Antidegradation Review: Trail Mountain Mine

Energy West Mining Company

ANTIDEGRADATION REVIEW FORM
UTAH DIVISION OF WATER QUALITY

Instructions

The objective of antidegradation rules and policies is to protect existing high quality waters and set forth a process for determining where and how much degradation is allowable for socially and/or economically important reasons. In accordance with Utah Administrative Code (UAC R317-2-3), an antidegradation review (ADR) is a permit requirement for any project that will increase the level of pollutants in waters of the state. The rule outlines requirements for both Level I and Level II ADRs, as well as public comment procedures. This review form is intended to assist the applicant and Division of Water Quality (DWQ) staff in complying with the rule but is not a substitute for the complete rule in R317-2-3.5. Additional details can be found in the *Utah Antidegradation Implementation Guidance* and relevant sections of the guidance are cited in this review form.

ADRs should be among the first steps of an application for a UPDES permit because the review helps establish treatment expectations. The level of effort and amount of information required for the ADR depends on the nature of the project and the characteristics of the receiving water. To avoid unnecessary delays in permit issuance, the Division of Water Quality (DWQ) recommends that the process be initiated at least one year prior to the date a final approved permit is required.

DWQ will determine if the project will impair beneficial uses (Level I ADR) using information provided by the applicant and whether a Level II ADR is required. The applicant is responsible for conducting the Level II ADR. For the permit to be approved, the Level II ADR must document that all feasible measures have been undertaken to minimize pollution for socially, environmentally or economically beneficial projects resulting in an increase in pollution to waters of the state.

For permits requiring a Level II ADR, this antidegradation form must be completed and approved by DWQ before any UPDES permit can be issued. Typically, the ADR form is completed in an iterative manner in consultation with DWQ. The applicant should first complete the statement of social, environmental and economic importance (SEEI) in Part C and determine the parameters of concern (POC) in Part D. Once the POCs are agreed upon by DWQ, the alternatives analysis and selection of preferred alternative in Part E can be conducted based on minimizing degradation resulting from discharge of the POCs. Once the applicant and DWQ agree upon the preferred alternative, the review is considered complete, and the form must be signed, dated, and submitted to DWQ.

For additional clarification on the antidegradation review process and procedures, please contact Nicholas von Stackelberg (801-536-4374) or Jeff Ostermiller (801-536-4370).

Antidegradation Review Form

Part A: Applicant Information

Facility Name: Trail Mountain Mine

Facility Owner: PacifiCorp, Energy West Mining Company

Facility Location: North of Hwy 29 (12 miles west of Orangeville)

Form Prepared By: CH2M HILL, 215 South State St, SLC, UT 84111

Outfall Number: 001and 002

Receiving Water: Cottonwood Canyon Creek, tributaries to Cottonwood Creek

What Are the Designated Uses of the Receiving Water (R317-2-6)?

Domestic Water Supply: 1C
Recreation: 2B - Secondary Contact
Aquatic Life: 3A - Cold Water Aquatic Life
Agricultural Water Supply: 4
Great Salt Lake: None

Category of Receiving Water (R317-2-3.2, -3.3, and -3.4): Category ~~2~~ 1

UPDES Permit Number (if applicable): UT0023728

Effluent Flow Reviewed: 50 gpm (Outfall 001) and 300 gpm (Outfall 002)
Typically, this should be the maximum daily discharge at the design capacity of the facility. Exceptions should be noted.

<u>What is the application for? (check all that apply)</u>

- ☐ A UPDES permit for a new facility, project, or outfall.
- ☐ A UPDES permit renewal with an expansion or modification of an existing wastewater treatment works.
- ☐ A UPDES permit renewal requiring limits for a pollutant not covered by the previous permit and/or an increase to existing permit limits.
- ☒ A UPDES permit renewal with no changes in facility operations.

Part B. Is a Level II ADR required?

This section of the form is intended to help applicants determine if a Level II ADR is required for specific permitted activities. In addition, the Executive Secretary may require a Level II ADR for an activity with the potential for major impact on the quality of waters of the state (R317-2-3.5a.1).

B1. The receiving water or downstream water is a Class 1C drinking water source.

☒ **Yes** A Level II ADR is required (Proceed to Part C of the Form)

☐ **No** (Proceed to Part B2 of the Form)

B2. The UPDES permit is new <u>or</u> is being renewed and the proposed effluent concentration and loading limits are higher than the concentration and loading limits in the previous permit and any previous antidegradation review(s).

☐ **Yes** (Proceed to Part B3 of the Form)

☐ **No** No Level II ADR is required and there is <u>no need to proceed further with review questions</u>.

B3. Will any pollutants use assimilative capacity of the receiving water, i.e. do the pollutant concentrations in the effluent exceed those in the receiving waters at critical conditions? For most pollutants, effluent concentrations that are higher than the ambient concentrations require an antidegradation review? For a few pollutants such as dissolved oxygen, an antidegradation review is required if the effluent concentrations are less than the ambient concentrations in the receiving water. (Section 3.3.3 of Implementation Guidance)

☐ **Yes** (Proceed to Part B4 of the Form)

☐ **No** No Level II ADR is required and there is <u>no need to proceed further with review questions</u>.

B4. Are water quality impacts of the proposed project temporary and limited (Section 3.3.4 of Implementation Guidance)? Proposed projects that will have temporary and limited effects on water quality can be exempted from a Level II ADR.

☐ **Yes** Identify the reasons used to justify this determination in Part B4.1 and proceed to Part G. No Level II ADR is required.

☒ **No** A Level II ADR is required (Proceed to Part C)

B4.1 Complete this question only if the applicant is requesting a Level II review exclusion for temporary and limited projects (see R317-2-3.5(b)(3) and R317-2-3.5(b)(4)). For projects requesting a temporary and limited exclusion please indicate the factor(s) used to justify this determination (check all that apply and provide details as appropriate) (Section 3.3.4 of Implementation Guidance):

☐ Water quality impacts will be temporary and related exclusively to sediment or turbidity and fish spawning will not be impaired.

Factors to be considered in determining whether water quality impacts will be temporary and limited:

a) The length of time during which water quality will be lowered: ☐
b) The percent change in ambient concentrations of pollutants: ☐
c) Pollutants affected: ☐
d) Likelihood for long-term water quality benefits: ☐
e) Potential for any residual long-term influences on existing uses: ☐
f) Impairment of fish spawning, survival and development of aquatic fauna excluding fish removal efforts: ☐

Additional justification, as needed: ☐

Level II ADR

Part C, D, E, and F of the form constitute the Level II ADR Review. The applicant must provide as much detail as necessary for DWQ to perform the antidegradation review. Questions are provided for the convenience of applicants; however, for more complex permits it may be more effective to provide the required information in a separate report. Applicants that prefer a separate report should record the report name here and proceed to Part G of the form.

Optional Report Name: *Antidegradation Review and Statement of Social, Environmental, and Economic Importance: Trail Mountain Mine*

Part C. Is the degradation from the project socially and economically necessary to accommodate important social or economic development in the area in which the waters are located?

The applicant must provide as much detail as necessary for DWQ to concur that the project is socially and economically necessary when answering the questions in this section. More information is available in Section 6.2 of the Implementation Guidance.

C1. Describe the social and economic benefits that would be realized through the proposed project, including the number and nature of jobs created and anticipated tax revenues.

See Attachment A

C2. Describe any environmental benefits to be realized through implementation of the proposed project.

See Attachment A

C3. Describe any social and economic losses that may result from the project, including impacts to recreation or commercial development.

See Attachment A

C4. Summarize any supporting information from the affected communities on preserving assimilative capacity to support future growth and development.

See Attachment A

C5. Please describe any structures or equipment associated with the project that will be placed within or adjacent to the receiving water.

See Attachment A

Part D. Identify and rank (from increasing to decreasing potential threat to designated uses) the parameters of concern. *Parameters of concern are parameters in the effluent at concentrations greater than ambient concentrations in the receiving water. The applicant is responsible for identifying parameter concentrations in the effluent and DWQ will provide parameter concentrations for the receiving water. More information is available in Section 3.3.3 of the Implementation Guidance.*

Parameters of Concern:

Rank	Pollutant	Ambient Concentration	Effluent Concentration
1	Total suspended solids	56 mg/L	28 mg/L (outfall 001) 11 mg/L (outfall 002)
2	Total dissolved solids	292 mg/L	2262 mg/L (001) 936 mg/L (002)
3	Iron	0.01 mg/L dissolved	0.54 mg/L (001) 0.55 mg/L (002)
4	Cadmium Copper	Non-detect Non-detect	0.0028 mg/L (002) 0.034 mg/L (002)
5	Oil and grease	Non-detect	7 mg/L (001) 2 mg/L (002)

Pollutants Evaluated that are not Considered Parameters of Concern:

Pollutant	Ambient Concentration	Effluent Concentration	Justification
pH	6.6 - 8.8 s.u.	7.6 - 8.4 (001) 7.8 - 8.5 (002)	Meets WQ criteria and permit limits
Arsenic, chromium, lead, mercury, nickel, selenium, and zinc	See Attachment A	See Attachment A	Effluent is non-detect or below ambient concentrations

Part E. Alternative Analysis Requirements of a Level II Antidegradation Review.

Level II ADRs require the applicant to determine whether there are feasible less-degrading alternatives to the proposed project. More information is available in Section 5.5 and 5.6 of the Implementation Guidance.

E1. The UPDES permit is being renewed without any changes to flow or concentrations. Alternative treatment and discharge options including changes to operations and maintenance were considered and compared to the current processes. No economically feasible treatment or discharge alternatives were identified that were not previously considered for any previous antidegradation review(s).

☐ **Yes** (Proceed to Part F)

☒ **No or Does Not Apply** (Proceed to E2)

E2. Attach as an appendix to this form a report that describes the following factors for all alternative treatment options (see 1) a technical description of the treatment process, including construction costs and continued operation and maintenance expenses, 2) the mass and concentration of discharge constituents, and 3) a description of the reliability of the system, including the frequency where recurring operation and maintenance may lead to temporary increases in discharged pollutants. Most of this information is typically available from a Facility Plan, if available.

Report Name: *Antidegradation Review and Statement of Social, Environmental, and Economic Importance: Trail Mountain Mine*

E3. Describe the proposed method and cost of the baseline treatment alternative. The baseline treatment alternative is the minimum treatment required to meet water quality based effluent limits (WQBEL) as determined by the preliminary or final wasteload analysis (WLA) and any secondary or categorical effluent limits.

E4. Were any of the following alternatives feasible and affordable?

Alternative	Feasible	Reason Not Feasible/Affordable
Pollutant Trading	Yes	
Water Recycling/Reuse	No	Mine uses no water
Land Application	No	Suitable land is not available near the mine
Connection to Other Facilities	No	No treatment capacity or suitable processes are available
Upgrade to Existing Facility	Yes	
Total Containment	Yes	
Improved O&M of Existing Systems	No	Mine drain is passive system
Seasonal or Controlled Discharge	No	Mine operation requires year round discharge
New Construction	Yes	
No Discharge	No	Mine operation requires water discharge

E5. From the applicant's perspective, what is the preferred treatment option?

Outfall 001 sedimentation pond, Outfall 002 in-mine sedimentation

E6. Is the preferred option also the least polluting feasible alternative?

☐ **Yes**

☒ **No**

If no, what were less degrading feasible alternative(s)? **See Attachment A**

If no, provide a summary of the justification for not selecting the least polluting feasible alternative and if appropriate, provide a more detailed justification as an attachment.

See Attachment A

Part F. Optional Information

F1. Does the applicant want to conduct optional public review(s) in addition to the mandatory public review? Level II ADRs are public noticed for a thirty day comment period. More information is available in Section 3.7.1 of the Implementation Guidance.

☒ **No**

☐ **Yes**

F2. Does the project include an optional mitigation plan to compensate for the proposed water quality degradation?

☒ **No**

☐ **Yes**

Report Name: ☐

Part G. Certification of Antidegradation Review

G1. Applicant Certification

The form should be signed by the same responsible person who signed the accompanying permit application or certification.

Based on my inquiry of the person(s) who manage the system or those persons directly responsible for gathering the information, the information in this form and associated documents is, to the best of my knowledge and belief, true, accurate, and complete.

Print Name: Rick Poulson

Signature: [signature]

Date: 11-15-2013

G2. DWQ Approval

To the best of my knowledge, the ADR was conducted in accordance with the rules and regulations outlined in UAC R-317-2-3.

Water Quality Management Section

Print Name: NICHOLAS VON STACKELBERG

Signature: [signature]

Date: 11/19/13

Errata sheet for ADR Application Form
Trail Mountain Mine

Response to Item E.3 – See Attachment A

Attachment A

Antidegradation Review and Statement of Social, Environmental, and Economic Importance: Trail Mountain Mine

Prepared for

Utah Division of Water Quality on behalf of Energy West Mining Company

November 2013

Prepared by

CH2MHILL

215 South State Street, Suite 1000
Salt Lake City, Utah 84111

Attachment A

Antidegradation Review and Statement of Social, Environmental, and Economic Importance: Trail Mountain Mine

Submitted to

Utah Division of Water Quality on behalf of Energy West Mining Company

November 2013

CH2MHILL.

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Appendix

Acronyms and Abbreviations

µg/L	microgram per liter
ADR	antidegradation review
C&D	construction and demolition
CFR	*Code of Federal Regulations*
CWA	Clean Water Act
EPA	U.S. Environmental Protection Agency
ft^3	cubic feet
kW	kilowatt
lb/d	pound per day
lb/yr	pound per year
lb-eq/yr	pound equivalent per year
LS	lump sum
mg/L	milligram per liter
mgd	million gallons per day
MW	megawatt
NAAQS	National Ambient Air Quality Standards
O&M	operation and maintenance
POC	parameter of concern
POTW	publicly owned treatment works
RO	reverse osmosis
SEEI	Social, Environmental, and Economic Importance
TDS	total dissolved solids
TRC	total residual chlorine
TSS	total suspended solids
TWF	toxic weighting factor
UAC	Utah Administrative Code
UDWQ	Utah Division of Water Quality
UPDES	Utah Pollutant Discharge Elimination System
ZLD	zero liquid discharge

1.0 Introduction and Purpose

Energy West Mining Company (Energy West), a subsidiary of PacifiCorp, owns the Trail Mountain Mine, located about 12 miles west of Orangeville, Utah. Since mining was suspended in 2001, the mine portals have been sealed and there has been no mining activity or personnel on site.

Energy West has a Utah Pollution Discharge Elimination System (UPDES) permit to discharge to Cottonwood Canyon Creek, a tributary to Cottonwood Creek, from its Trail Mountain Mine. UPDES Permit Number UT0023728 was renewed to PacifiCorp – Energy West Mining Company in 2007 and expired on December 31, 2012. PacifiCorp's application for reissuance was submitted in a timely manner in early 2012, by its wholly-owned subsidiary Energy West Mining Company. Energy West anticipates reissuance activity by the Utah Division of Water Quality (DWQ) in 2013.

In accordance with UAC R317-2-3, an antidegradation review (ADR) is a permit requirement for any project that will increase the level of pollutants in waters of the State. It is considered one of the first steps in obtaining a new or revised UPDES permit. In this case, Energy West does not anticipate such an increase for its upcoming permit reissuance. However, Cottonwood Creek is classified as a 1C water body, and DWQ requested that Energy West prepare a Level II evaluation for use during the permitting process. The discharge also enters a Category 1 stream segment of Cottonwood Canyon Creek. However, the discharge is a grandfathered flow, since the outfalls were permitted before 1982 and existed before the rule establishing Category 1 waters was promulgated in February 1994. The January 1982 public notice for the Trail Mountain NPDES permit renewal was previously provided to DWQ to document that the discharge was permitted before February 1994.

A Level II ADR review is intended to review the permitted discharge to ensure that the project is both economically and socially important to local and regional communities and that feasible treatment alternatives have been analyzed. This *Antidegradation Review and Statement of Social, Environmental, and Economic Importance: Trail Mountain Mine* (Attachment A) is intended to supplement the information being provided by Energy West in the Level II ADR application. Specifically, it identifies the parameters of concern (POCs) for the mine effluent, identifies and analyzes feasible treatment alternatives, and provides a justification for the determination that the facility is socially and economically necessary for the local and regional communities.

2.0 Project Description

2.1 Site and Facility Description

The Trail Mountain Creek Mine is located on the eastern edge of the Wasatch Plateau Coal Field, about 12 miles west of Orangeville, Utah. During operation, coal was transferred by beltline through the Cottonwood/Wilberg Mine to surface loading facilities located in Grimes Wash. The coal was loaded into trucks and hauled to the Hunter Power Plant. The mine encompasses approximately 3,500 acres with a combination of fee, federal, and state leases. The longwall method of mining produced about 4 million tons of coal annually before the mining stopped in 2001 and the mine was sealed.

The UPDES permit for the Trail Mountain Mine authorizes discharge from two outfalls: 1) Outfall 001 is a discharge from a sedimentation pond which treats surface water runoff from the mine site, and 2) Outfall 002 discharges groundwater from the mine. Both outfalls discharge to the Cottonwood Canyon Creek drainage upstream of its confluence with Cottonwood Creek. Cottonwood Canyon Creek above the mine outfalls is an ephemeral stream. Neither outfall has discharged since 2001. Water quality characteristics of the discharges relative to background quality in Cottonwood Canyon Creek and Cottonwood Creek are lower quality due to their total dissolved solids concentration. The mines in the coal fields of the Wasatch Plateau tend to act as interceptor drains. The groundwater that is brought to the surface has a lower dissolved solids content than would have occurred were the water to continue its downward movement through the shale layers, dissolving increased amounts of salt with distance (Danielson, 1981)[1]. Because the outfalls contains elevated TDS, it has been determined[2] that degradation of Cottonwood Canyon Creek water quality could occur with continued discharge, and therefore that this POC analysis and subsequent ADR should focus on water quality in Cottonwood Canyon Creek and Cottonwood Creek.

[1] Danielson, T.W., Remillard, M.D., Fuller, R.H., Hydrology of the Coal Resource Areas in the Upper Drainages of Huntington and Cottonwood Creeks, Central Utah, U.S. Geological Survey Water Resource Investigations, Open-file Report 81-539.

[2] This was determined in the September 13, 2012 ADR meeting between Energy West and DWQ in DWQ's Salt Lake City office.

3.0 Identification of the Parameters of Concern

As per Utah Administrative Code (UAC) R317-2.3.5, both Level I and Level II anti-degradation reviews (ADRs) are to be conducted on a "parameter-by-parameter basis." An important component of the ADR process is for the applicant and the Utah Division of Water Quality (UDWQ) to agree on the parameters of concern (POCs) for a wastewater discharge. The following technical memorandum provides a list of the parameters that were considered as potential POCs for the Trail Mountain Mine and the screening process that was used to select the POCs for the Trail Mountain Mine ADR analysis.

3.1.1 Selection of Potential POCs

Section 4.0 of the *Utah Antidegradation Reviews: Implementation Guidance, Version 1.1* (dated May 2012) (*ADR Implementation Guidance*) provides six considerations that should be addressed when an applicant is considering what pollutants to consider as potential POCs. The primary source of pollutants that must be considered is the list of priority pollutants provided in the EPA Form 2C – Application for Permit to Discharge Wastewater. Based on the nature of operations at underground coal mines such as Trail Mountain Mine, the facility has the potential to discharge priority pollutants in its effluent. Applicable technology based standards for Coal Mining-Alkaline Mine Drainage are found in 40 CFR 434 Subpart D, and establish effluent limits for pH, total iron, and total suspended solids (TSS). These parameters have been included in the list of potential POCs to be considered for the Trail Mountain Mine ADR analysis. In addition to using the list of priority pollutants, the *ADR Implementation Guidance* also recommends that the following factors be considered when selecting pollutants to screen as potential POCs:

1. *Are there any parameters in the effluent or expected to be in the effluent that exceed ambient concentrations in the receiving water?* Ambient water quality data for Cottonwood Creek upstream of the confluence with Grimes Wash that was collected within the past 10 years was reviewed. These data are compared to Trail Mountain Mine effluent data in Table 3-1. Since the mine is inactive, historical data were used for Outfall 001 and 002. Metals data for the mine potable water supply, which was supplied by the mine water discharged through Outfall 002, was also reviewed and compared to data for Cottonwood Creek.

2. *Is the parameter/pollutant already included in an existing UPDES permit?* The existing Trail Mountain Mine UPDES permit contains limits for the following parameters at Outfall 001 and 002:

   - pH, total iron, oil & grease, total suspended solids (TSS), and total dissolved solids (TDS).

3. *Are parameter concentrations and/or loads exceeding or projected to exceed the current permitted load or design basis?* Wastewater effluent from the Trail Mountain Mine is not expected to exceed the current permit limits. No increases in plant capacity are planned for the permit duration.

4. *Are there any parameters that are considered to be important by UDWQ or the general public? For instance, nutrients or bioaccumulative compounds?* To Energy West's knowledge, there are no parameters/pollutants that have been identified as "important" through public comment or other public input forums for discharges to Cottonwood Creek. TDS is a POC under the Colorado River Salinity Control Forum.

5. *Are there any parameters in the effluent that are known to potentially degrade the beneficial uses of the receiving water?* Yes, there are several parameters in the Trail Mountain Mine effluent discharge that have the potential to degrade the existing beneficial uses of Cottonwood Creek, including TSS and TDS. Groundwater pumped from the mine also has a lower TDS concentration than would occur were the water to continue down through the shale layers and eventually discharge to the surface.

6. *Is the receiving water listed as impaired for any parameters?* No.

Based on the above-referenced considerations, the following list of preliminary parameters/pollutants was established as potential POCs for further consideration in the Trail Mountain Mine ADR analysis:

1) Total Suspended Solids
2) Totals Dissolved Solids
3) Oil & Grease
4) Iron
5) pH
6) Temperature
7) Metals (As, Cd, Cr, Cu, Pb, Hg, Ni, Se, Zn)

3.1.2 Selection of Final POCs for ADR Analysis

The criteria listed in Section 3.1 of the *ADR Implementation Guidance* are used to screen the large number of potential parameters/pollutants that may be present in the facility's wastewater effluent to develop a preliminary list of potential POCs that must be considered for the Trail Mountain Mine ADR analysis. To select the final POCs to be incorporated into the Trail Mountain Mine ADR analysis from the list of potential parameters listed above, Section 4.0 of the *ADR Implementation Guidance* indicates that "only parameters in the discharge effluent that exceed, or potentially exceed, ambient concentrations [in the receiving water body] should be considered".

Table 3-1 below provides a summary of the preliminary list of POCs that were considered and whether or not each potential POC was selected as a final POC for the Trail Mountain Mine ADR analysis. The final POCs identified in Table 3-1 will be used to aid in the selection of effluent treatment and discharge alternatives that will be analyzed in detail in the final ADR analysis. In addition, the POCs will also be used by UDWQ as a factor in evaluating the potential effects on Cottonwood Canyon Creek and Cottonwood Creek from the discharge and in their renewal of the UPDES permit for the facility.

TABLE 3-1
Summary of Final POCs for the Trail Mountain Mine ADR Analysis
Energy West Trail Mountain Mine

Potential POC Being Considered	Cottonwood Creek above Grimes Wash (average 2002 – 2008)[1]	Cottonwood Canyon Creek, 1 mile above Outfall 001 (average 2007-2012)[2]	Outfall 001 – Sedimentation Pond Discharge (average 1996 – 2000)	Outfall 002 – Mine Discharge (average 1997 – 2001)	Final Parameter of Concern (Yes/No)	Rationale
1. Total Suspended Solids (mg/L)	56[3]	19	28	11	**Yes**	Current permit limit
2. Total Dissolved Solids (mg/L)	292	547	2262	936	**Yes**	Current permit limit
3. Oil & Grease (mg/L)	No data[4]	Non-detect	7	2	**Yes**	Current permit limit
4. pH (s.u.)	6.6 – 8.8	7.6 – 8.5	7.6 – 8.4	7.8 – 8.5	No	Effluent within permit limits and meet WQ criteria
5. Iron, Total (mg/L)	0.010[5]	0.31	0.54	0.55	**Yes**	Current permit limit
6. Temperature (C)	9.8	12.3	6.1	13.2	No	Temperature <1 C above upstream segment temperature
7 Arsenic (mg/L)	Non-detect[6]	<0.01	No data[4]	<0.002[9]	No	Not detected
8 Cadmium (mg/L)	Non-detect[6]	<0.001	No data[4]	0.0028	**Yes**	Above ambient
9 Chromium (mg/L)	0.006	No data[4]	No data[4]	<0.006[9]	No	Not detected
10 Copper (mg/L)	<0.0012[7]	<0.01	No data[4]	0.034	**Yes**	Above ambient
11 Lead (mg/L)	Non-detect[6]	<0.01	No data[4]	<0.0025[9]	No	Not detected
12 Mercury (mg/L)	Non-detect[6]	No data[4]	No data[4]	<0.00008[9]	No	Not detected
13 Nickel (mg/L)	Non-detect[6]	No data[4]	No data[4]	0.024	No	Below aquatic WQ criteria
14 Selenium (mg/L)	Non-detect[6]	No data[4]	No data[4]	<0.0027[9]	No	Not detected

TABLE 3-1
Summary of Final POCs for the Trail Mountain Mine ADR Analysis
Energy West Trail Mountain Mine

Potential POC Being Considered	Cottonwood Creek above Grimes Wash (average 2002 – 2008)[1]	Cottonwood Canyon Creek, 1 mile above Outfall 001 (average 2007-2012)[2]	Outfall 001 – Sedimentation Pond Discharge (average 1996 – 2000)	Outfall 002 – Mine Discharge (average 1997 – 2001)	Final Parameter of Concern (Yes/No)	Rationale
15 Zinc (mg/L)	<0.017[8]	0.004	No data[4]	No data[4]	No	No data

1. Utah DWQ Station ID 4930950 (sampling location is at the Utah Highway 57 bridge and Cottonwood Creek.)
2. Energy West surface water monitoring location
3. Average of reported values for 7 samples and half of the estimated reporting limit (0.5 x 4 mg/L) for 9 samples.
4. No monitoring data within the last 10 years.
5. Results reported as dissolved iron. Average of reported values for 2 samples, and half of the estimated reporting limit (0.5 x 5 µg/L) for 4 samples.
6. Results reported as dissolved metals and no reporting limit was provided.
7. One result of 0.0012 mg/L dissolved copper and five non-detect samples with no reporting value provided.
8. One result of 0.017 mg/L dissolved zinc and five non-detect samples with no reporting value provided.
9. Data from mine potable water supply (2000-2001).

4.0 Alternatives Analysis

Energy West has submitted a request to renew the UPDES permit for the Trail Mountain Mine. The existing UPDES permit includes two discharge points, Outfalls 001 and 002. Outfall 001 is a discharge from a sedimentation pond which treats surface water runoff from the mine site, and Outfall 002 discharges groundwater pumped out of the mine.

The intent of this section is to evaluate whether there are any reasonable nondegrading or less degrading alternatives when compared with the discharge alternative for handling of water from the Trail Mountain Mine. The section provides an initial screening of potential alternatives based on their feasibility followed by a detailed screening of those alternatives deemed feasible based on their total financial costs, pollution/POC reduction, and performance based on several criteria, including reliability, operability, maintainability, sustainability, and adaptability to future regulatory changes. The analysis is followed by identification of Energy West's preferred treatment alternative and the justification for selection of that treatment alternative.

4.1 Initial Screening of Alternatives

The requirements found in UAC R317-2-3.5 stipulate the following alternatives should be considered, evaluated, and implemented to the extent feasible:

a) Innovative or alternative treatment options

b) More effective treatment options or higher treatment levels

c) Connection to other wastewater treatment facilities

d) Process changes or product or raw material substitution

e) Seasonal or controlled discharge options to minimize discharging during critical water quality periods

f) Pollutant trading

g) Water conservation

h) Water recycle and reuse

i) Alternative discharge locations or alternative receiving water bodies

j) Land application

k) Total containment

l) Improved operation and maintenance (O&M) of existing treatment systems

m) Other appropriate alternatives

Section 5.2 of the Implementation Guidance indicates that the feasibility of all treatment alternatives should be examined before the alternatives are included for further consideration as part of the ADR analysis. Based on this requirement, many of the alternatives listed in UAC R317-2-3.5 can be excluded from further consideration as part of this ADR analysis based on their impracticality or inability to be implemented at the Trail Mountain Mine. The following are treatment alternatives from the above list that are excluded from further consideration along with the justifications for exclusion:

- **Alternative B – Higher treatment levels**: Ion exchange and reverse osmosis are demonstrated treatment processes for removing TDS from effluent. However, these processes concentrate the salt ions into a reverse osmosis membrane reject stream or an ion exchange resin regeneration brine, and do not reduce the mass of TDS requiring discharge to surface or disposal by other methods. Due the cost and complexity of managing reject and regeneration wastes, higher level treatment processes were not considered further.
- **Alternative C—Connection to other wastewater treatment facilities:** The Castle Valley Special Service District operates a sanitary wastewater treatment facility near Castle Dale, UT, which is the only wastewater treatment works facility located in proximity to the Trail Mountain Mine. The District's treatment system does not have the capacity or the treatment technology to effectively handle the wastewater flow.
- **Alternative D—Process changes or product or raw material substitution:** The Trail Mountain Mine is an underground coal mine. Outfall 001 is required to manage surface runoff from the mine site. Outfall 002 is required to manage water levels within the mine and maintain safe working conditions.
- **Alternative E—Seasonal or controlled discharge options:** Water cannot be stored within the mine. Year-round discharges are required to maintain safe working conditions. Limiting the retention time in the sedimentation pond is necessary to reduce TDS increase from the local geology
- **Alternative G—Water conservation:** The primary uses of water at the mine are dust control, area cleanup, and potable water supply. The discharges result from surface runoff and groundwater intercepted by the underground mine workings. Neither source of discharge is controllable. There are no practical options for further water conservation at the mine.
- **Alternative I—Use of alternative discharge locations or alternative receiving water bodies:** The only receiving water body in proximity to the Trail Mountain Mine is Cottonwood Canyon Creek.
- **Alternative J—Land application:** The facility is located in a relatively narrow canyon and property suitable for an effluent storage pond and land application sprays fields is not available.
- **Alternative L—Improved operation and maintenance of existing treatment systems:** Not applicable. Outfall 002 relies on sedimentation in mine pools to remove TSS and iron, and does not have the capability to remove TDS.

After excluding these treatment alternatives deemed infeasible from further consideration, the following alternatives listed in UAC R317-2-3.5 are being carried forward for further analysis as part of this ADR:

Outfall 001 – Sedimentation Pond

- **Baseline Alternative for Comparison Purposes (hereafter referred to as Outfall 001 Alternative 1):** The existing sedimentation pond is the baseline alternative for comparison and evaluation of feasible treatment alternatives.
- **Alternative A – Alternative treatment option (hereafter referred to as Outfall 001 Alternative 2):** Oleophilic media and greensand filtration is carried forward for evaluation as an alternative to the existing sedimentation pond.
- **Alternative F—Pollutant trading:** The discharge is located within the Colorado River basin, and is subject to the Colorado River Basin Salinity Control Forum's policies for TDS. The Forum policy allows permitting authorities to allow industrial sources of salinity to conduct or finance salinity offset projects. Purchasing salinity offsets is a potential alternative to reduce the TDS discharge from the entire Trail Mountain Mine site. However, the Outfall 001 TDS discharge is <1 ton per day (tpd), and salinity credits are not available for this outfall.
- **Alternative K—Total containment (hereafter referred to as Outfall 001 Alternative 4):** Options for total containment include an evaporation pond, deep well injection, and thermal evaporation using a mechanical concentrator and crystallizer. However, the construction of holding or evaporation ponds or other containment structures would require about 100 acres of suitable, undeveloped land to operate effectively. Based on the rugged topography surrounding the mine site and limited undeveloped areas with moderate slopes, total containment using evaporation ponds is not considered for the Trail Mountain Mine.

  Total containment using deep well injection is used at some locations to dispose of effluent streams. However, the geology and hydrogeology is not well known at the depth and area of interest for the Trail Mountain Mine site, and the risks associated with siting, permitting, and drilling a successful well are high. The cost of installing an injection well is difficult to determine, but an estimate for drilling the injection well and associated monitoring well is $600,000 or more. Well completion and injection pumps would increase the capital cost to over $2 million. Total containment using an injection well is not considered for the Trail Mountain Mine.

  A mechanical concentrator and crystallizer treatment system is being carried forward for evaluation as an alternative to the existing sedimentation pond.

Outfall 002 – Mine Discharge

- **Baseline Alternative for Comparison Purposes (hereafter referred to as Outfall 002 Alternative 1):** The existing in-mine sedimentation is the baseline alternative for comparison and evaluation of feasible treatment alternatives.

- **Alternative A – Alternative treatment option (hereafter referred to as Outfall 002 Alternative 2):** Oleophilic media and greensand media filtration is carried forward for evaluation as an alternative to the existing in-mine sedimentation.
- **Alternative B – Higher treatment option (hereafter referred to as Outfall 002 Alternative 3):** Oleophilic media and greensand media filtration followed by enhanced alumina adsorptive media is carried forward for evaluation as an alternative to the existing in-mine sedimentation.
- **Alternative F—Pollutant trading (hereafter referred to as Outfall 002 Alternative 4):** The discharge is located within the Colorado River basin, and is subject to the Colorado River Basin Salinity Control Forum's policies for TDS. The Forum policy allows permitting authorities to allow industrial sources of salinity to conduct or finance salinity offset projects. Purchasing salinity offsets is a potential alternative to reduce the TDS discharge from the facility.
- **Alternative K—Total containment (hereafter referred to as Outfall 002 Alternative 5):** Options for total containment include an evaporation pond, deep well injection, and thermal evaporation using a mechanical concentrator and crystallizer. As discussed for Outfall 001, an evaporation pond and deep well injection are not feasible options at the Trail Mountain Mine. A mechanical concentrator and crystallizer treatment system is being carried forward for evaluation as an alternative to the existing in-mine sedimentation.

As mentioned previously, these alternatives will be analyzed and compared in detail in Section 4.2 and 4.3 based on several criteria, including the following:

- Construction and O&M costs
- Ability to minimize degradation and increase pollutant reduction
- Several performance criteria, including reliability, maintainability, operability, sustainability, and adaptability

4.2 Detailed Analysis of Feasible Alternatives Outfall 001

4.2.1 Alternative 1 – Existing Sedimentation Pond

Trail Mountain Mine has a sedimentation pond to remove TSS before discharge via Outfall 001. Accumulated solids are removed from the pond approximately every 2 years to maintain the pond's treatment capacity.

Alternative 1—Expected Pollutant Removal

Table 4-1 presents the estimated POC removal by the sedimentation pond. Some POCs have been weighted to reflect that their removal from the effluent is more critical than other POCs. The relative weight of each POC was determined using EPA toxic weighting factors (TWFs). In the majority of cases, TWFs are derived from both chronic freshwater aquatic criteria and human health criteria for consumption of fish. A higher TWF indicates a more toxic pollutant and thus a higher POC weight.

TABLE 4-1
Estimated Pollutant Removal by Outfall 001 Alternative 1 – Sedimentation Pond
Energy West Trail Mountain Mine

Parameter	Influent (mg/L)	Influent (lb/d)	Effluent (mg/L)	Effluent (lb/d)	Removal (lb/yr)	Removal	TWF	Removal (lb-eq/yr)
TSS	40	24	28	17	2,630	30%	-	-
TDS	2,262	1358	2,262	1358	0	0%	-	-
Oil & grease	7	4	7	4	0	0%		
Iron	0.55	0.3	0.54	0.3	2	2%	0.0056	0.01

NOTES:
lb/d = pound per day
lb/yr = pound per year
lb-eq/yr = equivalent toxics removal; mass removal in lb/yr multiplied by the toxic weighting factor (TWF)
mg/L = milligram per liter
Influent TSS = 40 mg/L is engineering estimate. Influent iron is based on Outfall 002 (mine water) iron data.
Mass loads are based on a flow of 72,000 gallons per day.
Toxic weighting factors from EPA-HQ-OW-2004-0032-0853.

Alternative 1—Cost Analysis

The estimated construction cost for a 3,600 cubic yard sedimentation pond is $140,000. The estimated costs assume excavation of an unlined, earthen basin and spoil stockpiling on existing mine property. The sedimentation basin and other treatment alternatives will be located on existing mine property, and no land purchase costs are included in the capital cost estimates. The primary operating cost of the sedimentation pond is solids removal every 2 years. The estimated annualized cost of pond cleaning and effluent monitoring is approximately $50,000/year.

4.2.2 Alternative 2 – Oleophilic Media and Greensand Filtration

Oleophilic media filters are proposed to remove oil and grease from the pond effluent. Although Outfall 001 achieves the current TSS and iron limits, greensand filters are proposed to reduce the effluent TSS and iron concentrations. Greensand filter media promotes oxidation of dissolved iron, and then removes the particulate iron and TSS similar to a conventional granular media filter. An oleophilic media and greensand filter system includes the following equipment:

- Influent pumps
- Oleophilic media filters
- Greensand media filters
- Oxidant feed system
- Backwash holding tank

The filtration system would be installed at the outlet of the existing sedimentation basin. A skid-mounted filter system with integral controls is possible, and would need to be installed in a building to provide freeze protection.

Alternative 2—Expected Pollutant Removal

Table 4-2 presents the estimated POC removal provided by oleophilic media and greensand filtration.

TABLE 4-2
Estimated Pollutant Removal by Outfall 001 Alternative 2 – Oleophilic Media and Greensand Filtration
Energy West Trail Mountain Mine

Parameter	Influent (mg/L)	Influent (lb/d)	Effluent (mg/L)	Effluent (lb/d)	Removal (lb/yr)	Removal	TWF	Removal (lb-eq/yr)
TSS	40	24	4	2.4	7,890	90%	-	-
TDS	2,262	1,358	2,262	1,358	0	0%	-	-
Oil & grease	7	4	1	1	1,315	86%	-	-
Iron	0.55	0.3	0.05	0.03	110	91%	0.0056	0.6

NOTES:
lb/d = pound per day
lb/yr = pound per year
lb-eq/yr = equivalent toxics removal; mass removal in lb/yr multiplied by the toxic weighting factor (TWF)
mg/L = milligram per liter
Influent TSS = 40 mg/L is engineering estimate. Influent iron is based on Outfall 002 (mine water) iron data.
Mass loads are based on an average flow of 72,000 gallons per day.
Toxic weighting factors from EPA-HQ-OW-2004-0032-0853.

Oleophilic media is commonly used for industrial wastewater treatment and is effective for removing low concentrations of oil and grease. Greensand filtration is commonly used in municipal and industrial water treatment systems and is effective for iron and TSS removal and meeting effluent limits. However, greensand filtration will not remove TDS. With proper maintenance and operator training, the reliability of a filtration system is high.

Alternative 2—Cost Analysis

The estimated total installed cost for a 50 gpm effluent oleophilic media and greensand filtration system is $700,000. The cost estimate worksheet is presented in the Appendix. Table 4-3 presents the estimated annual O&M costs and annualized capital cost for the filtration alternative. These annual costs are in addition to the current sedimentation basin O&M costs.

TABLE 4-3
Total Annualized Cost for Outfall 001 Alternative 2—Oleophilc Media and Greensand Filtration
Energy West Trail Mountain Mine

Item	Quantity	Cost
Labor	730 hours/year	$36,500
Laboratory analysis	LS	$2,800
Electricity	10 kW	$4,400
Media replacement	10,000 lbs	$20,000
Spent media disposal	6 tons	$1,200
Maintenance	3% of equipment cost	$4,500
Annual Total O&M Cost		**$69,400**
Cost of capital	$700,000 at 7% over 20 years	$66,100
Total Annualized Cost		**$135,500**

NOTES:
kW = kilowatt
LS = lump sum

4.2.3 Alternative 3: Total Containment

Total containment can be provided using a system consisting of media filtration pretreatment, reverse osmosis (RO) to concentrate the wastewater and evaporative crystallization of the RO concentrate. This process is a zero liquid discharge (ZLD) system; water is recovered for reuse or discharged, and salt is dried. The RO permeate and condensate from the crystallizer can be returned to the process. Salt cake is disposed of in an offsite landfill.

The following processes are included in the ZLD system:

- Influent pumps
- Granular media pressure filters
- Reverse osmosis system
- Chemical feed systems
- Membrane clean-in-place systems
- Mechanical recompression brine crystallizer
- Salt cake filter press
- Brine equalization tank

The cost estimate in Appendix A presents the size or capacity of major equipment.

Alternative 3—Expected Pollutant Removal

Table 4-4 presents the estimated POC removal provided by a ZLD system.

TABLE 4-4
Estimated Pollutant Removal by Outfall 001 Alternative 3 – Zero Liquid Discharge
Energy West Trail Mountain Mine

Parameter	Influent (mg/L)	Influent (lb/d)	Effluent (mg/L)	Effluent (lb/d)	Removal (lb/yr)	Removal	TWF	Removal (lb-eq/yr)
TSS	40	24	0	0	8,767	100%	-	-
TDS	2,262	1,358	25	15	490,295	99%	-	-
Oil & grease	7	4	0	0	1,534	100%		
Iron	0.55	0.3	0	0	121	100%	0.0056	0.7

NOTES:
lb/d = pound per day
lb/yr = pound per year
lb-eq/yr = equivalent toxics removal; mass removal in lb/yr multiplied by the toxic weighting factor (TWF)
mg/L = milligram per liter
Influent TSS = 40 mg/L is engineering estimate. Influent iron is based on Outfall 002 (mine water) iron data.
Mass loads are based on an average flow of 72,000 gallons per day.
Toxic weighting factors from EPA-HQ-OW-2004-0032-0853.

A ZLD system provides the highest level of treatment and eliminates the liquid discharge from the facility. However, a ZLD system is a complex treatment system and has significantly higher capital and operating costs than other treatment options. In addition, the ZLD system requires a significant amount of power for operation and steam for start-up. The ZLD unit processes are reliable, and the processes are currently used at other mines and electric generating facilities to manage high TDS streams. Zero liquid discharge systems are typically used when no surface water bodies are available to accept an effluent discharge.

Alternative 3—Cost Analysis

The estimated total installed cost for a ZLD system is $8,990,000. The cost estimate worksheet is presented in the Appendix. Table 4-5 presents the estimated annual O&M costs and annualized capital cost for this alternative based on a flow of 50 gpm.

TABLE 4-5
Total Annualized Cost for Outfall 001 Alternative 3—Zero Liquid Discharge
Energy West Trail Mountain Mine

Item	Quantity	Cost
Labor	5,840 hours/year	$292,000
Laboratory analysis	LS	$25,000
Electricity	275 kW	$120,500
Maintenance	3% of equipment cost	$58,100
Membrane Replacement	Escrow for 5 yr replacement	$24,750
Chemicals	LS	$9,800
Solids disposal	400 tons/year	$30,000
Annual Total O&M Cost		**$560,150**
Cost of capital	$8,990,000 at 7% over 20 years	$848,600
Total Annualized Cost		**$1,408,750**

NOTES:
LS = lump sum
MW = megawatt

4.3 Detailed Analysis of Feasible Alternatives Outfall 002

4.3.1 Alternative 1 – Existing Mine Pool Sedimentation

Sedimentation pools within the mine are used to remove iron and TSS before pumping to the surface and discharge via Outfall 002. A network of pumps and discharge pipes are used to intercept groundwater and control the water levels in the mine. Energy West strategically selects abandoned mine workings to provide adequate storage volume to achieve a minimum retention time to allow for the settling of solids particles in intercepted groundwater. Intercepted groundwater is collected through a series of submersible pumps discharging into an underground pipe network. Collected groundwater is pumped into the abandoned mine workings that retain it for at least 24 hours. This time frame allows suspended sediment to settle prior to discharging to the surface drainage. All discharged groundwater is metered and recorded at Outfall 002.

Alternative 1—Expected Pollutant Removal

Table 4-6 presents the estimated POC removal by in-mine sedimentation. Some POCs have been weighted to reflect that their removal from the effluent is more critical than other POCs. The relative weight of each POC was determined using EPA toxic weighting factors (TWFs). In the majority of cases, TWFs are derived from both chronic freshwater aquatic criteria and human health criteria for consumption of fish. A higher TWF indicates a more toxic pollutant and thus a higher POC weight.

TABLE 4-6
Estimated Pollutant Removal by Outfall 002 Alternative 1 – In-mine Sedimentation
Energy West Trail Mountain Mine

Parameter	Influent (mg/L)	Influent (lb/d)	Effluent (mg/L)	Effluent (lb/d)	Removal (lb/yr)	Removal	TWF	Removal (lb-eq/yr)
TSS	25	90	11	40	18,411	56%	-	-
TDS	936	3,372	936	3,372	0	0%	-	-
Oil & grease	2	7	2	7	0	0%		-
Iron	1	3.6	0.55	2.0	592	45%	0.0056	3.3
Cadmium	0.0028	0.010	0.0028	0.010	0	0%	2.6	0
Copper	0.034	0.122	0.034	0.122	0	0%	0.63	0

NOTES:
lb/d = pound per day
lb/yr = pound per year
lb-eq/yr = equivalent toxics removal; mass removal in lb/yr multiplied by the toxic weighting factor (TWF)
mg/L = milligram per liter
Influent TSS = 25 mg/L and influent iron = 1 mg/L are engineering estimates.(In-mine influent has not been sampled for results listed)
Mass loads are based on an average flow of 432,000 gallons per day.
Toxic weighting factors from EPA-HQ-OW-2004-0032-0853.

The quantity and quality of groundwater pumped from the mine varies based on geology and groundwater conditions in areas with active mining operations. Maintaining the water levels required to conduct safe mine operations does not allow selective pumping of low TDS water sources, and the in-mine sedimentation pools cannot be managed to reduce the TDS concentration in the mine drainage.

Alternative 1—Cost Analysis

The estimated capital costs for the in-mine pumping system is $220,000. The system includes pumps to transfer intercepted groundwater to the sedimentation pool, pumps connecting the sedimentation pool to Outfall 002, and associated piping. The primary operating cost of the sedimentation pools is electricity to operate the pumps and pump maintenance. The estimated annualized cost of sedimentation pool operation is approximately $100,000/year.

4.3.2 Alternative 2 – Oleophilic Media and Greensand Filtration

Although Outfall 002 achieves the current TSS and iron limits, greensand filters are proposed to reduce the effluent TSS and iron concentrations. Greensand filter media promotes oxidation of dissolved iron, and then removes the particulate iron and TSS similar a conventional granular media filter. A greensand filter system includes the following equipment:

- Influent pumps
- Oleophilic media filters
- Greensand media filters
- Oxidant feed system
- Backwash holding tank

The filtration system would be installed at the outlet of the existing mine discharge. A skid-mounted filter system with integral controls is possible, and would need to be installed in a building to provide freeze protection.

Alternative 2—Expected Pollutant Removal

Table 4-7 presents the estimated POC removal provided by oleophilic media and greensand filtration.

TABLE 4-7
Estimated Pollutant Removal by Outfall 002 Alternative 2 – Oleophilic Media and Greensand Filtration
Energy West Trail Mountain Mine

Parameter	Influent (mg/L)	Influent (lb/d)	Effluent (mg/L)	Effluent (lb/d)	Removal (lb/yr)	Removal	TWF	Removal (lb-eq/yr)
TSS	25	90	4	14	27,616	84%	-	-
TDS	936	3,372	936	3,372	0	0%	-	-
Oil & Grease	2	7	1	4	1,315	50%	-	-
Iron	1	3.6	0.05	0.2	1,249	95%	0.0056	7.0
Cadmium	0.0028	0.010	0.0028	0.010	0	0%	2.6	0
Copper	0.034	0.122	0.034	0.122	0	0%	0.63	0

NOTES:
lb/d = pound per day
lb/yr = pound per year
lb-eq/yr = equivalent toxics removal; mass removal in lb/yr multiplied by the toxic weighting factor (TWF)
mg/L = milligram per liter
Influent TSS = 25 mg/L and influent iron = 1 mg/L are engineering estimates. (In-mine influent has not been sampled for results listed)
Mass loads are based on an average flow of 432,000 gallons per day.
Toxic weighting factors from EPA-HQ-OW-2004-0032-0853.

Greensand filtration is commonly used in municipal and industrial water treatment systems and is effective for iron and TSS removal and meeting effluent limits. Oleophilic media is commonly used to remove oil and grease. However, neither greensand filtration nor oleophilic media will remove TDS. With proper maintenance and operator training, the reliability of a filtration system is high.

Alternative 2—Cost Analysis

The estimated total installed cost for an effluent greensand filtration system is $1,780,000. The treatment system is sized for a flow of 0.43 mgd. The cost estimate worksheet is presented in the Appendix. Table 4-8 presents the estimated annual O&M costs and annualized capital cost for the filtration alternative.

TABLE 4-8
Total Annualized Cost for Outfall 002 Alternative 2—Oleophilic Media and Greensand Filtration
Energy West Trail Mountain Mine

Item	Quantity	Cost
Labor	730 hours/year	$36,500
Laboratory analysis	LS	$5,000
Electricity	45 kW	$19,700
Media replacement	50,000 lbs	$100,000
Spent media disposal	30 tons	$3,000
Maintenance	3% of equipment cost	$11,300
Annual Total O&M Cost		**$175,500**
Cost of capital	$1,780,000 at 7% over 20 years	$168,000
Total Annualized Cost		**$343,500**

NOTES:
kW = kilowatt
LS = lump sum

4.3.3 Alternative 3: Greensand Filtration plus Oleophilic and Adsorptive Media

Greensand filters, oleophilic media, and enhanced alumina adsorption are proposed to reduce the effluent concentrations of TSS, oil and grease, iron, copper, and cadmium. Greensand filter media promotes oxidation of dissolved iron, and then removes the particulate iron and TSS similar to a conventional granular media filter. Enhanced alumina adsorption use proprietary media that bonds trace metals to its active sites and removes the constituent from the effluent. A filter and adsorption system includes the following equipment:

- Influent pumps
- Oleophilic media filters
- Greensand media filters
- Oxidant feed system
- Enhanced alumina adsorption vessels
- Backwash holding tank

The filtration and adsorption system would be installed at the outlet of the existing mine discharge. A skid-mounted pressure vessel system with integral controls is possible, and would need to be installed in a building to provide freeze protection.

Alternative 3—Expected Pollutant Removal

Table 4-9 presents the estimated POC removal provided by oleophilic media, greensand filtration and enhanced alumina adsorption.

TABLE 4-9
Estimated Pollutant Removal by Outfall 002 Alternative 3 – Greensand Filtration plus Oleophilic and Adsorption Media
Energy West Trail Mountain Mine

Parameter	Influent (mg/L)	Influent (lb/d)	Effluent (mg/L)	Effluent (lb/d)	Removal (lb/yr)	Removal	TWF	Removal (lb-eq/yr)
TSS	25	90	4	14	27,616	84%	-	-
TDS	936	3,372	936	3,372	0	0%	-	-
Oil & Grease	2	7	1	4	1,315	50%		
Iron	1	3.6	0.05	0.2	1,249	95%	0.0056	7.0
Cadmium	0.0028	0.010	0.001	0.004	2	64%	2.6	6.2
Copper	0.034	0.122	0.005	0.018	38	85%	0.63	24

NOTES:
lb/d = pound per day
lb/yr = pound per year
lb-eq/yr = equivalent toxics removal; mass removal in lb/yr multiplied by the toxic weighting factor (TWF)
mg/L = milligram per liter
Influent TSS = 25 mg/L and influent iron = 1 mg/L are engineering estimates. (In-mine influent has not been sampled for results listed)
Mass loads are based on an average flow of 432,000 gallons per day.
Toxic weighting factors from EPA-HQ-OW-2004-0032-0853.

Greensand filtration is commonly used in municipal and industrial water treatment systems and is effective for iron and TSS removal and meeting effluent limits. Oleophilic media and enhanced alumina have been demonstrated to remove oil and grease and metals, respectively. However, none of the treatment processes will remove TDS. With proper maintenance and operator training, the reliability of a filtration and adsorption system is high.

Alternative 3—Cost Analysis

The estimated total installed cost for an effluent greensand filtration system is $2,950,000. The treatment system is sized for a flow of 0.43 mgd. The cost estimate worksheet is presented in the Appendix. Table 4-10 presents the estimated annual O&M costs and annualized capital cost for the filtration alternative.

TABLE 4-10
Total Annualized Cost for Outfall 002 Alternative 3 – Greensand Filtration plus Oleophilic and Adsorption Media
Energy West Trail Mountain Mine

Item	Quantity	Cost
Labor	730 hours/year	$36,500
Laboratory	LS	$5,000
Electricity	50 kW	$21,900
Replacement Media	100,000 lbs	350,000
Spent Media Disposal	60 tons	6,000
Maintenance	3% of equipment cost	$16,200
Annual Total O&M Cost		**$435,600**
Cost of capital	$2,950,000 at 7% over 20 years	$278,500
Total Annualized Cost		**$714,100**

TABLE 4-10
Total Annualized Cost for Outfall 002 Alternative 3 – Greensand Filtration plus Oleophilic and Adsorption Media
Energy West Trail Mountain Mine

Item	Quantity	Cost

NOTES:
kW = kilowatt
LS = lump sum

4.3.4 Alternative 4: Salinity Offset Credits

Funding salinity offset projects is allowed under the permitting policy of the Colorado River Salinity Control Forum. The Forum's permitting policy indicates that salinity offset projects can be used in cases where it is not practical to: (i) prevent the discharge of all salt from proposed new construction; (ii) reduce the salt loading to the Colorado River to less than one ton per day; or (iii) when the proposed discharge exceeds the 500 mg/L TDS definition of "fresh water" for the receiving stream. Salinity offsets would be based on the TDS mass exceeding a 1 ton per day discharge. Using average TDS data for Outfall 002 and an effluent flow of 0.432 mgd, a credit of 0.7 tons per day is needed to meet the 1 ton per day TDS criterion.

Alternative 4—Expected Pollutant Removal

Salinity offset credits will not change the effluent quality discharged by the Trail Mountain Mine, but will reduce the salt discharge within the Cottonwood Creek basin. The proposed salinity offset is 0.7 tons per day, or 250 tons per year.

Alternative 4—Cost Analysis

DWQ staff indicated that the 2012 cost of salinity offset credits is $50/ton. Salinity offsets must be purchased for the entire five year UPDES permit duration at the beginning of the permit term. The cost of 0.7 ton per day salinity credit for five years is $62,500 or $12,500 per year. (It should be noted that the cost of Alternative 1 would be added to this cost because of the requirement of in-mine sedimentation would not be eliminated.)

4.3.5 Alternative 5: Total Containment

Total containment can be provided using a system consisting of media filtration pretreatment, reverse osmosis (RO) to concentrate the wastewater and evaporative crystallization of the RO concentrate. This process is a zero liquid discharge (ZLD) system; water is recovered for reuse or discharged, and salt is dried. The RO permeate and condensate from the crystallizer can be returned to the process. Salt cake is disposed of in an offsite landfill.

The following processes are included in the ZLD system:

- Influent pumps
- Granular media pressure filters
- Reverse osmosis system
- Chemical feed systems
- Membrane clean-in-place systems
- Mechanical recompression brine crystallizer

- Salt cake filter press
- Brine equalization tank

The cost estimate in Appendix A presents the size or capacity of major equipment.

Alternative 5—Expected Pollutant Removal

Table 4-11 presents the estimated POC removal provided by a ZLD system.

TABLE 4-11
Estimated Pollutant Removal by Outfall 002 Alternative 5 – Zero Liquid Discharge
Energy West Trail Mountain Mine

Parameter	Influent (mg/L)	Influent (lb/d)	Effluent (mg/L)	Effluent (lb/d)	Removal (lb/yr)	Removal	TWF	Removal (lb-eq/yr)
TSS	25	90	0	0	32,876	100%	-	-
TDS	936	3,372	25	90	1,198,012	97%	-	-
Oil & Grease	2	7	0	0	2,630	100%	-	-
Iron	1	3.6	0	0	1,315	100%	0.0056	7.4
Cadmium	0.0028	0.010	0	0	4	100%	2.6	9.6
Copper	0.034	0.122	0	0	45	100%	0.63	28

NOTES:
lb/d = pound per day
lb/yr = pound per year
lb-eq/yr = equivalent toxics removal; mass removal in lb/yr multiplied by the toxic weighting factor (TWF)
mg/L = milligram per liter
Influent TSS = 25 mg/L and influent iron = 1 mg/L are engineering estimates. (In-mine influent has not been sampled for results listed)
Mass loads are based on an average flow of 432,000 gallons per day.
Toxic weighting factors from EPA-HQ-OW-2004-0032-0853.

A ZLD system provides the highest level of treatment and eliminates the liquid discharge from the facility. However, a ZLD system is a complex treatment system and has significantly higher capital and operating costs than other treatment options. In addition, the ZLD system requires a significant amount of power for operation and steam for start-up. The ZLD unit processes are reliable, and the processes are currently used at other mines and electric generating facilities to manage high TDS streams. Zero liquid discharge systems are typically used when no surface water bodies are available to accept an effluent discharge.

Alternative 5—Cost Analysis

The estimated total installed cost for a ZLD system is $27,340,000. The treatment system is sized for a flow of 0.43 mgd. The cost estimate worksheet is presented in the Appendix. Table 4-12 presents the estimated annual O&M costs and annualized capital cost for this alternative.

TABLE 4-12
Total Annualized Cost for Outfall 002 Alternative 5—Zero Liquid Discharge
Energy West Trail Mountain Mine

Item	Quantity	Cost
Labor	5,840 hours/year	$292,000
Laboratory analysis	LS	$25,000
Electricity	700 kW	$306,600
Maintenance	3% of equipment cost	$188,000
Membrane Replacement	Escrow for 5 yr membrane life	$82.500
Chemicals	LS	$34,200
Solids disposal	730 tons/year	$54,800
Annual Total O&M Cost		**$983,100**
Cost of capital	$27,340,000 at 7% over 20 years	$2,580,700
Total Annualized Cost		**$3,563,800**

4.4 Cost of Achieving Effluent Reduction

To evaluate the cost effectiveness of treatment technologies, the EPA considers the cost per pound of toxic pollutant removed from effluent. Equivalent pounds of toxic pollutant are determined by multiplying the actual or estimated pounds removed by a toxic weighting factor (TWF). The equivalent pounds of pollutant removed are presented in the previous discussion of each treatment alternative. Once the equivalent pounds of pollutant removed have been determined, the incremental cost effectiveness of an option can be calculated as the incremental annual cost of the alternative divided by the incremental pounds-equivalent removed by that alternative as compared to the base case. TDS and TSS are also a POC selected for the ADR evaluation, and do not have an established TWF. Therefore, the treatment effectiveness was also evaluated based on the total mass removal for TDS and TSS.

Conceptual level unit process sizing and equipment selection was completed to support preparation of order-of-magnitude cost estimates for each treatment alternative. The cost estimates presented in Sections 4.2 & 4.3 are considered Class 5 estimates as defined by the Association for the Advancement of Cost Engineering, with actual costs not more than 100 percent or less than 50 percent of the estimated total value. Actual project costs will depend on the selected project scope, actual labor and material costs, competitive market conditions, actual site conditions, productivity, schedule, and other variables. As a result, the costs for these treatment alternatives will vary from the estimates prepared, within the stated accuracy range.

4.4.1 Outfall 001 Cost Effectiveness

Table 4-13 presents a summary of the cost effectiveness evaluation for the three treatment alternatives described for Outfall 001.

TABLE 4-13
Summary of Cost Effectiveness of Treatment Alternatives Outfall 001
Energy West Trail Mountain Mine

Item	Alt 1- Sedimentation Basin	Alt 2 – Oleophilic Media + Greensand Filters	Alt 3 - ZLD
Capital cost	$140,000	$700,000	$8,990,000
O&M ($/year)	$50,000	$119,400	$560,250
Total annualized cost ($/year)	$63,200	$185,500	$1,408,850
Incremental annualized cost ($/year)	$63,200	$122,300	$1,345,650
Removal (lb-eq/yr)	0.01	0.6	0.7
Incremental removal (lb-eq/yr)	0.01	0.59	0.69
Cost effectiveness ($/lb-eq removed)	$6,320,000	$207,288	$1,950,217
TDS Removal (tpy)	0	0	245
TDS Cost Effectiveness ($/ton TDS)	-	-	$5,492
TSS Removal (tpy)	1.32	3.95	4.38
Incremental TSS Removal (tpy)	1.32	2.63	3.06
TSS Cost Effectiveness ($/ton TSS)	$47,879	$46,502	$439,755

NOTES:
Incremental annualized cost and incremental removal are a comparison to the sedimentation basin alternative.

In developing categorical treatment standards for the metal product and machinery industries, the EPA compared the selected technologies by comparing their cost-per-pound equivalents with those of the previous industrial categories (EPA, 2000). These cost-effectiveness factors for the effluent limitation guidelines in various industrial categories are presented in Appendix A, converted from 1999 dollars to 2013 dollars, using the Construction Cost Index from *Engineering News-Record*. For comparison, the cost effectiveness used to select treatment technologies ranges from less than $3 per pound equivalent to $1097 per pound equivalent in 2013 dollars.

Table 4-13 presents the estimated cost-effectiveness for each of the treatment technologies reviewed in this report for removal of TSS, iron, oil and grease, and TDS from Outfall 001. By this analysis, the existing sedimentation basin has the lowest annualized cost. The cost effectiveness for each alternative on a pound equivalent basis is also significantly higher than the range established by EPA.

The cost effectiveness of TDS and TSS removal was also reviewed. Alternative 3 include provisions to reduce TDS discharges to the receiving water. The incremental capital cost and annual operating and maintenance cost a ZLD system is $8.99 million and $0.56 million per year, respectively. The incremental annualized cost for TDS removal is 2,100 percent (ZLD) higher than Alternative 1. The total annual cost for TDS removal in Alternative 3 is and $5,750 per pound of TDS. The incremental capital cost to remove TSS ranges from $700,000 for oleophilic media and greensand filtration to $8,990,000 for ZLD. The incremental annualized cost for TSS removal is 200 to 2,100 percent higher than Alternative 1.

As demonstrated, providing additional treatment to remove TSS, oil and grease, and iron provides limited improvement in the effluent quality and has a high incremental annual cost. The sedimentation basin alternative more than meets the State's guidance for cost-effective treatment and is the recommended treatment approach for the Trail Mountain Mine Outfall 001 based on costs considerations.

4.4.2 Outfall 002 Cost Effectiveness

Table 4-14 presents a summary of the cost effectiveness evaluation for the five treatment alternatives described for Outfall 002. Table 4-14 presents the estimated cost-effectiveness for each of the treatment technologies reviewed in this report for POC removal from Outfall 002. By this analysis, the existing sedimentation within the mine has the lowest annualized cost. The cost effectiveness for each alternative on a pound equivalent basis is also significantly higher than the range established by EPA, due to the low mass of toxic equivalents discharged by the outfall.

The cost effectiveness of TDS and TSS removal was also reviewed. Alternatives 4 and 5 include provisions to reduce TDS discharges the receiving water. The cost to purchase salinity credits is $12,500 per year. The incremental capital cost and annual operating and maintenance cost a ZLD system is $27.3 million and $1 million per year, respectively. The incremental annualized cost for TDS removal is 20 percent (salinity offsets) to over 2,850 percent (ZLD) higher than Alternative 1. The total annual cost for TDS removal in Alternative 4 and 5 is $50 and $5,950 per pound of TDS, respectively. The incremental capital cost to remove TSS ranges from $1.56 million for greensand filtration to over $27 million for ZLD. The incremental annualized cost for TSS removal is 260 percent (greensand filtration) to 2,850 percent (ZLD) higher than Alternative 1.

As demonstrated, providing additional treatment to remove POCs provides limited improvement in the effluent quality and has a high incremental annual cost. The current in-mine sedimentation alternative more than meets the State's guidance for cost-effective treatment and is the recommended treatment approach for the Trail Mountain Mine Outfall 002 based on costs considerations

TABLE 4-14
Summary of Cost Effectiveness of Treatment Alternatives Outfall 002
Energy West Trail Mountain Mine

Item	Alt 1 – In-Mine Sedimentation Pool	Alt 2 – Greensand Filters + Oleophilic Media	Alt 3 – Greensand + Oleophilic Media + Adsorption	Alt 4 – Salinity Offsets	Alt 5 - ZLD
Capital Cost	$220,000	$1,780,000	$2,950,000	$0	$27,340,000
O&M ($/yr)	$100,000	$275, 500	$535,600	$124,800	$983,100
Total annualized Cost ($/yr)	$120,800	$443,500	$814,100	$145,600	$3,563,800
Incremental annualized cost ($/yr)	$120,800	$322,700	$693,300	$24,800	$3,443,000
Removal (lb-eq/yr)	3.3	7.0	37.2	3.3	45.1
Incremental removal (lb-eq/yr)	3.3	3.7	33.9	0	41.8
Cost effectiveness ($/lb-eq removed)	$36,606	$87,216	$20,451	-	$82,368
TDS Removal (tpy)	0	0	0	496	599
TDS Cost Effectiveness ($/ton TDS)	-	-	-	$50	$5,748
TSS Removal (tpy)	9.2	13.8	13.8	9.2	16.4
Incremental TSS Removal (tpy)	9.2	4.6	4.6	0	7.2
TSS Cost Effectiveness ($/ton)	$13,116	$70,152	$150,717	-	$476,210

NOTES:
Incremental annualized cost and incremental removal are a comparison to the in mine sedimentation alternative.

4.5 Performance Criteria Analysis

Table 4-15 presents a comparison of the three Outfall 001 treatment alternatives based on a series of performance criteria. These criteria were equally weighted to determine the overall performance of each alternative.

The reliability for the existing sedimentation basin alternative will be high with proper O&M practices. The maintainability and operability of the sedimentation basin alternative is considered more favorable because the alternatives include the least equipment and require the lowest amount of operator attention. A ZLD system will have the most equipment and involve the most complex unit processes and due to this is rated low (less attractive) for maintainability and operability.

TABLE 4-15
Comparison of Outfall 001 Alternatives Using Performance Criteria
Energy West Trail Mountain Mine

Performance Criterion	Alt 1 – Sedimentation Basin	Alt 2 – Greensand + Oleophilic Media	Alt 3 - ZLD
Reliability	High	High	High
Maintainability	High	High	Low
Operability	High	Medium	Low
Sustainability	High	Medium	Low
Adaptability	Low	Low	High
Overall Performance	**High**	**Medium**	**Low/Medium**

NOTES:
High = more favorable
Low = less favorable

A sedimentation basin is a simple system with low power usage and is rated more favorably for sustainability. The ZLD system has high chemical and energy usage, and is rated low for sustainability. ZLD will also require a larger site footprint and generate solids requiring offsite disposal. Although the ZLD does produce water suitable for reuse, the significant energy use by the ZLD process determined the low rating.

As for adaptability to future regulatory changes, sedimentation and filtration will require additional treatment processes to address POCs beyond TSS, iron, oil and grease, and TDS, and are rated low for adaptability to future permit conditions. A ZLD system eliminates the wastewater discharge entirely and would not be affected by future limits or regulatory changes, resulting in the highest rating of the three alternatives for adaptability.

Table 4-16 presents a comparison of the five Outfall 002 treatment alternatives based on a series of performance criteria. These criteria were equally weighted to determine the overall performance of each alternative.

The reliability for the existing in-mine sedimentation system will be high with proper O&M practices. The reliability of salinity offsets is rated medium, because the availability and cost of salinity offsets for the next permit cycle, i.e., after 2017, is unknown. The maintainability and operability of the in-mine sedimentation and salinity offset alternatives are considered more favorable because the alternatives include the least equipment and require the lowest amount of operator attention. A ZLD system will have the most equipment and involve the most complex unit processes and due to this is rated low (less attractive) for maintainability and operability.

TABLE 4-16
Comparison of Outfall 002 Alternatives Using Performance Criteria
Energy West Trail Mountain Mine

Performance Criterion	Alt 1 – In-Mine Sedimentation	Alt 2 – Greensand + Oleophilic	Alt 3 – Greensand + Oleophilic +Adsorption	Alt 4 – Salinity Offsets	Alt 5 – ZLD
Reliability	High	High	Medium	Medium	High
Maintainability	High	High	High	High	Low
Operability	High	Medium	Medium	High	Low
Sustainability	High	Medium	Medium	High	Low
Adaptability	Low	Low	Medium	Low	High
Overall Performance	**High**	**Medium**	**Medium/High**	**Medium/High**	**Low/Medium**

NOTES:
High = more favorable
Low = less favorable

The mine sedimentation process is a simple system and is integral to the mine operation. It has low power usage and is rated more favorably for sustainability. The ZLD system has high chemical and energy usage, and is rated low for sustainability. ZLD will also require a larger site footprint and generate solids requiring offsite disposal. Although the ZLD does produce water suitable for reuse, the significant energy use by the ZLD process determined the low rating.

As for adaptability to future regulatory changes, sedimentation, filtration, and salinity offset credits will require additional treatment processes to address POCs beyond TSS, iron, oil and grease, copper, cadmium, and TDS, and are rated low for adaptability to future permit conditions. A ZLD system eliminates the wastewater discharge entirely and would not be affected by future limits or regulatory changes, resulting in the highest rating of the five alternatives for adaptability.

4.6 Preferred Treatment Alternative

Based on the preceding analysis, Energy West's preferred alternatives remain the Outfall 001 sedimentation basin and in-mine sedimentation for Outfall 002 which are the current processes at the Trail Mountain Mine.

4.6.1 Outfall 001

Based on the comparison of the three treatment alternatives for Outfall 001 against the performance criteria, Alternative 1, the sedimentation basin, is rated as more favorable than the three other alternatives in overall performance—particularly in reliability, maintainability, operability, and sustainability. The incremental cost of the treatment options is 200 (oleophilic media and greensand filtration) to 2,100 percent (ZLD) higher than the operating cost of the existing sedimentation basin and would remove <1,400 lb/day of TDS and other POCs. The incremental cost of the treatment options exceeds the 20 percent threshold established by Utah regulation. Given that Alternative 1 is the most cost-effective alternative, Alternative 1 (sedimentation basin) is the recommended treatment alternative for Outfall 001 at the Trail Mountain Mine.

4.6.2 Outfall 002

Based on the comparison of the five treatment alternatives for Outfall 002 against the performance criteria, Alternative 1, in-mine sedimentation, is rated as more favorable than the four other alternatives in overall performance—particularly in reliability, maintainability, operability, and sustainability. The incremental cost of the treatment options is 20 (salinity offsets) to 2,850 percent (ZLD) higher than the operating cost of the existing in mine sedimentation system. The incremental cost of the active treatment options exceeds the 20% threshold established by Utah regulation. Given that Alternative 1 is the most cost-effective alternative, Alternative 1 (in-mine sedimentation) is the recommended treatment alternative for Outfall 002 at the Trail Mountain Mine.

5.0 Statement of Social, Environmental, and Economic Importance

The requirement for applicants to complete a Statement of Social, Environmental, and Economic Importance (SEEI) originates in the *Code of Federal Regulations*, Chapter 40, Part 131.12(a)(2) [40 CFR 40.131.12(a)(2)]. It requires applicants to demonstrate that allowing lower water quality is necessary to accommodate social or economic development in the area in which the waters to be degraded are located. In UAC R317-2-3.5(c)(4), the State of Utah defines the minimum information that an applicant must provide to demonstrate that degradation is necessary, which includes the following:

- Impacts on employment
- Increases in production
- Improved community tax base
- Impacts on housing
- Correction of an environmental or public health problem

In addition, the Implementation Guidance further clarifies these minimum considerations as well as further considerations that should be included in an applicant's SEEI analysis, including the following:

- Effects on public and social services, including the identification of public or social services that would be provided to the community or required of the community in the affected area as well as effects on health/nursing care, police/fire protection, infrastructure, housing, and public education

- Effects on public health and safety, including any health and safety services that will be provided or required in the affected areas as well as identification of potential project benefits that will enhance food or drinking water quality, control disease vectors, or improve air quality, industrial hygiene, occupational health, and public safety

- Effects on quality of life of residents of affected area, including educational, cultural, and recreational opportunities, daily life experience (in regards to dust, noise, traffic, etc.), and aesthetics (views cape)

- Effects on employment and tax revenues in the affected areas

- Effects on tourism, including the creation or enhancement of tourist attractions or impacts resulting from elimination or reduction of existing tourist attractions

- The pros and cons of preserving assimilative capacity for future industry and development in the affected areas (which is to include the approval/disapproval of local communities for the proposed project)

The purpose of this section is to provide an SEEI that addresses the requirements provided in state and federal regulations as well as the recommendations provided in the ADR

Implementation Guidance in an effort to demonstrate that potential degradation, however minor, of Cottonwood Creek from the Trail Mountain Mine operations is necessary to accommodate economic and social development.

5.1 Description of Affected Communities

Trail Mountain Mine is located in Emery County, Utah approximately 12 miles west of Orangeville, Utah. The 2011 population of Orangeville was 1,471 residents (www.city-data.com/city/Orangeville-Utah.html). The 2009 median household income was $36,969. In August 2012, the unemployment rate within incorporated areas of Orangeville was 7.5 percent (www.city-data.com/city/Orangeville-Utah.html).

Orangeville was established along Cottonwood Creek, which continues to supply irrigation water to the community. Agriculture and mining have been a large part of Orangeville's history and the local economy continues to reflect the trends of these industries.

5.2 Effects on Community Resources from Trail Mountain Mine

The Trail Mountain Mine has been in temporary cessation since 2001 and no employees are located at the mine site. Energy West continues to make property tax and lease payments for the site. The discharge is a result of legacy mining activities that were socially and economically important at that time, and need to occur to maintain the option to restart operations in the future, which would have social and economic importance.

Coal mining has occurred in the area for over 60 years and is an established part of Emery County. Future operation of the mine is not expected to require additional community services, place additional infrastructure and education demands on the community, or consume assimilative capacity in Cottonwood Creek that is needed for other projects. Future workforce requirements can be supported by Orangeville and other nearby communities, and would be an economic benefit for the communities. Future operation of the mine is not expected to impact existing area tourism activities.

6.0 References

Orangeville, Utah, (UT84528) Profile, www.city-data.com/city/Orangeville-Utah.html, Accessed July 8, 2013.

U.S. Environmental Protection Agency (EPA). 2000. *Cost-Effectiveness Analysis of Proposed Effluent Limitations Guidelines and Standards for the Metal Products and Machinery Industry*. EPA-821-B-00-007. Washington, D.C.

APPENDIX

Cost Worksheets for Treatment Alternatives

Order-of-magnitude Level Construction Cost Estimate
Trail Mountain Mine Outfall 001 Sedimentation Pond

Item	Design Criteria	Quantity	Basis	Cost per Unit	Estimated Cost
none					0
Total Equipment Cost (TEC)					$0
Freight and Taxes		10%	of TEC		0
Equipment Delivery Adjustment: Schedule		0%	of TEC		0
Equipment Delivery Adjustment: Location		0%	of TEC		0
Purchased Equipment Cost - Delivered (PEC-D)					$0
Equipment Installation (a)		30%	of PEC-D		0
Piping		20%	of PEC-D		0
Heat Tracing and Insulation		5%	of PEC-D		0
Instrumentation and Controls		15%	of PEC-D		0
Electrical		18%	of PEC-D		0
Buildings		0%	of PEC-D		0
Yard Improvements (b)		5%	of PEC-D		0
Service Facilities (c)		5%	of PEC-D		0
Subtotal					$0
Other Direct Costs:					
Basin excavation	2.25 acre feet	3600		$20 per CY	72,000
Outlet structure	discharge valve and high level standpipe	LS			10,000
Total Direct Costs (TDC)					$82,000
Engineering (d)	excludes geotech and speciality services	15%	of TDC		12,000
Other Indirect Costs (e)		10%	of PEC-D		0
Total Direct + Indirect Costs (TD+I)					$94,000
Contractor's Fee		10%	of TD+I		9,000
Contingency (f)		25%	of TD+I		24,000
Total Construction Cost (TCC)					$127,000
Bond/Insurance		0%	of TCC		$0
Owners Costs		10%	of TCC		$13,000
Mix Tests		LS			$0
Services During Construction		0%	of TCC		0
O&M Manual/Startup Plan		0%	of TCC		0
Startup Expenses (g)		0%	of TCC		0
Escalation	no escalation included	0.0%			0
Total Estimated Cost (h)					$140,000
Annualized Cost of Capital	7% over 20 years				$13,215

(a) Includes costs for labor, foundations, supports, platforms, construction expenses, and other factors directly related to the erection of purchased equipment.
(b) Includes fencing, grading, roads, sidewalks, and similar items.
(c) Includes required improvements to steam, water, compressed air, waste disposal, fire protection, and other plant services.
(d) Engineering costs include process design, detailed design, basic specifications/data sheets.
(e) Includes temporary construction and operations, construction tools and rental, home office personnel in field, field payroll, travel and living expenses, taxes and insurance, startup materials and labor, and overhead.
(f) Does not include scope contingency.
(g) Includes preparation of startup plan and O&M plan, and startup of facilities. Analytical costs are not included.
(h) This cost estimate has been prepared for guidance in project evaluation and implementation and was based on information available at the time that the estimate was prepared. Final costs for the project, and the project's resulting feasibility will depend on actual labor and material costs, competitive market conditions, actual site conditions, final project scope, implementation schedule, and other variable factors. As a result, the final project cost will vary from the estimate prepared. Because of these factors, project feasibility, benefit/cost ratios, risks, and funding needs must be carefully reviewed before making specific financial decisions or establishing project budgets in order to help ensure proper project evaluation and adequate funding.

Note: Factors from Plant Design and Economics for Chemical Engineers, Fourth Edition, M.S.Peters

Annual O&M Costs

		Quantity		Unit Rate	Total
Labor	annual basin cleanout (labor, equipment)	lump sum	LS	$50 per hr	47,500
Laboratory analysis	routine discharge monitoring	1		LS	2,500
Electricity			0 kW	$0.05 per kWhr	0
Maintenance	3% of total equipment costs	$0		3%	0
					0
Total					$50,000

Order-of-magnitude Level Construction Cost Estimate
Trail Mountain Mine Outfall 001 Oleophilic + Greensand Filter

Item	Design Criteria	Quantity	Basis	Cost per Unit	Estimated Cost
Influent pumps	50 gpm x 75 ft TDH, VFDs	2	Prior experience	$10,000	20,000
Oleophilic Media Vessels	2-ft diam CS vessels	4	Prior experience	$15,000	60,000
Media Filter Vessels	2-ft diam CS vessels	4	Prior experience	$15,000	60,000
Filter Backwash Holding Tank	5000 gals CS API 650	1	Prior experience	$2.00 per gallon	10,000
Total Equipment Cost (TEC)					$150,000
Freight and Taxes		10%	of TEC		15,000
Equipment Delivery Adjustment: Schedule		0%	of TEC		0
Equipment Delivery Adjustment: Location		0%	of TEC		0
Purchased Equipment Cost - Delivered (PEC-D)					$165,000
Equipment Installation (a)		30%	of PEC-D		50,000
Piping		20%	of PEC-D		33,000
Heat Tracing and Insulation		5%	of PEC-D		8,000
Instrumentation and Controls		15%	of PEC-D		25,000
Electrical		18%	of PEC-D		30,000
Buildings		0%	of PEC-D		0
Yard Improvements (b)		5%	of PEC-D		8,000
Service Facilities (c)		5%	of PEC-D		8,000
Subtotal					$327,000
Other Direct Costs:					
Filter Building	20 ft x 25 ft Pre-Egr Building	400	Prior Experience	$125 per sq ft	50,000
Total Direct Costs (TDC)					$377,000
Engineering (d)	excludes geotech and speciality services	10%	of TDC		38,000
Other Indirect Costs (e)		10%	of PEC-D		17,000
Total Direct + Indirect Costs (TD+I)					$432,000
Contractor's Fee		10%	of TD+I		40,000
Contingency (f)		25%	of TD+I		110,000
Total Construction Cost (TCC)					$582,000
Bond/Insurance		2%	of TCC		$10,000
Owners Costs		10%	of TCC		$60,000
Pilot Testing	assume not required	LS			$0
Services During Construction		6%	of TCC		30,000
O&M Manual/Startup Plan		2%	of TCC		10,000
Startup Expenses (g)		2%	of TCC		10,000
Escalation	no escalation included	0.0%			0
Total Estimated Cost (h)					**$700,000**
Annualized Cost of Capital	7% over 20 years				$66,075

(a) Includes costs for labor, foundations, supports, platforms, construction expenses, and other factors directly related to the erection of purchased equipment.
(b) Includes fencing, grading, roads, sidewalks, and similar items.
(c) Includes required improvements to steam, water, compressed air, waste disposal, fire protection, and other plant services.
(d) Engineering costs include process design, detailed design, basic specifications/data sheets.
(e) Includes temporary construction and operations, construction tools and rental, home office personnel in field, field payroll, travel and living expenses, taxes and insurance, startup materials and labor, and overhead.
(f) Does not include scope contingency.
(g) Includes preparation of startup plan and O&M plan, and startup of facilities. Analytical costs are not included.
(h) This cost estimate has been prepared for guidance in project evaluation and implementation and was based on information available at the time that the estimate was prepared. Final costs for the project, and the project's resulting feasibility will depend on actual labor and material costs, competitive market conditions, actual site conditions, final project scope, implementation schedule, and other variable factors. As a result, the final project cost will vary from the estimate prepared. Because of these factors, project feasibility, benefit/cost ratios, risks, and funding needs must be carefully reviewed before making specific financial decisions or establishing project budgets in order to help ensure proper project evaluation and adequate funding.

Note: Factors from Plant Design and Economics for Chemical Engineers, Fourth Edition, M.S. Peters

Annual O&M Costs

Item	Design Criteria	Quantity	Unit Rate	Total
Labor	2 hr/d, 7 d/wk	730 hr/yr	$50 per hr	36,500
Laboratory analysis		1	LS	2,800
Electricity		10 kW	$0.05 per kWhr	4,400
Replacment media	200 ft3/yr	10000 lbs	$2.00 per lb	20,000
Spent media disposal		6 tons	$200 per ton	1,200
Maintenance	3% of total equipment costs	150000	3%	4,500
Total				$69,400

Order-of-magnitude Level Construction Cost Estimate
Trail Mountain Mine Outfall 001 Zero Liquid Discharge (RO/Brine Crystalizer)

Item	Design Criteria	Quantity	Basis	Cost per Unit	Estimated Cost
Influent pumps	50 gpm x 75 ft TDH, VFDs	2	Prior experience	$7,500	15,000
RO Feed Tank	6000 gals CS API 650	1	Prior experience	$2.50 per gallon	15,000
RO Feed Pumps	50 gpm @900 psi, 40 hp	2	Prior experience	$1000 per hp	80,000
Media Filter Vessels	2-ft diam CS vessels	4	Prior experience	$15,000	60,000
Filter Backwash Holding Tank	5000 gals CS API 650	1	Prior experience	$2.00 per gallon	10,000
RO Cartridge Filter Skid	FRP housing, 3 @ 50%	1	Prior experience	$10,000	10,000
RO Skid	50 gpm skid, 3x2x1 array	2	Prior experience	$120,000	240,000
RO Acid Feed System	1000 gal tank w/ pump skid	1	Prior experience	$30,000	30,000
RO Anti-scale Feed	vendor package	1	Prior experience	$10,000	10,000
CIP System	vendor package	1	Prior experience	$50,000	50,000
Brine Crystallizer	5 gpm avg, 2% TDS feed	1	Prior experience	$1,200,000	1,200,000
Brine Diversion Tank	Rubber lined carbon steel, 70,000 gal	1	Prior experience	$1.50 per gallon	105,000
Soda Ash Feed System	10 ton silo and feed system	1	prior experience	$80,000	80,000
Distillate Storage Tank	Stainless steel, 5,000 gals	1	prior experience	$4.00 per gallon	20,000
Reuse Water Pumps	50 gpm @ 60 psi, 5 hp	2	prior experience	$1000 per hp	10,000
Total Equipment Cost (TEC)					$1,935,000
Freight and Taxes		10%	of TEC		194,000
Equipment Delivery Adjustment: Schedule		0%	of TEC		0
Equipment Delivery Adjustment: Location		0%	of TEC		0
Purchased Equipment Cost - Delivered (PEC-D)					$2,129,000
Equipment Installation (a)		30%	of PEC-D		639,000
Piping		20%	of PEC-D		426,000
Heat Tracing and Insulation		5%	of PEC-D		106,000
Instrumentation and Controls		15%	of PEC-D		319,000
Electrical		18%	of PEC-D		383,000
Buildings		0%	of PEC-D		0
Yard Improvements (b)		5%	of PEC-D		106,000
Service Facilities (c)		5%	of PEC-D		106,000
Subtotal					$4,214,000
Other Direct Costs:					
Membrane Building	40 ft x 60 ft Pre-Egr Building	2400	Prior Experience	$125 per sq ft	300,000
Total Direct Costs (TDC)					$4,514,000
Engineering (d)	excludes geotech and speciality services	10%	of TDC		451,000
Other Indirect Costs (e)		10%	of PEC-D		213,000
Total Direct + Indirect Costs (TD+I)					$5,178,000
Contractor's Fee		10%	of TD+I		520,000
Contingency (f)		25%	of TD+I		1,290,000
Total Construction Cost (TCC)					$6,988,000
Bond/Insurance		2%	of TCC		$140,000
Owners Costs		10%	of TCC		$700,000
Pilot Testing		LS			$500,000
Services During Construction		6%	of TCC		380,000
O&M Manual/Startup Plan		2%	of TCC		140,000
Startup Expenses (g)		2%	of TCC		140,000
Escalation	no escalation included	0.0%			0
Total Estimated Cost (h)					$8,990,000
Annualized Cost of Capital	7% over 20 years				$848,592

(a) Includes costs for labor, foundations, supports, platforms, construction expenses, and other factors directly related to the erection of purchased equipment.
(b) Includes fencing, grading, roads, sidewalks, and similar items.
(c) Includes required improvements to steam, water, compressed air, waste disposal, fire protection, and other plant services.
(d) Engineering costs include process design, detailed design, basic specifications/data sheets.
(e) Includes temporary construction and operations, construction tools and rental, home office personnel in field, field payroll, travel and living expenses, taxes and insurance, startup materials and labor, and overhead.
(f) Does not include scope contingency.
(g) Includes preparation of startup plan and O&M plan, and startup of facilities. Analytical costs are not included.
(h) This cost estimate has been prepared for guidance in project evaluation and implementation and was based on information available at the time that the estimate was prepared. Final costs for the project, and the project's resulting feasibility will depend on actual labor and material costs, competitive market conditions, actual site conditions, final project scope, implementation schedule, and other variable factors. As a result, the final project cost will vary from the estimate prepared. Because of these factors, project feasibility, benefit/cost ratios, risks, and funding needs must be carefully reviewed before making specific financial decisions or establishing project budgets in order to help ensure proper project evaluation and adequate funding.

Note: Factors from Plant Design and Economics for Chemical Engineers, Fourth Edition, M.S.Peters

Annual O&M Costs

		Quantity	Unit Rate	Total
Labor	16 hr/d, 7 d/wk	5840 hr/yr	$50 per hr	292,000
Laboratory analysis		1	LS	25,000
Electricity		275 kW	$0.05 per kWhr	120,500
Maintenance	3% of total equipment costs	1935000	3%	58,100
Citric Acid	membrane cleaning	1.5 ton/yr	$2500 per ton	3,800
Scale inhibitor	2.5 ppm dose	2 lb/d	$2.20 per lb	1,200
Sodium EDTA	membrane cleaning	1 ton/yr	$1250 per ton	900
Sulfuric acid	20 ppm dose	12 lb/d	$0.08 per lb	300
Sodium hydroxide	membrane cleaning	1 ton/yr	$800 per ton	800
Antifoam	20 ppm dose	4 lb/d	$2.20 per lb	2,800
Solids disposal	85% solids cake from crystalizer	1.1 ton/day	$75 per ton	30,100
Total				$535,500
RO membrane replacement	5 yr replacement cycle	45	550	$24,750

Order-of-magnitude Level Construction Cost Estimate
Trail Mountain Mine Outfall 002 Mine Pool Settling

Item	Design Criteria	Quantity	Basis	Cost per Unit	Estimated Cost
Transfer pumps to sedimenation pool	5 hp MSHA submersible	5	prior experience	$1000 per hp	25,000
Drainage pumps from sedimentation pool	10 hp MSHA submersible	4	prior experience	$1000 per hp	40,000
Total Equipment Cost (TEC)					$65,000
Freight and Taxes		10%	of TEC		7,000
Equipment Delivery Adjustment: Schedule		0%	of TEC		0
Equipment Delivery Adjustment: Location		0%	of TEC		0
Purchased Equipment Cost - Delivered (PEC-D)					$72,000
Equipment Installation (a)		25%	of PEC-D		18,000
Piping		20%	of PEC-D		14,000
Heat Tracing and Insulation		0%	of PEC-D		0
Instrumentation and Controls		15%	of PEC-D		11,000
Electrical		18%	of PEC-D		13,000
Buildings		0%	of PEC-D		0
Yard Improvements (b)		0%	of PEC-D		0
Service Facilities (c)		5%	of PEC-D		4,000
Subtotal					$132,000
Other Direct Costs:					
					0
Total Direct Costs (TDC)					$132,000
Engineering (d)	excludes geotech and speciality services	10%	of TDC		13,000
Other Indirect Costs (e)		10%	of PEC-D		7,000
Total Direct + Indirect Costs (TD+I)					$152,000
Contractor's Fee	installation by mine work force	0%	of TD+I		0
Contingency (f)		25%	of TD+I		40,000
Total Construction Cost (TCC)					$192,000
Bond/Insurance		2%	of TCC		$4,000
Owners Costs		10%	of TCC		$20,000
Pilot Testing	none	LS			$0
Services During Construction	provided by daily mine operations	0%	of TCC		0
O&M Manual/Startup Plan		2%	of TCC		4,000
Startup Expenses (g)	provided by daily mine operations	0%	of TCC		0
Escalation	no escalation included	0.0%			0
Total Estimated Cost (h)					**$220,000**
Annualized Cost of Capital	7% over 20 years				$20,766

(a) Includes costs for labor, foundations, supports, platforms, construction expenses, and other factors directly related to the erection of purchased equipment.
(b) Includes fencing, grading, roads, sidewalks, and similar items.
(c) Includes required improvements to steam, water, compressed air, waste disposal, fire protection, and other plant services.
(d) Engineering costs include process design, detailed design, basic specifications/data sheets.
(e) Includes temporary construction and operations, construction tools and rental, home office personnel in field, field payroll, travel and living expenses, taxes and insurance, startup materials and labor, and overhead.
(f) Does not include scope contingency.
(g) Includes preparation of startup plan and O&M plan, and startup of facilities. Analytical costs are not included.
(h) This cost estimate has been prepared for guidance in project evaluation and implementation and was based on information available at the time that the estimate was prepared. Final costs for the project, and the project's resulting feasibility will depend on actual labor and material costs, competitive market conditions, actual site conditions, final project scope, implementation schedule, and other variable factors. As a result, the final project cost will vary from the estimate prepared. Because of these factors, project feasibility, benefit/cost ratios, risks, and funding needs must be carefully reviewed before making specific financial decisions or establishing project budgets in order to help ensure proper project evaluation and adequate funding.

Note: Factors from Plant Design and Economics for Chemical Engineers, Fourth Edition, M.S.Peters

Annual O&M Costs

		Quantity	Unit Rate	Total
Labor	2 hr/d	730 hr/yr	$50 per hr	36,500
Laboratory analysis		1	LS	3,200
Electricity	assume 75 hp	60 kW	$0.05 per kWhr	26,300
Maintenance	allowance	$34,000	100%	34,000
Chemicals		0 lb/d	$0.50 per lb	0
Total				$100,000

Order-of-magnitude Level Construction Cost Estimate
Trail Mountain Mine Outfall 002 Oleophilic + Greensand Filter

Item	Design Criteria	Quantity	Basis	Cost per Unit	Estimated Cost
Influent pumps	300 gpm x 75 ft TDH, VFDs	2	Prior experience	$15,000	30,000
Oleophilic Media Vessels	5-ft diam CS vessels	4	Prior experience	$40,000	160,000
Media Filter Vessels	5-ft diam CS vessels	4	Prior experience	$40,000	160,000
Filter Backwash Holding Tank	25000 gals CS API 650	1	Prior experience	$1.00 per gallon	25,000
Total Equipment Cost (TEC)					$375,000
Freight and Taxes		10%	of TEC		38,000
Equipment Delivery Adjustment: Schedule		0%	of TEC		0
Equipment Delivery Adjustment: Location		0%	of TEC		0
Purchased Equipment Cost - Delivered (PEC-D)					$413,000
Equipment Installation (a)		30%	of PEC-D		124,000
Piping		20%	of PEC-D		83,000
Heat Tracing and Insulation		5%	of PEC-D		21,000
Instrumentation and Controls		15%	of PEC-D		62,000
Electrical		18%	of PEC-D		74,000
Buildings		0%	of PEC-D		0
Yard Improvements (b)		5%	of PEC-D		21,000
Service Facilities (c)		5%	of PEC-D		21,000
Subtotal					$819,000
Other Direct Costs:					
Filter Building	40 ft x 25 ft Pre-Egr Building	1000	Prior Experience	$125 per sq ft	125,000
Total Direct Costs (TDC)					$944,000
Engineering (d)	excludes geotech and speciality services	10%	of TDC		94,000
Other Indirect Costs (e)		10%	of PEC-D		41,000
Total Direct + Indirect Costs (TD+I)					$1,079,000
Contractor's Fee		10%	of TD+I		110,000
Contingency (f)		25%	of TD+I		270,000
Total Construction Cost (TCC)					$1,459,000
Bond/Insurance		2%	of TCC		$30,000
Owners Costs		10%	of TCC		$150,000
Pilot Testing	assume not required	LS			$0
Services During Construction		6%	of TCC		80,000
O&M Manual/Startup Plan		2%	of TCC		30,000
Startup Expenses (g)		2%	of TCC		30,000
Escalation	no escalation included	0.0%			0
Total Estimated Cost (h)					**$1,780,000**
Annualized Cost of Capital	7% over 20 years				$168,019

(a) Includes costs for labor, foundations, supports, platforms, construction expenses, and other factors directly related to the erection of purchased equipment.
(b) Includes fencing, grading, roads, sidewalks, and similar items.
(c) Includes required improvements to steam, water, compressed air, waste disposal, fire protection, and other plant services.
(d) Engineering costs include process design, detailed design, basic specifications/data sheets.
(e) Includes temporary construction and operations, construction tools and rental, home office personnel in field, field payroll, travel and living expenses, taxes and insurance, startup materials and labor, and overhead.
(f) Does not include scope contingency.
(g) Includes preparation of startup plan and O&M plan, and startup of facilities. Analytical costs are not included.
(h) This cost estimate has been prepared for guidance in project evaluation and implementation and was based on information available at the time that the estimate was prepared. Final costs for the project, and the project's resulting feasibility will depend on actual labor and material costs, competitive market conditions, actual site conditions, final project scope, implementation schedule, and other variable factors. As a result, the final project cost will vary from the estimate prepared. Because of these factors, project feasibility, benefit/cost ratios, risks, and funding needs must be carefully reviewed before making specific financial decisions or establishing project budgets in order to help ensure proper project evaluation and adequate funding.

Note: Factors from Plant Design and Economics for Chemical Engineers, Fourth Edition, M.S.Peters

Annual O&M Costs

		Quantity		Unit Rate	Total
Labor	2 hr/d, 7 d/wk	730	hr/yr	$50 per hr	36,500
Laboratory analysis		1		LS	5,000
Electricity		45	kW	$0.05 per kWhr	19,700
Maintenance	3% of total equipment costs	375000		3%	11,300
Replacement media	1000 ft3/yr @ 50 lb/ft3	50000	lbs	$2.00 per lb	100,000
Spent media disposal	Non-hazardous waste to landfill	30	ton	$100 per ton	3,000
Total					$175,500

Order-of-magnitude Level Construction Cost Estimate
Trail Mountain Mine Outfall 002 Oleophilic + Greensand Filter + Enhanced Alumina

Item	Design Criteria	Quantity	Basis	Cost per Unit	Estimated Cost
Influent pumps	300 gpm x 90 ft TDH, VFDs	2	Prior experience	$18,000	36,000
Oleophilic Media Vessels	5-ft diam CS vessels	4	Prior experience	$40,000	160,000
Media Filter Vessels	5-ft diam CS vessels	4	Prior experience	$40,000	160,000
Enhanced Alumina Vessels	5-ft diam CS vessels	4	Prior experience	$40,000	160,000
Filter Backwash Holding Tank	25000 gals CS API 650	1	Prior experience	$1.00 per gallon	25,000
Total Equipment Cost (TEC)					$541,000
Freight and Taxes		10%	of TEC		54,000
Equipment Delivery Adjustment: Schedule		0%	of TEC		0
Equipment Delivery Adjustment: Location		0%	of TEC		0
Purchased Equipment Cost - Delivered (PEC-D)					$595,000
Equipment Installation (a)		30%	of PEC-D		179,000
Piping		20%	of PEC-D		119,000
Heat Tracing and Insulation		5%	of PEC-D		30,000
Instrumentation and Controls		15%	of PEC-D		89,000
Electrical		18%	of PEC-D		107,000
Buildings		0%	of PEC-D		0
Yard Improvements (b)		5%	of PEC-D		30,000
Service Facilities (c)		5%	of PEC-D		30,000
Subtotal					$1,179,000
Other Direct Costs:					
Filter Building	50 ft x 25 ft Pre-Egr Building	1250	Prior Experience	$125 per sq ft	156,250
Enhanced Alumina Media		50100		$5.00 per lb	250,500
Total Direct Costs (TDC)					$1,585,750
Engineering (d)	excludes geotech and speciality services	10%	of TDC		159,000
Other Indirect Costs (e)		10%	of PEC-D		60,000
Total Direct + Indirect Costs (TD+I)					$1,804,750
Contractor's Fee		10%	of TD+I		180,000
Contingency (f)		25%	of TD+I		450,000
Total Construction Cost (TCC)					$2,434,750
Bond/Insurance		2%	of TCC		$50,000
Owners Costs		10%	of TCC		$240,000
Pilot Testing	assume not required	LS			$0
Services During Construction		6%	of TCC		130,000
O&M Manual/Startup Plan		2%	of TCC		50,000
Startup Expenses (g)		2%	of TCC		50,000
Escalation	no escalation included	0.0%			0
Total Estimated Cost (h)					$2,950,000
Annualized Cost of Capital	7% over 20 years				$278,459

(a) Includes costs for labor, foundations, supports, platforms, construction expenses, and other factors directly related to the erection of purchased equipment.
(b) Includes fencing, grading, roads, sidewalks, and similar items.
(c) Includes required improvements to steam, water, compressed air, waste disposal, fire protection, and other plant services.
(d) Engineering costs include process design, detailed design, basic specifications/data sheets.
(e) Includes temporary construction and operations, construction tools and rental, home office personnel in field, field payroll, travel and living expenses, taxes and insurance, startup materials and labor, and overhead.
(f) Does not include scope contingency.
(g) Includes preparation of startup plan and O&M plan, and startup of facilities. Analytical costs are not included.
(h) This cost estimate has been prepared for guidance in project evaluation and implementation and was based on information available at the time that the estimate was prepared. Final costs for the project, and the project's resulting feasibility will depend on actual labor and material costs, competitive market conditions, actual site conditions, final project scope, implementation schedule, and other variable factors. As a result, the final project cost will vary from the estimate prepared. Because of these factors, project feasibility, benefit/cost ratios, risks, and funding needs must be carefully reviewed before making specific financial decisions or establishing project budgets in order to help ensure proper project evaluation and adequate funding.

Note: Factors from Plant Design and Economics for Chemical Engineers, Fourth Edition, M.S.Peters

Annual O&M Costs

		Quantity		Unit Rate	Total
Labor	2 hr/d, 7 d/wk	730	hr/yr	$50 per hr	36,500
Laboratory analysis		1		LS	5,000
Electricity		50	kW	$0.05 per kWhr	21,900
Maintenance	3% of total equipment costs	541000		3%	16,200
Replacement Media	Enhanced alumina	50100	lbs	$5.00 per lb	250,500
Replacement Media	Oleophilic media	50100	lbs	$2.00 per lb	100,200
Media disposal		60	ton	$100 per ton	6,000
Total					$436,300

Order-of-magnitude Level Construction Cost Estimate
Trail Mountain Mine Outfall 002 Zero Liquid Discharge (RO/Brine Crystalizer)

Item	Design Criteria	Quantity	Basis	Cost per Unit	Estimated Cost
Influent pumps	300 gpm x 75 ft TDH, VFDs	2	Prior experience	$15,000	30,000
RO Feed Tank	30000 gals CS API 650	1	Prior experience	$1.00 per gallon	30,000
RO Feed Pumps	300 gpm @900 psi, 250 hp	2	Prior experience	$1000 per hp	500,000
Media Filter Vessels	5-ft diam CS vessels	4	Prior experience	$40,000	160,000
Filter Backwash Holding Tank	25000 gals CS API 650	1	Prior experience	$1.00 per gallon	25,000
RO Cartridge Filter Skid	FRP housing, 3 @ 50%	1	Prior experience	$25,000	25,000
RO Skid	300 gpm skid, 3x2x1 array	2	Prior experience	$600,000	1,200,000
RO Acid Feed System	3000 gal tank w/ pump skid	1	Prior experience	$50,000	50,000
RO Anti-scale Feed	vendor package	1	Prior experience	$15,000	15,000
CIP System	vendor package	1	Prior experience	$75,000	75,000
Brine Crystallizer	30 gpm avg, 1% TDS feed	1	Prior experience	$3,500,000	3,500,000
Brine Diversion Tank	Rubber lined carbon steel, 400,000 gal	1	Prior experience	$1.25 per gallon	500,000
Soda Ash Feed System	20 ton silo and feed system	1	prior experience	$120,000	120,000
Distillate Storage Tank	Stainless steel, 5,000 gals	1	prior experience	$4.00 per gallon	20,000
Reuse Water Pumps	300 gpm @ 60 psi, 15 hp	2	prior experience	$500 per hp	15,000
Total Equipment Cost (TEC)					$6,265,000
Freight and Taxes		10%	of TEC		627,000
Equipment Delivery Adjustment: Schedule		0%	of TEC		0
Equipment Delivery Adjustment: Location		0%	of TEC		0
Purchased Equipment Cost - Delivered (PEC-D)					$6,892,000
Equipment Installation (a)		30%	of PEC-D		2,068,000
Piping		20%	of PEC-D		1,378,000
Heat Tracing and Insulation		5%	of PEC-D		345,000
Instrumentation and Controls		15%	of PEC-D		1,034,000
Electrical		18%	of PEC-D		1,241,000
Buildings		0%	of PEC-D		0
Yard Improvements (b)		5%	of PEC-D		345,000
Service Facilities (c)		5%	of PEC-D		345,000
Subtotal					$13,648,000
Other Direct Costs:					
Membrane Building	80 ft x 60 ft Pre-Egr Building	4800	Prior Experience	$125 per sq ft	600,000
Total Direct Costs (TDC)					$14,248,000
Engineering (d)	excludes geotech and speciality services	10%	of TDC		1,425,000
Other Indirect Costs (e)		10%	of PEC-D		689,000
Total Direct + Indirect Costs (TD+I)					$16,362,000
Contractor's Fee		10%	of TD+I		1,640,000
Contingency (f)		25%	of TD+I		4,090,000
Total Construction Cost (TCC)					$22,092,000
Bond/Insurance		2%	of TCC		$440,000
Owners Costs		10%	of TCC		$2,210,000
Pilot Testing		LS			$500,000
Services During Construction		6%	of TCC		1,220,000
O&M Manual/Startup Plan		2%	of TCC		440,000
Startup Expenses (g)		2%	of TCC		440,000
Escalation	no escalation included	0.0%			0
Total Estimated Cost (h)					**$27,340,000**
Annualized Cost of Capital	7% over 20 years				$2,580,703

(a) Includes costs for labor, foundations, supports, platforms, construction expenses, and other factors directly related to the erection of purchased equipment.
(b) Includes fencing, grading, roads, sidewalks, and similar items.
(c) Includes required improvements to steam, water, compressed air, waste disposal, fire protection, and other plant services.
(d) Engineering costs include process design, detailed design, basic specifications/data sheets.
(e) Includes temporary construction and operations, construction tools and rental, home office personnel in field, field payroll, travel and living expenses, taxes and insurance, startup materials and labor, and overhead.
(f) Does not include scope contingency.
(g) Includes preparation of startup plan and O&M plan, and startup of facilities. Analytical costs are not included.
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Note: Factors from Plant Design and Economics for Chemical Engineers, Fourth Edition, M.S.Peters

Annual O&M Costs

		Quantity	Unit Rate	Total
Labor	16 hr/d, 7 d/wk	5840 hr/yr	$50 per hr	292,000
Laboratory analysis		1	LS	25,000
Electricity		700 kW	$0.05 per kWhr	306,600
Maintenance	3% of total equipment costs	6265000	3%	188,000
Citric Acid	membrane cleaning	5 ton/yr	$2500 per ton	12,500
Scale inhibitor	2.5 ppm dose	9 lb/d	$2.20 per lb	7,200
Sodium EDTA	membrane cleaning	2 ton/yr	$1250 per ton	2,500
Sulfuric acid	20 ppm dose	72 lb/d	$0.08 per lb	2,000
Sodium hydroxide	membrane cleaning	2 ton/yr	$800 per ton	1,600
Antifoam	20 ppm dose	11 lb/d	$2.20 per lb	8,400
Solids disposal	85% solids cake from crystalizer	2.0 ton/day	$75 per ton	54,800
Total				$900,600
RO membrane replacement	5 yr replacement cycle	150	550	$82,500

APPENDIX
Summary of Cost-effectiveness Factors for Various Categorical Standard Effluent Guidelines
Energy West Deer Creek Mine

Industry	Cost-effectiveness ($/lb-Equivalent Removed)	
	1999$	2013$
Aluminum Forming	208	328
Battery Manufacturing	3	5
Can Making	17	27
Centralized Waste Treatment	9–12	14-19
Coastal Oil and Gas		
- Produced Water	5	8
- Drilling Waste	503	793
- Treatment, workover, and completion fluids	344	542
Coil Coating	84	132
Copper Forming	46	73
Electronics I	696	1097
Foundries	145	229
Inorganic Chemicals I	<2	<3
Inorganic Chemicals II	10	16
Iron and Steel	3	5
Metal Finishing	21	33
Nonferrous Metals Forming	118	186
Nonferrous Metals Manufacturing I	7	11
Nonferrous Metals Manufacturing II	10	16
Offshore Oil and Gas	57	90
Organic Chemicals, Plastics	9	14
Pesticide Manufacturing (1993)	26	41
Pharmaceuticals	2	3
Porcelain Enameling	10	16
Pulp and Paper	67	106
Transportation Equipment Cleaners	554	873

NOTES:

Cost effectiveness factors takes from United States Environmental Protection Agency (USEPA). 2000. *Cost-Effectiveness Analysis of Proposed Effluent Limitations Guidelines and Standards for the Metal Products and Machinery Industry*. EPA-821-B-00-007. Washington, D.C.

Cost effectiveness factors for the effluent limitation guidelines in various industrial categories were converted from 1999 dollars to February 2012 dollars, using the Construction Cost Index (CCI) from the *Engineering News-Record*. 1999 CCI = 6059 and July 2013 CCI = 9552.