COLORADO
Division of Reclamation, Mining and Safety
Department of Natural Resources

1313 Sherman Street, Room 215
Denver, CO 80203

June 18, 2019

Jerry Nettleton
Twentymile Coal, LLC
29515 Routt County Road No. 27
Oak Creek, CO 80467

Re: Foidel Creek Mine (Permit No. C-1982-056)
Proposed Decision - Technical Revision No. 84 (TR-84)
6MN Passive Water Treatment System.

Dear Mr. Nettleton:

Enclosed you will find the Division of Reclamation, Mining and Safety's Proposed Decision for Technical Revision No. 84 at the Foidel Creek Mine. Notice of the proposed decision will be published in the *Steamboat Pilot* as soon as possible. The first publication will initiate the ten (10) day public comment period for the Division's decision.

Documentation must be submitted to the Division demonstrating that a copy of the approved revision application was sent to the Office of Surface Mining and the Bureau of Land Management. The material should be sent within 15 days of final approval.

Please refer to the Performance Bond heading on the enclosed proposed decision form. If the amount of Bond Held equals or exceeds the Revised Liability, you need not submit additional bond. However, if the Revised Liability exceeds the Bond Held, please submit additional bond or rider to your existing bond that equals or exceeds the Revised Liability. This Technical Revision must not be implemented until this proposed decision becomes final and until any required increase in bond is submitted to and approved by the Division.

If there are stipulations attached, please sign and return the proposed decision form to the Division.

If you have any questions, please contact me.

Sincerely,

Tabetha N. Lynch
Environmental Protection Specialist
Tabetha.lynch@state.co.us

Enclosure

cc: Howard Strand, Office of Surface Mining, with enclosures

COLORADO
Division of Reclamation, Mining and Safety
Department of Natural Resources
1313 Sherman Street, Room 215, Denver, CO 80203 P 303.866.3567 F 303.832.8106 http://mining.state.co.us

COAL MINING PERMIT - TECHNICAL REVISION DECISION

Foidel Creek Mine, Twentymile Coal, LLC
Permit No. C-1982-056

The Division of Reclamation, Mining and Safety has proposed the decision stated below. Provided there are no objections, the decision will become effective upon the termination of the ten (10) day public comment period, in accordance with Rule 2.08.4(6)(b)(iii).

Technical Revision No. 84 Decision: Approve

Submittal Date: July 22, 2016 Decision Date: June 18, 2019

Description of Revision: 6MN Passive Water Treatment System.

DIVISION OF RECLAMATION, MINING AND SAFETY

PERMITTEE

Authorized Representative - Division

Authorized Representative - Permittee (if applicable)

Date: June 18, 2019

Date:

CHANGE IN ACREAGE		REVISED TOTAL ACREAGE		PERFORMANCE BOND	
Disturbed:	19.00	Disturbed:	792.00	Prior Liability:	$9,643,597.26
Affected:	0.00	Affected:	19,996.33	Change in Liability:	$87,272.00
Permit:	0.00	Permit:	22,647.00	Revised Liability:	$9,730,869.26
State:	0.00	State:	7,613.00	Bond Held:	$10,267,597.55
Federal:	0.00	Federal:	6,070.00		
Private:	0.00	Private:	8,964.00		
County:	0.00	County:	0.00		

REVISED APPLICATION PAGES

List of Exhibits pg iv and xii
Pages 2.04-9.1 and 9.2
Pages 2.05-45.26, 45.27, 45.28, 45.29, 45.30, 45.31, 45.32, 45.33, 50, 50.1, 50.10, 50.11, 51, 74.2, 84.5, 84.6, 84.7, 84.8, 84.9, 84.10, 84.11, 84.12, 84.13, 84.14, 84.15, 106, 106.1, 160.2, 106.3, 106.4, 121, 122.1, 127.1, 128, 131, 138, 145, 146, 146.1, 149,

REVISED MAPS

23C sheet3, 24 sheet2, and 29 sheet4

150, 151, 152, 153, 154, 155, 156, 157, 158, 158.1, 164.1, 169

DELETED APPLICATION PAGES	DELETED MAPS
Na	Na

DEPARTMENT OF THE ARMY
U.S. ARMY CORPS OF ENGINEERS, SACRAMENTO DISTRICT
1325 J STREET
SACRAMENTO CA 95814-2922

July 31, 2018

Regulatory Division (SPK-2016-00652)

Twenty Mile Coal, LLC
Attn: Mr. Jerry Nettleton
29515 County Road 27
Oak Creek, Colorado 80467

Dear Mr. Nettleton:

We are responding to your July 30, 2018, request for an approved jurisdictional determination for the 6-Main North Passive Water Treatment site. The approximately 24-acre project site as, depicted on the enclosed ***Map 1: Field Evaluation for Wetland Characters - Unnamed Drainage - 20-Mile Coal Company – 2017*** (enclosure 1), is located approximately 9 miles west of the Town of Oak Creek, within the NE ½ SE ¼ of Section 18, Township 5 North, Range 86 West, at Latitude 40.388443°, Longitude -107.073153°, Routt County, Colorado.

Based on the information you have provided and our review of the site, we have determined that no jurisdictional waters of the United States occur within the project area and the proposed work will not result in the discharge of dredged or fill material within waters of the United States. Therefore, a Department of the Army Permit is not required for this work. Measures should be taken to prevent construction materials and/or activities from entering any waters of the United States. Appropriate soil erosion and sediment controls should be implemented onsite to achieve this end.

We are enclosing a copy of the *Dry Land Approved Jurisdictional Determination Form* for your site (enclosure 2). This approved jurisdictional determination is valid for five years from the date of this letter, unless new information warrants revision of the determination before the expiration date. If you object to this determination, you may request an administrative appeal under Corps regulations at 33 Code of Federal Regulations (CFR) Part 331.

A *Notification of Appeal Process (NAP) and Request for Appeal (RFA) Form* is enclosed (enclosure 3). If you request to appeal this determination, you must submit a completed RFA form to the South Pacific Division Office at the following address: Administrative Appeal Review Officer, Army Corps of Engineers, South Pacific Division, CESPD-PDO, 1455 Market Street, 2052B, San Francisco, California 94103-1399, Telephone: 415-503-6574, FAX: 415-503-6646.

In order for an RFA to be accepted by the Corps, we must determine that the form is complete, that it meets the criteria for appeal under 33 CFR Part 331.5, and that the form was received by the Division Office within 60 days of the date of the NAP. It is not necessary to submit an RFA form to the Division Office unless you object to the determination in this letter.

This approved jurisdictional determination has been conducted to identify the limits of aquatic resources subject to U.S. Army Corps of Engineers jurisdiction under Section 404 of the Clean Water Act for the particular site identified in this request. We recommend that you provide a copy of this letter and notice to all other affected parties, including any individual who has an identifiable and substantial legal interest in the property.

Please refer to identification number SPK-2016-00652 in any correspondence concerning this project. If you have any questions, please contact Tyler Adams at Colorado West Regulatory Section, 400 Rood Avenue, Room 224, Grand Junction, Colorado 81501, by email at *Tyler.R.Adams@usace.army.mil*, or telephone at (970) 243-1199, extension 1013. For program information or to complete our Customer Survey, visit our website at *www.spk.usace.army.mil/Missions/Regulatory.aspx*. We appreciate feedback, especially about interaction with our staff and our processes.

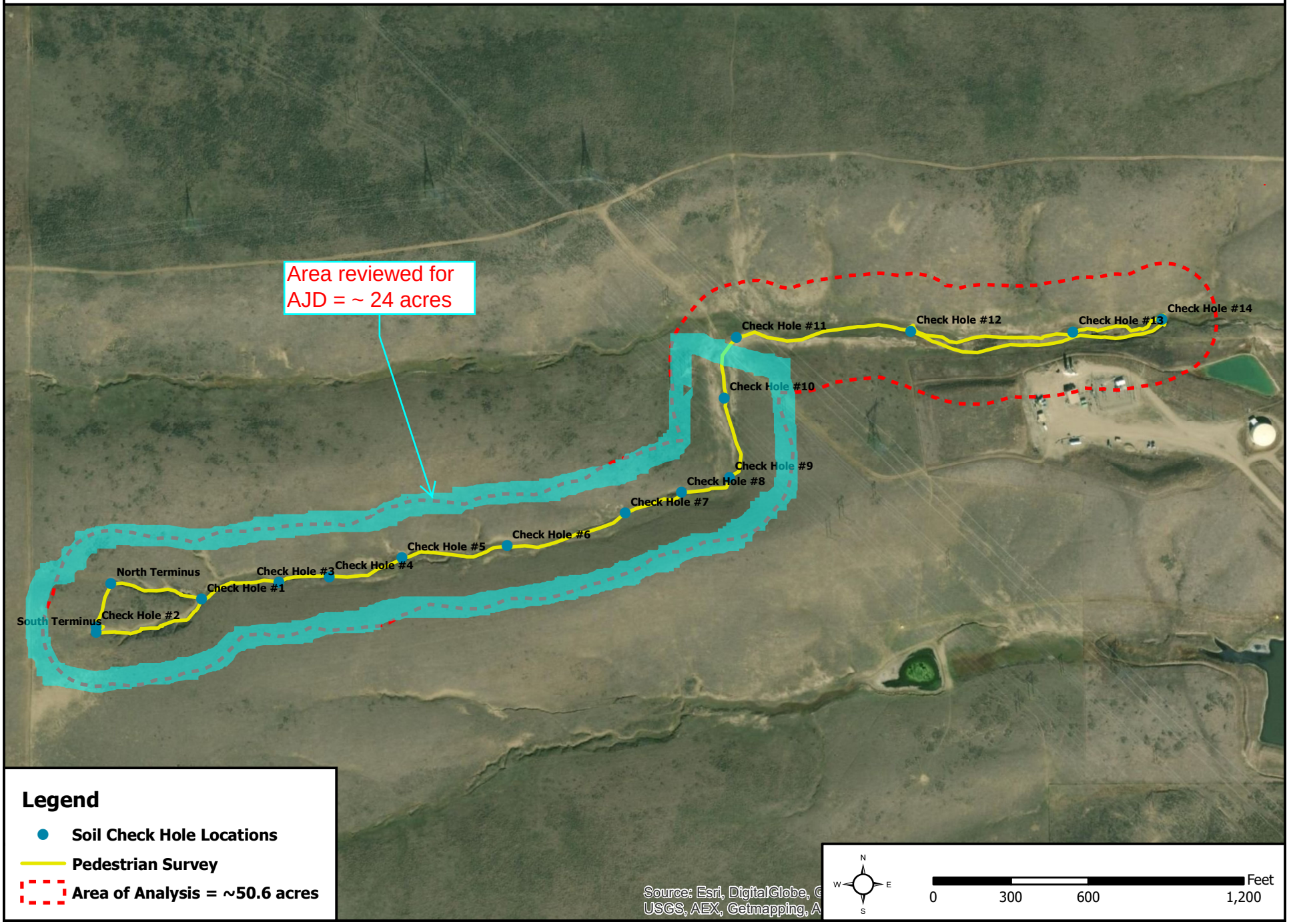
Sincerely,

Susan Nall
Chief, Colorado West Section
Regulatory Division

Enclosures (3)

cc:
Mr. Steven Viert, Cedar Creek Associates, Inc., sviert@digis.net
Mr. Chad Phillips, Director Routt County Planning Department, cphillips@co.routt.co.us

Map 1: Field Evaluation for Wetland Characters - Unnamed Drainage - 20-Mile Coal Company - 2017



enclosure 1

DRY LAND APPROVED JURISDICTIONAL DETERMINATION FORM[1]
U.S. Army Corps of Engineers

This form should be completed by following the instructions provided in Section IV of the JD Form Instructional Guidebook.

SECTION I: BACKGROUND INFORMATION

A. REPORT COMPLETION DATE FOR APPROVED JURISDICTIONAL DETERMINATION (JD): **July 30, 2018**

B. DISTRICT OFFICE, FILE NAME, AND NUMBER: **6 Main North AJD (SPK-2016-00652)**

C. PROJECT LOCATION AND BACKGROUND INFORMATION:

State: **Colorado** County/parish/borough: **Routt** City: **Oak Creek**
Center coordinates of site (lat/long in degree decimal format): Lat. **40.389809** °, Long. **-107.067215** °
Universal Transverse Mercator: **13 324544.445459 4473075.101371**
Name of nearest waterbody: **Fish Creek**
Name of watershed or Hydrologic Unit Code (HUC): **14050001**

- ☑ Check if map/diagram of review area is available upon request.
- ☐ Check if other sites (e.g., offsite mitigation sites, disposal sites, etc…) are associated with this action and are recorded on a different JD form.

D. REVIEW PERFORMED FOR SITE EVALUATION (CHECK ALL THAT APPLY):

- ☐ Office (Desk) Determination. Date:
- ☑ Field Determination. Date(s): **May 22, 2018**

SECTION II: SUMMARY OF FINDINGS

A. RHA SECTION 10 DETERMINATION OF JURISDICTION.

There **are no** "*navigable waters of the U.S.*" within Rivers and Harbors Act (RHA) jurisdiction (as defined by 33 CFR part 329) in the review area.

B. CWA SECTION 404 DETERMINATION OF JURISDICTION.

There **are no** "*waters of the U.S.*" within Clean Water Act (CWA) jurisdiction (as defined by 33 CFR part 328) in the review area.

SECTION III: DATA SOURCES.

A. SUPPORTING DATA. Data reviewed for JD (check all that apply - checked items shall be included in case file and, where checked and requested, appropriately reference sources below):

- ☑ Maps, plans, plots or plat submitted by or on behalf of the applicant/consultant: **January 2018 Twentymile Coal Company's Wetlands Evaluation for Unnamed Tributary of Fish Creek**
- ☑ Data sheets prepared/submitted by or on behalf of the applicant/consultant.
  - ☑ Office concurs with data sheets/delineation report.
  - ☐ Office does not concur with data sheets/delineation report.
- ☐ Data sheets prepared by the Corps:
- ☐ U.S. Geological Survey Hydrologic Atlas:
  - ☐ USGS NHD data.
  - ☐ USGS 8 and 12 digit HUC maps.
- ☑ U.S. Geological Survey map(s). Cite scale & quad name: **1:24K: Milner**
- ☐ USDA Natural Resources Conservation Service Soil Survey.
- ☐ National wetlands inventory map(s). Cite name:
- ☐ State/Local wetland inventory map(s):
- ☐ FEMA/FIRM maps:
- ☐ 100-year Floodplain Elevation is:
- ☑ Photographs: ☑ Aerial (Name & Date): **Google Earth Aerial Imagery dates; 9/7/1999, 8/21/2003, 6/16/2005, 4/5/2006, 6/18/2014.**
  ☐ or ☑ Other (Name & Date): **Photographs - Plate 1-17, dated January 2018.**
- ☐ Previous determination(s). File no. and date of response letter:
- ☐ Applicable/supporting case law:
- ☐ Applicable/supporting scientific literature:
- ☐ Other information (please specify):

B. REQUIRED ADDITIONAL COMMENTS TO SUPPORT JD. EXPLAIN RATIONALE FOR DETERMINATION THAT THE REVIEW AREA ONLY INCLUDES DRY LAND: **No wetlands occur within the review area. Within the project boundary there is an erosional feature that traverses west-to-east toward an unnamed tributary to Fish Creek but does not have evidence of flow, OHWM physical indicators, defined bed and bank, and is vegetated by upland species. No aquatic resources occur within the project boundaries.**

[1] This form is for use only in recording approved JDs involving dry land. It extracts the relevant elements of the longer approved JD form in use since 2007 for aquatic areas and adds no new fields.

NOTIFICATION OF ADMINISTRATIVE APPEAL OPTIONS AND PROCESS AND REQUEST FOR APPEAL

Applicant: Twenty Mile Coal LLC, Attn: Mr. Jerry Nettleton	File No.: SPK-2016-00652	Date: July 31, 2018
Attached is:		See Section below
	INITIAL PROFFERED PERMIT (Standard Permit or Letter of permission)	A
	PROFFERED PERMIT (Standard Permit or Letter of permission)	B
	PERMIT DENIAL	C
→	APPROVED JURISDICTIONAL DETERMINATION	D
	PRELIMINARY JURISDICTIONAL DETERMINATION	E

SECTION I - The following identifies your rights and options regarding an administrative appeal of the above decision. Additional information may be found at *http://www.usace.army.mil/cecw/pages/reg_materials.aspx* or Corps regulations at 33 CFR Part 331.

A: INITIAL PROFFERED PERMIT: You may accept or object to the permit.

- ACCEPT: If you received a Standard Permit, you may sign the permit document and return it to the district engineer for final authorization. If you received a Letter of Permission (LOP), you may accept the LOP and your work is authorized. Your signature on the Standard Permit or acceptance of the LOP means that you accept the permit in its entirety, and waive all rights to appeal the permit, including its terms and conditions, and approved jurisdictional determinations associated with the permit.

- OBJECT: If you object to the permit (Standard or LOP) because of certain terms and conditions therein, you may request that the permit be modified accordingly. You must complete Section II of this form and return the form to the district engineer. Your objections must be received by the district engineer within 60 days of the date of this notice, or you will forfeit your right to appeal the permit in the future. Upon receipt of your letter, the district engineer will evaluate your objections and may: (a) modify the permit to address all of your concerns, (b) modify the permit to address some of your objections, or (c) not modify the permit having determined that the permit should be issued as previously written. After evaluating your objections, the district engineer will send you a proffered permit for your reconsideration, as indicated in Section B below.

B: PROFFERED PERMIT: You may accept or appeal the permit

- ACCEPT: If you received a Standard Permit, you may sign the permit document and return it to the district engineer for final authorization. If you received a Letter of Permission (LOP), you may accept the LOP and your work is authorized. Your signature on the Standard Permit or acceptance of the LOP means that you accept the permit in its entirety, and waive all rights to appeal the permit, including its terms and conditions, and approved jurisdictional determinations associated with the permit.

- APPEAL: If you choose to decline the proffered permit (Standard or LOP) because of certain terms and conditions therein, you may appeal the declined permit under the Corps of Engineers Administrative Appeal Process by completing Section II of this form and sending the form to the division engineer (address on reverse). This form must be received by the division engineer within 60 days of the date of this notice.

C: PERMIT DENIAL: You may appeal the denial of a permit under the Corps of Engineers Administrative Appeal Process by completing Section II of this form and sending the form to the division engineer (address on reverse). This form must be received by the division engineer within 60 days of the date of this notice.

D: APPROVED JURISDICTIONAL DETERMINATION: You may accept or appeal the approved JD or provide new information.

- ACCEPT: You do not need to notify the Corps to accept an approved JD. Failure to notify the Corps within 60 days of the date of this notice, means that you accept the approved JD in its entirety, and waive all rights to appeal the approved JD.

- APPEAL: If you disagree with the approved JD, you may appeal the approved JD under the Corps of Engineers Administrative Appeal Process by completing Section II of this form and sending the form to the division engineer (address on reverse). This form must be received by the division engineer within 60 days of the date of this notice.

E: PRELIMINARY JURISDICTIONAL DETERMINATION: You do not need to respond to the Corps regarding the preliminary JD. The Preliminary JD is not appealable. If you wish, you may request an approved JD (which may be appealed), by contacting the Corps district for further instruction. Also you may provide new information for further consideration by the Corps to reevaluate the JD.

SECTION II - REQUEST FOR APPEAL or OBJECTIONS TO AN INITIAL PROFFERED PERMIT

REASONS FOR APPEAL OR OBJECTIONS: (Describe your reasons for appealing the decision or your objections to an initial proffered permit in clear concise statements. You may attach additional information to this form to clarify where your reasons or objections are addressed in the administrative record.)

ADDITIONAL INFORMATION: The appeal is limited to a review of the administrative record, the Corps memorandum for the record of the appeal conference or meeting, and any supplemental information that the review officer has determined is needed to clarify the administrative record. Neither the appellant nor the Corps may add new information or analyses to the record. However, you may provide additional information to clarify the location of information that is already in the administrative record.

POINT OF CONTACT FOR QUESTIONS OR INFORMATION:

If you have questions regarding this decision and/or the appeal process you may contact:

Tyler R. Adams
Project Manager, Colorado West Section
Regulatory Division
U.S. Army Corps of Engineers
Colorado West Regulatory Section
400 Rood Avenue, Room 224
Grand Junction, Colorado 81501
FAX (970) 241-2358
Phone: (970) 243-1199 X 1013, FAX 916-557-7803
Email: Tyler.R.Adams@usace.army.mil

If you only have questions regarding the appeal process you may also contact:

Thomas J. Cavanaugh
Administrative Appeal Review Officer
U.S. Army Corps of Engineers
South Pacific Division
1455 Market Street, 2052B
San Francisco, California 94103-1399
Phone: 415-503-6574, FAX 415-503-6646)
Email: Thomas.J.Cavanaugh@usace.army.mil

RIGHT OF ENTRY: Your signature below grants the right of entry to Corps of Engineers personnel, and any government consultants, to conduct investigations of the project site during the course of the appeal process. You will be provided a 15 day notice of any site investigation, and will have the opportunity to participate in all site investigations.

	Date:	Telephone number:
Signature of appellant or agent.		

Twentymile Coal Mine Discharge Passive Treatment System Design

Prepared for

Peabody Energy

10/10/2018

Revision: Final

ch2m

Tables

Acronyms and Abbreviations

cfs: cubic feet per second

µg/g: microgram per gram

µg/L: microgram per liter (equivalent to parts per billion, or ppb)

BMP: best management practice

CDPS: Colorado Discharge Permit System (CDPS)

DWSE: Design Water Surface Elevation

Fe: Iron

gpm: gallons per minute

gpd: gallons per day

lbs/day: pounds per day

lbs/yr: pounds per year

mg/kg: milligram per kilogram

mg/L: milligram per liter (equivalent 2 parts per million, or ppm)

pH: potential of hydrogen (measurement of acidity of a water sample)

psi: pounds per square inch

SSF: subsurface flow

TDS: total dissolved solids

TSS: total suspended solids

USEPA: United States Environmental Protection Agency

Executive Summary

Twentymile Coal (TC), the current operator of the Foidel Creek Mine (the mine) located in northwest Colorado, has developed and is proceeding with mining of a coal seam which underlies previously mined areas. These mining activities will require drainage and treatment of water which has accumulated in the previously mined areas to remove mine water contaminants including iron, sulfate and total dissolved solids. TC intends to pump the mine water through a passive treatment system to improve the water quality, as part of the mine water treatment and handling system. Passive treatment systems have been shown to provide effective treatment of similar composition in other applications. TC had requested CH2M HILL (CH2M) to complete a conceptual study on passive treatment alternatives in December 2015. This study, "Twentymile Coal Mine Discharge Passive Treatment Evaluation" referenced in Appendix A, had identified that a constructed free water surface wetland system consisting of five cells in series, including the 6MN Pond as the final polishing cell, would provide cost effective removal of mine water contaminants. At the conclusion of the treatment project, the wetland area would be removed and reclaimed, although TC is further evaluating the potential to retain the wetlands to continue to function passively as a wildlife habitat, fed by natural precipitation and runoff.

The 2016 design ran into permitting obstacles that ultimately required the system to be moved to a new location. CH2M HILL was asked to update the system to conform to the new location while making minimal changes to the design. In general, the basis of design factors that influence sizing of the system remained similar or in most case led to the original design being conservatively sized. The system modeling for cell sizing and hydraulics remained as completed in the 2016 design. As a new location, TC will need to verify the characteristics of the foundation and construction materials, although given proximity and similar topography, it is reasonable to assume that they will be very similar to the original location.

Introduction

1.1 Project Background

The Foidel Creek Mine sits on 20,000 acres in the Uinta Coal Basin. Current coal reserve estimates are approximately 52 million tons of recoverable coal. The mining operation process includes mining coal seams and the associated overburden and interburden units which produce a limited amount of groundwater and drain to the mine workings. Excess water from mine drainage and dust control activities drain to established sumps which are then pumped to sealed and abandoned mine areas, acting as large underground water storage pools.

TC has recently developed rock slopes to provide access for future development and mining of a new coal seam. Two underground pools of accumulated ground water containing approximately 400 million gallons of water will need to be drained for safety reasons. TC is intending to pump the water to the surface and discharge it to a local stream. The pumping operation is estimated to require nine years, with pumping rates varying depending on the volume of stored water at different locations within the mine.

The ground water to be discharged includes concentrations of iron (Fe), sulfate (SO4), and total dissolved solids (TDS) concentrations that exceed typical surface water values. To enable surface discharge, the groundwater will require treatment. Final discharge criteria are anticipated to be defined through discussions with the Colorado Department of Public Health Safety and Environment (CDPHE). Given the relatively short duration of the pumping operation (dewatering), passive treatment systems are the preferred method to be used to improve the water quality of the effluent discharge.

Passive treatment systems such as the one covered in this design, require less energy and operational effort to maintain than conventional mechanical or chemical treatment systems, but typically require extensive areas of land to support the level of treatment necessary to meet discharge criteria. The proposed site has adequate area for this application, and has enough elevation change across the site to support a passive flow by gravity through the system. After the completion of the dewatering operation, the wetland system will remain in place as a wildlife habitat and for polishing of site stormwater runoff.

Passive treatment systems rely upon naturally occurring physical, chemical and biological processes to improve water quality without active introduction of energy and materials. Iron is typically removed through precipitation as iron hydroxides and oxyhydroxides in open water where oxygen is present (i.e., aerobic), or complexed as a sulfide compound (e.g., pyrite) in water where oxygen is low or absent (i.e., anaerobic). Sulfate is typically reduced in the same anaerobic environment to sulfide, which then may complex with available iron. Passive treatment of sulfate centers on reducing sulfate to sulfide under anaerobic conditions. Total dissolved solids (TDS) represents the total mass of elements and compounds present in the water. The dissolved solids are typically dominated by positively charged elements (i.e., cations) such as calcium, magnesium, sodium and potassium, among other trace metals, and anions that are typically dominated in freshwater by sulfate, carbonate, and nitrate. As such, the reduction of TDS typically occurs in passive treatment systems through sorption of salts to organic and metal surfaces and biological reduction of anions under anaerobic conditions. Of the three compounds of concern, iron has been demonstrated to be readily removed under both aerobic and anaerobic conditions. Of the three compounds comprising treatment criteria for the Foidel Creek mine discharge, iron is the parameter most responsive to passive treatment and serves as the primary basis of sizing in this analysis.

1.2 Purpose and Objectives

Waters treated by the proposed pond-wetland system will flow into the 6MN pond, which currently does not discharge. TC intends to drain this pond to allow a controlled flow to Fish Creek. The purpose of the passive treatment system is to reduce mine water contaminants to acceptable limits prior to discharge. This technical memorandum outlines the constructed wetland passive treatment configuration, design and cost information. A list of abbreviations and acronyms is provided at the end of the report.

1.3 Location

Foidel Creek Mine is located in Routt County, approximately 20 miles southwest of Steamboat Springs, Colorado at an elevation of approximately 6,800 feet. The 6MN Reservoir and the Fish Creek discharge point is located approximately 2.5 miles north of the mine (Figure 1-1).

On average, Steamboat Springs receives approximately 24 inches of rain and 166 inches of snow on an annual basis. Average evaporation rates range between 5.5 to 7 inches during the summer and 2.6 to 4.5 during the fall. The mean annual temperature at Steamboat Springs is 38°F with temperatures being as high as 82°F in the summer and as low as 0-3°F in the winter. Freezing temperatures can occur during any month of the year and the average annual growing season (above 20 °F) of irrigated land near the Yampa River (tributary basin of Fish Creek) and Steamboat Springs is 102 days (Colorado Water Conservation Board and USDA, 1969). Table 1-1 below provides monthly average temperatures, precipitation, snowfall and snow depth as reported by the Western Regional Climate Center for the duration of 9/1908 to 12/2005.

Figure 1-1: Foidel Creek Twentymile Coal Mine Location

Table 1-1: Climate Data Summary for Steamboat Springs, Colorado

	Average Max. Temperature (°F)	Average Min. Temperature (°F)	Average Total Precipitation (in.)	Average Total Snow Fall (in.)	Average Snow Depth (in.)
Jan	28.8	1.1	2.47	35.5	23
Feb	33.9	4.2	2.23	29.6	28
Mar	42	13.5	2.11	23.8	20
Apr	53.5	24.3	2.29	13.3	3
May	65.2	31.4	2.08	2.7	0
Jun	75.3	35.7	1.53	0.1	0
Jul	82.4	41.4	1.54	0	0
Aug	80.3	40.2	1.63	0	0
Sep	72.3	32.6	1.8	0.9	0
Oct	60.2	24	1.91	6.8	0
Nov	42.9	14.2	1.98	20.2	3
Dec	30.5	3.3	2.41	32.9	12
Annual	55.6	22.2	23.9	165.9	7

System Design Basis

2.1 System Type

For treatment of the Foidel Creek mine water, the type of passive treatment system selected was a free water surface constructed wetland. Land is available at the project location that encompasses a slope in the terrain sufficiently steep enough to ensure that water will flow through the system by gravity. Future use will include polishing of stormwater prior to discharging. Design layout, details and drawings of this system are included in Appendix C and are also covered in the System Description section of this TM.

2.2 Flow and Water Quality Design Criteria

TC provided flow and water quality data which serve as the design basis for the proposed wetland treatment system. Table 2 summarizes the water quality characteristics and inflow/outflow criteria used to determine an appropriate loading rate and size for this system.

The average flow data was determined based on the Mine Dewatering Schedule provided by TC as summarized in Conceptual Study in Appendix A. The East Mine District period will have the highest average flow of 357 gpm and is used as the design inflow rate for wetland sizing. Expected mine discharge water quality data was also provided by TC and conducted by ACZ Laboratories (Appendix B). For conservativism in analysis, the highest concentration values for iron, sulfate and TDS were selected as the influent design concentration.

Table 2-1: Basis of Design, Foidel Creek Passive Treatment System

Water Quality Data			
Water Quality	**Iron (mg/L)**	**Sulfate (mg/L)**	**TDS (mg/L)**
Influent Design Parameters	1.8	2,510	5,310
Discharge Goal	< 1.0	< 2,000	< 1,200
Flow and Temperature			
Average Design Rate (gpm)		357	
Average Inflow Temperature (degrees F)		46	

2.3 Performance Modeling and Results

During the conceptual study phase, treatment performance was modeled to determine size and configuration using a first-order wetland treatment model based on published first-order removal rates (Kadlec and Wallace, 2009). Details of the performance modeling can be referenced in the conceptual study in Appendix A. The system was modeled as a series of four wetlands that discharge into the 6MN pond. A minimum wetland treatment area, or Design Water Surface Elevation (DWSE) area, for each cell was determined to meet the water quality criterion for iron and sulfate. To ensure that iron in the outflow will be less than the design target, the first four wetland basins were sized to exceed the minimum treatment area requirement. In addition to this requirement, the existing 6MN Pond was included in the model to perform as the final polishing cell for additional treatment prior to final discharge into Fish Creek. The same

performance modeling requirement was used to confirm the results for the final design system. The total area for the final design system, including the 6MN Pond, is 8.9 acres. With this final design area, the model estimated an average 57% reduction in iron from 1.80 mg/L to 0.78 mg/L and a 20% sulfate reduction from 2520 mg/L to 2012 mg/L, thereby meeting the expected discharge targets outlined in Table 3. Although pumping rates will fluctuate over the life of the mine dewatering activities, iron and sulfate targets are expected to be achievable at minimum and maximum design flows.

Table 2-2: Basin Concentration Reduction Performance for the 357 gpm Design Dewatering Rate

Wetland Basin	Fe Rate Constant (m/yr)	Fe In (mg/L)	Fe Out (mg/L)	Sulfate Rate Constant (m/yr)	Sulfate In (mg/L)	Sulfate Out (mg/L)	TDS Rate Constant (m/yr)	TDS In (mg/L)	TDS Out (mg/L)
Basin 1	45	1.80	1.37	5	2510	2436	2	5310	5241
Basin 2	16	1.37	1.24	5	2436	2366	2	5241	5174
Basin 3	16	1.24	1.13	5	2366	2304	2	5174	5114
Basin 4	16	1.13	1 02	5	2304	2237	2	5114	5048
Basin 5	12	1.02	0.78	5	2237	2012	2	5048	4811
Total Fe Reduction:			57%	Total Sulfate Reduction:		20%	Total TDS Reduction:		9%

It is understood that the pumping rates will fluctuate over the life of the mine dewatering activities. Despite this variation, iron and sulfate targets are still expected to be achievable at minimum design flows. Lower flows provide additional retention time for solids settling and water processing, and therefore, lower final concentrations. Table 4 provides a comparison of iron, sulfate and TDS reduction at the maximum and minimum flowrate of 357 gpm and 75 gpm respectively. Although this design provides suitable performance for iron and sulfate, the target TDS removal is not achievable with a constructed wetland system. Options for TDS treatment have been discussed with Peabody and TDS treatment will need achieved outside the scope of this project.

Table 2-3: Wetland Performance Comparison for Min/Max Design Dewatering Rates

Size (Acre)	Flow Rate (gpm)	Fe k (m/yr)	Fe in (mg/L)	Fe Out (mg/L)	SO42- k (m/yr)	SO42- In (mg/L)	SO42- Out (mg/L)	TDS k (m/yr)	TDS in (mg/L)	TDS out (mg/L)
8.9	357	18	1.80	0.78	5	2510	2012	2	5310	4811
8.9	75	18	1.80	0.07	5	2510	919	2	5310	3521

Geotechnical Investigation

As part of the 2016 design CH2M HILL performed a geotechnical investigation to provide geotechnical recommendations for the system. The geotechnical recommendations for the 2018 design used those determined for the 2018 design, however, given that the location of the system moved to a new location there needs to be confirmation that the geotechnical recommendations still apply. TC informed CH2M HILL that they would be using a local geotechnical firm to confirm the previous site geotechnical recommendations still apply. The geotechnical firm will do their investigation as part of construction planning. The drawings as provided in this document are issued for review (IFR) given the geotechnical review that is required to take place ahead of construction.

3.1 Geotechnical Field and Laboratory Testing Program

A geotechnical investigation was performed as the first step of the final design phase in order to assess the stability of the proposed embankments slopes and verify suitability of borrow material for the constructed wetland system.

The geotechnical investigation included desktop study and field investigation components. The desktop study included reviews of available geological and soil maps, historical satellite imagery and geotechnical data for the 6MN Pond down slope of the project. Based on the information gathered during the desktop study and the data required to advance the design, a test pitting program was planned for early March 2016 (Appendix D). Originally 8 test-pits were planned to be excavated with locations selected to optimize data retrieval while assuming that no surface observations would be possible due to snow cover.

Due to a delay in site permitting, the field program was conducted in mid-April 2016, at which point the majority of the snow cover had melted and surface conditions could be assessed visually. Based on the consistency observed between test pits and surface conditions, 6 test pits were determined to be sufficient: TP16-1, 2, 3, 5, 6 and 7. Locations of the excavated test pits were selected based upon preliminary wetland areas, as shown on Figure 3-1.

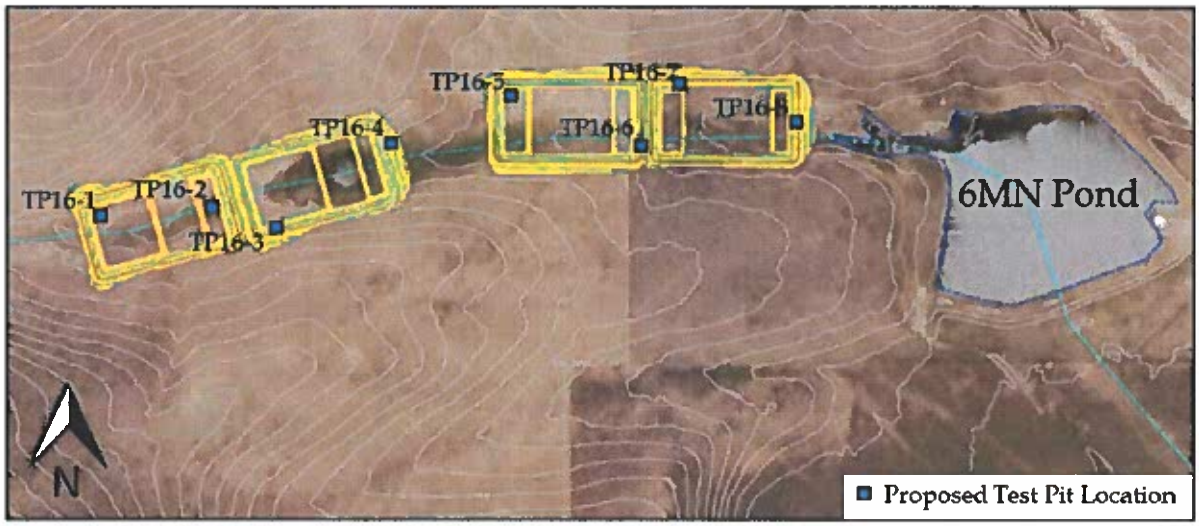


Figure 3-1: Test Pitting Locations

Observations from the test pit excavations included the following:

- A thin layer of organic rich topsoil was noted at each test pit location, typically to depths of 6 inches to one foot.
- Subsurface materials graded from residual clay soils through an intermediate material to a weathered shale over several vertical feet in each excavation, with the bottom of the excavation typically in the weathered shale unit. Material descriptions were made using the Unified Soil Classification System (USCS) and International Society of Rock Mechanics (ISRM) accepted descriptors for soil and rock materials, respectively.
  - Residual medium (lean) to high (fat) plasticity clay was observed to depths of 4 to 8 feet in all test pits except TP16-3.
    - Lean clay was observed to a depth of 3 feet in TP16-3, which was excavated on the South slope of the valley.
  - The intermediate material, between clay and shale was observed in each excavation and ranged from less than 1 to 4 feet thick.
    - The material was a highly to completely weathered rock, with the geological fabric of the underlying shale that could be broken apart to a mixed medium of clay and gravel sized shale fragments.
    - A layer with a notably lighter color (likely alkali precipitate) was observed in TP16-3 from a depth of 3 to 4 feet. This layer had the texture of the intermediate material, but was underlain by a stiff lean clay.
  - The shale that was excavated was moderately to highly weathered and extremely to very weak rock, which could be easily crumbled to gravel sized shale fragments without additional tools.
- Bulk samples were collected from the residual soil layer of each excavation. Grab samples were collected of the three material types observed in each excavation and where any notably different soil conditions were observed (e.g. the alkali layer in TP16-3). Note, no testing was performed on grab samples.
- Water seepage was observed in 4 of the 6 excavations. The water table typically occurred at the top of or up to a foot above the top of the shale layer.

Table 3-1: Geotechnical Laboratory Soil Testing Results

Test Pit ID	Sample Type	Date Retrieved	Moisture %	Atterberg Limits		pH	Percent Passing #200	AASHTO Class.	Soil Type (USCS)
				LL	PI				
TP16-1	Bulk	04/14/16	21.4	48	26	-	84.9	A-7-6 (23)	Lean Clay (CL)
TP16-2	Bulk	04/14/16	24.0	53	32	8.06	94.1	A-7-6 (33)	Fat Clay (CH)
TP16-3	Bulk	04/14/16	25.9	49	30	-	97.3	A-7-6 (32)	Lean Clay (CL)
TP16-5	Bulk	04/14/16	24.2	45	27	7.87	95.8	A-7-6 (27)	Lean Clay (CL)
TP16-6	Bulk	04/14/16	22.1	46	28	-	97.8	A-7-6 (29)	Lean Clay (CL)
TP16-7	Bulk	04/14/16	26.1	53	33	-	99.5	A-7-6 (37)	Fat Clay (CH)

Vine Laboratories, Inc. (Denver, CO) performed laboratory testing on select samples collected from the investigation to quantify soil properties. The laboratory testing results are included in Appendix F, and summarized in Table 5 below.

Index testing and soils gradations confirmed visual classifications of the on-site soils according to the Unified Soil Classification System (USCS) with fines contents typically exceeding 80 percent, as shown in Figures 3-2 and 3-3. Previous test data from the 2007 Site Investigation for the 6MN pond are also shown for reference.

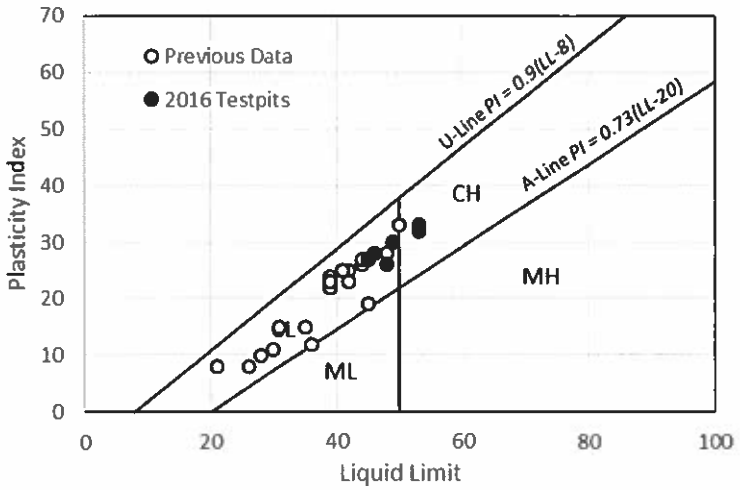


Figure 3-2: Plasticity Chart Depicting Distribution of Atterberg Limits from Laboratory Tests

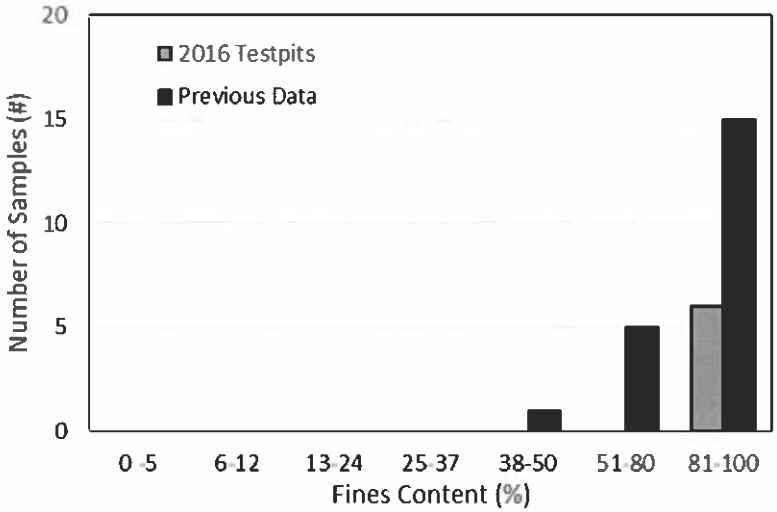


Figure 3-3: *Distribution of Fines Content from Sieve Testing of Samples*

3.2 Geotechnical Stability Analysis

Stability analyses of the embankment slopes were conducted to ensure that the global stability of the embankments met the minimum design criteria. Three loading conditions were considered during the stability analysis: End-of-Construction, Steady-State Seepage and Pseudostatic Seismic Analyses.

Slope stability analyses were performed using Slide, Version 7 (Rocscience, 2016). Limit equilibrium calculations are made to compute factors of safety with critical failure surfaces are identified using optimization search methods without constraints on the slip surface shape or location. A 3H:1V slope, the

maximum recommended for access and maintenance, satisfies all slope stability design criteria. Factors of safety (FOS) for the various stability analysis conditions are provided in Table 6.

Table 3-2: Computed Factors of Safety of 3H:1V
Upstream and Downstream Slopes for Considered Analysis Conditions

Analysis Condition	Slope	Factor of Safety	Design Criteria (Minimum FOS)
End-of-construction	Interior	1.89	1.3
End-of-construction	Exterior	1.57	1.3
Steady-state seepage	Exterior	2.23	1.5
Pseudostatic seismic stability	Exterior	1.91	1.0

3.3 Geotechnical Recommendations

3.3.1 Borrow Suitability

Based on the observed field conditions during the test pitting program, the soil graded gradually from residual clay soils appropriate for embankment fill material to the shale bedrock below. In all but one test pit, the transition from clay to shale was encountered at a depth of 4 to 8 feet. Within the transition zone, an intermediate weathered weak shale was encountered that crumbled easily to a clay rich soft gravel type material that does not compact to a water tight material in the same way as the clay soil above. The material used as borrow for the embankment should be restricted to the overlying clay soil, and not extend to include the intermediate material that crumbles into a clay rich material.

3.3.2 Embankment Foundation Preparation

The impoundment site is currently covered with grass. In addition, the uppermost 6 to 12 inches of the soil profile contains soil with organic matter that is unsuitable for embankment construction. Embankment foundation preparation will require stripping of the surface vegetation (roughly 6 inches) for disposal. The removed topsoil can be stockpiled for use as topsoil upon completion of the embankment.

3.3.3 Embankment Lining

Prior to the geotechnical investigation, the conceptual study proposed that the constructed wetlands would be lined with high density polyethylene (HDPE) geomembrane. However, results from the investigation have identified that a clay liner will be suitable for this application to prevent leakage of water through the berms and bottom and to maintain separation of residuals within the passive treatment systems.

For clay lined impoundments, it was determined that the maximum recommended permeability of materials used as fill is 1×10^{-7} cm/s. Based on the results of testing conducted in 2007 and the index properties of the materials tested within the project footprint in 2016, properly compacted borrow material is expected to meet permeability requirements. In addition, the native clay and shale underlying the proposed impoundments both have low permeability.

Practical methods for ensuring adequate permeability performance include the following design considerations:

- Construct the homogeneous embankment from clay compacted to 95% of standard proctor maximum density at a moisture content ranging from 1 point below to 3 points above optimum moisture content.

- In excavation/cut areas of each cell, scarify the subgrade in place to a depth of approximately 12 to 18 inches and re-compact to create a layer of compacted clay liner. Excess stripping material can be used to cover the compacted clay to protect the liner from desiccation by drying or freezing.

3.3.4 Embankment Slope Configuration

With consideration for geotechnical design evaluations, maximum slopes of 3H:1V are recommended for interior and exterior embankment slopes with a minimum crest width of 6 feet.

Case studies of embankments built with similar materials as the material observed at the passive treatment system site suggest that surface slumping is possible in embankments even at shallow slope angles. The surface slumps develop over time in the slopes due to degradation of the clay strength with wetting and drying, and heating and cooling of the materials. Case studies show that typically the softened behavior presents following 10-20 years of operation, but has been recorded as early as five years following construction.

Ongoing monitoring of the condition of the impoundment slopes is recommended over the full life of the system. In the case that surface slumps occur in the embankments, maintenance will be required to restore the slopes to their original state, so as to prevent further material degradation and global stability concerns.

Geotechnical specification that cover the earthwork and construction of the embankments are provided in Appendix D.

3.3.5 Bypass Ditch Configuration

No geotechnical design evaluations were conducted specifically for the proposed drainage ditch system that bypasses the north and south side of the treatment system. The 2H:1V drainage ditch slopes are expected to see some minor slumping and instabilities in these slopes given the slope materials and the steepness of the slopes. However, due to their height and function it is anticipated that the regular maintenance should be sufficient to maintain these slopes.

System Description

4.1 Configuration

The constructed wetland system is configured as five cells in series, including the 6MN Pond as a final polishing cell. This system is designed to include four new wetland basins totaling 4.54 acres, each averaging just over 1 to 1.5-feet in depth. Water will flow by gravity from basin to basin until discharge into the 6MN pond. Each Basin is separated by a spillway channel to assist with storm water conveyance. Bypass drainage ditches have been included on the north and south side of the wetland system to assist with stormwater conveyance around the treatment cells to the native flow path down the existing stream. Water from 6MN will be pumped to an existing TC treatment system. The layout for this system is provided in Figure 4-1 and detailed design drawings for this system are provided in Appendix C. Table 4-1 provides information on the wetland configuration and treatment size.

Table 4-1: Preliminary Wetland Configuration
Areas as measured from Design Water Surface Elevation (DWSE)

Wetland Basin	Planting Area (Acre)	Treatment Area (Acre)
Basin 1	0.62	1.17
Basin 2	0.69	1.16
Basin 3	0.81	1.05
Basin 4	0.92	1.16
Basin 5 (Existing 6 MN Pond)	0.00	4.36
Total:	3.07	8.90

4.2 Vegetation

Vegetation to be planted within the wetland is recommended to include common native wetland plants such as bulrush (*Schoenoplectus* sp.), cattail (*Typha* sp.) and rush (*Juncus* sp.). These species have depth requirements that are relatively shallow (1-2 feet) and are typically available from commercial aquatic plant nurseries. Plants would be installed on 3-foot centers, which will expand through natural vegetative growth and coalesce into a single cover. This process is expected to require two complete growing seasons at the project location and altitude. Greater planting density will accelerate growth in plant cover. Total planting areas are provided in Table 7 above.

Excavation and topsoil placement will be completed in areas where planting is required. Preparation and placement requirements are provided in the Earthwork Specifications in Appendix E. Perimeters of each wetland basin should be planted to a depth of +2 feet relative to the marsh grade, as this will provide additional treatment area sustained by water seepage, and help stabilize soils adjacent to the wetland. Deep zones should be planted to a depth of 1 foot below the marsh grade to maximize vegetated area and to stabilize the interface between the deep and shallow zones.

During filling of the wetland basins, water should be introduced first into each deep zone before discharging to the wetland system. This will protect the shallow and deep zone margins from erosion. The water to fill

the deep zones can be provided from the pumped groundwater. Alternatively, the downstream edge of each marsh zone can be temporarily covered in a liner to allow water to sheet over the top and into the deep zone, and then removed as the water levels in the deep zone approach the marsh grade.

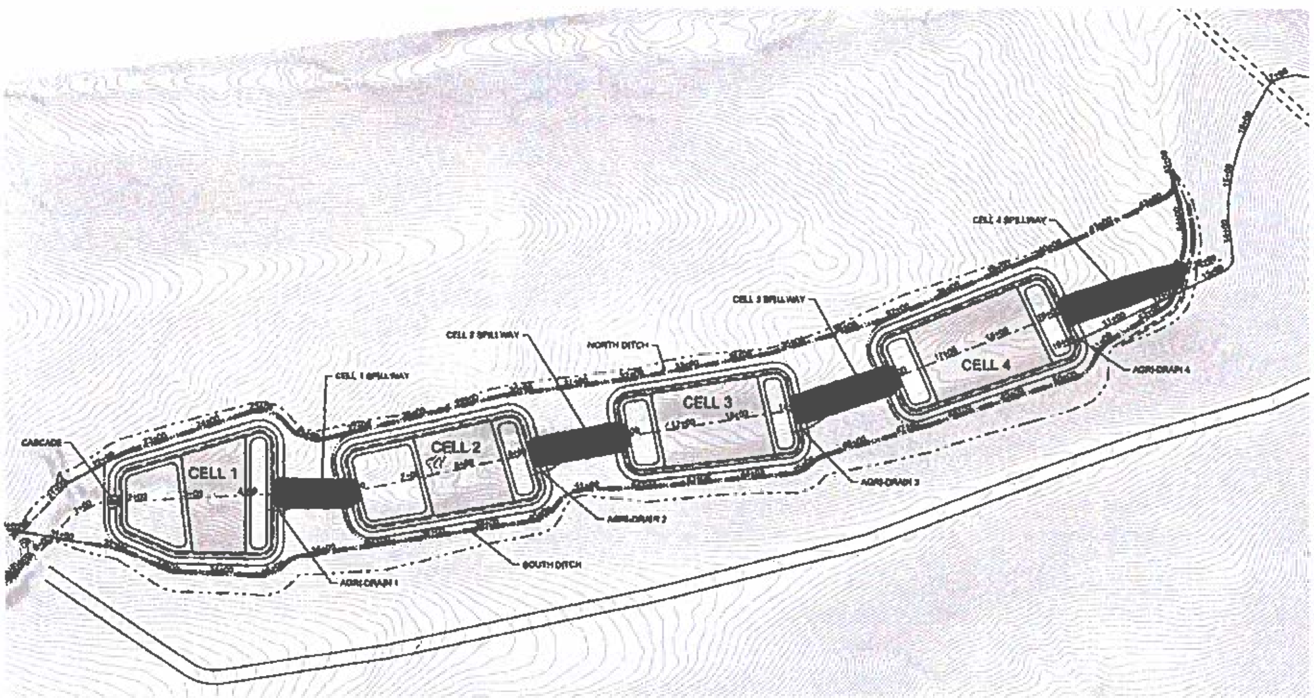


Figure 4-1: Constructed Wetland Layout

4.3 Pipe Sizing

The piping and infrastructure for each cell were selected to maintain water levels and accomplish the desired flow direction, timing, and control. Transfer of water from the level control structure (Agri Drain) to the riprap channel downstream of each cell by gravity flow was modeled using AFT Fathom software. HDPE pipe (SDR-21) with a length of 50 feet was used, assuming one 45° bend, entrance and exit losses and a design flow of 357 gpm. The model assumes full pipe flow. A slope of 1:100 (0.6°) was maintained for each pipe. For example, the pipe entrance and exit elevations corresponding to Cell 1 are 6750 feet and 6749.5 feet, respectively, and the Agri Drain overflow weir elevation was assumed to be 6753.75 feet. The velocities and head losses corresponding to 4-inch, 6-inch, and 8-inch pipes at a design flow of 357 gpm and a minimum flow of 75 gpm were evaluated, and the results are summarized in Table 8.

Table 4-2: Velocities and Head Losses

Pipe Diameter (inch)	Flow = 357 gpm		Flow = 75 gpm	
	Velocity (ft/sec)	Head Loss Through Pipe (ft)	Velocity (ft/sec)	Head Loss Through Pipe (ft)
4	8.910	4.852	1.872	0.257
6	4.110	0.870	0.864	0.044
8	2.425	0.274	0.510	0.014

The high head loss through the 4-inch pipe will cause the upstream water level at the pipe entrance to rise above the weir elevation, which would reduce the effectiveness of the level control structure. Therefore, the 4-inch pipe option is not recommended. While a 6-inch pipe will be sufficient to transfer water from the Agri Drain to the riprap channel, an 8-inch line is recommended since it provides additional flow capacity and will be less prone to pipe blockages from debris or animals that may enter the pipe. Since the water in the Agri Drain discharge is expected to be low in suspended solids, the minimum velocity of 0.5 ft/sec at 75 gpm is not a concern.

Figure 4-2 shows the elevation and calculated energy grade lines for the 8-inch pipe option at 357 gpm. The energy grade line (shown in blue) starts below the pipe elevation (shown in green), indicating that at this flow, the pipe is likely to be only partially full. Figure 4-3 shows the elevation and energy grade lines assuming the maximum possible flowrate of 1,434 gpm through the 8-inch pipe. At this flowrate, the upstream water level will be just below the Agri Drain weir elevation.

In 2018, TC noted to CH2M HILL that the site had 10" HDPE available so it was determined to use this pipe from each cell to the subsequent wetland cell.

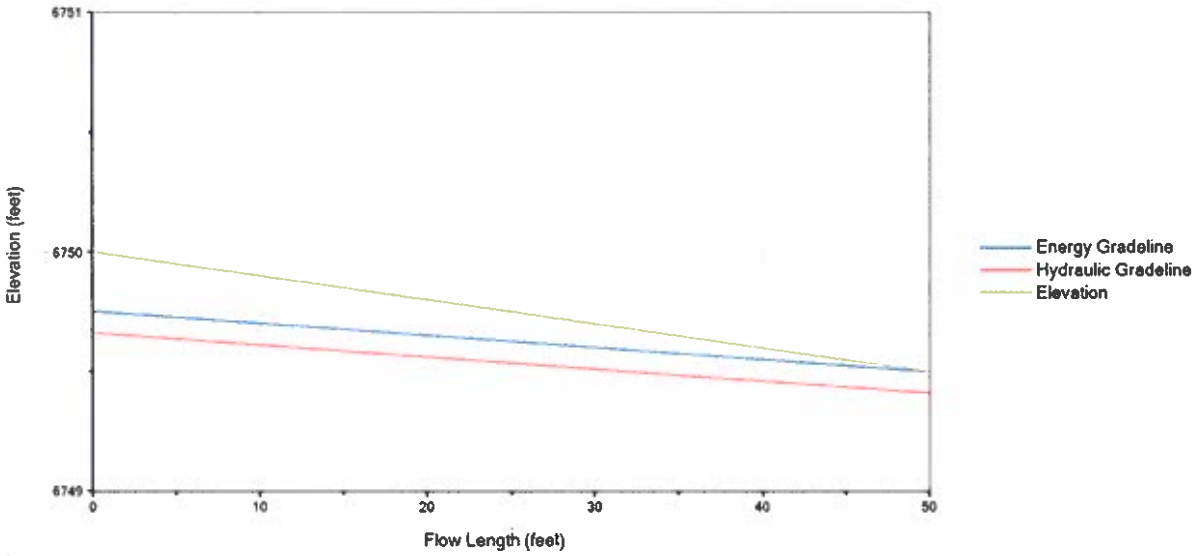


Figure 4-2: Hydraulic Grade Line and Energy Grade Line Corresponding to a Defined Flow of 357 gpm (8-inch pipe)

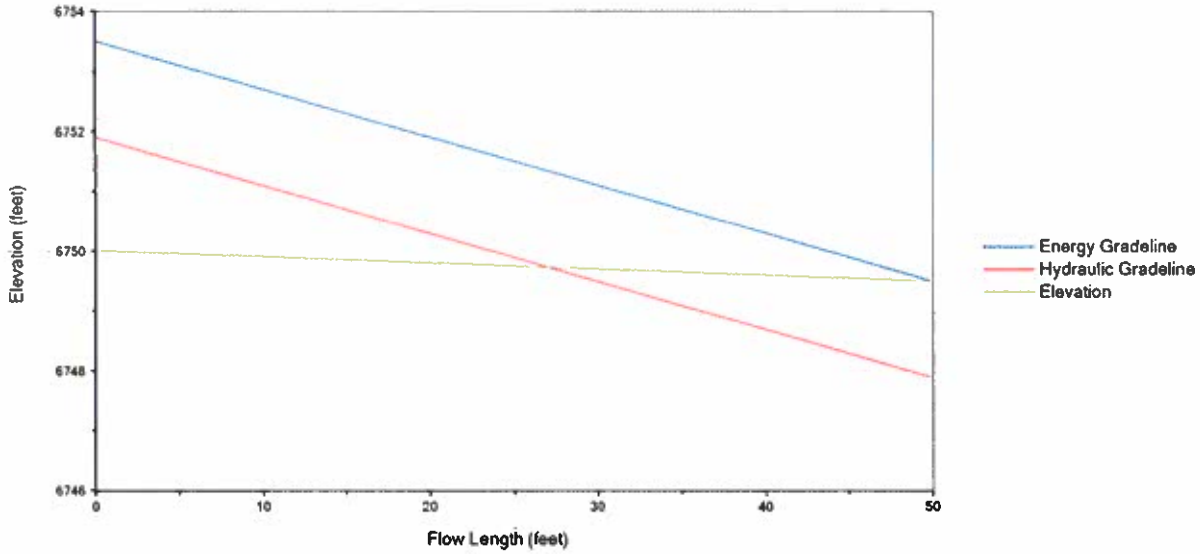


Figure 4-3: Hydraulic Grade Line and Energy Grade Line Corresponding to Upstream Reservoir Level of 6753.75 feet (8-inch pipe)

4.4 Agri Drain Water Level Control Structures

An Agri Drain is an in-line water level control structure manufactured by Agri Drain Corporation of Adair, Iowa. As shown in Figure 4-4, these are simple devices for controlling the water level in a PTS. The water level can be adjusted by adding or removing stop-logs using a metal tool designed to hook the stop-logs to allow them to be pulled up from the surface.

The Agri Drains were sized by calculating the head over the weir of the Agri Drain and the head loss through the upstream piping for a design flow of 357 gpm. The head over the Agri Drain weir was calculated assuming a rectangular suppressed weir and the losses in the upstream pipe were calculated assuming 20 feet of pipe at diameters corresponding to the various Agri Drain sizes. The hydraulic profile provided in Figure 4-5 was calculated by assuming a starting weir elevation, then adding the head over the weir plus the pipe friction and minor losses. This provided the calculated corresponding water level in a given cell in the constructed wetland system.

The results of the Agri Drain sizing calculations showed that multiple Agri Drain units will be able to maintain the desired water levels in each cell. Since an 10-inch HDPE pipe was selected to transfer water from each cell to the riprap channel downstream, an Agri Drain unit equipped with 10-inch inlet and outlet pipes was selected as the appropriate size to maintain water levels in each cell.

Figure 4-4: Agri-Drain Desicription and Component Details.
Source: Agri-Drain, Inc

Evaluation of an Agri Drain unit corresponding to an 10-inch pipe diameter and weir width of 11 5/8-inch resulted in a water depth of 1.4 feet in the shallow marsh zone. Figure 4-5 shows the hydraulic profile corresponding to an Agri Drain in Cell 1 with an 10-inch pipe.

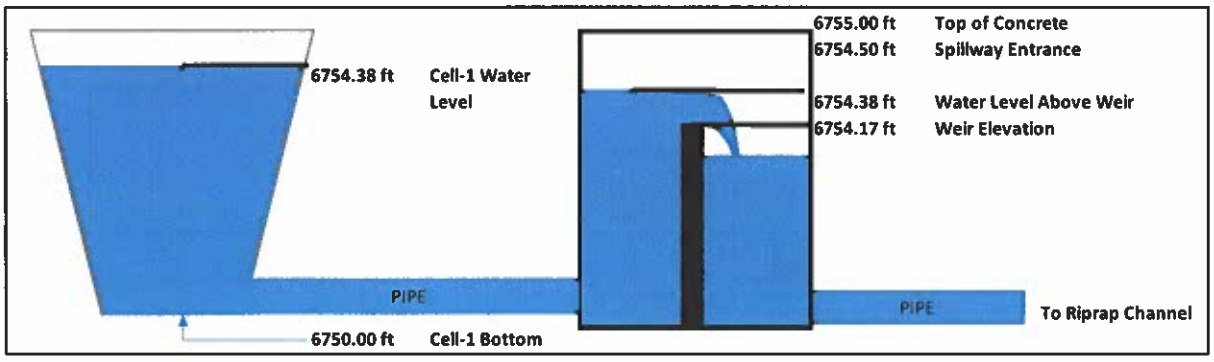


Figure 4-5: Hydraulic Profile, Cell 1 Basin and Agri-Drain Water Control Structure

4.5 Spillways

Spillways will be constructed on the influent and effluent end of each cell within the system to allow for capture and conveyance of storm water associated with extreme storm events. During rainfall events, storm water is expected to blend with the wetland-treated water. The spillways are notched into the downstream containment berm to allow high water flow directly to the subsequent cell. The spillways are lined with geotextile, protected with rip-rap or stone, and sprayed with grout.

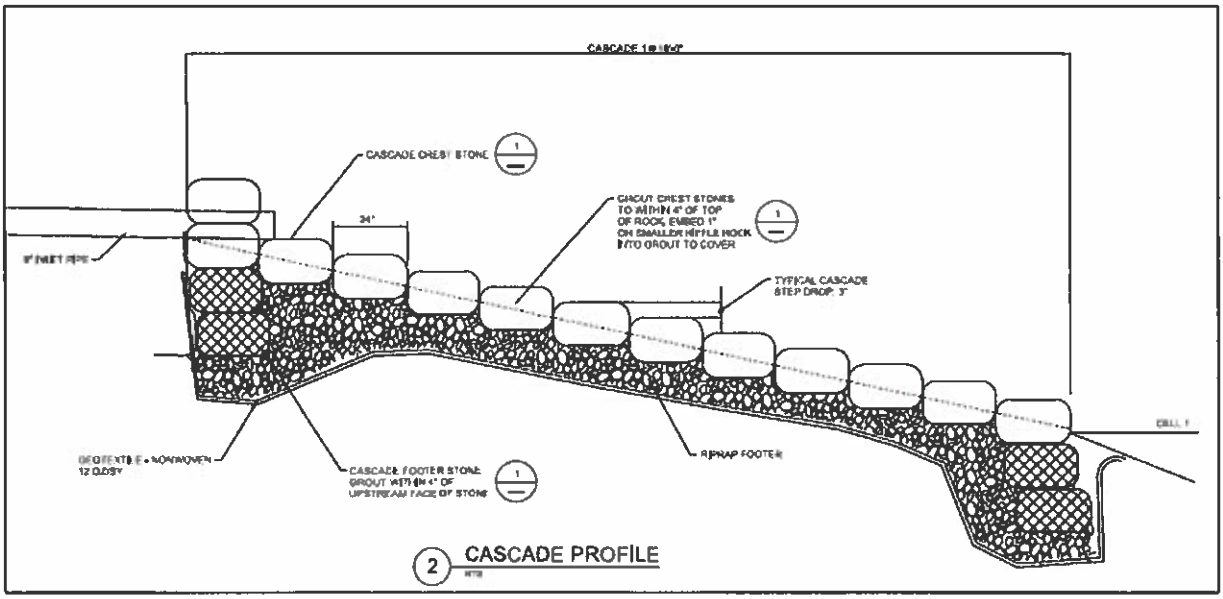


Figure 4-6: Influent Cascade Profile into Cell 1

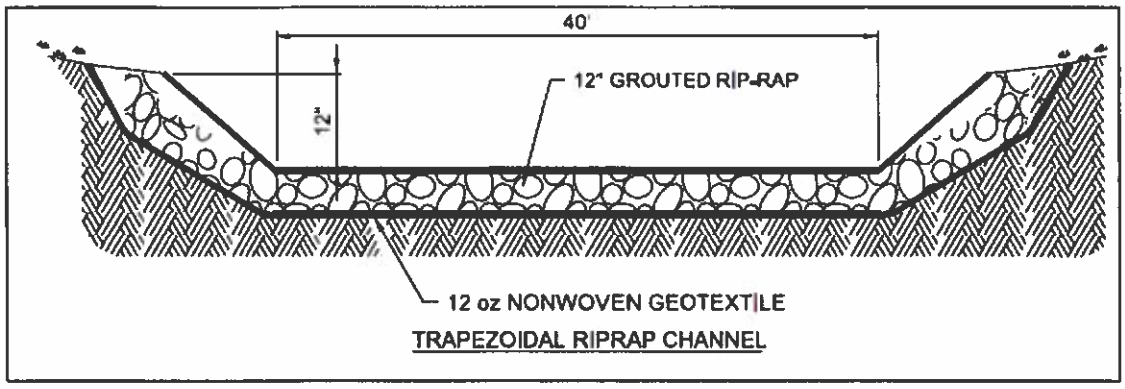


Figure 4-7: Rip Rap Lined Spillway Channel

4.6 Bypass Ditch

Stormwater flow through the system was assessed using the Interconnected Channel and Pond Routing (ICPR) Model (Streamline Technologies, Inc.). ICPR is a commercial software program used to estimate flood routing through networks of interconnected and hydraulically interdependent stormwater ponds. The drainage basin data and the 100 yr-24 storm event data (rainfall depth and storm type) were obtained from information provided by TC (Appendix G). The model was used to determine the sizing necessary for the bypass ditches and spillway channels to withstand expected stormwater volume with the current design parameters. It was also modeled to confirm that the system can handle the conceptual future post treatment plan when dewatering actives have ceased and the north and south bypass ditch have been tied into the wetland system for a post-treatment runoff routing.

In order to capture the worst-case scenario, the site catchment area was divided into North and South drainage basins, and the flow generated was assumed to discharge entirely into Cell 1 of the NTS and the system conveyance structures were sized accordingly. As an additional safety factor, the model assumed that each cell was full to the designed water surface elevation and that the cells were open ponds.

The model results confirmed that the system sizing is sufficient to handle the storm water event assumptions provided in the TC report.

Class III Cost Estimate

In 2016, a Class III capital cost estimate for the proposed constructed wetland design is provided in Appendix H. The basis of the estimate, allowances and other criteria are included in this detailed summary. A total cost of $1,374,000 was estimated to construct the four-cell wetland system above Pond 6MN, bypass, cascade and spillway structures.

PE Certification

I hereby certify that Jason Rysavy was the engineer in responsible charge for the final Peabody Passive Treatment System for Mine Dewatering design and addendum. I affirm that I have reviewed the documents for conformance with applicable standards of practice. I affirm that based on my best professional judgment the Peabody Passive Treatment System will perform to expectations based on influent load and flow ranges conforming to the design range.

Jason Rysavy, PE
Engineer
CH2M HILL Engineers, INC

References

Kadlec, R.H. and S. Wallace. 2009. Treatment Wetlands, 2nd Ed. CRC Press, Boca Raton, FL.

Twentymile Coal, LLC – Foidel Creek Mine Climatic Summary

www.usclimatedata.com

Watzlaf, G., K.Schroeder, R. Kleinmann, C. Kairies, and R. Nairn. 2004. The Passive Treatment of Coal Mine Drainage. National Energy Laboratory. US Department of Energy. Information Circular.

http://www.Agri Drain.com/watercontrolproductsinline. asp

Appendix A

Conceptual Study - Twentymile Coal Mine Discharge Passive Treatment Evaluation

Start Date	End Date	De-Watering Area	Days	De-watering Flow Rate	Flow Rate for Mining	Total Flow Rate (gpm)	Total Volume (gal)
9/15/2015	10/15/2015	LW & CM Mining	30	0	75	75	3,240,000
10/15/2015	7/26/2016	North Mine District	285	200	75	275	112,860,000
7/26/2016	6/1/2021	North Mine District	1771	10	75	85	216,770,400
6/1/2021	4/1/2023	East Mine District	669	282	75	357	343,919,520
4/1/2023	6/1/2024	LW & CM Mining	427	15	75	90	55,339,200
6/1/2024	10/1/2028	North Mine District	1583	118	75	193	439,947,360

Appendix B

Twentymile Coal Mine Water Quality Analysis

ACZ Laboratories, Inc.
2773 Downhill Drive Steamboat Springs, CO 80487 (800) 334-5493

Inorganic Analytical Results

Twentymile Coal Co.
Project ID: 450183184
Sample ID: 10RT

ACZ Sample ID: ***L71537-01***
Date Sampled: *09/02/08 09:35*
Date Received: *09/02/08*
Sample Matrix: *Ground Water*

Inorganic Prep

Parameter	EPA Method	Result	Qual	XD	Units	MDL	PQL	Date	Analyst
Total Recoverable Digestion	M200.2 ICP-MS							09/03/08 8:14	jws
Total Recoverable Digestion	M200.2 ICP							09/03/08 16:44	jws

Metals Analysis

Parameter	EPA Method	Result	Qual	XD	Units	MDL	PQL	Date	Analyst
Barium, total recoverable	M200.7 ICP		U	*	mg/L	0.03	0.2	09/04/08 21:05	aeh
Cadmium, total recoverable	M200.8 ICP-MS		U		mg/L	0.0001	0.0005	09/03/08 17:44	rac
Calcium, dissolved	M200.7 ICP	55		*	mg/L	2	10	09/04/08 15:08	ear
Iron, total recoverable	M200.7 ICP	1.8		*	mg/L	0.2	0.5	09/04/08 21:05	aeh
Magnesium, dissolved	M200.7 ICP	28		*	mg/L	2	10	09/04/08 15:08	ear
Manganese, total recoverable	M200.7 ICP		U	*	mg/L	0.05	0.3	09/04/08 21:05	aeh
Mercury, total	M245.1 CVAA		U		mg/L	0.0002	0.001	09/03/08 22:48	pmc
Molybdenum, total recoverable	M200.7 ICP		U	*	mg/L	0.1	0.5	09/05/08 14:55	aeh
Selenium, total recoverable	M200.8 ICP-MS	0.0002	B		mg/L	0.0001	0.0005	09/03/08 17:44	rac
Silver, total recoverable	M200.8 ICP-MS		U		mg/L	0.00005	0.0003	09/03/08 17:44	rac
Sodium, dissolved	M200.7 ICP	1590		*	mg/L	3	20	09/04/08 15:08	ear
Zinc, total recoverable	M200.7 ICP		U	*	mg/L	0.1	0.5	09/04/08 21:05	aeh

ACZ Laboratories, Inc.
2773 Downhill Drive Steamboat Springs, CO 80487 (800) 334-5493

Inorganic Analytical Results

Twentymile Coal Co.
Project ID: 450183184
Sample ID: 10RT

ACZ Sample ID: ***L71537-01***
Date Sampled: *09/02/08 09:35*
Date Received: *09/02/08*
Sample Matrix: *Ground Water*

Wet Chemistry

Parameter	EPA Method	Result	Qual	XQ	Units	MDL	PQL	Date	Analyst
Alkalinity as CaCO3	SM2320B - Titration								
Bicarbonate as Bicarbonate		1340			mg/L	2	20	09/04/08 0:00	kah
Carbonate as Carbonate		51			mg/L	2	20	09/04/08 0:00	kah
Hydroxide as Hydroxide			U		mg/L	2	20	09/04/08 0:00	kah
Total Alkalinity		1180			mg/L	2	20	09/04/08 0:00	kah
Carbon, total organic (TOC)	SM5310B	34		*	mg/L	3	20	09/09/08 12:04	scp
Conductivity @25C	SM2510B	7230			umhos/cm	1	10	09/04/08 5:05	kah
Lab Filtration	SM 3030 B			*				09/02/08 15:28	jlf
Lab Filtration & Acidification	SM 3030 B			*				09/02/08 16:17	jlf
Nitrate/Nitrite as N	M353.2 - H2SO4 preserved		U	*	mg/L	0.02	0.1	09/04/08 16:18	ccp
Nitrogen, ammonia	M350.1 - Automated Phenate	5.7		*	mg/L	0.1	1	09/04/08 17:05	lbn
pH (lab)	SM4500H+ B								
pH		8.5	H		units	0.1	0.1	09/04/08 0:00	kah
pH measured at		20.0			C	0.1	0.1	09/04/08 0:00	kah
Phosphorus, ortho dissolved	M365.1 - Automated Ascorbic Acid	0.01	B	*	mg/L	0.01	0.05	09/03/08 19:58	pjb
Residue, Filterable (TDS) @180C	SM2540C	5310		*	mg/L	10	20	09/03/08 15:23	kah
Residue, Non-Filterable (TSS) @105C	SM2540D	9	B	*	mg/L	5	20	09/04/08 13:29	gkj
Residue, Settleable Matter (SS)	SM2540F		U		mL/L/h	0.1	0.5	09/02/08 14:37	gkj
Sodium Absorption Ratio in Water	USGS - I1738-78	44.00				0.03	0.15	09/10/08 0:00	calc
Sulfate	SM4500 SO4-D	2510			mg/L	50	250	09/03/08 10:03	gkj

ACZ Laboratories, Inc.
2773 Downhill Drive Steamboat Springs, CO 80487 (800) 334-5493

Inorganic Analytical Results

Twentymile Coal Co.
Project ID:
Sample ID: 10RT

ACZ Sample ID: *L62810-01*
Date Sampled: *05/23/07 14:00*
Date Received: *05/24/07*
Sample Matrix: *Surface Water*

Inorganic Prep

Parameter	EPA Method	Result	Qual	XQ	Units	MDL	POL	Date	Analyst
Total Recoverable Digestion	M200.2 ICP							05/25/07 16:30	erf
Total Recoverable Digestion	M200.2 ICP-MS							05/25/07 17:13	erf

Metals Analysis

Parameter	EPA Method	Result	Qual	XQ	Units	MDL	POL	Date	Analyst
Cadmium, total recoverable	M200.8 ICP-MS		U		mg/L	0.0001	0.0005	05/26/07 2:23	jjr
Calcium, dissolved	M200.7 ICP	93			mg/L	1	5	06/01/07 0:38	djt
Iron, total recoverable	M200.7 ICP	0.3		*	mg/L	0.1	0.3	06/01/07 2:03	djt
Magnesium, dissolved	M200.7 ICP	65			mg/L	1	5	06/01/07 0:38	djt
Manganese, total recoverable	M200.7 ICP	0.14			mg/L	0.03	0.1	06/01/07 2:03	djt
Mercury, total	M245.1 CVAA		U		mg/L	0.0002	0.001	06/01/07 14:08	gme
Molybdenum, total recoverable	M200.7 ICP		U		mg/L	0.05	0.3	06/01/07 2:03	djt
Selenium, total recoverable	M200.8 ICP-MS	0.0006			mg/L	0.0001	0.0005	05/26/07 2:23	jjr
Silver, total recoverable	M200.8 ICP-MS		U		mg/L	5E-05	0.0003	05/26/07 2:23	jjr
Sodium, dissolved	M200.7 ICP	1580			mg/L	2	8	06/01/07 0:38	djt
Zinc, total recoverable	M200.7 ICP		U		mg/L	0.05	0.3	06/01/07 2:03	djt

** Please refer to Qualifier Reports for detail.*

ACZ Laboratories, Inc.
2773 Downhill Drive Steamboat Springs, CO 80487 (800) 334-5493

Inorganic Analytical Results

Twentymile Coal Co.
Project ID:
Sample ID: 10RT

ACZ Sample ID: ***L62810-01***
Date Sampled: *05/23/07 14:00*
Date Received: *05/24/07*
Sample Matrix: *Surface Water*

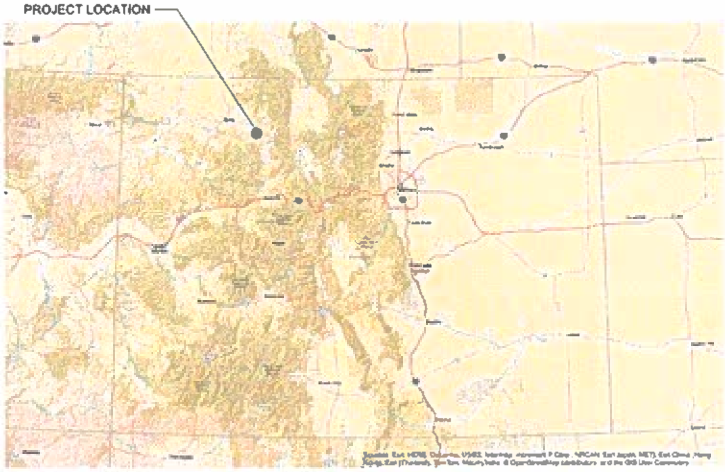
Wet Chemistry

Parameter	EPA Method	Result	Qual	XQ	Units	MDL	PQL	Date	Analyst
Alkalinity as CaCO3	SM2320B - Titration								
Bicarbonate as Bicarbonate		1330			mg/L	2	20	05/26/07 0:00	cas
Carbonate as Carbonate		33			mg/L	2	20	05/26/07 0:00	cas
Hydroxide as Hydroxide			U		mg/L	2	20	05/26/07 0:00	cas
Total Alkalinity		1150			mg/L	2	20	05/26/07 0:00	cas
Conductivity @25C	120.1 / SM2510B	7060			umhos/cm	1	10	05/26/07 13:46	cas
Lab Filtration	SM 3030 B			*				05/25/07 9:35	lmc
Lab Filtration & Acidification	SM 3030 B			*				05/25/07 10:40	lmc
Nitrate/Nitrite as N	M353.2 - H2SO4 preserved	0.79		*	mg/L	0.02	0.1	05/25/07 21:34	pjb
Nitrogen, ammonia	M350.1 - Automated Phenate	3.71		*	mg/L	0.05	0.5	05/25/07 14:04	jag
pH (lab)	150.1 / SM4500H+ B								
pH		8.4	H		units	0.1	0.1	05/26/07 0:00	cas
pH measured at		21.0			C	0.1	0.1	05/26/07 0:00	cas
Phosphorus, ortho dissolved	M365.1 - Automated Ascorbic Acid		U	*	mg/L	0.01	0.05	05/24/07 19:56	pjb
Residue, Filterable (TDS) @180C	160.1 / SM2540C	5150		*	mg/L	10	20	05/25/07 12:07	lcp
Residue, Non-Filterable (TSS) @105C	160.1 / SM2540C		U	*	mg/L	5	20	05/25/07 10:52	aeh
Sodium Absorption Ratio in Water	USGS - I1738-78	31.10				0.03	0.15	06/07/07 0:00	calc
Sulfate	SM4500 SO4-D	2680			mg/L	10	50	06/01/07 15:10	lcp

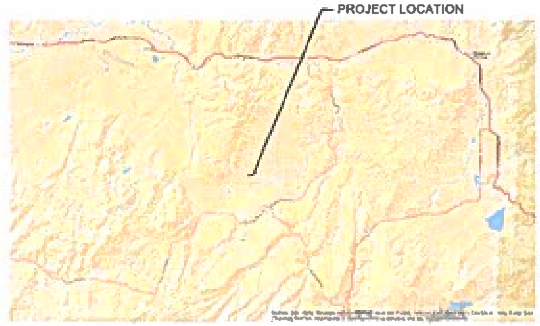
Appendix C

Final Design Drawing Package

PEABODY PASSIVE TREATMENT SYSTEM FOR MINE DEWATERING
FINAL DESIGN
TWENTYMILE COAL, LLC
OAK CREEK,COLORADO



LOCATION MAP



VICINITY MAP

INDEX TO DRAWINGS

GENERAL	Drawing	Description
1	G-01	[illegible]
2	G-02	[illegible]
3	G-03	[illegible]
CIVIL		
4	C-01	[illegible]
5	C-01P	[illegible]
6	C-02	[illegible]
7	C-03	[illegible]
8	[illegible]	[illegible]
9	[illegible]	[illegible]
10	[illegible]	LAYOUT AND GRADING PLAN [illegible] 4
11	[illegible]	[illegible]
12	C-08	[illegible]
13	C-09	[illegible]
14	[illegible]	[illegible]
15	C-11	[illegible]

ch2m:

GENERAL

TITLE SHEET, LOCATION MAP AND INDEX TO DRAWINGS

VERIFY SCALE

ISSUED FOR REVIEW

GENERAL SITE NOTES:

1. TWENTYMILE COAL COMPANY LLC TO CONFIRM GEOTECHNICAL DETAILS WITH GEOTECHNICAL ENGINEER OF RECORD. DRAWINGS ARE BEING SUBMITTED AS ISSUED FOR REVIEW (IFR) TO CONFIRM THE GEOTECHNICAL DETAILS PRIOR TO DRAWINGS BEING ISSUED FOR CONSTRUCTION (IFC).
2. ALL PIPING IS DR17 IPS HDPE AWWA F714

CIVIL LEGEND

- EXISTING CONTOUR LINE
- EXISTING ROAD
- EXISTING TOP OF BANK/WATER LEVEL
- EXISTING DITCH
- EXISTING CHAIN LINK FENCE
- EXISTING STORM SEWER
- EXISTING ELECTRIC BOX
- EXISTING POWER POLE
- PROPOSED CONTOUR
- PROPOSED DITCH
- SILT FENCE
- LIMITS OF GRADING
- FLOW ARROW
- RIPRAP

ABBREVIATIONS / ACRONYMS

BLDG	=	BUILDING
CC	=	CENTER TO CENTER
CMP	=	CORRUGATED METAL PIPE
CONC	=	CONCRETE
CONT	=	CONTINUED
CY	=	CUBIC YARD
DWG	=	DRAWING
E	=	EAST
ELEC	=	ELECTRIC
ELEV / EL	=	ELEVATION
EST	=	ESTIMATED
FF	=	FINISHED FLOOR
FL	=	FLOW LINE
GALV	=	GALVANIZED
GP	=	GUARD POST
HP	=	HIGH POINT
HT	=	HEIGHT
INV	=	INVERT
LF	=	LINEAR FOOT
LT	=	LEFT
MAX	=	MAXIMUM
MIN	=	MINIMUM
N	=	NORTH
NO / #	=	NUMBER
NTS	=	NOT TO SCALE
RCP	=	REINFORCED CONCRETE PIPE
RT	=	RIGHT
SHT	=	SHEET
SQ FT	=	SQUARE FEET
TOB	=	TOP OF BANK
TW	=	TOP WIDTH
TYP	=	TYPICAL
W	=	WEST
W/	=	WITH

ch2m:

GENERAL

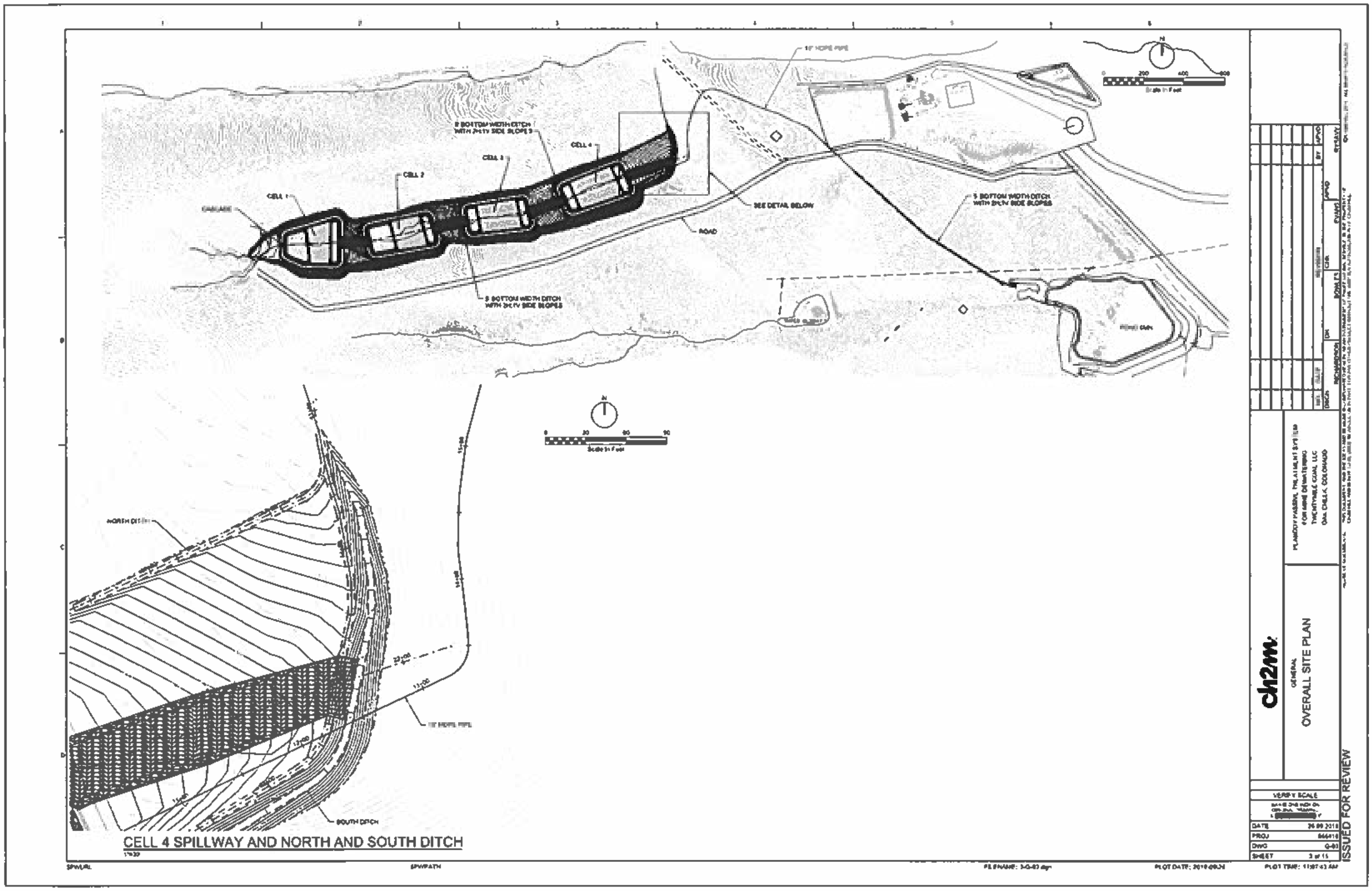
ABBREVIATIONS, LEGEND AND GENERAL NOTES

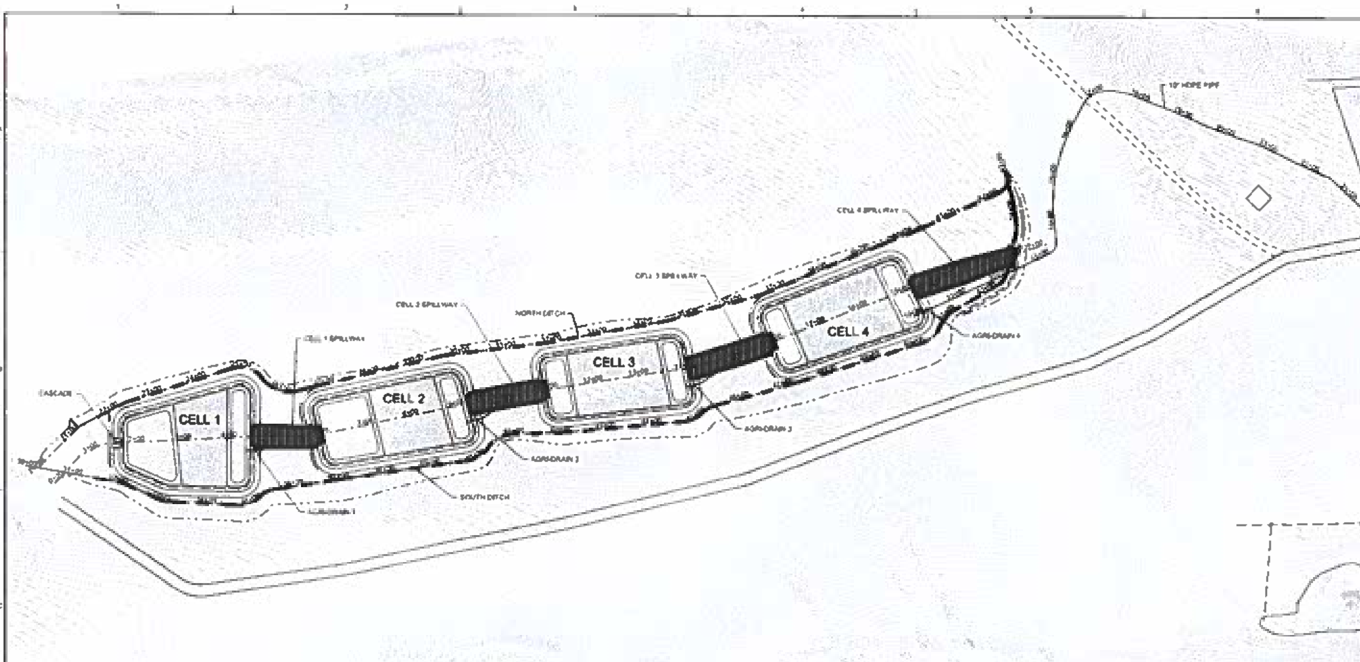
PLANNED PASSIVE TREATMENT SYSTEM FOR MINE DEWATERING
TWENTYMILE COAL, LLC
OAK CREEK, COLORADO

VERIFY SCALE

DATE	26 09 2018
PROJ	666418
DWG	G-02
SHEET	2 of 15

ISSUED FOR REVIEW


CELL 1
CELL 2
CELL 3
CELL 4
SEE DETAIL BELOW
ROAD
NORTH DITCH
SOUTH DITCH
CELL 4 SPILLWAY AND NORTH AND SOUTH DITCH
Scale In Feet
GENERAL
OVERALL SITE PLAN
VERIFY SCALE
DATE
PROJ
DWG
SHEET
ISSUED FOR REVIEW



Cell 1	Thickness	Elevation	Area (Ac)	Area (sf)
TOP OF BERM		6828.50	1.29	56185.97
WEIR ELEV	2.50	6827.00		
WATER ELEV		6826.00	1.17	50794.[illegible]
	3.00			
MARSH		6823.00	1.11	48183.08
	1.00			
DEEP ZONE		6822.00	0.42	18418.68
				[illegible]

Cell 2	Thickness	Elevation	Area (Ac)	Area (sf)
TOP OF BERM		6812.00	1.29	56188.71
WEIR ELEV	2.00	6810.50		
WATER ELEV		6809.50	1.16	50502.87
	1.00			
MARSH		6808.50	1.10	47744.77
	1.00			
DEEP ZONE		6806.50	0.41	18064.08
				16,942.09

Cell 3	Thickness	Elevation	Area (Ac)	Area (sf)
TOP OF BERM		6798.00	1.16	50712.32
WEIR ELEV	2.00	6796.00		
WATER ELEV		6794.00	1.05	45579.84
	1.00			
MARSH		6794.00	0.99	43089.46
	1.00			
DEEP ZONE		6790.00	0.21	9081.76
				5,014.80

Cell 4	Thickness	Elevation	Area (Ac)	Area (sf)
TOP OF BERM		6784.50	1.29	56188.71
WEIR ELEV	2.00	6783.50		
WATER ELEV		6782.50	1.16	50502.87
	1.00			
MARSH		6781.50	1.10	47744.77
	1.00			
DEEP ZONE		6779.50	0.21	9156.13
				4,976.17

STRUCTURE NO.	POINT NO.	NORTHING	EASTING	DEPTH (ft)	TOP ELEVATION	WEIR ELEVATION	DOWNSTREAM INVERT
1	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
2	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
3	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
4	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

SCALE IN FEET: 0, 100, 200, 300

PEABODY PASSIVE TREATMENT SYSTEM FOR MINE DEWATERING
TWENTYMILE COAL, LLC
OAK CREEK, COLORADO

ch2m

CIVIL
WETLAND PLAN

VERIFY SCALE

DATE: [illegible]
PROJ: [illegible]
DWG: [illegible]
SHEET: 6 of 15

ISSUED FOR REVIEW

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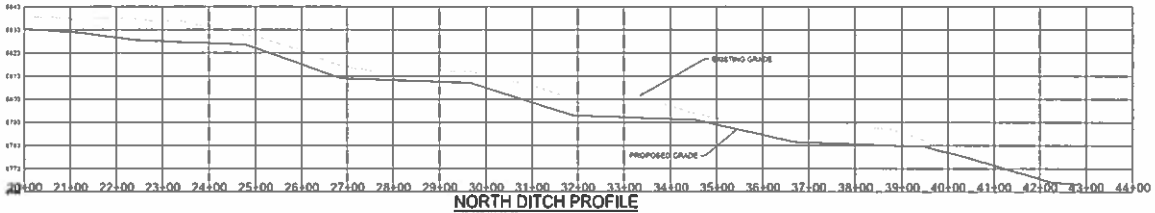
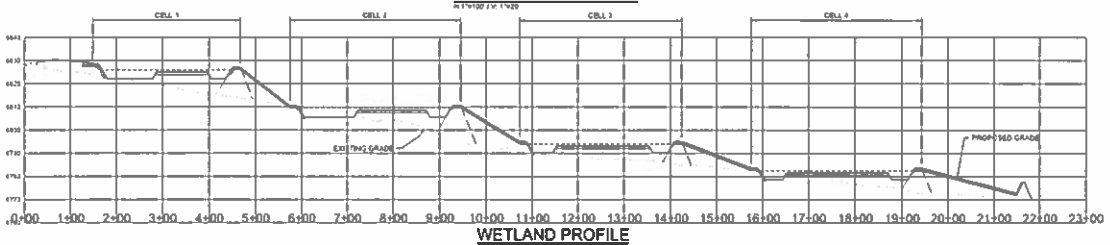


NORTH DITCH PROFILE



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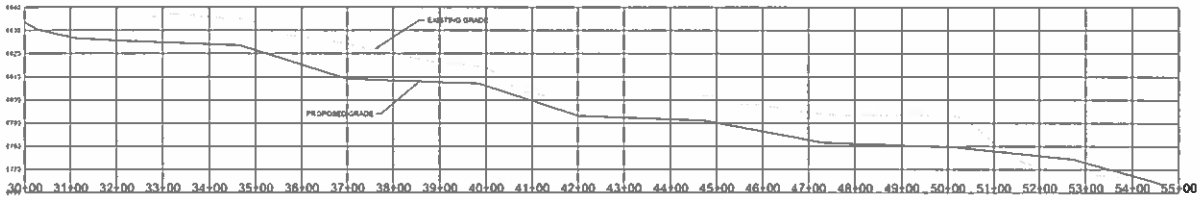


SOUTH DITCH PROFILE

0 100 200 300
Scale in Feet

ISSUED FOR REVIEW

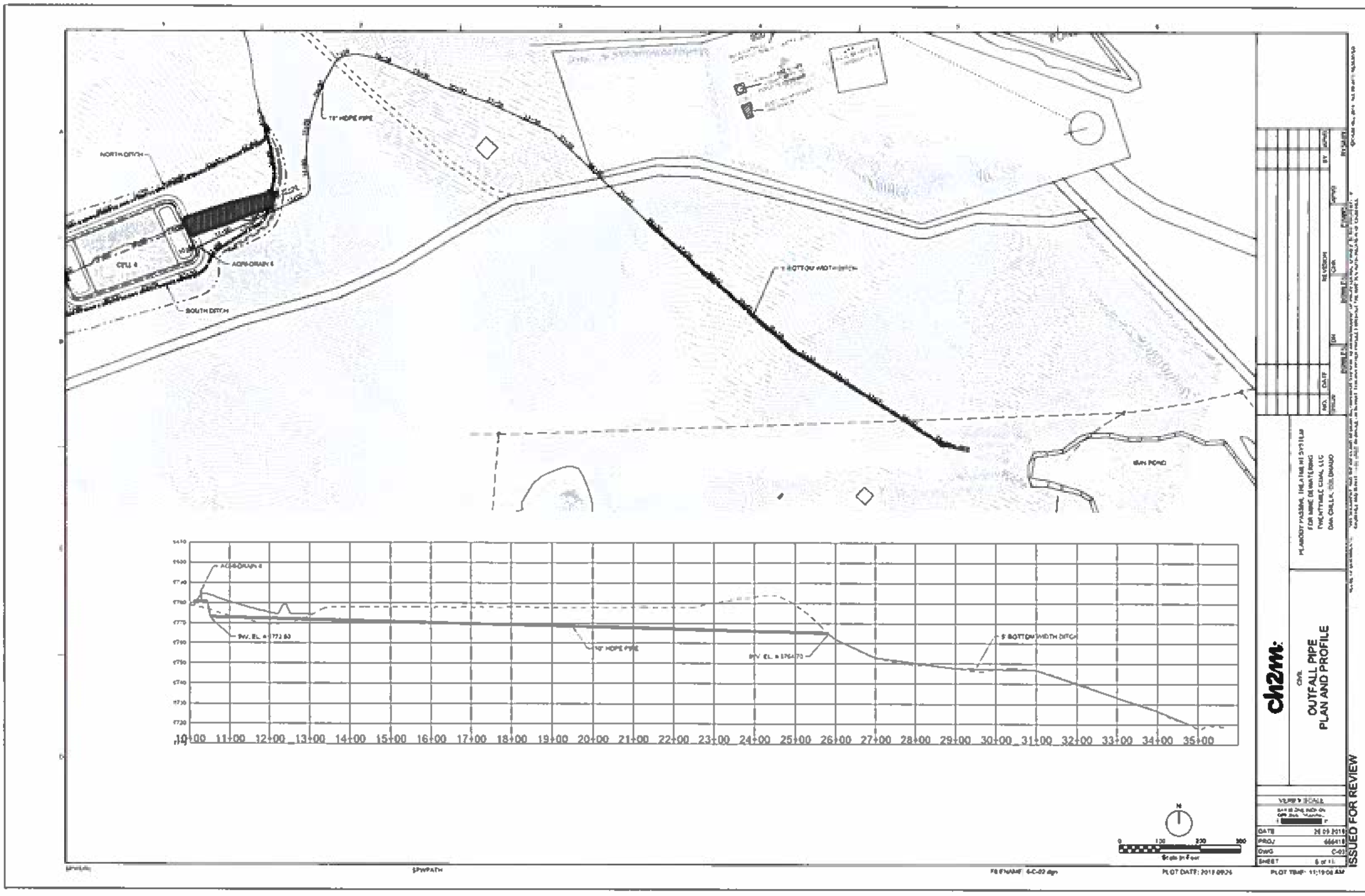
ch2m:
CIVIL
WETLAND AND DITCH PROFILES

PLANNING PHASE, INITIAL SITE WORK
FOR WWE DEMOLISHING
TWENTYMILE COAL, LLC
DEAD CREEK, COLORADO

VERIFY SCALE

DATE 26 09 2018
PROJ 666416
DWG C-619
SHEET 5 of 15

PLOT TIME: 12:51:51 PM


NORTH DITCH
CELL 4
SOUTH DITCH
10+00 11+00 12+00 13+00 14+00 15+00 16+00 17+00 18+00 19+00 20+00 21+00 22+00 23+00 24+00 25+00 26+00 27+00 28+00 29+00 30+00 31+00 32+00 33+00 34+00 35+00
ch2m:
CIVIL
OUTFALL PIPE
PLAN AND PROFILE
Scale in Feet
ISSUED FOR REVIEW

NORTH DITCH
DEEP ZONE
PLANTING ZONE
MARSH ZONE
WETLAND BASELINE
SHELF ZONE
CASCADE
18" PIPE
12" PIPE
AGRI-DRAIN NO. 1
SOUTH DITCH
LAYOUT AND GRADING PLAN
CELL 1
ISSUED FOR REVIEW

NORTH DITCH
PLANTING ZONE
DEEP ZONE
MARSH
WETLAND BASELINE
OFFP ZONE
AGRODRAIN NO 2
SOUTH DITCH
Scale in Feet
LAYOUT AND GRADING PLAN
CELL 2
ISSUED FOR REVIEW

ch2m:

CIVIL

LAYOUT AND GRADING PLAN
CELL 3

PLANNED FASSIL INSTALLMENT SYSTEM
FOR MINE DEWATERING
THE NTABLE CUAL LLC
OAK CREEK, COLORADO

VERIFY SCALE

DATE 06.09.2016
PROJ 666414
DWG C-05
SHEET 9 of 13

ISSUED FOR REVIEW

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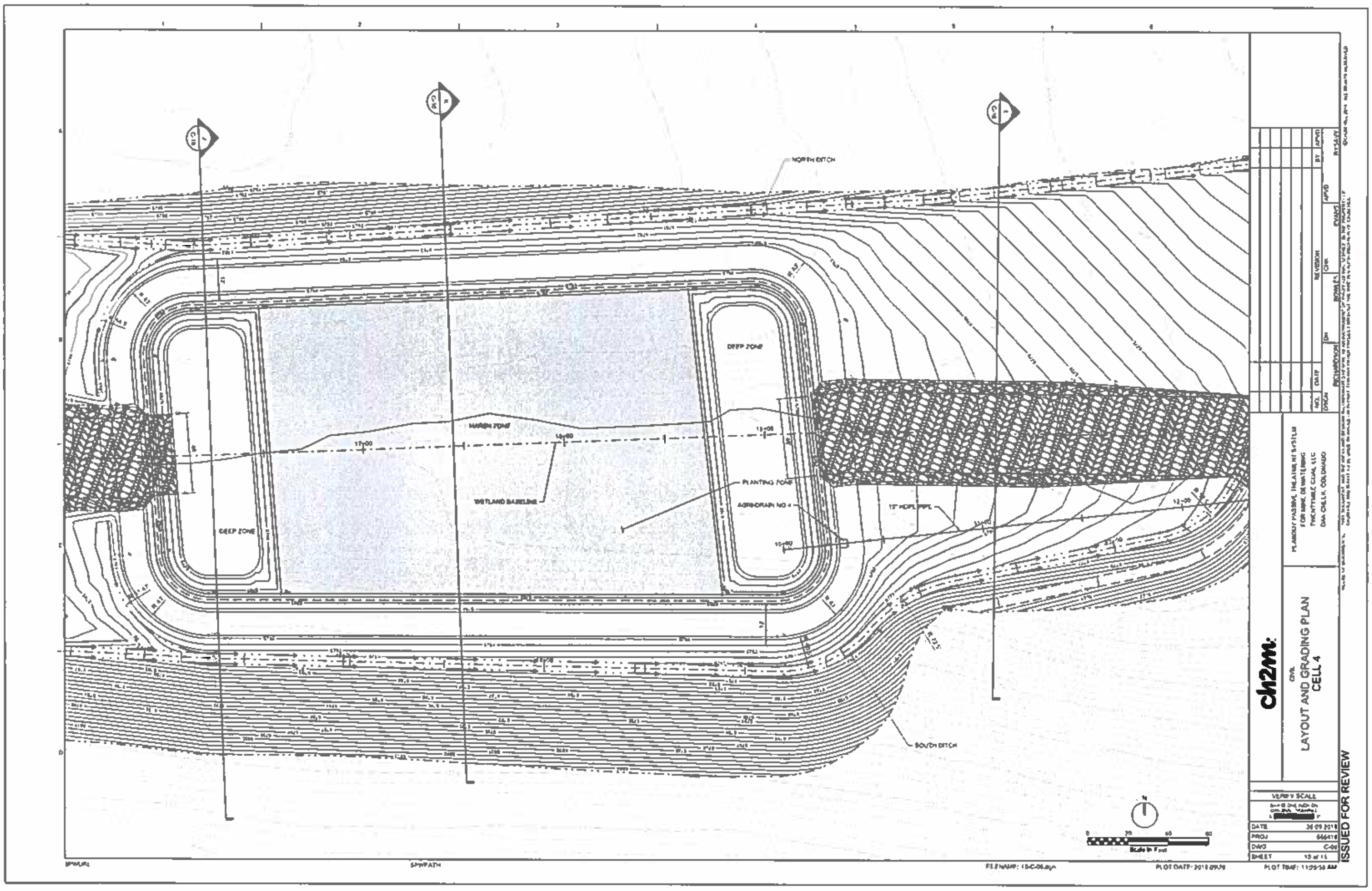
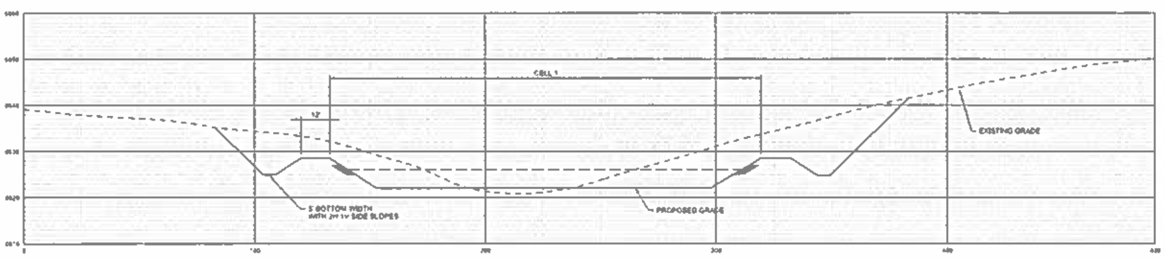


NORTH DITCH
DEEP ZONE
MARSH ZONE
WETLAND BASELINE
PLANTING ZONE
SOUTH DITCH
ch2m
CIVIL
LAYOUT AND GRADING PLAN
CELL 4
VERIFY SCALE
DATE
PROJ
DWG
SHEET
ISSUED FOR REVIEW



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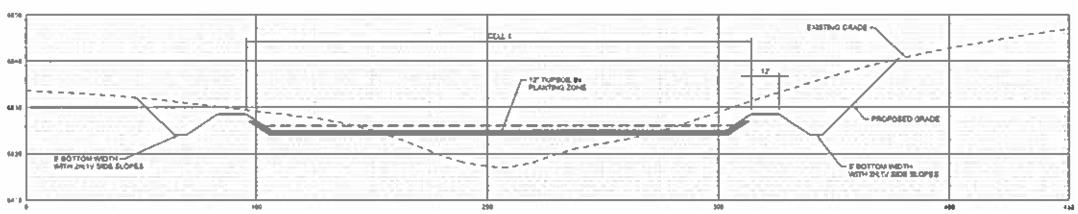
C-03



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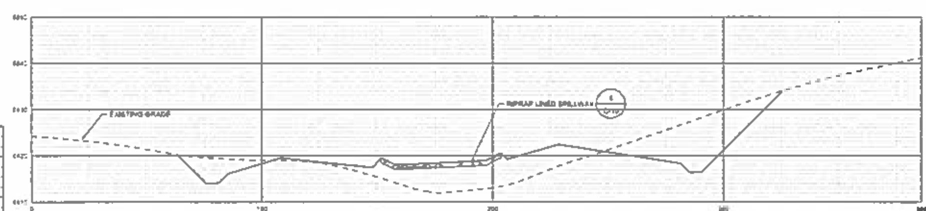


C SECTION
C-03

	Thickness	Elevation	Area (Ac)	Area (sf)
Cell 1				
TOP OF BERM		6829.50	1.79	96,194.07
WEIR ELEV	2.50	6827.00		
WATER ELEV		6828.00	2.17	30784.16
	1.00			
MARSH		6829.00	1.11	48,183.06
	3.00			
DEEP ZONE		6822.00	0.42	18419.68
				23409.307

Scale in Feet

ch2m

CIVIL

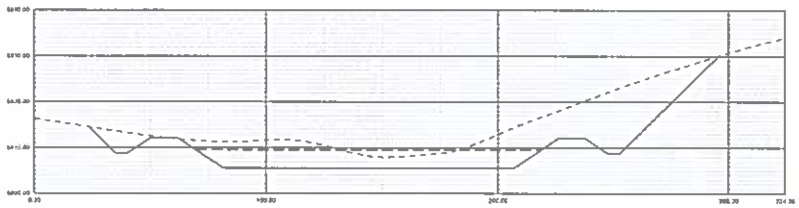
CROSS SECTIONS
CELL 1

VERIFY SCALE

DATE
PROJ
DWG C-07
SHEET

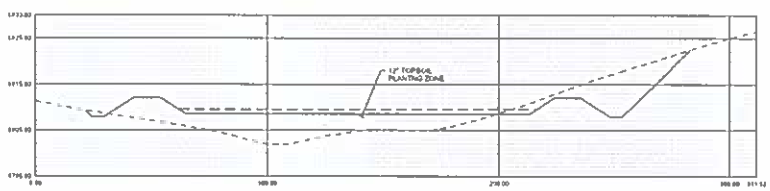
ISSUED FOR REVIEW

PLOT TIME: 11:27 AM



D SECTION

C-04



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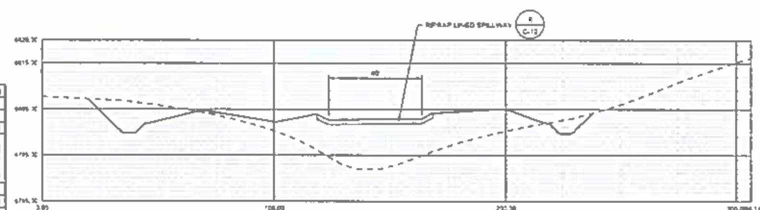
C-04



F SECTION

C-04

	Thickness	Elevation	Area (Ac)	Area (sf)
Cell 2				
TOP OF BERM		6812.00	1.29	56158.73
WEIR ELEV	2.50	6810.50		
WATER ELEV		6809.50	1.16	50502.87
	1.00			
MARSH		6808.50	1.10	47744.77
	3.00			
DEEP ZONE		6805.50	0.41	18064.03
				11542.08

Scale in Feet

ch2m:

CIVIL

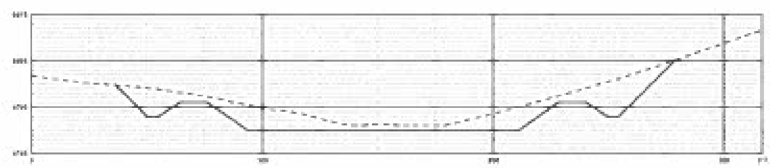
CROSS SECTION
CELL 2

PEABODY PASSIVE TREATMENT SYSTEM
FOR MINE DEWATERING
TWENTYMILE COAL, LLC
OAK CREEK, COLORADO

VERIFY SCALE	
DATE	2018
PROJ	
DWG	C-04
SHEET	13 of 15

ISSUED FOR REVIEW

PLOT TIME: 11:29:29 AM



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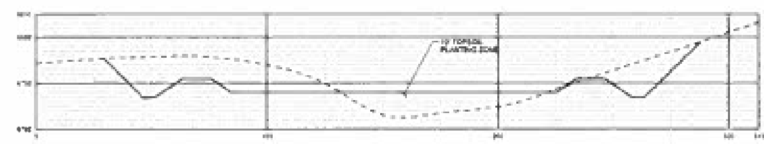

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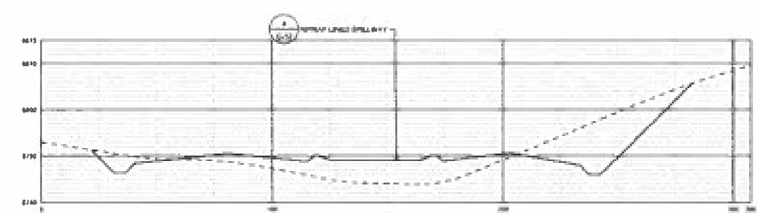

I SECTION

		Thickness	Elevation	Area (Ac)	Area (sf)
Cell 3					
TOP OF BERM			6796.30	1.16	50712.13
WATER ELEV		2.00	6795.30		
WATER ELEV			6794.30	1.05	45776.84
		1.00			
MARSH			6793.30	0.99	43099.46
		1.00			
DEEP ZONE			6790.30	0.21	9081.74
					[illegible]

Scale In Feet

ch2m.

CIVIL
CROSS SECTION
CELL 3

PLANDOT PASSIVE TREATMENT SYSTEM
FOR MINE DEWATERING
TWENTYMILE COAL LLC
OAK CREEK, COLORADO

VERIFY SCALE

DATE	07-09-2015
PROJ	666416
DWG	C-09
SHEET	13 of [illegible]

ISSUED FOR REVIEW

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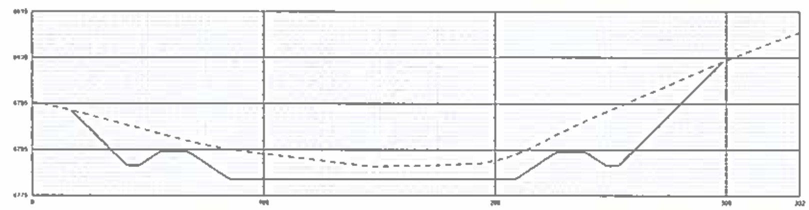

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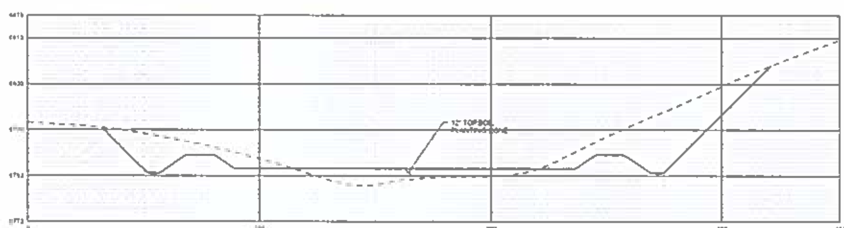
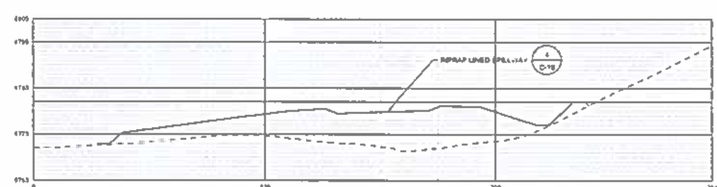
C-06



K SECTION

C-06



L SECTION

C-06

	Thickness	Elevation	Area (Ac)	Area (sf)
Cell 4				
TOP OF BERM		6784.50	1.29	56188.73
WEIR ELEV	2.??	6782.50		
WATER ELEV		6781.50	1.14	49642.87
	1.20			
MARSH		6781.50	1.10	47744.77
	1.20			
DEEP ZONE		6779.50	[illegible]	[illegible]
				[illegible]

Scale in Feet: 0, 20, 40, 60

ch2m:

PASSIVE TREATMENT SYSTEM FOR MINE DEWATERING
TWENTYMILE COAL, LLC
OAK CREEK, COLORADO

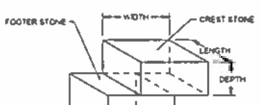
CIVIL
CROSS SECTIONS CELL 4

VERIFY SCALE

DATE	26.09.2018
PROJ	644416
DWG	C-18
SHEET	14 of 15

ISSUED FOR REVIEW

FILENAME: 14-C-18.dgn PLOT DATE: 2018.09.26 PLOT TIME: 11:39:32 AM



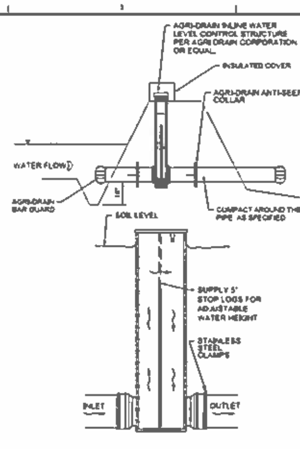
	TYPICAL	
DEPTH	8" MIN	
WIDTH	24" MIN	
LENGTH	24" MIN	

NOTES:

1. CREST STONES, FOOTER STONES, AND VORTEX STONES ARE TO BE LARGE BOULDER OR FIELD STONES, GENERALLY RECTANGULAR, WITH SMALLEST AXIS APPROXIMATELY 1/2 OF LARGEST AXIS. ONE FLAT SURFACE IS NEEDED TO SET ON TOP OF FOOTER STONES.
2. CREST STONES SHALL BE PLACED TO SPAN BEAMS BETWEEN FOOTER STONES. CREST STONES, FOOTER STONES, AND VORTEX STONES DIMENSIONS SHALL BE AS SPECIFIED IN THIS DETAIL.

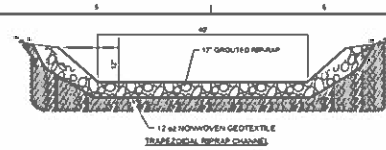
(1) CREST STONES AND FOOTER STONES

NTS



(3) INLINE AGRI-DRAIN

NTS



TRAPEZOIDAL RIPRAP CHANNEL

NOTES:

1. REMOVE ALL TREES, BRUSH, STUMPS, AND OTHER OBJECTIONABLE MATERIAL FROM THE FOUNDATION AREA AND DISPOSE OF PROPERLY.
2. BLEND THE FINISHED STONE SURFACE WITH SURROUNDING LAND SURFACE.
3. STABILIZE CHANNEL INLET POINTS AND INSTALL NEEDED OUTLET PROTECTION DURING CHANNEL INSTALLATION.
4. KEEP EROSION AND WATER POLLUTION TO A MINIMUM DURING CHANNEL CONSTRUCTION. STABILIZE ALL DISTURBED AREAS IMMEDIATELY.

(4) RIPRAP LINED SPILLWAY

NTS

1.1 GROUTING RIPRAP

A. REMOVE DIRT AND FOREIGN SUBSTANCES FROM SURFACES OF RIPRAP AND THEN MOISTEN.

B. DEPOSIT GROUT BY MEANS OF CHUTES, TUBES, OR BUCKETS, OR PLACE BY MEANS OF PNEUMATIC EQUIPMENT OR OTHER MECHANICAL METHODS. PLACE GROUT IN A CONTINUOUS OPERATION FOR ANY DAY'S RUN AT ANY ONE LOCATION.

C. LIMIT FLOW DISTANCE OF GROUT ALONG SLOPE TO LESS THAN 10 FEET.

D. SPADE AND ROD GROUT INTO PLACE WITH SUITABLE SPADES, TROWELS, OR OTHER APPROVED MEANS IMMEDIATELY AFTER DEPOSITING GROUT. DEPTHS OF GROUT SHALL BE APPROXIMATELY 1/2 THE THICKNESS OF THE RIPRAP.

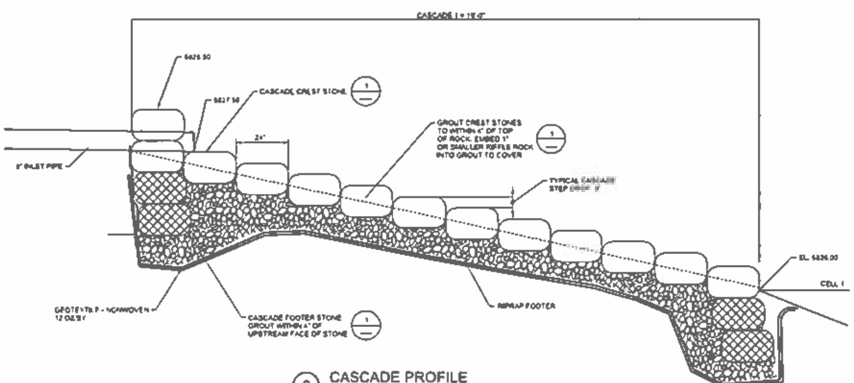
E. FOLLOWING PLACEMENT OF GROUT, THOROUGHLY BRUSH ROCKS SO TOP SURFACES ARE EXPOSED. OUTER ROCKS SHALL PROJECT 1/3 TO 1/4 THEIR DIAMETER ABOVE GROUT SURFACE. BRUSHING SHALL FOLLOW CLOSELY BEHIND RODDING SUCH THAT GROUT SHALL NOT BE IN PLACE MORE THAN 1 HOUR BEFORE BRUSHING.

F. ONCE BRUSHING OF AREA IS COMPLETE, NO WORKER OR LOAD WILL BE PERMITTED ON SURFACE FOR PERIOD OF AT LEAST 24 HOURS, OR LONGER IF SO REQUIRED BY ENGINEER.

1.1 CONCRETE GROUT

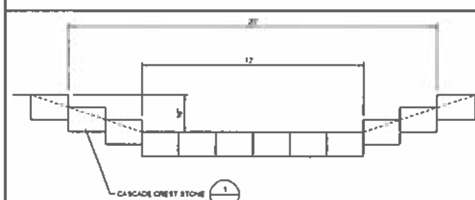
A. MIX: ASTM C94/C94M, OPTION A.

1. CEMENT: ASTM C150, TYPE II MAXIMUM ALKYL CONTENT OF 0.060 PERCENT.
2. COARSE AGGREGATE SIZE: 1 INCH.
3. DESIGN FOR MINIMUM COMPRESSIVE STRENGTH AT 28 DAYS: 2,500 PSI.



(2) CASCADE PROFILE

NTS



(6) TYPICAL CASCADE CROSS SECTION

NTS

PLANDRY PASSIVE TREATMENT SYSTEM FOR MINE DEWATERING
TWENTYMILE COAL, LLC
OAK CREEK, COLORADO

ch2m:
CIVIL
DETAILS

DSGN	RICHARDSON
DR	ROWLES
CHK	EVANS
APVD	EVANS

VERIFY SCALE

DATE	26.09.2018
PROJ	666418
DWG	C-11
SHEET	15 of 15

ISSUED FOR REVIEW

Appendix D

Test Pitting Program

SCOPE OF WORK (2/25/2016)
for
Subsurface Investigation

General

CH2M is providing engineering services to Twentymile Coal (TC) for the implementation of a passive treatment system to remove mine waste contaminants for the Foidel Creek Mine (the mine) located in Northern Colorado (Figure 1). The project generally consists of the design of a constructed wetland system which will include the development of four constructed basins and the modification of the existing 6MN pond to allow a controlled flow to Fish Creek.

Figure 1
Foidel Creek Twentymile Coal Mine and Project Site Location

In order to proceed with preliminary design, a geotechnical site investigation and analysis will be performed by CH2M.

Scope of Work

A CH2MHILL professional geotechnical engineer will visit the site to investigate foundation requirements for proposed berm and structure locations. The site investigation will establish the expected subsurface conditions, and the relative suitability and sufficiency of available borrow and embankment fill materials. The proposed site investigation includes the excavation, geotechnical logging and sampling of eight (8) test pits along the proposed configuration of the proposed basins, with approximate locations shown in Figure 2.

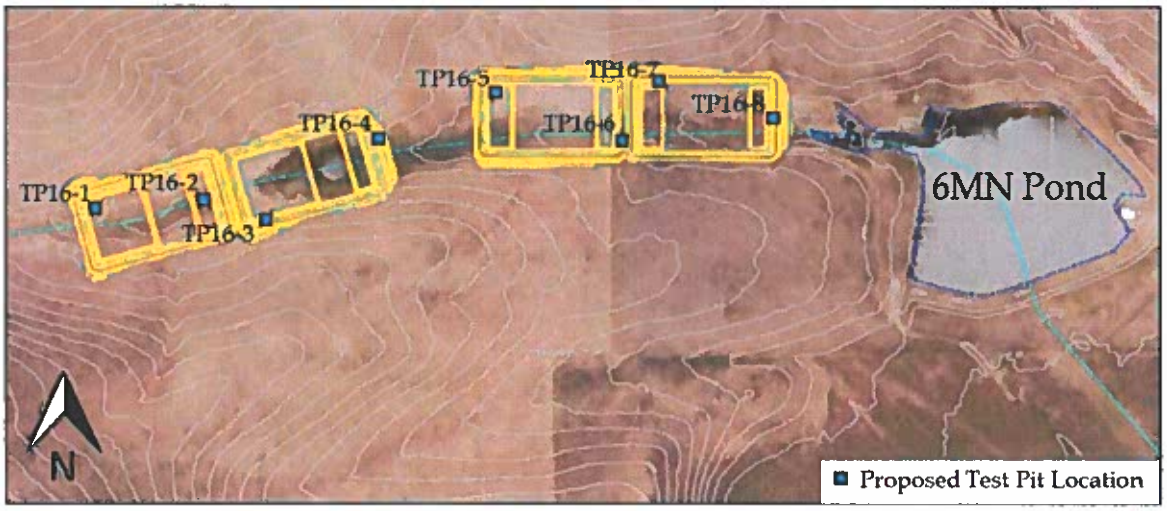


Figure 2
Proposed Test Pitting Locations
Preliminary constructed wetland layout shown for reference

Excavations will be made as close to the proposed locations as possible. Relocation of the test pits may be required based on access constraints and/or evaluated site conditions. Based on the observed conditions on site, and/or the observations from the proposed test pitting, additional borings or test pitting may be required. If additional borings or test pitting is determined to be required, then CH2M will provide a change order to this scope.

Field Investigation Work Requirements

1. TC will obtain any local and state permits required to complete the work.
2. TC will perform all necessary coordination, including but not limited to, providing underground utility clearance and site access.
3. The cost to repair any damage to utilities or resulting from utilities damaged during the field investigation is the responsibility of TC.
4. Notify and confirm mobilization for field work with CH2M a minimum of three (3) business days prior to commencement of field activities.
5. TC is responsible to access and excavate the test pits as proposed. CH2M or TC may be responsible for marking the boring locations. TC and CH2M shall ensure that if any boring needs to be relocated based on their evaluation of the site, the revised location falls within the permitted area.
6. TC is responsible for assessing the site and determining site accessibility.
7. Markings for boring locations shall be located using Global Positioning System (GPS). The horizontal location of each boring shall be to an accuracy of 10 feet. The surface elevation of each boring shall also be recorded. Survey of as-drilled locations will be performed by TC.

8. TC will select and provide the appropriate equipment and methods deemed necessary for the geotechnical site investigation based on excavation requirements and understanding of expected materials.
9. CH2M will record the groundwater table during excavation whenever possible.
10. Odors or signs of contaminated soils shall be noted in the soil logs. TC and CH2M will reassess Health and Safety procedures if any contaminated soil is encountered.
11. TC will backfill all borings and test excavations in accordance with State of Colorado and local regulations. After backfill, mark the locations with a wooden stake (1" x 2"x 2').
12. TC will cleanup of the boring locations and dispose of any spoils or waste in accordance with state and local ordinances.
13. All excavations will be performed under the full-time direct supervision of a qualified geotechnical engineer or geologist, provided by CH2M, experienced with visual-manual classification of soils in accordance with ASTM D2488.

Laboratory Testing

Bulk samples will be collected from each test pit for geotechnical laboratory testing.

Health and Safety Requirements

TC is responsible for the health and safety of its own personnel and any of its TC personnel while onsite, and shall provide, for all its own personnel and any of its TC's personnel, all health and safety equipments.

Proposed Schedule

Upon receipt of required permitting, the site investigation shall be completed within one (1) week from receiving confirmation of the permitting, site access and availability of equipment. The laboratory test program should be completed within two (2) weeks of completing the borings.

The site investigation is planned for early March 2016, and will likely require 2 days to complete.

If you have any questions or require additional information, please contact Anna Crockford, CH2M, 720-286-0780.

Sincerely,

Anna Crockford
CH2M, Inc.

Appendix E

Earthwork Specifications

SECTION 31 00 00
EARTHWORK

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of ASTM International (ASTM) standards that may be referenced in this section:

1. C136, Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.
2. D698, Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft^3 (600 Kn-m/m^3)).
3. D2487, Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System).
4. D6938, Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth).

1.02 DEFINITIONS

A. Backfill: Material or procedure for filling excavations, whether for structures, trenches, or restoring natural slopes.

B. Borrow Material: Material from required excavations or from designated borrow areas to be used in permanent construction.

C. Clearing: Removal of trash, rubbish, junk, and vegetation lying on or protruding above ground surface.

D. Embankment: A raised structure shown on Drawings constructed of soil from excavation or borrow sources.

E. Grubbing: Removal of vegetation, stumps, buried logs, and roots greater than 2-inch caliper to a depth at least 12 inches below subgrade.

F. Imported Material: Materials obtained from offsite sources.

G. Loose Lift: Layer of uncompacted material that is placed and spread in horizontal lift of specified thickness prior to compaction.

H. Nuclear Gauge: Instrument used to measure the density and water content of natural and compacted soil. The gauge obtains density and water content from measurements of gamma rays and neutrons that are emitted from the meter. Gamma rays are emitted from a probe inserted into the soil being measured; measurement of the gamma rays transmitted through the soil, when calibrated,

indicates the soil density. Neutrons are emitted from the base of the gauge; measuring the return of reflected neutrons indicates the soil water content.

I. Optimum Moisture Content: Water content at which a soil can be compacted to a maximum dry unit weight by a given compactive effort. The optimum moisture content is determined by laboratory compaction tests performed using reference compactive efforts.

J. Prepared Subgrade: Foundation after stripping, authorized excavation, and compaction.

K. Quality Control: Demonstration and documentation of quality achieved in the completed construction.

L. Roller Passes: The number of times the entire compactor and its operator travels past a particular location. Passing of front and rear drums/wheels do not count as separate roller passes.

M. Stockpiling: Depositing material at designated location(s) to be later used as construction material.

N. Stripping: Removal of surface soil that is unsuitable in embankment foundations or for constructing embankments.

PART 2 PRODUCTS

2.01 SOIL AND AGGREGATE MATERIALS

A. General: Materials shall be free from rocks larger than 3 inches, ashes, cinders, trash, debris and other deleterious materials.

B. Clay Fill:

1. Obtain the material onsite.
2. Material shall be CL or CH clay, as determined by ASTM D2487.
3. Material shall not be produced from processing of weathered shale. Source material shall be clay in situ, free from visible blocky structure, or weak shale pieces greater than 0.25-inch when disturbed.

C. Topsoil:

1. Obtain the material onsite.
2. Spoils from foundation stripping are acceptable materials for topsoil layer.

D. Crest Stones: Conform to product specifications as defined on the Drawings.

E. Footer Stones: Conform to product specifications as defined on the Drawings.

F. Riprap:

1. 1. Hard and durable quarry stone free from fractures, bedding planes, pronounced weathering, and earth or other adherent coatings.
2. 2. Minimum Dimension of Individual Pieces: Not less than 1/3 maximum dimension.
3. 3. The riprap designation and total thickness of riprap shall be as shown on the DRAWINGS. The maximum stone size shall not be larger than the thickness of the riprap.
4. 4. Bulk Density: Minimum 1.3 ton/cy.
5. 5: Specific Gravity: Minimum 2.5.
6. 6. The riprap shall have a percentage loss of not more than forty percent (40%) after five hundred (500) revolutions when tested in accordance with AASHTO T96.
7. 7. The riprap shall have a percentage loss of not more than ten percent (10%) after five (5) cycles when tested in accordance with AASHTO T104 for ledge rock using sodium sulfate.
8. 8. The riprap shall have a percentage loss of not more than ten percent (10%) after twelve (12) cycles of freezing and thawing when tested in accordance with AASHTO T103 for ledge rock, procedure A.
9. 9. Rock shall be free of calcite intrusions.
10. 10. Gradation: Smaller pieces shall generally fill voids between larger pieces without either excess or deficiency of one or more sizes of stone. Gradation shall be in conformance with the following:

D50* (INCHES)	% SMALLER THAN GIVEN SIZE BY WEIGHT	INTERMEDIATE ROCK DIMENSION (INCHES)
12	70-100	21
	50-70	18
	35-50	12
	2-10	4
*D50 = MEAN PARTICLE SIZE		

2.02 GROUT MATERIAL

A. Grout material shall conform to product specifications as defined on the Drawings.

2.03 GEOTEXTILE

A. Geotextile fabric shall conform to product specifications as defined on the Drawings.

2.04 DRAIN PIPE, WATER LEVEL CONTROL STRUCTURE AND FITTINGS

A. Drain pipe, water level control structure, and fittings shall conform to product specifications as defined on the Drawings.

PART 3 EXECUTION

3.01 SITE CLEARING

A. General:

1. Clear and grub areas required for construction within Work Limits as specified.
2. Do not injure or deface vegetation that is not designated for removal.
3. Remove clearing and grubbing debris.

B. Clearing and Grubbing Limits:

1. Within excavation limits and within 5 feet of the top of cut slopes.
2. Within embankment limits and within 5 feet of the toe of permanent fill.
3. Within identified borrow and material stockpile areas and within 2 feet of the area extents.

3.02 SUBGRADE PREPARATION

A. Stripping:

1. Strip upper 12 inches from ground surface to remove organic materials and topsoil.
2. Perform additional stripping to remove unsuitable soils, as determined based on visual inspection of the subgrade.
3. Strip excavation areas and within 2 feet beyond cut slopes.
4. Strip areas to receive fill and within 2 feet beyond toe of permanent fill.
5. Strip borrow areas and material stockpile areas and within 2 feet of the area extents.
6. Spoils from stripping shall be stockpiled and used only as topsoil material.

B. Subgrade Excavation:

1. After stripping, excavate the foundation subgrade to depths shown on Drawings.
2. Material excavated from below stripped surface may be used as clay fill where material meets clay fill requirements.
3. Surface after excavation shall be considered subgrade.
4. Prepare subgrade in accordance with Paragraph Subgrade Compaction.

C. Subgrade Compaction: Compact exposed subgrade material with a minimum of four passes using a self-propelled tamping-foot roller having a minimum operating weight of 65,000 pounds. The roller shall have chevron-shaped tamping feet with 7-inch minimum length. Roller speed shall not exceed 5 miles per hour when compacting soil.

D. Drainage Ditches: Do not compact native subgrade. Overexcavate unsuitable subgrade material as defined in Paragraph 2.01.A, based on visual inspection.

3.03 EXCAVATION

A. General: Excavate to lines, grades, and dimensions shown on Drawings and as needed to accomplish the Work.

B. Stockpiling Excavated Material:

1. Stockpile excavated material that is suitable for use as fill or topsoil until material is needed.
2. Post signs indicating proposed use of material stockpiled. Signs should be clearly worded and readable from all directions of approach to each stockpile. Signs should be clearly worded and readable by equipment operators from their normal seated position.
3. Do not stockpile excavated material adjacent to trenches and or other excavations, unless excavation side slopes and excavation support systems are designed, constructed and maintained for stockpile loads.
4. Do not stockpile excavated material adjacent to completed Work.
5. Stockpile excavated material on the downhill side of the excavation where practicable.

3.04 GROUNDWATER CONTROL

A. Provide, operate, and maintain dewatering systems of sufficient size and capacity to permit excavation and subsequent construction.

B. Discharge water in accordance with applicable discharge permits and in manner that will not cause erosion, flooding, or other damage to existing facilities, completed Work, or adjacent property.

3.05 CLAY FILL EMBANKMENT

A. Material Placement (General):

1. Place and spread materials in horizontal lifts of uniform thickness.
2. Do not place material in the embankment area, if the material moisture content is outside the specified limits.

3. Do not place embankment material on damaged material. Damaged material includes:
    a. Ponded water.
    b. Cracked soil from drying or freezing conditions.
4. Remove damaged material. Disk and compact the surface of previously placed embankment.
5. Do not place frozen material in the embankment.
6. Do not place material on frozen subgrade.

B. Maximum Loose Lift Thicknesses:

1. 12 inches for materials compacted with self-propelled compaction equipment.
2. 10 inches for materials compacted with hand-operated compaction equipment.
3. Reduce loose lift thickness, as necessary, to achieve compaction criteria.

C. Moisture Control:

1. Determine the optimum moisture content by ASTM D698.
2. Place and compact at moisture content at least 1 percentage point lower than the optimum moisture content but not greater than 3 percentage points higher than the optimum moisture content.
3. Moisture condition embankment materials within the borrow area prior to placement within the embankment. No more than 1 percentage point water shall be added to embankment materials already placed, but not yet compacted, within the embankment limits.

D. Compaction:

1. Equipment:
    a. Use compaction equipment of size and type capable of producing the required densities.
    b. Self-propelled rollers shall have functioning speedometers.
    c. Equipment for compacting imported materials shall be clean and shall not contaminate the imported materials.
2. Method and Density Requirements:
    a. Compact to dry density that is greater than or equal to 95 percent of the maximum dry density, as determined by ASTM D698.
    b. Finish the compaction of each lift with a minimum of four passes using a self-propelled tamping-foot roller having a minimum operating weight of 65,000 pounds. The roller shall have chevron-shaped tamping feet with 7-inch minimum length. Roller speed shall not exceed 5 miles per hour when compacting soil.
    c. Compaction Near Drain and Water Level Control System:
        1) Use hand operated equipment within 3 feet of the structures.

2) Prevent damage to installed structures caused by operation of compaction equipment.
3) Do not operate self-propelled compactors above installed pipes with soil cover less than 3 feet.

3.06 DRAIN AND WATER LEVEL CONTROL STRUCTURE INSTALLATION

A. Install drain and water level control structure components in accordance with manufacturer's recommendations and details indicated on the Drawings.

3.07 MARSH PREPARATION

A. Excavation:

1. In areas where topsoil is to be placed above Clay Fill, place and compact to lines, grades, and dimensions shown on Drawings.
2. In areas where topsoil is to be placed directly above prepared subgrade, excavate an additional 12 inches depth prior to preparing and compacting subgrade. Replace excavated material to lines, grades, and dimensions shown on Drawings following subgrade preparation.

B. Topsoil Placement:

1. Before topsoil is replaced, the sub-soil should be ripped to a depth of 12 inches. This can be accomplished by disking, ripping, plowing, and rototilling, made more effective by ripping in two directions perpendicular to each other. This process is more difficult to complete on slopes greater than 3:1. On steeper slopes, a track hoe and with a ripper tooth can be used to decompact soil to the proper depth.
2. Once the sub-soil is ripped and the topsoil is replaced, the soil should be tilled to 6 inches, in a pattern perpendicular to the proposed direction of flow, leaving no clod over 3 inches in diameter.
3. These two processes will allow for a total of 18 inches of decompaction, thus providing a better growing medium for native vegetation.

C. Bed Firming

1. Once the final tilling is completed, fine grading should be performed to ensure a smooth seeding/planting surface.
2. For wetland areas, the surface is considered firm enough when a person's footprint penetrates ¼ to ½ inch deep.
3. If necessary and when possible, firming of wetlands may be achieved by disking followed by rolling or harrowing just prior to seeding.
4. After grading has achieved the desired firmness, the wetland bed should receive a final discing perpendicular to the flow direction.

3.08 CASCADE AND RIPRAP SPILLWAY

A. Material Placement (General):

1. Maintain placement surfaces that are free of water, debris, and foreign objects during placement of materials.
2. Place and secure geotextile fabric as shown on the Drawings.
3. Place and spread riprap materials in horizontal lifts of uniform thickness to lines, grades, and dimensions shown on Drawings.
4. Install cascade footer stones at beginning and end station of stone cascade, ensuring the proper depth as shown in the Drawings. The stones shall be carefully picked and arranged so that adjacent rock surfaces of Crest Stones match within 0.1 foot in top elevation and 2 inches along the vertical exposed face or channel side of rock. Stones shall be placed such that adjacent stones "touch" each other and voids do not exceed 4 inches. It is the intent of construction to minimize voids between stones. Stones shall be placed such that upstream stones are wedged up against downstream stones, to prevent downstream movement of stones.
5. Place and secure Cascade Footer Stones and Crest Stones as shown on Drawings.
6. While placing riprap, bring material up evenly to prevent excessive stress on or displacement of the geotextile fabric.
7. Do not drop riprap materials directly on structures or pipes.

B. Maximum Loose Lift Thickness: Place in lifts not exceeding 12 inches for riprap materials.

C. Compaction: Do not compact riprap material.

D. Grout riprap in accordance with Drawings.

1. Grout voids between the stones to the depth specified in the Drawings. Deposit grout, in a continuous operation, by means of chutes, tubes, or buckets or place by means of pneumatic equipment or other mechanical methods. Spade grout into place with suitable spades, trowels, or other approved means immediately after depositing grout. Embed coarse Aggregate to cover grouted surface. Take precautions to prevent grout from penetrating bedding layer. Protect and cure surface for a minimum of 7 days.

3.09 QUALITY CONTROL

A. Document all quality management activities.

B. Test stockpiled and borrow materials to verify conformance with material requirements. Document test results including date, location, and name of persons performing and observing test.

C. Perform field and laboratory testing on placed materials to control the work. Record the results and locations of tests and samples. Location descriptions shall include survey coordinates, and elevation.

D. Minimum Quality Control Testing Frequencies Include:

1. Clay Fill:
   a. In-Place Moisture and Density Tests (ASTM D6938): Perform one test on randomly-selected sample from every 2,000 cubic yards placed.
   b. Laboratory Compaction Tests (ASTM D698): Perform one test for every 20,000 cubic yards placed.
2. Riprap:
   a. Gradation (ASTM C136) of Coarse Grained Soils: Perform one test on randomly-selected sample from every 4,000 cubic yards placed, with a minimum of one test per Cascade.

E. Develop and apply moisture correction for each nuclear density gauge.

F. Prevent segregation of materials during the processing and stockpiling of coarse grained soil and aggregate. Immediately change methods of handling materials to correct uniformity in grading when segregation occurs.

G. Drain Pipe and Water Level Control Structure Testing and Inspection: Conduct testing and inspection in accordance with manufacturer's recommendations.

3.10 TOLERANCES

A. Construct embankment crests within a tolerance of 0.3 feet.

B. Grade fill and cut slopes within a tolerance of 0.3 feet.

3.11 PROTECTION OF THE WORK

A. Maintain and protect completed Work until completion of the Contract.

B. Repair subgrade that becomes deficient during period after initial preparation and before embankment construction or backfilling.

C. Replace embankment that becomes deficient before completion of the Contract. When materials are rendered unsuitable (e.g., contamination of imported materials), replace and provide new materials.

END OF SECTION

Appendix F

Geotechnical Laboratory Test Results

Client: CH2MHILL
Attn: Anna Crockford

Project Name: Passive Treatment System, Twentymile Coal
Project No.: 16-5026
Date: 4/29/2016

Boring Designation	Sample Type	Sample Interval (Ft)	Date	Moisture %	Dry Density (pcf)	Atterberg Limit		PH	#200 Wash %	AASHTO CLASSIFICATION (group index)	SOIL OR BEDROCK TYPE
						LL	P.I.				
TP16-1	Bulk		4/26/2016	21.4		48	26		84.9	A-7-6 (23)	CL - Lean Clay
TP16-2	Bulk		4/26/2016	24.0		53	32	8.06	94.1	A-7-6 (33)	CH - Fat Clay
TP16-3	Bulk		4/26/2016	25.9		49	30		97.3	A-7-6 (32)	CL - Lean Clay
TP16-5	Bulk		4/26/2016	24.2		45	27	7.87	95.8	A-7-6 (27)	CL - Lean Clay
TP16-6	Bulk		4/26/2016	22.1		46	28		97.8	A-7-6 (29)	CL - Lean Clay
TP16-7	Bulk		4/26/2016	26.1		53	33		99.5	A-7-6 (37)	CH - Fat Clay

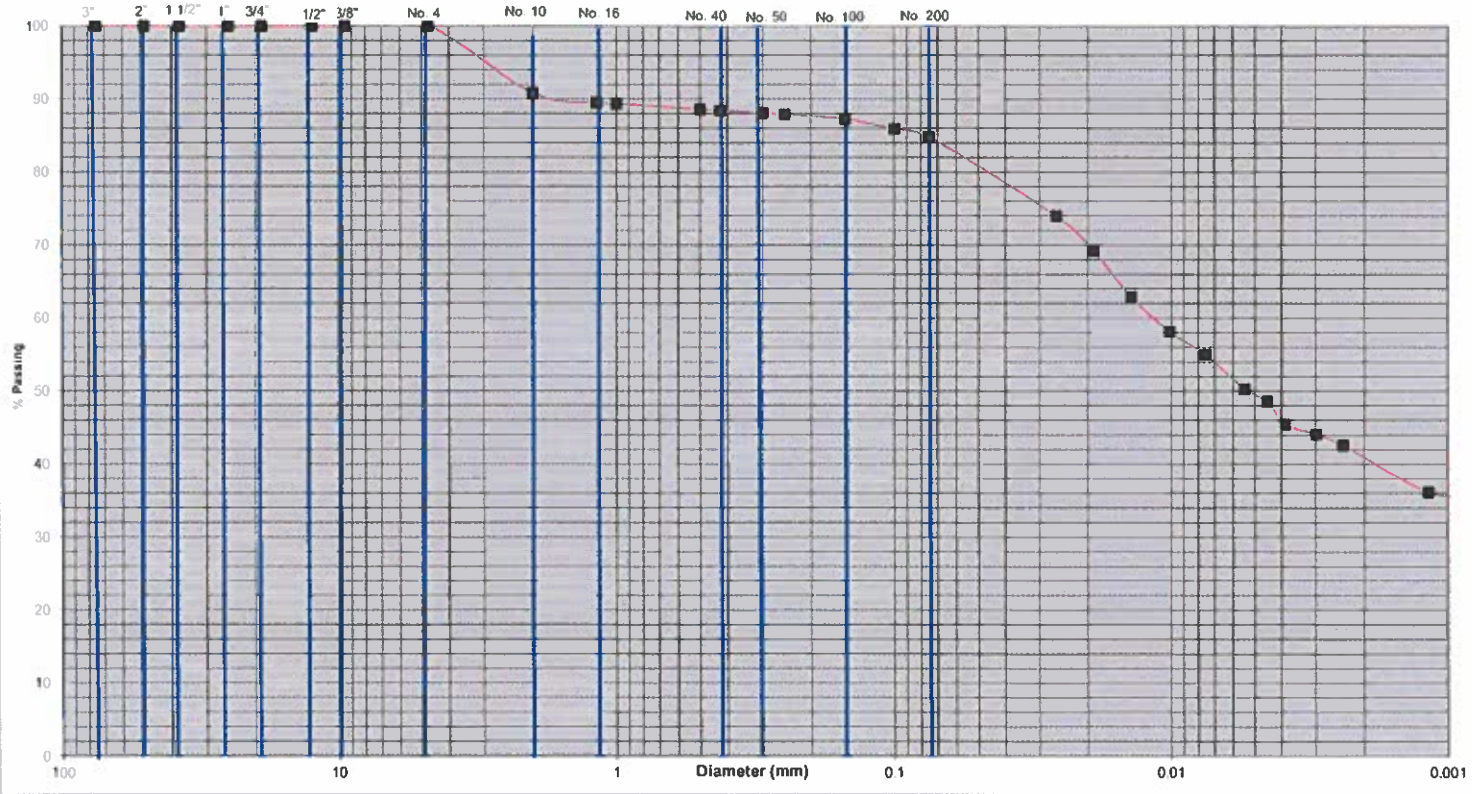
VINE LABORATORIES, INC.

VINE LABORATORIES, INC.

Particle Size Analysis ASTM D 422 USCS Classification

Job Number: Passive Treatment System, Twentymile Coal
Sample: TP16-1

Sieve Analysis	Hydrometer Readings
U.S Standard Sieves	Timed Readings



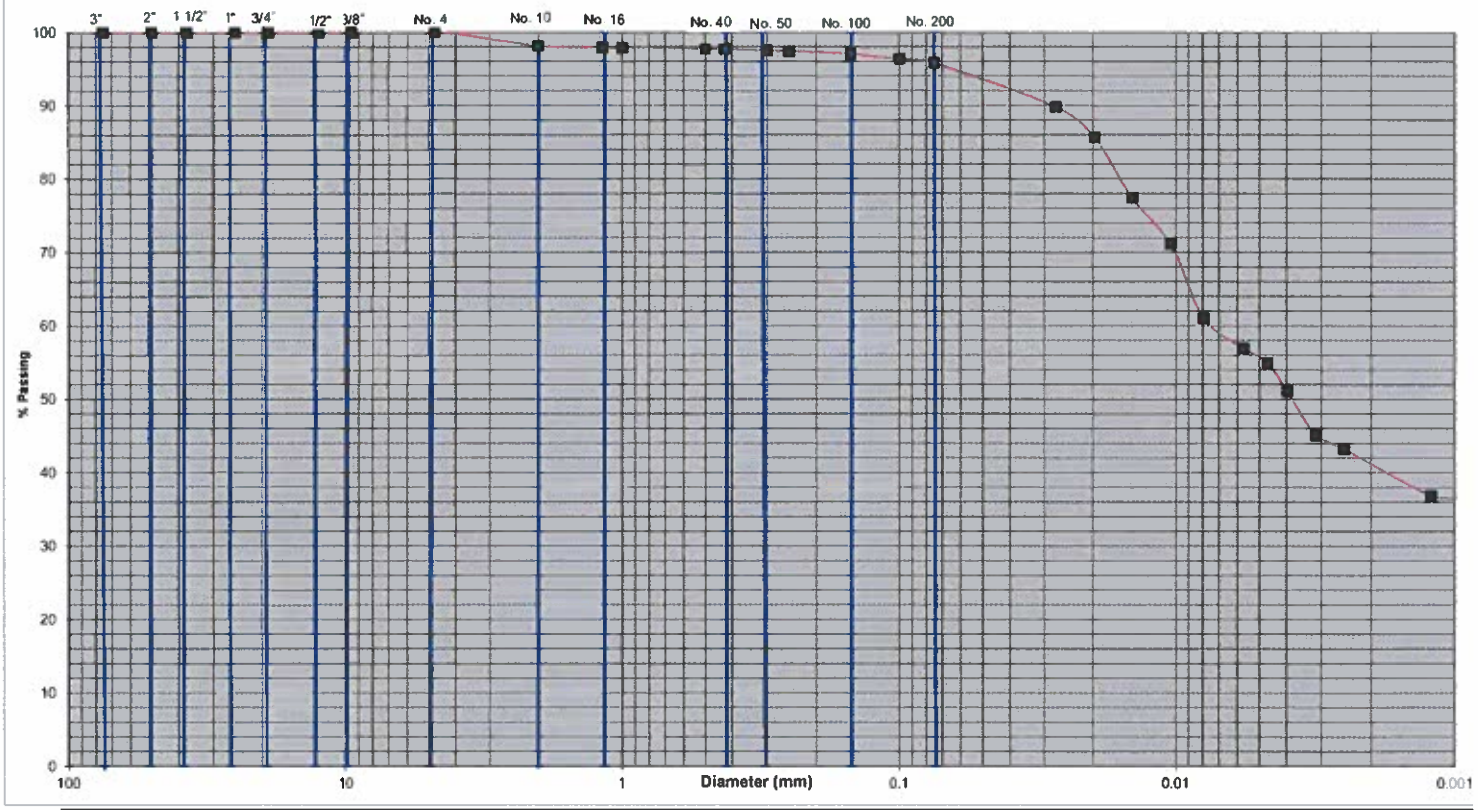
GRAVEL		SAND			SILT & CLAY		
0.0		15.1			84.9		
Coarse	*Fine*	*Coarse*	*Medium*	*Fine*	LL	48.0	
0.0	0.0	9.2	2.4	3.5	PL	22.0	USCS Classification CL
					PI	26.0	

VINE LABORATORIES, INC.

Particle Size Analysis ASTM D 422 USCS Classification

Job Number: Passive Treatment System, Twentymile Coal
Sample: TP16-5

Sieve Analysis	Hydrometer Readings
U.S Standard Sieves	Timed Readings



GRAVEL		SAND			SILT & CLAY		
0.0		4.2			95.8		
Coarse	*Fine*	*Coarse*	*Medium*	*Fine*	LL	45.0	
0.0	0.0	1.9	0.4	1.9	PL	18.0	USCS Classification CL
					PI	27.0	

COMPACTION TEST REPORT

Curve No.: 1

Project No.: 16-5026 **Date:** 4/26/2016

Project: Passive Treatment System, Twentymile Coal

Client: CH2MHILL

Location: TP16-1

Sample Number: 1 **Depth:** Bulk

Remarks:

MATERIAL DESCRIPTION

Description:

Classifications - **USCS:** CL **AASHTO:** A-7-6 (23)

Nat. Moist. = 21.4 %

Liquid Limit = 48

Sp.G. =

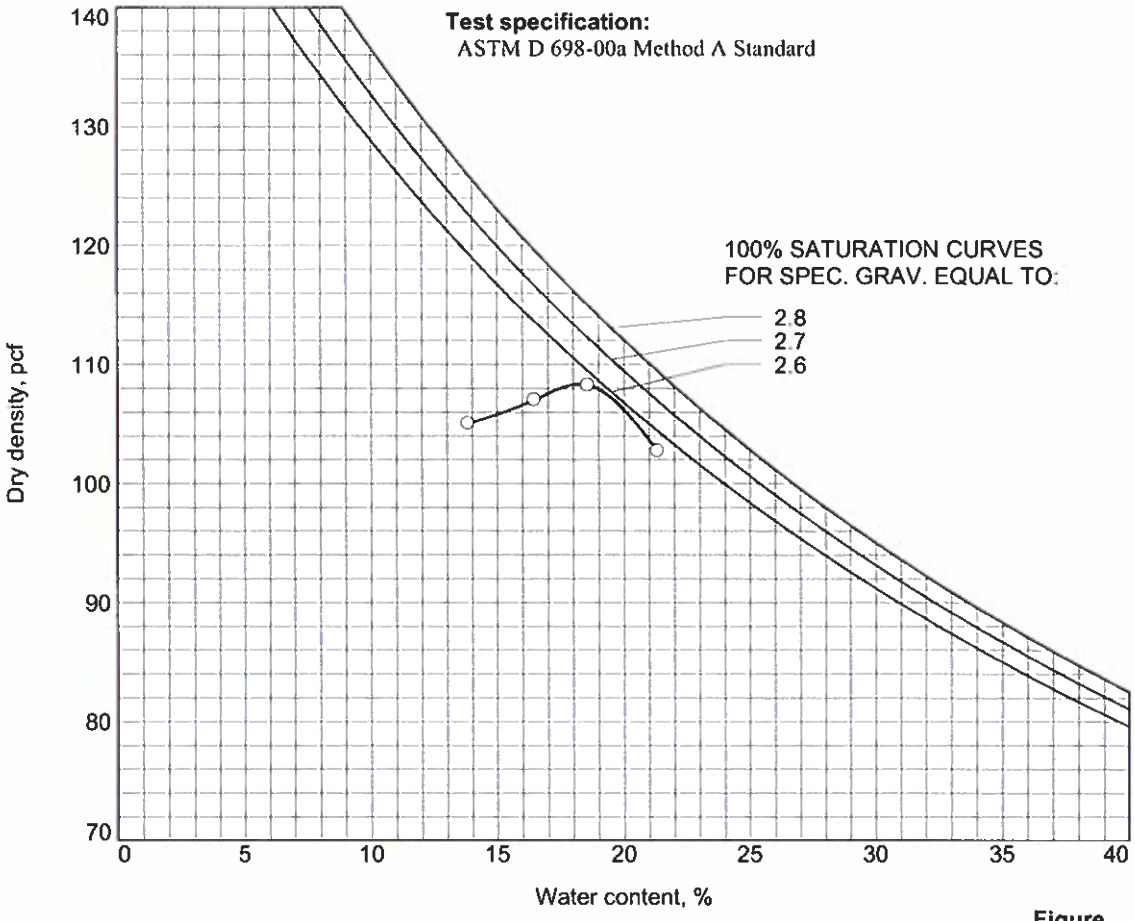
Plasticity Index = 26

% < No.200 = 84.9 %

TEST RESULTS

Maximum dry density = 108.4 pcf

Optimum moisture = 18.3 %



Figure

Vine Laboratories

COMPACTION TEST REPORT

Curve No.: 2

Project No.: 16-5026 **Date:** 4/26/2016

Project: Passive Treatment System, Twentymile Coal

Client: CH2MHILL

Location: TP16-5

Sample Number: 2 **Depth:** Bulk

Remarks:

MATERIAL DESCRIPTION

Description: Brown Lean Clay

Classifications - **USCS:** CL **AASHTO:** A-7-6 (27)

Nat. Moist. = 24.2 %

Liquid Limit = 45

Sp.G. =

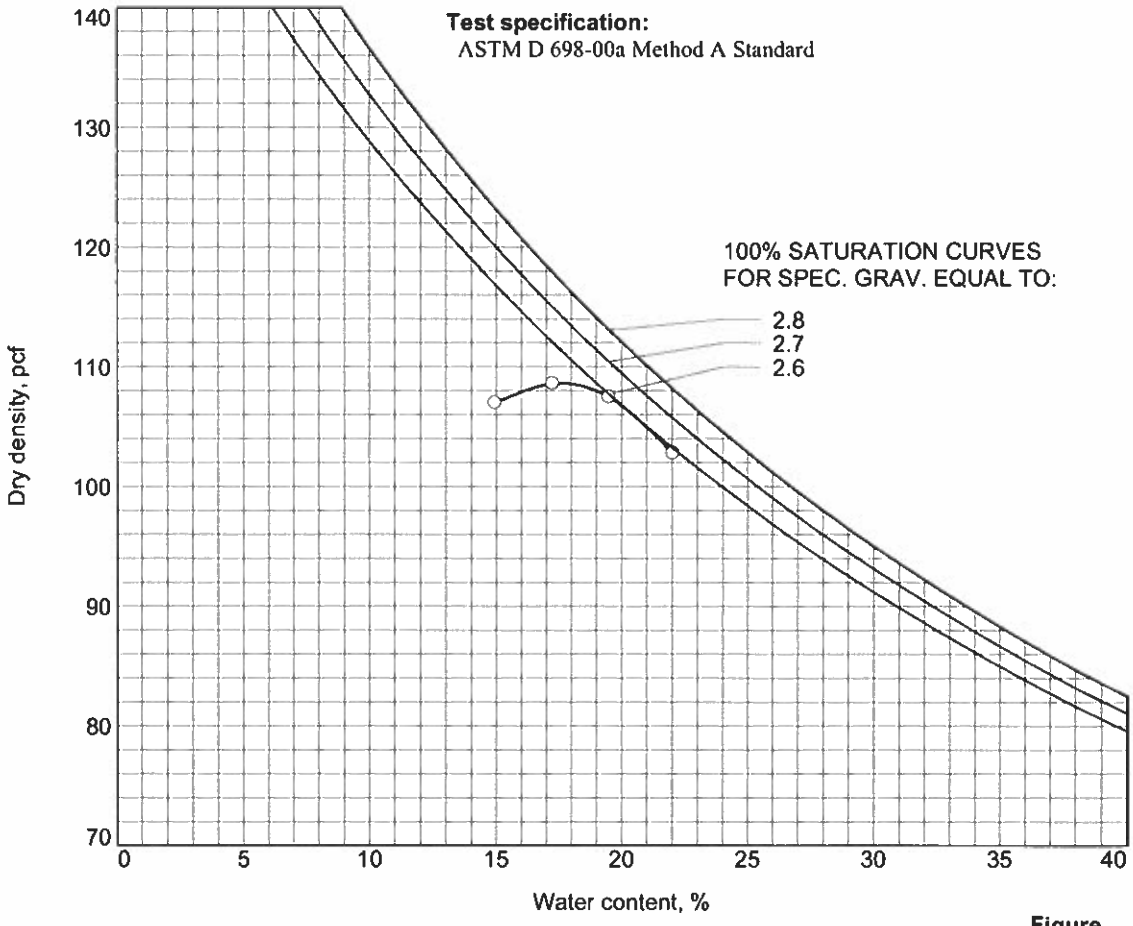
Plasticity Index = 27

% < No.200 = 95.8 %

TEST RESULTS

Maximum dry density = 108.6 pcf

Optimum moisture = 17.6 %



Figure

Vine Laboratories

COMPACTION TEST REPORT

Curve No.: 3

Project No.: 16-5026 **Date:** 4/26/2016

Project: Passive Treatment System, Twentymile Coal

Client: CH2MHILL

Location: TP16-7

Sample Number: 3 **Depth:** Bulk

Remarks:

MATERIAL DESCRIPTION

Description: Medium Brown Fat Clay

Classifications - **USCS:** CH **AASHTO:** A-7-6(37)

Nat. Moist. = 26.1 % **Sp.G. =**

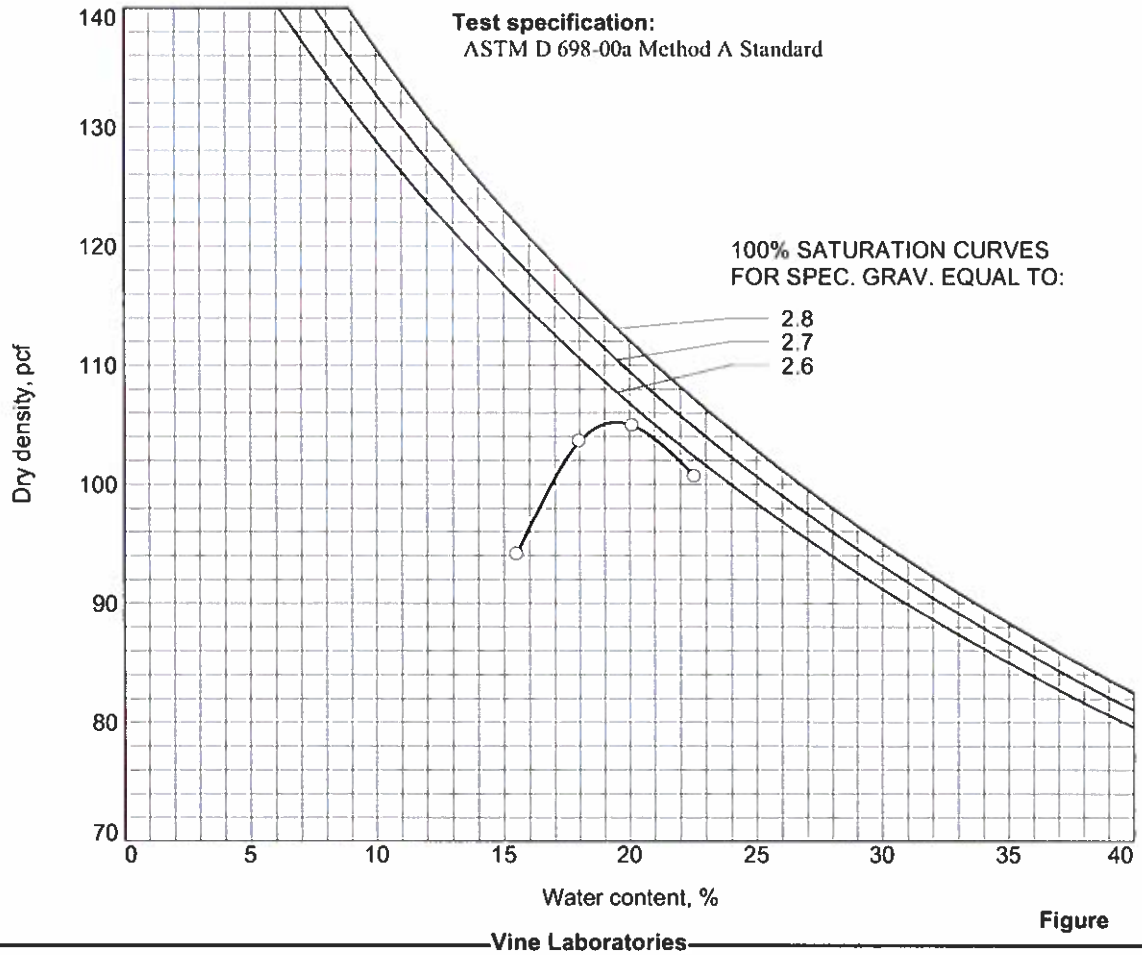
Liquid Limit = 53 **Plasticity Index =** 33

% < No.200 = 99.5 %

TEST RESULTS

Maximum dry density = 105.2 pcf

Optimum moisture = 19.5 %



Figure

Vine Laboratories

Appendix G

Foidel Creek 6MN Mine Water Storage and Stormwater Design Basis

TWENTYMILE COAL COMPANY –FOIDEL CREEK MINE
DESIGN BASIS FOR 6MN MINE WATER STORAGE RESERVOIR

The 6MN Storage Reservoir is designed as a closed reservoir (containment pond under Rule 4.05.9(2)), with no discharge, and provision for adequate operating freeboard to accommodate operational mine water storage, storage of the design storm runoff from a small upslope drainage area, and buffer storage to address any pump outage or malfunction. Most runoff from the upgradient drainage basin will be captured and diverted around the reservoir by a designed temporary diversion ditch. The design of the reservoir also incorporates a compacted soil liner (approximately 4,800 cy with an estimated permeability of 2×10^{-7} cm/in) to minimize infiltration and water loss.

The Reservoir is designed to consistently maintain approximately 9.55 million gallons, or 29.3 acre-feet, of operational mine water storage, to supply the mine water system; 1.9 acre-feet (equivalent to the runoff from a 100-year, 24-hour storm event) of storwater runoff from the limited contributing watershed; and to provide buffer storage for another 1.0 million gallons, or 3.1 acre-feet, of emergency mine water storage to address any maintenance or emergency shut-downs of the pumping system. At maximum water storage level, taking into account the incremental storage capacities outlined (34.3 acre-feet), reservoir freeboard, at the maximum pool level, will be approximately 0.5 feet to the invert of the open-channel spillway, and 2.6 feet to the top of the embankment.

TCC will remotely monitor and control reservoir water level, and mine water discharge to and from the 6MN Storage Reservoir, to maintain the water level at or below design storage capacities, and to maintain the design freeboard, at all times. Water level and pump control interfaces will provide for integrated control of pumping systems to balance inflow and discharge and shut-off the deep well pump if the pond level reaches a certain pre-set threshold level(s), and an integrated alarm system will remotely notify the operator of any system failure, malfunction, or water level concern. These controls will also assure that adequate storm-water storage capacity is maintained at all times. The discharge pumping system for the 6MN Storage Reservoir has been designed with the capacity to dewater the design storm-water storage volume in less than 12 hours. Any discharge of stored mine or stormwater from the 6MN Storage Reservoir, will be directly to the mine water system, with no discharge through the emergency spillway to natural drainage.

Even though the 6MN Storage Reservoir has been designed and will be operated as a closed reservoir, a single open-channel emergency spillway, with an invert of 6,714.9 feet, has been incorporated into the design in compliance with applicable CDRMS regulatory requirements for impoundments. While it will not be utilized during normal operations or under design storm conditions, the open-channel spillway, and the lower portion of the stormwater diversion channel are designed to safely pass the peak discharge (approximately 125.5 cfs), and the total runoff from the design storm event, as well as the pumped discharge. The lower portion of the stormwater diversion channel is designed to safely pass the maximum possible flow volume, which would be comprised of stormwater discharge from both the upgradient drainage and reservoir areas, and the pumped discharge volume.

Hydrologic design information for the 6MN Storage Reservoir is documented by the following hydrologic and hydraulic designs, completed using the SEDCAD+ hydrologic design software:

6MN Mine Water Storage Reservoir – 6MN Storage Reservoir SEDCAD Runs

6MN Mine Water Storage Reservoir – Evaluation with Reservoir Level at Invert of Emergency Spillway (Exhibit 8CC)

6MN Mine Water Storage Reservoir – Evaluation of Spillway Channel Flow with Pumped Discharge (Exhibit 8CC)

6MN Mine Water Storage Reservoir –Stage Storage Curve (Exhibit 8CC)

Due to the capacity and embankment height for the reservoir, reservoir design and construction must also meet the requirements of the Colorado Division of Water Resources – State Engineer's Office (C.R.S. 37-87-105) and the Mine Safety and Health Administration (MSHA, 30CFR 77.216). Reservoir design and construction specifications meet all applicable design and regulatory requirements. Separate applications for approval were submitted to these agencies, with copies of final approvals provided to the CDRMS.

6MN Pond 2

6MN Pond 2 will be constructed as a storage and surge pond for the 10RT dewatering pump. The 10RT well will pump to the pond, where the water will receive treatment and then be pumped to the 6MN million gallon tank.

This SEDCAD run utilizes ditches to divert the watershed runoff around the pond. The pond has been designed so that it WILL NOT discharge for the given design storm.

Chris Van Arsdale

Twentymile Coal Company
29515 RCR #27
Oak Creek, CO 80487

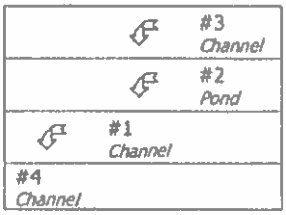
General Information

Storm Information:

Storm Type:	NRCS Type II
Design Storm:	100 yr - 24 hr
Rainfall Depth:	2.600 inches

Structure Networking:

Type	Stru #	(flows into)	Stru #	Musk. K (hrs)	Musk. X	Description
Channel	#1	==>	#4	0.002	0.434	Lower Diversion Ditch
Pond	#2	==>	#1	0.000	0.000	6MN Pond 2
Channel	#3	==>	#1	0.065	0.277	Upper Diversion Ditch
Channel	#4	==>	End	0.000	0.000	Ditch to Drainage



Structure Routing Details:

Stru #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#1	8. Large gullies, diversions, and low flowing streams	14.00	12.00	85.71	11.22	0.002
#1	**Muskingum K:**					**0.002**
#3	8. Large gullies, diversions, and low flowing streams	0.50	2.50	500.00	2.12	0.065
#3	**Muskingum K:**					**0.065**

Structure Summary:

		Immediate Contributing Area (ac)	Total Contributing Area (ac)	Peak Discharge (cfs)	Total Runoff Volume (ac-ft)
#3		119.090	119.090	125.47	13.16
#2	In	17.130	17.130	38.96	1.89
	Out			0.00	0.00
#1		0.000	136.220	120.92	15.05
#4		0.000	136.220	120.92	15.05

Structure Detail:

Structure #3 (Riprap Channel)

Upper Diversion Ditch

Trapezoidal Riprap Channel Inputs:

Material: Riprap

Bottom Width (ft)	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)
5.00	2.0:1	2.0:1	0.5	0.33		

Riprap Channel Results:

PADER Method - Mild Slope Design

	w/o Freeboard	w/ Freeboard
Depth:	2.67 ft	3.00 ft
Top Width:	15.66 ft	16.98 ft
Velocity:	4.56 fps	
X-Section Area:	27.54 sq ft	
Hydraulic Radius:	1.628	
Froude Number:	0.61	
Manning's n:	0.0320	
Dmin:	2.00 in	
D50:	3.00 in	
Dmax:	4.50 in	

Structure #2 (Pond)

6MN Pond 2

Pond Inputs:

Permanent Pool Elev:	6,714.25
Permanent Pool:	33.55 ac-ft

Emergency Spillway

Spillway Elev	Crest Length (ft)	Left Sideslope	Right Sideslope	Bottom Width (ft)
6,715.50	12.00	2.00:1	2.00:1	50.00

Pond Results:

Peak Elevation:	6,706.00

H'graph Detention Time:	0.00 hrs
Dewater Time:	0.00 days

Dewatering time is calculated from peak stage to lowest spillway

Elevation-Capacity-Discharge Table

Elevation	Area (ac)	Capacity (ac-ft)	Discharge (cfs)	Dewater Time (hrs)	
6,706.00	2.537	0.000	0.000		
6,706.00	2.537	35.443	0.000	0.00	Peak Stage
6,706.50	2.755	1.323	0.000		
6,707.00	2.982	2.757	0.000		
6,707.50	3.218	4.306	0.000		
6,708.00	3.463	5.976	0.000		
6,708.50	3.647	7.753	0.000		
6,709.00	3.836	9.624	0.000		
6,709.50	4.030	11.590	0.000		
6,710.00	4.228	13.654	0.000		
6,710.50	4.340	15.796	0.000		
6,711.00	4.454	17.995	0.000		
6,711.50	4.569	20.250	0.000		
6,712.00	4.685	22.563	0.000		
6,712.50	4.772	24.928	0.000		
6,713.00	4.860	27.336	0.000		
6,713.50	4.949	29.788	0.000		
6,714.00	5.038	32.284	0.000		
6,714.25	5.110	33.553	0.000		
6,714.50	5.183	34.839	0.000		
6,715.00	5.329	37.467	0.000		
6,715.50	5.477	40.168	0.000		Spillway #1
6,716.00	5.623	42.943	9.989		
6,716.50	5.779	45.794	127.795		
6,717.00	5.938	48.723	259.635		

Detailed Discharge Table

Elevation	Emergency Spillway (cfs)	Combined Total Discharge (cfs)
6,706.00	0.000	0.000
6,706.50	0.000	0.000
6,707.00	0.000	0.000
6,707.50	0.000	0.000
6,708.00	0.000	0.000
6,708.50	0.000	0.000
6,709.00	0.000	0.000
6,709.50	0.000	0.000

Elevation	Emergency Spillway (cfs)	Combined Total Discharge (cfs)
6,710.00	0.000	0.000
6,710.50	0.000	0.000
6,711.00	0.000	0.000
6,711.50	0.000	0.000
6,712.00	0.000	0.000
6,712.50	0.000	0.000
6,713.00	0.000	0.000
6,713.50	0.000	0.000
6,714.00	0.000	0.000
6,714.25	0.000	0.000
6,714.50	0.000	0.000
6,715.00	0.000	0.000
6,715.50	0.000	0.000
6,716.00	9.989	9.989
6,716.50	127.795	127.795
6,717.00	259.635	259.635

Structure #1 (Riprap Channel)

Lower Diversion Ditch

Trapezoidal Riprap Channel Inputs:

Material: Riprap

Bottom Width (ft)	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)
5.00	2.0:1	2.0:1	14.0	0.53		

Riprap Channel Results:

PADER Method - Steep Slope Design

	w/o Freeboard	w/ Freeboard
Depth:	1.47 ft	2.00 ft
Top Width:	10.87 ft	12.99 ft
Velocity:	10.38 fps	
X-Section Area:	11.65 sq ft	
Hydraulic Radius:	1.008	
Froude Number:	1.77	
Manning's n:	0.0540	
Dmin:	5.00 in	
D50:	9.00 in	
Dmax:	12.00 in	

Structure #4 (Riprap Channel)

Ditch to Drainage

Trapezoidal Riprap Channel Inputs:

Material: Riprap

Bottom Width (ft)	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)
5.00	2.0:1	2.0:1	3.0	0.06		

Riprap Channel Results:

PADER Method - Steep Slope Design

	w/o Freeboard	w/ Freeboard
Depth:	1.94 ft	2.00 ft
Top Width:	12.77 ft	13.01 ft
Velocity:	7.01 fps	
X-Section Area:	17.26 sq ft	
Hydraulic Radius:	1.261	
Froude Number:	1.06	
Manning's n:	0.0430	
Dmin:	3.00 in	
D50:	6.00 in	
Dmax:	9.00 in	

Subwatershed Hydrology Detail:

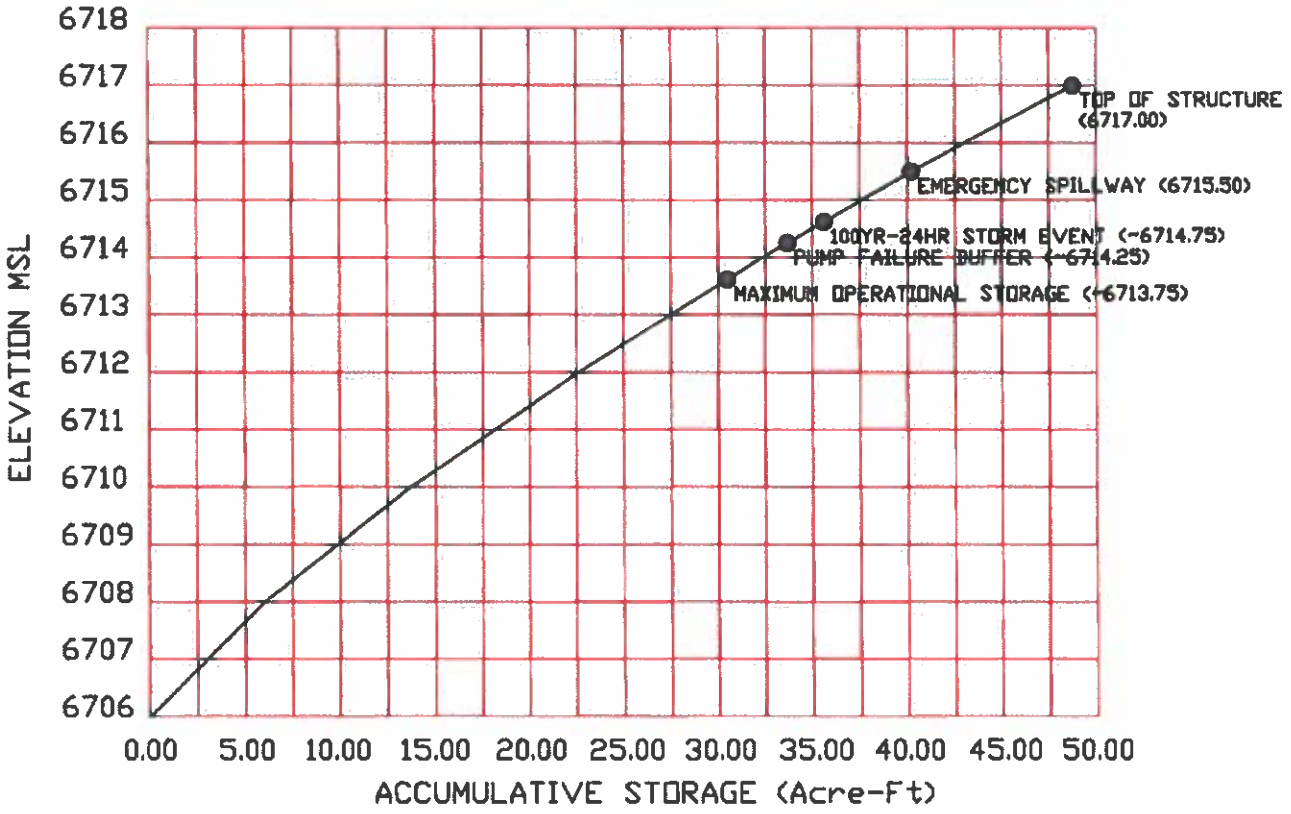
Stru #	SWS #	SWS Area (ac)	Time of Conc (hrs)	Musk K (hrs)	Musk X	Curve Number	UHS	Peak Discharge (cfs)	Runoff Volume (ac-ft)
#3	1	119.090	0.276	0.000	0.000	86.000	M	125.47	13.16
	S	**119.090**						**125.47**	**13.16**
#2	1	17.130	0.102	0.000	0.000	86.000	M	38.96	1.89
	S	**17.130**						**38.96**	**1.89**
#1	**S**	**136.220**						**120.92**	**15.05**
#4	**S**	**136.220**						**120.92**	**15.05**

Subwatershed Time of Concentration Details:

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#2	1	3. Short grass pasture	8.27	70.00	846.43	2.300	0.102
#2	**1**	**Time of Concentration:**					**0.102**
#3	1	3. Short grass pasture	8.48	196.00	2,311.34	2.320	0.276
#3	**1**	**Time of Concentration:**					**0.276**

STAGE STORAGE CURVE

6MN Storage Reservoir



STORAGE VOLUME COMPUTATIONS

6MN Storage Reservoir

ELEV. (ft)	WIDTH (ft)	LENGTH (ft)	AREA (ac)	AVG. AREA (ac)	INTERVAL (ft)	STORAGE (ac-ft)	ACC. STORAGE (ac-ft)	STAGE INTERVAL (ft)
6706.00	N/A	N/A	2.5370					
				3.0000	2.00	6.0000	6.0000	2.00
6708.00	N/A	N/A	3.4630					
				3.8455	2.00	7.6910	13.6910	4.00
6710.00	N/A	N/A	4.2280					
				4.4565	2.00	8.9130	22.6040	6.00
6712.00	N/A	N/A	4.6850					
				4.8615	2.00	9.7230	32.3270	8.00
6714.00	N/A	N/A	5.0380					
				5.2574	1.50	7.8861	40.2131	9.50
6715.50	N/A	N/A	5.4768					
				5.5499	0.50	2.7749	42.9880	10.00
6716.00	N/A	N/A	5.6230					
				5.7805	1.00	5.7805	48.7685	11.00
6717.00	N/A	N/A	5.9380					