compared to Chronic TVS Standard*

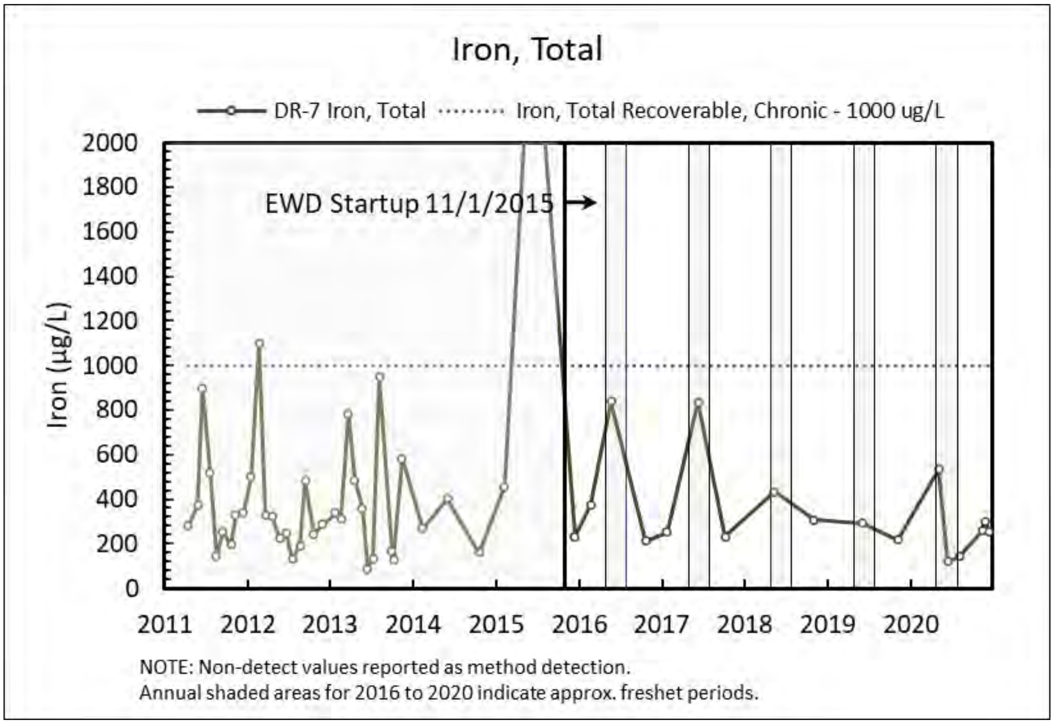

Figure 4-5. *Total Iron Measured at DR-7 Compared to Chronic Standard*

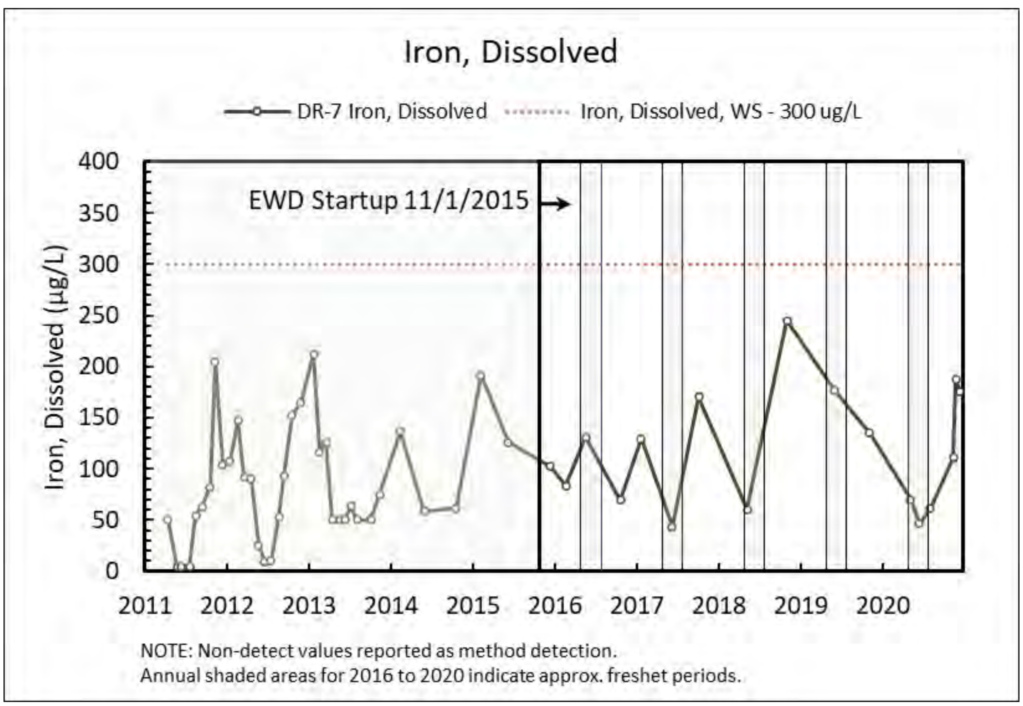

Figure 4-6. *Dissolved Iron Measured at DR-7 Compared to Water Supply Standard*

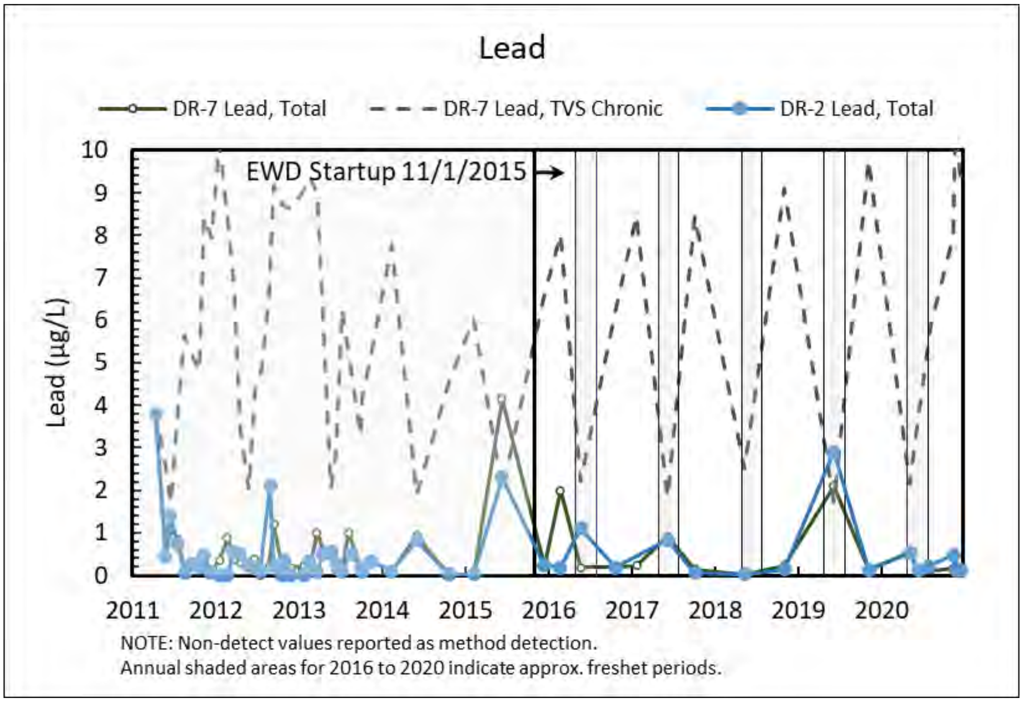

Figure 4-7. *Total Lead Measured at DR-7 and DR-2 Compared to Chronic TVS Standard*

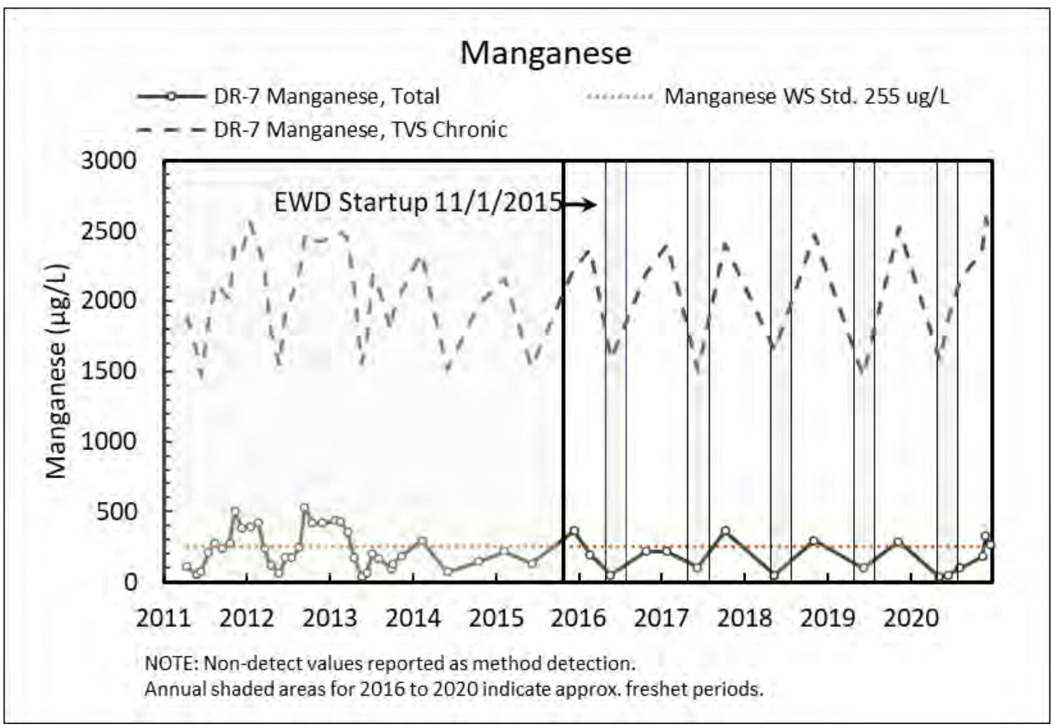

Figure 4-8. *Total Manganese Measured at DR-7 Compared to Water Supply Standard and Chronic TVS Standard*

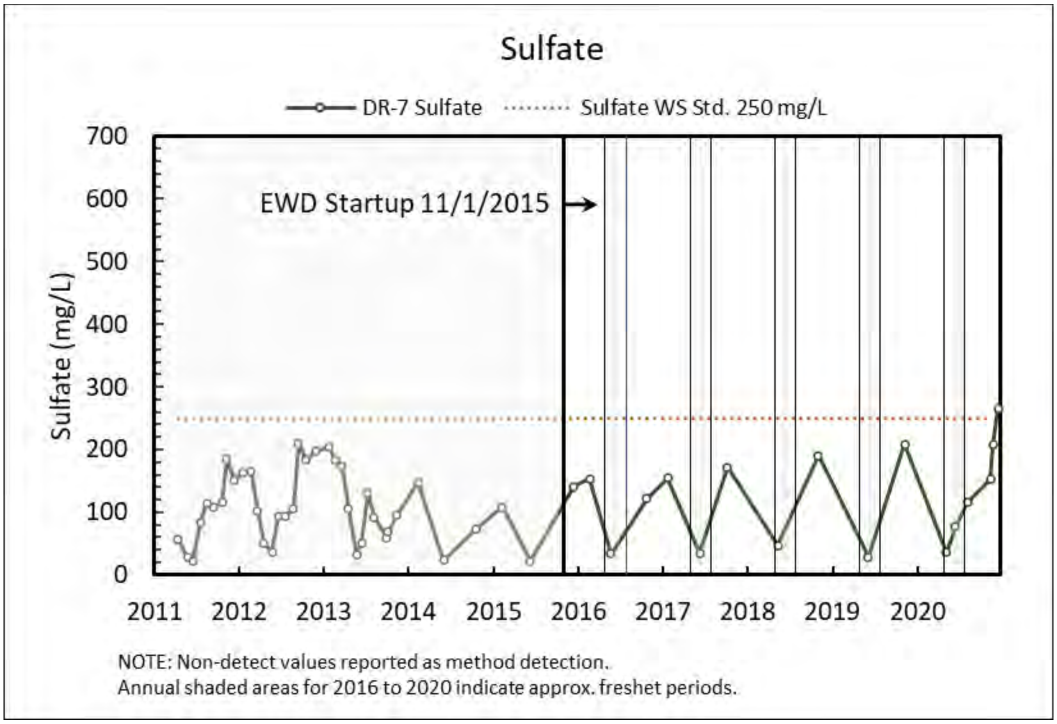

Figure 4-9. *Sulfate Measured at DR-7 Compared to Water Supply Standard*

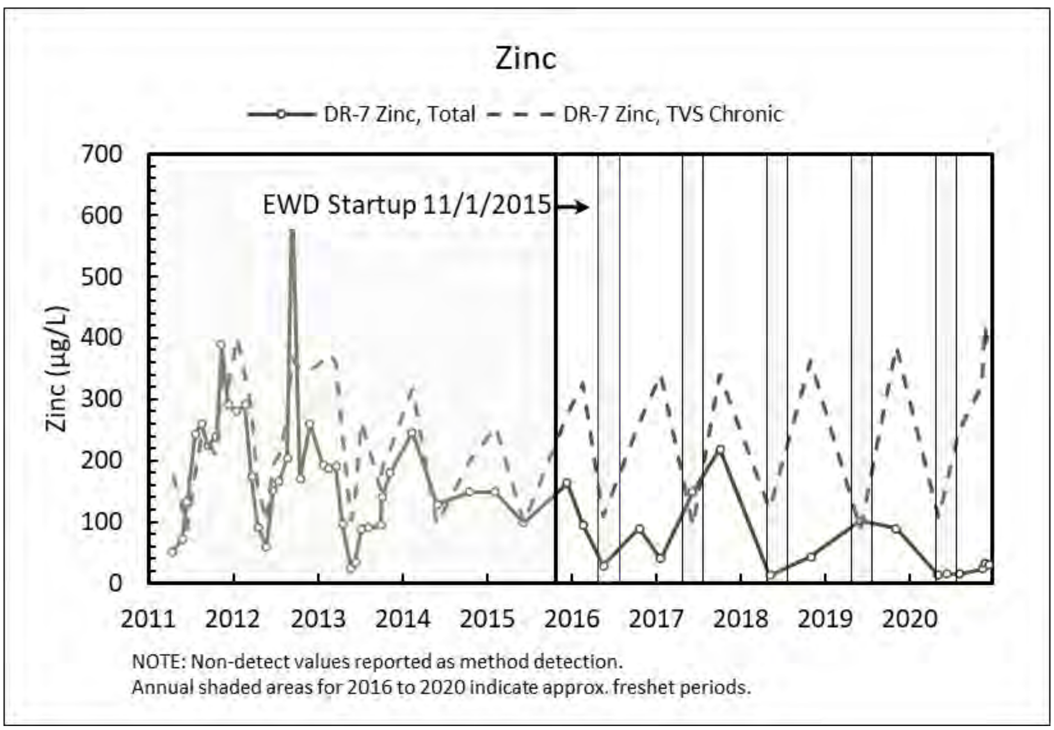

Figure 4-10. *Total Zinc Measured at DR-7 Compared to Chronic TVS Standard*

Rico-Argentine Site

Removal Action Work Plan

Appendix C: Previous Removal Action Task Status and Site Investigations

September 2021

Administrative Settlement Agreement and Order on Consent

Removal Action Tasks and Deliverables (from 2011 RAWP)	Current Status	Submittals Related to Removal Action Task (presented in chronological order per task)
Task A - Pre-Design and Ongoing Site Monitoring		
A1 Ongoing Water Quality and Flow Monitoring		• Rico Quality Assurance Project Plan Ground and Surface Water Final (Atlantic Richfield Company, 2014a) • Rico Sampling and Analysis Plan Ground and Surface Water Final (Atlantic Richfield Company, 2014b)
Flow monitoring installations	Completed	
Quarterly downloads	Ongoing	
A2 Seasonal Water Quality and Flow Monitoring	Ongoing	
SAP/QAPP	Completed	
First sampling event	Completed	
Task B - Management of Precipitation Solids in the Upper Settling Ponds		
B1 Develop Initial Solids Removal Plan	Completed	• Initial Solids Removal Plan (Atlantic Richfield Company, 2011a) • Field Sampling Plan for Solids Repository, Permanent Drying Facility and Pond Flood Dike and Embankment Improvements (Atlantic Richfield Company, 2011b) • Calcine Tailings Tech Memo (AECOM, 2011a) • Geotechnical Investigation of Pond 18 Treatment Solids Drying Behavior (AECOM, 2011b) • Interim Flood Dike Upgrades Technical Memorandum (AECOM, 2012) • Pond 15 Solids Removal Work Plan (Atlantic Richfield Company, 2012a) • 2013 Solids Removal Work Plan (Atlantic Richfield Company, 2013a) • 2014 Solids Removal Work Plan (Atlantic Richfield Company, 2014c)
B2 Drying Bed Construction, Solids Removal, and Solids Management		
Mobilization and site preparation	Completed	
Pond 18 initial solids removal	Completed	
Downstream ponds initial solids removal	Completed	
IDF Construction	Completed	
Additional pond solids removal (if/as needed)	See Task C	
B3 Pond Stability Analysis and Upgrades		
Pond stability analysis (Geotechnical and Hydrology)	Completed	
Embankment armoring	Completed	
Stability upgrades - structural	Completed through Pond 11	
Interim ponds solids management	Ongoing; Solids Management Plan to be submitted w/in 90 days of AOC Effective Date	

Removal Action Tasks and Deliverables (from 2011 RAWP)	Current Status	Submittals Related to Removal Action Task (presented in chronological order per task)
Task C - Design and Construction of a Solids Repository		
C1 Develop a Repository Design and Operating Plan		• Solids Repository Alternative Evaluation and Preliminary Design Report (Atlantic Richfield Company, 2013b) • Solids Repository Engineering Design and Operations Plan (AECOM, 2013)
Submit Repository Design and Operating Plan	Completed	
Permitting	Completed	
C2 Solids Repository Construction and Initial Solids Placement		
Mobilization	Completed	
Construct repository	Completed	
Placement of pond solids	Ongoing; Solids Management Plan to be submitted w/in 90 days of AOC Effective Date	
Task D - Hydraulic Control Measures for the Collapsed Area of St. Louis Tunnel Adit		
D1 Adit Collapse Area Investigations Plan		• Investigation Plan for Collapsed Adit Area at SLT (Atlantic Richfield, 2011c) • Supplement to Investigation Plan for Collapsed Adit Area at SLT Rico (Atlantic Richfield Company, 2012b) • 2013 Supplement to the Investigation Plan for Collapsed Adit Area at SLT (Atlantic Richfield Company, 2013c) • Preliminary Design Report, SLT Hydraulic Control Measures (Atlantic Richfield Company, 2013d) • Adit and Portal Investigation Report 2013 Update (Atlantic Richfield Company, 2013e) • Final Design Report, SLT Hydraulic Control Measures (Atlantic Richfield Company, 2014d) • SLT Water Level Monitoring Status Report (Amec Foster Wheeler, 2015) • Interim Risk Reduction Measures Work Plan and Addenda (Atlantic Richfield Company, 2016a; Atlantic Richfield Company, 2016b; Atlantic Richfield Company, 2016c)
Adit and Portal Investigation Report	Completed	
D2 Preliminary Design of Hydraulic Controls of the Adit Discharge		
Preliminary Design Report	Completed	
D3 Final Design and Construction of Adit Hydraulic Controls		
Stages 1 & 2 Final Design	Completed	
Stages 1 & 2 Construction	Completed	
Additional Monitoring/ Evaluations	Ongoing	
Stage 3 Design	Draft Design to be submitted w/in 180 days after the AOC Effective Date; Final Design to be submitted w/in 90 days after EPA approval of the Draft Design	
Stage 3 Construction	Next Field Season following Final Design Approval	

Removal Action Tasks and Deliverables (from 2011 RAWP)		Current Status	Submittals Related to Removal Action Task (presented in chronological order per task)
Task E - Source Water Investigations and Controls (Assumes Blaine/Argentine Treatment)			
E1	*Review Existing Data*	Completed	• 2011 Source Water Investigation Report (EPA, 2012) • Blaine Base Flow Measurement Work Plan (Atlantic Richfield Company, 2012c) • Evaluation of Source Water Controls Report Revision 1 (Atlantic Richfield Company, 2014e)
E2	*Additional Investigations* *Primary Blaine Rehab Work*	Completed Completed	
E3	*Evaluation of Hydraulic Controls Alternatives*	Completed	
E4	*Mine Water Source Controls - Design and Construction (Pending E3 Findings)*	None per E3 Findings	

Removal Action Tasks and Deliverables (from 2011 RAWP)	Current Status	Submittals Related to Removal Action Task (presented in chronological order per task)
Task F - Water Treatment System Analysis and Design (Assumes St. louis Tunnel/Ponds based System)		
F1 Preliminary Water Treatment Technology Alternatives Screening Report	Completed	• Preliminary Water Treatment Technology Screening Report (Atlantic Richfield Company, 2011d) • SLT Discharge Constructed Wetland Pilot Scale Test Work Plan (Atlantic Richfield Company, 2012d) • SLT Discharge Source Mine Water Treatability Study Work Plan (Atlantic Richfield Company, 2012e) • SLT Discharge Ion Exchange Bench-Scale Treatability Test Work Plan (Atlantic Richfield Company, 2013f) • SLT Discharge Source Mine Water Treatability Study Work Plan Addendum (Atlantic Richfield Company, 2013g) • SLT Discharge Constructed Wetland Pilot Scale Test Construction and Pre-Implementation Report (Atlantic Richfield Company, 2013h) • SLT Discharge CWD Treatability Study Work Plan (Atlantic Richfield Company, 2013i) • SLT Discharge Constructed Wetland Pilot Scale Test Completion Report (Atlantic Richfield Company, 2013j) • SLT Discharge CWD Treatability Study Unified Design (Atlantic Richfield Company, 2013k) • SLT Discharge CWD Treatability Study Final Design Report (Atlantic Richfield Company, 2014f) • SLT Discharge CWD Treatability Study Work Plan Revision 2 (Atlantic Richfield Company, 2014g) • SLT Discharge Constructed Wetland Pilot Scale Test Completion Report Addendum: Supplemental Sample Analysis Results (Atlantic Richfield Company, 2014h) • Final Commissioning Plan, Revision 1 (Atlantic Richfield Company, 2014i) • Operations, Maintenance, and Monitoring Plan (Atlantic Richfield Company, 2014j) • Performance Monitoring Plan Addendum 1 (Atlantic Richfield Company, 2015)
F2 Treatment System Conceptual Designs and Additional Investigations		
Pilot Scale – 517 Shaft In-Situ Treatment	Completed	
Additional Investigations/Pilot Scale Testing	Completed	
Demonstration Scale Wetland Constructed and Operating	Completed	
Enhanced Wetland Demonstration System – Hydraulic Commissioning and Inoculation	Completed	
Performance Evaluation and Technology(s) Selection Report	Ongoing - Will be submitted as Appendix A to the AOC Work Plan	
F3 30% Design Report	Draft Design to be submitted w/in 180 days of AOC Effective Date	
F4 Final Design and Construction of the Water Treatment Facility		
Final Design (including pond stability upgrades if/as needed)	Final Design to be submitted w/in 180 days of EPA approval of Draft Design	
Construction (including pond stability upgrades if/as needed)	Start - Next Field Season following Final Design Approval	

List of Site Investigations Conducted prior to 2011 RAWP
• Anaconda Copper Company, Rico Project, Final Report (Gibbs and Hill, Inc., December 1981) • Geotechnical and Hydrologic Investigations, St. Louis Adit Site, Silver Creek Tailings Site, Silver Creek Pipeline Route, Rico, Colorado; (Dames and Moore, 1981) • Summary of Water Quality Sampling and Modeling (SRK, 1983 and 1984) • Water Quality Studies for the Dolores River at Rico, Colorado (SRK, 1985) • Rico Water Quality Study – Preliminary Results of Duplicate Sampling Conducted on September 22, 1983 (Hutchinson,1983a) • Rico Project - Cadmium Contamination (Hutchinson, 1983b) • Analytical Results for Rico-Argentine Mine (E&E, 1985) • Dolores River Basin Water Quality Study (Bureau of Reclamation, 1993) • Phase I and Phase II Environmental Site Assessment, Rico Colorado (Walsh, 1995) • Summary of Surface Water and Groundwater Data for Rico, Colorado (PTI, 1995) • Dolores River Watershed Evaluation and Recommendations Report for the Town of Rico (Matrix Design Group, 2004)

Notes:

EPA = U.S. Environmental Protection Agency

SLT = St. Louis Tunnel

CWD = Constructed Wetlands Demonstration

SRK = Steffen Robertson and Kirsten (Colorado) Inc.

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Atlantic Richfield Company, 2011c, Investigation Plan for Collapsed Adit Area at St. Louis Tunnel, Rico-Argentine Mine Site—Rico Tunnels Operable Unit OU01, Rico, Colorado, submitted by Atlantic Richfield Company to US EPA, dated August 29, 2011.

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Atlantic Richfield Company, 2012c, Blaine Base Flow Measurement Work Plan, Rico-Argentine Mine Site—Rico Tunnels Operable Unit OU01, Rico Colorado, submitted by Atlantic Richfield Company to US EPA, dated March 20, 2012.

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Atlantic Richfield Company, 2013f, St. Louis Tunnel Discharge Ion Exchange Bench-Scale Treatability Study Work Plan, Rico-Argentine Mine Site—Rico Tunnels Operable Unit OU01, Rico Colorado, submitted by Atlantic Richfield Company to US EPA, dated June 21, 2013.

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