



May 2, 2022

Mr. Zach Trujillo
Environmental Protection Specialist
Colorado Division of Reclamation, Mining & Safety
Department of Natural Resources
1313 Sherman Street, Room 215
Denver, CO 80203

RE: Colowyo Coal Company L.P.
Permit No. C-1981-019
Technical Revision 154 (TR-154)
Collom Mine Plan and Post Mine Topography

Dear Mr. Trujillo,

Tri-State Generation and Transmission Association Inc. (Tri-State), is the parent company to Axial Basin Coal Company, which is the general partner to Colowyo Coal Company L.P. (Colowyo). Therefore, Tri-State on behalf of Colowyo is submitting technical revision 154 (TR-154) to Permit No. C-1981-019.

TR-154 proposes a revised mine plan including adjusted mine plan timing for the Collom Pit, and a revised post mine topography (PMT) including a permanent valley fill in Little Collom Gulch. Colowyo's mine plans at this time, are to drive the Collom box cut down through the B, C, D, and E seams using the truck shovel fleet. The dragline currently operating in South Taylor is scheduled to be moved to Collom in 2023 where it will mine the X seam only, and spoil overburden in the dragline's last-pass cut.

The PMT has been revised to accommodate the reduced mine plan volumes including a valley fill in Little Collom Gulch to permanently hold some of the excess (due to swell) overburden material from the Collom box cut. Lastly, TR-154 reduces the excess spoil pile (out of pit) footprint and reduces the overall volume of material that is necessary to be placed out of pit to support development of the Collom box cut.

Included in this technical revision is a change of index sheet to ease incorporation of this technical revision into the permit document, and a public notice for the Division's review. If you should have any additional questions or concerns, please feel free to contact Tony Tennyson at (970) 326-3560 or at ttennyson@tristategt.org.

Sincerely,

DocuSigned by:
A handwritten signature in black ink that reads "Chris Gilbreath".
D250C711D0BF450...

Chris Gilbreath
Senior Manager
Remediation and Reclamation



May 2, 2022

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CG:TT:der

Enclosure

cc: Jennifer Maiolo (BLM-LSFO)
Tony Tennyson (via email)
Angela Aalbers (via email)
File: C. F. 1.1.2.142 - G471-11.3(21)d

CHANGE SHEET FOR PERMIT REVISIONS, TECHNICAL REVISION, AND MINOR REVISIONS

Mine Company Name: Colowyo Coal Company

Permit Number: **C-1981-019**

Date: **April 28, 2022**

Revision Description: **TR-154 Collom PMT and Mine Plan**

Volume Number	Page, Map or other Permit Entry to be REMOVED	Page, Map or other Permit Entry to be ADDED	Description of Change
1	Table of Contents, pages ix and x (2 pages)	Table of Contents, pages ix and x (2 pages)	List of Maps has been updated.
2A			No Change
2B			No Change
2C			No Change
2D	Exhibit 7 Intro, Pages Exhibit 7 Page 2 and Exhibit 7 Page 3 (2 pages)	Exhibit 7 Intro, Pages Exhibit 7 Page 2 and Exhibit 7 Page 3 (2 pages)	Section 1.5 has been updated.
2E			No Change
3			No Change
4			No Change
4			No Change
5A			No Change
5B			No Change
6	List of Maps Pages 1 and 2 (2 pages)	List of Maps Pages 1 and 2 (2 pages)	List of Maps has been updated.
7	List of Maps Pages 1 and 2 (2 pages)	List of Maps Pages 1 and 2 (2 pages)	List of Maps has been updated.
8	List of Maps Pages 1 and 2 (2 pages)	List of Maps Pages 1 and 2 (2 pages)	List of Maps has been updated.
9	List of Maps Pages 1 and 2 (2 pages)	List of Maps Pages 1 and 2 (2 pages)	List of Maps has been updated.
10	List of Maps Pages 1 and 2 (2 pages)	List of Maps Pages 1 and 2 (2 pages)	List of Maps has been updated.
12			No Change
13			No Change
14	List of Maps Pages 1 and 2 (2 pages)	List of Maps Pages 1 and 2 (2 pages)	List of Maps has been updated.
15	Table of Contents, pages i though iv (4 pages)	Table of Contents, pages i though iv (4 pages)	Table of Contents has been updated.

CHANGE SHEET FOR PERMIT REVISIONS, TECHNICAL REVISION, AND MINOR REVISIONSMine Company Name: **Colowyo Coal Company**Permit Number: **C-1981-019**Date: **April 28, 2022**Revision Description: **TR-154 Collom PMT and Mine Plan**

Volume Number	Page, Map or other Permit Entry to be REMOVED	Page, Map or other Permit Entry to be ADDED	Description of Change
15	List of Tables Page vi (1 page)	List of Tables Page vi (1 page)	List of Tables Page has been updated.
15	List of Exhibits and Maps Pages viii through xii (5 pages)	List of Exhibits and Maps Pages viii through xii (5 pages)	List of Exhibits and Maps has been updated.
15	Table 2.05.6-5		Table 2.05.6-5 is being removed from the permit.
15	Rule 2, Page 32 and 33 (2 pages)	Rule 2, Page 32 and 33 (2 pages)	References to the Excess Spoil Pile have been updated.
15	Rule 2, Page 69 through Rule 2, Page 109 (48 pages)	Rule 2, Page 69 through Rule 2, Page 108 (47 pages)	Sections 2.05.3(1), 2.05.3(3), 2.05.3(4), 2.05.3(5), 2.05.3(6), 2.05.4(2)(a), 2.05.4(2)(c), 2.05.4(2)(d), and 2.06.5 have been updated. This caused a pagination shift through out all of Section 2.05.
15	Rule 4, Page 2 (1 page)	Rule 4, Page 2 (1 page)	References to the Excess Spoil Pile have been updated.
15	Rule 4, Page 5 (1 page)	Rule 4, Page 5 (1 page)	References to the Excess Spoil Pile have been updated.
15	Rule 4, Page 12 through Rule 4, Page 23 (12 pages)	Rule 4, Page 12 through Rule 4, Page 23 (12 pages)	Sections 4.05.13, 4.05.18, 4.09, 4.13, and 4.14.1 have been updated. This caused a pagination shift within Rule 4 sections.
16			No Change
17			No Change
18B	Pages Exh. 7-23-i through Exh. 7-23-iii (3 pages)	Volume 18B List of Exhibits (1 page)	Volume 18B List of Exhibits has been updated.
18B	Pages Exh. 7-23-1 and Exh. 7-23-2 (2 pages)		Exhibit 7 Item 23 Introduction has been removed.
18B	Exhibit 7 Item 23 Part B All pages, all SEDCAD models and all figures	Exhibit 7 Item 23 Part B, pages Exh. 7-23B-1 through Exh. 7-23B-3 (3 pages), Figure 7-23B-1, and 65 SEDCAD output pages	Exhibit 7 Item 23 Part B has been updated.
18B	Pages Exh. 7-23C-1 through Exh. 7-23C-81 (81 pages)	Exhibit 7 Item 23 Part C, pages Exh. 7-23C-1 through Exh. 7-23C-3 (3 pages), Figure 7-23C-1, and 29 SEDCAD output pages	Exhibit 7 Item 23 Part C has been moved into Exhibit 7 Item 23 Part B.

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18B	Exhibit 7 Item 23 Part E Pages Exh. 7-23E-1 through Exh. 7-23E-9 (9 pages)		Exhibit 7 Item 23 Part E has been removed from the permit.
18B	Exhibit 7 Item 23 Part G, Pages Exh. 7-23G-1 and Exh. 7-23G-2 (2 pages), 24 SEDCAD output pages	Exhibit 7 Item 23 Part G, Pages Exh. 7-23G-1 and Exh. 7-23G-2 (2 pages), 14 SEDCAD output pages	Exhibit 7 Item 23 Part G has been updated.
18B	Exhibit 7 Item 23 Part H Pages Exh. 7-23H-1 through Exh. 7-23H-37 (38 pages)		Exhibit 7 Item 23 Part H has been consolidated into Part G.
18B	Exhibit 7 Item 23 Part I Pages Exh. 7-23I-1 through Exh. 7-23I-154 (154 pages)	Exhibit 7 Item 23 Part I, Pages Exh. 7-23I-1 through Exh. 7-23I-5 (5 pages), Figures 7-23I-1 through 7-23I-5 (5 pages) and 118 SEDCAD output pages.	Exhibit 7 Item 23 Part I now contains information for the Section 25 Pond.
18C	Volume 18C List of Exhibits (1 page)	Volume 18C List of Exhibits (1 page)	Volume 18C List of Exhibits has been updated.
18C	Exhibit 7, Item 23, Part J All pages	Exhibit 7, Item 23, Part J Pages Exh. 7-23J-1 through Exh. 7-23J-3 (3 pages), Figures 7-23J-1 through 7-23J-4 (4 pages) and 54 SEDCAD output pages	Exhibit 7, Item 23 Part J now contains information for the Section 26 Pond.
18C	Exhibit 7 Item 23 Part M All pages	Exhibit 7 Item 23 Part M, pages Exh. 7-23M-1 and Exh. 7-23M-2 (2 pages), Figures Exh. 7-23M-1 and 7-23M-2 (2 pages) and 13 SEDCAD output pages.	Exhibit 7 Item 23 Part M has been updated.
18C		Exhibit 7 Item 23 Part N, page Exh. 7-23N-1 (1 page), 57 SEDCAD output pages	Exhibit 7 Item 23 Part N has been inserted.
18C	Exhibit 7, Item 25 All pages (77 pages)		Exhibit 7 Item 25 has been consolidated into the specific sediment pond it is applicable with.
18D	Figure 7-26C-1		Figure 7-26C-1 has been moved to Volume 18B.

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Volume Number	Page, Map or other Permit Entry to be REMOVED	Page, Map or other Permit Entry to be ADDED	Description of Change
18D	Figure 7-26D-1		Figure 7-26D-1 has been moved to Volume 18C.
18D	Figure 7-26E-1		Figure 7-26E-1 has been moved to Volume 18C.
18D	Figure 7-26F-1		Figure 7-26F-1 has been moved to Volume 18C.
18D	Figure 7-26G-1		Figure 7-26G-1 has been moved to Volume 18C.
18D	Figure 7-26H-1		Figure 7-26H-1 has been moved to Volume 18C.
19			No Change
20	Volume 20 Table of Contents (1 page)	Volume 20 Table of Contents (2 page)	Volume 20 Table of Contents has been updated.
20		Exhibit 23 Item 3 Cover page (1 page) and Report (18 pages)	Exhibit 23 Item 3 is being inserted into the permit.
21	List of Maps Pages 1 and 2 (2 pages)	List of Maps Pages 1 and 2 (2 pages)	List of Maps has been updated.
22	List of Maps Pages 1 and 2 (2 pages)	List of Maps Pages 1 and 2 (2 pages)	List of Maps has been updated.
22	Map 19C	Map 19C	Map 19C has been updated.
22	Map 19D		Map 19D is being removed from the permit.
22	Map 20C	Map 20C	Map 20C has been updated.
22	Map 20C	Map 20C	Map 22C has been updated.

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1.3 RETURN PERIOD/PRECIPITATION

A precipitation amount is required for the appropriate return period. The following return periods and precipitation events are used for the Colowyo Mine:

10-year, 24-hour storm event	1.8 in
25-year, 24-hour storm event	2.3 in
100-year, 24-hour storm event	2.7 in

1.4 HYDROGRAPH RESPONSE SHAPE

A unit hydrograph is chosen for each drainage area or sub-area modeled to predict the run-off response. The hydrograph responses available in the SEDCADTM4 model are slow, medium, and fast. A slow response corresponds to a forested area or an area with a number of obstructions. A fast response corresponds to an un-vegetated or poorly protected area. Medium and fast hydrograph responses are considered as most representative for mine areas.

The internal convolution increment is 0.05 hours, and values are saved at the user-specified interval of 0.1 hours or greater. A convolution increment of 0.1 is specified. It should be noted that a time of concentration less than 0.125 hours bypasses the unit hydrograph technique and instantaneous run-off is assumed. As explained in the SEDCADTM4 User's Manual (Schwab and Warner, 1998), the time of concentration restriction of 0.125 hours is dictated by a combination of array size restrictions, minimum internal convolution interval, and the user-specified time increment for saving convolution values.

1.5 DRAINAGE BASIN AREA

Drainage basin areas are determined for each pond from scaled topographic drawings. The final post-mining topography and or current mining topography is utilized to determine overall watershed for each ponds. Watershed (or sub-watershed) areas are delineated consistent with four general categories representing various stages of mining related disturbances and various stages of reclamation. The watershed or sub-watershed delineations (including curve number applications) reflect mining and reclamation status based on Colowyo's current mining and reclamation plans as presented on the mine plan (Maps 23 and 23B) and spoil grading timing maps (Maps 29 and 29B) in accordance with Rule 4.05.6(3)(a).

1.6 TIME OF CONCENTRATION, T_C

The time of concentration is calculated using the SCS upland method (Soil Conservation Service, 1986) as incorporated into the SEDCADTM4 software. The hydraulic lengths, drainage heights and associated slopes are determined from topographic drawings. The values calculated for each structure are shown on a sub-watershed basis in the SEDCADTM4 printouts.

1.7 MUSKINGUM ROUTING PARAMETERS, K, X

The Muskingum Routing Parameters are also calculated using the SCS upland method. The hydraulic lengths, drainage heights and associated slopes are determined from topographic drawings. The values calculated between each structure and/or sub-watershed are shown in the SEDCADTM4 printouts.

1.8 CURVE NUMBER, CN

The runoff curve number is a factor relating the amount of rainfall to the amount of runoff for a given area. Curve numbers were jointly developed and agreed upon by the Division and Colowyo.

The curve number for the undisturbed lands is selected as Hydrologic Soil Group (HSG) "C" based on the pre-mining mapped soils in the county SCS soil maps.

For disturbed lands the use of mapped SCS soil groups is not appropriate. Instead, Section 630.0702

“Disturbed Soils” in Chapter 7 of Part 630 of the NRCS National Engineering Handbook (NEH) recommends that onsite investigations should be made to determine the HSG, including on-site infiltration tests, grain size characteristics and lab permeability tests. A program meeting these requirements was carried out and reported in Striffler and Rhodes (1981), and it included tests performed at the Colowyo mine, as well as ten other Colorado coal mines.

All of the infiltration tests performed at the Colowyo Mine reported in Table C-5 of that study indicated infiltration rates well in excess of a “C” soil, and in all cases except one reflected rates that would be associated with a HSG “A” soil. That exceptional case indicated infiltration rate between HSG “A” and HSG B” soils. The selection of HSG “B” for the disturbed lands is therefore a conservative assumption, more likely to overestimate than to underestimate runoff rates.

With the HSG determined as described above for undisturbed and disturbed land, the CN is then determined based on the land cover condition as described in numerous hydrologic references, all ultimately based on NEH cover and condition tables.

The resulting hydrologic curve numbers (CN) for use in SEDCADTM4 for the various categories of land at the mine are presented below in Table 1. Table 7 provides a scanned image of published curve numbers typical for disturbed areas; these values will not be used directly but are only provided to support to Table 1. Table 8 provides a similar listing from the National Engineering Handbook (NEH-4) (USDA-SCS, 1985); these values are included within the drop down menus of the SEDCADTM4 model. Of the several tables included here as Table 8, the last table presented here in Table 8 is applies to Range lands in arid and semi-arid areas, and is the most appropriate set of Curve Numbers for the Colowyo Mine applications. Values in Table 8 will not be used directly but are provided to support the values presented below in Table 1.

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Much of Little Collom Gulch is located within the Collom Pit and spoil piles. As a result, an upgradient monitoring station was not established. Sampling point LLCG is located immediately adjacent to valley fill well MLC-04-01 east and just above the confluence of Little Collom and Collom Gulches (Map 10B).

Another monitoring well named MLC-04-20 was attempted to be drilled in Little Collom Gulch to monitor valley fill ground water in the upper portion of the gulch. The location selected was downstream of and within 500 feet of the northern end of the Collom Pit excess overburden pile. The location selected for the placement of the monitoring well was on a bench within the bottom of the valley that was considered to be underlain by valley fill material. The bench is 25 to 30 feet above the floor of the narrow incised channel of Little Collom in this area.

The MLC-04-02 location was sited approximately 30 feet west of the valley bottom. During the drilling of the hole, weathered bedrock was encountered at approximately four feet below ground surface, with a mixture of colluvium and eolian material from ground surface to four feet below ground surface. Drilling was advanced to 20 feet to determine if any shallow ground water could be encountered. The drilled materials to 20 feet were dry.

Examination of the bank wall above the floor of the Little Collom Gulch valley revealed weathered bedrock near the surface and less weathered bedrock encountered when digging further into the bank. The floor of the valley revealed predominantly colluvial and eolian material with some sheet wash material.

Based on the activities at the MLC-04-02 location, further examination of the Little Collom Gulch valley was undertaken from this point downstream (northward) to near the site of MLC-04-01 (near the confluence with Collom Gulch). The valley bottom of the Little Collom Gulch is narrow for over 0.3 miles to where the valley starts to spread out, but the channel remains narrow and deeply incised.

The surface material throughout the valley remains predominantly colluvial and eolian with some sheet wash deposition. The banks along the deeply incised channel do not show any significant falls due to undercutting of the banks. Only normal erosion seems to be occurring throughout the length of Little Collom before it enters Collom Gulch. Large trees and heavy rangeland vegetation occurs through the valley bottom.

Where the valley flattens on each side of the incised channel of Little Collom Gulch (approximately 0.9 miles north from the MLC-04-02 site), a two track road has crossed the incised valley bottom of Little Collom Gulch. Examination of this location shows no evidence of near surface ground water and no “wetlands” type vegetation is apparent in this area. The crossing is approximately 30 to 40 feet deeper than the flat area of the valley on each side of the incised channel.

Several impoundments in Little Collom Gulch show some water storage in the past. However, there is no evidence of recent surface water flow and/or storage due to the presence of rangeland vegetation in the incised channel bottom and the water storage areas. Another crossing near where Little Collom Gulch turns to the west to intersect with Collom Gulch, also shows no recent water flow or wet bottom in the incised channel bottom. This crossing is also approximately 30 to 40 feet deeper than the valley sides.

In addition to these observations, monitoring of surface and ground water in the valleys of the Collom mining area has been undertaken for over a decade and no surface flow has ever been noted in Little Collom. Drilling and field surveys by Colowyo geologic contract personnel in the Collom mining area for over the past 20 years have not noted any water flow in Little Collom Gulch.

The surface conditions of Little Collom Gulch north of the MLC-04-02 location and the shallow bedrock throughout the valley seems to preclude the presence of any significant valley fill north of the excess

overburden pile. There is some valley fill material close to the confluence of Little Collom and Collom Gulches due to the shallow ground water found in MLC-04-01 (greater than 55 feet bgs).

With the data accumulated to date in the Little Collom Gulch concerning surface and near surface conditions, it does not appear that there is any significant valley fill material through most of the Little Collom Gulch where a valley fill monitor well could be located since there is no significant shallow valley fill ground water to monitor. The surficial material deposited on the benches in Little Collom Gulch are definitely colluvial and eolian.

Jubb Creek – Jubb Creek is located on the eastern side of the Collom permit expansion area. Above the USGS gaging station, it drains approximately 7.53 square miles of hilly plateau terrain. The elevation of the stream channel ranges from about 6,400 ft amsl where it crosses Moffat County Road 51 north of the Collom Syncline, to approximately 7,600 ft amsl near the summit of the Danforth Hills. The two forks of Jubb Creek (East and West) join at approximately 6,700 ft amsl (Map 10B). The stream channel runs in a northeasterly direction across the Collom Syncline before joining Wilson Creek several miles northeast of the Trout Creek Sandstone outcrop. Jubb Creek generally has no flow during the winter. Flow in Jubb Creek is partially controlled by several small stock ponds located on both the East and West Forks of Jubb Creek.

The upper reaches of the West Fork of Jubb Creek lie just east of the footprint of the Collom Pit. Two sampling stations established in 1996 (EFJC and WFJC) are located in the east and west forks of Jubb Creek, respectively (Map 10B). During the pre-feasibility study, no surface water flow was observed at either location. To monitor surface water quality downstream of the mine, Jubb Creek sampling location CJC, located at the confluence of East and West Jubb Creeks adjacent to valley fill monitoring well MJ-95-03, was used. Samples were collected from all three locations by KEC in 1996 and 1997.

Surface Water Quantity – Baseline monitoring was conducted from December 2004 through May 2006 in the Collom Gulch, Little Collom Gulch, and Jubb Creek drainages. Field flow measurements were taken monthly at stream flow sampling locations, unless prevented by frozen or non-existent flow. Field flow measurements were attempted twice a year at springs and seeps.

Based on the flow monitoring in 2004 through 2006, conditions in Little Collom Gulch and within the upper Jubb Creek watershed were typical of intermittent or ephemeral streams, while the monitored sections of Collom Gulch can be characterized as intermittent or perennial. Baseline surface water monitoring data are presented in Tables 2.04.7-46 and 2.04.7-48. Streamflow hydrographs for representative surface water monitoring locations in these drainages are presented in figures 2.04.7-40 to 2.04.7-43. Surface water quality as measured by total dissolved solids (TDS) is also illustrated to show seasonal variability with respect to stream flows. Each drainage basin is discussed individually below.

Collom Gulch – Colowyo measured flows at two locations in Collom Gulch (UCG and LCG) that ranged from 0.004 cfs to 3.5 cfs. Winter base flows ranged from 0.004 to 0.04 cfs. Maximum flows occurred in June, corresponding to snowmelt, spring runoff and/or precipitation events. Summer base flows (July through September) in Collom Gulch ranged from 0.01 to 0.03 cfs. Both Upper Collom Gulch and Lower Collom Gulch exhibit intermittent or perennial characteristics, with spring high flows the apparent result of snowmelt. Both are likely to be intermittent in dry years. Hydrographs for Collom Gulch sample locations can be found in Figures 2.04.7-40 and 2.04.7-41. From the hydrographs, it can also be seen that water quality, as represented by Total Dissolved Solids (TDS), varies seasonally in response to dilution from spring runoff.

2.05 OPERATION AND RECLAMATION PLANS

2.05.1 Objectives

The planned operations and reclamation will be similar to those presented in Volume 1, Section 2.05. Operational changes and information specific to the Collom Pit within the Collom mining area are described in the following sections of this permit revision application.

2.05.2 Operation Plan - Estimated Area for Life of Operation

Information regarding the permit term is delineated in Section 2.01.5. Information for the operation plan is delineated in Section 2.05.3. Likewise, for purposes of this application, the permit area identifies the area for the life of the mine

Colowyo will employ detailed and current engineering designs for all surface mining activities in order to maximize coal recovery. The open pit mining technique minimizes or eliminates coal rib losses and coal fenders. The mining operations described in Section 2.05.3 are designed for maximum coal recovery.

2.05.3 (1) Operation Plan – Production Methods

Colowyo has selected its mining procedures on the basis of information from numerous exploration drill holes which penetrated the overburden, the interburden, and the coal seams. Each phase of mining has been carefully scheduled so that all equipment can be operated in situations suitable to their design capabilities. The overall operation plan is designed to flow logically from topsoil removal through reclamation. The plan is designed to maximize coal recovery and minimize environmental disturbances. Colowyo's existing operation plan is described in detail within Volume 1, Section 2.05.3.

The locations of the areas to be mined are shown on the Mine Plan Map (Map 23B). Topsoil removal schedules and stockpile locations are delineated on the Topsoil Handling Map, (Map 28C Sheet 1). Topsoil will be removed from an area primarily during the summer and fall months to allow for advancement of mining. A buffer zone, with topsoil removed, will be left between the undisturbed area and the crest of the pit. Additional information on topsoil handling is presented in Section 2.05.3 (5).

The area to be mined within the Collom Pit covers an area of two long ridge lines at about 7900 feet in elevation which is bisected by a 100 to 200 feet deep valley formed by the stream channel of Little Collom Gulch. Ultimately the Collom Pit could cover about 880 acres and could be up to 600 feet deep in places.

Seams that can be mined in the Collom Pit include the Y, X, A, B, C, E, F, and G. The lowermost seam that could be developed is the G_{ab}. As shown on the geologic cross-sections presented in Figure 2.04.6, all the coal seams in the Collom Pit are dipping at approximately 8 percent to the northeast. Cross section locations are shown on Map 11B.

Given current market forecasts for coal sales, not all coal seams located within the Collom Pit are scheduled to be mined at this time. Should coal markets change, the Collom Mine Plan will be revised to mine additional seams as needed to meet contractual obligations. The current operating plan is to finish dragline operations in the South Taylor Pit, and then relocate the dragline into the Collom Pit in or around 2023. Once the dragline is in the Collom Pit, it will uncover the upper-most X coal seam and spoil overburden in the last-pass cut location. The truck/shovel fleet will excavate and transport X coal, and will also continue developing the Collom boxcut through the B,C,D and E coal seams.

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The truck/shovel fleet will mine overburden and will haul the overburden to the out of pit dump or dump within the current pit shell. As the Collom boxcut is developed, highwall mining operations will mine coal in the B,C,D and E seams on the highwall and low wall sides of the boxcut. Highwall mining will also take place along the east and west flanks of the Little Collom Draw, located within the permitted pit shell. Further information on highwall mining in the Collom Pit is provided in Section 4.23. Please refer to Map 23B for a visual representation of the areas to be mined within the Collom Pit.

It is estimated that coal production from the Collom Pit will build from about 2.1 million tons in 2022 up to about 2.4 million tons in 2023 and 2024. Collom Pit coal production is estimated to fluctuate from 2025-2029 between 1.2 and 1.7 million tons. A total overburden/interburden volume of 47,971,955 bank cubic yards (bcy) and coal tonnage of 14,676,774 in-situ tons are estimated to be generated and produced, respectively, from the Collom Pit. Of the 14,676,774 in-situ tons in the Collom Pit, approximately 6,00,000 tons will come from highwall mining. Table 2.05-2 in Volume 1 presents estimated production for the permit term.

A general description of the initiation of mining activities in the Collom Pit is described below:

Sediment Control System Construction:

Please refer to Section 2.05.3(4) for a description of the sediment control system.

Collom Pit and Excess Overburden Pile:

Once sediment control structures were constructed, topsoil stripping commenced for the initial box cut area and Opile (also referred to as the temporary spoil pile). Construction of the excess overburden pile underdrain commenced in the valley bottom progressing upstream from the southernmost limit of the excess overburden pile and progressing downstream toward the final toe of the temporary spoil pile. Initial construction of the toe of the excess overburden pile (northern extent) will commence concurrently with boxcut development.

For development of the initial box cut of the Collom Pit, Colowyo will utilize truck/shovel techniques. Mining will be conducted in an up-dip direction. (north to south).

Please refer to Volume 1, Section 2.05.3 for blasting procedures and sequencing information applicable to the Collom expansion area activities. Please also refer to Section 4.08 of this package for additional information.

Once the overburden is sufficiently fragmented to allow for efficient removal and loading, overburden will be loaded and transported to the excess overburden pile or to adjoining mined-out areas within the pit. After removal of the overburden, the coal seams will be exposed. As the coal seams are exposed, they will be cleaned using auxiliary equipment, then either drilled and shot with explosives, or ripped to prepare the coal for loading and removal.

When explosives are needed, the drilling will be performed by an auger drill. The drill hole pattern is generally spaced approximately 12 feet by 12 feet, though dependent upon the actual coal seam thickness. Drill holes will be loaded with either ANFO or a waterproof explosive (if the holes are wet).

Once the coal has been prepared for loading by blasting or ripping, a rubber-tired front-end loader or excavator will load the coal into haulage trucks. Following loading, these haulage trucks will transport the coal along in pit haulage routes to the primary crusher located just outside of the pit, as shown on Map 25D (Collom Coal Haul Road). Coal from the primary crusher will be loaded into trucks and transported

on a paved haulage road (See Map 25E – Collom Haul Road, Sheets 1-4) to the coal crushing and load-out facility as shown on the Structures and Facilities Map (Volume 8, Map 22). Details of the coal crushing and load-out facilities are included in Volume 1, Section 2.05.3 under the heading of Mine Facilities.

As the excess overburden pile is constructed, best management practices to reduce sediment production and excess dust impacts to adjoining areas will be implemented. Interim reclamation and/or dust suppression chemicals may be utilized to impacts, if determined to be necessary.

As soon as possible after the coal is removed from the mining area and sufficient room is available for back-filling, reclamation begins. In general, rough backfilling is completed by the overburden trucks and bulldozers. Final grading will be performed to recreate a post mining topographic expression that is similar to the pre-mining topography. Moderation of some existing topographical expressions is anticipated to facilitate the stability of the reclaimed land surface; however, this is not anticipated to significantly alter the pre-mining topographical expression. Topsoil placement will be done in a manner that reduces erosion and provides a surface for topsoil that minimizes slippage. At the completion of the final grading, topsoil will be redistributed over the regraded spoil and revegetated in accordance with Section 2.05.4. Typically, after completion of topsoil replacement on 3H:1V (horizontal to vertical) slopes, a dozer will construct a drainage control bench or contour furrows, where necessary, to slow water flow on the longer slopes and minimize erosion.

Other surface treatments are also described in Section 2.05.4. A list of the equipment anticipated to be used by Colowyo in the Collom permit expansion area to perform the day-to-day operation of coal mining is shown in Table 2.05.3 in Volume 1.

2.05.3 (2) Operation Description

A detailed narrative description of the land to be affected within the Collom area is provided above under the heading Production Methods. The mining plan for Collom is graphically portrayed on the Mine Plan Map (Map 23B).

2.05.3 (3) Mine Facilities

Existing buildings, structures, utility corridors, loadout, other facilities that will support the Collom area are shown in Volume 8, Maps 21 and 22 and are discussed in Volume 1, Section 2.05.03. These facilities will continue to be used to support the Collom Pit. Facilities constructed at the Collom Pit are shown on Map 22B. The Collom area infrastructure includes power lines, water lines, in-pit haulage routes, crusher, a haul road, and support facilities including coal storage, blasting building and explosive storage. The Collom Coal Haul Road (please see Map 25D) leads out of the Collom Pit and Collom coal crusher and coal storage area. Coal will be loaded at the primary crusher into haul trucks designed for use on conventional roads and will be transported on a single haul road to the Gossard loadout. This haul road runs northeast out the mining area along the West Fork of Jubb Creek (See Map 25E – Collom Haul Road, Sheets 1-4).

Main Office

Please refer to Volume 1 Section 2.05.3.

Shops, Warehouse Facility

Please refer to Volume 1 Section 2.05.3.

Anaylsis Laboratory, Emergency Vehicle Garage

Please refer to Volume 1 Section 2.05.3.

Crushing and Loadout Facilities

The coal crushing and loadout facilities include two separate facilities: (1) primary crusher; (2) secondary crusher and train loadout; upon completion of coal production from the South Taylor pit the secondary crusher at the Gossard loadout may be removed.

The primary crusher facility will be located in Section 36, Township 4 North, Range 94 West, as shown on Map 22B. Included in the primary crusher facility are a raw coal stockpile area, a truck dump, a primary crusher, a covered conveyor, a storage bin, and a truck load-out.

Coal will typically be hauled from the pit in rear dump haulage trucks to the primary crusher site. The coal is then dumped directly into the truck dump hopper, or stockpiled. The truck dump hopper will be equipped with dust control spray bars. The coal from the stockpile can also be fed into the hopper by front-end loaders taking from the stockpile. Feeders at the bottom of the truck dump hopper discharge the coal into the primary crusher. Following primary crushing, the coal is discharged onto a conveyor belt which transports the coal to a storage bin. The coal is then gravity discharged into highway trucks and hauled to the secondary crusher facility.

The secondary crusher and train load-out facility is known as the Gossard Loadout and is located in Section 22, Township 4 North, Range 93 West, and is described in Section 2.05.3 in Volume 1.

Explosives Storage Area

The Collom area explosives storage facilities are shown on Map 22B, and will meet or exceed all MSHA and BATFE regulations. Overall volume of high explosives used by Colowyo collectively while mining activities transition over time from the existing operation to the Collom area exclusively logically dictates the number, capacity and configuration of the Collom facility magazines be similar existing facility to ensure sufficient magazine capacity is available at the time peak utilization of high explosives in the Collom area will occur. This logical approach is also applied to the ammonium nitrate, emulsion and Type V magazine storage area also identified on Map 22B. As these structures contain blasting materials and not high explosives, specific requirements governing their management are different and as such are separated by location from the high explosives storage area.

Loadout

Colowyo's loadout, the Gossard Loadout, is located at the end of the Colowyo's rail line. The only segment of the spur within the permit area is shown on Map 22A, Existing Structures North.

Power Lines

Because Colowyo utilizes electric-powered mining machines power lines will be located in the permit area to supply electricity to the equipment and facilities. The location of the supporting power lines within the Colowyo existing permit area is included in Volume 8, Map 22A. Power lines for the Collom expansion area are shown on the Structures and Facilities map (Map 22B). The 69kV power line that is routed through the permit boundary to the Collom facilities area will be owned, operated, maintained by White River Electric Association (WREA) not Colowyo, and will remain in place to service the area post-

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mining. Colowyo is the surface landowner that the power line will be routed upon, and for ground disturbances related to WREA's 69 kV power line to the Collom facilities area please see Volume 1 Section 4.12.

Electrical power lines located in the permit area will be constructed in accordance with requirement of Section 4.18 to minimize potential electrical hazards to large raptors.

The major pieces of equipment that will be powered by electricity in the Collom area are shovel(s) and dragline(s). Therefore, during the life of the mine it is necessary to periodically move the existing power line loop to accommodate the advancement of the pit.

Temporary Facilities Area (Jubb Creek)

During the construction of the primary sediment control structures, Collom haul road and the main Collom facilities area described above, a temporary facilities area was constructed at the Jubb Creek entrance directly off of Moffat County Road 32. This temporary facilities area contained temporary trailers for construction management and a laydown yard for incoming supplies and materials that was utilized during construction of the Collom haul road, sediment ponds, and main facilities area. The area is now used by the highwall mining contractor and provides a location for their temporary offices to support ongoing highwall mining in the Collom Pit. Any trailer or building in this location is temporary in nature, is not owned or leased by Colowyo, and once this area is no longer necessary to support highwall mining activities the trailers will be removed from the site and reclamation will commence in accordance with Section 2.05.4(1). The sediment control plan for this area can be found in Exhibit 7, Item 23, Part K.

Haul and Access Roads

A haul road was constructed to facilitate mine traffic from the Collom primary crusher to the Gossard load out facility located northeast of the Collom Pit. This approximate 6-mile long haul road was constructed to meet the specifications and standards set forth in Rule 4.03.1 (See Map 25E, Sheets 1-4). The haul road was constructed with a crown, and constructed upon the most stable available slope to minimize erosion. An elevated haul road crossing was installed at Moffat County Road 51 at the request of Moffat County (See Map 25F). This elevated crossing ensures the general public traffic is separated from the mine haul road traffic, and takes Moffat County Road 51 over the top of the Collom Haul Road. An equipment crossing adjacent to the elevated crossing will allow large equipment movement from the Collom mine to the existing operations (See Map 25F).

Overall grade of the Collom Haul Road does not exceed 10H:1V with a horizontal alignment consistent with the existing topography. Ditches, erosion controls, and culverts are used to minimize impacts to surrounding areas, and all culverts are designed to safely pass peak runoff from a 10 year, 24 hour precipitation event (Please see Volume 18C Exhibit 7, Item 25F).

The Collom Haul Road has been constructed to meet the applicable haul road regulations as well as internal road design guidelines while minimizing additional disturbed area and preventing environmental damage. The as-built configuration can be found on Map 25E Sheets 1 through 4. The Collom Haul Road has an overall width of approximately 100 feet, with a 28-foot asphalt-running surface as shown on (Map 25E Sheet 1).

Asphalt pavement specifications were based on a 30 year design life with an 18" thick base course (gravel) and 7.0" asphalt thickness. The asphalt installed will support a 50 ton coal haul trucks with axle loads of about 81 psi. Cut slopes have been completed at 0.25H: 1V or less when completed in competent rock. Elsewhere, cut slopes in unconsolidated materials were typically laid back at 2H:1V; however some

areas are steeper or shallower based on field conditions encountered during construction (please see Map 25E Sheet 3).

There is one main haul roads that has been constructed to haul coal from the Collom Pit to the Collom crusher area. This haul road is shown on Map 25D. Please see section 4.03.1 for details pertaining to this haul roads and other haul roads that will be constructed within the mining area.

Several access roads have been constructed to support mining operations at the Collom mine. Two access roads were constructed to the Section 25 and 26 sediment ponds, an access road was constructed to access the Collom Haul Road from the Jubb Creek entrance off Moffat County Road 32, and several temporary access roads were established to support initial mining operations. The locations and as-built configurations for these access roads are provided in Volume 18B, Exhibit 7-23, Part D, Figures D1 through Figure D4.

2.05.3 (4) Operation Plan – Ponds, Impoundments, and Diversions

To control runoff, and protect surface and ground water quality, Colowyo constructed several sedimentation ponds and diversion ditches. All ponds and diversions are designed to meet or exceed the requirements of 2.05.3(4) and 4.05.6. All sediment ponds are maintained in accordance with the parameters mentioned in Volume 1, Section 2.05. Impoundments will be inspected quarterly as discussed in Section 4.05.6. Please refer to Volume 18B Exhibit 7, Item 23, Parts A, B, C, and G for the sediment control plan during mining operations. Please refer to Volume 18B Exhibit 7, Item 23, Part I and Volume 18C Exhibit 7, Item 23, Parts J, M, and N for the sediment control plan post mining.

The sediment ponds and temporary diversion channels will remain in place until such time as the entire disturbance footprint area reporting to these structures is reclaimed, and the entire contributing watershed has achieved Phase II bond release in accordance with Rule 4.05.2(2).

One containment pond (Wilson Storage Pond) is utilized to store water as needed to support mining activities. Water is pumped or trucked in from an existing Colowyo held water right and is stored in the Wilson Storage Pond and utilized for dust suppression and other water needs. The design for this storage pond can be found in Volume 18C, Exhibit 7, Item 23, Part L.

2.05.3 (5) Topsoil

Prior to any mining related disturbances, topsoil will be removed from planned disturbance areas as discussed in Section 2.05 (*Topsoil Redistribution Plan*) and Section 4.06 (Topsoil) and redistributed or stockpiled as necessary to satisfy the needs of the reclamation timetable.

Topsoil will be removed by bulldozers, loaders or scrapers as described in Section 2.05.3, Production Methods and Equipment.

Topsoil stockpile locations and extent of stripping is presented in Topsoil Handling Map (Map 28C Sheet 1). Topsoil stripping will occur in advance of mining and can be anticipated to occur within the mine plan blocks depicted on Map 23B. The overall life-of-mine topsoil balance is provided in Volume 1, Table 2.05-1. An annual update to the overall topsoil balance for Colowyo is provide each year in the annual reclamation report.

The stockpiling of topsoil will continue until all pit development has progressed to its maximum extent. Areas available for final reclamation prior to mine closure consist primarily of backfilled pit areas. Topsoil to cover these areas will either be direct placed from areas of topsoil removal activities or topsoil

will be hauled from the topsoil stockpiles. Direct placement of topsoil will be the preferred method, however, the stockpiled material will be utilized if equipment schedules, weather conditions or other operational factors make direct placement less desirable or less cost effective. After mining and regrading operations have ceased, all stockpiled topsoil will be used to reclaim the remaining pit and other disturbance areas.

Topsoil will be stored in topsoil stockpiles as shown on Map 28C Sheet 1. Stockpiles will be constructed with outside slopes no steeper than 3H:1V. Stockpiles are specifically located to avoid erosion from wind and water and additional compaction or contamination. As can be determined from the Topsoil Handling Map (Map 28C Sheet 1), all stockpiles are located within stable areas. The piles will be protected from wind erosion by planting a perennial mixture as explained in Section 4.06.3 as soon as conditions allow. Proper seasons of planting will be early spring or late fall. In addition to the planted material, a considerable amount of volunteer growth can be expected to grow on all stockpiled topsoil.

External erosion will be controlled through proper location of the stockpiles. No topsoil stockpiles will be placed in a drainage bottom where external erosion might pose a potential threat.

Unnecessary compaction will be avoided by keeping all but essential traffic off the stockpiled areas. In accordance with Rule 4.02.7, topsoil signs will identify topsoil stockpiles. Contamination of the stockpiles will be eliminated by the careful selection of sites that are distant from the areas where actual mining activities are occurring. Drainage ways and areas near spoiling and blasting will be avoided where possible.

2.05.3 (6) Overburden

Additional description of the removal, handling and storage of overburden material within the permit area is described in Section 2.05.3(1). The spoil handling monitoring plan parameters for the operation can be found below.

Overburden Monitoring Program

As discussed in Volume 1, as long as the total percentage does not exceed 15% of the total truck/shovel sequence for each drill hole, suitability should not be an issue based upon the upper overburden seam quality and the expected dilution of lower overburden materials (more likely to exhibit elevated parameter levels) through mixing as part of the logical mining sequencing of overburden and coal removal in the Collom area.

In the following analysis, Colowyo demonstrates the likelihood spoil material placed near the surface of final regraded overburden areas will be unsuitable is low. This demonstration was completed by showing the total percentage of unsuitable material as it relates to the drill hole data shown in Volume 17, Exhibit 6 Item 9 for the sources of the majority of overburden to be generated in the area. A review of the analysis spreadsheet for drill hole C-04-04 shows that the source of all elevated SAR levels (> 15.0) originates from the bottom 121 feet of overburden from the bore hole. Normal overburden haulage and sequencing will ensure this material will not contribute to elevated SAR levels on the reclaimed surface post-mining in the Collom expansion area.

Drill Hole C-04-14

Unsuitability range in feet:

SAR $> 15 = 27.6$ feet

Se $> 0.3 = 7.3$ feet

B $> 5.0 = 0$ feet

Sat <25 or >80 = 45.35 feet
Mo > 1.0 = 0 feet
Total Drill Hole Depth = 354.3 feet

Total Percentage of unsuitable material:
SAR = 27.6 feet/354.3 feet = 7.7900084674%
Se = 7.3 feet/354.3 feet = 2.0606007903%
B = N/A
Sat = 45.35 feet/354.3 feet = 12.799887101%
Mo = N/A

Drill Hole C-04-25

Unsuitability range in feet:
SAR > 15 = 69.6 feet
Se > 0.3 = 15.15 feet
B > 5.0 = 0 feet
Sat <25 or >80 = 83.8 feet
Mo > 1.0 = 0 feet
Total Drill Hole Depth = 639.7 feet

Total Percentage of unsuitable material:
SAR = 69.6 feet/639.7 feet = 10.880100047%
Se = 15.15 feet/639.7 feet = 2.3682976395%
B = N/A
Sat = 83.8 feet/639.7 feet = 13.099890574%
Mo = N/A

Drill Hole C-04-04

Unsuitability range in feet:
SAR > 15 = 111.2 feet
Se > 0.3 = 0 feet
B > 5.0 = 0 feet
Sat <25 or >80 = 68.3 feet
Mo > 1.0 = 0 feet
Total Drill Hole Depth = 663.3 feet

Total Percentage of unsuitable material:
SAR = 111.2 feet/663.3 feet = 16.764661541%
Se = N/A
B = N/A
Sat = 68.3 feet/663.3 feet = 10.296999849%
Mo = N/A

Drill Hole C-04-36

Unsuitability range in feet:
SAR > 15 = 19.9 feet
Se > 0.3 = 5.15 feet
B > 5.0 = 0 feet
Sat <25 or >80 = 85.6 feet
Mo > 1.0 = 0 feet
Total Drill Hole Depth = 610.6 feet

Total Percentage of unsuitable material:

SAR = 19.9 feet/610.6 feet = 3.2590894202%

Se = 5.15 feet/610.6 feet = 0.84343268916%

B = N/A

Sat = 85.6 feet/610.6 feet = 14.018997707%

Mo = N/A

No Special Handling Procedures will be required for the overburden in the Collom Area (please see Section 2.04.6 – Exploration Test Boring Results Summary). It was discussed between the Division of Reclamation, Mining and Safety (DRMS) and Colowyo that suspect levels of the Sodium Adsorption Ratio (SAR), Selenium (Se), Boron (B), Saturation % (Sat), and Molybdenum (Mo) need to be addressed in more detail to determine that Special Handling Procedures, that are outside the normal pit operational procedures, will not be needed in the Collom expansion area. Review of the analysis spreadsheets in Exhibit 6, Item 9 demonstrate minimal instances of analyses for pH, electrical conductivity, nitrate as N and Acid-Base potential being outside of the suitable range for the four drill holes analyzed above.

Based on similarities between overburden suitability analysis results in the Colowyo existing permit area and the Collom permit expansion area, and on previous discussions between the Division and Colowyo, suspect levels of Sodium Adsorption Ratio (SAR), Selenium (Se), Boron (B), Saturation percent (Sat), and Molybdenum (Mo) will not need to be addressed in more detail to determine if Special Handling Procedures, that are outside the normal pit operational procedures, will be needed in the Collom area.

Historically, beginning around 1983, Colowyo initiated overburden monitoring in both the pit (truck/shovel materials) and on regraded overburden. See Exhibit 6, Item 4 as described in the associated January 4, 1983 Colowyo memo to Dan Mathews (Division staff at that time), for an overview of this initial program. Starting in 1990, Colowyo eliminated the in-pit sampling program. Sufficient data had been collected to indicate that all weathered overburden material (ie within ~ 50 feet of the ground surface) was suitable for replacement onto the reclaimed surface prior to topsoil replacement. Three revisions were submitted to the Division and approved on January 24, 1984, August 17, 1983, April 24, 1990, and PR-02 respectively. The following summarizes the requirements of the current regraded overburden (backfill) sampling program and supersedes all previous commitments. It is based on the following limitations of the earlier program.

1. Placing weathered overburden material onto reclamation areas prior to final grading, and
2. Sampling regraded overburden at a density of one composite surface sample per 5 acres of regraded spoil.

The regrading of overburden is an event that takes place sporadically during the year. Once backfill areas are regraded, but prior to topsoil replacement, the new locations are identified and sampled. A life-of-mine sampling grid has been established on 500-foot centers, and each sample location on the grid corresponds to a letter/number combination as established on the sampling map. Using this grid interval, each sample location represents an area of about 5.7 acres in size. A hand shovel is used to take small, representative surface samples of spoil across the sample area.

Regraded Overburden Suspect Levels:

Parameter	Suspect Level
pH	Less than 5 or greater than 9 standard units
Electrical Conductivity	Greater than 12 millimhos/cm
Sodium Absorption Ratio	Greater than 15

The laboratory results are kept at the mine site. Results of the sampling program are provided in the appropriate Annual Reclamation Report. The mining sequence for the planned operation is shown on the Mine Plan Map (Map 23B). Cross sections showing the post mining pit backfill are presented on the Pre-Mining and Post-Mining Cross Sections (Map 20C). The excess overburden pile location is presented on Map 23B. The map depicting spoil grading is presented as Map 29B.

The spoil suitability and special handling procedures are described in detail in section 2.05.3(1) of Volume 15. The initial development of the stockpile is anticipated to begin during the year 2018 with the excavation of the initial box cuts and continue over the next five years of operation dependent on production rates. Following this period, mine pit advancement will allow for placement of mined spoil into the original box cut area.

A portion of the excess overburden pile will be used to fill and recontour the final pit sequence in the final years of mining activities. Please refer to Map 29C. The out of pit excess overburden will be used in the construction of the post mine topography. Approximately 28 million cubic yards of storage capacity for the excess overburden stockpile will be needed.

The toe of the Little Collom Gulch Fill (please refer to Section 4.09) will be placed at the bottom of the Little Collom Gulch Drainage and the excess overburden pile will eventually extend upward about 350 feet in thickness to an elevation of 7500. The excess overburden pile will remain in place until the last few years of mining and will have a life equal to the mine plan (Map 23B) depending on production rates. As such, the lower portions of the excess overburden pile will be completed and stabilized before the top is completed. To ensure that a phreatic water surface does not develop during the life of the stockpile, a rock drain will be installed at the base of the fill along its entire length. The excess overburden pile will be confined by the valley slopes on both sides. Volume 20, Exhibit 23, Item 1 and Item 2 provide the geotechnical report for the excess overburden pile.

The excess overburden pile will be constructed in 50 to 100 foot lifts by use of trucks, dozers and loaders. Each lift will be dumped at angle of repose. Maintenance techniques will consist of blading of roads and ramps, along with the use of dust control during active times of operation. During construction a dozer will be used develop and spread the end-dumps created by the trucks, this will be the primary method used to build the excess overburden pile. Sediment control will be implemented to ensure adequate containment of potential runoff throughout the life of the operation.

The area that was disturbed in conjunction with this stockpile will be reclaimed in accordance the procedures outlined in the reclamation plan.

2.05.3 (7) Coal Handling Structures

Please Refer to Volume 1, Section 2.05, Coal Handling Structures and Map 22B.

2.05.3 (8) Coal Mine Waste and Non-Coal Processing Waste

Not applicable. Colowyo uses dry crushing facility for coal preparation; no coal processing waste, as defined in Rule 1.04 “Definitions”, is produced from any part of the mining operations.

2.05.3 (9) Return of Coal Mine Waste to Abandoned Workings

No coal processing waste or coal mine waste as defined in Rule 1.04 “Definitions” is produced from any part of the Colowyo mining operations. Therefore, this section is not applicable.

2.05.4 (1) Reclamation Plan

Please see Volume 1 Section 2.05.4 for a detailed description of the reclamation plan that will be implemented in the Collom area.

2.05.4 (2)(a) Reclamation Timetable

The sequence for reclamation following the mining process is shown on Map 29B (Spoil Grading – Collom). An excess overburden pile of approximately 28 million cubic yards will be needed during the initial years of mining. As activities progress, a sufficient volume of backfill void will be created, and the Collom Pit should reach a steady state of operation where the advancing overburden face moves southward at the same rate as the advancing backfilling benches. At that time, spoil regrading and subsequent reclamation activities will accelerate. The excess overburden pile is expected to remain in place until the final years of mining activities. At that time, some of the volume of material will be needed to fill the final pit void.

2.05.4 (2)(b) Reclamation Costs

The estimate of the cost of reclamation of the operations required to be covered by the performance bond will be found under Rule 3.

2.05.4 (2)(c) Backfilling Plan

Initially an excess overburden pile will be created to the north of the Collom Pit and will remain in place until the end of mine life. Then, as mining progresses to the south, overburden material from each successive cut will be backfilled into the previously mined out area and the additional spoil will continue to buildup in previously mined areas.

The backfilled mining areas will be graded to establish a stable post mine topography that blends into the undisturbed areas outside the mining limits. Please refer to Map 19C. Colowyo will grade all final slopes so that overall grades do not exceed 3H:1 as shown on Map 20C.

Please see Volume 1 Section 2.05.4 for additional information pertaining to backfilling operations at Colowyo.

2.05.4 (2)(d) Topsoil Salvage

Please see Volume 1, Section 2.05.3 for a detailed discussion on topsoil salvage and Map 28C for topsoil handling and storage for the Collom Pit.

Topsoil Redistribution Plan

Please see Volume 1 Section 2.05.4 for a detailed discussion on topsoil redistribution plans for the Collom area.

2.05.4 (2)(e) Reclamation Revegetation

Please see Volume 1 Section 2.05.4 for a description of the revegetation process that will be utilized for the Collom area.

2.05.4 (2)(f-h) Disposal, Mine Openings, Water and Air Control

Acid-Forming and Toxic-Forming Materials

No significant acid-forming materials exist within the overburden soil or coal seams to be mined. Therefore, Colowyo will not undertake special handling procedures as described in Section 2:05.3. A detailed description of the chemical characteristics of soils and overburden materials is presented under Sections 2.04.6 and 2.04.9.

For a detailed description of the special handling of spoil material and sampling programs, refer to the Production Methods and Equipment Segment of this section.

Flammable liquids, such as oil and fuel, will be protected from spilling into other areas by earthen, concrete or HDPE lined structures surrounding each storage facility. A spill containment control plan protects against spills and will be available to the Division to review as requested.

All major equipment on the Collom area mine operation will be equipped with portable fire extinguishers or automatic fire suppression systems. The water trucks used for dust suppression at this location could also be used to control most fires.

Sealing of Exploration and In-Pit Mine Drill Holes

Exploration and in-pit mine drill holes which remain open for use as a water supply well or for use as a groundwater monitoring well will be completed following the guidelines of the Colorado Division of Water Resources Water Well Construction Rules (2 CCR402-2, Eff. Date January 1, 2005). When the groundwater monitoring wells are no longer needed or required for any purpose, each well will be eliminated by plugging plugged and/or sealed following the before mention guidelines of the Colorado Duivision of Water Resources.

Plugging procedures utilized for exploration drill holes that will not be mined through during the current Permit term are as follows:

1. Drill holes drilled deeper than the stripping limit (450-500 feet) will be plugged by pumping cement or heavy solids bentonite Plug Gel or chips through the drill stem from the bottom up to within 3 feet of the ground surface.
2. Drill holes shallower than stripping limits (450-500 feet) may be plugged with the ready-mix concrete method instead the method in #1 to within 3 feet of the ground surface.
3. Drill holes with no water or coal zones may be plugged by backfilling with cuttings, and placing a plug ten feet below the ground surface to support a cement plug or bentonite chips to within 3 feet of the ground surface.

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For safety considerations, exploration drill holes that will eventually be mined through during the present Permit term need only be covered with wood, plastic or other such material or otherwise bermed to prevent access.

Those holes completed in continuous water bearing zones will be sealed entirely with cement or other suitable sealant to within 3 feet of the ground surface.

Where possible, the sealed holes will be marked. At times reclamation operations will cover up the sealed drill holes and marking of holes will not be possible.

Within 60 days of the abandonment of a drill hole, approved drilling program or when requested by the Division, the following information will be submitted:

- a) Location of drill hole as plotted accurately on a topographic map.
- b) Depth of drill hole.
- c) Surface elevation of drill hole.
- d) Intervals where water was encountered during drilling activities.
- e) Diameter of drill hole
- f) Type of amount of cement or other sealant used.
- g) Name of drilling contractor and license number of rig.
- h) How the hole was worked.

Exploration taking place inside and outside of the permit area will be handled through the Notice of Intent (NOI) procedures. See the appropriate NOI for details for each program.

Water and Air Quality Control Techniques

Steps to be taken to comply with the Clean Water Act and other applicable water quality laws and regulations and health and safety standards include a comprehensive drainage and sediment control plan described in Section 2.05.3 and Sections 4.05.1 through 4.05.18. With respect to compliance with the Clean Water Act, Colowyo has a discharge permit from the Colorado State Department of Health under the National Pollutant and Discharge Elimination System (NPDES) that will include all new discharge structures constructed for the Collom area expansion. Compliance with this permit will serve to effect compliance with the Clean Water Act and the Colorado Water Quality Control Act.

Colowyo, likewise, operates under several emission permits from the Colorado Department of Health, Air Pollution Control Division. Fugitive dust control measures will be employed as an integral part of the mining and reclamation operations.

Colowyo conducts air quality monitoring at the site in accordance with the requirements of emission permits approved by the Colorado Air Pollution Control Division.

Details of pollution control measures are discussed in section 2.05.6.

2.05.5 Post-Mining Land Uses

Historically, the Collom area has been managed utilizing the principles of multiple-use and can be most accurately described as rangeland and wildlife habitat. Map 17 serves to identify both the pre and post-mine land use designations. The land management staff of Colowyo, the BLM and the Colorado State Land Board fully support Colowyo's approach to the re-establishment and enhancement of multiple-use Rangeland with subcomponents of grazing land and wildlife habitat for the Collom area. Copies of the correspondence confirming these views have been included in this package and are identified as Figures

2.05.5-1, 2.05.5-2 and 2.05.5-3 respectively. Much of the lower portions of the Collom area receive light to moderate grazing pressure primarily from cattle but also some use by sheep herds. These lower elevations also provide seasonal transition (migratory) habitat for big game, but more importantly offer breeding and brooding habitat to indigenous sage grouse and sharp-tailed grouse populations. The higher elevations receive slight to light grazing pressure from cattle, but more typically light to moderate grazing pressure from sheep herds. These higher elevations also provide spring and summer habitat for big game, especially local elk herds (Exhibit 10 Item 6).

The post-mine land uses of rangeland with the subcomponents of grazing lands and wildlife habitat for the reclaimed areas in Collom is identical to the pre-mining land use found in the area. No change in land use is expected in the land use categories. Therefore, the post mine land use will be consistent with the historic land use on lands within the Collom area. Please see Section 2.04.3 for additional information regarding the pre-mine land uses in the Collom area.

2.05.6 Mitigation of Impacts of Mining Operations

2.05.6 (1) Air Pollution Control Plan

Air quality will be protected in accordance with the procedures outlined in Volume 1, Section 2.05.6. Air quality information including the CDPHE air permits are available onsite and can be reviewed by request.

2.05.6 (2) Fish and Wildlife Plan

Procedures specified in the permit document starting in Volume 1, Section 2.05.6 will be followed by Colowyo to ensure minimal impacts to fish and wildlife in the mining area. At the conclusion of mining activities in the Collom area, disturbed lands will be restored in accordance with the reclamation plan. Colowyo is continuously working with the regulatory community to improve habitat restoration practices and minimize disturbances to fish and wildlife. As discussed, the Collom Mining area should not impact any species currently listed as threatened or endangered. Big game animals endemic to this area utilize habitat regionally and reclamation efforts will not target them specifically as multiple off-site habitat improvement initiatives are on-going in cooperation with CPW to improve big game animal habitat. As impacts to sagegrouse habitat are going to be an area of high interest for the foreseeable future, it is prudent and appropriate to manage reclamation activities to mitigate impacts to this species specifically, if not exclusively. Efforts to increase the diversity and forage productivity of reclamation units in both the existing operation and Collom area should provide a great benefit to all species impacted by the physical disturbance of mining related activities. Livestock grazing and hunting activities will be reinitiated after full bond release has been granted in the future. These tools will assist in further development of an already diverse reclamation landscape post-mining.

Impacts of Mining Operations on Wildlife Resources Within the Mine Plan Area

Impacts to wildlife in the Collom expansion area can be found in Volume 1, Section 2.05.6

Range and Wildlife Management Programs

Range and wildlife management programs are described in Volume 1, Section 2.05.6.

Disturbed Areas

Please refer to Volume 1, Section 2.05.4 for a further description of disturbed acreages within the permit boundary.

Habitat Improvement Program

Please refer to Volume 1, Section 2.05.4 for detailed information on historical habitat improvement programs previously undertaken at Colowyo Mine.

Many individual habitat improvement initiatives have been completed through the efforts of the CPW and the Morgan Creek Ranching for Wildlife operation. These efforts will be continued into the future. The Collom area reclamation plan (collectively Volume 15, Section 2.05.4 and 4.15 and referenced sections from the existing Colowyo permit) specifically target improved shrub establishment over all future reclamation units and focus on the creation of sagegrouse brood rearing habitat that will improve habitat availability and value for other sagebrush obligate species as well.

Sagegrouse Mitigation

During permitting activities for the South Taylor Mining area, regulatory developments convinced Colowyo, CPW and the Colorado Division of Reclamation, Mining and Safety to target sagegrouse brood rearing habitat for future reclamation planning efforts and overall improvement in shrub establishment on reclaimed lands at Colowyo. The result of these efforts rewrote the existing reclamation plan and performance criteria for bond release. This plan was developed specifically to create sagegrouse brood rearing habitat, while promoting improved shrub establishment on all reclamation areas. This effort and focus will continue into the future with Collom expansion area reclamation, as the reclamation plan developed for Collom mirrors the principles and innovations applied to the existing mining area.

As stated previously, Colowyo will focus on sagebrush steppe establishment as a function of sagegrouse habitat creation. Sagebrush obligate species will also benefit from these efforts as a result. Again, please refer to Map 44 for the location of (potentially impacted) pre-mine sagegrouse lek areas and stockpiles that will add value for sagegrouse habitat.

The reclamation plan focus, reclamation seed mixes, bond release criteria, interim revegetation monitoring program and pre-planning of disturbance to avoidance high value habitat (leks) where practical, was initiated in large part to specifically mitigate potential impacts to area sagegrouse populations from mining activity. Consideration was given to all endemic wildlife populations during the creation of the reclamation plan and seed mixes in order to balance multiple uses among different wildlife species, not only on the sagebrush steppe areas, but areas targeted for grassland as well. Justification for the use of specific plant materials for the sagebrush steppe and grassland areas may be found under Section 2.05.4.

Electric power lines located in the permit area will be constructed in accordance with the requirements of Section 4.18 to minimize potential electrical hazards to large raptors.

Vehicle use within the Collom area will be limited to the active mining area and the various support facilities. Off-road vehicle use is kept to a minimum and is usually only authorized for surveying, environmental data collection and monitoring, security, etc. Travel by foot, which causes much more disturbance to wildlife than vehicle traffic, is highly unlikely outside active mining areas.

With regard to sage grouse populations, Colowyo believes that the revegetation metrics presented within this submittal address the concern for negative impacts to area populations and brooding habitat. It is anticipated that sage grouse use of reclaimed lands will return to pre-mining levels, or perhaps return to elevated levels as has been experienced at certain Wyoming mining operations.

Additional Mitigation Measures Recommended By CPW

During the PR-03 permitting process, Colowyo provided the Division with copies of the communications between CPW and Colowyo that identified additional mitigation strategies Colowyo will implement in order to further offset disturbance in the Collom Expansion Area. The Division received a letter from CPW dated February 15, 2011 regarding wildlife mitigation suggestions based on the disturbance area in the Collom Expansion Area. Colowyo management staff met with CPW staff on April 29, 2011 to discuss the specific mitigation issues raised by CPW's February 15, 2011 letter to the Division. Colowyo subsequently drafted a letter to CPW on May 4, 2011 clarifying points of agreement and providing specific proposals for additional wildlife mitigation measures. CPW responded to Colowyo's May 4, 2011 letter on May 17, 2011 in a letter further refining their recommendations. Colowyo has agreed to accommodate and is specifically identifying the following recommendations of Colowyo's May 4, 2011 letter to CPW and CPW May 17, 2011 letter to Colowyo that are not already incorporated/required by Colowyo's revised reclamation plan or other process or statute below:

Greater Sage Grouse:

- Colowyo has offered to evaluate current livestock grazing management practices and multiple stakeholder agreements in the Axial Basin and Morgan Creek Ranching for Wildlife areas for identification of additional opportunities to minimize impacts to and enhancement of habitat of Greater Sage Grouse in the area. Input from CPW will be a helpful component of these evaluations.
- Colowyo will incorporate the utilization of marking flags on perimeter fences in the Collom Expansion area to minimize incidents of Greater Sage Grouse mortality through grouse/fence collisions. CPW provided a letter dated July 30, 2014 which outlines the locations that Colowyo will demarcate fences to minimize Greater Sage Grouse impacts. Please see Figure 2.05.6-3.
- Colowyo will treat NPDES discharge ponds for mosquitos to reduce the potential of West Nile Virus transmission to local grouse populations if this treatment is not specifically precluded by CDPHE regulation of Colowyo's discharge ponds.

During a series of meetings since the approval of PR-03 between CPW, BLM, USFWS, Tri-State, and Colowyo it was determined that there would potentially be direct impacts to approximately 2,133 acres of mapped Preliminary Priority Habitat (PPH) for Greater Sage Grouse (GSG) from the mining plan approved under PR-03. In addition to the direct impacts, consultation with CPW, BLM and USFWS biologists determined that indirect impacts would potentially occur up to 900 meters (2,953 feet) from the edge of disturbance. This distance was determined using several years of monitoring data from the Axial Basin where existing operations have been occurring and a number of years of recorded GSG locations near the existing mining operations obtained through radio telemetry by CPW in cooperation with Colowyo. It was also determined that mining of the Little Collom X Pit (approved under PR-03) would cause a significant impact GSG lek adjacent to the pit. Therefore, Colowyo agreed to relinquish mining of the Little Collom X Pit and redesigned the temporary overburden spoil pile location to significantly reduce the potential impacts to GSG.

Based on the 900 meter distance, it was determined that there would be 2,180 acres of PPH potentially indirectly impacted. In total, there would be 4,313 acres of PPH potentially impacted both directly and indirectly by the mine plan disturbance under PR-04. To offset both the direct and indirect potential impacts to GSG PPH, Colowyo has agreed reduce the mining plan by not mining the Little Collom X Pit, redesign the temporary spoil pile and relocate to create a larger buffer from an active GSG lek, and also to implement the following GSG mitigation measures:

- Colowyo will donate a total of 4,543 acres of Colowyo privately owned surface within PPH but outside of the permitted mine boundary in five non-contiguous parcels to CPW. This land will be managed by CPW for the preservation and maintenance of GSG habitat in the Axial Basin in perpetuity. The land donation will become effective and CPW would assume management of these areas prior to any land disturbance activities at the Collom Pit or excess overburden pile area. A Land Donation Agreement will be signed between Tri-State/Colowyo and CPW, and will include details for the land donation along with a legal description of the area.
- Under the Land Donation Agreement with CPW, Colowyo will transfer all grazing and mineral rights held by Colowyo on those parcels to CPW, as well as the water rights to any stock watering structures located on those parcel
- Construct all sediment control structures outside of the GSG lekking and brook rearing seasons (March 15 – May 15 and May 15 to July 15, respectively).
- Colowyo will make a one-time cash donation of \$150,000 to CPW to preserve and protect the GSG and to fund on-going research monitoring of the GSG.

Columbian Sharp-Tail Grouse:

- Mitigation efforts identified for Greater Sage Grouse will also benefit Columbian Sharp-Tail Grouse. No specific mitigation efforts have been requested by CPW beyond the efforts to be undertaken for Greater Sage Grouse, Mule Deer and Elk.

Mule Deer and Elk:

- Colowyo will incorporate CPW recommended guidance for wildlife friendly fencing when constructing new fences in the Collom Expansion Area.

2.05.6 (3)(a) Protection of the Hydrologic Balance

Surface Water

Surface water will be protected in the mining areas by stormwater management as described in Section 2.05.3(4) of this permit revision application and in the Stormwater Management Plan portion of the Stormwater Discharge Permit and as shown in Exhibit 7, Item 23. Protection includes the use of diversion ditches to route surface water around the mining impact areas.

Current surface water rights will not be impacted by mining operations at Collom Pit. There is no expected long-term measurable impact to the quantity of surface water in Collom Gulch, Little Collom Gulch, Jubb Creek, or any of their tributaries. Surface water amounts that will be used in mining operations will be within the water rights owned by Colowyo.

Surface water quality of the three creeks is calculated to only be marginally impacted by mining activities. This marginal impact, described in the Probable Hydrologic Consequences section (Section 2.05.6 (3)(b)(iii) below), will be due to meteoric water being captured in and evaporated from the mine pit during operations, and meteoric water contacting an increased surface area of soil in the vadose zone and thereby theoretically increasing the mass of dissolved solids entering shallow groundwater. These dissolved solids in shallow groundwater may eventually enter the surface water system, with a theoretical increase in dissolved solids in the surface water. This increase is calculated to be small enough to have no impact on the current or projected surface water uses in the Collom Gulch, Little Collom Gulch, and Jubb Creek drainages.

Groundwater

Groundwater in the vicinity of the Collom mining areas occurs in perched (unconfined) and confined water bearing zones of limited areal extent within bedrock of the Williams Fork Formation, the Trout Creek Sandstone (a bedrock aquifer of regional extent), and valley-fill aquifers as described in Section 2.04.7. The Williams Fork Formation water bearing zones have no beneficial use owing to their limited extent and minimal water production. Based on studies in the Collom area, the saturated water table/piezometric surface is at approximately 7150 feet. This level means that the area in and around the Collom Pit outline is under static hydrologic conditions with the water level at approximately 7150 feet. Due to this static condition, Colowyo may dewater this zone to allow mining of the coals below this elevation in the northern cut(s) of the pit.

The Trout Creek Sandstone is a sandstone unit underlying most of the permit area and extending across much of northwestern Colorado. It contains water of useable quantity and quality as demonstrated by beneficial-use wells near the permit area. The Trout Creek Sandstone is stratigraphically several hundred feet below the rock units to be mined and is separated from those strata by low-permeability layers within the Williams Fork Formation, particularly the KM layer, a regionally-continuous clay layer (see Section 2.04.5 and 2.04.6). Additionally, the Trout Creek Sandstone was removed by erosion and structural uplifts north and south of the mining area and so is isolated from the regional perspective. Based on this information, mining is anticipated to have no impact on the Trout Creek Sandstone aquifer.

Groundwater in the shallow valley-fill aquifers of the drainages crossing the permit modification area is calculated to be marginally impacted by surface mining activities, as described in the Probable Hydrologic Consequences section.

There are no registered beneficial-use wells other than monitoring wells in the Colorado Division of Water Resources well database within at least one mile downgradient of the mining area (Map 11C). In Section 2.03.4, Identification of Interests, the legal or equitable owners of record of the property to be mined or affected by surface operations and facilities incidental thereto within the Collom permit expansion area are:

Colowyo Coal Company L.P.
State of Colorado
U.S. Bureau of Land Management

No other private individual or group owns or controls any land in the Collom permit expansion area. Thus, any well within the limits of the Collom permit expansion is controlled by Colowyo. This includes the Dudek and Sweeney wells. Table 2.04.7-44 and Map 11C reflect the location and ownership and control status of these wells.

2.05.6 (3)(b)(i & ii) Hydrologic Controls

Rule 2.05.6(3)(b)(iii) requires determination of probable hydrologic consequences for the mining operations. This rule indicates that these consequences must be defined for both the permit area and adjacent areas, for quantity and quality of surface water and groundwater. Baseline conditions must be established, and possible impacts from the activities must be anticipated.

Summary of Probable Hydrologic Consequences

An evaluation was made of potential hydrologic impacts of the Collom mine to determine if the potential impacts are likely to occur and if they would be significant. Based on the assessment of potential impacts, the probable hydrologic consequences of the Collom Project are:

- Two springs mapped within the pit footprint and facilities area will be eliminated by mining. Springs near the Collom pit might experience decreased flows during mining. Three additional springs located in Little Collom Gulch north of the mine and spoil footprint area may have reduced flows as a result of the mine dewatering activities. Significant impacts to other springs are not anticipated.
- Dewatering of the Collom pit is needed to achieve stable pit slopes for safe operating conditions and will cause a drawdown in bedrock groundwater levels in the vicinity of the pit. Groundwater levels are expected to recover after mining but may be at different levels than the pre-mining groundwater. It is unlikely that the groundwater level in the pit backfill will reach a high enough elevation to cause the discharge of spoil backfill groundwater at ground surface in Little Collom Gulch. If this were to occur, it would not have a significant impact on the quantity or quality of surface and subsurface flow in Little Collom Gulch.
- The hydraulic conductivity within the backfilled pit is anticipated to be more uniform and higher than the hydraulic conductivity of the individual geologic units in the adjacent unmined areas. This will result in alternation of the bedrock groundwater flow gradient in the mine footprint area and the immediate area surrounding the footprint. In general, the higher permeability of the spoil backfill will result in a flatter groundwater gradient. Groundwater flow conditions in the areas north of the pit are expected to be similar to the pre-mining groundwater flow conditions after re-saturation of the spoil backfill.
- No other statistically significant changes to surface water and groundwater quality or quantity are anticipated.

The potential impacts that were evaluated and the resulting hydrologic consequences are discussed in the following subsections.

Potential Impacts to Springs and Seeps

Springs in the Colowyo Mine area result from three general sources: 1) typified by a relatively deep soil accumulation immediately upslope and shallow bedrock downslope of the point of discharge, 2) discharge within valley bottom deposits, and 3) from sheer bedrock faces on hillsides (CDM 1985b). The first two of these sources may mask or contribute to bedrock sources of the springs. The seeps and low volume springs flow generally in response to snowpack accumulation and subsequent melting resulting in seasonal flows.

The majority of the springs with bedrock sources appear to be contact springs. A contact spring results from the infiltration of water from the surface to a porous zone (such as sandstone) above a horizontal hydrologic barrier (such as shale) where the water preferentially flows along the contact to the exposure. This type of spring is common in areas where alternating sequences of lithologies exist that exhibit differential hydraulic conductivities, such as the Williams Fork Formation.

Table 2.05.6-4 lists the springs and seeps found in the vicinity of the mining area. The locations of the investigated springs and seeps are presented on Map 10B. Data collected for the springs and seeps were previously summarized in Table 2.04.7-49.

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The potential impacts to springs and seeps listed below are evaluated for each of the three surface drainage areas that will be affected by the mine:

- Elimination of springs and seeps
- Changes in flow
- Formation of new springs and seeps

Little Collom Gulch Area

Two springs (SPRLC-01 and SPRLC-02) maintained flow during July and August 2005 in Little Collom Gulch, and produced a total of 0.30 cfs during spring runoff in June 2005, and 0.045 cfs during August 2005 base flow. (Table 2.04.7-49) Spring/seep SPRLC-03 produced a minor flow of 0.009 cfs in December 2004, and produced no measurable flow for any other sampling event. Springs/seeps V11 and V29 produced no measurable flow for any sampling event. All Little Collom Gulch spring and seep flows subsequently infiltrated into the valley fill or were captured by stock ponds. Streamflow monitoring point LLCG located near the mouth of Little Collom Gulch was dry throughout the 18 month sampling period.

Spring SPRLC-01 (V24) is located at an elevation of about 7270 ft in Little Collom Gulch within the pit footprint area and will be eliminated by the mining operations. The bedrock groundwater elevation in this area is about 7150 ft so the source of this spring is probably from perched groundwater. Spring V11 was mapped in the Little Collom Gulch drainage area at an elevation of about 7230 ft in the footprint area of the facilities but had no measurable flow during the 2005 and 2006 monitoring events. It may reflect localized discharge from snowmelt but is not a significant spring. It likely will be eliminated by the facility construction.

Spring SPRLC-02 (V30) is located at an elevation of about 6926 ft in Little Collom Gulch near the toe of the excess overburden pile and in the area of the southeast of the Section 25 Pond. Construction of the sediment pond may affect the discharge zone of this spring. Also, the mine dewatering operations may intercept groundwater that normally discharges at the spring and placement of the excess overburden may intercept local recharge sources for the spring. As a result, spring flow may decrease during mining operations. Springs SPRLC-03 (V31) and V29 are located at elevations of about 6691 ft and 6845 ft, respectively, in Little Collom Gulch north of the excess overburden pile and the Section 25 Pond. Similar to SPRLC-02, they may experience reduced flows as a result of the dewatering operations and placement of the excess overburden over potential recharge areas. Neither of these springs is a significant feature and V29 was dry during the 2005 and 2006 monitoring events.

In Little Collom Gulch, the springs potentially affected by mining operations produced a combined average flow of about 0.16 cfs with a maximum flow of about 0.30 cfs and a minimum flow of about 0.015 cfs during the baseline monitoring period.

As discussed below, there is a slight chance for a spring to develop in Little Collom Gulch during the post-mining period if the pit backfill re-saturates up to the elevation that the northern pit highwall daylight in Little Collom Gulch. This spring would discharge groundwater from the mine backfill material. Further evaluation is provided under the discussion of potential impacts to groundwater.

West Fork Jubb Creek Area

There are no mapped springs in the West Fork of Jubb Creek drainage that will be directly eliminated by the mining activities.

As indicated in Table 2.05.6-4, spring V1 is not a naturally occurring feature. It is a flowing well (Well Permit No 175218) located in the stream valley at about elevation 7170 ft and is completed at a depth of at least 600 ft below ground surface. Based on the data from available drill logs in the area the well is completed in the Trout Creek Sandstone. The Trout Creek Sandstone aquifer will not be affected by mining so the flow in this well would not be impacted.

Springs V10, and V32 are located at elevations 7295 ft and 7600 ft, respectively, along the West Fork of Jubb Creek and on the west side of the stream channel. However, the spring elevations are generally above the bedrock groundwater elevations and are likely sourced locally so impacts from dewatering the bedrock groundwater system are unlikely. Spring V2 is located at about elevation 6860 ft on the west side of the West Fork of Jubb Creek. It is north of the mine area and is likely sourced from local recharge. It is located within the Collom Haul Road corridor and will likely be impacted to some degree during the construction of the road.

Springs V3, V9a and V9b are also located well north of the mine area at elevations 6820 ft, 6895 ft and 6886 ft, respectively, along the east side of the stream channel. These springs are sourced from areas to the east of the stream and are not expected to be impacted by the mining activities. Two springs potentially affected by mining operations (V10, and V32) produced a combined average flow of about 0.013 cfs, a maximum flow of about 0.022 cfs and a minimum flow of about 0.004 cfs during the baseline monitoring period.

It is not expected that new springs will develop in the West Fork of Jubb Creek during the post-mining period.

Collom Gulch Area

There are no mapped springs in the Collom Gulch drainage that will be directly affected by the mining activities.

Springs SPRC-02 (V8), V27, V28 and SPRC-04 (V7) are located at elevations 6807 ft, 6701 ft, 6696 ft and 6601 ft, respectively, along the east side of Collom Gulch north of the mine area. There is a small chance for the flow in these springs to be reduced as a result of the mine dewatering activities intercepting bedrock groundwater flow that may feed the springs. However, they are more likely sourced from local groundwater that will not be affected by mining.

Springs SPRC-03 (V26), V20, V21 and V25 are located at elevations 6753 ft, 7074 ft, 7076 ft and 6785 ft, respectively, along the west side of Collom Gulch. These springs are sourced from areas to the west of Collom Gulch and are not expected to be impacted by the mining activities. Other springs listed in Table 2.05.6-4 are located up-gradient of the mine and are likely sourced from shallow groundwater and are not expected to be impacted by the mining activities.

In Collom Gulch, the springs potentially affected by mining operations (V27, V28, SPRC-02 and SPRC-04) produced a combined average flow of about 0.057 cfs, a maximum flow of about 0.13 cfs and a minimum flow of about 0.002 cfs during the baseline monitoring period.

It is not expected that new springs will develop in Collom Gulch during the post mining period.

Potential Impacts to Streams

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The three streams potentially affected by mining include Little Collom Gulch, the West Fork of Jubb Creek and Collom Gulch. An evaluation of each stream was made for the following potential impacts from mining operations:

- Changes in direct surface runoff to streams from storm flow and snowmelt
- Changes in stream base flow amounts
- Changes in surface water and groundwater interactions
- Effects from discharge of water from settling ponds
- Effects from discharge of excess dewatering well flows

Little Collom Gulch

Little Collom Gulch is an ephemeral stream throughout its entire length, has a drainage area of about 2.9 square miles (WMC, 2005) and flows south to north through the center of the mine footprint. The area of Little Collom Gulch within the pit footprint is about 0.74 square miles and the area within the spoil pile footprint is about 0.59 square miles for a total area of about 1.33 square miles. Thus, the disturbance is about 46% of the total watershed area. Several clean water diversion structures are planned in Little Collom Gulch upstream of the pit to intercept and safely reroute storm flows around the mine area. The water collected in these structures will come from undisturbed areas.

As described in Section 2.04.7 (2) no flow was observed in Little Collom Gulch during any of the sampling events.

The direct surface runoff from 25% of the drainage area of Little Collom Gulch will be intercepted by the pit and will be either lost to evaporation or be utilized for dust control within the pit. The surface runoff from 20% of the drainage area of Little Collom Gulch will be incident upon the out of pit spoil pile. This runoff will be captured by one of the five sediment ponds (See Map 41B) and will either be lost to surficial evaporation or be discharged according to CPDES requirements to Little Collom Gulch or Collom Gulch. Another 8% (0.24 square miles) of the watershed will be disturbed by the facilities area and report ultimately to the Section 25 Pond and will be lost either to evaporation or discharged to Little Collom Gulch. The runoff intercepted by the Little Collom Gulch clean water diversion structures upstream of the mine pit (0.78 square miles of drainage) will be redirected to either Collom Gulch or the West Fork of Jubb Creek and not be impacted by mining activities. Surface water flows in Little Collom Gulch have not been observed so impacts to direct runoff in Little Collom Gulch are expected to be minimal. Since Little Collom Gulch does not normally contribute to the direct surface water runoff in Collom Gulch, the overall effects on the streamflow in Collom Gulch are expected to be insignificant. During the post-mining period, the Little Collom Gulch surface drainage pattern will be re-established to pre-mine density.

There is currently a small amount of recharge to the shallow valley fill groundwater that occurs from precipitation and surface runoff in Little Collom Gulch. This source of recharge will be eliminated during mining by the pit and the spoil pile. There may also be some discharge of perched groundwater from the upper bedrock units to the Little Collom Gulch valley fill that could be affected (e.g., springs SPRLC-01, SPRLC-02). The potential impacts on spring flow are discussed above and impacts to groundwater are discussed in a following section.

There may be periodic releases of water from the Section 25 sediment pond located in Little Collom Gulch near the toe of the spoil pile. This water will be released to Little Collom Gulch and will either infiltrate into the valley fill or contribute to surface flows in Little Collom Gulch. It is possible that some surface flow may make it to Collom Gulch during the higher flow periods.

There are no plans to release any flows from the dewatering system to Little Collom Gulch.

West Fork Jubb Creek

The West Fork of Jubb Creek is an intermittent stream. It joins the East Fork of Jubb Creek to the northeast of the mine area to form Jubb Creek. The total drainage area of Jubb Creek above the USGS gaging station is about 7.53 square miles, including both the East and West Forks (WMC, 2005). The area of the West Fork of Jubb Creek within the pit footprint is about 0.21 square miles and no areas are within the spoil pile footprint. Thus, the mine disturbance affects is less than 3% of the total watershed area of Jubb Creek.

As described in Section 2.04.7 (2), the West Fork of Jubb Creek produced flow from May through August with a peak flow of about 0.30 cfs in June. It remained dry during late summer, fall and winter. As described above, there is flowing well in the West Fork of Jubb Creek at the location mapped as spring V1. This well contributes water to a small stock pond. Water from the pond infiltrates into the stream valley fill deposits and contributes to shallow ground water flow.

The lower portion of Jubb Creek below the confluence of the East and West Forks typically produces flow for much of the year except during the winter months. Based on USGS stream gaging data from 1976 to 1981 on the lower reach of Jubb Creek (WMC, 2005), the annual flow volume is highly variable, ranging from less than 2 to over 300 acre-ft per year with an average of 81 acre-ft per year.

The direct surface runoff from about 3% of the drainage area of the Jubb Creek watershed will be intercepted by the excavation of the Collom Pit. This minor amount of disturbance is not expected to have a significant impact on the amount of direct surface runoff in Jubb Creek.

Collom Gulch

Collom Gulch is an intermittent stream in its upper reaches but generally has perennial flow in its lower reach. It has a drainage area of about 5.05 square miles above its confluence with Little Collom Gulch. The watershed area of Collom Gulch within the pit footprint is about 0.41 square miles and the area within the spoil pile footprint is about 0.39 square miles for a total area of about 0.80 square miles. Thus, the mine disturbance is about 16% of the total watershed area above the Little Collom Gulch confluence.

As described in Section 2.04.7 (2), the lower Collom Gulch monitoring location had a maximum flow of about 3.5 cfs during the spring runoff period with a base flow of between 0.03 and 0.04 cfs during the summer and winter periods, respectively. Based on WMC (2005) the upper portion of Collom Gulch flows during the spring runoff period and this streamflow contributes groundwater recharge to the valley fill along the stream channel. During the summer and winter base flow periods, the upper portion of the stream typically does not flow so stream base flow in the lower reach of Collom Gulch is maintained by discharge of groundwater from the valley fill to the stream.

The direct surface runoff from 8% of the drainage area of Collom Creek above the confluence with Little Collom Gulch will be intercepted by the pit. The direct surface runoff from 8% of the drainage area which is associated with the excess overburden pile will be routed to the Sidehill Pond and West Pond sediment ponds. It will either be stored for on-site use or discharged using CDPHE criteria to Collom Gulch downstream of the Collom Pit. Therefore, the reduction of the amount of direct surface runoff in Collom Gulch caused by the mine is probably less than 16% and more likely in the range of 8 to 16%.

As described in Section 2.04.7 (2) the upper reach of Collom Gulch is generally intermittent with measured base flow in the range of 0.004 cfs and periods when the stream goes dry. The lower reach of Collom Gulch generally has perennial flow that is maintained during the summer and fall by discharge of groundwater from the valley fill. Most of the groundwater recharge to the valley fill comes from the flow in the upstream reach of Collom Gulch during the spring runoff season, which will not be affected by the mine. Therefore, the impacts of the mine on stream base flow are expected to be insignificant.

Flow in springs SPRC-02, V27, V28 and SPRC-04 may be reduced by mine dewatering operations as described above. These springs make up less than 5 % of the measured surface flows in Collom Gulch so the potential impact of reduced flows on Collom Gulch is not considered significant.

There may be periodic releases of water from the Section 26 Pond located in the Collom Gulch watershed at the toe of the spoil pile. This water will be released to Collom Gulch via a surface channel and will either infiltrate into the valley fill or contribute to surface flows in Collom Gulch, depending on the time of year.

If deemed necessary, water may be discharge to Collom Gulch from the dewatering well systems.

Potential Impacts to Groundwater

Drilling of exploration and monitoring wells by Colowyo and other parties in the Collom pit area as discussed in Section 2.04.7 identified very limited perched water in the shallow coal beds and interburden and saturated conditions in the lower third of the sequence to be mined. There are no continuous non-coal aquifers in the saturated section of the pit to be mined.

This subsection provides a discussion of the following potential impacts to groundwater:

- Changes in groundwater levels during mining
- Potential interactions with springs and seeps
- Potential interactions with valley fill aquifers and streams
- Effect on existing groundwater users in the area
- Effect on the Trout Creek Sandstone aquifer
- Effect of mining on the groundwater flow system
- Re-saturation of the pit backfill during the post-mining period

Changes in groundwater levels during mining

The Collom Pit will be excavated to a depth below the groundwater table and dewatering is needed to achieve stable pit slopes and safe mining conditions. Groundwater levels in the bedrock units within the pit footprint and in the immediate vicinity of the pit will be lowered ahead of mining by pumping from dewatering wells.

Colowyo will submit to the Colorado Division of Water Resources (CDWR) dewatering well/system application(s) to install dewatering wells and remove the groundwater to facilitate the mining. The Colowyo permit area is not in a designated groundwater basin as defined by the CDWR.

A dewatering well system is planned to intercept groundwater before it enters the pit and to achieve the depressurization necessary to maintain stable pit slopes. Based on the field work and computer modeling performed by Agapito Associates (2017) and presented in Exhibit 7, Item 22B, dewatering wells will be

installed to dewater the rock strata from below the F_{ab} coal seam, with a projected depth to about 100 ft below the bottom of the G_{ab} seam.

The dewatering plan includes 10 or 11 perimeter wells around the initial box cut. The drawdown of the groundwater will be monitored by up to five monitoring holes that will include wire piezometers to acquire data to truth the model.

The dewatering system is designed to include up to 11 dewatering wells, and each well is expected to pump between about 10 to 15 gpm. It is estimated that the dewatering system will not need to be operational until the third year of mining of the Collom Pit.

The groundwater removed during dewatering will be used in the daily operation of the Collom mine. Water produced from the mine dewatering well system will be pumped via pipeline to storage tank located in the facility area. The water will not be used for potable use. A properly permitted commercial well will be drilled, and with a permitted treatment system, be used for potable water.

At times there may be an excess of water produced from the mine dewatering system. The excess water will be discharged to Collom Gulch and the West Fork Jubb Creek with an approve CDPHE permit. It is unknown but may at times equal 300 gpm, divided between both drainages. If each drainage receives 150 gpm at times, then the increase flow to the drainages will be a maximum of 0.3 cfs (effects to surface water on Collom Gulch and West Fork Jubb Creek discussed previously in this section).

AAI (2017) developed a hydrogeological model of the Collom area. This model was calibrated to existing groundwater conditions and the transient response observed during a 30 day pumping test performed by WMC (2005) in the bedrock units that will be mined. Based on the modeling of the groundwater response to mining and dewatering, the groundwater level drawdown from mine dewatering potentially will extend some distance to the south of the mine but is unlikely to extend further than the drainage divide in the southern portion of the Collom area. Drawdown effects may extend laterally in bedrock units below the Collom Creek on the west side of the mine, but are unlikely to affect those below the West Fork of Jubb Creek on the east side of the mine. Groundwater drawdown experienced by strata below the Collom Gulch is unlikely to significantly impact the surface streamflow along Collom Gulch.

During AAI's field visit during summer 2016, the streamflows along different segments of the Collom Gulch were observed to be approximately 2.5 cfs (1,122 gpm) in the East Fork and 5 cfs (2,224 gpm) downstream of the confluence point with the West Fork. The observed flow rates were likely close to the annual peak levels experienced by the stream as a result of snowmelt; however, the flow along Collom Gulch had been reported by WMC (2005) to have reduced to zero at several time periods (notably in wintertime) during their study. Except during those no-flow periods, the surface flow rates along Collom Gulch are significantly higher than the design pumping rate (15-gpm) of each dewatering well and are unlikely to be impacted appreciably by the pit dewatering.

Groundwater levels in the bedrock will recover after mining but may vary from the pre-mining conditions. Potential changes in the final groundwater levels are discussed below in the section on pit backfill re-saturation.

Potential interactions with springs and seeps

The drawdown in groundwater levels caused by the mine dewatering activities may affect springs and seeps that are fed by groundwater discharge. The area where springs and seeps are affected will probably be bounded by the southern extent of the pit footprint to the south, the West Fork of Jubb Creek to the

east, Collom Gulch to the west, and one to two miles north of the pit highwall. The springs that are potentially affected by the dewatering operations are discussed in the section on springs and seeps above.

Potential interactions with valley fill and streams

There is some groundwater flow in the valley fill deposits associated with Little Collom Gulch that eventually enters Collom Gulch at the confluence between Little Collom Gulch and Collom Gulch. Recharge to shallow groundwater in the Little Collom Gulch valley fill will be reduced because the recharge area for valley fill groundwater south of the pit highwall will be eliminated during mining. This may result in an approximate 50% reduction in shallow groundwater flow in the Little Collom Gulch during mining.

The amount of groundwater flow in the Little Collom Gulch valley fill is estimated to be about 2,060 ft³/d (17 ac-ft/yr). This estimate is based on a hydraulic conductivity of the valley fill that averages 33 ft/d (WMC, 2005), a gradient of 0.025 ft/ft, a saturated thickness of valley fill of 25 ft (based on the measurements in valley fill monitoring well MLC-04-1 located near the mouth of Little Collom Gulch), and an estimated lateral extent of the saturated valley fill of 100 ft.

WMC (2006) estimates that the total valley fill groundwater flow is about 18,850 ft³/d to the north in Collom Gulch below the confluence with Little Collom Gulch. Of this amount, about 12,000 ft³/d is flowing in valley fill aquifer and an additional 6,900 ft³/d is groundwater flow that discharges to the stream as base flow. Thus, if the valley fill groundwater inflow from Little Collom Gulch is reduced by 50% from 2,060 to 1,030 ft³/d, this would only reduce the total groundwater flow out of Collom Gulch by about 5%.

The valley fill groundwater system in the West Fork of Jubb Creek is not anticipated to be affected by mining. The Jubb Creek area disturbed by mining is small, less than 3% of the total watershed area, and most of the recharge to the valley fill groundwater system will come from spring runoff from the higher elevation portions of the watershed. No measureable impacts to stream base flow are anticipated.

Dewatering water entering the valley fill groundwater system will not add a significant amount to the total system compared with the total amount of groundwater currently in the system.

Potential effect on existing groundwater users in the area

The Collom mine area and the surrounding land is predominantly owned and/or controlled by Colowyo Coal Company and/or its subsidiaries. There are numerous monitoring wells on these lands which are registered by Colowyo as wells under Colorado State Engineer's rules and regulations. Thus, any well within the limits of the Collom permit expansion is owned and controlled by Colowyo and the only impact from any dewatering will be on Colowyo itself. Table 2.04.7-44 and Map 11C reflect the location, ownership and control status of these wells.

The closest known and registered/permitted non-Colowyo owned domestic or commercial wells are located approximately two miles southeast of the initial Collom boxcut area. These wells are located in the SW1/4, Section 7, T.3N., R.93W and are completed below the base of the Williams Fork formation, in the Iles Formation, or in valley fill material along Wilson Creek. This can be verified by comparing the Geology map (Map 7A) with the well location map (Map 11C). Thus, no impacts to these wells from any dewatering activities in the Collom pit are anticipated.

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There are no beneficial use wells (other than those owned and/or controlled by Colowyo) within a two mile radius of the northern pit limit of Collom. Therefore, there will be no impact on any non-Colowyo well caused by the mine dewatering operations,

There is a lack of groundwater communication in the vicinity of the Collom pit with any beneficial use well located in Wilson Creek. The KM layer (an aquiclude) precludes any impact of the dewatering on the upgradient wells in Wilson Creek. In addition, the dip of the KM bed and the Trout Creek sandstone top is to the north and any groundwater flow would be down dip away from Wilson Creek. An examination of the cross section illustrated in Exhibit 7 Item 23B, demonstrates that the cone of influence of the dewatering wells on the north side of the Collom Pit will be several miles from Wilson Creek and any of the beneficial use wells near Wilson Creek. With, the cone of influence not extending much past the Collom Pit to the north, the KM layer acting as an aquiclude, and the dip of the KM bed away from Wilson Creek limits any potential impacts of dewatering to any beneficial use wells on Wilson Creek.

Potential effect on the Trout Creek Sandstone aquifer

No impacts are anticipated to the quantity of groundwater in the Williams Fork Formation or the Trout Creek Sandstone of the Iles Formation. The Williams Fork Formation is not a significant water supply source in the Danforth Hills. It is not used as a source of water where the valley-fill aquifers and surface waters are accessible.

The Trout Creek Sandstone aquifer is separated from the lowest coal seam to be mined by approximately 400 feet in the Collom pit area. Between this coal seam and the Trout Creek Sandstone is a mudstone/shale, sandstone, siltstone, and coal sequence of the Williams Fork Formation. About 200 feet above the Trout Creek Sandstone, a laterally continuous, smectite clay layer known as the KM bed exists. This layer has very low permeability and, therefore, is an effective barrier to vertical groundwater flow.

No impacts from mining or mine dewatering activities are anticipated to the quantity of groundwater in the Williams Fork Formation or the Trout Creek Sandstone of the Iles Formation.

Potential effect of mining on the groundwater flow system

The bedrock groundwater system intersected by the Collom Pit will be affected by mining and backfilling activities. The existing bedrock groundwater system is highly anisotropic because of the alternating layers in the bedrock that have permeabilities varying over many orders of magnitude. The coal seams generally comprise the higher permeability layers, the sandstones have a lower permeability and the siltstone and mudstone units have a very low permeability. The hydraulic conductivity values of the bedrock units are reported to average about 0.14 ft/d for the coal seams and about 0.006 ft/d for the sandstone units. The hydraulic conductivity value for the mudstone and siltstone units is expected to be less than 0.0001 ft/d (WMC, 2005). Mining will displace these layers within the mine footprint and replace them with a more uniform and isotropic backfill material.

The permeability of the backfill will be higher than the bedrock units and will be more similar the permeability of an valley fill material. The hydraulic conductivity of the backfill is expected to be in the range of 1 to 200 ft/d. The geometric mean value of hydraulic conductivity for valley fill is about 33 ft/d (WMC, 2005) so this value is considered a reasonable estimate of the hydraulic conductivity of the backfill.

The capacity of the backfill to transmit groundwater will be much greater than the capacity of the un-mined bedrock as a result of the higher hydraulic conductivity. This means that the saturated thickness of the spoil backfill necessary to provide the same quantity of groundwater flow under a similar hydraulic

gradient will be much less than the saturated thickness of the un-mined bedrock. Thus, it is likely that the groundwater level in most parts of the backfilled pit area will be lower than the current groundwater level in the bedrock. Conceptually, this means that the groundwater levels in bedrock around the backfilled areas up-dip of the highwall will re-adjust to lower groundwater levels in the backfill itself. The exception will be near the north highwall of the pit where the quantity of groundwater flow to the north from the backfill will be limited by the permeability of the bedrock units to the north. In this area, groundwater levels are expected to re-establish to the pre-mining elevation of about 7150 ft or higher.

Re-saturation of the pit backfill during the post-mining period

During mining the Collom pit will be progressively backfilled with spoil material once the initial boxcut is established. The mine advances from north to the south, which is the up-dip direction for the bedrock layers, so as the deeper portions of the pit are backfilled with spoil, water accumulating in the pit can flow down-dip along the pit bottom into the backfill. The mining activity will not cause any decrease in the hydraulic conductivity or transmissivity of the un-mined bedrock units located down-dip (north) of the pit, and the capacity of the bedrock units to transmit groundwater will not diminish. Consequently, the recharge and upgradient inflow entering the pit area will re-enter the bedrock units on the down dip side of the pit. While the highwall dewatering wells to the north of the boxcut are operating, they will collect this seepage. Once they are turned off, the seepage will continue to flow to the north in the bedrock groundwater system in the same way that groundwater flow occurs prior to mining.

Some of the seepage from the pit into the backfill may accumulate against the highwall of the pit since the permeability of the unmined bedrock units is expected to be lower than that of the backfilled spoil material. The amount of water that accumulates will depend on the quantity of water available in the pit and the rate that the bedrock groundwater system recovers after dewatering wells are progressively turned off as mining advances up-dip from north to south. Once wells are turned off, groundwater inflow to the pit backfill may occur from lateral inflow from the bedrock units that are directly intersected by the mine and from limited upward vertical flow from underlying bedrock units.

Once mining is completed the Collom pit will have a reclaimed surface area of approximately 825 acres and a pit bottom that dips predominantly toward the north. The low point in the reclaimed pit surface topography will be at its intersection with Little Collom Gulch at an elevation of approximately 7,300 feet amsl. During the post-mining period, re-saturation of the reclaimed pit backfill will occur from bedrock groundwater inflow from the pit walls, infiltration of direct precipitation on the backfill area, seepage of surface water flowing over the backfill area, and groundwater inflow from the bedrock units underlying the backfilled pit. The groundwater level will recover in the backfill until pre-mine water levels of 7100 to 7150 ft amsl are reached. These elevations would be below the Little Collom Gulch channel elevation of 7,300 ft amsl. Outflow will occur as bedrock groundwater flow in a down-dip direction to the north. Post mining backfill static water levels may be elevated at times above pre-mine levels due to the higher transmissivity of the backfill and infiltration of surface water runoff. It is highly unlikely that backfill water levels would rise sufficiently to reach a level where a spring would emanate into Little Collom Gulch.

The pre-mining bedrock groundwater elevation in the northern portion of the pit is in the range of 7100 to 7150 ft based on WMC (2005). This is likely the minimum groundwater level that will be re-established in the backfill in the northernmost part of the pit. As described above, some re-saturation of the backfill may occur during mining.

The pre-mining rate of groundwater flow from south to north through the bedrock units in the northern part of the pit can be estimated based on the measured transmissivity in the bedrock, the hydraulic gradient and the width of the flow zone, taken to be the east-west distance between the West Fork of Jubb

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Creek and Collom Gulch. The long-term pumping test reported in WMC (2005) measured a transmissivity in this area of about $15 \text{ ft}^2/\text{d}$, with about $10 \text{ ft}^2/\text{d}$ attributed to the F/G sequence and $5 \text{ ft}^2/\text{d}$ to the bedrock units above the F_{ab} coal. This transmissivity value represents a saturated thickness of bedrock in the range of 200 ft (from elevation 6950 to 7150 ft). The hydraulic gradient in this area is measured from wells and piezometers to be about 0.04 ft/ft. The width of the zone is about 10,000 ft. This results in a pre-mining groundwater flow rate from south to north at the northern pit highwall of about 50 acre-ft per year.

The hydraulic head in the backfill at the northern wall of the pit should re-establish itself to at least elevation 7150 ft once equilibrium conditions are reached. At this hydraulic head, the post mining rate of groundwater flow from south to north out of the backfill will be about equal to the pre-mining flow rate and the post-mining groundwater flow system down-gradient of the mine will be essentially the same as the pre-mining system.

The time for the pit backfill to re-saturate to the 7150 ft elevation at the north highwall is estimated based on the volume of backfill in the pit up to the 7150 elevation and the estimated recharge rate to the backfill. The bottom of the pit dips upward to the south at about 250 ft vertical distance per 2,000 ft horizontal distance or at slope of about 0.125 ft/ft. The width of the pit is about 4,500 ft. This results in a backfill volume of about 1.44 billion cubic feet. At a 20% porosity in the backfill, the volume of water needed to saturate the backfill up to an elevation of 7150 ft is about 288 million cubic feet or about 6,610 acre ft. At the estimated pre-mining groundwater flow rate through the pit area of 50 ac-ft/yr, this would require about 130 years to re-saturate assuming no flow to the north out of the pit backfill.

The infiltration rate into the mine backfill may be higher than under pre-mining conditions because of the substitution of the highly stratified pre-mine bedrock aquifers with the homogenous backfill aquifer. The pre-mining groundwater recharge rate from infiltration in the Collom area is estimated to range from about 0.11 in/yr in the southern portion of the area to about 1.1 in/yr in the northern areas where bedrock units outcrop (WMC, 2006). The backfill area is expected to cover about 825 acres. If infiltration into the backfill increases to 3 in/yr (about 20% of precipitation) then an additional amount of groundwater recharge will be available to saturate the pit backfill. Under this condition, it is estimated that the total amount of recharge to groundwater would be about 230 ac-ft per year and the time to re-saturate the backfill would decrease to about 30 years, again assuming no outflow of groundwater to the north.

Groundwater will flow down-dip in the bedrock units to the north from the pit backfill as the backfill re-saturates. If it is assumed that the flow rate out of the backfill at the north pit wall is equal to the pre-mining flow rate at this location, then there will be an annual average groundwater flow of about 50 ac-ft per year. At the higher groundwater recharge rate into the backfill of about 230 ac-ft/yr as described above, this would result in a time to re-saturate of about 40 yrs. Lower infiltration rates into the backfill would increase the time to re-saturate the backfill. The estimated range of times to re-saturate the backfill up to the 7150 ft elevation varies from about 30 to 130 years.

Potential for development of springs from pit backfill

If the saturated thickness of the backfilled area of the pit increases as described above, then the groundwater flow rate to the north potentially will be higher than the natural groundwater flow rate because of the higher hydraulic head. This may result in a groundwater elevation in the highwall area of the pit backfill that is higher than the pre-mining groundwater level elevation of about 7150 ft.

Little Collom Gulch intersects the north wall of the pit at about elevation 7300ft. If the water level in the backfill increases to the 7300 ft elevation, then a spring could develop in Little Collom Gulch where it intersects the pit highwall. An evaluation of the time that would be needed to re-saturate the backfill to

the elevation and the potential spring flow quantity is made based on the information in WMC (2005, 2006) and the information presented above.

The time re-saturate the backfill up to the 7300 ft elevation will largely depend on the infiltration rate into the backfill. It is expected to be about 40 years for the maximum infiltration rate of 3 in/yr into the backfill considered above.

The likelihood of a spoil spring developing is considered to be low. Based on the estimates described above, an infiltration rate of less than about 2.5 in/yr into the backfill would not result in a saturation level in the backfill high enough to form a spring. It is unlikely that the effective infiltration rate will be greater than 2.5 in/yr. It is more likely to be in the range of 1 to 1.5 in/yr, which is similar to the value of 1.1 in/yr estimated for the upper portion of the watershed in the regional groundwater model (WMC, 2006).

If a spring develops at this location, the flow will likely re-infiltrate into the valley fill in Little Collom Gulch and not flow down the stream channel as a surface flow. There is a significant thickness of unsaturated valley fill in lower portion of Little Collom Gulch. The water level in well MLC-04-01 near the mouth of Little Collom Gulch is at 46 ft below ground surface. Therefore, it is unlikely that a spoil spring would result in surface water flow down Little Collom Gulch.

Potential Impacts to Water Quality

The quality of surface water, springs and seeps and groundwater is described in Sections 2.04.7 (1) and 2.04.7 (2). This section evaluates potential impacts of mining to water quality including:

- Potential effect on stream water quality
- Potential effect on spring and seep water quality
- Potential effect on groundwater quality

Potential effect on stream water quality

As described above, Little Collom Gulch is ephemeral, and showed no evidence of surface flow during 18 months of baseline monitoring. As a result, no water quality samples are available.

There may be periodic releases of water to Little Collom Gulch from the Section 25 pond. Most of the water released from the pond will probably infiltrate into the valley fill in the Gulch and will result in little if any direct surface flow down to the mouth of Little Collom Gulch. Adequate settling time will be provided in the pond to meet Colorado Point Discharge Elimination System (CPDES) permitted discharge criteria. The water quality from any pond discharge is anticipated to be of higher quality than the surface water quality seen in the lower reaches of the streams in the Collom area. No surface water quality impacts to Little Collom Gulch or to Collom Gulch as a result of surface water flow from Little Collom Gulch are anticipated.

Periodic releases of water to Collom Gulch from the Section 26 sediment pond may occur. This section of Collom Gulch is intermittent so some of this discharge may continue down the stream as surface water flow. Adequate settling time will be provided in the pond to meet CPDES permitted discharge criteria. The quality is anticipated to be of higher quality than the surface water quality seen in the lower portions of the streams in the Collom area. Periodic discharge of water may occur from the Little Collom Gulch diversion structures to Collom Gulch and the West Fork of Jubb Creek. This water will be surface runoff from undisturbed areas and will have a good water quality. No surface water quality impacts to Collom Gulch or to the West Fork of Jubb Creek from these potential releases are anticipated.

Any dewatering water entering the surface water system tends to have better water quality than the surface water. This is based on a comparison of the ground water quality from C-04-16B (16B) versus water quality data from Jubb Creek (JC) and Collom Gulch (CG), as detailed in the WMC report, 2005. The water quality sample from 16B was collected after 500,00 gallons of water were pumped from the welland is therefore a good example of the water that would be coming from the dewatering wells with time.

In C-04-16B, the pH is approximately 7.2, while the pH is greater than 7.5 in JC and CG. The total dissolved solids (TDS) are 710 ppm in 16B, while in the CG, the mean was 838 and in JC the mean was 1663. All water samples were high in bicarbonate, while the groundwater from 16B had higher sodium than calcium, while the surface water had higher calcium than sodium. No heavy metals were detected in the 16B water sample while the surface water samples from both streams had low levels of selenium and manganese (approximately 0.10 ppm for both metals). Thus, except for adding excess sodium to the surface water, all other qualities are better.

Thus, the water quality will be improved for a short distance until it intermixes with any surface water.

Potential effect on spring and seep water quality

Based on data presented in WMC (2005) springs and seeps have variable water quality with TDS concentrations ranging from 390 to 1,780 mg/l. This variable water quality reflects the source waters for the springs. Springs sourced from local infiltration and shallow groundwater will generally have lower TDS concentrations and springs sourced from the deeper bedrock groundwater will have higher TDS concentrations.

No significant impacts to spring and seep water quality are anticipated. Springs lying outside of the mine footprint that are sourced from local infiltration and shallow groundwater will not be affected by mining and no changes in the water quality are expected.

Spring SPRLC-01 lies within the pit footprint and will be eliminated by mining. However, it has a relatively high TDS concentration of 1,720 mg/l which is likely representative of the deeper bedrock groundwater quality. In the unlikely event that a spoil seep develops after the mine backfill re-saturates, the water quality of the spoil groundwater is expected to be similar to that of the deeper bedrock so TDS concentrations will be similar. Springs SPRLC-02 and SPRLC-03 are located north of the pit and spoil pile and their TDS values are in the range of 390 to 770 mg/l, probably reflecting a relatively shallow water source. During mining, potential seepage through the spoil pile up-gradient of the source areas of these springs may result in somewhat higher TDS values. Once mining is completed, the spoil pile will be removed from the Little Collom Gulch drainage as part of the mine reclamation and the Section 25 Pond will be removed following bond release. The source areas for these two springs should be re-established and no long-term changes to water quality at these two springs are expected.

There is some potential that flow from several of the springs and seeps in the West Fork of Jubb Creek and Collom Gulch drainages may be affected while the mine dewatering system is operating. The TDS concentration of the discharge from these springs is generally in the range of 700 to 1,100 mg/l, indicating a shallow or intermediate depth source. Once the mine dewatering system is turned off, groundwater flow eventually should be re-established to pre-mining conditions. It is not anticipated that there will be significant water quality impacts to these springs since they lie well outside of the mine area and are unlikely to be affected by the reclaimed pit.

Potential effect on groundwater quality

The main impact to pre-mining groundwater quality would be caused by flow out of the re-saturated pit backfill. The water quality of the groundwater at the Collom site is summarized in WMC (2005). The bedrock groundwater generally has TDS concentrations of 500 to 1,000 mg/l, a pH between 7.6 to 8.3 and low concentrations of dissolved metals. The valley fill groundwater has TDS concentrations of 400 to 1,500 mg/l, a pH between 7.6 to 8.1 and low dissolved metals concentrations. The springs and seeps, which reflect discharge from groundwater, have TDS concentrations of 390 to 1,780 mg/l, a pH between 7.8 and 8.3 and low dissolved metals concentrations.

With respect to spoil water quality, current water, rock, and soil quality analyses at the Colowyo Mine predominantly show a basic environment with a pH above 7.0. This chemical environment has been present in this area since quality testing was initiated. Some adverse chemical conditions have been identified in the soils and overburden analyses; however, these have been discussed in the application and have been adequately handled by Colowyo in the past.

The mine backfill will be comprised of spoil material that is not geologically or chemically different from the surrounding bedrock units that currently comprise the bedrock groundwater system. The water quality of the groundwater that will be contained in the mine backfill after it re-saturates is expected to be similar to the measured quality of groundwater in the bedrock and valley fill and the water quality of the spring discharges. Since there will be a mixing of various geologic units in the mine backfill, the average groundwater quality in the backfill may reflect the higher end of the measured groundwater quality, in the range of 1,500 mg/l TDS. No significant changes in bedrock or valley fill groundwater quality are anticipated as a result of mining.

The dewatering water quality is better than or equivalent to the valley fill water quality so there will be no impacts on the valley fill water quality, based on the WMC report, 2005. This is based on a comparison of the ground water quality from C-04-16B (16B) versus water quality data from Jubb Creek (JC) and Collom Gulch (CG), as detailed in the WMC report, 2005. The water quality sample from 16B was collected after 500,00 gallons of water were pumped from the well and is therefore a good example of the water that would be coming from the dewatering wells with time.

For valley fill ground water, comparing 16B water quality with the downstream water quality on JC and CG, all values except for metals are comparable. However, while the valley fill wells did contain low levels of iron, manganese and selenium, these metals were not detected in the sample from 16B.

Other Potential Impacts

Flooding and stream flow regimes in the Colowyo Mine area do not appear to have been affected by past mining operations or reclamation, nor are they anticipated to be affected by the Collom mining. Groundwater availability in the area may potentially be enhanced with the storage of water in the reclaimed pits. Colowyo owns significant water rights within the affected drainages. Any potential diminishment of flow that impacts other adjudicated water rights will be compensated for by reduced use by Colowyo. There is sufficient capacity for Colowyo to reduce their use of adjudicated water to compensate for potential diminishment of flow, allowing downstream users full access to their water rights.

With respect to alluvial valley floors (AVFs), lower portions of Collom Gulch have been studied prior to and after the release of the 1985 OSM Alluvial Valley Floor (AVF) Reconnaissance map. The reconnaissance by OSM was compiled on 1:100,000-scale maps and was meant to represent a reconnaissance level effort to identify areas which are likely to meet the AVF definition (from Introduction to OSM report accompanying this study). Thus, any areas identified on the OSM maps are

potential AVFs. It was recognized in this study that future studies may more conclusively prove or disprove the AVF findings in the report.

Colowyo and other companies in this area performed AVF studies to more conclusively prove or disprove the existence of AVFs in this potential coal mining area of the Danforth Hills. For the Collom area, there have been significant studies to date examining the Collom Gulch area and the potential for an AVF possibly affected by mining activities in the Collom area.

Alluvial sediments are present in the valley bottoms of the Collom Gulch drainages but are intermixed with significant fractions of colluvium and sheetwash from adjacent slopes. This can be seen in the geologic description of the monitoring well (MC-04-02) in the lower portion of Collom Gulch in Section 24, T. 3 N., R. 93 W. The cuttings obtained from the drill hole are predominantly silty clays, with minor amounts of sand and gravel (<25%). Based on depth to groundwater in this drill hole (10 feet below ground surface), it is doubtful that sub irrigation of any plant crop is possible. Further to the north, near the confluence of Collom Gulch and Little Collom Gulch, monitoring well MLC-04-01, has a groundwater level of between 40 and 50 feet below ground surface.

In addition, active erosion in the Collom Gulch channel is causing further incision, which is lowering the unconfined groundwater table found in the valley. The incision in Collom Gulch is at least two feet and in excess of 20 feet in sections before that flow of Collom Gulch exits through the ‘hogback’ and flows onto the Mancos Shale located in the Axial Basin to the north. The incision is also widening due to the down cutting and erosion of the supporting banks during periods of higher flow (normally occurring during the spring). With the low surface water flow rates and the reduced flood frequency, this has reduced the ability of the valley bottoms to support any agricultural use other than rangeland.

Local and regional agricultural economics are prohibitive to developing irrigation projects within these valley bottoms, and such practices are in decline locally, especially on such a small scale as would be required by the narrow and fragmented nature of irrigable bottomlands within the subject drainages.

The narrow width and fragmented nature of the minimal flat land, depth to groundwater, and impracticality of economically irrigating or mechanically farming the valley bottoms within Collom Gulch indicate that those drainages do not qualify as alluvial valley floors.

In conclusion, no adverse impact to the water environment downstream of the reclaimed Collom Pit is projected.

2.05.6 (4) Protection of Public Parks and Historic Places

No public parks are located within the permit or adjacent areas; therefore, no public parks will be affected by the mining operations. The mining operations are anticipated to affect specific sites and areas listed or eligible for listing in the National Register of Historic Places. These sites are discussed in further detail in Sec 2.04.4. A treatment plan has been prepared for some of the sites expected to experience impacts from the development of this mine. This treatment plan will identify specific mitigation processes needed to develop in and around these sensitive locations.

2.05.6 (5-6) Surface Mining near Underground Mining; Subsidence Control

No surface mining activities will be conducted within 500 feet of an underground mine. Therefore, there is no subsidence control plan for operations.

2.06 PERMIT REQUIREMENTS - SPECIAL MINING CATEGORIES

2.06.1-3 Scope, Experimental Mining, and Mountain Top Removal

There will be no experimental mining practices at the Collom Pit.

2.06.4 Steep Slope Mining

Colowyo may request a variance for mining and reclamation for steep slope mining as specified in Rules 2.06.4(2) and 4.27.

2.06.5 Variance from Approximate Original Contour Restoration Requirements

The Collom mining area will include non-mountaintop removal steep slope surface coal mining and reclamation operations. Colowyo is not currently requesting a variance from approximate original contour in the post-mining topography (PMT), but maintains the option to pursue this in the future as an amendment to the permit. The PMT as presented reflects the pre-mining topography generally, with drainages and drainage divides remaining in their approximate current locations. Some minor moderation in topography is expected due to limitations associated with reclamation equipment. Post-mining topography is shown on Map 19C. The PMT is designed based on the Division's rules for Operations on Steep Slopes as discussed in Section 4.27 of this document.

2.06.6 Prime Farmlands

Prime farmlands do not exist within the Collom permit revision boundary (see Section 2.04.12).

2.06.7 Reclamation Variance

There will be no delay in contemporaneous reclamation due to underground mining activities; therefore, this section is not applicable.

2.06.8 Alluvial Valley Floor (AVF)

General

The geologic and hydrologic conditions of the Collom Mine Expansion area have been studied since at least 1980 by Colowyo and other potential interests. These studies have included the examination of the valley bottoms for the possible presence of alluvial valley floors. These studies include the 1985 Office of Surface Mining Reclamation and Enforcement (OSMRE) Alluvial Valley Floor (AVF) Reconnaissance report and map of northwest Colorado. The reconnaissance by OSMRE was compiled on 1:100,000-scale maps and was meant to represent a reconnaissance level effort to identify areas which are likely to meet the AVF definition (from Introduction to OSMRE report). Thus, any area identified on the OSMRE maps is only potential AVFs. It was recognized in the OSMRE study that future studies may more conclusively prove or disprove the AVF findings in the report.

In examining the land of the Collom Mine Expansion area and the surrounding area, the landforms are controlled by two distinct geologic features. One is the Collom syncline/Danforth Hills and the other is the Axial Basin (these have been described previously in section 2.04.6 - Geology Description). The area of the Collom Syncline has sloping topography to the north until the Collom Syncline axis is reached and then a hogback formed by the uplift of the Iles formation is present. Proceeding north, the open area of the Axial Basin is then encountered.

All drainages in the Collom Mine Expansion area form on the southern portion of the Collom syncline/Danforth Hills. These drainages all flow northward toward and cross the Iles formation and then flow into the Axial Basin. The drainages tend to be narrow, confined drainages until the drainages exit to the Axial Basin.

AVF Specific Study-Collom Mine Area

In 2005, Tetra Tech, doing business as Maxim Technologies, conducted a preliminary field investigation and technical evaluation of the Collom permit expansion area located in the Collom syncline area to determine the presence of alluvial valley floors. The drainages examined include Collom Gulch, Little Collom Gulch, and Jubb Creek (including the West Fork of Jubb Creek). The investigation was conducted in accordance with Section 2.06.8 of the Regulations of the Colorado Mined Land Reclamation Board for Coal Mining and OSMRE Technical Guideline. The results of the investigation concluded that no alluvial valley floors exist in the areas to be mined. The findings were submitted to CDRMS on September 23, 2005 in a letter, a copy of which is included in Volume 18A, Exhibit 7, Item 22. These findings are also discussed further in appropriate sections below.

The mined area is located within Little Collom Gulch, and the Collom Pit and excess overburden pile will occupy much of the Little Collom Gulch valley bottom during the mining operation. Portions of the Collom Pit will lie within the adjacent watersheds of Collom Gulch and the West Fork of Jubb Creek, but will not encroach on the valley bottoms (Map 23B). Groundwater in the general area occurs in valley fill material associated with the stream valleys and in the permeable and semi-permeable bedrock strata (CDM, 1985a). As discussed in Section 2.04.7, the existence of groundwater in the permit expansion area is limited to perched systems that primarily discharge small amounts of water in the canyon walls near the mine on a seasonal basis, and in some of the unconsolidated valley fill. Little Collom Gulch is ephemeral, and did not produce any measurable flow during the baseline hydrologic monitoring efforts described in Section 2.04.7. Very little groundwater is found in the current active mine; and, based on existing geological and hydrological evidence, the area to be mined provides no or only minor amounts of recharge to local surface water features.

Geomorphic Characteristics

Tetra Tech's 2005 investigation included mapping unconsolidated valley deposits in the Collom permit expansion area, using published and unpublished geologic maps and ground reconnaissance. The results are shown in Figure 1 of Exhibit 7, Item 24. Much of the mapped valley deposits contained substantial proportions of colluvium and/or sheetwash materials. The source material for the valley fills was primarily erosion and deposition of loess, leading to a loamy soil texture which supports more lush vegetation than adjacent uplands, even absent sub-irrigation.

In addition, valley bottoms within the permit expansion area were very narrow and historically uncultivated. Most floodplains in the area are generally extremely narrow (less than 20 feet), have been severely down-cut, and/or contain too much topographic relief in the form of slopes to be considered capable of being irrigated. Due to downcutting, flooding does not extend beyond the limits of the incised channel.

Flood Irrigation and Agricultural Activities

Section 2.04.3 contains a description and map of agricultural activities in the permit and adjacent area. The Premining and Postmining Land Use Map (Map 17) shows that the historic pre-mining land use of the area has been generally undeveloped rangeland. Exceptions to undeveloped range land in the permit area include the presence of equipment staging areas, small structures, reservoirs, roads, and stream crossings. However, documentation exists indicating several small parcels along the West Fork of Jubb Creek, totaling approximately 24 acres, were historically used for hay production. No evidence of any irrigation for these parcels was found.

Historically, there has not been a developed water supply for agricultural activities in the potentially-affected drainages. In addition, based on field investigations, there is no evidence of historical flood irrigation in the Collom permit expansion area.

Subirrigation

Depths to groundwater in the valley fill materials in the Collom Mine Expansion area have been recorded as between 9 feet below ground surface (bgs) along West Fork Jubb Creek (near a small pond), to greater than 47 feet bgs within Little Collom Gulch. Further information on groundwater occurrence is provided in Section 2.04.7.

The effects of the mass-wasting event of 1983-1984 downcut the valley fill throughout this area as much as 20 to 30 feet below the former surface in some locations. The resulting lowering of the valley fill groundwater table was noted by Tetra Tech as having caused drying of former wetlands and colonization of the land by upland plant species. Remaining wetlands in the valley bottoms are generally associated with springs and seeps issuing from perched water in bedrock along the valley wall. Examination of non-wetland soil profiles next to drainages revealed very few soils with mottles, shallow rooting depth, or other characteristics indicative of subirrigation.

Suitability for Flood Irrigation

Since 1974, Colowyo and other private and governmental groups have collected samples of water flows and water quality in the area. Water of sufficient quality and quantity for seasonal flood irrigation does exist in some areas (WMC 2005). However, the cost to develop such an irrigation system would be prohibitive given the remote location and limited area available for irrigation (Dames and Moore 1980,

Walsh 1984). New irrigation projects are very rare in local agricultural practice, and would incorporate sprinkler irrigation rather than inefficient flood irrigation.

Conclusion

Tetra Tech's 2005 report presented the following findings regarding the presence of alluvial valley floors in the Collom permit expansion area:

- Alluvial materials are present in the valley bottoms of the Collom Gulch, Little Collom Gulch, and Jubb Creek drainages, but the materials are intermixed with significant fractions of colluvium and sheetwash from adjacent slopes.
- Based on depth to groundwater, subirrigation within these valley bottoms is very limited.
- Active erosion in the stream channels is causing further incision, lowering of the groundwater table, and reduced flood frequency, reducing the ability of the valley bottoms to support any agricultural use other than rangeland.
- Local and regional agricultural economics are prohibitive to developing irrigation projects within these valley bottoms, and such practices are in decline locally, especially on such a small scale as would be required by the narrow and fragmented nature of irrigable bottomlands within the subject drainages.

The narrow width and fragmented nature of the minimal flat land, depth to ground water, and impracticality of economically irrigating or mechanically farming the valley bottoms within Collom Gulch, Little Collom Gulch, and West Fork of Jubb Creek of the Collom Mine Expansion area indicate that those drainages do not qualify as alluvial valley floors.

Specific discussion of the Collom Gulch Valley

As noted in the previous text, alluvial materials are present in the valley bottoms of the Collom Gulch drainages but the materials are intermixed with significant fractions of colluvium and sheetwash from adjacent slopes. This can be seen in the geologic description of the monitoring well (MC-04-02) in the lower portion of Collom Gulch in Section 24, T. 3 N., R. 93 W. The cuttings obtained from the drill hole are predominantly silty clays, with minor amounts of sand and gravel (<25%).

Based on depth to groundwater in this drill hole (10 feet below ground surface), it is doubtful that subirrigation of any plant crop is possible. Further to the north, near the confluence of Collom Gulch and Little Collom Gulch, monitoring well MLC-04-01 has a ground water level of between 40 and 50 feet below ground water surface.

In addition, active erosion in the Collom Gulch channel is causing further incision, which is lowering the unconfined groundwater table found in the valley. The incision in Collom Gulch is at least two feet and in excess of 20 feet in sections before that flow of Collom Gulch exits through the 'Iles formation hogback' and flows onto the Mancos Shale located in the Axial Basin to the north. The incision is also widening due to the downcutting and erosion of the supporting banks during periods of higher flow (normally occurring during the spring). With the low surface water flow rates and the reduced flood frequency, this has reduced the ability of the valley bottoms to support any agricultural use other than rangeland.

Local and regional agricultural economics are prohibitive to developing irrigation projects within these valley bottoms, and such practices are in decline locally, especially on such a small scale as would be required by the narrow and fragmented nature of irrigable bottomlands within the subject drainages.

The narrow width and fragmented nature of the minimal flat land, depth to ground water, and impracticality of economically irrigating or mechanically farming the valley bottoms within Collom Gulch indicate that these drainages do not qualify as alluvial valley floors.

AVF Studies- Gossard Loadout and surrounding areas

All the streams/creeks that exit the Collom syncline/Iles formation hogback still exhibit the deep downcutting that originates in the Collom Syncline lands. This downcutting is easily visible in all streams/creeks exiting the hogback and continues for several miles downstream. This downcutting was due to the 1983/1984 mass-wasting event discussed above. The two streams that will be affected by the Collom Mine Expansion are Jubb Creek and Wilson Creek, near the Gossard Loadout.

The possibility of any AVF in Jubb Creek was discussed above. As noted, there is no AVF in the Jubb Creek valley north of the hogback. With respect to Wilson Creek, after the creek exits the hogback, a broad valley filled with valley fill materials is encountered. In the area where the Collom haul road crosses from the Collom Pit to the Gossard loadout, Wilson Creek is at least 20 feet deep. The banks show some undercutting and blocks of valley fill material coming off the sides. The vegetation on the land on both sides of the creek in this area is predominantly upland vegetation. The vegetation is old growth due to the size of the brush in this area. The deep valley of the creek and vegetation continues along the length of Wilson Creek to the north of the loadout and for several miles north of the loadout.

Groundwater in this area is at least 20 feet below ground surface (bgs) in the shallow monitoring wells, Gossard Well and MW-95-02. The Gossard Well is located northeast of the Gossard Loadout in the field and MW-95-02 is located on the east bank of Wilson Creek, southwest of the loadout. The historical average depth to water at the Gossard Well is approximately 21 feet (2009 Annual Reclamation Report). Tetra Tech (2005) concluded that such depths to groundwater are too great to allow for agriculturally significant subirrigation. MW-95-02 had a water level of 25.1 feet bgs in November 2016. (Further information on groundwater occurrence is provided in Section 2.04.7).

In September of 2015, four geotechnical holes were drilled on both sides of Wilson Creek where the crossing for the haul road leading from the Collom pit to the loadout is to be located. Groundwater was detected in these geotechnical test hole at approximately 25 feet bgs. There are no visible seeps on the sidewalls of the valley in the crossing area and both upstream and downstream of the crossing area. This new data provides additional information to the conclusion that groundwater in the area is too deep for any subirrigation.

The near surface valley fill materials in the area of the Collom haul road crossing over Wilson Creek were found to be predominantly clay, based on the four geotechnical test holes. The clays do contain minor amounts of gravel, sand and silt and were gray to dark brown in color. The thickness of the clays are at least 10 feet thick and are stiff to hard. The materials present do not appear to meet the definition of alluvial material for alluvial valley floors.

No evidence of flood irrigation was found for the fields surrounding the Gossard loadout. However, some limited flood irrigation was conducted in the floodplain of Wilson Creek, north of and outside the permit boundary (north of County Road 17). The ditch constructed for this irrigation is now heavily overgrown with upland vegetation. The gate for this water diversion sets several feet above the Wilson Creek channel and cannot be reached by current water flow from Wilson Creek. The area of concern surrounding the Gossard Loadout facility was bypassed for flood irrigation historically in order to apply irrigation water downstream to lands outside the current permit boundary.

Irrigation diversion points, irrigation ditches, and topography are shown on Map 10B. These areas are well outside the subject drainages of Collom Gulch, Little Collom Gulch, and Jubb Creek.

Thus, the same conclusions as those previously presented for the creeks in the Collom syncline area may be reached for the area of disturbance for construction of the Collom Haul Road in the vicinity of the Gossard Loadout facility (Map 25E Sheet 1 of 4):

- Alluvial materials are present in the valley bottom of the Gossard Loadout complex, and the lower reaches of the Lower Wilson Creek drainage, but the materials are intermixed with significant fractions of colluvium and sheetwash from adjacent slopes and the mass wasting event experienced in 1983-1984.
- Based on an average depth to groundwater of at least 20 feet, coupled with data from monitoring wells and geotechnical test holes in the Wilson Creek area drilled in 2015, subirrigation within this valley bottom is very limited in extent (outside and north of the permit area) or non-existent. Active erosion in the stream channels is causing further incision and reduced flood frequency, reducing the ability of this valley bottom to support any agricultural use other than rangeland or dryland agriculture. There is no evidence of “modern terracing” in the area that will be disturbed near the Gossard Loadout facilities.
- Local and regional agricultural economics are prohibitive to developing irrigation projects within this valley bottoms, and such practices are in decline locally.
- Historical irrigation activities associated with the “diversion structure and ditch” located on Wilson Creek; divert water around the existing grain fields, under County Road 17, outside the current permit boundary to the fields northeast of County Road 17. This activity is still performed when water is available to the diversion structure as the mass wasting events (1983-1984) limited the function of this system.

Colowyo contends that based on the descriptions and defining characteristics needed to classify an area as a functioning alluvial valley floor, the area to be disturbed that is associated with the Collom Haul Road within the Lower Wilson Drainage does not qualify as an alluvial valley floor. Thus, no material damage assessment, water monitoring program, etc., is required due to the fact the area is not a functional alluvial valley floor. Colowyo does plan to return the area of disturbance to pre-disturbance condition at the cessation of mining activities.

2.06.9 – 2.06.11 Augering, Processing Plants, In-Situ Processing

In the Collom Pit, specifically the endwall and low walls of the box cut, highwall mining will target the X3/X4, B2/B3, C3/C5, D1/D2, E2, F5/F6, FA/FB, G8/G9 and GB seams. Please see Map 23B for the overall extent of the highwall mining plan for the Collom Pit. All seams will be developed in a top-down sequence following the Collom box cut down as it is driven. The planned highwall mining sequencing will begin with the X3/X4 seam, and once mining is completed the highwall mining will continue down to the next available seam in the sequence following right behind pre-strip surface mining operations. For additional detail on the highwall mining technique that will be utilized please see Volume 1, Section 2.06.9.

Please see Volume 1 for Sections 2.06.10 and 2.06.11.

2.06.12.1 Coal Refuse Piles

Coal refuse piles do not exist on the Colowyo property. Thus, this section is not applicable.

2.07 – 2.10 VARIOUS

Information required by these sections is included in Volume 1.

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a manner to safely pass peak runoff from a 10 year, 24 hour precipitation event (Please see Volume 18C Exhibit 7, Item 25F). During construction of the Collom Haul Road, the field engineer shall determine the need for control measures during construction. Such temporary and permanent control measures would include silt fences, S-fence, straw bales, straw wattles, rock check dams, or other measures such as downstream sediment ponds.

A network of temporary channels and small sediment sumps will be utilized to management stormwater runoff from the Collom Haul Road. The location of these channels and small sediment sumps are shown on Map 25E. Sheet1. The channel configuration details including reporting watershed delineations for these channels can be found in Volume 18C Exhibit 7, Item 25E.

At the request of Moffat County an elevated roadway crossing will be installed where the Collom haul road crosses Moffat County Road 51 (CR-51). Once the elevated crossing is installed, CR-51 will allow public traffic to cross over the top of the Collom Haul Road. An equipment corridor will be installed adjacent to the elevated crossing to provide large equipment access from the existing mining areas to the Collom mine. Design details for this elevated crossing can be found on Map 25F.

The Collom Haul Road heavy equipment traffic will cross CR-51 at grade. Only non-production mine traffic will utilize the at grade crossing. All normal light vehicle and coal haul traffic will be separated from CR-51 by an overpass. The at grade crossing will employ typical signage as well as visual indication on the CR-51 approach to the intersection at adequate distance to warn the public of the intersection and potential interaction with mine equipment. Crossing gates to the haul road will be kept in the closed position preventing access to the Collom Haul Road by non-authorized personnel to restrict access onto the Collom Haul Road. When the Colowyo Mine vehicles approach to cross CR-51, gate(s) will close to the CR-51 traffic, then gate(s) will open to the haul road allowing the mine vehicles to pass. Access to the haul road gates will be through authorized Colowyo staff only with appropriate measures to ensure that the public cannot readily open the gates.

For wildlife protection measures on the Collom Haul Road, Colowyo limit's vehicle speed limits to 50 mph at the locations where the Collom Haul Road to the Gossard Loadout intersects established wildlife travel/migration corridors. These areas also have supplemental lightening installed to improve wildlife visibility and to assist in minimizing wildlife/vehicle collisions. Colowyo maintains a record of all wildlife/vehicle collisions if they occur that includes date, time, location, and species involved in the collision.

There is one haul road that will be constructed outside of the Collom Pit to haul coal to the coal stockpile area and primary crusher (please see Map 22B for stockpile and crusher locations). This haul road is shown Map 25D and is designated as the Collom Coal Haul Road. The Collom Coal Haul Road is designed to allow large mining equipment access and egress to and from the pit area to the coal stockpile and coal crushing facility. Once this haul road intercept the crest of the mining limit, within the Collom Pit, it will be exempt from any construction specifications, since roadways within the immediate mining pit area are exempt for construction specifications in accordance with Rule 1.04(111). The Collom Coal Haul Road will be designed and constructed in accordance with Rule 4.03.1 as shown on Map 25D.

Temporary haul roads and in-pit haul road will be utilized to support mining will be developed within the Collom Pit and the excess spoil pile area. These roads will constantly be changing and moving as the Collom pit advances and as the excess spoil pile is constructed. In accordance with Rule 1.04(111) these roads will be exempt from design specification required under Rule 4.03.1. They will be designed to Colowyo's internal haul road design standards for the equipment that will be operating on them.

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stockpile area to preclude loss and/or contamination of the topsoil resource. A demonstration of the effectiveness of sediment control structures to be constructed around several topsoil stockpiles planned outside of primary sediment control may be found under Exhibit 7, Item 23, Part D.

4.05.4 Stream Channel Diversions (Relocation of Streams)

The drainage and sediment control measures described under Section 2.05.6 and presented in the Erosion and Sedimentation Control Plan (Exhibit 7, Item 23) will provide for temporary diversion of surface drainages within the permit area, as needed for mine operations. A system of temporary ditches will be used to divert runoff from disturbed areas to sediment ponds. The natural drainage systems will be restored to historic drainage patterns once diversion ditches are removed; therefore, there will be no permanent diversions of these channels.

The only stream channel that will be impacted by the Collom Pit is the main stream of Little Collom Gulch, an ephemeral stream draining less than one square mile at the upstream pit boundary. Clean water diversions will be installed above the Collom Pit (Exhibit 7, Item 23, Part A) and will be removed as mining progresses. It will also be channelized further downstream, alongside the haul road leading from the Collom Pit to the spoil pile, where it drains greater than one square mile (Exhibit 7, Item 2, Part B).

4.05.5 Sediment Control Measures

Sediment control measures to be implemented are shown in Exhibit 7, Item 23 Erosion and Sedimentation Control Plan, and postmining channels are shown on Map 41B. These facilities, consisting primarily of diversion ditches and sedimentation ponds, will be located, constructed and maintained to avoid erosion and increased contribution of sediment load to runoff.

Facilities to control sediment are typically installed in areas above and/or below the planned sites of disturbance. “Upstream” facilities, such as clean water diversion ditches upslope from the mining activities, serve to divert runoff away from the disturbed areas. Temporary diversion ditches below the disturbed area of the pit will help collect runoff from disturbed areas and route it into the sedimentation ponds. During active mining, the mining areas will aid in retaining sediment within the disturbed areas by catching water in pits, small depressions and dozer basins, etc. Once reclaimed, the basins will drain as they did prior to mining activities (i.e., historic drainage patterns will be re-established).

All temporary diversions will be removed and reclaimed when no longer needed for sediment control in accordance with Rule 4.05.2(2)

Channel lining rock riprap and energy dissipaters will be used when necessary. As stated above, all temporary diversion structures will be seeded and revegetated after removal. Colowyo does not anticipate that there will be any significant excess material resulting from the construction of diversion ditches.

None of the diversions will drain into underground mines.

4.05.6 Sedimentation Ponds

The location, design parameters, and detailed sedimentation calculations of all planned sedimentation ponds are presented in Erosion and Sedimentation Control Plan (Exhibit 7, Item 23). The design plans and specifications for the sedimentation ponds are described in this section (Part C). All sedimentation ponds will be located as close as practical to the areas to be disturbed. Steep terrain in the upper basins precludes location of the ponds at the Collom Pit disturbance boundaries during the critical early phase of operations, necessitating down-valley locations downstream of the Collom Pit and excess overburden pile

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Groundwater Fill Piezometers - Monitoring of the West Pit fill piezometer and Section 16 Fill piezometer have been discontinued. The West Pit Fill and West Taylor Fill piezometers will be monitored quarterly for water levels. One additional piezometers will be installed into the toe of East Taylor Fill, once constructed, as described in Exhibit 21 Item 1.

A spoil water monitoring well may be drilled and water quality monitored should the Collom Pit be developed lower than the E seam. If the Collom Pit is not mined down to the E seam or below, the spoil monitoring well will not be drilled since the aquifer in the Collom Pit will not be dewatered nor impacted by mining activities. The potential location for the spoil well is shown on Map 41B. This location represents the lowest point in the Collom Pit based on current mining plans.

4.05.14 Transfer of Wells

Please see Section 4.05.14 in Volume 1.

4.05.15 Water Rights and Replacment

Please see Section 4.05.14 in Volume 1 and Section 2.04.7(2) in Volume 15.

4.05.16 Dischrage of Water into an Underground Mine

This section is not applicable to the Collom Mine.

4.05.17 Postmining and Rehabilitation of Sediment Pond, Diversions, Impoundments, and Treatment Facilities

Please see Section 4.05.17 in Volume 1.

4.05.18 Stream Buffer Zones

Lands within 100 feet, or greater distance if required, of a perennial, an intermittent, or an ephemeral stream with a drainage area larger than one square mile are required to be protected under Rule 4.05.18, unless the Division specifically authorizes surface operations within the stream buffer zone. Stream buffer zones have been identified along Wilson Creek and Jubb Creek, as the drainage area reporting to these streams is larger than one square mile. Colowyo will be developing the Collom Haul Road which will be inside the stream buffer zone on both Wilson Creek and Jubb Creek.

The Collom Haul Road will cross Wilson Creek as shown on Map 25E Sheet 1. During construction Colowyo will install a round culvert, and will employ proper best management practices (BMPs) during the construction phase in accordance with Colowyo's approved stormwater management plan, Section 401 certification, and US Army Corps 404 permit..

The Collom Haul Road will also cross Jubb Creek as shown on Map 25E Sheet 1. The construction of the crossing will be similar to the Wilson Creek crossing and will utilize the same BMPs as will be installed at the Wilson Creek crossing.

As shown on Map 25E Sheet 1, the Collom Haul Road will parallel Jubb Creek. There will be one section of the haul road that will be slightly within 100 feet of the stream. As shown on Map 25E Sheet 1, at approximately Station 230+00 to 250+00 there will a slight amount of disturbance within the stream buffer zone on Jubb Creek. Proper BMPs will be employed prior to any disturbance occurring within

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this area and once the road construction is complete any areas that can be reclaimed will be completed as soon as possible.

Little Collom Gulch will be directly impacted by the Collom Pit, the excess overburden pile, and the Section 25 Pond (see Map 23C). The Section 25 Pond will protect the lower reaches of Little Collom Gulch that will not be disturbed during mining and reclamation. It is expected that during mining the Collom Pit will intercept and hold surface water runoff thus providing less discharge through the Section 25 Pond. Clean water diversions will be constructed above the active operations (also potentially within Little Collom Gulch) to direct surface water runoff around the disturbed areas. Once mining is complete part of Collom Pit will be backfilled with the material stored in the excess overburden pile and the profile and function of Little Collom Gulch will be restored.

It is not anticipated that any of the areas that are to be disturbed within the stream buffer zones will have any long term impacts to Wilson Creek, Jubb Creek, or Little Collom Gulch due to proper use of BMPs, sediment control structures, clean water diversions, and due the fact the disturbance will be offset by reclamation. The two road crossing will be stabilized immediately following construction, and Little Collom Gulch will be restored to the premine condition when mining and reclamation activities are complete.

No other areas within the Collom disturbance footprint will impact any stream buffer zones.

4.06 TOPSOIL

The topsoil removal, storage, and redistribution plan for the disturbed area associated with the Collom Pit mining areas will follow the procedures described Section 2.05.3 (5) and 2.05.4 (2) (d) in this volume. Additional information regarding the topsoil resource may be found in the Collom Soils baseline survey located in Exhibit 9, Volume 13. Before the disturbance of any area, topsoil is removed and segregated from other material. Upon removal, this material is either immediately redistributed on regraded areas or stockpiled in locations shown on the Topsoil Handling Map 28C

All topsoil, as classified in section 2.04.9, is removed from areas to be affected by the surface coal mining operations. The graphical representation of the topsoil removal is shown on the Topsoil Handling Map 28C. The average thicknesses for each soils series to be removed can be found on Table 2.04.9-16 as defined in Table 2.04.9-19. Removal techniques for topsoil are described in Section 2.05.3. Furthermore, please see Section 4.06 in Volume 1 for additional information regarding topsoil.

4.07 SEALING OF DRILLED HOLES AND UNDERGROUND OPENINGS

Drill holes and underground openings will be sealed in accordance with the procedures outlined in the Section 4.07 in Volume 1.

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Groundwater Fill Piezometers - Monitoring of the West Pit fill piezometer and Section 16 Fill piezometer have been discontinued. The West Pit Fill and West Taylor Fill piezometers will be monitored quarterly for water levels. One additional piezometers will be installed into the toe of East Taylor Fill, once constructed, as described in Exhibit 21 Item 1.

A spoil water monitoring well may be drilled and water quality monitored should the Collom Pit be developed lower than the E seam. If the Collom Pit is not mined down to the E seam or below, the spoil monitoring well will not be drilled since the aquifer in the Collom Pit will not be dewatered nor impacted by mining activities. The potential location for the spoil well is shown on Map 41B. This location represents the lowest point in the Collom Pit based on current mining plans.

4.05.14 Transfer of Wells

Please see Section 4.05.14 in Volume 1.

4.05.15 Water Rights and Replacment

Please see Section 4.05.14 in Volume 1 and Section 2.04.7(2) in Volume 15.

4.05.16 Dischrage of Water into an Underground Mine

This section is not applicable to the Collom Mine.

4.05.17 Postmining and Rehabilitation of Sediment Pond, Diversions, Impoundments, and Treatment Facilities

Please see Section 4.05.17 in Volume 1.

4.05.18 Stream Buffer Zones

Lands within 100 feet, or greater distance if required, of a perennial, an intermittent, or an ephemeral stream with a drainage area larger than one square mile are required to be protected under Rule 4.05.18, unless the Division specifically authorizes surface operations within the stream buffer zone. Stream buffer zones have been identified along Wilson Creek and Jubb Creek, as the drainage area reporting to these streams is larger than one square mile. Colowyo will be developing the Collom Haul Road which will be inside the stream buffer zone on both Wilson Creek and Jubb Creek.

The Collom Haul Road will cross Wilson Creek as shown on Map 25E Sheet 1. During construction Colowyo will install a round culvert, and will employ proper best management practices (BMPs) during the construction phase in accordance with Colowyo's approved stormwater management plan, Section 401 certification, and US Army Corps 404 permit..

The Collom Haul Road will also cross Jubb Creek as shown on Map 25E Sheet 1. The construction of the crossing will be similar to the Wilson Creek crossing and will utilize the same BMPs as will be installed at the Wilson Creek crossing.

As shown on Map 25E Sheet 1, the Collom Haul Road will parallel Jubb Creek. There will be one section of the haul road that will be slightly within 100 feet of the stream. As shown on Map 25E Sheet 1, at approximately Station 230+00 to 250+00 there will a slight amount of disturbance within the stream buffer zone on Jubb Creek. Proper BMPs will be employed prior to any disturbance occurring within

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this area and once the road construction is complete any areas that can be reclaimed will be completed as soon as possible.

Little Collom Gulch will be directly impacted by the Collom Pit, the excess overburden pile, and the Section 25 Pond (see Map 23C). The Section 25 Pond will protect the lower reaches of Little Collom Gulch that will not be disturbed during mining and reclamation. It is expected that during mining the Collom Pit will intercept and hold surface water runoff thus providing less discharge through the Section 25 Pond. Clean water diversions will be constructed above the active operations (also potentially within Little Collom Gulch) to direct surface water runoff around the disturbed areas. Once mining is complete part of Collom Pit will be backfilled with the material stored in the excess overburden pile and the profile and function of Little Collom Gulch will be restored.

It is not anticipated that any of the areas that are to be disturbed within the stream buffer zones will have any long term impacts to Wilson Creek, Jubb Creek, or Little Collom Gulch due to proper use of BMPs, sediment control structures, clean water diversions, and due the fact the disturbance will be offset by reclamation. The two road crossing will be stabilized immediately following construction, and Little Collom Gulch will be restored to the premine condition when mining and reclamation activities are complete.

No other areas within the Collom disturbance footprint will impact any stream buffer zones.

4.06 TOPSOIL

The topsoil removal, storage, and redistribution plan for the disturbed area associated with the Collom Pit mining areas will follow the procedures described Section 2.05.3 (5) and 2.05.4 (2) (d) in this volume. Additional information regarding the topsoil resource may be found in the Collom Soils baseline survey located in Exhibit 9, Volume 13. Before the disturbance of any area, topsoil is removed and segregated from other material. Upon removal, this material is either immediately redistributed on regraded areas or stockpiled in locations shown on the Topsoil Handling Map 28C

All topsoil, as classified in section 2.04.9, is removed from areas to be affected by the surface coal mining operations. The graphical representation of the topsoil removal is shown on the Topsoil Handling Map 28C. The average thicknesses for each soils series to be removed can be found on Table 2.04.9-16 as defined in Table 2.04.9-19. Removal techniques for topsoil are described in Section 2.05.3. Furthermore, please see Section 4.06 in Volume 1 for additional information regarding topsoil.

4.07 SEALING OF DRILLED HOLES AND UNDERGROUND OPENINGS

Drill holes and underground openings will be sealed in accordance with the procedures outlined in the Section 4.07 in Volume 1.

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4.08 USE OF EXPLOSIVES

Explosives will be used for blasting in accordance with the procedures and specifications presented in the Section 4.08 of Volume 1. Map 26B presents distances to various structures of possible concern surrounding the mining area. Only Section 4.08.2 has changed from the Volume 1; see Sections 4.08.1 and 4.08.3 through 4.08.6 in Volume 1.

4.08.2 Pre-Blast Survey

In accordance with Rule 4.08.2(1), pre-blast surveys will be offered to owners of all structures within one-half mile of the permit area 30 days before initiation of blast activities. Please see Exhibit 14, Item 8, Figure 1 for structures located within a half-mile of the the permit area. Pre-blast survey offerings will be made to the owners shown on Exhibit 14, Item 8, Figure 1. Should any owner of a structure request a pre-blast survey, the survey will occur prior to commencement of blasting activities, and copies of completed assessments will be included in Exhibit 14, Item 8 after the structure assessments have been completed. All blasting within the Collom area will be conducted in accordance with the blasting parameters described in Volume 1, Section 2.05, Blasting.

Blasting Records

Colowyo will keep a record of each individual blast by utilizing report formats shown in Volume 1, Figure 2.05-2 - Blasting Report (coal and overburden), and Volume 1, Figure 2.05-3 – Colowyo Chargeweight Sheet (overburden only).

Colorado Oil and Gas Registered Facility Locations

There are three locations within the permit boundary extension for the Collom Mining Area (Map 11B – Drill Hole Locations) that are identified in the Colorado Oil and Gas Conservation Commission database. They are described as follows:

- 1) ID# 05-081-07203 – Plugged and abandoned oil exploration well. Owned by Infinity Oil & Gas of Wyoming, completed in December, 2004. Plugged and abandoned July, 2005.
- 2) ID# 05-081-06328 – Plugged and abandoned oil exploration well. Owned by Tiger Oil Company, completed February, 1978. Plugged and abandoned February, 1978.
- 3) ID# 05-081-06339 – Planned oil exploration well location permitted but well was not constructed and the drilling permit was allowed to expire in May, 1978. Owned by Tiger Oil Company.

4.09 DISPOSAL OF EXCESS SPOIL

Overburden removed from the Collom Pit will be stockpiled out of pit as shown on Maps 23B and 29C. Colowyo expects approximately 20% swell of excavated materials; therefore, part of the material stockpiled in the excess overburden pile will remain out of pit and will also be disposed of permanently in the Little Collom Valley Fill at the conclusion mining as shown on Map 29C. Colowyo expects the excess overburden pile to contain approximately 28 million cubic yards of overburden, with approximately 17,274,124 cubic yards remaining permanently out of pit on the ridge north of the Collom Pit, and approximately 4,103,860 cubic yards of permanent spoil to remain in the Little Collom Gulch Valley Fill. Colowyo expects 6,608,464 cuic yards of the excess overburden will come back to the Collom Pit to fill the final void left from the mining process.

Design of the Little Collom Valley Fill is provided in Volume 20 Exhibit 23 Item 3. The excess out-of-pit stockpile and the Little Collom Valley Fill will be reclaimed in accordance with the approved post

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mine topography shown on Map 19C. The final configuration of the fill is designed to minimize erosion. The final outslope will not exceed 3h:1v. A geotechnical evaluation of the stability of the permanent out of pit excess overburden is provided in Volume 20 Exhibit 23, Item 3.

Two terrace ditches will be constructed on the face of the Little Collom Valley Fill. Please refer to Volume 18B Exhibit 7, Item 23, Part I for the location and design configuration of the terrace ditches. Both terrace ditches will be backsloped to direct runoff against the face to prevent flows from overflowing the edge of the ditch. These terrace ditches will direct surface runoff perpendicular to the face into a permanent drainage channel designed to pass safely the runoff from a 100-year, 24 hour precipitation event.

CONSTRUCTION PLAN

All available topsoil will be removed for the Little Collom Valley Fill and either stockpiled for later use or direct hauled to a reclaimed area.

The Little Collom Gulch Valley Fill drain has already been installed in accordance with Volume 20 Exhibit 23, Item 1. Prior to placing overburden into Little Collom Gulch Valley Fill, an 820 feet long by 24 feet wide rock drain was constructed. This rock drain was constructed from large sandstone rock sorted on-site from existing excess spoil areas, and the sorted rock was placed with loaders and dozers. Once the rock drain was completed, excess spoil was placed over the rock drain, rising in approximately 50-foot-high lifts until reaching a final height of 130 feet above the valley floor at the north edge of the rock drain.

North of the constructed rock drain, natural dump sorting was used to create the remaining excess spoil rock drain. When material is placed at heights over 100 feet, the larger boulders and rock roll down the slope effectively sorting the material and making a natural drain at the toe of the spoil. This method has been implemented at Colowyo for many years and is further described in Volume 20 Exhibit 23 Item 1 report. This report states in Section 8.2, "In our opinion, a drain extending the full distance from the downstream toe to the upstream toe is not required, particularly for a temporary spoil fill. Our experience and observations indicate that the spoil and placement methods at Colowyo produce a relatively free draining layer at the base of each lift of spoil." Once a suitable height that allowed for natural dump sorting was achieved, the Little Collom Valley Fill construction progressed towards the northern limits of its overall footprint.

INSPECTION PLAN

During construction of the Little Collom Valley Fill, Colowyo will provide certified reports as required by Rule 4.09.1(11). Inspections will be conducted at quarterly during the construction period, final grading, and revegetation.

Each inspection report will be provided to the Division within two weeks after the end of each quarter of the year, and the report will be certified by a professional engineer. Each report will certify that the fill has been constructed as specified in the minimum design approved by the Division. The reports will include a description of any appearances of instability, structural weakness and other hazardous conditions observed during the inspection.

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4.10 – 4.12 COAL MINE WASTE BANKS, COAL MINE WASTE, SLIDES AND OTHER DAMAGE

These sections are addressed in Volume 1.

4.13 CONTEMPORANEOUS RECLAMATION

All reclamation efforts, including backfilling, grading, topsoil replacement and revegetation of land disturbed by the mining activities in the Collom pit shall occur as contemporaneously as practicable with mining operations. Implementation of the reclamation plan, as described in Section 2.05.4, will assure that each step in the reclamation process is completed in a timely manner. Colowyo is formally requesting a variance for a delay in contemporaneous reclamation in the Collom Pit mining areas as the requirements listed in Rule 4.14.1(1)(d) are unachievable.

The sequence for reclamation following the mining process is shown on Map 29B (Spoil Grading – Collom). Final reclamation of the Collom Pit will continue through 2033. An excess overburden pile (out of pit) will be needed during the initial years of mining to establish the initial boxcut configuration for the Collom Pit. Full establishment of the Collom Pit Boxcut should occur approximately five years after mining is initiated and backfilling activities will begin during that timeframes illustrated on Map 29B. At that time, spoil regrading and subsequent reclamation activities will accelerate. As activities progress, a sufficient volume of backfill void will be created, and the Collom Pit should reach a steady state of operation where the advancing overburden face moves southward at the same rate as the advancing backfilling benches. The excess overburden pile is expected to remain in place until the final years of mining activities. At that time, this material will be needed to fill the final pit void.

Colowyo is currently targeting multiple coal seams in the box cut area and a single seam outside the box cut area. Because of the multi-seam nature of the mining operation described in Section 2.05, backfilling and grading cannot be completed within 180 days following coal removal within the boxcut area. Backfilling and grading will be completed in variance of the 180 day requirement in a manner previously approved and described below, and in Sections 2.05 and 4.14.1. A series of benches will be necessary in the operation to recover the lower coal seams, and an additional series of benches will be necessary to dump the shovel/truck overburden material in a configuration that achieves the topography shown on the post-mining Topography Map (Map 19C). When multi-seams are mined, backfilling and rough grading cannot begin until the lower-most seam is mined. See Spoil Grading Map (Map 29B), which shows the time frames in which grading will occur in relation to the mine plan (Map 23B). Further, highwall mining is planned to occur with the center portion of the Collom Pit, and that area needs to remain free of backfill and grading until highwall mining is completed.

As mining progresses to the south, overburden material from each successive cut will be backfilled into the previously mined out area if space is available and the additional spoil will continue to buildup in previously mined areas. Initially an excess out of pit spoil pile will be created to the north of the Collom Pit and will remain in place until the end of mine life.

The backfilled mining areas will be graded to establish a stable post mine topography that blends into the undisturbed areas outside the mining limits (Map 19C). Colowyo will grade all final slopes so that overall grades do not exceed 3H:1V (Map 20C).

Where necessary, the regraded spoil surface will be roughened by ripping or discing etc., to ensure a bond between the topsoil and spoil to reduce slippage and to allow vegetative root penetration. To date there is no evidence of topsoil slippage on reclaimed areas in the existing permit area. A few small tension cracks

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resulting from settling of fill and topsoil have occurred in a few areas within a year or two after reclamation, but soon stabilize and begin to fill in.

The final surface as shown on the Post-mining Topography Map (Map 19C) will approximate the overall pre-mining grades. Appropriate cross sections that show the anticipated final surface configuration of the Collom mining area, in conjunction with the existing pre-mining topography, are shown on the Pre-mining and Post-mining Cross Section (Map 20C).

The regrading plan reestablishes escape cover, south facing slopes for wintering big game populations and small drainages suitable as future location of stockponds necessary to achieve the post-mining land use.

Revegetation will commence as soon as the topsoil has been redistributed and prepared for seeding as described in Section 2.05.4. The area will be seeded with the seed mixture described in Section 2.05.4 as quickly as possible, typically in the fall of each year following topsoil placement activities.

4.14 BACKFILLING AND GRADING

4.14.1 General Requirements

The mining operations of Colowyo will not employ the use of contour mining methods.

The original permit demonstrates that Colowyo does not have thin or thick overburden as defined in Subsection 4.14.4 or Subsection 4.14.5.

The mining plan, as described in Section 2.05.3, maximizes coal conservation and recovery while minimizing adverse environmental impacts. Because of the mining configuration planned by Colowyo, an exemption from the 180 day or four spoil ridge limitations has been formally requested. The mining plan has been designed as a continuously-moving open pit operation with the mine advancing in the up dip (north to south) direction. The mining operation will progress in a southward direction with shovels/trucks proceeding along the entire length of the mining area (Map 23B). With the numerous benches used in an open pit operation, the mine area will be opened for some time until the equipment comes back to initiate another pass on a designated bench.

As the mining operations remove coal seams, the mining area must be left open until such time as the lower-most coal seam can be recovered. With the mining configuration, the time differences between mining the upper-most seam versus the lower-most seam may be greater than 180 days. As the operation advances, backfilling will be as contemporaneous as practical but not so as to interfere with removal of the lower-most coal seam. Colowyo will rough backfill and grade as shown on the Map 29B – Spoil Grading. All disturbed areas may be returned to the appropriate final contour by grading and backfilling with the use of a dragline, trucks, dozers, and scrapers. Additional detail of the backfilling and grading for the mining operation is set forth in the discussion under Sections 2.05.3 and 2.05.4.

The area to be mined will be restored to a topography approximating pre-mining grades. The slopes of backfilled areas, as necessary, will utilize contour furrows, surface roughening, and cross ripping for erosion control and stability. Where applicable, Colowyo will retain all overburden and spoil on the solid portion of existing benches. The final graded slopes will not exceed the approximate original pre-mining slope grade as shown on the Map 19C – Post Mining Topography. Post-mining surface drainage channels will be located to minimize erosion and to minimize slippage.

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4.14.2 General Grading Requirements

The final graded slopes at the mining operation will not exceed the approximate original pre-mining slope grade as shown on Map 19C. Colowyo will retain all overburden and spoil material on solid portions of existing or new benches. The final bench at the terminus of the operation will be eliminated by backfilling overburden into the final pit area.

Final grading before topsoil placement will be conducted in a manner that minimizes erosion and provides a surface for the topsoil that minimizes slippage. Final grading will be accomplished so that overall grades will not exceed 1v:3h. The plan for backfilling and grading is shown graphically on the Map 29B.

4.14.3 Covering Coal and Acid and Toxic Forming Materials

Colowyo will not have any exposed coal seams remaining at the end of mining and reclamation. Colowyo does not have any acid forming materials at the mine. For discussion on acid and toxic-forming materials, refer to Section 2.04.6. For disposal of non-coal wastes or materials constituting a fire hazard, refer to Section 4.11.4.

4.14.4 Thin Overburden

Colowyo does not have a thin overburden situation as defined in Section 4.14.4 of the regulations.

4.14.5 Thick Overburden

Colowyo does not have a thick overburden situation as defined in Section 4.14.5 of the regulations.

4.14.6 Re-grading or Stabilizing Rills and Gullies

Please see Section 4.14.6 in Volume 1.

4.15 REVEGETATION REQUIREMENTS

Please refer Volume 1, Section 4.15 for revegetation requirements for the Collom area.

4.16 POSTMINING LAND USE

4.16.1 General

Please refer to Volume 1, Section 4.16.

4.17 AIR RESOURCES PROTECTION

Please see Section 2.05.6 in Volume 1.

4.18 PROTECTION OF FISH, WILDLIFE, AND RELATED VALUES

Current and historical mitigation efforts, protection efforts, and habitat improvement plans are discussed in Colowyo's existing permit and Section 2.05.4. Most of these efforts have been targeted at Greater Sage-Grouse, mule deer, elk, and raptors.

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As discussed in Section 2.04.11(4), it is unlikely that any threatened or endangered species occur in the Collom permit expansion area disturbance. No designated critical habitat for any species is known to exist in the permit expansion area. Golden eagles are known to nest in the permit expansion area, but the nests are located outside the area to be mined. No bald eagles are known to nest in or near the permit expansion area. Golden eagle nests and nests used by other raptor species are described in Section 2.04.11. There were eight nests used by raptor species other than golden eagles that were located within the permit expansion area. Two of these nests have recently been active (in 2006 or 2007), and were used by the long-eared owl and Cooper's hawk.

As described in Section 2.04.11(1-3), two Greater Sage-Grouse and two Columbian sharp-tailed grouse lek sites would be impacted by mining disturbances. Based on the survey information captured and discussed previously in this submittal, the impact to the overall grouse populations in the area can reasonably be described as minor. Habitat mitigation measures for sage-grouse populations displaced during mining are discussed in Section 2.04.11(4), 2.05.4, 2.05.6(2). The locations of possible raptor nesting sites within the Collom expansion area disturbance boundary have also been included on the map. Based on the language provided within the Environmental Assessment for securing the Collom Lease Tract COC-68590, Colowyo will relocate these structures to a nearby area not targeted for disturbance. Based on the survey work previously referenced in this submittal, the sites targeted for direct impact by mining are not being heavily utilized by raptors at this time. This Map also identifies the location of habitat enhancement "stockponds" that will facilitate additional opportunities for all wildlife species.

Section 4.18 in Volume 1 discusses electric power line and transmission facility construction guidelines for retrofitting of existing power poles to protect raptors. Colowyo has implemented these raptor protection measures in the Colowyo existing permit area and will also implement them in the Collom permit expansion area. Because many raptor species are predators of the Greater Sage-Grouse and Colombian shap-tailed grouse, specific restorative and enhancement activities are purposefully not being pursued beyond the protective measures described above with respect to electrical structures. Enhancement of raptor habitat in the Collom expansion area would likely lead to a lower probability of successful resumption of grouse activity post-mining.

As described in Section 2.05.6(2) in Volume 1, all disturbed acreage, including roads, have been kept to a minimum by proper planning to reduce impacts to all environmental resources, including impacts on wildlife.

As part of the plan to return the post-mining land use to a rangeland condition capable of supporting the diverse wildlife populations identified in the permit areas, Colowyo initiated efforts to restore wildlife habitats during pre-mine planning and early mining. This was accomplished by conducting an extensive four year study to assist in determination of the best techniques for revegetating disturbed areas with native species to enhance wildlife habitat. In addition, Colowyo implemented a habitat improvement program in 1975 to offset temporary habitat loss during mining. The reestablishment of herbaceous species, topographic relief, impoundments and limited reestablishment of a shrub component form the integral elements of the reclamation plan.

Sagebrush steppe reclamation areas specifically target sage-grouse habitat is described in Section 2.05.4.(2)(e). These areas will also serve as enhanced habitat for many other species, including mule deer and elk. Grassland reclamation areas specifically target livestock grazing but the seed mix and reclamation plan focus on ensuring plant species beneficial to wildlife will prosper as well. The nutritional value of both plant communities targeted for establishment on reclaimed lands in the Collom expansion area should be enhanced as compared to pre-mining condition based especially on increased forage availability and diversity (for both livestock and wildlife species).

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To date, reclamation efforts at the existing operation have proven successful. Herds of deer and elk are regularly seen grazing on the reclaimed areas. Rodent and small game populations have reestablished on the reclaimed areas providing a readily available food source for local raptor populations and other predators. Columbian sharp-tailed grouse also use reclaimed grasslands.

Public Land Survey Protection

Colowyo will protect all survey monuments, witness corners, reference monuments, and bearing trees against destruction, obliteration, or damage during mining operations. Any monuments, corners or accessories that are removed by the mining process, Colowyo will hire an appropriate county surveyor or registered land surveyor to reestablish or restore the monuments, corners, or accessories at the same locations, using the surveying procedures in accordance with the “Manual of Surveying Instructions for the Survey of the Public Lands of the United States.” The survey will be recorded in the appropriate county records, with a copy sent to the Authorized Officer.

4.19 PROTECTION OF UNDERGROUND MINING

Colowyo will conduct no coal mining closer than 500 feet to any point of either an active or abandoned underground mine. Underground coal mines have been operated in the past as discussed in Section 2.04.4, but their locations were on the-northern side of Streeter Draw well over 500 feet from present Colowyo mining.

The surface mining activities of Colowyo have been designed so as not to endanger any present or future operations of either surface or underground mining operations. As discussed in Section 2.05.3, Colowyo has engineered its mining plan to maximize recovery of coal by current economical surface mining methods.

4.20 SUBSIDENCE CONTROL

Colowyo is conducting a surface coal mining operation. Therefore, the requirements of 4.20 are not applicable to the Colowyo operation.

4.21 COAL EXPLORATION

All coal exploration activities within the Collom permit revision area will be completed in accordance with the requirements and procedures outlined in the Volume 1.

4.22 CONCURRENT SURFACE AND UNDERGROUND MINING

Colowyo does not plan to have concurrent surface or underground mining activities; therefore, the requirements of this Section are not applicable to this permit application.

4.23 AUGER AND HIGHWALL MINING

4.23.1 Scope

Highwall mining allows for the recovery of additional coal resources beyond the final pit highwalls and endwalls. Colowyo’s has previously effectively highwall mined in the East, Section 16, West, and South Taylor Pits in the past. Colowyo will utilized the vast experience gained from previous highwall mining and implement a highwall mining plan in the Collom Pit. Please see Section 2.06.9 and Map 23B for the seams and areas planned to be highwall mined.

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From a surface mining perspective, the Collom Pit delineates the maximum recoverable coal resources permitted by this mining permit for Colowyo to mine. Highwall mining in the Collom Pit will allow for maximum recovery in accordance with Rule 4.23.2(1). Please refer to Sections 2.06.9 in Volume 1 for additional discussion regarding the removal of coal using highwall mining methods.

4.23.2 Performance Standards

4.23.2(1) Undisturbed Areas of Coal Shall be Left in Unmined Sections

As for the rules requirements [Rules 4.23.2(1)(a)-(c)] for leaving undisturbed areas of coal in unmined sections, Colowyo requests a variance from the requirements of this rule for the Collom Pit. Colowyo's highly successful highwall mining methods that will be used in the Collom Pit, will maximize production and ensure no subsidence occurs. Using this particular method of highwall mining by leaving pillars and barriers allows the seams to be mined below each other and still ensures geologic stability once all seams have been mined out. Please see Exhibit 27, Item 6 and Item 7 in Volume 20 for further discussion on the geotechnical design and operational considerations implemented highwall mining the Collom Pit.

4.23.2(2) Abandoned or Active Underground Mine Workings

No abandoned or active underground mine workings have ever existed or currently exist anywhere near the Collom Pit. Therefore, in accordance with Rule 4.23.2(2), no highwall mining activities will occur closer than 500 feet in horizontal distance of any underground mining workings.

4.23.2(3) Contemporaneous Surface and Auger (Highwall) Mining

Highwall mining will follow the surface coal mining activities in a top-down sequence in the Collom Pit. Highwall mining has to occur as contemporaneous as possible behind surface mining to ensure further advancement of the Collom box cut is not hindered by highwall mining operations. When surface mining opens up a large enough area in the Collom Pit, highwall mining will commence shortly thereafter. As the Collom Pit is advanced, highwall mining will follow as soon as is practical, and will be timed appropriately with continued surface mining operations.

4.23.2(4) Prevention of Pollution of Surface and Ground Water and Fire Hazards

Each highwall mining hole will be plugged within 30 days following coal extraction to prevent discharge of water from the hole or access of air to the coal seam inside the highwall miner hole in accordance with Rule 4.23.2(4)(b). Typically, highwall miner holes will be sealed much sooner than 30 days, but to ensure operational flexibility and compliance with Rule 4.23.4(4) a hole may need to remain open up to 30 days.

Groundwater flow regimes and the negligible impact that Colowyo's surface mining activities have on ground water as a result of mining these target coal seams are detailed extensively in Section 2.04.7(1) and 2.05.6(3)(b)(i & ii). From this body of data and from experiences to date with past highwall mining activities, no toxic forming or acid forming water discharge is anticipated from any of the highwall openings. Should toxic forming or acid forming water discharges be encountered, the opening exhibiting the discharge will be backfilled within 72 hours of completion.

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4.23.2(5) Holes Not Need to be Plugged

Colowyo will backfill and plugge each highwall miner entrance hole. As required, this will occur within 30 days following coal extraction. Further, all highwall miner entrance holes will be buried by pit backfill during the normal backfill sequence for the pit to remain in compliance with Rules 4.05.1 and 4.05.2.

4.23.2(6) Division Shall Prohibit Auger (Highwall) Mining

There is no probable reason to prohibit the highwall mining in light of no anticipated adverse impacts to water quality, fill stability, pit backfilling, increased resource recovery, and highwall mining is designed for zero subsidence to prevent disturbance or damage to power lines, buildings, or other surface facilities.

4.23.2(7) Backfill and Grading Requirements

Highwall mining will be conducted in accordance with the backfilling and grading requirements of 4.14.

4.24 OPERATIONS IN ALLUVIAL VALLEY FLOORS

The field investigation described in Section 2.04.7 and 2.06.8 resulted in no identification of alluvial valley floors in the general mining area which would be adversely affected by mining operations; therefore, no special performance standards for operations in the alluvial valley floors are applicable to this mining permit application, and no protection or remedial measures are proposed for compliance to this Section.

4.25 OPERATIONS ON PRIME FARMLANDS

Since a negative determination of prime farmland was arrived at using the eligibility requirements established for prime farmland under Section 2.04.12, these performance standards do not apply to the present permit application.

4.26 MOUNTAINTOP REMOVAL

Based on the present data, no determination of mountain top removal has been made. When available, the pertinent data will be delivered to the Division for a determination.

4.27 OPERATIONS ON STEEP SLOPES

Mining and reclamation activities for the Collom operation will generally occur on slopes that are less than 20 degrees. On occasion, in limited areas, operations will occur on slopes greater than 20 degrees. In accordance in Rule 4.27.2, operations can occur occasionally on steep slopes and the requirements of Rule 4.27 do not apply. The Collom operations meet this definition.

4.28 FACILITIES NOT LOCATED AT THE MINESITE

All facilities used by Colowyo will be within the current permit boundary. Therefore, this section is not applicable.

4.29 IN SITU PROCESSING

This section is not applicable.

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4.30 CESSATION OF OPERATIONS

4.30.1 Temporary

If, for any unforeseeable circumstances, temporary cessation of mining and reclamation operations at the Colowyo operation becomes necessary for a period of thirty (30) days or more, Colowyo will submit to the Division a notice of intention to temporarily cease or abandon mining and reclamation activities. This notice will include a statement of the exact number of acres that will have been affected in the permit area prior to temporary cessation and an identification of back filling, regrading, revegetation, environmental monitoring, and water treatment activities that will continue during temporary cessation.

4.30.2 Permanent

At the permanent conclusion of surface mining operations, Colowyo will close, backfill, or otherwise permanently reclaim all affected areas. The reclamation plans are set forth in Section 2.05.5. The projected post-mining topography is set forth on the Post-mining Topography map (Map 19C).

Colowyo will remove any equipment, structures, or other facilities at the conclusion of mining activities and will reclaim the affected land. Structures that are identified by the landowner to be necessary to conduct post mining activities will be designated at the time of final bond release.

LIST OF EXHIBITS – VOLUME 18B

Exhibit 7 Item 23 Part A Clean Water Diversions

Exhibit 7 Item 23 Part B Section 25 Pond Sediment Control During Mining

Exhibit 7 Item 23 Part C Section 26 Pond Sediment Control During Mining

Exhibit 7 Item 23 Part D Access Roads

Exhibit 7 Item 23 Part F Geotechnical Investigation Collom Sediment Ponds

Exhibit 7 Item 23 Part G Perimeter Sediment Control During Mining

Exhibit 7 Item 23 Part I Section 25 Pond Sediment Post Mining

Exhibit 7, Item 23, PART B
Section 25 Pond Sediment Control During Mining

Introduction

Exhibit 7, Item 14 in Volume 2D describes the hydrologic methodology used in sediment pond, permanent post-mine channels, and temporary conveyance channel demonstrations. Runoff curve numbers assigned to the undisturbed and/or reclaimed lands in various stages of mining and reclamation have been selected in accordance with Table 1 in the Introductory Text for Exhibit 7 in Volume 2D or as further described below. For channels protected by a riprap liner, selection of minimum riprap size is done using the Simons/OSM method in SEDCADTM. For channels to be protected by a vegetative liner, the permissible velocities are also determined using SEDCADTM routines.

SEDCADTM demonstrations with two distinct time frames have been evaluated in detail for the Section 25 Pond. Exhibit 7, Item 23, Parts I addresses sediment control for the Section 25 Pond during the post mining timeframe including post mine drainage channels.

This exhibit (Exhibit 7, Item 23, Part B) address sediment control during the mining timeframe for the Section 25 Pond and provides a demonstration for a temporary channel configuration (D-3 Ditch). The assumed condition during mining is the temporary spoil pile is constructed to its maximum configuration and the entire area from the temporary spoil pile and native areas below are reporting to the Section 25 Pond.

Based on recommendations provided in a February 2015 telephone conversation with Dr. Richard Warner of the University of Kentucky Biosystems and Agricultural Engineering Department, and a coauthor of the SEDCADTM Design Manual and User's Guide, the "Cover Factor" appropriate for loose dumped spoil is between 0.40 and 0.45. The higher value was conservatively selected for use in this analysis. When advised that we are using curve number of 74 for runoff from loose dumped spoils, as per the approved Introductory Text of Volume 2D, Dr. Warner pointed out that a value of 74 is probably an overly conservative number, and a value on the order of 65 would be more appropriate based on his experience and measurements made over the years at numerous coal mines. A curve number of 74 was nevertheless used for spoil piles in the SEDCADTM modeling included in this submittal.

Selection of SEDCADTM input parameters L and S which are needed for sediment generation in the sedimentation evaluation analysis are selected on a case basis for each subwatershed. The MUSLE (Modified Soil Loss Equation) is used to estimate sediment generation at the source. Selection of the parameters R, K, LS C and P is described in the literature. LS is derived via an equation that includes a "length" parameter "L", and a "slope" parameter "S". However, LS is not the simple product of those two terms. Both "L" and "S" are based on the topography of the subwatershed in question with certain limitations provided in the literature as well as SEDCADTM users' training courses. First a representative slope is determined from the topography, and this sets the parameter "S". The "length" parameter "L" is more complicated as it represents the longest slope that water will have to flow before encountering a concentration point, such as a rivulet of a distinct slope change. SEDCADTM instructors advise that regardless of the topography, "L" can ever practicably exceed about 200 feet.

The selection of "L" and "S" for input into the SEDCAD™ model for the near repose angle slopes of a benched spoil pile is also complex. The values of 145 feet for "L" and 31% for "S" were selected for the dumped spoil pile lifts to approximate the combined LS factor that would apply to a compound slope, in this case a concave slope with a very steep (repose angle) upper part and a very flat lower part (bench). SEDCAD™ cannot handle a compound slope directly, but a method to do so is described in Chapter 5 of "Hydrology and Sedimentology for Disturbed Areas" by Barfield, Warner and Haan, 1981. The method uses the original 1965 Wischmeier and Smith USDA Handbook No. 282 formula, then adjusts each segment with a factor, and finally provides a weighted average for the compound slope.

The above-described method was applied to a 65 foot upper segment at repose angle (77%) followed by an 85 foot flat bench at 1%, resulting in a weighted average LS of 9.0. Several possible combinations of a single L and a single S were then examined for input into SEDCAD™ to arrive at a similar LS factor. It was found that a single line with L of 145 feet with a drop of 45 feet, producing a S of 31% produces a LS of 10.1, which is slightly higher than the calculated value of 9.0 for the actual compound slope. That line also happens to be close to a simple straight line from the crest of one bench to the crest of the next one lower down the face, so it has some physical relevance to the actual spoil pile face. The L and S of 145 feet and 31%, producing a LS factor about 12% greater than the actual compound concave slope calculated were then conservatively used in the modeling of all spoil pile faces.

Section 25 Pond – During Mining

The location of the Section 25 Pond and its watershed is presented on Map 41B. The temporary channel (D-3 Ditch) that might route water to the Section 25 Pond is presented on 41B.

The as-built configuration for the Middle Pond is presented on Figure 7-23I-1, the as-built configuration for the Section 36 Pond is presented on Figure 7-23I-2, and as-built configuration for the Section 25 Pond is presented on Figure 7-23I-3. Figure 7-23B-1 provides the breakdown of drainage areas and hydrologic conditions for all areas in the watershed reporting to these three sediment ponds during mining. The Middle and Section 36 Ponds are part of the Section 25 Pond sediment control system and are utilized to reduced peak flows and provide additional sediment storage if need. All discharges from the Middle and Section 36 Ponds flow directly to the Section 25 Pond through natural channels, and the Section 25 Pond is the final discharge location.

The SEDCAD™ model herein provides the results of the 10-year 24-hour design storm and demonstrates the Section 25 Pond will meet the applicable settleable solids standard under this modeled storm event. The second SEDCAD™ model demonstrates that the Section 25 Pond emergency spillway elevation is capable of containing the 25-year 24-hour storm.

In summary, for the mining case at the Section 25 Pond, the 10-year 24-hour storm produces 9.1 acre feet of runoff, and the peak settleable solids concentration is 0.00 ml/l. The 25-year 24-hour storm event peaks at the 6,987.04 elevation, which is right at the emergency spillway elevation of 6,986.0'

Temporary Channels

The Section 25 Pond watershed is comprised of one temporary channels the D-3 Ditch. The configuration for this ditch is include in the Section 26 Pond 10-Year, 24-Hour During Mining Storm Event Demonstration and is further outlined as described in the following table:

Ditch Name	Flow, Q	Slope, %	Type	Specified Depth	Bottom Width	Side Slope, H:1V	Rip Rap, D50, in
D-3 Ditch	0.02	16.1%	Riprap	4.0	12.0	2.0	6.0

Section 25 Pond **Effluent Demonstration During Mining**

10-Year 24-Hour Storm Event

Tony Tennyson

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General Information

Storm Information:

Storm Type:	NRCS Type II
Design Storm:	10 yr - 24 hr
Rainfall Depth:	1.800 inches

Particle Size Distribution:

Size (mm)	Colowyo Particle Size
4.7500	100.000%
0.0750	73.000%
0.0400	33.000%
0.0010	20.000%

Structure Networking:

Type	Stru #	(flows into)	Stru #	Musk. K (hrs)	Musk. X	Description
Null	#1	==>	End	0.000	0.000	Null Below Section 25 Pond
Pond	#2	==>	#1	0.000	0.000	Section 25 Pond
Channel	#3	==>	#2	0.000	0.000	Little Collom Gulch Natural Channel
Null	#4	==>	#3	0.000	0.000	Null at Confluence D-3 Ditch and Little Collom Gulch
Channel	#5	==>	#4	0.000	0.000	D-3 Ditch
Channel	#6	==>	#2	0.000	0.000	Natural Channel Below Middle Pond
Null	#7	==>	#6	0.000	0.000	Null at Outlet of Middle Pond
Pond	#8	==>	#7	0.000	0.000	Middle Pond
Channel	#9	==>	#8	0.000	0.000	Natural Channel Middle Pond to Section 36 Pond
Pond	#10	==>	#9	0.000	0.000	Section 36 Pond
Channel	#11	==>	#10	0.000	0.000	Natural Channel Section 36 Pond to Culvert 44A
Culvert	#12	==>	#11	0.000	0.000	Culvert 44A
Null	#13	==>	#12	0.000	0.000	Null at Confluence of Culverts 62 and 63
Culvert	#14	==>	#15	0.000	0.000	Culvert 62
Channel	#15	==>	#12	0.000	0.000	Natural Channel within Disturbed Area to Culvert 44A
Culvert	#16	==>	#13	0.000	0.000	Culvert 63
Culvert	#17	==>	#16	0.000	0.000	Culvert 66
Channel	#18	==>	#16	0.000	0.000	Road Ditch from Culvert 66 to Culvert 63
Channel	#19	==>	#17	0.000	0.000	Road Ditch to Culvert 66
Null	#20	==>	#18	0.000	0.000	Null out Outlet of Culvert 65
Culvert	#21	==>	#20	0.000	0.000	Culvert 65
Channel	#22	==>	#21	0.000	0.000	Road Ditch to Culvert 65
Null	#23	==>	#22	0.000	0.000	Null Below Culvert 67
Culvert	#24	==>	#23	0.000	0.000	Culvert 67
Channel	#25	==>	#24	0.000	0.000	Road Ditch to Culvert 67
Channel	#26	==>	#3	0.000	0.000	Natural Sorted Ditch at Toe of Temp Spoil Pile
Null	#27	==>	#26	0.000	0.000	Null Below Culvert 70
Culvert	#28	==>	#27	0.000	0.000	Culvert 70
Channel	#29	==>	#28	0.000	0.000	Haul Road Ditch to Culvert 70
Null	#30	==>	#29	0.000	0.000	Null below Culvert 69
Culvert	#31	==>	#30	0.000	0.000	Culvert 69
Channel	#32	==>	#31	0.000	0.000	Road Ditch to Culvert 69
Null	#33	==>	#32	0.000	0.000	Null below Culvert 68
Culvert	#34	==>	#33	0.000	0.000	Culvert 68
Channel	#35	==>	#34	0.000	0.000	Natural Channel to Culvert 68

	#14 Culvert	
	#15 Chan'l	
		#23 Null
		#22 Chan'l
		#21 Culvert
		#20 Null
		#18 Chan'l
		#19 Chan'l
		#17 Culvert
		#16 Culvert
		#13 Null
		#12 Culvert
		#11 Chan'l
		#10 Pond
		#9 Chan'l
		#8 Pond
		#7 Null
		#6 Chan'l
		#35 Chan'l
		#34 Culvert

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#33 Null
#32 Chan'l
#31 Culvert
#30 Null
#29 Chan'l
#28 Culvert
#27 Null
#26 Chan'l
#5 Chan'l
#4 Null
#3 Chan'l
#2 Pond
#1 Null

Structure Summary:

	Immediate Contributing Area (ac)	Total Contributing Area (ac)	Peak Discharge (cfs)	Total Runoff Volume (ac-ft)	Sediment (tons)	Peak Sediment Conc. (mg/l)	Peak Settleable Conc. (ml/l)	24VW (ml/l)
#14	50.700	50.700	1.39	0.12	27.1	334,377	190.58	86.31
#15	66.800	117.500	35.99	3.24	566.1	224,596	122.31	65.42
#25	4.400	4.400	3.21	0.24	37.1	208,518	118.85	61.15
#24	0.000	4.400	3.21	0.24	37.1	208,518	118.85	61.15
#23	0.000	4.400	3.21	0.24	37.1	208,518	118.85	61.15
#22	24.800	29.200	12.47	1.05	122.8	166,701	92.07	45.22
#21	0.000	29.200	12.47	1.05	122.8	166,701	92.07	45.22
#20	0.000	29.200	12.47	1.05	122.8	166,701	92.07	45.22
#18	4.200	33.400	15.53	1.28	151.5	160,691	89.29	46.13
#19	13.000	13.000	4.41	0.39	68.9	228,801	123.69	65.52
#17	0.000	13.000	4.41	0.39	68.9	228,801	123.69	65.52
#16	0.000	46.400	19.60	1.67	220.4	184,350	101.57	50.73
#13	0.000	46.400	19.60	1.67	220.4	184,350	101.57	50.73
#12	0.000	163.900	53.77	4.91	786.5	214,135	117.00	60.47
#11	27.700	191.600	57.08	5.19	788.8	211,652	115.66	57.56
#10 In	0.000	191.600	57.08	5.19	788.8	211,652	115.66	57.56
Out			16.48	5.18	0.0	1	0.00	0.00
#9	0.000	191.600	16.48	5.18	0.0	1	0.00	0.00
#8 In	19.600	211.200	16.48	5.18	0.0	1	0.00	0.00
Out			11.56	5.16	0.0	1	0.00	0.00
#7	0.000	211.200	11.56	5.16	0.0	1	0.00	0.00
#6	79.900	291.100	11.77	5.44	5.1	24,377	13.89	0.50
#35	7.800	7.800	1.68	0.12	14.6	160,804	91.65	46.91
#34	0.000	7.800	1.68	0.12	14.6	160,804	91.65	46.91
#33	0.000	7.800	1.68	0.12	14.6	160,804	91.65	46.91
#32	9.900	17.700	4.74	0.35	49.2	188,940	107.69	55.29
#31	0.000	17.700	4.74	0.35	49.2	188,940	107.69	55.29
#30	0.000	17.700	4.74	0.35	49.2	188,940	107.69	55.29
#29	6.900	24.600	7.80	0.58	91.6	211,642	120.63	62.10
#28	0.000	24.600	7.80	0.58	91.6	211,642	120.63	62.10
#27	0.000	24.600	7.80	0.58	91.6	211,642	120.63	62.10
#26	96.900	121.500	44.20	3.25	2,079.8	753,468	429.45	215.36
#5	14.800	14.800	0.02	0.01	0.1	4,228	2.41	1.60
#4	0.000	14.800	0.02	0.01	0.1	4,228	2.41	1.60
#3	186.300	322.600	49.70	3.66	2,089.4	695,730	396.54	195.64
#2 In	0.000	613.700	53.58	9.10	2,094.5	659,524	375.91	94.74
Out			8.84	6.83	13.8	1,617	0.00	0.00
#1	0.000	613.700	8.84	6.83	13.8	1,617	0.00	0.00

Particle Size Distribution(s) at Each Structure***Structure #14 (Culvert 62):***

Size (mm)	In/Out
4.7500	100.000%
0.0750	73.000%
0.0400	33.000%
0.0010	20.000%

Structure #15 (Natural Channel within Disturbed Area to Culvert 44A):

Size (mm)	In/Out
4.7500	100.000%
0.0750	81.062%
0.0400	36.645%
0.0010	22.209%

Structure #25 (Road Ditch to Culvert 67):

Size (mm)	In/Out
4.7500	100.000%
0.0750	73.000%
0.0400	33.000%
0.0010	20.000%

Structure #24 (Culvert 67):

Size (mm)	In/Out
4.7500	100.000%
0.0750	73.000%
0.0400	33.000%
0.0010	20.000%

Structure #23 (Null Below Culvert 67):

Size (mm)	In/Out
4.7500	100.000%
0.0750	73.000%
0.0400	33.000%
0.0010	20.000%

Structure #22 (Road Ditch to Culvert 65):

Size (mm)	In/Out
4.7500	100.000%
0.0750	78.603%
0.0400	35.533%
0.0010	21.535%

Structure #21 (Culvert 65):

Size (mm)	In/Out
4.7500	100.000%
0.0750	78.603%
0.0400	35.533%
0.0010	21.535%

Structure #20 (Null out Outlet of Culvert 65):

Size (mm)	In/Out
4.7500	100.000%
0.0750	78.603%
0.0400	35.533%
0.0010	21.535%

Structure #18 (Road Ditch from Culvert 66 to Culvert 63):

Size (mm)	In/Out
4.7500	100.000%
0.0750	77.541%
0.0400	35.053%
0.0010	21.244%

Structure #19 (Road Ditch to Culvert 66):

Size (mm)	In/Out
4.7500	100.000%

Size (mm)	In/Out
0.0750	82.323%
0.0400	37.215%
0.0010	22.554%

Structure #17 (Culvert 66):

Size (mm)	In/Out
4.7500	100.000%
0.0750	82.323%
0.0400	37.215%
0.0010	22.554%

Structure #16 (Culvert 63):

Size (mm)	In/Out
4.7500	100.000%
0.0750	79.037%
0.0400	35.729%
0.0010	21.654%

Structure #13 (Null at Confluence of Culverts 62 and 63):

Size (mm)	In/Out
4.7500	100.000%
0.0750	79.037%
0.0400	35.729%
0.0010	21.654%

Structure #12 (Culvert 44A):

Size (mm)	In/Out
4.7500	100.000%
0.0750	80.495%
0.0400	36.388%
0.0010	22.053%

Structure #11 (Natural Channel Section 36 Pond to Culvert 44A):

Size (mm)	In/Out
4.7500	100.000%
0.0750	80.472%

Size (mm)	In/Out
0.0400	36.378%
0.0010	22.047%

Structure #10 (Section 36 Pond):

Size (mm)	In	Out
4.7500	100.000%	100.000%
0.0750	80.472%	100.000%
0.0400	36.378%	100.000%
0.0010	22.047%	100.000%

Structure #9 (Natural Channel Middle Pond to Section 36 Pond):

Size (mm)	In/Out
4.7500	0.000%
0.0750	0.000%
0.0400	0.000%
0.0010	0.000%

Structure #8 (Middle Pond):

Size (mm)	In	Out
4.7500	0.000%	100.000%
0.0750	0.000%	100.000%
0.0400	0.000%	100.000%
0.0010	0.000%	92.060%

Structure #7 (Null at Outlet of Middle Pond):

Size (mm)	In/Out
4.7500	0.000%
0.0750	0.000%
0.0400	0.000%
0.0010	0.000%

Structure #6 (Natural Channel Below Middle Pond):

Size (mm)	In/Out
4.7500	100.000%
0.0750	73.000%
0.0400	33.000%

Size (mm)	In/Out
0.0010	20.000%

Structure #35 (Natural Channel to Culvert 68):

Size (mm)	In/Out
4.7500	100.000%
0.0750	73.000%
0.0400	33.000%
0.0010	20.000%

Structure #34 (Culvert 68):

Size (mm)	In/Out
4.7500	100.000%
0.0750	73.000%
0.0400	33.000%
0.0010	20.000%

Structure #33 (Null below Culvert 68):

Size (mm)	In/Out
4.7500	100.000%
0.0750	73.000%
0.0400	33.000%
0.0010	20.000%

Structure #32 (Road Ditch to Culvert 69):

Size (mm)	In/Out
4.7500	100.000%
0.0750	73.000%
0.0400	33.000%
0.0010	20.000%

Structure #31 (Culvert 69):

Size (mm)	In/Out
4.7500	100.000%
0.0750	73.000%
0.0400	33.000%
0.0010	20.000%

Structure #30 (Null below Culvert 69):

Size (mm)	In/Out
4.7500	100.000%
0.0750	73.000%
0.0400	33.000%
0.0010	20.000%

Structure #29 (Haul Road Ditch to Culvert 70):

Size (mm)	In/Out
4.7500	100.000%
0.0750	73.000%
0.0400	33.000%
0.0010	20.000%

Structure #28 (Culvert 70):

Size (mm)	In/Out
4.7500	100.000%
0.0750	73.000%
0.0400	33.000%
0.0010	20.000%

Structure #27 (Null Below Culvert 70):

Size (mm)	In/Out
4.7500	100.000%
0.0750	73.000%
0.0400	33.000%
0.0010	20.000%

Structure #26 (Natural Sorted Ditch at Toe of Temp Spoil Pile):

Size (mm)	In/Out
4.7500	100.000%
0.0750	73.000%
0.0400	33.000%
0.0010	20.000%

Structure #5 (D-3 Ditch):

Size (mm)	In/Out
4.7500	100.000%
0.0750	73.000%
0.0400	33.000%
0.0010	20.000%

Structure #4 (Null at Confluence D-3 Ditch and Little Collom Gulch):

Size (mm)	In/Out
4.7500	100.000%
0.0750	73.000%
0.0400	33.000%
0.0010	20.000%

Structure #3 (Little Collom Gulch Natural Channel):

Size (mm)	In/Out
4.7500	100.000%
0.0750	73.000%
0.0400	33.000%
0.0010	20.000%

Structure #2 (Section 25 Pond):

Size (mm)	In	Out
4.7500	100.000%	100.000%
0.0750	73.000%	100.000%
0.0400	33.000%	100.000%
0.0010	20.000%	100.000%

Structure #1:

Size (mm)	In/Out
4.7500	100.000%
0.0750	100.000%
0.0400	100.000%
0.0010	100.000%

Structure Detail:***Structure #14 (Culvert)****Culvert 62*

Culvert Inputs:

Length (ft)	Slope (%)	Manning's n	Max. Headwater (ft)	Tailwater (ft)	Entrance Loss Coef. (Ke)
220.00	1.50	0.0150	5.00	0.00	0.90

Culvert Results:

Design Discharge = 1.39 cfs

Minimum pipe diameter: 1 - 8 inch pipe(s) required

Structure #15 (Erodible Channel)*Natural Channel within Disturbed Area to Culvert 44A*

Parabolic Erodible Channel Inputs:

Material: Shales and hardpans

Slope (%)	Manning's n	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)	Limiting Velocity (fps)
8.0	0.0250				6.0

Erodible Channel Results:

	w/o Freeboard	w/ Freeboard
Design Discharge:		35.99 cfs
Depth:		1.06 ft
Top Width:		4.23 ft
Velocity:		12.05 fps
X-Section Area:		2.99 sq ft
Hydraulic Radius:		0.605 ft
Froude Number:		2.53

Structure #25 (Erodible Channel)*Road Ditch to Culvert 67*

Triangular Erodible Channel Inputs:

Material: Shales and hardpans

Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Manning's n	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)	Limiting Velocity (fps)
1.5:1	1.5:1	8.0	0.0250				6.0

Erodible Channel Results:

	w/o Freeboard	w/ Freeboard
Design Discharge:	3.21 cfs	
Depth:	0.57 ft	
Top Width:	1.72 ft	
Velocity:	6.48 fps	
X-Section Area:	0.49 sq ft	
Hydraulic Radius:	0.239 ft	
Froude Number:	2.13	

Structure #24 (Culvert)
Culvert 67
Culvert Inputs:

Length (ft)	Slope (%)	Manning's n	Max. Headwater (ft)	Tailwater (ft)	Entrance Loss Coef. (Ke)
60.00	2.00	0.0150	5.00	0.00	0.90

Culvert Results:

Design Discharge = 3.21 cfs

Minimum pipe diameter: 1 - 10 inch pipe(s) required

Structure #23 (Null)
Null Below Culvert 67
Structure #22 (Erodible Channel)
Road Ditch to Culvert 65
Triangular Erodible Channel Inputs:

Material: Shales and hardpans

Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Manning's n	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)	Limiting Velocity (fps)
1.5:1	1.5:1	6.0	0.0250				6.0

Erodible Channel Results:

	w/o Freeboard	w/ Freeboard
Design Discharge:	12.47 cfs	
Depth:	1.01 ft	
Top Width:	3.02 ft	
Velocity:	8.18 fps	
X-Section Area:	1.52 sq ft	
Hydraulic Radius:	0.419 ft	
Froude Number:	2.03	

Structure #21 (Culvert)

Culvert 65

Culvert Inputs:

Length (ft)	Slope (%)	Manning's n	Max. Headwater (ft)	Tailwater (ft)	Entrance Loss Coef. (Ke)
60.00	2.00	0.0150	5.00	0.00	0.90

Culvert Results:

Design Discharge = 12.47 cfs

Minimum pipe diameter: 1 - 18 inch pipe(s) required

Structure #20 (Null)

Null out Outlet of Culvert 65

Structure #18 (Erodible Channel)

Road Ditch from Culvert 66 to Culvert 63

Triangular Erodible Channel Inputs:

Material: Shales and hardpans

Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Manning's n	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)	Limiting Velocity (fps)
1.5:1	1.5:1	7.0	0.0250				6.0

Erodible Channel Results:

	w/o Freeboard	w/ Freeboard
Design Discharge:	15.53 cfs	
Depth:	1.06 ft	
Top Width:	3.19 ft	
Velocity:	9.16 fps	
X-Section Area:	1.70 sq ft	
Hydraulic Radius:	0.442 ft	
Froude Number:	2.21	

Structure #19 (Erodible Channel)

Road Ditch to Culvert 66

Triangular Erodible Channel Inputs:

Material: Shales and hardpans

Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Manning's n	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)	Limiting Velocity (fps)
1.5:1	1.5:1	8.0	0.0250				6.0

Erodible Channel Results:

	w/o Freeboard	w/ Freeboard
Design Discharge:	4.41 cfs	
Depth:	0.65 ft	
Top Width:	1.94 ft	
Velocity:	7.03 fps	
X-Section Area:	0.63 sq ft	
Hydraulic Radius:	0.269 ft	
Froude Number:	2.18	

Structure #17 (Culvert)

Culvert 66

Culvert Inputs:

Length (ft)	Slope (%)	Manning's n	Max. Headwater (ft)	Tailwater (ft)	Entrance Loss Coef. (Ke)
80.00	2.00	0.0150	5.00	0.00	0.90

Culvert Results:

Design Discharge = 4.41 cfs

Minimum pipe diameter: 1 - 12 inch pipe(s) required

Structure #16 (Culvert)

Culvert 63

Culvert Inputs:

Length (ft)	Slope (%)	Manning's n	Max. Headwater (ft)	Tailwater (ft)	Entrance Loss Coef. (Ke)
180.00	1.50	0.0150	5.00	0.00	0.90

Culvert Results:

Design Discharge = 19.60 cfs

Minimum pipe diameter: 1 - 21 inch pipe(s) required

Structure #13 (Null)

Null at Confluence of Culverts 62 and 63

Structure #12 (Culvert)

Culvert 44A

Culvert Inputs:

Length (ft)	Slope (%)	Manning's n	Max. Headwater (ft)	Tailwater (ft)	Entrance Loss Coef. (Ke)
300.00	1.50	0.0150	5.00	0.00	0.90

Culvert Results:

Design Discharge = 53.77 cfs

Minimum pipe diameter: 1 - 36 inch pipe(s) required

Structure #11 (Vegetated Channel)

Natural Channel Section 36 Pond to Culvert 44A

Parabolic Vegetated Channel Inputs:

Material: Tall fescue

Slope (%)	Retardance Classes	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)	Limiting Velocity (fps)
12.9	D, B				5.0

Vegetated Channel Results:

	Stability Class D w/o Freeboard	Stability Class D w/ Freeboard	Capacity Class B w/o Freeboard	Capacity Class B w/ Freeboard
Design Discharge:	57.08 cfs		57.08 cfs	
Depth:	1.21 ft		1.49 ft	
Top Width:	4.85 ft		5.96 ft	
Velocity:	14.55 fps		9.63 fps	
X-Section Area:	3.92 sq ft		5.93 sq ft	
Hydraulic Radius:	0.693 ft		0.852 ft	
Froude Number:	2.85		1.70	
Roughness Coefficient:	0.0288		0.0499	

Structure #10 (Pond)

Section 36 Pond

Pond Inputs:

Initial Pool Elev:	7,116.00 ft
Initial Pool:	0.97 ac-ft
*Sediment Storage:	0.00 ac-ft
Dead Space:	0.00 %

**No sediment capacity defined*

Perforated Riser

Riser Diameter (in)	Riser Height (ft)	Barrel Diameter (in)	Barrel Length (ft)	Barrel Slope (%)	Manning's n	Spillway Elev (ft)	Number of Holes per Elev
18.00	11.00	18.00	170.00	3.00	0.0150	7,118.00	2

Emergency Spillway

Spillway Elev	Crest Length (ft)	Left Sideslope	Right Sideslope	Bottom Width (ft)
7,125.00	46.00	3.00:1	3.00:1	30.00

Pond Results:

Peak Elevation:	7,121.77 ft
H'graph Detention Time:	2.23 hrs
Pond Model:	CSTRS
Dewater Time:	0.96 days
Trap Efficiency:	100.00 %

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)
7,105.00	0.000	0.000	0.000	Top of Sed. Storage
7,106.00	0.010	0.003	0.000	
7,107.00	0.025	0.020	0.000	
7,108.00	0.038	0.052	0.000	
7,109.00	0.053	0.097	0.000	
7,110.00	0.075	0.161	0.000	
7,111.00	0.093	0.244	0.000	
7,112.00	0.112	0.347	0.000	
7,113.00	0.132	0.469	0.000	
7,114.00	0.154	0.611	0.000	
7,115.00	0.178	0.777	0.000	
7,116.00	0.205	0.969	0.000	Low hole SPW #1
7,117.00	0.235	1.188	0.473	5.63*

Elevation	Area (ac)	Capacity (ac-ft)	Discharge (cfs)	Dewater Time (hrs)	
7,118.00	0.267	1.439	0.669	5.35	Spillway #1
7,119.00	0.301	1.723	8.509	10.15	
7,120.00	0.340	2.043	12.033	0.70	
7,121.00	0.387	2.407	14.738	0.60	
7,121.77	0.422	2.720	16.483	0.65	Peak Stage
7,122.00	0.433	2.816	17.018		
7,123.00	0.485	3.275	19.026		
7,124.00	0.538	3.786	20.842		
7,125.00	0.599	4.355	22.512		Spillway #2
7,126.00	0.664	4.986	82.907		
7,127.00	0.732	5.684	248.131		
7,128.00	0.813	6.456	490.139		
7,129.00	0.915	7.319	829.643		
7,130.00	1.043	8.298	1,243.042		

**Designates time(s) to dewater have been extrapolated beyond the 50 hour hydrograph limit.*

Detailed Discharge Table

Elevation (ft)	Perf. Riser (cfs)	Emergency Spillway (cfs)	Combined Total Discharge (cfs)
7,105.00	0.000	0.000	0.000
7,106.00	0.000	0.000	0.000
7,107.00	0.000	0.000	0.000
7,108.00	0.000	0.000	0.000
7,109.00	0.000	0.000	0.000
7,110.00	0.000	0.000	0.000
7,111.00	0.000	0.000	0.000
7,112.00	0.000	0.000	0.000
7,113.00	0.000	0.000	0.000
7,114.00	0.000	0.000	0.000
7,115.00	0.000	0.000	0.000
7,116.00	3.00>0.000	0.000	0.000
7,117.00	0.473	0.000	0.473
7,118.00	0.669	0.000	0.669
7,119.00	8.509	0.000	8.509
7,120.00	12.033	0.000	12.033
7,121.00	14.738	0.000	14.738
7,122.00	17.018	0.000	17.018
7,123.00	19.026	0.000	19.026
7,124.00	20.842	0.000	20.842

Elevation (ft)	Perf. Riser (cfs)	Emergency Spillway (cfs)	Combined Total Discharge (cfs)
7,125.00	22.512	0.000	22.512
7,126.00	24.066	58.841	82.907
7,127.00	25.526	222.604	248.131
7,128.00	26.907	463.232	490.139
7,129.00	28.220	801.423	829.643
7,130.00	29.205	1,213.837	1,243.042

Structure #9 (Vegetated Channel)

Natural Channel Middle Pond to Section 36 Pond

Trapezoidal Vegetated Channel Inputs:

Material: Tall fescue

Bottom Width (ft)	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Retardance Classes	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)	Limiting Velocity (fps)
5.00	2.0:1	2.0:1	6.4	D, B				6.0

Vegetated Channel Results:

	Stability Class D w/o Freeboard	Stability Class D w/ Freeboard	Capacity Class B w/o Freeboard	Capacity Class B w/ Freeboard
Design Discharge:	16.48 cfs		16.48 cfs	
Depth:	0.56 ft		0.91 ft	
Top Width:	7.22 ft		8.65 ft	
Velocity:	4.85 fps		2.65 fps	
X-Section Area:	3.40 sq ft		6.22 sq ft	
Hydraulic Radius:	0.454 ft		0.686 ft	
Froude Number:	1.25		0.55	
Roughness Coefficient:	0.0458		0.1105	

Structure #8 (Pond)

Middle Pond

Pond Inputs:

Initial Pool Elev:	7,057.00 ft
Initial Pool:	0.53 ac-ft
*Sediment Storage:	0.00 ac-ft
Dead Space:	0.00 %

**No sediment capacity defined*

Perforated Riser

Riser Diameter (in)	Riser Height (ft)	Barrel Diameter (in)	Barrel Length (ft)	Barrel Slope (%)	Manning's n	Spillway Elev (ft)	Number of Holes per Elev
18.00	10.00	18.00	198.00	5.00	0.0150	7,061.00	2

Emergency Spillway

Spillway Elev	Crest Length (ft)	Left Sideslope	Right Sideslope	Bottom Width (ft)
7,066.00	38.00	3.00:1	3.00:1	24.00

Pond Results:

Peak Elevation:	7,062.87 ft
H'graph Detention Time:	0.00 hrs
Pond Model:	CSTRS
Dewater Time:	1.29 days
Trap Efficiency:	0.00 %

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)
7,048.00	0.000	0.000	0.000	Top of Sed. Storage
7,049.00	0.009	0.003	0.000	
7,050.00	0.021	0.018	0.000	
7,051.00	0.035	0.045	0.000	
7,052.00	0.050	0.088	0.000	
7,053.00	0.063	0.144	0.000	
7,054.00	0.078	0.214	0.000	
7,055.00	0.095	0.301	0.000	
7,056.00	0.113	0.405	0.000	
7,057.00	0.132	0.527	0.000	Low hole SPW #1
7,058.00	0.158	0.672	0.473	3.71*
7,059.00	0.183	0.842	0.669	4.40
7,060.00	0.210	1.038	0.819	4.55
7,061.00	0.248	1.267	0.945	7.35 Spillway #1
7,062.00	0.284	1.533	8.509	9.70
7,062.87	0.322	1.797	11.559	1.25 Peak Stage
7,063.00	0.327	1.838	12.033	
7,064.00	0.371	2.187	14.738	
7,065.00	0.417	2.581	17.018	
7,066.00	0.465	3.022	19.026	Spillway #2
7,067.00	0.552	3.529	71.605	

Elevation	Area (ac)	Capacity (ac-ft)	Discharge (cfs)	Dewater Time (hrs)
7,068.00	0.576	4.093	211.288	
7,069.00	0.628	4.695	418.987	
7,070.00	0.685	5.351	716.430	
7,071.00	0.760	6.074	1,074.454	

**Designates time(s) to dewater have been extrapolated beyond the 50 hour hydrograph limit.*

Detailed Discharge Table

Elevation (ft)	Perf. Riser (cfs)	Emergency Spillway (cfs)	Combined Total Discharge (cfs)
7,048.00	0.000	0.000	0.000
7,049.00	0.000	0.000	0.000
7,050.00	0.000	0.000	0.000
7,051.00	0.000	0.000	0.000
7,052.00	0.000	0.000	0.000
7,053.00	0.000	0.000	0.000
7,054.00	0.000	0.000	0.000
7,055.00	0.000	0.000	0.000
7,056.00	0.000	0.000	0.000
7,057.00	3.00>0.000	0.000	0.000
7,058.00	0.473	0.000	0.473
7,059.00	0.669	0.000	0.669
7,060.00	0.819	0.000	0.819
7,061.00	0.945	0.000	0.945
7,062.00	8.509	0.000	8.509
7,063.00	12.033	0.000	12.033
7,064.00	14.738	0.000	14.738
7,065.00	17.018	0.000	17.018
7,066.00	19.026	0.000	19.026
7,067.00	20.842	50.763	71.605
7,068.00	22.512	188.776	211.288
7,069.00	24.066	394.921	418.987
7,070.00	25.526	690.903	716.430
7,071.00	26.907	1,047.547	1,074.454

Structure #7 (Null)

Null at Outlet of Middle Pond

Structure #6 (Vegetated Channel)

Natural Channel Below Middle Pond

Trapezoidal Vegetated Channel Inputs:

Material: Tall fescue

Bottom Width (ft)	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Retardance Classes	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)	Limiting Velocity (fps)
5.00	2.0:1	2.0:1	9.7	D, B				6.0

Vegetated Channel Results:

	Stability Class D w/o Freeboard	Stability Class D w/ Freeboard	Capacity Class B w/o Freeboard	Capacity Class B w/ Freeboard
Design Discharge:	11.77 cfs		11.77 cfs	
Depth:	0.42 ft		0.72 ft	
Top Width:	6.70 ft		7.89 ft	
Velocity:	4.73 fps		2.53 fps	
X-Section Area:	2.49 sq ft		4.65 sq ft	
Hydraulic Radius:	0.360 ft		0.565 ft	
Froude Number:	1.37		0.58	
Roughness Coefficient:	0.0495		0.1252	

Structure #35 (Vegetated Channel)

Natural Channel to Culvert 68

Trapezoidal Vegetated Channel Inputs:

Material: Tall fescue

Bottom Width (ft)	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Retardance Classes	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)	Limiting Velocity (fps)
20.00	5.0:1	5.0:1	10.0	D, B				6.0

Vegetated Channel Results:

	Stability Class D w/o Freeboard	Stability Class D w/ Freeboard	Capacity Class B w/o Freeboard	Capacity Class B w/ Freeboard
Design Discharge:	1.68 cfs		1.68 cfs	
Depth:	0.10 ft		0.26 ft	
Top Width:	21.03 ft		22.57 ft	
Velocity:	0.79 fps		0.31 fps	
X-Section Area:	2.11 sq ft		5.47 sq ft	
Hydraulic Radius:	0.100 ft		0.242 ft	
Froude Number:	0.44		0.11	
Roughness Coefficient:	0.1263		0.5945	

Structure #34 (Culvert)

Culvert 68

Culvert Inputs:

Length (ft)	Slope (%)	Manning's n	Max. Headwater (ft)	Tailwater (ft)	Entrance Loss Coef. (Ke)
380.00	2.00	0.0150	5.00	0.00	0.90

Culvert Results:

Design Discharge = 1.68 cfs

Minimum pipe diameter: 1 - 8 inch pipe(s) required

Structure #33 (Null)

Null below Culvert 68

Structure #32 (Erodible Channel)

Road Ditch to Culvert 69

Triangular Erodible Channel Inputs:

Material: Shales and hardpans

Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Manning's n	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)	Limiting Velocity (fps)
1.5:1	1.5:1	9.0	0.0250				6.0

Erodible Channel Results:

	w/o Freeboard	w/ Freeboard
Design Discharge:	4.74 cfs	
Depth:	0.65 ft	
Top Width:	1.95 ft	
Velocity:	7.48 fps	
X-Section Area:	0.63 sq ft	
Hydraulic Radius:	0.270 ft	
Froude Number:	2.31	

Structure #31 (Culvert)

Culvert 69

Culvert Inputs:

Length (ft)	Slope (%)	Manning's n	Max. Headwater (ft)	Tailwater (ft)	Entrance Loss Coef. (Ke)
170.00	2.00	0.0150	5.00	0.00	0.90

Culvert Results:

Design Discharge = 4.74 cfs

Minimum pipe diameter: 1 - 12 inch pipe(s) required

Structure #30 (Null)

Null below Culvert 69

Structure #29 (Erodible Channel)

Haul Road Ditch to Culvert 70

Triangular Erodible Channel Inputs:

Material: Shales and hardpans

Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Manning's n	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)	Limiting Velocity (fps)
1.5:1	1.5:1	1.5	0.0250				6.0

Erodible Channel Results:

	w/o Freeboard	w/ Freeboard
Design Discharge:	7.80 cfs	
Depth:	1.10 ft	
Top Width:	3.29 ft	
Velocity:	4.33 fps	
X-Section Area:	1.80 sq ft	
Hydraulic Radius:	0.456 ft	
Froude Number:	1.03	

Structure #28 (Culvert)

Culvert 70

Culvert Inputs:

Length (ft)	Slope (%)	Manning's n	Max. Headwater (ft)	Tailwater (ft)	Entrance Loss Coef. (Ke)
170.00	2.00	0.0150	5.00	0.00	0.90

Culvert Results:

Design Discharge = 7.80 cfs

Minimum pipe diameter: 1 - 15 inch pipe(s) required

Structure #27 (Null)

Null Below Culvert 70

Structure #26 (Erodible Channel)

Natural Sorted Ditch at Toe of Temp Spoil Pile

Triangular Erodible Channel Inputs:

Material: Shales and hardpans

Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Manning's n	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)	Limiting Velocity (fps)
1.5:1	1.5:1	12.0	0.0250				6.0

Erodible Channel Results:

	w/o Freeboard	w/ Freeboard
Design Discharge:	44.20 cfs	
Depth:	1.42 ft	
Top Width:	4.27 ft	
Velocity:	14.56 fps	
X-Section Area:	3.04 sq ft	
Hydraulic Radius:	0.592 ft	
Froude Number:	3.04	

Structure #5 (Riprap Channel)

D-3 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)
12.00	2.0:1	2.0:1	16.1	2.98		

Riprap Channel Results:

Simons/OSM Method - Mild Slope Design

	w/o Freeboard	w/ Freeboard
Design Discharge:	0.02 cfs	
Depth:	0.02 ft	3.00 ft
Top Width:	12.07 ft	23.99 ft
Velocity:	0.11 fps	
X-Section Area:	0.21 sq ft	

	w/o Freeboard	w/ Freeboard
Hydraulic Radius:	0.017 ft	
Froude Number:	0.15	
Manning's n:	0.0322	
Dmin:	2.00 in	
D50:	6.00 in	
Dmax:	9.00 in	

Structure #4 (Null)

Null at Confluecne D-3 Ditch and Little Collom Gulch

Structure #3 (Vegetated Channel)

Little Collom Gulch Natural Channel

Trapezoidal Vegetated Channel Inputs:

Material: Tall fescue

Bottom Width (ft)	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Retardance Classes	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)	Limiting Velocity (fps)
5.00	2.0:1	2.0:1	5.7	D, B				6.0

Vegetated Channel Results:

	Stability Class D w/o Freeboard	Stability Class D w/ Freeboard	Capacity Class B w/o Freeboard	Capacity Class B w/ Freeboard
Design Discharge:	49.70 cfs		49.70 cfs	
Depth:	0.91 ft		1.32 ft	
Top Width:	8.65 ft		10.26 ft	
Velocity:	7.97 fps		4.95 fps	
X-Section Area:	6.23 sq ft		10.03 sq ft	
Hydraulic Radius:	0.686 ft		0.922 ft	
Froude Number:	1.66		0.88	
Roughness Coefficient:	0.0347		0.0680	

Structure #2 (Pond)

Section 25 Pond

Pond Inputs:

Initial Pool Elev:	6,868.00 ft
Initial Pool:	4.36 ac-ft
*Sediment Storage:	0.00 ac-ft
Dead Space:	0.00 %

**No sediment capacity defined*

Perforated Riser

Riser Diameter (in)	Riser Height (ft)	Barrel Diameter (in)	Barrel Length (ft)	Barrel Slope (%)	Manning's n	Spillway Elev (ft)	Number of Holes per Elev
18.00	16.00	18.00	182.00	5.00	0.0150	6,872.00	2

Emergency Spillway

Spillway Elev	Crest Length (ft)	Left Sideslope	Right Sideslope	Bottom Width (ft)
6,875.00	45.00	2.00:1	2.00:1	20.00

Pond Results:

Peak Elevation:	6,873.09 ft
H'graph Detention Time:	5.81 hrs
Pond Model:	CSTRS
Dewater Time:	2.75 days
Trap Efficiency:	99.34 %

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)
6,855.00	0.047	0.000	0.000	Top of Sed. Storage
6,855.01	0.048	0.000	0.000	
6,856.00	0.102	0.073	0.000	
6,857.00	0.156	0.201	0.000	
6,858.00	0.191	0.374	0.000	
6,859.00	0.228	0.583	0.000	
6,860.00	0.266	0.830	0.000	
6,861.00	0.306	1.116	0.000	
6,862.00	0.348	1.443	0.000	
6,863.00	0.391	1.812	0.000	
6,864.00	0.436	2.225	0.000	
6,865.00	0.483	2.684	0.000	
6,866.00	0.532	3.192	0.000	
6,867.00	0.582	3.749	0.000	
6,868.00	0.635	4.357	0.000	Low hole SPW #1
6,869.00	0.689	5.019	0.473	16.94*
6,870.00	0.746	5.736	0.669	12.98*
6,871.00	0.804	6.511	0.819	11.45*

Elevation	Area (ac)	Capacity (ac-ft)	Discharge (cfs)	Dewater Time (hrs)	
6,872.00	0.864	7.345	0.945	10.67*	Spillway #1
6,873.00	0.927	8.240	8.509	13.25	
6,873.09	0.934	8.331	8.842	0.70	Peak Stage
6,874.00	0.991	9.199	12.033		
6,875.00	1.060	10.224	14.738		Spillway #2
6,876.00	1.125	11.316	56.584		
6,877.00	1.187	12.472	168.142		
6,878.00	1.250	13.691	330.639		
6,879.00	1.318	14.975	558.801		
6,880.00	1.386	16.326	834.822		

**Designates time(s) to dewater have been extrapolated beyond the 50 hour hydrograph limit.*

Detailed Discharge Table

Elevation (ft)	Perf. Riser (cfs)	Emergency Spillway (cfs)	Combined Total Discharge (cfs)
6,855.00	0.000	0.000	0.000
6,855.01	0.000	0.000	0.000
6,856.00	0.000	0.000	0.000
6,857.00	0.000	0.000	0.000
6,858.00	0.000	0.000	0.000
6,859.00	0.000	0.000	0.000
6,860.00	0.000	0.000	0.000
6,861.00	0.000	0.000	0.000
6,862.00	0.000	0.000	0.000
6,863.00	0.000	0.000	0.000
6,864.00	0.000	0.000	0.000
6,865.00	0.000	0.000	0.000
6,866.00	0.000	0.000	0.000
6,867.00	0.000	0.000	0.000
6,868.00	3.00>0.000	0.000	0.000
6,869.00	0.473	0.000	0.473
6,870.00	0.669	0.000	0.669
6,871.00	0.819	0.000	0.819
6,872.00	0.945	0.000	0.945
6,873.00	8.509	0.000	8.509
6,874.00	12.033	0.000	12.033
6,875.00	14.738	0.000	14.738
6,876.00	17.018	39.567	56.584
6,877.00	19.026	149.116	168.142

Elevation (ft)	Perf. Riser (cfs)	Emergency Spillway (cfs)	Combined Total Discharge (cfs)
6,878.00	20.842	309.797	330.639
6,879.00	22.512	536.289	558.801
6,880.00	24.066	810.756	834.822

Structure #1 (Null)

Null Below Section 25 Pond

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)
#14	1	1.900	0.009	0.000	0.000	85.000	F	1.39	0.103
	2	18.800	0.156	0.000	0.000	47.000	M	0.00	0.000
	3	4.000	0.025	0.000	0.000	62.000	M	0.03	0.016
	4	26.000	0.148	0.000	0.000	47.000	M	0.00	0.000
	Σ	50.700						1.39	0.119
#15	1	59.600	0.149	0.000	0.000	85.000	F	35.72	3.120
	2	7.200	0.051	0.000	0.000	47.000	M	0.00	0.000
	Σ	117.500						35.99	3.239
#25	1	4.400	0.118	0.000	0.000	85.000	F	3.21	0.239
	Σ	4.400						3.21	0.239
#24	Σ	4.400						3.21	0.239
#23	Σ	4.400						3.21	0.239
#22	1	11.000	0.129	0.000	0.000	85.000	F	6.59	0.576
	2	9.400	0.096	0.000	0.000	47.000	M	0.00	0.000
	3	4.400	0.056	0.000	0.000	85.000	F	3.21	0.239
	Σ	29.200						12.47	1.053
#21	Σ	29.200						12.47	1.053
#20	Σ	29.200						12.47	1.053
#18	1	4.200	0.061	0.000	0.000	85.000	F	3.06	0.228
	Σ	33.400						15.53	1.281
#19	1	5.500	0.062	0.000	0.000	47.000	M	0.00	0.000
	2	7.500	0.181	0.000	0.000	85.000	F	4.41	0.391
	Σ	13.000						4.41	0.391
#17	Σ	13.000						4.41	0.391
#16	Σ	46.400						19.60	1.672
#13	Σ	46.400						19.60	1.672
#12	Σ	163.900						53.77	4.911
#11	1	24.000	1.445	0.000	0.000	47.000	M	0.00	0.000
	2	2.700	0.034	0.000	0.000	85.000	F	1.97	0.146
	3	1.000	0.003	0.000	0.000	98.000	F	1.35	0.130
	Σ	191.600						57.08	5.187

Stru #	SWS #	SWS Area (ac)	Time of Conc (hrs)	Musk K (hrs)	Musk X	Curve Number	UHS	Peak Discharge (cfs)	Runoff Volume (ac-ft)
#10	Σ	191.600						57.08	5.187
#9	Σ	191.600						16.48	5.181
#8	1	19.600	0.108	0.000	0.000	47.000	M	0.00	0.000
	Σ	211.200						16.48	5.181
#7	Σ	211.200						11.56	5.162
#6	1	75.900	0.401	0.000	0.000	47.000	M	0.00	0.000
	2	3.200	0.068	0.000	0.000	85.000	F	2.33	0.174
	3	0.800	0.006	0.000	0.000	98.000	F	1.08	0.104
	Σ	291.100						11.77	5.439
#35	1	2.300	0.065	0.000	0.000	85.000	F	1.68	0.125
	2	5.500	0.079	0.000	0.000	47.000	M	0.00	0.000
	Σ	7.800						1.68	0.125
#34	Σ	7.800						1.68	0.125
#33	Σ	7.800						1.68	0.125
#32	1	4.200	0.053	0.000	0.000	85.000	F	3.06	0.228
	2	5.700	0.095	0.000	0.000	47.000	M	0.00	0.000
	Σ	17.700						4.74	0.353
#31	Σ	17.700						4.74	0.353
#30	Σ	17.700						4.74	0.353
#29	1	2.700	0.031	0.000	0.000	47.000	M	0.00	0.000
	2	4.200	0.045	0.000	0.000	85.000	F	3.06	0.228
	Σ	24.600						7.80	0.580
#28	Σ	24.600						7.80	0.580
#27	Σ	24.600						7.80	0.580
#26	1	79.600	0.009	0.000	0.000	74.000	F	23.78	1.729
	2	17.300	0.036	0.000	0.000	85.000	F	12.61	0.939
	Σ	121.500						44.20	3.248
#5	1	14.800	0.082	0.000	0.000	57.000	F	0.02	0.013
	Σ	14.800						0.02	0.013
#4	Σ	14.800						0.02	0.013
#3	1	167.900	0.156	0.000	0.000	47.000	M	0.00	0.000
	2	18.400	0.057	0.000	0.000	74.000	F	5.50	0.400
	Σ	322.600						49.70	3.661

Stru #	SWS #	SWS Area (ac)	Time of Conc (hrs)	Musk K (hrs)	Musk X	Curve Number	UHS	Peak Discharge (cfs)	Runoff Volume (ac-ft)
#2	Σ	613.700						53.58	9.100
#1	Σ	613.700						8.84	6.831

Subwatershed Sedimentology Detail:

Stru #	SWS #	Soil K	L (ft)	S (%)	C	P	PS #	Sediment (tons)	Peak Sediment Conc. (mg/l)	Peak Settleable Conc (ml/l)	24VW (ml/l)
#14	1	0.300	50.00	27.00	1.0000	0.9000	1	27.1	334,377	190.58	99.77
	2	0.300	400.00	9.00	0.0310	0.9000	1	0.0	1	0.00	0.00
	3	0.300	75.00	10.00	0.0100	0.3800	1	0.0	107	0.06	0.05
	4	0.300	400.00	7.00	0.0310	0.9000	1	0.0	1	0.00	0.00
	Σ							27.1	334,377	190.58	86.31
#15	1	0.300	400.00	6.00	1.0000	0.9000	1	539.0	225,073	122.28	64.57
	2	0.300	200.00	10.00	0.0310	0.9000	1	0.0	1	0.00	0.00
	Σ							566.1	224,596	122.31	65.42
#25	1	0.300	300.00	8.00	1.0000	0.9000	1	37.1	208,518	118.85	61.15
	Σ							37.1	208,518	118.85	61.15
#24	Σ							37.1	208,518	118.85	61.15
#23	Σ							37.1	208,518	118.85	61.15
#22	1	0.300	400.00	6.00	1.0000	0.9000	1	81.2	186,855	101.52	53.34
	2	0.300	300.00	9.00	0.0310	0.9000	1	0.0	1	0.00	0.00
	3	0.300	50.00	2.00	1.0000	0.9000	1	4.5	27,248	15.53	7.82
	Σ							122.8	166,701	92.07	45.22
#21	Σ							122.8	166,701	92.07	45.22
#20	Σ							122.8	166,701	92.07	45.22
#18	1	0.300	200.00	8.00	1.0000	0.9000	1	28.7	172,007	98.04	50.21
	Σ							151.5	160,691	89.29	46.13
#19	1	0.300	200.00	9.00	0.0310	0.9000	1	0.0	1	0.00	0.00
	2	0.300	400.00	8.00	1.0000	0.9000	1	68.9	228,801	123.69	65.52
	Σ							68.9	228,801	123.69	65.52
#17	Σ							68.9	228,801	123.69	65.52
#16	Σ							220.4	184,350	101.57	50.73
#13	Σ							220.4	184,350	101.57	50.73

Stru #	SWS #	Soil K	L (ft)	S (%)	C	P	PS #	Sediment (tons)	Peak Sediment Conc. (mg/l)	Peak Settleable Conc (ml/l)	24VW (ml/l)
#12	Σ							786.5	214,135	117.00	60.47
#11	1	0.300	300.00	8.00	0.0310	0.9000	1	0.0	1	0.00	0.00
	2	0.300	25.00	1.50	1.0000	0.9000	1	1.6	16,349	9.32	4.69
	3	0.300	10.00	1.00	1.0000	0.9000	1	0.7	6,917	3.94	2.19
	Σ							788.8	211,652	115.66	57.56
#10	Σ							788.8	211,652	115.66	57.56
#9	Σ							0.0	1	0.00	0.00
#8	1	0.300	300.00	10.00	0.0310	0.9000	1	0.0	1	0.00	0.00
	Σ							0.0	1	0.00	0.00
#7	Σ							0.0	1	0.00	0.00
#6	1	0.300	400.00	10.00	0.0310	0.9000	1	0.0	1	0.00	0.00
	2	0.300	150.00	2.00	1.0000	0.9000	1	4.4	36,332	20.71	10.43
	3	0.300	25.00	1.00	1.0000	0.9000	1	0.7	8,861	5.05	2.81
	Σ							5.1	24,377	13.89	0.50
#35	1	0.300	200.00	8.00	1.0000	0.9000	1	14.6	160,804	91.65	46.91
	2	0.300	200.00	10.00	0.0310	0.9000	1	0.0	1	0.00	0.00
	Σ							14.6	160,804	91.65	46.91
#34	Σ							14.6	160,804	91.65	46.91
#33	Σ							14.6	160,804	91.65	46.91
#32	1	0.300	200.00	9.00	1.0000	0.9000	1	34.5	204,063	116.31	59.81
	2	0.300	200.00	9.00	0.0310	0.9000	1	0.0	1	0.00	0.00
	Σ							49.2	188,940	107.69	55.29
#31	Σ							49.2	188,940	107.69	55.29
#30	Σ							49.2	188,940	107.69	55.29
#29	1	0.300	50.00	10.00	0.0310	0.9000	1	0.0	1	0.00	0.00
	2	0.300	100.00	13.00	1.0000	0.9000	1	42.4	245,909	140.16	72.46
	Σ							91.6	211,642	120.63	62.10
#28	Σ							91.6	211,642	120.63	62.10
#27	Σ							91.6	211,642	120.63	62.10
#26	1	0.300	400.00	17.00	1.0000	0.9000	1	1,336.4	892,757	508.84	249.04
	2	0.300	200.00	24.00	1.0000	0.9000	1	651.8	723,218	412.21	227.99
	Σ							2,079.8	753,468	429.45	215.36
#5	1	0.300	400.00	19.30	0.0310	0.9000	1	0.1	4,228	2.41	1.60

Stru #	SWS #	Soil K	L (ft)	S (%)	C	P	PS #	Sediment (tons)	Peak Sediment Conc. (mg/l)	Peak Settleable Conc (ml/l)	24VW (ml/l)
	Σ							0.1	4,228	2.41	1.60
#4	Σ							0.1	4,228	2.41	1.60
#3	1	0.300	400.00	7.90	0.0310	0.9000	1	0.0	1	0.00	0.00
	2	0.300	300.00	23.00	0.0310	0.9000	1	9.6	42,344	24.13	9.94
	Σ							2,089.4	695,730	396.54	195.64
#2	Σ							2,094.5	659,524	375.91	94.74
#1	Σ							13.8	1,617	0.00	0.00

Subwatershed Time of Concentration Details:

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#3	1	3. Short grass pasture	11.50	175.72	1,528.00	2.710	0.156
#3	1	Time of Concentration:					0.156
#3	2	5. Nearly bare and untilled, and alluvial valley fans	23.00	227.24	988.00	4.790	0.057
#3	2	Time of Concentration:					0.057
#5	1	3. Short grass pasture	19.00	196.84	1,036.00	3.480	0.082
#5	1	Time of Concentration:					0.082
#6	1	3. Short grass pasture	10.00	364.30	3,643.00	2.520	0.401
#6	1	Time of Concentration:					0.401
#6	2	5. Nearly bare and untilled, and alluvial valley fans	2.00	7.00	350.00	1.410	0.068
#6	2	Time of Concentration:					0.068
#6	3	7. Paved area and small upland gullies	1.00	0.50	50.00	2.010	0.006
#6	3	Time of Concentration:					0.006
#8	1	3. Short grass pasture	10.00	98.40	984.00	2.520	0.108
#8	1	Time of Concentration:					0.108
#11	1	3. Short grass pasture	8.00	941.00	11,762.50	2.260	1.445
#11	1	Time of Concentration:					1.445
#11	2	5. Nearly bare and untilled, and alluvial valley fans	1.50	2.25	150.00	1.220	0.034
#11	2	Time of Concentration:					0.034
#11	3	7. Paved area and small upland gullies	1.00	0.24	24.00	2.010	0.003
#11	3	Time of Concentration:					0.003
#14	1	5. Nearly bare and untilled, and alluvial valley fans	27.00	49.14	182.00	5.190	0.009
#14	1	Time of Concentration:					0.009
#14	2	3. Short grass pasture	9.00	121.68	1,352.00	2.400	0.156
#14	2	Time of Concentration:					0.156

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#14	3	3. Short grass pasture	10.00	23.40	234.00	2.520	0.025
#14	3	Time of Concentration:					0.025
#14	4	3. Short grass pasture	7.00	78.89	1,127.00	2.110	0.148
#14	4	Time of Concentration:					0.148
#15	1	5. Nearly bare and untilled, and alluvial valley fans	6.00	78.54	1,309.00	2.440	0.149
#15	1	Time of Concentration:					0.149
#15	2	3. Short grass pasture	10.00	47.00	470.00	2.520	0.051
#15	2	Time of Concentration:					0.051
#18	1	5. Nearly bare and untilled, and alluvial valley fans	8.00	49.60	620.00	2.820	0.061
#18	1	Time of Concentration:					0.061
#19	1	3. Short grass pasture	9.00	48.51	539.00	2.400	0.062
#19	1	Time of Concentration:					0.062
#19	2	5. Nearly bare and untilled, and alluvial valley fans	8.00	147.03	1,838.00	2.820	0.181
#19	2	Time of Concentration:					0.181
#22	1	5. Nearly bare and untilled, and alluvial valley fans	6.00	68.40	1,140.00	2.440	0.129
#22	1	Time of Concentration:					0.129
#22	2	3. Short grass pasture	9.00	75.42	838.00	2.400	0.096
#22	2	Time of Concentration:					0.096
#22	3	5. Nearly bare and untilled, and alluvial valley fans	2.00	5.70	285.00	1.410	0.056
#22	3	Time of Concentration:					0.056
#25	1	5. Nearly bare and untilled, and alluvial valley fans	8.00	96.00	1,200.00	2.820	0.118
#25	1	Time of Concentration:					0.118
#26	1	3. Short grass pasture	31.00	44.95	145.00	4.450	0.009
#26	1	Time of Concentration:					0.009
#26	2	5. Nearly bare and untilled, and alluvial valley fans	24.00	152.64	636.00	4.890	0.036
#26	2	Time of Concentration:					0.036
#29	1	3. Short grass pasture	9.00	24.30	270.00	2.400	0.031
#29	1	Time of Concentration:					0.031
#29	2	5. Nearly bare and untilled, and alluvial valley fans	13.00	76.96	592.00	3.600	0.045
#29	2	Time of Concentration:					0.045
#32	1	5. Nearly bare and untilled, and alluvial valley fans	9.00	51.66	574.00	3.000	0.053
#32	1	Time of Concentration:					0.053
#32	2	3. Short grass pasture	9.00	73.89	821.00	2.400	0.095
#32	2	Time of Concentration:					0.095
#35	1	5. Nearly bare and untilled, and alluvial valley fans	8.00	52.87	661.00	2.820	0.065
#35	1	Time of Concentration:					0.065
#35	2	3. Short grass pasture	10.00	71.90	719.00	2.520	0.079

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#35	2	Time of Concentration:					0.079

Section 25 Pond **Emergency Spillway Demonstration**

25-Year 24-Hour Storm Event

Tony Tennyson

Tri-State Generation & Transmission Association, Inc.
1100 West 116th Avenue
Westminster, CO 80234

Phone: (970) 326-3560
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General Information

Storm Information:

Storm Type:	NRCS Type II
Design Storm:	25 yr - 24 hr
Rainfall Depth:	2.300 inches

Structure Networking:

Type	Stru #	(flows into)	Stru #	Musk. K (hrs)	Musk. X	Description
Null	#1	==>	End	0.000	0.000	Null Below Section 25 Pond
Pond	#2	==>	#1	0.000	0.000	Section 25 Pond
Channel	#3	==>	#2	0.000	0.000	Little Collom Gulch Natural Channel
Null	#4	==>	#3	0.000	0.000	Null at Confluence D-3 Ditch and Little Collom Gulch
Channel	#5	==>	#4	0.000	0.000	D-3 Ditch
Channel	#6	==>	#2	0.000	0.000	Natural Channel Below Middle Pond
Null	#7	==>	#6	0.000	0.000	Null at Outlet of Middle Pond
Pond	#8	==>	#7	0.000	0.000	Middle Pond
Channel	#9	==>	#8	0.000	0.000	Natural Channel Middle Pond to Section 36 Pond
Pond	#10	==>	#9	0.000	0.000	Section 36 Pond
Channel	#11	==>	#10	0.000	0.000	Natural Channel Section 36 Pond to Culvert 44A
Culvert	#12	==>	#11	0.000	0.000	Culvert 44A
Null	#13	==>	#12	0.000	0.000	Null at Confluence of Culverts 62 and 63
Culvert	#14	==>	#15	0.000	0.000	Culvert 62
Channel	#15	==>	#12	0.000	0.000	Natural Channel within Disturbed Area to Culvert 44A
Culvert	#16	==>	#13	0.000	0.000	Culvert 63
Culvert	#17	==>	#16	0.000	0.000	Culvert 66
Channel	#18	==>	#16	0.000	0.000	Road Ditch from Culvert 66 to Culvert 63
Channel	#19	==>	#17	0.000	0.000	Road Ditch to Culvert 66
Null	#20	==>	#18	0.000	0.000	Null out Outlet of Culvert 65
Culvert	#21	==>	#20	0.000	0.000	Culvert 65
Channel	#22	==>	#21	0.000	0.000	Road Ditch to Culvert 65
Null	#23	==>	#22	0.000	0.000	Null Below Culvert 67
Culvert	#24	==>	#23	0.000	0.000	Culvert 67
Channel	#25	==>	#24	0.000	0.000	Road Ditch to Culvert 67
Channel	#26	==>	#3	0.000	0.000	Natural Sorted Ditch at Toe of Temp Spoil Pile
Null	#27	==>	#26	0.000	0.000	Null Below Culvert 70
Culvert	#28	==>	#27	0.000	0.000	Culvert 70
Channel	#29	==>	#28	0.000	0.000	Haul Road Ditch to Culvert 70
Null	#30	==>	#29	0.000	0.000	Null below Culvert 69
Culvert	#31	==>	#30	0.000	0.000	Culvert 69
Channel	#32	==>	#31	0.000	0.000	Road Ditch to Culvert 69
Null	#33	==>	#32	0.000	0.000	Null below Culvert 68
Culvert	#34	==>	#33	0.000	0.000	Culvert 68
Channel	#35	==>	#34	0.000	0.000	Natural Channel to Culvert 68

	#14 Culvert	
	#15 Chan'l	
		#23 Null
		#22 Chan'l
		#21 Culvert
		#20 Null
		#18 Chan'l
		#19 Chan'l
		#17 Culvert
		#16 Culvert
		#13 Null
		#12 Culvert
		#11 Chan'l
		#10 Pond
		#9 Chan'l
		#8 Pond
		#7 Null
		#6 Chan'l
		#35 Chan'l
		#34 Culvert

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#33 Null
#32 Chan'l
#31 Culvert
#30 Null
#29 Chan'l
#28 Culvert
#27 Null
#26 Chan'l
#5 Chan'l
#4 Null
#3 Chan'l
#2 Pond
#1 Null

Structure Summary:

	Immediate Contributing Area (ac)	Total Contributing Area (ac)	Peak Discharge (cfs)	Total Runoff Volume (ac-ft)
#14	50.700	50.700	2.65	0.21
#15	66.800	117.500	56.57	5.10
#25	4.400	4.400	4.87	0.37
#24	0.000	4.400	4.87	0.37
#23	0.000	4.400	4.87	0.37
#22	24.800	29.200	19.45	1.65
#21	0.000	29.200	19.45	1.65
#20	0.000	29.200	19.45	1.65
#18	4.200	33.400	24.10	2.01
#19	13.000	13.000	6.97	0.61
#17	0.000	13.000	6.97	0.61
#16	0.000	46.400	30.63	2.62
#13	0.000	46.400	30.63	2.62
#12	0.000	163.900	85.94	7.72
#11	27.700	191.600	90.66	8.12
#10 In	0.000	191.600	90.66	8.12
Out			21.59	8.12
#9	0.000	191.600	21.59	8.12
#8 In	19.600	211.200	21.59	8.12
Out			15.78	8.10
#7	0.000	211.200	15.78	8.10
#6	79.900	291.100	16.04	8.51
#35	7.800	7.800	2.54	0.20
#34	0.000	7.800	2.54	0.20
#33	0.000	7.800	2.54	0.20
#32	9.900	17.700	7.19	0.55
#31	0.000	17.700	7.19	0.55
#30	0.000	17.700	7.19	0.55
#29	6.900	24.600	11.84	0.91
#28	0.000	24.600	11.84	0.91
#27	0.000	24.600	11.84	0.91
#26	96.900	121.500	77.22	5.69
#5	14.800	14.800	0.22	0.09
#4	0.000	14.800	0.22	0.09
#3	186.300	322.600	87.92	6.55
#2 In	0.000	613.700	93.54	15.05
Out			16.44	12.77
#1	0.000	613.700	16.44	12.77

Structure Detail:

Structure #14 (Culvert)

Culvert 62

Culvert Inputs:

Length (ft)	Slope (%)	Manning's n	Max. Headwater (ft)	Tailwater (ft)	Entrance Loss Coef. (Ke)
220.00	1.50	0.0150	5.00	0.00	0.90

Culvert Results:

Design Discharge = 2.65 cfs

Minimum pipe diameter: 1 - 10 inch pipe(s) required

Structure #15 (Erodible Channel)

Natural Channel within Disturbed Area to Culvert 44A

Parabolic Erodible Channel Inputs:

Material: Shales and hardpans

Slope (%)	Manning's n	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)	Limiting Velocity (fps)
8.0	0.0250				6.0

Erodible Channel Results:

	w/o Freeboard	w/ Freeboard
Design Discharge:		56.57 cfs
Depth:		1.25 ft
Top Width:		5.01 ft
Velocity:		13.50 fps
X-Section Area:		4.19 sq ft
Hydraulic Radius:		0.716 ft
Froude Number:		2.60

Structure #25 (Erodible Channel)

Road Ditch to Culvert 67

Triangular Erodible Channel Inputs:

Material: Shales and hardpans

Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Manning's n	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)	Limiting Velocity (fps)
1.5:1	1.5:1	8.0	0.0250				6.0

Erodible Channel Results:

	w/o Freeboard	w/ Freeboard
Design Discharge:	4.87 cfs	
Depth:	0.67 ft	
Top Width:	2.01 ft	
Velocity:	7.20 fps	
X-Section Area:	0.68 sq ft	
Hydraulic Radius:	0.279 ft	
Froude Number:	2.19	

Structure #24 (Culvert)
Culvert 67
Culvert Inputs:

Length (ft)	Slope (%)	Manning's n	Max. Headwater (ft)	Tailwater (ft)	Entrance Loss Coef. (Ke)
60.00	2.00	0.0150	5.00	0.00	0.90

Culvert Results:

Design Discharge = 4.87 cfs

Minimum pipe diameter: 1 - 12 inch pipe(s) required

Structure #23 (Null)
Null Below Culvert 67
Structure #22 (Erodible Channel)
Road Ditch to Culvert 65
Triangular Erodible Channel Inputs:

Material: Shales and hardpans

Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Manning's n	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)	Limiting Velocity (fps)
1.5:1	1.5:1	6.0	0.0250				6.0

Erodible Channel Results:

	w/o Freeboard	w/ Freeboard
Design Discharge:	19.45 cfs	
Depth:	1.19 ft	
Top Width:	3.57 ft	
Velocity:	9.14 fps	
X-Section Area:	2.13 sq ft	
Hydraulic Radius:	0.495 ft	
Froude Number:	2.09	

Structure #21 (Culvert)

Culvert 65

Culvert Inputs:

Length (ft)	Slope (%)	Manning's n	Max. Headwater (ft)	Tailwater (ft)	Entrance Loss Coef. (Ke)
60.00	2.00	0.0150	5.00	0.00	0.90

Culvert Results:

Design Discharge = 19.45 cfs

Minimum pipe diameter: 1 - 21 inch pipe(s) required

Structure #20 (Null)

Null out Outlet of Culvert 65

Structure #18 (Erodible Channel)

Road Ditch from Culvert 66 to Culvert 63

Triangular Erodible Channel Inputs:

Material: Shales and hardpans

Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Manning's n	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)	Limiting Velocity (fps)
1.5:1	1.5:1	7.0	0.0250				6.0

Erodible Channel Results:

	w/o Freeboard	w/ Freeboard
Design Discharge:	24.10 cfs	
Depth:	1.25 ft	
Top Width:	3.76 ft	
Velocity:	10.22 fps	
X-Section Area:	2.36 sq ft	
Hydraulic Radius:	0.522 ft	
Froude Number:	2.27	

Structure #19 (Erodible Channel)

Road Ditch to Culvert 66

Triangular Erodible Channel Inputs:

Material: Shales and hardpans

Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Manning's n	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)	Limiting Velocity (fps)
1.5:1	1.5:1	8.0	0.0250				6.0

Erodible Channel Results:

	w/o Freeboard	w/ Freeboard
Design Discharge:	6.97 cfs	
Depth:	0.77 ft	
Top Width:	2.30 ft	
Velocity:	7.88 fps	
X-Section Area:	0.88 sq ft	
Hydraulic Radius:	0.319 ft	
Froude Number:	2.24	

Structure #17 (Culvert)

Culvert 66

Culvert Inputs:

Length (ft)	Slope (%)	Manning's n	Max. Headwater (ft)	Tailwater (ft)	Entrance Loss Coef. (Ke)
80.00	2.00	0.0150	5.00	0.00	0.90

Culvert Results:

Design Discharge = 6.97 cfs

Minimum pipe diameter: 1 - 15 inch pipe(s) required

Structure #16 (Culvert)

Culvert 63

Culvert Inputs:

Length (ft)	Slope (%)	Manning's n	Max. Headwater (ft)	Tailwater (ft)	Entrance Loss Coef. (Ke)
180.00	1.50	0.0150	5.00	0.00	0.90

Culvert Results:

Design Discharge = 30.63 cfs

Minimum pipe diameter: 1 - 30 inch pipe(s) required

Structure #13 (Null)

Null at Confluence of Culverts 62 and 63

Structure #12 (Culvert)

Culvert 44A

Culvert Inputs:

Length (ft)	Slope (%)	Manning's n	Max. Headwater (ft)	Tailwater (ft)	Entrance Loss Coef. (Ke)
300.00	1.50	0.0150	5.00	0.00	0.90

Culvert Results:

Design Discharge = 85.94 cfs

Minimum pipe diameter: 1 - 48 inch pipe(s) required

Structure #11 (Vegetated Channel)

Natural Channel Section 36 Pond to Culvert 44A

Parabolic Vegetated Channel Inputs:

Material: Tall fescue

Slope (%)	Retardance Classes	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)	Limiting Velocity (fps)
12.9	D, B				5.0

Vegetated Channel Results:

	Stability Class D w/o Freeboard	Stability Class D w/ Freeboard	Capacity Class B w/o Freeboard	Capacity Class B w/ Freeboard
Design Discharge:	90.66 cfs		90.66 cfs	
Depth:	1.39 ft		1.65 ft	
Top Width:	5.56 ft		6.61 ft	
Velocity:	17.60 fps		12.46 fps	
X-Section Area:	5.15 sq ft		7.28 sq ft	
Hydraulic Radius:	0.794 ft		0.944 ft	
Froude Number:	3.22		2.09	
Roughness Coefficient:	0.0261		0.0413	

Structure #10 (Pond)

Section 36 Pond

Pond Inputs:

Initial Pool Elev:	7,116.00 ft
Initial Pool:	0.97 ac-ft

Perforated Riser

Riser Diameter (in)	Riser Height (ft)	Barrel Diameter (in)	Barrel Length (ft)	Barrel Slope (%)	Manning's n	Spillway Elev (ft)	Number of Holes per Elev
18.00	11.00	18.00	170.00	3.00	0.0150	7,118.00	2

Emergency Spillway

Spillway Elev	Crest Length (ft)	Left Sideslope	Right Sideslope	Bottom Width (ft)
7,125.00	46.00	3.00:1	3.00:1	30.00

Pond Results:

Peak Elevation:	7,124.45 ft
Dewater Time:	0.96 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)
7,105.00	0.000	0.000	0.000	
7,106.00	0.010	0.003	0.000	
7,107.00	0.025	0.020	0.000	
7,108.00	0.038	0.052	0.000	
7,109.00	0.053	0.097	0.000	
7,110.00	0.075	0.161	0.000	
7,111.00	0.093	0.244	0.000	
7,112.00	0.112	0.347	0.000	
7,113.00	0.132	0.469	0.000	
7,114.00	0.154	0.611	0.000	
7,115.00	0.178	0.777	0.000	
7,116.00	0.205	0.969	0.000	Low hole SPW #1
7,117.00	0.235	1.188	0.473	5.63*
7,118.00	0.267	1.439	0.669	5.35 Spillway #1
7,119.00	0.301	1.723	8.509	8.90
7,120.00	0.340	2.043	12.033	0.65
7,121.00	0.387	2.407	14.738	0.55
7,122.00	0.433	2.816	17.018	0.50
7,123.00	0.485	3.275	19.026	0.50

Elevation	Area (ac)	Capacity (ac-ft)	Discharge (cfs)	Dewater Time (hrs)
7,124.00	0.538	3.786	20.842	0.60
7,124.45	0.568	4.043	21.595	0.45 Peak Stage
7,125.00	0.599	4.355	22.512	Spillway #2
7,126.00	0.664	4.986	82.907	
7,127.00	0.732	5.684	248.131	
7,128.00	0.813	6.456	490.139	
7,129.00	0.915	7.319	829.643	
7,130.00	1.043	8.298	1,243.042	

Detailed Discharge Table

Elevation (ft)	Perf. Riser (cfs)	Emergency Spillway (cfs)	Combined Total Discharge (cfs)
7,105.00	0.000	0.000	0.000
7,106.00	0.000	0.000	0.000
7,107.00	0.000	0.000	0.000
7,108.00	0.000	0.000	0.000
7,109.00	0.000	0.000	0.000
7,110.00	0.000	0.000	0.000
7,111.00	0.000	0.000	0.000
7,112.00	0.000	0.000	0.000
7,113.00	0.000	0.000	0.000
7,114.00	0.000	0.000	0.000
7,115.00	0.000	0.000	0.000
7,116.00	3.00>0.000	0.000	0.000
7,117.00	0.473	0.000	0.473
7,118.00	0.669	0.000	0.669
7,119.00	8.509	0.000	8.509
7,120.00	12.033	0.000	12.033
7,121.00	14.738	0.000	14.738
7,122.00	17.018	0.000	17.018
7,123.00	19.026	0.000	19.026
7,124.00	20.842	0.000	20.842
7,125.00	22.512	0.000	22.512
7,126.00	24.066	58.841	82.907
7,127.00	25.526	222.604	248.131
7,128.00	26.907	463.232	490.139
7,129.00	28.220	801.423	829.643
7,130.00	29.205	1,213.837	1,243.042

Structure #9 (Vegetated Channel)

Natural Channel Middle Pond to Section 36 Pond

Trapezoidal Vegetated Channel Inputs:

Material: Tall fescue

Bottom Width (ft)	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Retardance Classes	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)	Limiting Velocity (fps)
5.00	2.0:1	2.0:1	6.4	D, B				6.0

Vegetated Channel Results:

	Stability Class D w/o Freeboard	Stability Class D w/ Freeboard	Capacity Class B w/o Freeboard	Capacity Class B w/ Freeboard
Design Discharge:	21.59 cfs		21.59 cfs	
Depth:	0.62 ft		0.99 ft	
Top Width:	7.49 ft		8.95 ft	
Velocity:	5.55 fps		3.13 fps	
X-Section Area:	3.89 sq ft		6.89 sq ft	
Hydraulic Radius:	0.500 ft		0.732 ft	
Froude Number:	1.36		0.63	
Roughness Coefficient:	0.0427		0.0977	

Structure #8 (Pond)

Middle Pond

Pond Inputs:

Initial Pool Elev:	7,057.00 ft
Initial Pool:	0.53 ac-ft

Perforated Riser

Riser Diameter (in)	Riser Height (ft)	Barrel Diameter (in)	Barrel Length (ft)	Barrel Slope (%)	Manning's n	Spillway Elev (ft)	Number of Holes per Elev
18.00	10.00	18.00	198.00	5.00	0.0150	7,061.00	2

Emergency Spillway

Spillway Elev	Crest Length (ft)	Left Sideslope	Right Sideslope	Bottom Width (ft)
7,066.00	38.00	3.00:1	3.00:1	24.00

Pond Results:

Peak Elevation:	7,064.46 ft
Dewater Time:	1.28 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)
7,048.00	0.000	0.000	0.000	
7,049.00	0.009	0.003	0.000	
7,050.00	0.021	0.018	0.000	
7,051.00	0.035	0.045	0.000	
7,052.00	0.050	0.088	0.000	
7,053.00	0.063	0.144	0.000	
7,054.00	0.078	0.214	0.000	
7,055.00	0.095	0.301	0.000	
7,056.00	0.113	0.405	0.000	
7,057.00	0.132	0.527	0.000	Low hole SPW #1
7,058.00	0.158	0.672	0.473	3.71*
7,059.00	0.183	0.842	0.669	4.40
7,060.00	0.210	1.038	0.819	4.55
7,061.00	0.248	1.267	0.945	7.20 Spillway #1
7,062.00	0.284	1.533	8.509	8.20
7,063.00	0.327	1.838	12.033	0.70
7,064.00	0.371	2.187	14.738	0.85
7,064.46	0.393	2.367	15.782	1.00 Peak Stage
7,065.00	0.417	2.581	17.018	
7,066.00	0.465	3.022	19.026	Spillway #2
7,067.00	0.552	3.529	71.605	
7,068.00	0.576	4.093	211.288	
7,069.00	0.628	4.695	418.987	
7,070.00	0.685	5.351	716.430	
7,071.00	0.760	6.074	1,074.454	

Detailed Discharge Table

Elevation (ft)	Perf. Riser (cfs)	Emergency Spillway (cfs)	Combined Total Discharge (cfs)
7,048.00	0.000	0.000	0.000
7,049.00	0.000	0.000	0.000
7,050.00	0.000	0.000	0.000
7,051.00	0.000	0.000	0.000
7,052.00	0.000	0.000	0.000
7,053.00	0.000	0.000	0.000

Elevation (ft)	Perf. Riser (cfs)	Emergency Spillway (cfs)	Combined Total Discharge (cfs)
7,054.00	0.000	0.000	0.000
7,055.00	0.000	0.000	0.000
7,056.00	0.000	0.000	0.000
7,057.00	3.00>0.000	0.000	0.000
7,058.00	0.473	0.000	0.473
7,059.00	0.669	0.000	0.669
7,060.00	0.819	0.000	0.819
7,061.00	0.945	0.000	0.945
7,062.00	8.509	0.000	8.509
7,063.00	12.033	0.000	12.033
7,064.00	14.738	0.000	14.738
7,065.00	17.018	0.000	17.018
7,066.00	19.026	0.000	19.026
7,067.00	20.842	50.763	71.605
7,068.00	22.512	188.776	211.288
7,069.00	24.066	394.921	418.987
7,070.00	25.526	690.903	716.430
7,071.00	26.907	1,047.547	1,074.454

Structure #7 (Null)

Null at Outlet of Middle Pond

Structure #6 (Vegetated Channel)

Natural Channel Below Middle Pond

Trapezoidal Vegetated Channel Inputs:

Material: Tall fescue

Bottom Width (ft)	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Retardance Classes	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)	Limiting Velocity (fps)
5.00	2.0:1	2.0:1	9.7	D, B				6.0

Vegetated Channel Results:

	Stability Class D w/o Freeboard	Stability Class D w/ Freeboard	Capacity Class B w/o Freeboard	Capacity Class B w/ Freeboard
Design Discharge:	16.04 cfs		16.04 cfs	
Depth:	0.48 ft		0.79 ft	
Top Width:	6.94 ft		8.17 ft	
Velocity:	5.55 fps		3.08 fps	
X-Section Area:	2.89 sq ft		5.21 sq ft	

	Stability Class D w/o Freeboard	Stability Class D w/ Freeboard	Capacity Class B w/o Freeboard	Capacity Class B w/ Freeboard
Hydraulic Radius:	0.403 ft		0.610 ft	
Froude Number:	1.52		0.68	
Roughness Coefficient:	0.0456		0.1085	

Structure #35 (Vegetated Channel)

Natural Channel to Culvert 68

Trapezoidal Vegetated Channel Inputs:

Material: Tall fescue

Bottom Width (ft)	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Retardance Classes	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)	Limiting Velocity (fps)
20.00	5.0:1	5.0:1	10.0	D, B				6.0

Vegetated Channel Results:

	Stability Class D w/o Freeboard	Stability Class D w/ Freeboard	Capacity Class B w/o Freeboard	Capacity Class B w/ Freeboard
Design Discharge:	2.54 cfs		2.54 cfs	
Depth:	0.12 ft		0.29 ft	
Top Width:	21.22 ft		22.90 ft	
Velocity:	1.01 fps		0.41 fps	
X-Section Area:	2.51 sq ft		6.22 sq ft	
Hydraulic Radius:	0.118 ft		0.271 ft	
Froude Number:	0.52		0.14	
Roughness Coefficient:	0.1115		0.4811	

Structure #34 (Culvert)

Culvert 68

Culvert Inputs:

Length (ft)	Slope (%)	Manning's n	Max. Headwater (ft)	Tailwater (ft)	Entrance Loss Coef. (Ke)
380.00	2.00	0.0150	5.00	0.00	0.90

Culvert Results:

Design Discharge = 2.54 cfs

Minimum pipe diameter: 1 - 10 inch pipe(s) required

Structure #33 (Null)

Null below Culvert 68

Structure #32 (Erodible Channel)

Road Ditch to Culvert 69

Triangular Erodible Channel Inputs:

Material: Shales and hardpans

Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Manning's n	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)	Limiting Velocity (fps)
1.5:1	1.5:1	9.0	0.0250				6.0

Erodible Channel Results:

	w/o Freeboard	w/ Freeboard
Design Discharge:	7.19 cfs	
Depth:	0.76 ft	
Top Width:	2.28 ft	
Velocity:	8.30 fps	
X-Section Area:	0.87 sq ft	
Hydraulic Radius:	0.316 ft	
Froude Number:	2.37	

Structure #31 (Culvert)

Culvert 69

Culvert Inputs:

Length (ft)	Slope (%)	Manning's n	Max. Headwater (ft)	Tailwater (ft)	Entrance Loss Coef. (Ke)
170.00	2.00	0.0150	5.00	0.00	0.90

Culvert Results:

Design Discharge = 7.19 cfs

Minimum pipe diameter: 1 - 15 inch pipe(s) required

Structure #30 (Null)

Null below Culvert 69

Structure #29 (Erodible Channel)

Haul Road Ditch to Culvert 70

Triangular Erodible Channel Inputs:

Material: Shales and hardpans

Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Manning's n	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)	Limiting Velocity (fps)
1.5:1	1.5:1	1.5	0.0250				6.0

Erodible Channel Results:

	w/o Freeboard	w/ Freeboard
Design Discharge:	11.84 cfs	
Depth:	1.28 ft	
Top Width:	3.85 ft	
Velocity:	4.80 fps	
X-Section Area:	2.47 sq ft	
Hydraulic Radius:	0.533 ft	
Froude Number:	1.06	

Structure #28 (Culvert)
Culvert 70
Culvert Inputs:

Length (ft)	Slope (%)	Manning's n	Max. Headwater (ft)	Tailwater (ft)	Entrance Loss Coef. (Ke)
170.00	2.00	0.0150	5.00	0.00	0.90

Culvert Results:

Design Discharge = 11.84 cfs

Minimum pipe diameter: 1 - 18 inch pipe(s) required

Structure #27 (Null)
Null Below Culvert 70
Structure #26 (Erodible Channel)
Natural Sorted Ditch at Toe of Temp Spoil Pile
Triangular Erodible Channel Inputs:

Material: Shales and hardpans

Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Manning's n	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)	Limiting Velocity (fps)
1.5:1	1.5:1	12.0	0.0250				6.0

Erodible Channel Results:

	w/o Freeboard	w/ Freeboard
Design Discharge:	77.22 cfs	
Depth:	1.75 ft	
Top Width:	5.26 ft	
Velocity:	16.73 fps	
X-Section Area:	4.61 sq ft	
Hydraulic Radius:	0.730 ft	
Froude Number:	3.15	

Structure #5 (Riprap Channel)

D-3 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)
12.00	2.0:1	2.0:1	16.1	2.98		

Riprap Channel Results:

Simons/OSM Method - Steep Slope Design

	w/o Freeboard	w/ Freeboard
Design Discharge:	0.22 cfs	
Depth:	0.02 ft	3.00 ft
Top Width:	12.07 ft	23.99 ft
Velocity*:		
X-Section Area:	0.22 sq ft	
Hydraulic Radius:	0.019 ft	
Froude Number*:		
Manning's n*:		
Dmin:	2.00 in	
D50:	6.00 in	
Dmax:	7.50 in	

Velocity and Manning's n calculations may not apply for this method.

Structure #4 (Null)

Null at Confluence D-3 Ditch and Little Collom Gulch

Structure #3 (Vegetated Channel)

Little Collom Gulch Natural Channel

Trapezoidal Vegetated Channel Inputs:

Material: Tall fescue

Bottom Width (ft)	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Retardance Classes	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)	Limiting Velocity (fps)
5.00	2.0:1	2.0:1	5.7	D, B				6.0

Vegetated Channel Results:

	Stability Class D w/o Freeboard	Stability Class D w/ Freeboard	Capacity Class B w/o Freeboard	Capacity Class B w/ Freeboard
Design Discharge:	87.92 cfs		87.92 cfs	
Depth:	1.15 ft		1.56 ft	
Top Width:	9.62 ft		11.22 ft	
Velocity:	10.41 fps		6.97 fps	
X-Section Area:	8.44 sq ft		12.62 sq ft	
Hydraulic Radius:	0.831 ft		1.056 ft	
Froude Number:	1.96		1.16	
Roughness Coefficient:	0.0302		0.0529	

Structure #2 (Pond)

Section 25 Pond

Pond Inputs:

Initial Pool Elev:	6,868.00 ft
Initial Pool:	4.36 ac-ft

Perforated Riser

Riser Diameter (in)	Riser Height (ft)	Barrel Diameter (in)	Barrel Length (ft)	Barrel Slope (%)	Manning's n	Spillway Elev (ft)	Number of Holes per Elev
18.00	16.00	18.00	182.00	5.00	0.0150	6,872.00	2

Emergency Spillway

Spillway Elev	Crest Length (ft)	Left Sideslope	Right Sideslope	Bottom Width (ft)
6,875.00	45.00	2.00:1	2.00:1	20.00

Pond Results:

Peak Elevation:	6,875.04 ft
Dewater Time:	2.76 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)
6,855.00	0.047	0.000	0.000	
6,855.01	0.048	0.000	0.000	
6,856.00	0.102	0.073	0.000	
6,857.00	0.156	0.201	0.000	
6,858.00	0.191	0.374	0.000	
6,859.00	0.228	0.583	0.000	
6,860.00	0.266	0.830	0.000	
6,861.00	0.306	1.116	0.000	
6,862.00	0.348	1.443	0.000	
6,863.00	0.391	1.812	0.000	
6,864.00	0.436	2.225	0.000	
6,865.00	0.483	2.684	0.000	
6,866.00	0.532	3.192	0.000	
6,867.00	0.582	3.749	0.000	
6,868.00	0.635	4.357	0.000	Low hole SPW #1
6,869.00	0.689	5.019	0.473	16.94*
6,870.00	0.746	5.736	0.669	12.98*
6,871.00	0.804	6.511	0.819	11.45*
6,872.00	0.864	7.345	0.945	10.67* Spillway #1
6,873.00	0.927	8.240	8.509	9.10
6,874.00	0.991	9.199	12.033	2.15
6,875.00	1.060	10.224	14.738	2.30 Spillway #2
6,875.04	1.061	10.268	16.437	0.55 Peak Stage
6,876.00	1.125	11.316	56.584	
6,877.00	1.187	12.472	168.142	
6,878.00	1.250	13.691	330.639	
6,879.00	1.318	14.975	558.801	
6,880.00	1.386	16.326	834.822	

**Designates time(s) to dewater have been extrapolated beyond the 50 hour hydrograph limit.*

Detailed Discharge Table

Elevation (ft)	Perf. Riser (cfs)	Emergency Spillway (cfs)	Combined Total Discharge (cfs)
6,855.00	0.000	0.000	0.000
6,855.01	0.000	0.000	0.000
6,856.00	0.000	0.000	0.000
6,857.00	0.000	0.000	0.000
6,858.00	0.000	0.000	0.000

Elevation (ft)	Perf. Riser (cfs)	Emergency Spillway (cfs)	Combined Total Discharge (cfs)
6,859.00	0.000	0.000	0.000
6,860.00	0.000	0.000	0.000
6,861.00	0.000	0.000	0.000
6,862.00	0.000	0.000	0.000
6,863.00	0.000	0.000	0.000
6,864.00	0.000	0.000	0.000
6,865.00	0.000	0.000	0.000
6,866.00	0.000	0.000	0.000
6,867.00	0.000	0.000	0.000
6,868.00	3.00>0.000	0.000	0.000
6,869.00	0.473	0.000	0.473
6,870.00	0.669	0.000	0.669
6,871.00	0.819	0.000	0.819
6,872.00	0.945	0.000	0.945
6,873.00	8.509	0.000	8.509
6,874.00	12.033	0.000	12.033
6,875.00	14.738	0.000	14.738
6,876.00	17.018	39.567	56.584
6,877.00	19.026	149.116	168.142
6,878.00	20.842	309.797	330.639
6,879.00	22.512	536.289	558.801
6,880.00	24.066	810.756	834.822

Structure #1 (Null)

Null Below Section 25 Pond

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)
#14	1	1.900	0.009	0.000	0.000	85.000	F	2.10	0.161
	2	18.800	0.156	0.000	0.000	47.000	M	0.00	0.000
	3	4.000	0.025	0.000	0.000	62.000	M	0.55	0.053
	4	26.000	0.148	0.000	0.000	47.000	M	0.00	0.000
	Σ	50.700						2.65	0.215
#15	1	59.600	0.149	0.000	0.000	85.000	F	56.04	4.887
	2	7.200	0.051	0.000	0.000	47.000	M	0.00	0.000
	Σ	117.500						56.57	5.102
#25	1	4.400	0.118	0.000	0.000	85.000	F	4.87	0.374
	Σ	4.400						4.87	0.374
#24	Σ	4.400						4.87	0.374
#23	Σ	4.400						4.87	0.374
#22	1	11.000	0.129	0.000	0.000	85.000	F	10.34	0.902
	2	9.400	0.096	0.000	0.000	47.000	M	0.00	0.000
	3	4.400	0.056	0.000	0.000	85.000	F	4.87	0.374
	Σ	29.200						19.45	1.650
#21	Σ	29.200						19.45	1.650
#20	Σ	29.200						19.45	1.650
#18	1	4.200	0.061	0.000	0.000	85.000	F	4.65	0.357
	Σ	33.400						24.10	2.007
#19	1	5.500	0.062	0.000	0.000	47.000	M	0.00	0.000
	2	7.500	0.181	0.000	0.000	85.000	F	6.97	0.612
	Σ	13.000						6.97	0.612
#17	Σ	13.000						6.97	0.612
#16	Σ	46.400						30.63	2.619
#13	Σ	46.400						30.63	2.619
#12	Σ	163.900						85.94	7.721
#11	1	24.000	1.445	0.000	0.000	47.000	M	0.00	0.000
	2	2.700	0.034	0.000	0.000	85.000	F	2.99	0.229
	3	1.000	0.003	0.000	0.000	98.000	F	1.73	0.172
	Σ	191.600						90.66	8.123

Stru #	SWS #	SWS Area (ac)	Time of Conc (hrs)	Musk K (hrs)	Musk X	Curve Number	UHS	Peak Discharge (cfs)	Runoff Volume (ac-ft)
#10	Σ	191.600						90.66	8.123
#9	Σ	191.600						21.59	8.116
#8	1	19.600	0.108	0.000	0.000	47.000	M	0.00	0.000
	Σ	211.200						21.59	8.116
#7	Σ	211.200						15.78	8.096
#6	1	75.900	0.401	0.000	0.000	47.000	M	0.01	0.000
	2	3.200	0.068	0.000	0.000	85.000	F	3.54	0.272
	3	0.800	0.006	0.000	0.000	98.000	F	1.39	0.137
	Σ	291.100						16.04	8.505
#35	1	2.300	0.065	0.000	0.000	85.000	F	2.54	0.195
	2	5.500	0.079	0.000	0.000	47.000	M	0.00	0.000
	Σ	7.800						2.54	0.195
#34	Σ	7.800						2.54	0.195
#33	Σ	7.800						2.54	0.195
#32	1	4.200	0.053	0.000	0.000	85.000	F	4.65	0.357
	2	5.700	0.095	0.000	0.000	47.000	M	0.00	0.000
	Σ	17.700						7.19	0.552
#31	Σ	17.700						7.19	0.552
#30	Σ	17.700						7.19	0.552
#29	1	2.700	0.031	0.000	0.000	47.000	M	0.00	0.000
	2	4.200	0.045	0.000	0.000	85.000	F	4.65	0.357
	Σ	24.600						11.84	0.909
#28	Σ	24.600						11.84	0.909
#27	Σ	24.600						11.84	0.909
#26	1	79.600	0.009	0.000	0.000	74.000	F	46.25	3.307
	2	17.300	0.036	0.000	0.000	85.000	F	19.14	1.471
	Σ	121.500						77.22	5.687
#5	1	14.800	0.082	0.000	0.000	57.000	F	0.22	0.092
	Σ	14.800						0.22	0.092
#4	Σ	14.800						0.22	0.092
#3	1	167.900	0.156	0.000	0.000	47.000	M	0.03	0.002
	2	18.400	0.057	0.000	0.000	74.000	F	10.69	0.764
	Σ	322.600						87.92	6.545

Stru #	SWS #	SWS Area (ac)	Time of Conc (hrs)	Musk K (hrs)	Musk X	Curve Number	UHS	Peak Discharge (cfs)	Runoff Volume (ac-ft)
#2	Σ	613.700						93.54	15.051
#1	Σ	613.700						16.44	12.766

Subwatershed Time of Concentration Details:

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#3	1	3. Short grass pasture	11.50	175.72	1,528.00	2.710	0.156
#3	1	Time of Concentration:					0.156
#3	2	5. Nearly bare and untilled, and alluvial valley fans	23.00	227.24	988.00	4.790	0.057
#3	2	Time of Concentration:					0.057
#5	1	3. Short grass pasture	19.00	196.84	1,036.00	3.480	0.082
#5	1	Time of Concentration:					0.082
#6	1	3. Short grass pasture	10.00	364.30	3,643.00	2.520	0.401
#6	1	Time of Concentration:					0.401
#6	2	5. Nearly bare and untilled, and alluvial valley fans	2.00	7.00	350.00	1.410	0.068
#6	2	Time of Concentration:					0.068
#6	3	7. Paved area and small upland gullies	1.00	0.50	50.00	2.010	0.006
#6	3	Time of Concentration:					0.006
#8	1	3. Short grass pasture	10.00	98.40	984.00	2.520	0.108
#8	1	Time of Concentration:					0.108
#11	1	3. Short grass pasture	8.00	941.00	11,762.50	2.260	1.445
#11	1	Time of Concentration:					1.445
#11	2	5. Nearly bare and untilled, and alluvial valley fans	1.50	2.25	150.00	1.220	0.034
#11	2	Time of Concentration:					0.034
#11	3	7. Paved area and small upland gullies	1.00	0.24	24.00	2.010	0.003
#11	3	Time of Concentration:					0.003
#14	1	5. Nearly bare and untilled, and alluvial valley fans	27.00	49.14	182.00	5.190	0.009
#14	1	Time of Concentration:					0.009
#14	2	3. Short grass pasture	9.00	121.68	1,352.00	2.400	0.156
#14	2	Time of Concentration:					0.156
#14	3	3. Short grass pasture	10.00	23.40	234.00	2.520	0.025
#14	3	Time of Concentration:					0.025
#14	4	3. Short grass pasture	7.00	78.89	1,127.00	2.110	0.148
#14	4	Time of Concentration:					0.148
#15	1	5. Nearly bare and untilled, and alluvial valley fans	6.00	78.54	1,309.00	2.440	0.149
#15	1	Time of Concentration:					0.149

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#15	2	3. Short grass pasture	10.00	47.00	470.00	2.520	0.051
#15	2	Time of Concentration:					0.051
#18	1	5. Nearly bare and untilled, and alluvial valley fans	8.00	49.60	620.00	2.820	0.061
#18	1	Time of Concentration:					0.061
#19	1	3. Short grass pasture	9.00	48.51	539.00	2.400	0.062
#19	1	Time of Concentration:					0.062
#19	2	5. Nearly bare and untilled, and alluvial valley fans	8.00	147.03	1,838.00	2.820	0.181
#19	2	Time of Concentration:					0.181
#22	1	5. Nearly bare and untilled, and alluvial valley fans	6.00	68.40	1,140.00	2.440	0.129
#22	1	Time of Concentration:					0.129
#22	2	3. Short grass pasture	9.00	75.42	838.00	2.400	0.096
#22	2	Time of Concentration:					0.096
#22	3	5. Nearly bare and untilled, and alluvial valley fans	2.00	5.70	285.00	1.410	0.056
#22	3	Time of Concentration:					0.056
#25	1	5. Nearly bare and untilled, and alluvial valley fans	8.00	96.00	1,200.00	2.820	0.118
#25	1	Time of Concentration:					0.118
#26	1	3. Short grass pasture	31.00	44.95	145.00	4.450	0.009
#26	1	Time of Concentration:					0.009
#26	2	5. Nearly bare and untilled, and alluvial valley fans	24.00	152.64	636.00	4.890	0.036
#26	2	Time of Concentration:					0.036
#29	1	3. Short grass pasture	9.00	24.30	270.00	2.400	0.031
#29	1	Time of Concentration:					0.031
#29	2	5. Nearly bare and untilled, and alluvial valley fans	13.00	76.96	592.00	3.600	0.045
#29	2	Time of Concentration:					0.045
#32	1	5. Nearly bare and untilled, and alluvial valley fans	9.00	51.66	574.00	3.000	0.053
#32	1	Time of Concentration:					0.053
#32	2	3. Short grass pasture	9.00	73.89	821.00	2.400	0.095
#32	2	Time of Concentration:					0.095
#35	1	5. Nearly bare and untilled, and alluvial valley fans	8.00	52.87	661.00	2.820	0.065
#35	1	Time of Concentration:					0.065
#35	2	3. Short grass pasture	10.00	71.90	719.00	2.520	0.079
#35	2	Time of Concentration:					0.079

Exhibit 7, Item 23, PART C
Section 26 Pond Sediment Control During Mining

Introduction

Exhibit 7, Item 14 in Volume 2D describes the hydrologic methodology used in sediment pond, permanent post-mine channels, and temporary conveyance channel demonstrations. Runoff curve numbers assigned to the undisturbed and/or reclaimed lands in various stages of mining and reclamation have been selected in accordance with Table 1 in the Introductory Text for Exhibit 7 in Volume 2D or as further described below. For channels protected by a riprap liner, selection of minimum riprap size is done using the Simons/OSM method in SEDCADTM. For channels to be protected by a vegetative liner, the permissible velocities are also determined using SEDCADTM routines.

SEDCADTM demonstrations with two distinct time frames have been evaluated in detail for the Section 26 Pond. Exhibit 7, Item 23, Parts I addresses sediment control for the Section 26 Pond during the post mining timeframe including post mine drainage channels.

This exhibit (Exhibit 7, Item 23, Part B) address sediment control during the mining timeframe for the Section 26 Pond and provides demonstrations for the temporary channel configurations supporting the Section 26 Pond. The assumed condition during mining is the temporary spoil pile is constructed to its maximum configuration and the entire area from the temporary spoil pile and native areas below are reporting to the Section 26 Pond.

Based on recommendations provided in a February 2015 telephone conversation with Dr. Richard Warner of the University of Kentucky Biosystems and Agricultural Engineering Department, and a coauthor of the SEDCADTM Design Manual and User's Guide, the "Cover Factor" appropriate for loose dumped spoil is between 0.40 and 0.45. The higher value was conservatively selected for use in this analysis. When advised that we are using curve number of 74 for runoff from loose dumped spoils, as per the approved Introductory Text of Volume 2D, Dr. Warner pointed out that a value of 74 is probably an overly conservative number, and a value on the order of 65 would be more appropriate based on his experience and measurements made over the years at numerous coal mines. A curve number of 74 was nevertheless used for spoil piles in the SEDCADTM modeling included in this submittal.

Selection of SEDCADTM input parameters L and S which are needed for sediment generation in the sedimentation evaluation analysis are selected on a case basis for each subwatershed. The MUSLE (Modified Soil Loss Equation) is used to estimate sediment generation at the source. Selection of the parameters R, K, LS C and P is described in the literature. LS is derived via an equation that includes a "length" parameter "L", and a "slope" parameter "S". However, LS is not the simple product of those two terms. Both "L" and "S" are based on the topography of the subwatershed in question with certain limitations provided in the literature as well as SEDCADTM users' training courses. First a representative slope is determined from the topography, and this sets the parameter "S". The "length" parameter "L" is more complicated as it represents the longest slope that water will have to flow before encountering a concentration point, such as a rivulet of a distinct slope change. SEDCADTM instructors advise that regardless of the topography, "L" can ever practicably exceed about 200 feet.

The selection of "L" and "S" for input into the SEDCAD™ model for the near repose angle slopes of a benched spoil pile is also complex. The values of 145 feet for "L" and 31% for "S" were selected for the dumped spoil pile lifts to approximate the combined LS factor that would apply to a compound slope, in this case a concave slope with a very steep (repose angle) upper part and a very flat lower part (bench). SEDCAD™ cannot handle a compound slope directly, but a method to do so is described in Chapter 5 of "Hydrology and Sedimentology for Disturbed Areas" by Barfield, Warner and Haan, 1981. The method uses the original 1965 Wischmeier and Smith USDA Handbook No. 282 formula, then adjusts each segment with a factor, and finally provides a weighted average for the compound slope.

The above described method was applied to a 65 foot upper segment at repose angle (77%) followed by an 85 foot flat bench at 1%, resulting in a weighted average LS of 9.0. Several possible combinations of a single L and a single S were then examined for input into SEDCAD™ to arrive at a similar LS factor. It was found that a single line with L of 145 feet with a drop of 45 feet, producing a S of 31% produces a LS of 10.1, which is slightly higher than the calculated value of 9.0 for the actual compound slope. That line also happens to be close to a simple straight line from the crest of one bench to the crest of the next one lower down the face, so it has some physical relevance to the actual spoil pile face. The L and S of 145 feet and 31%, producing a LS factor about 12% greater than the actual compound concave slope calculated were then conservatively used in the modeling of all spoil pile faces.

Section 26 Pond – During Mining

The location of the Section 26 Pond and its watershed is presented on Map 41B. The temporary channels that route water to the Section 26 Pond are presented on 41B.

The as-built configuration for the Section 26 Pond is presented on Figure 7-23J-1, and the as-built configuration for the Sidehill Pond is presented on Figure 7-23J-2. Figure 7-23D-1 provides the breakdown of drainage areas and hydrologic conditions for all areas in the watershed reporting to these two sediment ponds during mining. The Sidehill Pond is part of the Section 26 Pond sediment control system and is utilized to reduced peak flows and provide additional sediment storage if need. All discharges from the Sidehill Ponds flow directly to the Section 26 Pond through the D-1 Ditch, and the Section 26 Pond is the final discharge location.

The SEDCAD™ model herein provides the results of the 10-year 24-hour design storm and demonstrates the Section 26 Pond will meet the applicable settleable solids standard under this modeled storm event. The second SEDCAD™ model demonstrates that the Section 26 Pond emergency spillway elevation is capable of containing the 25-year 24-hour storm.

In summary, for the mining case at the Section 26 Pond, the 10-year 24-hour storm produces 2.2 acre feet of runoff, and the peak settleable solids concentration is 0.00 ml/l. The 25-year 24-hour storm event peaks at the 6,984.1 elevation, which is below the emergency spillway elevation of 6,986.0'

Temporary Channels

The Section 26 Pond watershed is comprised of three temporary channels including the D-1, D-2, and D-6 Ditches. The configuration for each of these three ditches is include in the Section 26 Pond 10-Year, 24-Hour During Mining Storm Event Demonstration and is further outlined as described in the following table:

Ditch Name	Flow, Q	Slope, %	Type	Specified Depth	Bottom Width	Side Slope, H:1V	Rip Rap, D50, in
D-1 Ditch	12.4	21.0%	riprap	4.0	12.0	2.0	6.0
D-2 Ditch	10.5	4.9%	riprap	4.0	12.0	2.0	3.0
D-4 Ditch	37.6	5.9%	vegetated	4.0	20.0	2.0	NA

Section 26 Pond **Effluent Demonstration**

10-Year 24-Hour Storm Event
During Mining

Tony Tennyson

Tri-State Generation & Transmission Association, Inc.
1100 West 116th Avenue
Westminster, CO 80234

Phone: (970) 326-3560
Email: ttennyson@tristategt.org

General Information

Storm Information:

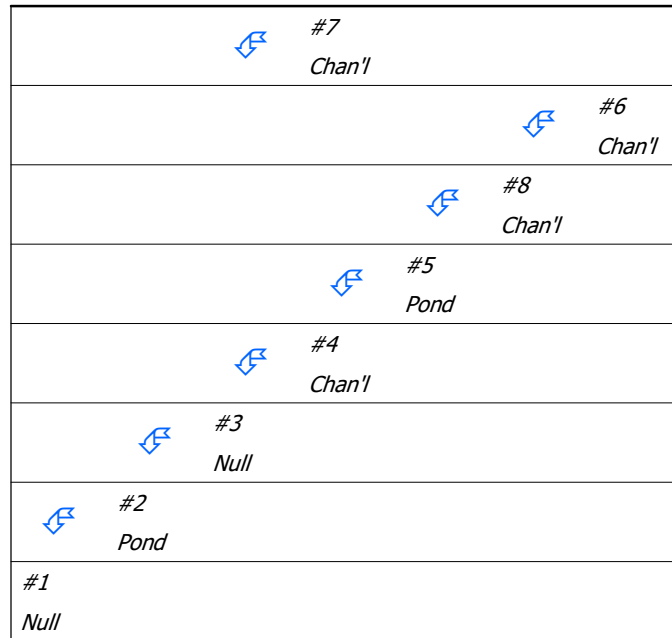
Storm Type:	NRCS Type II
Design Storm:	10 yr - 24 hr
Rainfall Depth:	1.800 inches

Particle Size Distribution:

Size (mm)	Colowyo Particle Size
4.7500	100.000%
0.0750	73.000%
0.0400	33.000%
0.0010	20.000%

Structure Networking:

Type	Stru #	(flows into)	Stru #	Musk. K (hrs)	Musk. X	Description
Null	#1	==>	End	0.000	0.000	Null Below Section 26 Pond
Pond	#2	==>	#1	0.000	0.000	Section 26 Pond
Null	#3	==>	#2	0.000	0.000	Null at Confluence of D-1 & D-2 Ditch
Channel	#4	==>	#3	0.000	0.000	D-1 Ditch
Pond	#5	==>	#4	0.000	0.000	Sidehill Pond
Channel	#6	==>	#8	0.000	0.000	D-4 Ditch 7+50 to 37+41
Channel	#7	==>	#3	0.000	0.000	D-2 Ditch
Channel	#8	==>	#5	0.000	0.000	D-4 Ditch 0+00 to 7+50



Structure Summary:

	Immediate Contributing Area (ac)	Total Contributing Area (ac)	Peak Discharge (cfs)	Total Runoff Volume (ac-ft)	Sediment (tons)	Peak Sediment Conc. (mg/l)	Peak Settleable Conc. (ml/l)	24VW (ml/l)
#7	55.400	55.400	3.76	0.34	42.9	180,100	99.06	47.97
#6	63.800	63.800	22.20	1.62	625.3	538,916	307.16	140.18
#8	1.700	65.500	23.44	1.72	634.5	521,132	297.03	135.33
#5	In Out	0.000	65.500	23.44	634.5	521,132	297.03	135.33
				0.65	30.5	20,180	0.00	0.00
#4	1.500	67.000	1.47	1.60	64.5	399,605	120.16	9.22
#3	0.000	122.400	5.22	1.94	107.4	260,316	104.19	17.52
#2	In Out	5.900	128.300	8.14	169.2	285,106	131.79	28.57
				0.82	36.3	15,695	0.00	0.00
#1	0.000	128.300	0.82	1.89	36.3	15,689	0.00	0.00

Particle Size Distribution(s) at Each Structure

Structure #7 (D-2 Ditch):

Size (mm)	In/Out
4.7500	100.000%
0.0750	79.337%
0.0400	35.865%
0.0010	21.736%

Structure #6 (D-4 Ditch 7+50 to 37+41):

Size (mm)	In/Out
4.7500	100.000%
0.0750	73.000%
0.0400	33.000%
0.0010	20.000%

Structure #8 (D-4 Ditch 0+00 to 7+50):

Size (mm)	In/Out
4.7500	100.000%
0.0750	73.000%
0.0400	33.000%
0.0010	20.000%

Structure #5 (Sidehill Pond):

Size (mm)	In	Out
4.7500	100.000%	100.000%
0.0750	73.000%	100.000%
0.0400	33.000%	100.000%
0.0010	20.000%	100.000%

Structure #4 (D-1 Ditch):

Size (mm)	In/Out
4.7500	100.000%
0.0750	85.754%
0.0400	64.650%
0.0010	57.791%

Structure #3 (Null at Confluence of D-1 & D-2 Ditch):

Size (mm)	In/Out
4.7500	100.000%
0.0750	83.192%
0.0400	53.156%
0.0010	43.395%

Structure #2 (Section 26 Pond):

Size (mm)	In	Out
4.7500	100.000%	100.000%
0.0750	79.467%	100.000%
0.0400	45.790%	100.000%
0.0010	34.845%	100.000%

Structure #1:

Size (mm)	In/Out
4.7500	100.000%
0.0750	100.000%
0.0400	100.000%
0.0010	100.000%

Structure Detail:

Structure #7 (Riprap Channel)

D-2 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)
12.00	2.0:1	2.0:1	4.9	3.91		

Riprap Channel Results:

Simons/OSM Method - Steep Slope Design

	w/o Freeboard	w/ Freeboard
Design Discharge:	3.76 cfs	
Depth:	0.09 ft	4.00 ft
Top Width:	12.34 ft	27.98 ft
Velocity*:		
X-Section Area:	1.04 sq ft	
Hydraulic Radius:	0.084 ft	
Froude Number*:		
Manning's n*:		
Dmin:	1.00 in	
D50:	3.00 in	
Dmax:	3.75 in	

Velocity and Manning's n calculations may not apply for this method.

Structure #6 (Vegetated Channel)

D-4 Ditch 7+50 to 37+41

Trapezoidal Vegetated Channel Inputs:

Material: Tall fescue

Bottom Width (ft)	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Retardance Classes	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)	Limiting Velocity (fps)
12.00	2.0:1	2.0:1	5.9	D, B	3.25			6.0

Vegetated Channel Results:

	Stability Class D w/o Freeboard	Stability Class D w/ Freeboard	Capacity Class B w/o Freeboard	Capacity Class B w/ Freeboard
Design Discharge:	22.20 cfs		22.20 cfs	
Depth:	0.44 ft	3.69 ft	0.75 ft	4.00 ft
Top Width:	13.76 ft	26.76 ft	15.00 ft	28.00 ft
Velocity:	3.92 fps		2.20 fps	
X-Section Area:	5.67 sq ft		10.11 sq ft	
Hydraulic Radius:	0.406 ft		0.659 ft	
Froude Number:	1.08		0.47	
Roughness Coefficient:	0.0506		0.1245	

Structure #8 (Vegetated Channel)

D-4 Ditch 0+00 to 7+50

Trapezoidal Vegetated Channel Inputs:

Material: Tall fescue

Bottom Width (ft)	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Retardance Classes	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)	Limiting Velocity (fps)
12.00	2.0:1	2.0:1	5.9	D, B	3.68			6.0

Vegetated Channel Results:

	Stability Class D w/o Freeboard	Stability Class D w/ Freeboard	Capacity Class B w/o Freeboard	Capacity Class B w/ Freeboard
Design Discharge:	23.44 cfs		23.44 cfs	
Depth:	0.45 ft	4.13 ft	0.76 ft	4.44 ft
Top Width:	13.80 ft	28.52 ft	15.04 ft	29.76 ft
Velocity:	4.03 fps		2.28 fps	
X-Section Area:	5.82 sq ft		10.29 sq ft	
Hydraulic Radius:	0.415 ft		0.668 ft	
Froude Number:	1.09		0.49	
Roughness Coefficient:	0.0498		0.1212	

Structure #5 (Pond)

Sidehill Pond

Pond Inputs:

Initial Pool Elev:	7,166.00 ft
Initial Pool:	3.40 ac-ft
*Sediment Storage:	0.00 ac-ft
Dead Space:	20.00 %

**No sediment capacity defined*

Perforated Riser

Riser Diameter (in)	Riser Height (ft)	Barrel Diameter (in)	Barrel Length (ft)	Barrel Slope (%)	Manning's n	Spillway Elev (ft)	Number of Holes per Elev
18.00	7.00	18.00	90.00	2.00	0.0150	7,169.70	2

Pond Results:

Peak Elevation:	7,167.92 ft
H'graph Detention Time:	12.88 hrs
Pond Model:	CSTRS
Dewater Time:	1.24 days
Trap Efficiency:	95.20 %

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)
7,155.00	0.000	0.000	0.000	Top of Sed. Storage
7,156.00	0.157	0.052	0.000	
7,157.00	0.205	0.233	0.000	
7,158.00	0.234	0.452	0.000	
7,159.00	0.264	0.701	0.000	
7,160.00	0.294	0.979	0.000	
7,161.00	0.328	1.290	0.000	
7,162.00	0.362	1.635	0.000	
7,163.00	0.399	2.016	0.000	
7,164.00	0.440	2.435	0.000	
7,165.00	0.480	2.895	0.000	
7,166.00	0.525	3.397	0.000	Low hole SPW #1
7,167.00	0.572	3.945	0.473	14.04*
7,167.92	0.618	4.496	0.653	15.75 Peak Stage
7,168.00	0.622	4.542	0.669	
7,169.00	0.672	5.189	0.819	
7,169.70	0.708	5.672	0.909	Spillway #1
7,170.00	0.724	5.887	2.398	
7,171.00	0.778	6.638	9.701	
7,172.00	0.833	7.443	12.904	
7,173.00	0.833	8.276	15.456	
7,174.00	0.833	9.108	17.644	

Detailed Discharge Table

Elevation (ft)	Perf. Riser (cfs)	Combined Total Discharge (cfs)
7,155.00	0.000	0.000
7,156.00	0.000	0.000
7,157.00	0.000	0.000
7,158.00	0.000	0.000
7,159.00	0.000	0.000
7,160.00	0.000	0.000
7,161.00	0.000	0.000
7,162.00	0.000	0.000
7,163.00	0.000	0.000
7,164.00	0.000	0.000
7,165.00	0.000	0.000
7,166.00	3.00>0.000	0.000
7,167.00	0.473	0.473
7,168.00	0.669	0.669
7,169.00	0.819	0.819
7,169.70	0.909	0.909
7,170.00	2.398	2.398
7,171.00	9.701	9.701
7,172.00	12.904	12.904
7,173.00	15.456	15.456
7,174.00	17.644	17.644

Structure #4 (Riprap Channel)

D-1 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)
12.00	2.0:1	2.0:1	21.0	3.98		

Riprap Channel Results:

Simons/OSM Method - Steep Slope Design

	w/o Freeboard	w/ Freeboard
Design Discharge:	1.47 cfs	
Depth:	0.02 ft	4.00 ft
Top Width:	12.08 ft	28.00 ft
Velocity*:		

	w/o Freeboard	w/ Freeboard
X-Section Area:	0.23 sq ft	
Hydraulic Radius:	0.019 ft	
Froude Number*:		
Manning's n*:		
Dmin:	2.00 in	
D50:	6.00 in	
Dmax:	7.50 in	

Velocity and Manning's n calculations may not apply for this method.

Structure #3 (Null)

Null at Confluence of D-1 & D-2 Ditch

Structure #2 (Pond)

Section 26 Pond

Pond Inputs:

Initial Pool Elev:	6,982.00 ft
Initial Pool:	1.62 ac-ft
*Sediment Storage:	0.00 ac-ft
Dead Space:	20.00 %

**No sediment capacity defined*

Perforated Riser

Riser Diameter (in)	Riser Height (ft)	Barrel Diameter (in)	Barrel Length (ft)	Barrel Slope (%)	Manning's n	Spillway Elev (ft)	Number of Holes per Elev
18.00	14.00	18.00	200.00	4.00	0.0150	6,984.00	2

Emergency Spillway

Spillway Elev	Crest Length (ft)	Left Sideslope	Right Sideslope	Bottom Width (ft)
6,986.00	30.00	2.50:1	2.50:1	24.00

Pond Results:

Peak Elevation:	6,984.02 ft
H'graph Detention Time:	6.61 hrs
Pond Model:	CSTRS
Dewater Time:	1.34 days
Trap Efficiency:	78.55 %

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)
6,969.00	0.039	0.000	0.000	Top of Sed. Storage
6,970.00	0.014	0.026	0.000	
6,971.00	0.027	0.046	0.000	
6,972.00	0.042	0.080	0.000	
6,973.00	0.060	0.130	0.000	
6,974.00	0.079	0.199	0.000	
6,975.00	0.100	0.288	0.000	
6,976.00	0.124	0.400	0.000	
6,977.00	0.148	0.536	0.000	
6,978.00	0.175	0.698	0.000	
6,979.00	0.203	0.886	0.000	
6,980.00	0.231	1.103	0.000	
6,981.00	0.260	1.349	0.000	
6,982.00	0.290	1.623	0.000	Low hole SPW #1
6,983.00	0.319	1.927	0.473	7.79*
6,984.00	0.350	2.262	0.669	23.20 Spillway #1
6,984.02	0.351	2.269	0.822	1.15 Peak Stage
6,985.00	0.381	2.627	8.509	
6,986.00	0.414	3.025	12.033	Spillway #2
6,987.00	0.414	3.439	67.527	
6,988.00	0.414	3.853	204.557	
6,989.00	0.414	4.267	411.119	
6,990.00	0.414	4.681	688.306	
6,991.00	0.414	5.095	1,033.669	

**Designates time(s) to dewater have been extrapolated beyond the 50 hour hydrograph limit.*

Detailed Discharge Table

Elevation (ft)	Perf. Riser (cfs)	Emergency Spillway (cfs)	Combined Total Discharge (cfs)
6,969.00	0.000	0.000	0.000
6,970.00	0.000	0.000	0.000
6,971.00	0.000	0.000	0.000
6,972.00	0.000	0.000	0.000
6,973.00	0.000	0.000	0.000
6,974.00	0.000	0.000	0.000
6,975.00	0.000	0.000	0.000
6,976.00	0.000	0.000	0.000
6,977.00	0.000	0.000	0.000

Elevation (ft)	Perf. Riser (cfs)	Emergency Spillway (cfs)	Combined Total Discharge (cfs)
6,978.00	0.000	0.000	0.000
6,979.00	0.000	0.000	0.000
6,980.00	0.000	0.000	0.000
6,981.00	0.000	0.000	0.000
6,982.00	3.00>0.000	0.000	0.000
6,983.00	0.473	0.000	0.473
6,984.00	0.669	0.000	0.669
6,985.00	8.509	0.000	8.509
6,986.00	12.033	0.000	12.033
6,987.00	14.738	52.789	67.527
6,988.00	17.018	187.539	204.557
6,989.00	19.026	392.093	411.119
6,990.00	20.842	667.464	688.306
6,991.00	22.512	1,011.157	1,033.669

Structure #1 (Null)

Null Below Section 26 Pond

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)
#7	1	1.900	0.016	0.000	0.000	74.000	F	0.57	0.041
	2	16.800	0.216	0.000	0.000	47.000	M	0.00	0.000
	3	5.800	0.132	0.000	0.000	85.000	F	3.48	0.304
	4	26.400	0.193	0.000	0.000	47.000	M	0.00	0.000
	5	4.500	0.031	0.000	0.000	47.000	M	0.00	0.000
	Σ	55.400						3.76	0.345
#6	1	56.500	0.056	0.000	0.000	74.000	F	16.88	1.227
	2	7.300	0.044	0.000	0.000	85.000	F	5.32	0.396
	Σ	63.800						22.20	1.623
#8	1	1.700	0.018	0.000	0.000	85.000	F	1.24	0.092
	Σ	65.500						23.44	1.716
#5	Σ	65.500						23.44	1.716
#4	1	1.500	0.017	0.000	0.000	85.000	F	1.09	0.081
	Σ	67.000						1.47	1.596
#3	Σ	122.400						5.22	1.941
#2	1	1.000	0.010	0.000	0.000	85.000	F	0.73	0.054
	2	1.900	0.014	0.000	0.000	57.000	M	0.00	0.000
	3	3.000	0.003	0.000	0.000	85.000	F	2.19	0.163
	Σ	128.300						8.14	2.158
#1	Σ	128.300						0.82	1.888

Subwatershed Sedimentology Detail:

Stru #	SWS #	Soil K	L (ft)	S (%)	C	P	PS #	Sediment (tons)	Peak Sediment Conc. (mg/l)	Peak Settleable Conc (ml/l)	24VW (ml/l)
#7	1	0.300	145.00	31.00	0.4500	1.0000	1	10.8	395,631	225.50	99.10
	2	0.300	400.00	4.00	0.0310	0.9000	1	0.0	1	0.00	0.00
	3	0.300	400.00	4.80	1.0000	0.9000	1	32.1	142,690	77.52	40.52
	4	0.300	400.00	9.00	0.0310	0.9000	1	0.0	1	0.00	0.00
	5	0.300	200.00	27.00	0.0310	0.9000	1	0.0	1	0.00	0.00
	Σ							42.9	180,100	99.06	47.97
#6	1	0.300	200.00	31.00	0.4500	1.0000	1	584.9	637,845	363.55	167.88
	2	0.300	200.00	6.00	1.0000	0.9000	1	40.5	141,378	80.58	41.11

Stru #	SWS #	Soil K	L (ft)	S (%)	C	P	PS #	Sediment (tons)	Peak Sediment Conc. (mg/l)	Peak Settleable Conc (ml/l)	24VW (ml/l)
Σ								625.3	538,916	307.16	140.18
#8	1	0.300	50.00	12.00	1.0000	0.9000	1	9.1	137,232	78.22	39.94
Σ								634.5	521,132	297.03	135.33
#5 Σ								634.5	521,132	297.03	135.33
#4	1	0.300	100.00	29.00	1.0000	0.9000	1	34.0	492,403	280.65	150.26
Σ								64.5	399,605	120.16	9.22
#3 Σ								107.4	260,316	104.19	17.52
#2	1	0.300	50.00	17.00	1.0000	0.9000	1	7.8	195,479	111.42	57.41
	2	0.300	75.00	25.00	0.0850	0.9000	1	0.0	1	0.00	0.00
	3	0.300	50.00	32.00	1.0000	0.9000	1	54.0	407,119	232.04	122.58
Σ								169.2	285,106	131.79	28.57
#1 Σ								36.3	15,689	0.00	0.00

Subwatershed Time of Concentration Details:

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#2	1	5. Nearly bare and untilled, and alluvial valley fans	17.00	25.84	152.00	4.120	0.010
#2	1	Time of Concentration:					0.010
#2	2	3. Short grass pasture	24.80	50.09	202.00	3.980	0.014
#2	2	Time of Concentration:					0.014
#2	3	5. Nearly bare and untilled, and alluvial valley fans	32.00	25.28	79.00	5.650	0.003
#2	3	Time of Concentration:					0.003
#4	1	5. Nearly bare and untilled, and alluvial valley fans	29.00	100.34	346.00	5.380	0.017
#4	1	Time of Concentration:					0.017
#6	1	5. Nearly bare and untilled, and alluvial valley fans	31.00	348.75	1,125.00	5.560	0.056
#6	1	Time of Concentration:					0.056
#6	2	5. Nearly bare and untilled, and alluvial valley fans	6.00	23.46	391.00	2.440	0.044
#6	2	Time of Concentration:					0.044
#7	1	5. Nearly bare and untilled, and alluvial valley fans	31.00	102.50	330.64	5.560	0.016
#7	1	Time of Concentration:					0.016
#7	2	3. Short grass pasture	4.00	49.80	1,245.00	1.600	0.216
#7	2	Time of Concentration:					0.216
#7	3	5. Nearly bare and untilled, and alluvial valley fans	4.80	50.20	1,046.00	2.190	0.132

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#7	3	Time of Concentration:					0.132
#7	4	3. Short grass pasture	9.00	150.12	1,668.00	2.400	0.193
#7	4	Time of Concentration:					0.193
#7	5	3. Short grass pasture	27.00	126.90	470.00	4.150	0.031
#7	5	Time of Concentration:					0.031
#8	1	5. Nearly bare and untilled, and alluvial valley fans	11.00	23.98	218.00	3.310	0.018
#8	1	Time of Concentration:					0.018

Section 26 Pond **Emergency Spillway Demonstration**

25-Year 24-Hour Storm Event
During Mining

Tony Tennyson

Tri-State Generation & Transmission Association, Inc.
1100 West 116th Avenue
Westminster, CO 80234

Phone: (970) 326-3560
Email: ttennyson@tristategt.org

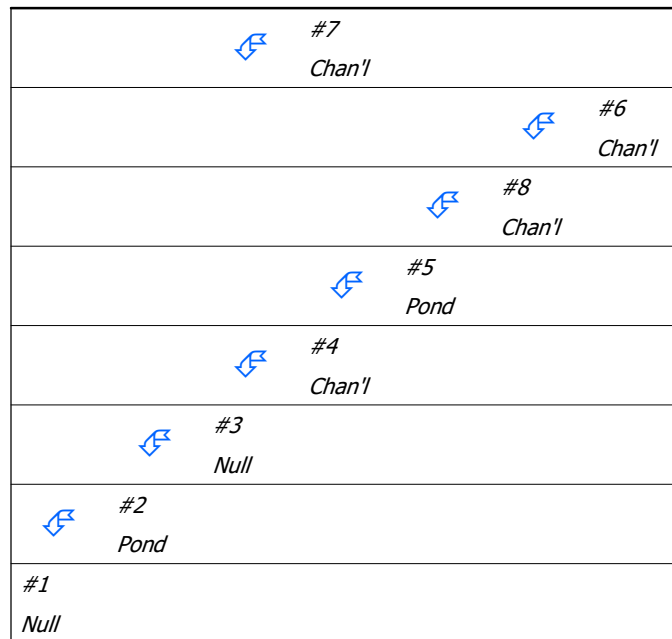
General Information

Storm Information:

Storm Type:	NRCS Type II
Design Storm:	25 yr - 24 hr
Rainfall Depth:	2.300 inches

Structure Networking:

Type	Stru #	(flows into)	Stru #	Musk. K (hrs)	Musk. X	Description
Null	#1	==>	End	0.000	0.000	Null Below Section 26 Pond
Pond	#2	==>	#1	0.000	0.000	Section 26 Pond
Null	#3	==>	#2	0.000	0.000	Null at Confluence of D-1 & D-2 Ditch
Channel	#4	==>	#3	0.000	0.000	D-1 Ditch
Pond	#5	==>	#4	0.000	0.000	Sidehill Pond
Channel	#6	==>	#8	0.000	0.000	D-4 Ditch 7+50 to 37+41
Channel	#7	==>	#3	0.000	0.000	D-2 Ditch
Channel	#8	==>	#5	0.000	0.000	D-4 Ditch 0+00 to 7+50



Structure Summary:

	Immediate Contributing Area (ac)	Total Contributing Area (ac)	Peak Discharge (cfs)	Total Runoff Volume (ac-ft)
#7	55.400	55.400	6.23	0.55
#6	63.800	63.800	40.90	2.97
#8	1.700	65.500	42.78	3.11
#5 In	0.000	65.500	42.78	3.11
Out			0.90	2.41
#4	1.500	67.000	2.27	2.54
#3	0.000	122.400	8.50	3.09
#2 In	5.900	128.300	12.93	3.44
Out			1.57	2.85
#1	0.000	128.300	1.57	2.85

Structure Detail:

Structure #7 (Riprap Channel)

D-2 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)
12.00	2.0:1	2.0:1	4.9	3.91		

Riprap Channel Results:

Simons/OSM Method - Steep Slope Design

	w/o Freeboard	w/ Freeboard
Design Discharge:	6.23 cfs	
Depth:	0.11 ft	4.02 ft
Top Width:	12.44 ft	28.08 ft
Velocity*:		
X-Section Area:	1.33 sq ft	
Hydraulic Radius:	0.107 ft	
Froude Number*:		
Manning's n*:		
Dmin:	1.00 in	
D50:	3.00 in	
Dmax:	3.75 in	

Velocity and Manning's n calculations may not apply for this method.

Structure #6 (Vegetated Channel)

D-4 Ditch 7+50 to 37+41

Trapezoidal Vegetated Channel Inputs:

Material: Tall fescue

Bottom Width (ft)	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Retardance Classes	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)	Limiting Velocity (fps)
12.00	2.0:1	2.0:1	5.9	D, B	3.25			6.0

Vegetated Channel Results:

	Stability Class D w/o Freeboard	Stability Class D w/ Freeboard	Capacity Class B w/o Freeboard	Capacity Class B w/ Freeboard
Design Discharge:	40.90 cfs		40.90 cfs	
Depth:	0.57 ft	3.82 ft	0.90 ft	4.15 ft
Top Width:	14.28 ft	27.28 ft	15.59 ft	28.59 ft
Velocity:	5.46 fps		3.30 fps	
X-Section Area:	7.49 sq ft		12.39 sq ft	
Hydraulic Radius:	0.515 ft		0.774 ft	
Froude Number:	1.33		0.65	
Roughness Coefficient:	0.0425		0.0923	

Structure #8 (Vegetated Channel)

D-4 Ditch 0+00 to 7+50

Trapezoidal Vegetated Channel Inputs:

Material: Tall fescue

Bottom Width (ft)	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Retardance Classes	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)	Limiting Velocity (fps)
12.00	2.0:1	2.0:1	5.9	D, B	3.68			6.0

Vegetated Channel Results:

	Stability Class D w/o Freeboard	Stability Class D w/ Freeboard	Capacity Class B w/o Freeboard	Capacity Class B w/ Freeboard
Design Discharge:	42.78 cfs		42.78 cfs	
Depth:	0.58 ft	4.26 ft	0.91 ft	4.59 ft
Top Width:	14.32 ft	29.04 ft	15.64 ft	30.36 ft
Velocity:	5.59 fps		3.40 fps	
X-Section Area:	7.65 sq ft		12.58 sq ft	
Hydraulic Radius:	0.524 ft		0.783 ft	
Froude Number:	1.35		0.67	
Roughness Coefficient:	0.0420		0.0903	

Structure #5 (Pond)

Sidehill Pond

Pond Inputs:

Initial Pool Elev:	7,166.00 ft
Initial Pool:	3.40 ac-ft

Perforated Riser

Riser Diameter (in)	Riser Height (ft)	Barrel Diameter (in)	Barrel Length (ft)	Barrel Slope (%)	Manning's n	Spillway Elev (ft)	Number of Holes per Elev
18.00	7.00	18.00	90.00	2.00	0.0150	7,169.70	2

Pond Results:

Peak Elevation:	7,169.66 ft
Dewater Time:	1.74 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)
7,155.00	0.000	0.000	0.000	
7,156.00	0.157	0.052	0.000	
7,157.00	0.205	0.233	0.000	
7,158.00	0.234	0.452	0.000	
7,159.00	0.264	0.701	0.000	
7,160.00	0.294	0.979	0.000	
7,161.00	0.328	1.290	0.000	
7,162.00	0.362	1.635	0.000	
7,163.00	0.399	2.016	0.000	
7,164.00	0.440	2.435	0.000	
7,165.00	0.480	2.895	0.000	
7,166.00	0.525	3.397	0.000	Low hole SPW #1
7,167.00	0.572	3.945	0.473	14.04*
7,168.00	0.622	4.542	0.669	10.81*
7,169.00	0.672	5.189	0.819	10.60
7,169.66	0.706	5.642	0.904	6.35 Peak Stage
7,169.70	0.708	5.672	0.909	Spillway #1
7,170.00	0.724	5.887	2.398	
7,171.00	0.778	6.638	9.701	
7,172.00	0.833	7.443	12.904	
7,173.00	0.833	8.276	15.456	
7,174.00	0.833	9.108	17.644	

**Designates time(s) to dewater have been extrapolated beyond the 50 hour hydrograph limit.*

Detailed Discharge Table

Elevation (ft)	Perf. Riser (cfs)	Combined Total Discharge (cfs)
7,155.00	0.000	0.000
7,156.00	0.000	0.000
7,157.00	0.000	0.000
7,158.00	0.000	0.000
7,159.00	0.000	0.000
7,160.00	0.000	0.000
7,161.00	0.000	0.000
7,162.00	0.000	0.000
7,163.00	0.000	0.000
7,164.00	0.000	0.000
7,165.00	0.000	0.000
7,166.00	3.00>0.000	0.000
7,167.00	0.473	0.473
7,168.00	0.669	0.669
7,169.00	0.819	0.819
7,169.70	0.909	0.909
7,170.00	2.398	2.398
7,171.00	9.701	9.701
7,172.00	12.904	12.904
7,173.00	15.456	15.456
7,174.00	17.644	17.644

Structure #4 (Riprap Channel)

D-1 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)
12.00	2.0:1	2.0:1	21.0	3.98		

Riprap Channel Results:

Simons/OSM Method - Steep Slope Design

	w/o Freeboard	w/ Freeboard
Design Discharge:	2.27 cfs	
Depth:	0.02 ft	4.00 ft
Top Width:	12.10 ft	28.02 ft
Velocity*:		
X-Section Area:	0.29 sq ft	

	w/o Freeboard	w/ Freeboard
Hydraulic Radius:	0.024 ft	
Froude Number*:		
Manning's n*:		
Dmin:	2.00 in	
D50:	6.00 in	
Dmax:	7.50 in	

Velocity and Manning's n calculations may not apply for this method.

Structure #3 (Null)

Null at Confluence of D-1 & D-2 Ditch

Structure #2 (Pond)

Section 26 Pond

Pond Inputs:

Initial Pool Elev:	6,982.00 ft
Initial Pool:	1.62 ac-ft

Perforated Riser

Riser Diameter (in)	Riser Height (ft)	Barrel Diameter (in)	Barrel Length (ft)	Barrel Slope (%)	Manning's n	Spillway Elev (ft)	Number of Holes per Elev
18.00	14.00	18.00	200.00	4.00	0.0150	6,984.00	2

Emergency Spillway

Spillway Elev	Crest Length (ft)	Left Sideslope	Right Sideslope	Bottom Width (ft)
6,986.00	30.00	2.50:1	2.50:1	24.00

Pond Results:

Peak Elevation:	6,984.11 ft
Dewater Time:	1.70 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)
6,969.00	0.039	0.000	0.000	
6,970.00	0.014	0.026	0.000	
6,971.00	0.027	0.046	0.000	

Elevation	Area (ac)	Capacity (ac-ft)	Discharge (cfs)	Dewater Time (hrs)
6,972.00	0.042	0.080	0.000	
6,973.00	0.060	0.130	0.000	
6,974.00	0.079	0.199	0.000	
6,975.00	0.100	0.288	0.000	
6,976.00	0.124	0.400	0.000	
6,977.00	0.148	0.536	0.000	
6,978.00	0.175	0.698	0.000	
6,979.00	0.203	0.886	0.000	
6,980.00	0.231	1.103	0.000	
6,981.00	0.260	1.349	0.000	
6,982.00	0.290	1.623	0.000	Low hole SPW #1
6,983.00	0.319	1.927	0.473	7.79*
6,984.00	0.350	2.262	0.669	6.05* Spillway #1
6,984.11	0.354	2.304	1.568	26.85 Peak Stage
6,985.00	0.381	2.627	8.509	
6,986.00	0.414	3.025	12.033	Spillway #2
6,987.00	0.414	3.439	67.527	
6,988.00	0.414	3.853	204.557	
6,989.00	0.414	4.267	411.119	
6,990.00	0.414	4.681	688.306	
6,991.00	0.414	5.095	1,033.669	

**Designates time(s) to dewater have been extrapolated beyond the 50 hour hydrograph limit.*

Detailed Discharge Table

Elevation (ft)	Perf. Riser (cfs)	Emergency Spillway (cfs)	Combined Total Discharge (cfs)
6,969.00	0.000	0.000	0.000
6,970.00	0.000	0.000	0.000
6,971.00	0.000	0.000	0.000
6,972.00	0.000	0.000	0.000
6,973.00	0.000	0.000	0.000
6,974.00	0.000	0.000	0.000
6,975.00	0.000	0.000	0.000
6,976.00	0.000	0.000	0.000
6,977.00	0.000	0.000	0.000
6,978.00	0.000	0.000	0.000
6,979.00	0.000	0.000	0.000
6,980.00	0.000	0.000	0.000
6,981.00	0.000	0.000	0.000

Elevation (ft)	Perf. Riser (cfs)	Emergency Spillway (cfs)	Combined Total Discharge (cfs)
6,982.00	3.00>0.000	0.000	0.000
6,983.00	0.473	0.000	0.473
6,984.00	0.669	0.000	0.669
6,985.00	8.509	0.000	8.509
6,986.00	12.033	0.000	12.033
6,987.00	14.738	52.789	67.527
6,988.00	17.018	187.539	204.557
6,989.00	19.026	392.093	411.119
6,990.00	20.842	667.464	688.306
6,991.00	22.512	1,011.157	1,033.669

Structure #1 (Null)

Null Below Section 26 Pond

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)
#7	1	1.900	0.016	0.000	0.000	74.000	F	1.10	0.079
	2	16.800	0.216	0.000	0.000	47.000	M	0.00	0.000
	3	5.800	0.132	0.000	0.000	85.000	F	5.45	0.476
	4	26.400	0.193	0.000	0.000	47.000	M	0.00	0.000
	5	4.500	0.031	0.000	0.000	47.000	M	0.00	0.000
	Σ	55.400						6.23	0.555
#6	1	56.500	0.056	0.000	0.000	74.000	F	32.83	2.347
	2	7.300	0.044	0.000	0.000	85.000	F	8.07	0.621
	Σ	63.800						40.90	2.968
#8	1	1.700	0.018	0.000	0.000	85.000	F	1.88	0.144
	Σ	65.500						42.78	3.112
#5	Σ	65.500						42.78	3.112
#4	1	1.500	0.017	0.000	0.000	85.000	F	1.66	0.127
	Σ	67.000						2.27	2.537
#3	Σ	122.400						8.50	3.091
#2	1	1.000	0.010	0.000	0.000	85.000	F	1.11	0.085
	2	1.900	0.014	0.000	0.000	57.000	M	0.03	0.008
	3	3.000	0.003	0.000	0.000	85.000	F	3.32	0.255
	Σ	128.300						12.93	3.439
#1	Σ	128.300						1.57	2.848

Subwatershed Time of Concentration Details:

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#2	1	5. Nearly bare and untilled, and alluvial valley fans	17.00	25.84	152.00	4.120	0.010
#2	1	Time of Concentration:					0.010
#2	2	3. Short grass pasture	24.80	50.09	202.00	3.980	0.014
#2	2	Time of Concentration:					0.014
#2	3	5. Nearly bare and untilled, and alluvial valley fans	32.00	25.28	79.00	5.650	0.003
#2	3	Time of Concentration:					0.003
#4	1	5. Nearly bare and untilled, and alluvial valley fans	29.00	100.34	346.00	5.380	0.017
#4	1	Time of Concentration:					0.017

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#6	1	5. Nearly bare and untilled, and alluvial valley fans	31.00	348.75	1,125.00	5.560	0.056
#6	1	Time of Concentration:					0.056
#6	2	5. Nearly bare and untilled, and alluvial valley fans	6.00	23.46	391.00	2.440	0.044
#6	2	Time of Concentration:					0.044
#7	1	5. Nearly bare and untilled, and alluvial valley fans	31.00	102.50	330.64	5.560	0.016
#7	1	Time of Concentration:					0.016
#7	2	3. Short grass pasture	4.00	49.80	1,245.00	1.600	0.216
#7	2	Time of Concentration:					0.216
#7	3	5. Nearly bare and untilled, and alluvial valley fans	4.80	50.20	1,046.00	2.190	0.132
#7	3	Time of Concentration:					0.132
#7	4	3. Short grass pasture	9.00	150.12	1,668.00	2.400	0.193
#7	4	Time of Concentration:					0.193
#7	5	3. Short grass pasture	27.00	126.90	470.00	4.150	0.031
#7	5	Time of Concentration:					0.031
#8	1	5. Nearly bare and untilled, and alluvial valley fans	11.00	23.98	218.00	3.310	0.018
#8	1	Time of Concentration:					0.018

EXHIBIT 7, ITEM 23, PART G
Perimeter Area Sediment Control During Mining

Introduction

Colowyo will have ground disturbance along the perimeter of the Collom Pit that cannot effectively be routed to one of the existing sediment ponds. Colowyo will implement a perimeter sediment control plan for these areas. Generally, this will be ground disturbance on the west and east sides of the pit, and directly adjacent to the crest of the pit. This ground disturbance will be where topsoil is removed from the crest of the pit to a nominal distance back from the crest of the pit to allow a light vehicle road or buffer area for blasting activities from native areas. Typically, this area will be less than 200 feet of disturbance from the crest of the pit to native areas. Please refer to Map 23B for the location of the perimeter sediment control for the Collom Pit. This demonstration will, in accordance with Rule 4.05.2(3)(a), provide an exemption from the requirements of 4.05.2. Therefore, surface water runoff from this disturbed around will be treated through a grass filter.

For the model demonstration, SEDCADTM grass filter routine has been used to demonstrate that runoff from this area will meet the effluent standards of 0.5 ml/l in accordance with Rule 4.05.2(7) (US EPA, 40 C.F.R. §434.52). Runoff curve numbers assigned to the undisturbed and/or native lands in various stages of mining and reclamation have been selected in accordance with Table 1 in the Introductory Text for Exhibit 7 in Volume 2D or as further described below.

The grass filter physical parameters were taken as the defaults in the SEDCAD drop down tables for a good stand of well established rye grass, except that the stem spacing was conservatively increased from 0.67 inches to 2.0 inches, and the roughness coefficient reduced from 0.0121 to 0.008, as described Reference 1, page 568, for a "fair stand" of grass. Both of these revisions produce a more severe loading on the grass filter by allowing the flow velocity to be higher than in a "good stand". Slope of the grass filters was set at 25% to 50%, which is representative of the land slopes in the areas shown on Map 23B.

Two generic SEDCADTM models have been ran to determine the feasibility of using grass filters to capture sediment from these perimeter areas. Specifically, a grass filter length of 20 feet (length is in the direction of flow) and width equal to the similar disturbance and larger disturbances than is anticipated were evaluated for performance in a 10 year, 24 hour storm. Note that the length and width dimensions used in SEDCADTM evaluation are reversed from what seems intuitive. SEDCADTM refers to the "length" of the filter as the length in the direction of flow, and the width as the direction perpendicular to that. For a 20 foot wide strip 1,000 feet long parallel to the contours, with the 20 foot dimension in the direction of flow, the "length" is 20 feet, not 1,000 feet.

A disturbance was evaluated for 1,000 feet of disturbance, 100 feet wide. This area is 2.3 acres, assumed to be at curve number of 85. It produces 1.68 cfs of runoff released onto the 1,000 foot wide by 20 foot long grass filter immediately downgradient on the slope. Here the trap efficiency is 94.7% , and it releases water with settleable solids concentration of 0.00 ml/l, well below the 50 ml/l standard.

Finally, a conservative 300 foot wide by 1,000 foot long disturbed area of 6.89 acres was modeled with a curve number of 85. This produced a flow in the 10 year 24 hour storm of 5.02 cfs distributed along the 1,000 foot boundary with the down-gradient grass filter. This model was run with the grass filter sloping at 50%, and thus should be considered the most severe application of this approach. The first 20 feet of flow through the grass filter reduced the 24 hour weighted settleable solids to 0.35 ml/l, which satisfies the 0.5 ml/l standard. This grass filter has a trap efficiency of 80.4 %.

References

- 1) Applied Hydrology and Sedimentology for Disturbed Areas, Barfield, Warner and Haan, 1981

Collom Perimeter Sediment Control
Disturbance, 100 ft x 1,000 ft passing
through grass filter 20 ft long by 1,000
ft wide

Tom Peterson

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Cheyenne, WY 82001

General Information

Storm Information:

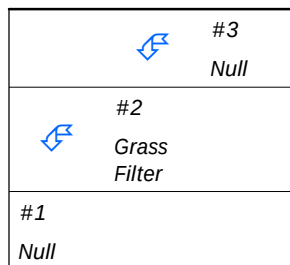
Storm Type:	NRCS Type II
Design Storm:	10 yr - 24 hr
Rainfall Depth:	1.800 inches

Particle Size Distribution:

Size (mm)	New Horizon 2
4.0000	100.000%
2.0000	100.000%
1.0000	80.000%
0.1000	65.000%
0.0500	55.000%
0.0020	25.000%
0.0001	0.000%

Structure Networking:

Type	Stru #	(flows into)	Stru #	Musk. K (hrs)	Musk. X	Description
Null	#1	==>	End	0.000	0.000	Outlet null
Grass Filter	#2	==>	#1	0.000	0.000	nat'l veg area dnstrm of disturbance
Null	#3	==>	#2	0.000	0.000	dwnstrm edge of generic disturbed area



Structure Summary:

	Immediate Contributing Area (ac)	Total Contributing Area (ac)	Peak Discharge (cfs)	Total Runoff Volume (ac-ft)	Sediment (tons)	Peak Sediment Conc. (mg/l)	Peak Settleable Conc. (ml/l)	24VW (ml/l)
#3	2.300	2.300	1.68	0.12	4.3	49,960	23.53	11.88
#2 In	0.000	2.300	1.68	0.12	4.3	49,960	23.53	11.88
Out			1.58	0.06	0.2	5,647	0.00	0.00
#1	0.000	2.300	1.58	0.06	0.2	5,645	0.00	0.00

Particle Size Distribution(s) at Each Structure

Structure #3 (dwnstrm edge of generic disturbed area):

Size (mm)	In/Out
4.0000	100.000%
2.0000	100.000%
1.0000	80.000%
0.1000	65.000%
0.0500	55.000%
0.0020	25.000%
0.0001	0.000%

Structure #2 (nat'l veg area dnstrm of disturbance):

Size (mm)	In	Out
4.0000	100.000%	100.000%
2.0000	100.000%	100.000%
1.0000	80.000%	100.000%
0.1000	65.000%	100.000%
0.0500	55.000%	100.000%
0.0020	25.000%	100.000%
0.0001	0.000%	0.000%

Structure #1:

Size (mm)	In/Out
4.0000	100.000%
2.0000	100.000%
1.0000	100.000%
0.1000	100.000%
0.0500	100.000%
0.0020	100.000%
0.0001	0.000%

Structure Detail:

Structure #3 (Null)

dwnstrm edge of generic disturbed area

Structure #2 (Grass Filter)

nat'l veg area dnstrm of disturbance

Grass Filter Inputs:

Roughness Coefficient	Grass Height (in)	Hydraulic Spacing (in)	Infiltration Rate (iph)	Stiffness Factor (N-sq m)	Filter Length (ft)	Filter Width (ft)	Filter Slope (%)
0.0080	4.0	2.00	0.20	20.000	20.0	1000.0	25.0

Grass Filter Results:

Total Infiltration Volume:	0.0624 ac-ft
Filter Infiltration Rate:	0.0926 cfs
Peak Flow Depth:	0.017 in
Critical Prone Velocity:	1.0367 fps
Wedge Location:	0.12 ft
Sediment Depth in Zone D:	0.0279 in
Trap Efficiency:	94.7 %

Structure #1 (Null)

Outlet null

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	2.300	0.000	0.000	0.000	85.000	M	1.68	0.125
	Σ	2.300						1.68	0.125
#2	Σ	2.300						1.68	0.125
#1	Σ	2.300						1.58	0.062

Subwatershed Sedimentology Detail:

Stru #	SWS #	Soil K	L (ft)	S (%)	C	P	PS #	Sediment (tons)	Peak Sediment Conc. (mg/l)	Peak Settleable Conc (ml/l)	24VW (ml/l)
#3	1	0.310	100.00	3.30	1.0000	0.9000	1	4.3	49,960	23.53	11.88
	Σ							4.3	49,960	23.53	11.88
#2	Σ							4.3	49,960	23.53	11.88
#1	Σ							0.2	5,645	0.00	0.00

Collom Perimeter Sediment Control
Disturbance, 300 ft x 1,000 ft passing
through grass filter 20 ft long by 1,000
ft wide

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General Information

Storm Information:

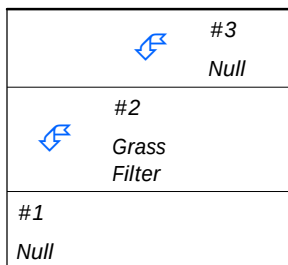
Storm Type:	NRCS Type II
Design Storm:	10 yr - 24 hr
Rainfall Depth:	1.800 inches

Particle Size Distribution:

Size (mm)	New Horizon 2
4.0000	100.000%
2.0000	100.000%
1.0000	80.000%
0.1000	65.000%
0.0500	55.000%
0.0020	25.000%
0.0001	0.000%

Structure Networking:

Type	Stru #	(flows into)	Stru #	Musk. K (hrs)	Musk. X	Description
Null	#1	==>	End	0.000	0.000	Outlet null
Grass Filter	#2	==>	#1	0.000	0.000	nat'l veg area dnstrm of disturbance
Null	#3	==>	#2	0.000	0.000	dwnstrm edge of generic disturbed area



Structure Summary:

	Immediate Contributing Area (ac)	Total Contributing Area (ac)	Peak Discharge (cfs)	Total Runoff Volume (ac-ft)	Sediment (tons)	Peak Sediment Conc. (mg/l)	Peak Settleable Conc. (ml/l)	24VW (ml/l)
#3	6.890	6.890	5.02	0.37	14.8	56,823	26.76	13.51
#2 In	0.000	6.890	5.02	0.37	14.8	56,823	26.76	13.51
Out			4.93	0.27	2.9	18,858	0.85	0.35
#1	0.000	6.890	4.93	0.27	2.9	18,852	0.85	0.35

Particle Size Distribution(s) at Each Structure

Structure #3 (dwnstrm edge of generic disturbed area):

Size (mm)	In/Out
4.0000	100.000%
2.0000	100.000%
1.0000	80.000%
0.1000	65.000%
0.0500	55.000%
0.0020	25.000%
0.0001	0.000%

Structure #2 (nat'l veg area dnstrm of disturbance):

Size (mm)	In	Out
4.0000	100.000%	100.000%
2.0000	100.000%	100.000%
1.0000	80.000%	100.000%
0.1000	65.000%	100.000%
0.0500	55.000%	100.000%
0.0020	25.000%	87.344%
0.0001	0.000%	0.000%

Structure #1:

Size (mm)	In/Out
4.0000	100.000%
2.0000	100.000%
1.0000	100.000%
0.1000	100.000%
0.0500	100.000%
0.0020	87.344%
0.0001	0.000%

Structure Detail:

Structure #3 (Null)

dwnstrm edge of generic disturbed area

Structure #2 (Grass Filter)

nat'l veg area dnstrm of disturbance

Grass Filter Inputs:

Roughness Coefficient	Grass Height (in)	Hydraulic Spacing (in)	Infiltration Rate (iph)	Stiffness Factor (N-sq m)	Filter Length (ft)	Filter Width (ft)	Filter Slope (%)
0.0080	4.0	2.00	0.20	20.000	20.0	1000.0	50.0

Grass Filter Results:

Total Infiltration Volume:	0.1006 ac-ft
Filter Infiltration Rate:	0.0926 cfs
Peak Flow Depth:	0.027 in
Critical Prone Velocity:	1.0367 fps
Wedge Location:	0.32 ft
Sediment Depth in Zone D:	0.0901 in
Trap Efficiency:	80.4 %

Structure #1 (Null)

Outlet null

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	6.890	0.000	0.000	0.000	85.000	M	5.02	0.374
	Σ	6.890						5.02	0.374
#2	Σ	6.890						5.02	0.374
#1	Σ	6.890						4.93	0.273

Subwatershed Sedimentology Detail:

Stru #	SWS #	Soil K	L (ft)	S (%)	C	P	PS #	Sediment (tons)	Peak Sediment Conc. (mg/l)	Peak Settleable Conc (ml/l)	24VW (ml/l)
#3	1	0.310	100.00	3.30	1.0000	0.9000	1	14.8	56,823	26.76	13.51
	Σ							14.8	56,823	26.76	13.51
#2	Σ							14.8	56,823	26.76	13.51
#1	Σ							2.9	18,852	0.85	0.35

EXHIBIT 7, ITEM 23, PART I
Section 25 Pond Sediment Control Post Mining

Introduction

Exhibit 7, Item 14 in Volume 2D describes the hydrologic methodology used in sediment pond, permanent post-mine channels, and temporary conveyance channel demonstrations. Runoff curve numbers assigned to the undisturbed and/or reclaimed lands in various stages of reclamation have been selected in accordance with Table 1 in the Introductory Text for Exhibit 7 in Volume 2D and are directly tied to Colowyo's reclamation procedures and timing presented on Map 29B as required by Rule 4.05.6(3)(a). For channels protected by a riprap liner, selection of minimum riprap size is done using the Simons/OSM method in SEDCADTM. For channels to be protected by a vegetative liner, the permissible velocities are also determined using SEDCADTM routines.

SEDCADTM demonstrations with two distinct time frames have been evaluated in detail for the Section 25 Pond. Exhibit 7, Item 23, Parts B addresses sediment control for the Section 25 Pond during the mining timeframe. Exhibit 7, Item 23, Part B also contain the design criteria for all temporary channels used to route surface runoff to the sediment pond, except for the temporary D-5 and D-7 Ditches which will be constructed during reclamation activities. The design criteria for the D-5 and D-7 Ditches are contained below.

This exhibit (Exhibit 7, Item 23, Part I) address sediment control during the post mining timeframe for the Section 25 Pond and provides the design criteria for the post mine channel configurations, the temporary ditch, and terrace ditches. The temporary conveyance channel will be retained until Phase II bond release has been achieved in the entire watershed reporting to particular pond the temporary channel is supporting.

Colowyo has several types of mining disturbances shown in this demonstration and in the larger mining permit. The disturbance limit shown on maps and figures (a greenish colored boundary on maps) is the permitted disturbance limit. This is the disturbance limit that could potentially be disturbed but may not depending on mine plans and a reclamation bond has not been posted to date to disturb to this limit. Volume 20, Exhibit 13C provides the cumulative bond schedule disturbance limits. These disturbance limits are areas that Colowyo has permitted for disturbance and posted a reclamation bond to disturbed. However, given Colowyo's current mine plans it may not have disturbed the entire area shown in Exhibit 13C. The disturbance or reclaimed areas shown in this hydrology demonstration for the Section 25 Pond are actual disturbance to date with planned future disturbances. Current mining plans do not anticipate any further ground disturbances beyond these areas, especially north of the temporary out of pit spoil pile (Map 29C), and on the west and end sides of the Collom Pit. Should mine plan changes occur, and additional disturbance is necessary, it will be permitted and bonded for accordingly, and this hydrology demonstration for the Section 25 Pond will be reevaluated prior to implementation of ground disturbance activities in the Section 25 Pond watershed.

Section 25 Pond – Post Mining

The location of the Section 25 Pond and its watershed is presented on Map 41B. The profiles of the associated permanent channels associated with the Section 25 Pond watershed are presented

on Map 33C. The temporary channels that route water to the Section 25 and Coal Stockpile Ponds are presented on 41B. Seven post mine channels will be constructed in the Section 25 watershed. In the 10-Year 24-Hour and 25-Year 24-Hour modeled events, Lower and Middle Bobcat Draw are not included as they will be reconstructed within the footprints of the Middle and Section 36 Ponds respectively when both are reclaimed. A separate hydrology model demonstration is included for the post mine channel design and is discussion later in this exhibit.

The as-built configuration for the Middle Pond is presented on Figure 7-23I-1, the as-built configuration for the Section 36 Pond is presented on Figure 7-23I-2, the as-built configuration for the Section 25 Pond is presented on Figure 7-23I-3, and the as-built configuration for the Coal Stockpile Pond is presented in Exhibit 7, Item 23 Part M, Figure 7-26M-1. Figure 7-23I-4 provides the breakdown of drainage areas and hydrologic conditions for all areas in the watershed reporting to these four sediment ponds. The Middle and Section 36 Ponds are part of the Section 25 Pond sediment control system and are utilized to reduced peak flows and provide additional sediment storage if need. All discharges from the Middle and Section 36 Ponds flow directly to the Section 25 Pond through a natural channel, and the Section 25 Pond is the final discharge location.

The Coal Stockpile Pond is total containment pond during reclamation activities with surface water runoff from reclamation and non-disturbed areas being routed to it through the D-5 Ditch. During reclamation the Coal Stockpile Pond will fully contain the 10-year 24-hour and 25-year 24-hour storm events. The Coal Stockpile Pond is necessary to provide sediment control in a fairly large, young, reclaimed area to assist in controlling surface water runoff and add an additional layer of protection to the Section 25 Pond. The D-5 Ditch will constructed prior to reclamation activities commencing in the Coal Stockpile Pond watershed shown on Figure 7-23I-4. The

The following pages present the results of the SEDCADTM models for the post mining condition. At this stage all areas that have been disturbed by mining activities in the Section 25 watershed has been reclaimed with the newest or younger (topsoil and seeded) reclamation near the northern and eastern reaches of the reconstructed Little Collom Gulch. The northern portion of the watershed is relatively undisturbed.

The SEDCADTM model herein provides the results of the 10-year 24-hour design storm and demonstrates the Section 25 Pond will meet the applicable settleable solids standard under this modeled storm event. The second SEDCADTM model demonstrates that the Section 25 Pond emergency spillway elevation is capable of containing the 25-year 24-hour storm.

In summary, for the post mining case at the Section 25 Pond, the 10-year 24-hour storm produces 5.4 acre feet of runoff, and the peak settleable solids concentration is 0.00 ml/l. The 25-year 24-hour storm event peaks at the 6,874.3 elevation, which below the emergency spillway elevation of 6,875.0'

Temporary Channels

Two temporary channels, the D-5 and D-7 Ditches, will be constructed during reclamation activities to route surface water runoff from reclaimed and non-disturbed areas to the Coal

Stockpile Pond. The location of these temporary channel is shown on Map 41B and Figure 7-23I-4. The ditches will be constructed concurrent with reclamation activities in the applicable watershed, and they be retained until Phase II bond is granted for the entire watershed reporting to both ditches. The ditches will be configured as follows:

D-5 Ditch

<u>Station</u>	<u>Peak Flow (cfs)</u>	<u>Average Slope (%)</u>	<u>Channel Type</u>	<u>Side Slopes</u>	<u>Erosion Protection</u>	<u>Total Depth</u>
Station 0+00 to 21+41	50.74	2.0	Trapezoidal 5' bottom	2H:1V	None	3'

D-7 Ditch

<u>Station</u>	<u>Peak Flow (cfs)</u>	<u>Average Slope (%)</u>	<u>Channel Type</u>	<u>Side Slopes</u>	<u>Erosion Protection</u>	<u>Total Depth</u>
Station 0+00 to 21+41	18.51	6	Trapezoidal 5' bottom	2H:1V	None	3'

Permanent Post Mine Channels

The Section 25 Pond watershed is comprised of seven post-mining channels which are Little Collom Gulch, Sage Draw, Grouse Draw, Sharpie Draw, Lower, Middle, and Upper Bobcat Draws respectively. The locations of these post mine channels are presented on Map 41B and Figure 7-23I-5, and the channel profiles are presented on Map 33C.

Little Collom Gulch

The area contributory to Little Collom Gulch is greater than one square mile, and the lower portion of the channel passes over a permanent valley fill; therefore, the modeled storm event required by rule is the 100-year 24-hour event. The entire length of Little Collom Gulch will be riprap lined. Four stock ponds LCG-1, LGC-2, LCG-3, and LCG-4 will be constructed inline in the channel to reduce peak flows from larger storm events and provide a water source to support the post mine land use.

A SEDCADTM model (100 Year 24 Hour Channel Demonstration) has been included which evaluates the peak flow for each of the channel. The minimum channel configurations for Little Collom Gulch are summarized below.

Little Collom Gulch

<u>Station</u>	<u>Peak Flow (CFS)</u>	<u>Average Slope (%)</u>	<u>Channel Type</u>	<u>Side Slopes</u>	<u>Minimum Depth (Feet)</u>	<u>Erosion Protection</u>
Station 0+00 to 10+00 (LCG-1)	31.06	16.6	Trapezoidal 15' bottom	3H:1V	4.0	Riprap, D50 = 6"

Station 10+00 to 25+00 (LCG-2)	62.39	4.9	Trapezoidal 10' bottom	3H:1V	4.0	Riprap, D50 = 9"
Station 25+00 to 55+00 (LCG-3)	88.39	4.7	Trapezoidal 12' bottom	3H:1V	4.0	Riprap, D50 = 9"
Station 55+00 to 85+00 (LCG-4)	93.23	7.8	Trapezoidal 10' bottom	3H:1V	4.0	Riprap, D50 = 9"
Station 85+00 to 102+79	43.19	7.4	Trapezoidal 10' bottom	3H:1V	4.0	Riprap, D50 = 6"

Sage Draw, Grouse Draw, Sharpie Draw, Lower, Middle, and Upper Bobcat Draws

Sage Draw, Grouse Draw, Sharpie Draw are tributary drainages to the reconstructed portion of Little Collom Gulch, while Lower, Middle, and Upper Bobcat Draws are tributary to natural portion of Little Collom Gulch. Contributory areas to these ditches are less than one square mile which would make the required modeled storm event the 10-year 24-hour storm event. For ease and conservatism, all six channels have been modeled against the 100-year 24-hour storm event.

Lower and Middle Bobcat Draw will be constructed inside the reclaimed footprint of the Section 36 and Middle Ponds. Therefore, in the 100-Year 24-Hour model, it is assumed the entire watersheds reporting to both ponds have been approved for Phase II bond release and both ponds are no longer necessary for sediment control. In lieu of the two sediments ponds post mine channel configurations have been added to the model.

A SEDCAD™ model (100 Year 24 Hour Channel Demonstration model) has been included which evaluates the peak flow for each of the channel. The minimum channel configurations for Little Collom Gulch are summarized below

<u>Name</u>	<u>Peak Flow (CFS)</u>	<u>Average Slope (%)</u>	<u>Channel Type</u>	<u>Side Slopes</u>	<u>Minimum Depth (Feet)</u>	<u>Erosion Protection</u>
Sage Draw	21.46	2.1	Trapezoidal 5' bottom	3H:1V	4.0	Riprap, D50 = 9"
Grouse Draw	36.89	16.8	Trapezoidal 10' bottom	3H:1V	4.0	Riprap, D50 = 9"
Sharpie Draw	6.51	22.0	Trapezoidal 10' bottom	3H:1V	4.0	Riprap, D50 = 6"
Lower Bobcat Draw	64.62	6.4	Trapezoidal 10' bottom	3H:1V	4.0	Riprap, D50 = 9"
Middle Bobcat Draw	64.62	5.0	Trapezoidal 10' bottom	3H:1V	4.0	Riprap, D50 = 9"
Upper Bobcat Draw	59.37	8.3	Trapezoidal 10' bottom	3H:1V	4.0	Riprap, D50 = 9"

Terrace Ditches

Two terrace ditches will be constructed across the face of the Little Collom Valley Fill to route surface water runoff to the reconstructed Little Collom Gulch. The locations of both terrace ditches are shown on Map 41B and Figure 7-23I-5. The terrace ditches on the Little Collom Valley Fill will originate near the post mining contours of 7200' and 7300' elevations on the fill face. Actual on the ground topography will dictate the final placement and profile of the terrace ditches to ensure proper water flow.

The function of the terrace ditches is to collect surface flows and direct the flows to Little Collom Gulch. The design basis for these terrace ditches is the 100-year, 24-hours event as they will be permanent in the post mine topography, and the 100-year 24-hour storm provides a conservative approach.

A SEDCADTM model (100 Year 24 Hour Channel Demonstration model) has been included which evaluates the peak flow for each terrace ditch. The minimum ditch configurations are summarized below

<u>Terrace Ditch</u>						
<u>Terrace Ditch Name</u>	<u>Peak Flow (CFS)</u>	<u>Average Slope (%)</u>	<u>Channel Type</u>	<u>Side Slopes</u>	<u>Minimum Depth (Feet)</u>	<u>Erosion Protection</u>
7200' (Lower Terrace Ditch)	4.7	2.0	Triangular	Left - 1.5H:1V Right - 3.0H:1V	3.0	Vegetation
7300' (Upper Terrace Ditch)	9.78	2.0	Triangular	Left - 1.5H:1V Right - 3.0H:1V	3.0	Vegetation

LIST OF EXHIBITS – VOLUME 18C

Exhibit 7 Item 23 Part J Section 26 Pond Post Mine Sediment Control

Exhibit 7 Item 23 Park K Temporary Facilities Pond Sediment Control

Exhibit 7 Item 23 Part L Wilson Storage Pond

Exhibit 7 Item 25 Part M Coal Stockpile Pond Sediment Control

Exhibit 7 Item 25 Part N Perimeter Sediment Control Post Mining

Exhibit 7 Item 25A Collom In Pit Drilling Small Area Exemption

Exhibit 7 Item 25B Collom Topsoil Depth Testing Small Area Exemption

Exhibit 7 Item 25C Temporary Access Road Small Area Exemption

Exhibit 7 Item 25D Power Line Road Small Area Exemption

Exhibit 7 Item 25E Collom Haul Road Channels

Exhibit 7 Item 25F Collom Haul Road Culverts

EXHIBIT 7, ITEM 23, PART J

Section 26 Pond Sediment Control Post Mining

Introduction

Exhibit 7, Item 14 in Volume 2D describes the hydrologic methodology used in sediment pond, permanent post-mine channels, and temporary conveyance channel demonstrations. Runoff curve numbers assigned to the undisturbed and/or reclaimed lands in various stages of reclamation have been selected in accordance with Table 1 in the Introductory Text for Exhibit 7 in Volume 2D and are directly tied to Colowyo's reclamation procedures and timing presented on Map 29B as required by Rule 4.05.6(3)(a). For channels protected by a riprap liner, selection of minimum riprap size is done using the Simons/OSM method in SEDCADTM. For channels to be protected by a vegetative liner, the permissible velocities are also determined using SEDCADTM routines.

SEDCADTM demonstrations with two distinct time frames have been evaluated in detail for the Section 26 Pond. Exhibit 7, Item 23, Parts C addresses sediment control for the Section 26 Pond during the mining timeframe. This exhibit also contains the design criteria for all temporary channels used to route surface runoff to the sediment pond. This exhibit (Exhibit 7, Item 23, Part J) addresses sediment control during the post mining timeframe for the Section 26 Pond and provides a demonstration for the post mine channel configurations.

Colowyo has several types of mining disturbances shown in this demonstration and in the larger mining permit. The disturbance limit shown on maps and figures (a greenish colored boundary on maps) is the permitted disturbance limit. This is the disturbance limit that could potentially be disturbed but may not depending on mine plans and a reclamation bond has not been posted to date to disturb to this limit. Volume 20, Exhibit 13C provides the cumulative bond schedule disturbance limits. These disturbance limits are areas that Colowyo has permitted for disturbance and posted a reclamation bond to disturb. However, given Colowyo's current mine plans it may not have disturbed the entire area shown in Exhibit 13C. The disturbance or reclaimed areas shown in this hydrology demonstration for the Section 26 Pond are actual disturbance to date combined with planned future disturbances. Current mining plans do not anticipate any further ground disturbances beyond these areas, especially north of the temporary out of pit spoil pile (Map 29C), and on the west and end sides of the Collom Pit. Should mine plan changes occur, and additional disturbance is necessary, it will be permitted and bonded for accordingly, and this hydrology demonstration for the Section 26 Pond will be reevaluated prior to implementation of additional ground disturbance activities not currently modeled in the Section 26 Pond watershed.

Section 26 Pond – Post Mining

The location of the Section 26 Pond and its watershed is presented on Map 41B. The profiles of the associated permanent channels associated with the Section 26 Pond watershed are presented on Map 33C. The temporary channels that route water to the Section 26 Pond are presented on 41B. Two post mine channels will be constructed in the Section 26 watershed including Lower and Upper Bear Draw respectively. In the 10-Year 24-Hour and 25-Year 24-Hour modeled events, Lower Bear Draw is not included as it will be reconstructed within the footprint of the Section 26 Pond. A separate hydrology model demonstration is included for the post mine channel design and is discussed later in this exhibit.

The as-built configuration for the Section 26 Pond is presented on Figure 7-23J-1, and the as-built configuration for the Sidehill Pond is presented on Figure 7-23J-2. Figure 7-23J-3 provides the breakdown of drainage areas and hydrologic conditions for all areas in the watershed reporting to these two sediment ponds. The Sidehill Pond as part of the Section 26 Pond sediment control system is utilized to reduced peak flows and provide additional sediment storage if need. All discharges from the Sidehill Pond flow directly to the Section 26 Pond through the D-1 Ditch, and the Section 26 Pond is the final discharge location.

The following pages present the results of the SEDCAD™ models for the post mining condition. At this stage all areas that have been disturbed by mining activities in the Section 26 watershed has been reclaimed with the newest or younger (topsoil and seeded) reclamation is in the central and northern areas of the Section 26 Pond watershed. The farthest northern portion of the watershed is relatively undisturbed.

The SEDCAD™ model herein provides the results of the 10-year 24-hour design storm and demonstrates the Section 26 Pond will meet the applicable settleable solids standard under this modeled storm event. The second SEDCAD™ model demonstrates that the Section 26 Pond emergency spillway elevation is capable of containing the 25-year 24-hour storm.

In summary, for the post mining case at the Section 26 Pond, the 10-year 24-hour storm produces 5.6 acre feet of runoff, and the peak settleable solids concentration is 0.00 ml/l. The 25-year 24-hour storm event peaks at the 6,985.5 elevation, which below the emergency spillway elevation of 6,986.0’

Section 26 Pond Temporary Post Mine Channels

One temporary channel is necessary during the reclamation of areas within the Section 26 Pond watershed. This temporary channel (D-6 Ditch) will route water from reclamation areas to the upper reaches of the permanent post mine channel Bear Draw as shown on Figure 7-23J-3. Once Phase II bond release has been achieved in the entire sub-watershed reporting to the D-6 Ditch, it will be reclaimed.

A SEDCAD™ model (25 Year 24 Hour Channel Demonstration model) has been included which evaluates the peak flow for this temporary channel. The minimum channel configurations are summarized below

<u>Name</u>	<u>Peak Flow (CFS)</u>	<u>Average Slope (%)</u>	<u>Channel Type</u>	<u>Side Slopes</u>	<u>Minimum Depth (Feet)</u>	<u>Erosion Protection</u>
D-6 Ditch	12.09	6.0	Trapezoidal 5' bottom	2H:1V	3.0	Vegetation

Section 26 Pond Permanent Post Mine Channels

The Section 26 Pond watershed is comprised of two post-mining channels which include Bear Draw and Lower Bear Draw. The locations of these post mine channels are presented on Map 41B and Figure 7-23J-4, and the channel profiles are presented on Map 33C.

The area contributory to Bear Draw and Little Bear Draw are less than one square mile; therefore, the modeled storm event required by rule is the 10-year 24-hour event. However, for built in conservatism, both channels will be modeled against the 25-year 24-hour storm event.

The upper reaches of Bear Draw will be a vegetative lined while the lowest most portion will be riprap lined. Lower Bear Draw will be protected with riprap over the entire length of the channel. Two stock ponds, BD-1 and BD-2 will be constructed inline in the Bear Draw to reduce peak flows from larger storm events and provide a water source to support the post mine land use.

Lower Bear Draw will be constructed inside the reclaimed footprint of the Section 26 Pond. Therefore, in the 25-Year 24-Hour model, it is assumed the entire watershed reporting to both The Sidehill and Section 26 Ponds has been approved for Phase II bond release and both ponds are no longer necessary for sediment control.

A SEDCADTM model (25 Year 24 Hour Channel Demonstration model) has been included which evaluates the peak flow for each of the channel. The minimum channel configurations are summarized below

<u>Name</u>	<u>Peak Flow (CFS)</u>	<u>Average Slope (%)</u>	<u>Channel Type</u>	<u>Side Slopes</u>	<u>Minimum Depth (Feet)</u>	<u>Erosion Protection</u>
Lower Bear Draw	27.04	9.5	Trapezoidal 10' bottom	3H:1V	4.0	Riprap, D50 = 6"
Bear Draw 0+00 to 15+00	30.03	10.8	Trapezoidal 10' bottom	3H:1V	4.0	Riprap, D50 = 6"
Bear Draw 15+00 to 34+00	60.49	2.8	Trapezoidal 10' bottom	3H:1V	4.0	Vegetation
Bear Draw 34+00 to 81+10	35.80	7.1	Trapezoidal 10' bottom	3H:1V	4.0	Vegetation

Section 26 Pond **Effluent Demonstration**

10- Year 24-Hour Storm Event
Post Mining

Tony Tennyson

General Information

Storm Information:

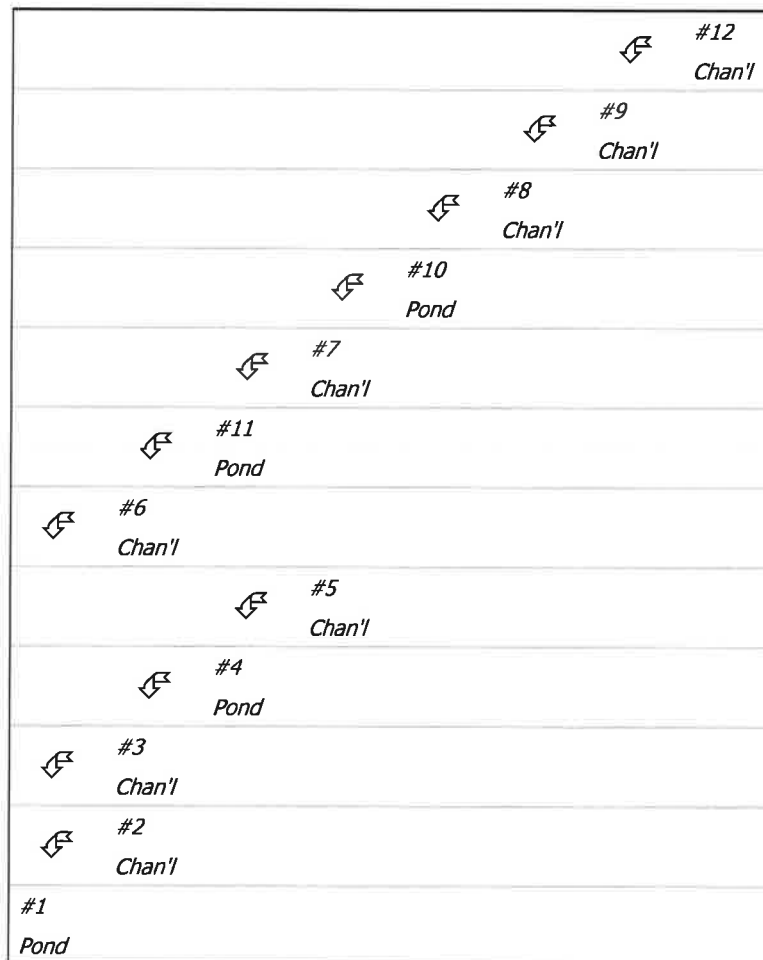
Storm Type:	NRCS Type II
Design Storm:	10 yr - 24 hr
Rainfall Depth:	1.800 inches

Particle Size Distribution:

Size (mm)	Colowyo Particle Size
4.7500	100.000%
0.0750	73.000%
0.0400	33.000%
0.0010	20.000%

Structure Networking:

Type	Stru #	(flows into)	Stru #	Musk. K (hrs)	Musk. X	Description
Pond	#1	==>	End	0.000	0.000	Section 26 Pond
Channel	#2	==>	#1	0.000	0.000	D-2 Ditch
Channel	#3	==>	#1	0.000	0.000	D-1 Ditch
Pond	#4	==>	#3	0.000	0.000	Sidehill Pond
Channel	#5	==>	#4	0.000	0.000	D-4 Ditch
Channel	#6	==>	#1	0.000	0.000	Natural Channel
Channel	#7	==>	#11	0.000	0.000	Bear Draw 0+00 to 15+00
Channel	#8	==>	#10	0.000	0.000	Bear Draw 15+00 to 34+00
Channel	#9	==>	#8	0.000	0.000	Bear Draw 34+00 to 81+10
Pond	#10	==>	#7	0.000	0.000	BD-2 Stockpond
Pond	#11	==>	#6	0.000	0.000	BD-1 Stockpond
Channel	#12	==>	#9	0.000	0.000	D-6 Ditch



Structure Summary:

	Immediate Contributing Area (ac)	Total Contributing Area (ac)	Peak Discharge (cfs)	Total Runoff Volume (ac-ft)	Sediment (tons)	Peak Sediment Conc. (mg/l)	Peak Settleable Conc. (ml/l)	24VW (ml/l)
#12	33.400	33.400	5.70	0.69	3.3	7,201	3.50	1.68
#9	72.300	105.700	17.01	2.17	6.3	4,071	1.92	1.01
#8	40.000	145.700	31.36	3.65	260.0	178,754	101.46	28.35
#10 In	0.000	145.700	31.36	3.65	260.0	178,754	101.46	28.35
Out			1.45	1.57	0.0	1	0.00	0.00
#7	35.200	180.900	18.14	2.87	260.3	282,235	160.86	44.16
#11 In	0.000	180.900	18.14	2.87	260.3	282,235	160.86	44.16
Out			0.72	0.78	0.0	0	0.00	0.00
#6	55.200	236.100	11.70	1.63	159.3	269,322	153.50	70.57
#5	26.200	26.200	9.63	0.94	49.8	79,650	42.83	20.52
#4 In	0.000	26.200	9.63	0.94	49.8	79,650	42.83	20.52
Out			0.00	0.00	49.8	0	0.00	0.00
#3	1.600	27.800	0.82	0.06	58.2	207,202	158.88	75.56
#2	47.400	47.400	2.83	0.20	1.0	7,864	4.48	2.07
#1 In	5.000	316.300	16.33	1.96	223.9	215,991	134.15	62.12
Out			0.53	1.31	0.0	7	0.00	0.00

Particle Size Distribution(s) at Each Structure***Structure #12 (D-6 Ditch):***

Size (mm)	In/Out
4.7500	100.000%
0.0750	99.864%
0.0400	45.144%
0.0010	27.360%

Structure #9 (Bear Draw 34+00 to 81+10):

Size (mm)	In/Out
4.7500	100.000%
0.0750	99.694%
0.0400	47.060%
0.0010	28.521%

Structure #8 (Bear Draw 15+00 to 34+00):

Size (mm)	In/Out
4.7500	100.000%
0.0750	73.648%
0.0400	33.341%
0.0010	20.207%

Structure #10 (BD-2 Stockpond):

Size (mm)	In	Out
4.7500	100.000%	100.000%
0.0750	73.648%	100.000%
0.0400	33.341%	100.000%
0.0010	20.207%	100.000%

Structure #7 (Bear Draw 0+00 to 15+00):

Size (mm)	In/Out
4.7500	100.000%
0.0750	73.000%
0.0400	33.000%
0.0010	20.000%

Structure #11 (BD-1 Stockpond):

Size (mm)	In	Out
4.7500	100.000%	100.000%
0.0750	73.000%	100.000%
0.0400	33.000%	100.000%
0.0010	20.000%	100.000%

Structure #6 (Natural Channel):

Size (mm)	In/Out
4.7500	100.000%
0.0750	73.000%
0.0400	33.000%
0.0010	20.000%

Structure #5 (D-4 Ditch):

Size (mm)	In/Out
4.7500	100.000%
0.0750	83.260%
0.0400	37.638%
0.0010	22.811%

Structure #4 (Sidehill Pond):

Size (mm)	In	Out
4.7500	100.000%	0.000%
0.0750	83.260%	0.000%
0.0400	37.638%	0.000%
0.0010	22.811%	0.000%

Structure #3 (D-1 Ditch):

Size (mm)	In/Out
4.7500	14.436%
0.0750	10.538%
0.0400	4.764%
0.0010	2.887%

Structure #2 (D-2 Ditch):

Size (mm)	In/Out
4.7500	100.000%
0.0750	73.000%
0.0400	33.000%
0.0010	20.000%

Structure #1:

Size (mm)	In	Out
4.7500	77.763%	100.000%
0.0750	56.767%	100.000%
0.0400	25.662%	100.000%
0.0010	15.553%	100.000%

Structure Detail:

Structure #12 (Vegetated Channel)

D-6 Ditch

Trapezoidal Vegetated Channel Inputs:

Material: Tall fescue

Bottom Width (ft)	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Retardance Classes	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)	Limiting Velocity (fps)
5.00	2.0:1	2.0:1	6.0	D, B	2.32			6.0

Vegetated Channel Results:

	Stability Class D w/o Freeboard	Stability Class D w/ Freeboard	Capacity Class B w/o Freeboard	Capacity Class B w/ Freeboard
Design Discharge:	5.70 cfs		5.70 cfs	
Depth:	0.36 ft	2.68 ft	0.68 ft	3.00 ft
Top Width:	6.45 ft	15.73 ft	7.70 ft	16.98 ft
Velocity:	2.75 fps		1.33 fps	
X-Section Area:	2.07 sq ft		4.29 sq ft	
Hydraulic Radius:	0.313 ft		0.535 ft	
Froude Number:	0.86		0.31	
Roughness Coefficient:	0.0610		0.1809	

Structure #9 (Vegetated Channel)

Bear Draw 34+00 to 81+10

Trapezoidal Vegetated Channel Inputs:

Material: Tall fescue

Bottom Width (ft)	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Retardance Classes	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)	Limiting Velocity (fps)
10.00	3.0:1	3.0:1	7.1	D, B	3.35			6.0

Vegetated Channel Results:

	Stability Class D w/o Freeboard	Stability Class D w/ Freeboard	Capacity Class B w/o Freeboard	Capacity Class B w/ Freeboard
Design Discharge:	17.01 cfs		17.01 cfs	
Depth:	0.40 ft	3.75 ft	0.70 ft	4.05 ft
Top Width:	12.42 ft	32.52 ft	14.21 ft	34.31 ft
Velocity:	3.77 fps		2.01 fps	
X-Section Area:	4.52 sq ft		8.48 sq ft	
Hydraulic Radius:	0.360 ft		0.588 ft	
Froude Number:	1.10		0.46	
Roughness Coefficient:	0.0531		0.1387	

Structure #8 (Vegetated Channel)

Bear Draw 15+00 to 34+00

Trapezoidal Vegetated Channel Inputs:

Material: Tall fescue

Bottom Width (ft)	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Retardance Classes	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)	Limiting Velocity (fps)
10.00	3.0:1	3.0:1	2.8	D, B	2.90			7.0

Vegetated Channel Results:

	Stability Class D w/o Freeboard	Stability Class D w/ Freeboard	Capacity Class B w/o Freeboard	Capacity Class B w/ Freeboard
Design Discharge:	31.36 cfs		31.36 cfs	
Depth:	0.69 ft	3.59 ft	1.13 ft	4.03 ft
Top Width:	14.14 ft	31.54 ft	16.76 ft	34.16 ft
Velocity:	3.77 fps		2.08 fps	
X-Section Area:	8.33 sq ft		15.06 sq ft	
Hydraulic Radius:	0.580 ft		0.880 ft	
Froude Number:	0.86		0.39	
Roughness Coefficient:	0.0459		0.1099	

Structure #10 (Pond)

BD-2 Stockpond

Pond Inputs:

Initial Pool Elev:	102.00 ft
Initial Pool:	0.34 ac-ft

*Sediment Storage:	0.00 ac-ft
Dead Space:	20.00 %

**No sediment capacity defined*

Straight Pipe

Barrel Diameter (in)	Barrel Length (ft)	Barrel Slope (%)	Manning's n	Spillway Elev (ft)	Entrance Loss Coefficient	Tailwater Depth (ft)
12.00	100.00	2.00	0.0150	105.00	0.90	0.00

Emergency Spillway

Spillway Elev	Crest Length (ft)	Left Sideslope	Right Sideslope	Bottom Width (ft)
107.00	20.00	2.00:1	2.00:1	15.00

Pond Results:

Peak Elevation:	105.69 ft
H'graph Detention Time:	8.18 hrs
Pond Model:	CSTRS
Dewater Time:	1.45 days
Trap Efficiency:	100.00 %

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)
100.00	0.016	0.000	0.000	Top of Sed. Storage
101.00	0.096	0.050	0.000	
102.00	0.539	0.338	0.000	
103.00	0.654	0.933	0.000	
104.00	0.735	1.628	0.000	
105.00	0.843	2.416	0.000	Spillway #1
105.69	0.851	3.008	1.446	29.90 Peak Stage
106.00	0.872	3.273	2.094	
107.00	0.872	4.145	4.414	Spillway #2
108.00	0.872	5.017	42.121	

**Designates time(s) to dewater have been extrapolated beyond the 50 hour hydrograph limit.*

Detailed Discharge Table

Elevation (ft)	Straight Pipe (cfs)	Emergency Spillway (cfs)	Combined Total Discharge (cfs)
100.00	0.000	0.000	0.000
101.00	0.000	0.000	0.000
102.00	0.000	0.000	0.000
103.00	0.000	0.000	0.000
104.00	0.000	0.000	0.000
105.00	0.000	0.000	0.000
106.00	(3)>2.094	0.000	2.094
107.00	(5)>4.414	0.000	4.414
108.00	(6)>5.182	36.939	42.121

Structure #7 (Riprap Channel)

Bear Draw 0+00 to 15+00

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)
10.00	2.0:1	2.0:1	10.8	3.59		

Riprap Channel Results:

Simons/OSM Method - Steep Slope Design

	w/o Freeboard	w/ Freeboard
Design Discharge:	18.14 cfs	
Depth:	0.20 ft	3.79 ft
Top Width:	10.78 ft	25.14 ft
Velocity*:		
X-Section Area:	2.04 sq ft	
Hydraulic Radius:	0.187 ft	
Froude Number*:		
Manning's n*:		
Dmin:	2.00 in	
D50:	6.00 in	
Dmax:	7.50 in	

Velocity and Manning's n calculations may not apply for this method.

Structure #11 (Pond)

BD-1 Stockpond

Pond Inputs:

Initial Pool Elev:	102.00 ft
Initial Pool:	0.34 ac-ft
*Sediment Storage:	0.00 ac-ft
Dead Space:	20.00 %

**No sediment capacity defined*

Straight Pipe

Barrel Diameter (in)	Barrel Length (ft)	Barrel Slope (%)	Manning's n	Spillway Elev (ft)	Entrance Loss Coefficient	Tailwater Depth (ft)
12.00	100.00	2.00	0.0150	105.00	0.90	0.00

Emergency Spillway

Spillway Elev	Crest Length (ft)	Left Sideslope	Right Sideslope	Bottom Width (ft)
107.00	20.00	2.00:1	2.00:1	15.00

Pond Results:

Peak Elevation:	105.34 ft
H'graph Detention Time:	12.63 hrs
Pond Model:	CSTRS
Dewater Time:	1.14 days
Trap Efficiency:	100.00 %

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)
100.00	0.016	0.000	0.000	Top of Sed. Storage
101.00	0.096	0.050	0.000	
102.00	0.539	0.338	0.000	
103.00	0.654	0.933	0.000	
104.00	0.735	1.628	0.000	
105.00	0.843	2.416	0.000	Spillway #1
105.34	0.827	2.710	0.718	22.50 Peak Stage

Elevation	Area (ac)	Capacity (ac-ft)	Discharge (cfs)	Dewater Time (hrs)
106.00	0.872	3.273	2.094	
107.00	0.872	4.145	4.414	Spillway #2
108.00	0.872	5.017	42.121	

**Designates time(s) to dewater have been extrapolated beyond the 50 hour hydrograph limit.*

Detailed Discharge Table

Elevation (ft)	Straight Pipe (cfs)	Emergency Spillway (cfs)	Combined Total Discharge (cfs)
100.00	0.000	0.000	0.000
101.00	0.000	0.000	0.000
102.00	0.000	0.000	0.000
103.00	0.000	0.000	0.000
104.00	0.000	0.000	0.000
105.00	0.000	0.000	0.000
106.00	(3)>2.094	0.000	2.094
107.00	(5)>4.414	0.000	4.414
108.00	(6)>5.182	36.939	42.121

Structure #6 (Vegetated Channel)

Natural Channel

Trapezoidal Vegetated Channel Inputs:

Material: Bermuda grass

Bottom Width (ft)	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Retardance Classes	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)	Limiting Velocity (fps)
5.00	2.0:1	2.0:1	11.0	D, B	3.00			6.0

Vegetated Channel Results:

	Stability Class D w/o Freeboard	Stability Class D w/ Freeboard	Capacity Class B w/o Freeboard	Capacity Class B w/ Freeboard
Design Discharge:	11.70 cfs		11.70 cfs	
Depth:	0.41 ft	3.41 ft	0.69 ft	3.69 ft
Top Width:	6.63 ft	18.63 ft	7.77 ft	19.77 ft
Velocity:	4.93 fps		2.65 fps	
X-Section Area:	2.37 sq ft		4.42 sq ft	

	Stability Class D w/o Freeboard	Stability Class D w/ Freeboard	Capacity Class B w/o Freeboard	Capacity Class B w/ Freeboard
Hydraulic Radius:	0.348 ft		0.546 ft	
Froude Number:	1.45		0.62	
Roughness Coefficient:	0.0495		0.1246	

Structure #5 (Vegetated Channel)

D-4 Ditch

Trapezoidal Vegetated Channel Inputs:

Material: Tall fescue

Bottom Width (ft)	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Retardance Classes	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)	Limiting Velocity (fps)
20.00	2.0:1	2.0:1	5.9	D, B	3.68			6.0

Vegetated Channel Results:

	Stability Class D w/o Freeboard	Stability Class D w/ Freeboard	Capacity Class B w/o Freeboard	Capacity Class B w/ Freeboard
Design Discharge:	9.63 cfs		9.63 cfs	
Depth:	0.25 ft	3.93 ft	0.49 ft	4.17 ft
Top Width:	21.00 ft	35.72 ft	21.98 ft	36.70 ft
Velocity:	1.89 fps		0.93 fps	
X-Section Area:	5.10 sq ft		10.39 sq ft	
Hydraulic Radius:	0.242 ft		0.468 ft	
Froude Number:	0.67		0.24	
Roughness Coefficient:	0.0741		0.2347	

Structure #4 (Pond)

Sidehill Pond

Pond Inputs:

Initial Pool Elev:	7,160.00 ft
Initial Pool:	0.98 ac-ft
*Sediment Storage:	0.00 ac-ft
Dead Space:	0.00 %

**No sediment capacity defined*

Perforated Riser

Riser Diameter (in)	Riser Height (ft)	Barrel Diameter (in)	Barrel Length (ft)	Barrel Slope (%)	Manning's n	Spillway Elev (ft)	Number of Holes per Elev
18.00	13.00	18.00	125.00	4.00	0.0240	7,170.00	2

Emergency Spillway

Spillway Elev	Crest Length (ft)	Left Sideslope	Right Sideslope	Bottom Width (ft)
7,172.00	40.00	2.00:1	2.00:1	12.00

Pond Results:

Peak Elevation:	7,162.74 ft
H'graph Detention Time:	0.00 hrs
Pond Model:	CSTRS
Dewater Time:	0.00 days
Trap Efficiency:	0.00 %

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)
7,155.00	0.000	0.000	0.000	Top of Sed. Storage
7,156.00	0.157	0.052	0.000	
7,157.00	0.205	0.233	0.000	
7,158.00	0.234	0.452	0.000	
7,159.00	0.264	0.701	0.000	
7,160.00	0.294	0.979	0.000	
7,161.00	0.328	1.290	0.000	
7,162.00	0.362	1.635	0.000	
7,162.74	0.390	1.918	0.000	0.00 Peak Stage
7,163.00	0.399	2.016	0.000	
7,164.00	0.440	2.435	0.000	
7,165.00	0.480	2.895	0.000	
7,166.00	0.525	3.397	0.000	
7,167.00	0.572	3.945	0.000	Low hole SPW #1
7,168.00	0.622	4.542	0.473	
7,169.00	0.672	5.189	0.669	
7,170.00	0.724	5.887	0.819	Spillway #1
7,171.00	0.778	6.638	8.509	
7,172.00	0.833	7.443	12.033	Spillway #2

Elevation	Area (ac)	Capacity (ac-ft)	Discharge (cfs)	Dewater Time (hrs)
7,173.00	0.833	8.276	40.297	
7,174.00	0.833	9.108	115.083	

Detailed Discharge Table

Elevation (ft)	Perf. Riser (cfs)	Emergency Spillway (cfs)	Combined Total Discharge (cfs)
7,155.00	0.000	0.000	0.000
7,156.00	0.000	0.000	0.000
7,157.00	0.000	0.000	0.000
7,158.00	0.000	0.000	0.000
7,159.00	0.000	0.000	0.000
7,160.00	0.000	0.000	0.000
7,161.00	0.000	0.000	0.000
7,162.00	0.000	0.000	0.000
7,163.00	0.000	0.000	0.000
7,164.00	0.000	0.000	0.000
7,165.00	0.000	0.000	0.000
7,166.00	0.000	0.000	0.000
7,167.00	3.00	0.000	0.000
7,168.00	0.473	0.000	0.473
7,169.00	0.669	0.000	0.669
7,170.00	0.819	0.000	0.819
7,171.00	8.509	0.000	8.509
7,172.00	12.033	0.000	12.033
7,173.00	14.738	25.559	40.297
7,174.00	17.018	98.065	115.083

Structure #3 (Riprap Channel)

D-1 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)
12.00	2.0:1	2.0:1	21.0	3.92		

Riprap Channel Results:

Simons/OSM Method - Steep Slope Design

	w/o Freeboard	w/ Freeboard
Design Discharge:	0.82 cfs	
Depth:	0.01 ft	3.93 ft
Top Width:	12.06 ft	27.74 ft
Velocity*:		
X-Section Area:	0.18 sq ft	
Hydraulic Radius:	0.015 ft	
Froude Number*:		
Manning's n*:		
Dmin:	2.00 in	
D50:	6.00 in	
Dmax:	7.50 in	

Velocity and Manning's n calculations may not apply for this method.

Structure #2 (Riprap Channel)

D-2 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)
12.00	2.0:1	2.0:1	4.9	3.91		

Riprap Channel Results:

Simons/OSM Method - Steep Slope Design

	w/o Freeboard	w/ Freeboard
Design Discharge:	2.83 cfs	
Depth:	0.08 ft	3.99 ft
Top Width:	12.30 ft	27.94 ft
Velocity*:		
X-Section Area:	0.92 sq ft	
Hydraulic Radius:	0.075 ft	
Froude Number*:		
Manning's n*:		
Dmin:	1.00 in	
D50:	3.00 in	
Dmax:	3.75 in	

Velocity and Manning's n calculations may not apply for this method.

Structure #1 (Pond)

Section 26 Pond

Pond Inputs:

Initial Pool Elev:	6,980.00 ft
Initial Pool:	1.06 ac-ft
*Sediment Storage:	0.00 ac-ft
Dead Space:	20.00 %

**No sediment capacity defined*

Perforated Riser

Riser Diameter (in)	Riser Height (ft)	Barrel Diameter (in)	Barrel Length (ft)	Barrel Slope (%)	Manning's n	Spillway Elev (ft)	Number of Holes per Elev
18.00	14.00	18.00	200.00	4.00	0.0150	6,984.00	2

Emergency Spillway

Spillway Elev	Crest Length (ft)	Left Sideslope	Right Sideslope	Bottom Width (ft)
6,986.00	30.00	2.50:1	2.50:1	24.00

Pond Results:

Peak Elevation:	6,983.28 ft
H'graph Detention Time:	9.24 hrs
Pond Model:	CSTRS
Dewater Time:	0.64 days
Trap Efficiency:	100.00 %

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)
6,968.00	0.000	0.000	0.000	Top of Sed. Storage
6,969.00	0.001	0.000	0.000	
6,970.00	0.021	0.009	0.000	
6,971.00	0.030	0.035	0.000	
6,972.00	0.045	0.072	0.000	
6,973.00	0.060	0.124	0.000	
6,974.00	0.078	0.193	0.000	
6,975.00	0.097	0.280	0.000	

Elevation	Area (ac)	Capacity (ac-ft)	Discharge (cfs)	Dewater Time (hrs)
6,976.00	0.118	0.388	0.000	
6,977.00	0.141	0.517	0.000	
6,978.00	0.167	0.671	0.000	
6,979.00	0.195	0.852	0.000	
6,980.00	0.224	1.061	0.000	
6,981.00	0.256	1.301	0.000	
6,982.00	0.290	1.574	0.000	Low hole SPW #1
6,983.00	0.327	1.882	0.473	7.89*
6,983.28	0.338	1.978	0.527	7.40 Peak Stage
6,984.00	0.365	2.228	0.669	Spillway #1
6,985.00	0.405	2.612	8.509	
6,986.00	0.448	3.039	12.033	Spillway #2
6,987.00	0.473	3.499	67.527	
6,988.00	0.499	3.985	204.557	
6,989.00	0.525	4.497	411.119	
6,990.00	0.551	5.035	688.306	
6,991.00	0.578	5.600	1,033.669	

*Designates time(s) to dewater have been extrapolated beyond the 50 hour hydrograph limit.

Detailed Discharge Table

Elevation (ft)	Perf. Riser (cfs)	Emergency Spillway (cfs)	Combined Total Discharge (cfs)
6,968.00	0.000	0.000	0.000
6,969.00	0.000	0.000	0.000
6,970.00	0.000	0.000	0.000
6,971.00	0.000	0.000	0.000
6,972.00	0.000	0.000	0.000
6,973.00	0.000	0.000	0.000
6,974.00	0.000	0.000	0.000
6,975.00	0.000	0.000	0.000
6,976.00	0.000	0.000	0.000
6,977.00	0.000	0.000	0.000
6,978.00	0.000	0.000	0.000
6,979.00	0.000	0.000	0.000
6,980.00	0.000	0.000	0.000
6,981.00	0.000	0.000	0.000
6,982.00	3.00	>0.000	0.000

Elevation (ft)	Perf. Riser (cfs)	Emergency Spillway (cfs)	Combined Total Discharge (cfs)
6,983.00	0.473	0.000	0.473
6,984.00	0.669	0.000	0.669
6,985.00	8.509	0.000	8.509
6,986.00	12.033	0.000	12.033
6,987.00	14.738	52.789	67.527
6,988.00	17.018	187.539	204.557
6,989.00	19.026	392.093	411.119
6,990.00	20.842	667.464	688.306
6,991.00	22.512	1,011.157	1,033.669

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)
#12	1	33.400	0.267	0.000	0.000	74.000	F	5.70	0.690
Σ		33.400						5.70	0.690
#9	1	32.500	0.383	0.000	0.000	74.000	F	4.69	0.665
	2	18.300	0.146	0.000	0.000	62.000	M	0.09	0.061
	3	21.500	0.268	0.000	0.000	80.000	F	7.36	0.756
Σ		105.700						17.01	2.172
#8	1	40.000	0.064	0.000	0.000	80.000	F	20.61	1.480
Σ		145.700						31.36	3.652
#10	Σ	145.700						31.36	3.652
#7	1	35.200	0.119	0.000	0.000	80.000	F	18.14	1.303
Σ		180.900						18.14	2.873
#11	Σ	180.900						18.14	2.873
#6	1	22.700	0.091	0.000	0.000	80.000	F	11.70	0.840
	2	0.300	0.017	0.000	0.000	47.000	M	0.00	0.000
	3	19.700	0.111	0.000	0.000	47.000	M	0.00	0.000
	4	12.500	0.083	0.000	0.000	57.000	M	0.02	0.011
Σ		236.100						11.70	1.626
#5	1	23.300	0.157	0.000	0.000	80.000	F	9.33	0.832
	2	2.900	0.039	0.000	0.000	80.000	F	1.49	0.107
Σ		26.200						9.63	0.939
#4	Σ	26.200						9.63	0.939
#3	1	1.600	0.018	0.000	0.000	80.000	F	0.82	0.059
Σ		27.800						0.82	0.059
#2	1	12.000	0.105	0.000	0.000	47.000	M	0.00	0.000
	2	5.500	0.035	0.000	0.000	80.000	F	2.83	0.204
	3	29.900	0.126	0.000	0.000	47.000	M	0.00	0.000
Σ		47.400						2.83	0.204
#1	1	0.300	0.021	0.000	0.000	47.000	M	0.00	0.000
	2	0.400	0.016	0.000	0.000	80.000	F	0.21	0.011
	3	1.900	0.014	0.000	0.000	57.000	M	0.00	0.000
	4	1.500	0.004	0.000	0.000	80.000	F	0.77	0.056
	5	0.900	0.038	0.000	0.000	57.000	M	0.00	0.000

Stru #	SWS #	SWS Area (ac)	Time of Conc (hrs)	Musk K (hrs)	Musk X	Curve Number	UHS	Peak Discharge (cfs)	Runoff Volume (ac-ft)
Σ		316.300						16.33	1.955

Subwatershed Sedimentology Detail:

Stru #	SWS #	Soil K	L (ft)	S (%)	C	P	PS #	Sediment (tons)	Peak Sediment Conc. (mg/l)	Peak Settleable Conc (ml/l)	24VW (ml/l)
#12	1	0.300	400.00	8.00	0.0700	0.3800	1	3.3	7,201	3.50	1.68
Σ								3.3	7,201	3.50	1.68
#9	1	0.300	400.00	8.00	0.0700	0.3800	1	2.9	6,266	2.85	1.44
	2	0.300	400.00	10.80	0.0100	0.3800	1	0.0	344	0.17	0.15
	3	0.300	400.00	3.00	0.0100	0.3800	1	0.2	307	0.16	0.08
Σ								6.3	4,071	1.92	1.01
#8	1	0.300	400.00	12.30	0.8000	0.3800	1	253.7	246,038	140.23	67.08
Σ								260.0	178,754	101.46	28.35
#10	Σ							260.0	178,754	101.46	28.35
#7	1	0.300	400.00	14.00	0.8000	0.3800	1	260.3	282,235	160.86	77.37
Σ								260.3	282,235	160.86	44.16
#11	Σ							260.3	282,235	160.86	44.16
#6	1	0.300	400.00	14.00	0.8000	0.3800	1	159.2	269,322	153.50	73.68
	2	0.300	50.00	1.00	0.0310	0.9000	1	0.0	1	0.00	0.00
	3	0.300	400.00	8.20	0.0310	0.9000	1	0.0	1	0.00	0.00
	4	0.300	400.00	13.90	0.0310	0.9000	1	0.0	2,828	1.61	1.45
Σ								159.3	269,322	153.50	70.57
#5	1	0.300	400.00	6.80	0.8000	0.3800	1	46.2	81,393	43.56	21.35
	2	0.300	200.00	6.80	0.8000	0.3800	1	3.6	52,910	30.16	14.03
Σ								49.8	79,650	42.83	20.52
#4	Σ							49.8	79,650	42.83	20.52
#3	1	0.300	150.00	23.60	0.8000	0.3800	1	8.4	207,202	118.10	56.17
Σ								58.2	207,202	158.88	75.56
#2	1	0.300	300.00	4.10	0.0310	0.9000	1	0.0	1	0.00	0.00
	2	0.300	50.00	1.50	0.8000	0.3800	1	1.0	7,864	4.48	2.07
	3	0.300	400.00	9.10	0.0310	0.9000	1	0.0	1	0.00	0.00
Σ								1.0	7,864	4.48	2.07

Stru #	SWS #	Soil K	L (ft)	S (%)	C	P	PS #	Sediment (tons)	Peak Sediment Conc. (mg/l)	Peak Settleable Conc (ml/l)	24VV (ml/l)
#1	1	0.300	100.00	11.90	0.0310	0.9000	1	0.0	1	0.00	0.00
	2	0.300	100.00	11.90	0.8000	0.3800	1	0.6	71,289	40.63	23.63
	3	0.300	100.00	23.90	0.0850	0.9000	1	0.0	1	0.00	0.00
	4	0.300	50.00	27.90	0.8000	0.3800	1	4.8	131,564	74.99	35.27
	5	0.300	125.00	8.00	0.0850	0.9000	1	0.0	1	0.00	0.00
Σ								223.9	215,991	134.15	62.12

Subwatershed Time of Concentration Details:

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#1	1	3. Short grass pasture	11.90	24.87	209.00	2.750	0.021
#1	1	Time of Concentration:					0.021
#1	2	5. Nearly bare and untilled, and alluvial valley fans	11.90	24.87	209.00	3.440	0.016
#1	2	Time of Concentration:					0.016
#1	3	3. Short grass pasture	23.90	49.95	209.00	3.910	0.014
#1	3	Time of Concentration:					0.014
#1	4	5. Nearly bare and untilled, and alluvial valley fans	27.90	25.10	90.00	5.280	0.004
#1	4	Time of Concentration:					0.004
#1	5	3. Short grass pasture	8.00	24.96	312.00	2.260	0.038
#1	5	Time of Concentration:					0.038
#2	1	3. Short grass pasture	4.10	24.96	609.00	1.610	0.105
#2	1	Time of Concentration:					0.105
#2	2	5. Nearly bare and untilled, and alluvial valley fans	1.50	2.35	157.00	1.220	0.035
#2	2	Time of Concentration:					0.035
#2	3	3. Short grass pasture	9.10	99.64	1,095.00	2.410	0.126
#2	3	Time of Concentration:					0.126
#3	1	5. Nearly bare and untilled, and alluvial valley fans	23.60	75.04	318.00	4.850	0.018
#3	1	Time of Concentration:					0.018
#5	1	5. Nearly bare and untilled, and alluvial valley fans	6.80	100.50	1,478.00	2.600	0.157
#5	1	Time of Concentration:					0.157
#5	2	5. Nearly bare and untilled, and alluvial valley fans	6.80	25.16	370.00	2.600	0.039
#5	2	Time of Concentration:					0.039
#6	1	5. Nearly bare and untilled, and alluvial valley fans	14.00	172.90	1,235.00	3.740	0.091
#6	1	Time of Concentration:					0.091

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#6	2	3. Short grass pasture	1.00	0.50	50.00	0.800	0.017
#6	2	Time of Concentration:					0.017
#6	3	3. Short grass pasture	8.20	75.19	917.00	2.290	0.111
#6	3	Time of Concentration:					0.111
#6	4	3. Short grass pasture	13.90	125.23	901.00	2.980	0.083
#6	4	Time of Concentration:					0.083
#7	1	5. Nearly bare and untilled, and alluvial valley fans	14.00	224.84	1,606.00	3.740	0.119
#7	1	Time of Concentration:					0.119
#8	1	5. Nearly bare and untilled, and alluvial valley fans	12.30	100.36	816.00	3.500	0.064
#8	1	Time of Concentration:					0.064
#9	1	3. Short grass pasture	8.00	249.68	3,121.00	2.260	0.383
#9	1	Time of Concentration:					0.383
#9	2	3. Short grass pasture	10.80	149.58	1,385.00	2.620	0.146
#9	2	Time of Concentration:					0.146
#9	3	5. Nearly bare and untilled, and alluvial valley fans	3.00	50.21	1,674.00	1.730	0.268
#9	3	Time of Concentration:					0.268
#12	1	3. Short grass pasture	8.00	174.22	2,177.75	2.260	0.267
#12	1	Time of Concentration:					0.267

Section 26 Pond **Emergency Spillway Demonstration**

25 - Year 24 - Hour Storm Event
Post Mining

Tony Tennyson

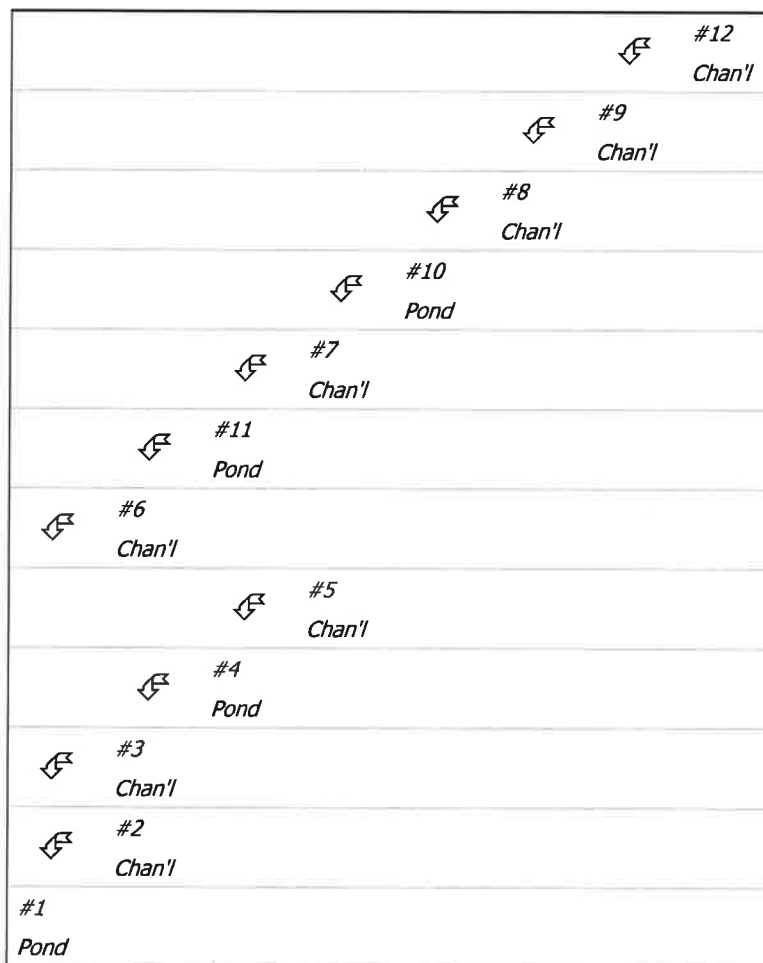
General Information

Storm Information:

Storm Type:	NRCS Type II
Design Storm:	25 yr - 24 hr
Rainfall Depth:	2.300 inches

Structure Networking:

Type	Stru #	(flows into)	Stru #	Musk. K (hrs)	Musk. X	Description
Pond	#1	==>	End	0.000	0.000	Section 26 Pond
Channel	#2	==>	#1	0.000	0.000	D-2 Ditch
Channel	#3	==>	#1	0.000	0.000	D-1 Ditch
Pond	#4	==>	#3	0.000	0.000	Sidehill Pond
Channel	#5	==>	#4	0.000	0.000	D-4 Ditch
Channel	#6	==>	#1	0.000	0.000	Natural Channel
Channel	#7	==>	#11	0.000	0.000	Bear Draw 0+00 to 15+00
Channel	#8	==>	#10	0.000	0.000	Bear Draw 15+00 to 34+00
Channel	#9	==>	#8	0.000	0.000	Bear Draw 34+00 to 81+10
Pond	#10	==>	#7	0.000	0.000	BD-2 Stockpond
Pond	#11	==>	#6	0.000	0.000	BD-1 Stockpond
Channel	#12	==>	#9	0.000	0.000	D-6 Ditch



Structure Summary:

	Immediate Contributing Area (ac)	Total Contributing Area (ac)	Peak Discharge (cfs)	Total Runoff Volume (ac-ft)
#12	33.400	33.400	12.09	1.31
#9	72.300	105.700	35.80	4.06
#8	40.000	145.700	60.49	6.57
#10 In	0.000	145.700	60.49	6.57
Out			4.24	4.48
#7	35.200	180.900	30.03	6.69
#11 In	0.000	180.900	30.03	6.69
Out			3.53	4.57
#6	55.200	236.100	19.36	6.07
#5	26.200	26.200	17.02	1.59
#4 In	0.000	26.200	17.02	1.59
Out			0.00	0.00
#3	1.600	27.800	1.36	0.10
#2	47.400	47.400	4.69	0.34
#1 In	5.000	316.300	27.04	6.64
Out			4.15	5.78

Structure Detail:

Structure #12 (Vegetated Channel)

D-6 Ditch

Trapezoidal Vegetated Channel Inputs:

Material: Tall fescue

Bottom Width (ft)	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Retardance Classes	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)	Limiting Velocity (fps)
5.00	2.0:1	2.0:1	6.0	D, B	2.15			6.0

Vegetated Channel Results:

	Stability Class D w/o Freeboard	Stability Class D w/ Freeboard	Capacity Class B w/o Freeboard	Capacity Class B w/ Freeboard
Design Discharge:	12.09 cfs		12.09 cfs	
Depth:	0.50 ft	2.65 ft	0.85 ft	3.00 ft
Top Width:	6.99 ft	15.59 ft	8.39 ft	16.99 ft
Velocity:	4.06 fps		2.13 fps	
X-Section Area:	2.98 sq ft		5.68 sq ft	
Hydraulic Radius:	0.412 ft		0.646 ft	
Froude Number:	1.10		0.46	
Roughness Coefficient:	0.0498		0.1279	

Structure #9 (Vegetated Channel)

Bear Draw 34+00 to 81+10

Trapezoidal Vegetated Channel Inputs:

Material: Tall fescue

Bottom Width (ft)	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Retardance Classes	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)	Limiting Velocity (fps)
10.00	3.0:1	3.0:1	7.1	D, B	3.35			6.0

Vegetated Channel Results:

	Stability Class D w/o Freeboard	Stability Class D w/ Freeboard	Capacity Class B w/o Freeboard	Capacity Class B w/ Freeboard
Design Discharge:	35.80 cfs		35.80 cfs	
Depth:	0.55 ft	3.90 ft	0.87 ft	4.22 ft
Top Width:	13.30 ft	33.40 ft	15.25 ft	35.35 ft
Velocity:	5.59 fps		3.24 fps	
X-Section Area:	6.41 sq ft		11.05 sq ft	
Hydraulic Radius:	0.475 ft		0.711 ft	
Froude Number:	1.42		0.67	
Roughness Coefficient:	0.0433		0.0974	

Structure #8 (Vegetated Channel)

Bear Draw 15+00 to 34+00

Trapezoidal Vegetated Channel Inputs:

Material: Tall fescue

Bottom Width (ft)	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Retardance Classes	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)	Limiting Velocity (fps)
10.00	3.0:1	3.0:1	2.8	D, B	2.90			7.0

Vegetated Channel Results:

	Stability Class D w/o Freeboard	Stability Class D w/ Freeboard	Capacity Class B w/o Freeboard	Capacity Class B w/ Freeboard
Design Discharge:	60.49 cfs		60.49 cfs	
Depth:	0.91 ft	3.81 ft	1.37 ft	4.27 ft
Top Width:	15.44 ft	32.84 ft	18.21 ft	35.61 ft
Velocity:	5.24 fps		3.13 fps	
X-Section Area:	11.54 sq ft		19.31 sq ft	
Hydraulic Radius:	0.733 ft		1.035 ft	
Froude Number:	1.07		0.54	
Roughness Coefficient:	0.0386		0.0814	

Structure #10 (Pond)

BD-2 Stockpond

Pond Inputs:

Initial Pool Elev:	102.00 ft
Initial Pool:	0.34 ac-ft

Straight Pipe

Barrel Diameter (in)	Barrel Length (ft)	Barrel Slope (%)	Manning's n	Spillway Elev (ft)	Entrance Loss Coefficient	Tailwater Depth (ft)
12.00	100.00	2.00	0.0150	105.00	0.90	0.00

Emergency Spillway

Spillway Elev	Crest Length (ft)	Left Sideslope	Right Sideslope	Bottom Width (ft)
107.00	20.00	2.00:1	2.00:1	15.00

Pond Results:

Peak Elevation:	106.92 ft
Dewater Time:	0.61 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)
100.00	0.016	0.000	0.000	
101.00	0.096	0.050	0.000	
102.00	0.539	0.338	0.000	
103.00	0.654	0.933	0.000	
104.00	0.735	1.628	0.000	
105.00	0.843	2.416	0.000	Spillway #1
106.00	0.872	3.273	2.094	4.95*
106.92	0.871	4.078	4.235	9.65 Peak Stage
107.00	0.872	4.145	4.414	Spillway #2
108.00	0.872	5.017	42.121	

**Designates time(s) to dewater have been extrapolated beyond the 50 hour hydrograph limit.*

Detailed Discharge Table

Elevation (ft)	Straight Pipe (cfs)	Emergency Spillway (cfs)	Combined Total Discharge (cfs)
100.00	0.000	0.000	0.000
101.00	0.000	0.000	0.000
102.00	0.000	0.000	0.000
103.00	0.000	0.000	0.000
104.00	0.000	0.000	0.000
105.00	0.000	0.000	0.000
106.00	(3)>2.094	0.000	2.094
107.00	(5)>4.414	0.000	4.414
108.00	(6)>5.182	36.939	42.121

Structure #7 (Riprap Channel)

Bear Draw 0+00 to 15+00

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)
10.00	2.0:1	2.0:1	10.8	3.59		

Riprap Channel Results:

Simons/OSM Method - Steep Slope Design

	w/o Freeboard	w/ Freeboard
Design Discharge:	30.03 cfs	
Depth:	0.29 ft	3.88 ft
Top Width:	11.15 ft	25.51 ft
Velocity*:		
X-Section Area:	3.03 sq ft	
Hydraulic Radius:	0.269 ft	
Froude Number*:		
Manning's n*:		
Dmin:	2.00 in	
D50:	6.00 in	
Dmax:	7.50 in	

Velocity and Manning's n calculations may not apply for this method.

Structure #11 (Pond)

BD-1 Stockpond

Pond Inputs:

Initial Pool Elev:	102.00 ft
Initial Pool:	0.34 ac-ft

Straight Pipe

Barrel Diameter (in)	Barrel Length (ft)	Barrel Slope (%)	Manning's n	Spillway Elev (ft)	Entrance Loss Coefficient	Tailwater Depth (ft)
12.00	100.00	2.00	0.0150	105.00	0.90	0.00

Emergency Spillway

Spillway Elev	Crest Length (ft)	Left Sideslope	Right Sideslope	Bottom Width (ft)
107.00	20.00	2.00:1	2.00:1	15.00

Pond Results:

Peak Elevation:	106.62 ft
Dewater Time:	0.49 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)
100.00	0.016	0.000	0.000	
101.00	0.096	0.050	0.000	
102.00	0.539	0.338	0.000	
103.00	0.654	0.933	0.000	
104.00	0.735	1.628	0.000	
105.00	0.843	2.416	0.000	Spillway #1
106.00	0.872	3.273	2.094	4.95*
106.62	0.866	3.814	3.532	6.90 Peak Stage
107.00	0.872	4.145	4.414	Spillway #2
108.00	0.872	5.017	42.121	

**Designates time(s) to dewater have been extrapolated beyond the 50 hour hydrograph limit.*

Detailed Discharge Table

Elevation (ft)	Straight Pipe (cfs)	Emergency Spillway (cfs)	Combined Total Discharge (cfs)
100.00	0.000	0.000	0.000
101.00	0.000	0.000	0.000
102.00	0.000	0.000	0.000
103.00	0.000	0.000	0.000
104.00	0.000	0.000	0.000
105.00	0.000	0.000	0.000
106.00	(3)>2.094	0.000	2.094
107.00	(5)>4.414	0.000	4.414
108.00	(6)>5.182	36.939	42.121

Structure #6 (Vegetated Channel)

Natural Channel

Trapezoidal Vegetated Channel Inputs:

Material: Bermuda grass

Bottom Width (ft)	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Retardance Classes	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)	Limiting Velocity (fps)
5.00	2.0:1	2.0:1	11.0	D, B	3.00			6.0

Vegetated Channel Results:

	Stability Class D w/o Freeboard	Stability Class D w/ Freeboard	Capacity Class B w/o Freeboard	Capacity Class B w/ Freeboard
Design Discharge:	19.36 cfs		19.36 cfs	
Depth:	0.50 ft	3.50 ft	0.81 ft	3.81 ft
Top Width:	7.02 ft	19.02 ft	8.22 ft	20.22 ft
Velocity:	6.38 fps		3.63 fps	
X-Section Area:	3.04 sq ft		5.33 sq ft	
Hydraulic Radius:	0.418 ft		0.619 ft	
Froude Number:	1.71		0.80	
Roughness Coefficient:	0.0432		0.0987	

Structure #5 (Vegetated Channel)

D-4 Ditch

Trapezoidal Vegetated Channel Inputs:

Material: Tall fescue

Bottom Width (ft)	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Retardance Classes	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)	Limiting Velocity (fps)
20.00	2.0:1	2.0:1	5.9	D, B	3.68			6.0

Vegetated Channel Results:

	Stability Class D w/o Freeboard	Stability Class D w/ Freeboard	Capacity Class B w/o Freeboard	Capacity Class B w/ Freeboard
Design Discharge:	17.02 cfs		17.02 cfs	
Depth:	0.32 ft	4.00 ft	0.58 ft	4.26 ft
Top Width:	21.26 ft	35.98 ft	22.34 ft	37.06 ft
Velocity:	2.61 fps		1.38 fps	
X-Section Area:	6.52 sq ft		12.36 sq ft	
Hydraulic Radius:	0.304 ft		0.547 ft	
Froude Number:	0.83		0.33	
Roughness Coefficient:	0.0625		0.1756	

Structure #4 (Pond)

Sidehill Pond

Pond Inputs:

Initial Pool Elev:	7,160.00 ft
Initial Pool:	0.98 ac-ft

Perforated Riser

Riser Diameter (in)	Riser Height (ft)	Barrel Diameter (in)	Barrel Length (ft)	Barrel Slope (%)	Manning's n	Spillway Elev (ft)	Number of Holes per Elev
18.00	13.00	18.00	125.00	4.00	0.0240	7,170.00	2

Emergency Spillway

Spillway Elev	Crest Length (ft)	Left Sideslope	Right Sideslope	Bottom Width (ft)
7,172.00	40.00	2.00:1	2.00:1	12.00

Pond Results:

Peak Elevation:	7,164.29 ft
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)
7,155.00	0.000	0.000	0.000	
7,155.01	0.002	0.000	0.000	
7,156.00	0.157	0.058	0.000	
7,157.00	0.205	0.238	0.000	
7,158.00	0.234	0.457	0.000	
7,159.00	0.264	0.706	0.000	
7,160.00	0.294	0.985	0.000	
7,161.00	0.328	1.295	0.000	
7,162.00	0.362	1.640	0.000	
7,163.00	0.399	2.021	0.000	
7,164.00	0.440	2.440	0.000	
7,164.29	0.451	2.575	0.000	0.00 Peak Stage
7,165.00	0.480	2.900	0.000	
7,166.00	0.525	3.402	0.000	
7,167.00	0.572	3.950	0.000	Low hole SPW #1
7,168.00	0.622	4.547	0.473	
7,169.00	0.672	5.194	0.669	
7,170.00	0.724	5.892	0.819	Spillway #1
7,171.00	0.778	6.643	8.509	
7,172.00	0.833	7.448	12.033	Spillway #2
7,173.00	0.833	8.281	40.297	
7,174.00	0.833	9.114	115.083	

Detailed Discharge Table

Elevation (ft)	Perf. Riser (cfs)	Emergency Spillway (cfs)	Combined Total Discharge (cfs)
7,155.00	0.000	0.000	0.000
7,155.01	0.000	0.000	0.000
7,156.00	0.000	0.000	0.000
7,157.00	0.000	0.000	0.000
7,158.00	0.000	0.000	0.000
7,159.00	0.000	0.000	0.000
7,160.00	0.000	0.000	0.000
7,161.00	0.000	0.000	0.000
7,162.00	0.000	0.000	0.000
7,163.00	0.000	0.000	0.000

Elevation (ft)	Perf. Riser (cfs)	Emergency Spillway (cfs)	Combined Total Discharge (cfs)
7,164.00	0.000	0.000	0.000
7,165.00	0.000	0.000	0.000
7,166.00	0.000	0.000	0.000
7,167.00	3.00>0.000	0.000	0.000
7,168.00	0.473	0.000	0.473
7,169.00	0.669	0.000	0.669
7,170.00	0.819	0.000	0.819
7,171.00	8.509	0.000	8.509
7,172.00	12.033	0.000	12.033
7,173.00	14.738	25.559	40.297
7,174.00	17.018	98.065	115.083

Structure #3 (Riprap Channel)

D-1 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)
12.00	2.0:1	2.0:1	21.0	3.92		

Riprap Channel Results:

Simons/OSM Method - Steep Slope Design

	w/o Freeboard	w/ Freeboard
Design Discharge:	1.36 cfs	
Depth:	0.02 ft	3.94 ft
Top Width:	12.07 ft	27.75 ft
Velocity*:		
X-Section Area:	0.22 sq ft	
Hydraulic Radius:	0.018 ft	
Froude Number*:		
Manning's n*:		
Dmin:	2.00 in	
D50:	6.00 in	
Dmax:	7.50 in	

Velocity and Manning's n calculations may not apply for this method.

Structure #2 (Riprap Channel)

D-2 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)
12.00	2.0:1	2.0:1	4.9	3.91		

Riprap Channel Results:

Simons/OSM Method - Steep Slope Design

	w/o Freeboard	w/ Freeboard
Design Discharge:	4.69 cfs	
Depth:	0.09 ft	4.00 ft
Top Width:	12.38 ft	28.02 ft
Velocity*:		
X-Section Area:	1.15 sq ft	
Hydraulic Radius:	0.092 ft	
Froude Number*:		
Manning's n*:		
Dmin:	1.00 in	
D50:	3.00 in	
Dmax:	3.75 in	

Velocity and Manning's n calculations may not apply for this method.

Structure #1 (Pond)

Section 26 Pond

Pond Inputs:

Initial Pool Elev:	6,980.00 ft
Initial Pool:	1.06 ac-ft

Perforated Riser

Riser Diameter (in)	Riser Height (ft)	Barrel Diameter (in)	Barrel Length (ft)	Barrel Slope (%)	Manning's n	Spillway Elev (ft)	Number of Holes per Elev
18.00	14.00	18.00	200.00	4.00	0.0150	6,984.00	2

Emergency Spillway

Spillway Elev	Crest Length (ft)	Left Sideslope	Right Sideslope	Bottom Width (ft)
6,986.00	30.00	2.50:1	2.50:1	24.00

Pond Results:

Peak Elevation:	6,984.44 ft
Dewater Time:	1.22 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)
6,968.00	0.000	0.000	0.000	
6,969.00	0.001	0.000	0.000	
6,970.00	0.021	0.009	0.000	
6,971.00	0.030	0.035	0.000	
6,972.00	0.045	0.072	0.000	
6,973.00	0.060	0.124	0.000	
6,974.00	0.078	0.193	0.000	
6,975.00	0.097	0.280	0.000	
6,976.00	0.118	0.388	0.000	
6,977.00	0.141	0.517	0.000	
6,978.00	0.167	0.671	0.000	
6,979.00	0.195	0.852	0.000	
6,980.00	0.224	1.061	0.000	
6,981.00	0.256	1.301	0.000	
6,982.00	0.290	1.574	0.000	Low hole SPW #1
6,983.00	0.327	1.882	0.473	7.89*
6,984.00	0.365	2.228	0.669	6.26* Spillway #1
6,984.44	0.383	2.399	4.155	15.05 Peak Stage
6,985.00	0.405	2.612	8.509	
6,986.00	0.448	3.039	12.033	Spillway #2
6,987.00	0.473	3.499	67.527	
6,988.00	0.499	3.985	204.557	
6,989.00	0.525	4.497	411.119	
6,990.00	0.551	5.035	688.306	
6,991.00	0.578	5.600	1,033.669	

**Designates time(s) to dewater have been extrapolated beyond the 50 hour hydrograph limit.*

Detailed Discharge Table

Elevation (ft)	Perf. Riser (cfs)	Emergency Spillway (cfs)	Combined Total Discharge (cfs)
6,968.00	0.000	0.000	0.000
6,969.00	0.000	0.000	0.000
6,970.00	0.000	0.000	0.000
6,971.00	0.000	0.000	0.000
6,972.00	0.000	0.000	0.000
6,973.00	0.000	0.000	0.000
6,974.00	0.000	0.000	0.000
6,975.00	0.000	0.000	0.000
6,976.00	0.000	0.000	0.000
6,977.00	0.000	0.000	0.000
6,978.00	0.000	0.000	0.000
6,979.00	0.000	0.000	0.000
6,980.00	0.000	0.000	0.000
6,981.00	0.000	0.000	0.000
6,982.00	3.00>0.000	0.000	0.000
6,983.00	0.473	0.000	0.473
6,984.00	0.669	0.000	0.669
6,985.00	8.509	0.000	8.509
6,986.00	12.033	0.000	12.033
6,987.00	14.738	52.789	67.527
6,988.00	17.018	187.539	204.557
6,989.00	19.026	392.093	411.119
6,990.00	20.842	667.464	688.306
6,991.00	22.512	1,011.157	1,033.669

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)
#12	1	33.400	0.285	0.000	0.000	74.000	F	12.09	1.308
	Σ	33.400						12.09	1.308
#9	1	32.500	0.383	0.000	0.000	74.000	F	10.48	1.272
	2	18.300	0.146	0.000	0.000	62.000	M	0.97	0.199
	3	21.500	0.268	0.000	0.000	80.000	F	13.14	1.281
	Σ	105.700						35.80	4.059
#8	1	40.000	0.064	0.000	0.000	80.000	F	34.12	2.509
	Σ	145.700						60.49	6.568
#10	Σ	145.700						60.49	6.568
#7	1	35.200	0.119	0.000	0.000	80.000	F	30.03	2.208
	Σ	180.900						30.03	6.690
#11	Σ	180.900						30.03	6.690
#6	1	22.700	0.091	0.000	0.000	80.000	F	19.36	1.424
	2	0.300	0.017	0.000	0.000	47.000	M	0.00	0.000
	3	19.700	0.111	0.000	0.000	47.000	M	0.00	0.000
	4	12.500	0.083	0.000	0.000	57.000	M	0.19	0.078
	Σ	236.100						19.36	6.074
#5	1	23.300	0.157	0.000	0.000	80.000	F	16.12	1.410
	2	2.900	0.039	0.000	0.000	80.000	F	2.47	0.182
	Σ	26.200						17.02	1.591
#4	Σ	26.200						17.02	1.591
#3	1	1.600	0.018	0.000	0.000	80.000	F	1.36	0.100
	Σ	27.800						1.36	0.100
#2	1	12.000	0.105	0.000	0.000	47.000	M	0.00	0.000
	2	5.500	0.035	0.000	0.000	80.000	F	4.69	0.345
	3	29.900	0.126	0.000	0.000	47.000	M	0.00	0.000
	Σ	47.400						4.69	0.345
#1	1	0.300	0.021	0.000	0.000	47.000	M	0.00	0.000
	2	0.400	0.016	0.000	0.000	80.000	F	0.34	0.021
	3	1.900	0.014	0.000	0.000	57.000	M	0.03	0.008
	4	1.500	0.004	0.000	0.000	80.000	F	1.28	0.094
	5	0.900	0.038	0.000	0.000	57.000	M	0.01	0.000

Stru #	SWS #	SWS Area (ac)	Time of Conc (hrs)	Musk K (hrs)	Musk X	Curve Number	UHS	Peak Discharge (cfs)	Runoff Volume (ac-ft)
Σ		316.300						27.04	6.642

Subwatershed Time of Concentration Details:

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#1	1	3. Short grass pasture	11.90	24.87	209.00	2.750	0.021
#1	1	Time of Concentration:					0.021
#1	2	5. Nearly bare and untilled, and alluvial valley fans	11.90	24.87	209.00	3.440	0.016
#1	2	Time of Concentration:					0.016
#1	3	3. Short grass pasture	23.90	49.95	209.00	3.910	0.014
#1	3	Time of Concentration:					0.014
#1	4	5. Nearly bare and untilled, and alluvial valley fans	27.90	25.10	90.00	5.280	0.004
#1	4	Time of Concentration:					0.004
#1	5	3. Short grass pasture	8.00	24.96	312.00	2.260	0.038
#1	5	Time of Concentration:					0.038
#2	1	3. Short grass pasture	4.10	24.96	609.00	1.610	0.105
#2	1	Time of Concentration:					0.105
#2	2	5. Nearly bare and untilled, and alluvial valley fans	1.50	2.35	157.00	1.220	0.035
#2	2	Time of Concentration:					0.035
#2	3	3. Short grass pasture	9.10	99.64	1,095.00	2.410	0.126
#2	3	Time of Concentration:					0.126
#3	1	5. Nearly bare and untilled, and alluvial valley fans	23.60	75.04	318.00	4.850	0.018
#3	1	Time of Concentration:					0.018
#5	1	5. Nearly bare and untilled, and alluvial valley fans	6.80	100.50	1,478.00	2.600	0.157
#5	1	Time of Concentration:					0.157
#5	2	5. Nearly bare and untilled, and alluvial valley fans	6.80	25.16	370.00	2.600	0.039
#5	2	Time of Concentration:					0.039
#6	1	5. Nearly bare and untilled, and alluvial valley fans	14.00	172.90	1,235.00	3.740	0.091
#6	1	Time of Concentration:					0.091
#6	2	3. Short grass pasture	1.00	0.50	50.00	0.800	0.017
#6	2	Time of Concentration:					0.017
#6	3	3. Short grass pasture	8.20	75.19	917.00	2.290	0.111
#6	3	Time of Concentration:					0.111
#6	4	3. Short grass pasture	13.90	125.23	901.00	2.980	0.083
#6	4	Time of Concentration:					0.083

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#7	1	5. Nearly bare and untilled, and alluvial valley fans	14.00	224.84	1,606.00	3.740	0.119
#7	1	Time of Concentration:					0.119
#8	1	5. Nearly bare and untilled, and alluvial valley fans	12.30	100.36	816.00	3.500	0.064
#8	1	Time of Concentration:					0.064
#9	1	3. Short grass pasture	8.00	249.68	3,121.00	2.260	0.383
#9	1	Time of Concentration:					0.383
#9	2	3. Short grass pasture	10.80	149.58	1,385.00	2.620	0.146
#9	2	Time of Concentration:					0.146
#9	3	5. Nearly bare and untilled, and alluvial valley fans	3.00	50.21	1,674.00	1.730	0.268
#9	3	Time of Concentration:					0.268
#12	1	3. Short grass pasture	8.00	185.84	2,323.00	2.260	0.285
#12	1	Time of Concentration:					0.285

Section 26 Pond **Post Mine Channel Configurations**

25 - Year 24 - Hour Storm Event
Post Mining

Tony Tennyson

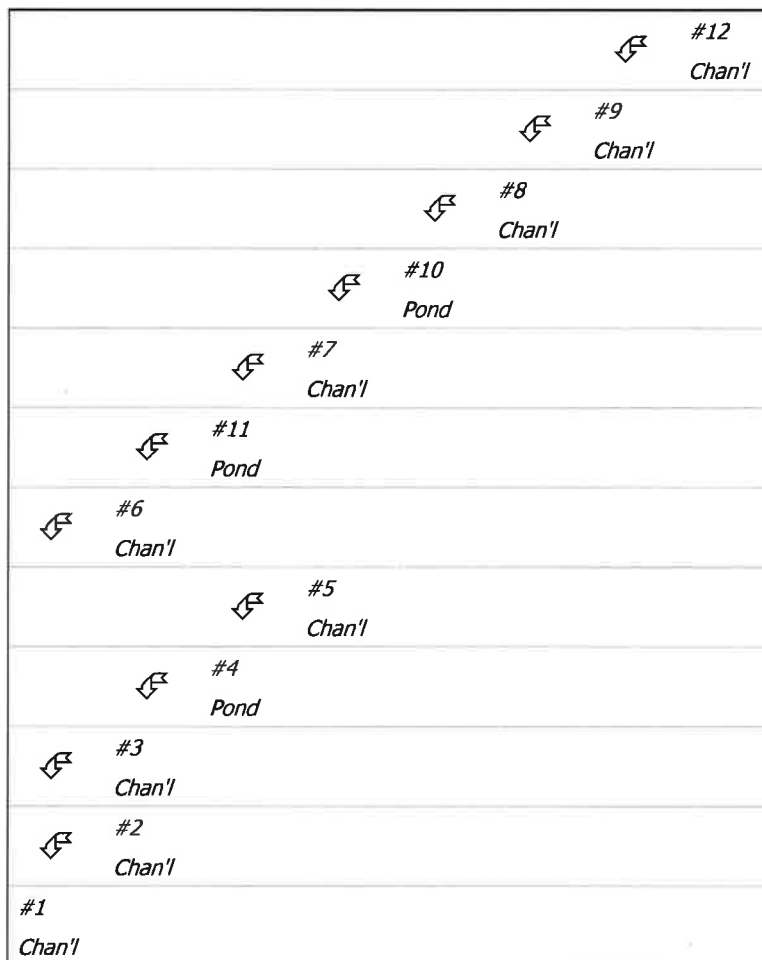
General Information

Storm Information:

Storm Type:	NRCS Type II
Design Storm:	25 yr - 24 hr
Rainfall Depth:	2.300 inches

Structure Networking:

Type	Stru #	(flows into)	Stru #	Musk. K (hrs)	Musk. X	Description
Channel	#1	==>	End	0.000	0.000	Lower Bear Draw (Section 26 Pond)
Channel	#2	==>	#1	0.000	0.000	D-2 Ditch
Channel	#3	==>	#1	0.000	0.000	D-1 Ditch
Pond	#4	==>	#3	0.000	0.000	Sidehill Pond
Channel	#5	==>	#4	0.000	0.000	D-4 Ditch
Channel	#6	==>	#1	0.000	0.000	Natural Channel
Channel	#7	==>	#11	0.000	0.000	Bear Draw 0+00 to 15+00
Channel	#8	==>	#10	0.000	0.000	Bear Draw 15+00 to 34+00
Channel	#9	==>	#8	0.000	0.000	Bear Draw 34+00 to 81+10
Pond	#10	==>	#7	0.000	0.000	BD-2 Stockpond
Pond	#11	==>	#6	0.000	0.000	BD-1 Stockpond
Channel	#12	==>	#9	0.000	0.000	D-6 Ditch



Structure Summary:

	Immediate Contributing Area (ac)	Total Contributing Area (ac)	Peak Discharge (cfs)	Total Runoff Volume (ac-ft)
#12	33.400	33.400	12.09	1.31
#9	72.300	105.700	35.80	4.06
#8	40.000	145.700	60.49	6.57
#10 In	0.000	145.700	60.49	6.57
Out			4.24	4.48
#7	35.200	180.900	30.03	6.69
#11 In	0.000	180.900	30.03	6.69
Out			3.53	4.57
#6	55.200	236.100	19.36	6.07
#5	26.200	26.200	17.02	1.59
#4 In	0.000	26.200	17.02	1.59
Out			0.00	0.00
#3	1.600	27.800	1.36	0.10
#2	47.400	47.400	4.69	0.34
#1	5.000	316.300	27.04	6.64

Structure Detail:

Structure #12 (Vegetated Channel)

D-6 Ditch

Trapezoidal Vegetated Channel Inputs:

Material: Tall fescue

Bottom Width (ft)	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Retardance Classes	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)	Limiting Velocity (fps)
5.00	2.0:1	2.0:1	6.0	D, B	2.15			6.0

Vegetated Channel Results:

	Stability Class D w/o Freeboard	Stability Class D w/ Freeboard	Capacity Class B w/o Freeboard	Capacity Class B w/ Freeboard
Design Discharge:	12.09 cfs		12.09 cfs	
Depth:	0.50 ft	2.65 ft	0.85 ft	3.00 ft
Top Width:	6.99 ft	15.59 ft	8.39 ft	16.99 ft
Velocity:	4.06 fps		2.13 fps	
X-Section Area:	2.98 sq ft		5.68 sq ft	
Hydraulic Radius:	0.412 ft		0.646 ft	
Froude Number:	1.10		0.46	
Roughness Coefficient:	0.0498		0.1279	

Structure #9 (Vegetated Channel)

Bear Draw 34+00 to 81+10

Trapezoidal Vegetated Channel Inputs:

Material: Tall fescue

Bottom Width (ft)	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Retardance Classes	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)	Limiting Velocity (fps)
10.00	3.0:1	3.0:1	7.1	D, B	3.13			6.0

Vegetated Channel Results:

	Stability Class D w/o Freeboard	Stability Class D w/ Freeboard	Capacity Class B w/o Freeboard	Capacity Class B w/ Freeboard
Design Discharge:	35.80 cfs		35.80 cfs	
Depth:	0.55 ft	3.68 ft	0.87 ft	4.00 ft
Top Width:	13.30 ft	32.08 ft	15.25 ft	34.03 ft
Velocity:	5.59 fps		3.24 fps	
X-Section Area:	6.41 sq ft		11.05 sq ft	
Hydraulic Radius:	0.475 ft		0.711 ft	
Froude Number:	1.42		0.67	
Roughness Coefficient:	0.0433		0.0974	

Structure #8 (Vegetated Channel)

Bear Draw 15+00 to 34+00

Trapezoidal Vegetated Channel Inputs:

Material: Tall fescue

Bottom Width (ft)	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Retardance Classes	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)	Limiting Velocity (fps)
10.00	3.0:1	3.0:1	2.8	D, B	2.63			7.0

Vegetated Channel Results:

	Stability Class D w/o Freeboard	Stability Class D w/ Freeboard	Capacity Class B w/o Freeboard	Capacity Class B w/ Freeboard
Design Discharge:	60.49 cfs		60.49 cfs	
Depth:	0.91 ft	3.54 ft	1.37 ft	4.00 ft
Top Width:	15.44 ft	31.22 ft	18.21 ft	33.99 ft
Velocity:	5.24 fps		3.13 fps	
X-Section Area:	11.54 sq ft		19.31 sq ft	
Hydraulic Radius:	0.733 ft		1.035 ft	
Froude Number:	1.07		0.54	
Roughness Coefficient:	0.0386		0.0814	

Structure #10 (Pond)

BD-2 Stockpond

Pond Inputs:

Initial Pool Elev:	102.00 ft
Initial Pool:	0.34 ac-ft

Straight Pipe

Barrel Diameter (in)	Barrel Length (ft)	Barrel Slope (%)	Manning's n	Spillway Elev (ft)	Entrance Loss Coefficient	Tailwater Depth (ft)
12.00	100.00	2.00	0.0150	105.00	0.90	0.00

Emergency Spillway

Spillway Elev	Crest Length (ft)	Left Sideslope	Right Sideslope	Bottom Width (ft)
107.00	20.00	2.00:1	2.00:1	15.00

Pond Results:

Peak Elevation:	106.92 ft
Dewater Time:	0.61 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)	
100.00	0.016	0.000	0.000		
101.00	0.096	0.050	0.000		
102.00	0.539	0.338	0.000		
103.00	0.654	0.933	0.000		
104.00	0.735	1.628	0.000		
105.00	0.843	2.416	0.000		Spillway #1
106.00	0.872	3.273	2.094	4.95*	
106.92	0.871	4.078	4.235	9.65	Peak Stage
107.00	0.872	4.145	4.414		Spillway #2
108.00	0.872	5.017	42.121		

**Designates time(s) to dewater have been extrapolated beyond the 50 hour hydrograph limit.*

Detailed Discharge Table

Elevation (ft)	Straight Pipe (cfs)	Emergency Spillway (cfs)	Combined Total Discharge (cfs)
100.00	0.000	0.000	0.000
101.00	0.000	0.000	0.000
102.00	0.000	0.000	0.000
103.00	0.000	0.000	0.000
104.00	0.000	0.000	0.000
105.00	0.000	0.000	0.000
106.00	(3)>2.094	0.000	2.094
107.00	(5)>4.414	0.000	4.414
108.00	(6)>5.182	36.939	42.121

Structure #7 (Riprap Channel)

Bear Draw 0+00 to 15+00

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)
10.00	2.0:1	2.0:1	10.8	3.71		

Riprap Channel Results:

Simons/OSM Method - Steep Slope Design

	w/o Freeboard	w/ Freeboard
Design Discharge:	30.03 cfs	
Depth:	0.29 ft	4.00 ft
Top Width:	11.15 ft	25.99 ft
Velocity*:		
X-Section Area:	3.03 sq ft	
Hydraulic Radius:	0.269 ft	
Froude Number*:		
Manning's n*:		
Dmin:	2.00 in	
D50:	6.00 in	
Dmax:	7.50 in	

Velocity and Manning's n calculations may not apply for this method.

Structure #11 (Pond)

BD-1 Stockpond

Pond Inputs:

Initial Pool Elev:	102.00 ft
Initial Pool:	0.34 ac-ft

Straight Pipe

Barrel Diameter (in)	Barrel Length (ft)	Barrel Slope (%)	Manning's n	Spillway Elev (ft)	Entrance Loss Coefficient	Tailwater Depth (ft)
12.00	100.00	2.00	0.0150	105.00	0.90	0.00

Emergency Spillway

Spillway Elev	Crest Length (ft)	Left Sideslope	Right Sideslope	Bottom Width (ft)
107.00	20.00	2.00:1	2.00:1	15.00

Pond Results:

Peak Elevation:	106.62 ft
Dewater Time:	0.49 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)
100.00	0.016	0.000	0.000	
101.00	0.096	0.050	0.000	
102.00	0.539	0.338	0.000	
103.00	0.654	0.933	0.000	
104.00	0.735	1.628	0.000	
105.00	0.843	2.416	0.000	Spillway #1
106.00	0.872	3.273	2.094	4.95*
106.62	0.866	3.814	3.532	6.90 Peak Stage
107.00	0.872	4.145	4.414	Spillway #2
108.00	0.872	5.017	42.121	

**Designates time(s) to dewater have been extrapolated beyond the 50 hour hydrograph limit.*

Detailed Discharge Table

Elevation (ft)	Straight Pipe (cfs)	Emergency Spillway (cfs)	Combined Total Discharge (cfs)
100.00	0.000	0.000	0.000
101.00	0.000	0.000	0.000
102.00	0.000	0.000	0.000
103.00	0.000	0.000	0.000
104.00	0.000	0.000	0.000
105.00	0.000	0.000	0.000
106.00	(3)>2.094	0.000	2.094
107.00	(5)>4.414	0.000	4.414
108.00	(6)>5.182	36.939	42.121

Structure #6 (Vegetated Channel)

Natural Channel

Trapezoidal Vegetated Channel Inputs:

Material: Bermuda grass

Bottom Width (ft)	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Retardance Classes	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)	Limiting Velocity (fps)
5.00	2.0:1	2.0:1	11.0	D, B	3.00			6.0

Vegetated Channel Results:

	Stability Class D w/o Freeboard	Stability Class D w/ Freeboard	Capacity Class B w/o Freeboard	Capacity Class B w/ Freeboard
Design Discharge:	19.36 cfs		19.36 cfs	
Depth:	0.50 ft	3.50 ft	0.81 ft	3.81 ft
Top Width:	7.02 ft	19.02 ft	8.22 ft	20.22 ft
Velocity:	6.38 fps		3.63 fps	
X-Section Area:	3.04 sq ft		5.33 sq ft	
Hydraulic Radius:	0.418 ft		0.619 ft	
Froude Number:	1.71		0.80	
Roughness Coefficient:	0.0432		0.0987	

Structure #5 (Vegetated Channel)

D-4 Ditch

Trapezoidal Vegetated Channel Inputs:

Material: Tall fescue

Bottom Width (ft)	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Retardance Classes	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)	Limiting Velocity (fps)
20.00	2.0:1	2.0:1	5.9	D, B	3.68			6.0

Vegetated Channel Results:

	Stability Class D w/o Freeboard	Stability Class D w/ Freeboard	Capacity Class B w/o Freeboard	Capacity Class B w/ Freeboard
Design Discharge:	17.02 cfs		17.02 cfs	
Depth:	0.32 ft	4.00 ft	0.58 ft	4.26 ft
Top Width:	21.26 ft	35.98 ft	22.34 ft	37.06 ft
Velocity:	2.61 fps		1.38 fps	
X-Section Area:	6.52 sq ft		12.36 sq ft	
Hydraulic Radius:	0.304 ft		0.547 ft	
Froude Number:	0.83		0.33	
Roughness Coefficient:	0.0625		0.1756	

Structure #4 (Pond)

Sidehill Pond

Pond Inputs:

Initial Pool Elev:	7,160.00 ft
Initial Pool:	0.98 ac-ft

Perforated Riser

Riser Diameter (in)	Riser Height (ft)	Barrel Diameter (in)	Barrel Length (ft)	Barrel Slope (%)	Manning's n	Spillway Elev (ft)	Number of Holes per Elev
18.00	13.00	18.00	125.00	4.00	0.0240	7,170.00	2

Emergency Spillway

Spillway Elev	Crest Length (ft)	Left Sideslope	Right Sideslope	Bottom Width (ft)
7,172.00	40.00	2.00:1	2.00:1	12.00

Pond Results:

Peak Elevation:	7,164.29 ft
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)
7,155.00	0.000	0.000	0.000	
7,155.01	0.002	0.000	0.000	
7,156.00	0.157	0.058	0.000	
7,157.00	0.205	0.238	0.000	
7,158.00	0.234	0.457	0.000	
7,159.00	0.264	0.706	0.000	
7,160.00	0.294	0.985	0.000	
7,161.00	0.328	1.295	0.000	
7,162.00	0.362	1.640	0.000	
7,163.00	0.399	2.021	0.000	
7,164.00	0.440	2.440	0.000	
7,164.29	0.451	2.575	0.000	0.00 Peak Stage
7,165.00	0.480	2.900	0.000	
7,166.00	0.525	3.402	0.000	
7,167.00	0.572	3.950	0.000	Low hole SPW #1
7,168.00	0.622	4.547	0.473	
7,169.00	0.672	5.194	0.669	
7,170.00	0.724	5.892	0.819	Spillway #1
7,171.00	0.778	6.643	8.509	
7,172.00	0.833	7.448	12.033	Spillway #2
7,173.00	0.833	8.281	40.297	
7,174.00	0.833	9.114	115.083	

Detailed Discharge Table

Elevation (ft)	Perf. Riser (cfs)	Emergency Spillway (cfs)	Combined Total Discharge (cfs)
7,155.00	0.000	0.000	0.000
7,155.01	0.000	0.000	0.000
7,156.00	0.000	0.000	0.000
7,157.00	0.000	0.000	0.000
7,158.00	0.000	0.000	0.000
7,159.00	0.000	0.000	0.000
7,160.00	0.000	0.000	0.000
7,161.00	0.000	0.000	0.000
7,162.00	0.000	0.000	0.000
7,163.00	0.000	0.000	0.000

Elevation (ft)	Perf. Riser (cfs)	Emergency Spillway (cfs)	Combined Total Discharge (cfs)
7,164.00	0.000	0.000	0.000
7,165.00	0.000	0.000	0.000
7,166.00	0.000	0.000	0.000
7,167.00	3.00>0.000	0.000	0.000
7,168.00	0.473	0.000	0.473
7,169.00	0.669	0.000	0.669
7,170.00	0.819	0.000	0.819
7,171.00	8.509	0.000	8.509
7,172.00	12.033	0.000	12.033
7,173.00	14.738	25.559	40.297
7,174.00	17.018	98.065	115.083

Structure #3 (Riprap Channel)

D-1 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)
12.00	2.0:1	2.0:1	21.0	3.92		

Riprap Channel Results:

Simons/OSM Method - Steep Slope Design

	w/o Freeboard	w/ Freeboard
Design Discharge:	1.36 cfs	
Depth:	0.02 ft	3.94 ft
Top Width:	12.07 ft	27.75 ft
Velocity*:		
X-Section Area:	0.22 sq ft	
Hydraulic Radius:	0.018 ft	
Froude Number*:		
Manning's n*:		
Dmin:	2.00 in	
D50:	6.00 in	
Dmax:	7.50 in	

Velocity and Manning's n calculations may not apply for this method.

Structure #2 (Riprap Channel)

D-2 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)
12.00	2.0:1	2.0:1	4.9	3.91		

Riprap Channel Results:

Simons/OSM Method - Steep Slope Design

	w/o Freeboard	w/ Freeboard
Design Discharge:	4.69 cfs	
Depth:	0.09 ft	4.00 ft
Top Width:	12.38 ft	28.02 ft
Velocity*:		
X-Section Area:	1.15 sq ft	
Hydraulic Radius:	0.092 ft	
Froude Number*:		
Manning's n*:		
Dmin:	1.00 in	
D50:	3.00 in	
Dmax:	3.75 in	

Velocity and Manning's n calculations may not apply for this method.

Structure #1 (Riprap Channel)

Lower Bear Draw (Section 26 Pond)

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)
10.00	3.0:1	3.0:1	9.5	3.73		

Riprap Channel Results:

Simons/OSM Method - Steep Slope Design

	w/o Freeboard	w/ Freeboard
Design Discharge:	27.04 cfs	
Depth:	0.27 ft	4.00 ft
Top Width:	11.63 ft	34.01 ft
Velocity*:		
X-Section Area:	2.93 sq ft	
Hydraulic Radius:	0.250 ft	
Froude Number*:		
Manning's n*:		
Dmin:	2.00 in	
D50:	6.00 in	
Dmax:	7.50 in	

Velocity and Manning's n calculations may not apply for this method.

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)
#12	1	33.400	0.285	0.000	0.000	74.000	F	12.09	1.308
Σ		33.400						12.09	1.308
#9	1	32.500	0.383	0.000	0.000	74.000	F	10.48	1.272
	2	18.300	0.146	0.000	0.000	62.000	M	0.97	0.199
	3	21.500	0.268	0.000	0.000	80.000	F	13.14	1.281
Σ		105.700						35.80	4.059
#8	1	40.000	0.064	0.000	0.000	80.000	F	34.12	2.509
Σ		145.700						60.49	6.568
#10	Σ	145.700						60.49	6.568
#7	1	35.200	0.119	0.000	0.000	80.000	F	30.03	2.208
Σ		180.900						30.03	6.690
#11	Σ	180.900						30.03	6.690
#6	1	22.700	0.091	0.000	0.000	80.000	F	19.36	1.424
	2	0.300	0.017	0.000	0.000	47.000	M	0.00	0.000
	3	19.700	0.111	0.000	0.000	47.000	M	0.00	0.000
	4	12.500	0.083	0.000	0.000	57.000	M	0.19	0.078
Σ		236.100						19.36	6.074
#5	1	23.300	0.157	0.000	0.000	80.000	F	16.12	1.410
	2	2.900	0.039	0.000	0.000	80.000	F	2.47	0.182
Σ		26.200						17.02	1.591
#4	Σ	26.200						17.02	1.591
#3	1	1.600	0.018	0.000	0.000	80.000	F	1.36	0.100
Σ		27.800						1.36	0.100
#2	1	12.000	0.105	0.000	0.000	47.000	M	0.00	0.000
	2	5.500	0.035	0.000	0.000	80.000	F	4.69	0.345
	3	29.900	0.126	0.000	0.000	47.000	M	0.00	0.000
Σ		47.400						4.69	0.345
#1	1	0.300	0.021	0.000	0.000	47.000	M	0.00	0.000
	2	0.400	0.016	0.000	0.000	80.000	F	0.34	0.021
	3	1.900	0.014	0.000	0.000	57.000	M	0.03	0.008
	4	1.500	0.004	0.000	0.000	80.000	F	1.28	0.094
	5	0.900	0.038	0.000	0.000	57.000	M	0.01	0.000

Stru #	SWS #	SWS Area (ac)	Time of Conc (hrs)	Musk K (hrs)	Musk X	Curve Number	UHS	Peak Discharge (cfs)	Runoff Volume (ac-ft)
Σ		316.300						27.04	6.642

Subwatershed Time of Concentration Details:

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#1	1	3. Short grass pasture	11.90	24.87	209.00	2.750	0.021
#1	1	Time of Concentration:					0.021
#1	2	5. Nearly bare and untilled, and alluvial valley fans	11.90	24.87	209.00	3.440	0.016
#1	2	Time of Concentration:					0.016
#1	3	3. Short grass pasture	23.90	49.95	209.00	3.910	0.014
#1	3	Time of Concentration:					0.014
#1	4	5. Nearly bare and untilled, and alluvial valley fans	27.90	25.10	90.00	5.280	0.004
#1	4	Time of Concentration:					0.004
#1	5	3. Short grass pasture	8.00	24.96	312.00	2.260	0.038
#1	5	Time of Concentration:					0.038
#2	1	3. Short grass pasture	4.10	24.96	609.00	1.610	0.105
#2	1	Time of Concentration:					0.105
#2	2	5. Nearly bare and untilled, and alluvial valley fans	1.50	2.35	157.00	1.220	0.035
#2	2	Time of Concentration:					0.035
#2	3	3. Short grass pasture	9.10	99.64	1,095.00	2.410	0.126
#2	3	Time of Concentration:					0.126
#3	1	5. Nearly bare and untilled, and alluvial valley fans	23.60	75.04	318.00	4.850	0.018
#3	1	Time of Concentration:					0.018
#5	1	5. Nearly bare and untilled, and alluvial valley fans	6.80	100.50	1,478.00	2.600	0.157
#5	1	Time of Concentration:					0.157
#5	2	5. Nearly bare and untilled, and alluvial valley fans	6.80	25.16	370.00	2.600	0.039
#5	2	Time of Concentration:					0.039
#6	1	5. Nearly bare and untilled, and alluvial valley fans	14.00	172.90	1,235.00	3.740	0.091
#6	1	Time of Concentration:					0.091
#6	2	3. Short grass pasture	1.00	0.50	50.00	0.800	0.017
#6	2	Time of Concentration:					0.017
#6	3	3. Short grass pasture	8.20	75.19	917.00	2.290	0.111
#6	3	Time of Concentration:					0.111
#6	4	3. Short grass pasture	13.90	125.23	901.00	2.980	0.083
#6	4	Time of Concentration:					0.083

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#7	1	5. Nearly bare and untilled, and alluvial valley fans	14.00	224.84	1,606.00	3.740	0.119
#7	1	Time of Concentration:					0.119
#8	1	5. Nearly bare and untilled, and alluvial valley fans	12.30	100.36	816.00	3.500	0.064
#8	1	Time of Concentration:					0.064
#9	1	3. Short grass pasture	8.00	249.68	3,121.00	2.260	0.383
#9	1	Time of Concentration:					0.383
#9	2	3. Short grass pasture	10.80	149.58	1,385.00	2.620	0.146
#9	2	Time of Concentration:					0.146
#9	3	5. Nearly bare and untilled, and alluvial valley fans	3.00	50.21	1,674.00	1.730	0.268
#9	3	Time of Concentration:					0.268
#12	1	3. Short grass pasture	8.00	185.84	2,323.00	2.260	0.285
#12	1	Time of Concentration:					0.285

EXHIBIT 7, ITEM 23, PART M

Coal Stockpile Pond

The location of the Coal Stockpile Pond is presented on Map 23B. The as-built configuration for the Coal Stockpile Pond is presented on Figure 7-23M-1, and Figure 7-23M-2 provides the breakdown of drainage areas and hydrologic conditions for this sediment pond.

Exhibit 7, Item 14 in Volume 2D describes the hydrologic methodology used in sediment pond and channel assumptions. Runoff curve numbers assigned to the undisturbed and reclaimed lands in various stages of reclamation have been selected in accordance with Table 1 in the Introductory Text for Exhibit 7 in Volume 2D. For channels protected by a riprap liner, selection of minimum riprap size is done using the Simons/OSM method in SEDCADTM. For channels to be protected by a vegetative liner, the permissible velocities are also determined using SEDCADTM routines.

Coal Stockpile Pond

The following pages present the results of the SEDCADTM model for the Coal Stockpile Pond. The Coal Stockpile Pond contains all runoff from the Collom crusher area and is a non-discharging structure during mining activities. The Coal Stockpile Pond will be used during reclamation as an additional sediment pond within the larger Section 25 Pond watershed. Please refer to Volume Exhibit 7 Item 23 Part I.

During mining a conservative approach has been implemented in this model. Areas above the Collom crusher contain stockpiled coal, but at time may also not contain any coal. A more appropriate curve number of the coal stockpile area could be 74 or lower. However, for built in conservatism, a curve number of 85 was used throughout this model even though a lower curve number may be more appropriate in areas like the Collom coal storage area, or other disturbed areas where surface roughness would reduce surface water flows. It is Colowyo's experience operating the Coal Stockpile Pond since it was constructed that it is typically dry or nearly dry. Therefore, in this model the initial pond level is set nearly to the pond bottom elevation of 7,211'.

Two culverts are included in this model, culverts 45 and 64 respectively. Both culverts as installed are 36 inch. One other culvert (culvert 68) may appear to be within the Coal Stockpile Pond watershed on Figure 7-23M-2; however, it routes water from an upstream non-disturbed area back towards the Collom Pit. Therefore, it is not included in this model.

A paved area where Colowyo's highway haul trucks enter the Collom crusher area for loading was modeled with a curve number of 98. This curve number was selected directly from the SEDCADTM software for paved roads.

Temporary conveyance channels shown on Figure Exh. 7-23M-2 are for the most part natural drainages areas that flowed water prior to mining commencing, or areas where a berm directs flow to the Coal Stockpile Pond. Two areas of short riprap channel exists where water is routed away from the truck loading area on the top of the Collom crusher area. These channels were too small for SEDCADTM to model effectively with a subwatershed, therefore the entire channel is shown

as riprapped when in fact only a very small portion on a steep slope contains riprap. The lower portions of these channels are erodible structures.

Colowyo also has two small concrete sumps and a small concrete channel (less than 1 foot wide) that are utilized to collect coal fines and route the settle out water to the Coal Stockpile Pond. These two structures were not modeled to add another layer of conservatism into the model by removing the retention time both structures provide.

In summary, for the Coal Stockpile Pond, the 100-year, 24-hour storm produces 6.54-acre feet of runoff. The entire storm event is contained within the pond below the emergency spillway elevation of 7217'.

Coal Stock Pile Pond **Containment Demonstration**

100 Year 24 Hour Storm Event

Tony Tennyson

Tri-State Generation & Transmission Association, Inc.
1100 West 116th Avenue
Westminster, CO 80234

Phone: (970) 326-3560
Email: ttennyson@tristategt.org

General Information

Storm Information:

Storm Type:	NRCS Type II
Design Storm:	100 yr - 24 hr
Rainfall Depth:	2.700 inches

Structure Networking:

Type	Stru #	(flows into)	Stru #	Musk. K (hrs)	Musk. X	Description
Null	#1	==>	End	0.000	0.000	Null Below Coal Stockpile Pond
Pond	#2	==>	#1	0.000	0.000	Coal Stockpile Pond
Channel	#3	==>	#2	0.000	0.000	Southeast Natural Channel
Null	#4	==>	#3	0.000	0.000	Null at outlet on Culvert 64
Culvert	#5	==>	#4	0.000	0.000	Culvert 64
Null	#6	==>	#5	0.000	0.000	Null at Inlet on Culvert 64
Channel	#7	==>	#2	0.000	0.000	Southeast Crusher Ditch w/Natural Channel
Channel	#8	==>	#2	0.000	0.000	Crusher Pad Ditch
Null	#9	==>	#8	0.000	0.000	Null at outlet on Culvert 45
Culvert	#10	==>	#9	0.000	0.000	Culvert 45
Null	#11	==>	#10	0.000	0.000	Null at inlet on Culvert 45
Channel	#12	==>	#11	0.000	0.000	Northwest Crusher Ditch w/Natural Channel
Channel	#13	==>	#12	0.000	0.000	Ditch on Southside of Collom Haul Road



#1

Null

Structure Summary:

	Immediate Contributing Area (ac)	Total Contributing Area (ac)	Peak Discharge (cfs)	Total Runoff Volume (ac-ft)
#13	4.200	4.200	2.84	0.22
#12	18.200	22.400	21.84	2.14
#11	0.000	22.400	21.84	2.14
#10	0.000	22.400	21.84	2.14
#9	0.000	22.400	21.84	2.14
#8	5.600	28.000	28.51	2.77
#7	8.700	8.700	11.50	0.90
#6	0.000	0.000	0.00	0.00
#5	13.200	13.200	15.08	1.40
#4	0.000	13.200	15.08	1.40
#3	13.100	26.300	19.90	1.89
#2 In	10.800	73.800	72.82	6.58
Out			0.00	0.00
#1	0.000	73.800	0.00	0.00

Structure Detail:

Structure #13 (Erodible Channel)

Ditch on Southside of Collom Haul Road

Triangular Erodible Channel Inputs:

Material: Shales and hardpans

Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Manning's n	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)	Limiting Velocity (fps)
1.5:1	1.5:1	7.0	0.0250				6.0

Erodible Channel Results:

	w/o Freeboard	w/ Freeboard
Design Discharge:	2.84 cfs	
Depth:	0.56 ft	
Top Width:	1.69 ft	
Velocity:	5.98 fps	
X-Section Area:	0.47 sq ft	
Hydraulic Radius:	0.234 ft	
Froude Number:	1.99	

Structure #12 (Erodible Channel)

Northwest Crusher Ditch w/Natural Channel

Trapezoidal Erodible Channel Inputs:

Material: Shales and hardpans

Bottom Width (ft)	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Manning's n	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)	Limiting Velocity (fps)
3.00	2.0:1	2.0:1	15.0	0.0250				6.0

Erodible Channel Results:

	w/o Freeboard	w/ Freeboard
Design Discharge:	21.84 cfs	
Depth:	0.47 ft	
Top Width:	4.88 ft	
Velocity:	11.76 fps	
X-Section Area:	1.86 sq ft	
Hydraulic Radius:	0.364 ft	

w/o Freeboard	w/ Freeboard
Froude Number:	3.36

Structure #11 (Null)

Null at inlet on Culvert 45

Structure #10 (Culvert)

Culvert 45

Culvert Inputs:

Length (ft)	Slope (%)	Manning's n	Max. Headwater (ft)	Tailwater (ft)	Entrance Loss Coef. (Ke)
375.00	2.00	0.0150	3.00	0.00	0.90

Culvert Results:

Design Discharge = 21.84 cfs

Minimum pipe diameter: 1 - 30 inch pipe(s) required

Structure #9 (Null)

Null at outlet on Culvert 45

Structure #8 (Erodible Channel)

Crusher Pad Ditch

Trapezoidal Erodible Channel Inputs:

Material: Shales and hardpans

Bottom Width (ft)	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Manning's n	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)	Limiting Velocity (fps)
2.00	1.0:1	1.0:1	3.0	0.0250	1.00			6.0

Erodible Channel Results:

w/o Freeboard	w/ Freeboard
Design Discharge:	28.51 cfs
Depth:	1.14 ft 2.14 ft
Top Width:	4.27 ft 6.27 ft
Velocity:	8.01 fps
X-Section Area:	3.56 sq ft
Hydraulic Radius:	0.683 ft
Froude Number:	1.55

Structure #7 (Riprap Channel)

Southeast Crusher Ditch w/Natural Channel

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)
3.00	2.0:1	2.0:1	12.0	1.89		

Riprap Channel Results:

Simons/OSM Method - Steep Slope Design

	w/o Freeboard	w/ Freeboard
Design Discharge:	11.50 cfs	
Depth:	0.24 ft	2.13 ft
Top Width:	3.96 ft	11.52 ft
Velocity*:		
X-Section Area:	0.83 sq ft	
Hydraulic Radius:	0.205 ft	
Froude Number*:		
Manning's n*:		
Dmin:	5.00 in	
D50:	15.00 in	
Dmax:	18.75 in	

Velocity and Manning's n calculations may not apply for this method.

Structure #6 (Null)

Null at Inlet on Culvert 64

Structure #5 (Culvert)

Culvert 64

Culvert Inputs:

Length (ft)	Slope (%)	Manning's n	Max. Headwater (ft)	Tailwater (ft)	Entrance Loss Coef. (Ke)
180.00	4.00	0.0150	3.00	0.00	0.90

Culvert Results:

Design Discharge = 15.08 cfs

Minimum pipe diameter: 1 - 21 inch pipe(s) required

Structure #4 (Null)

Null at outlet on Culvert 64

Structure #3 (Erodible Channel)*Southeast Natural Channel*

Parabolic Erodible Channel Inputs:

Material: Stiff clay very colloidal

Slope (%)	Manning's n	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)	Limiting Velocity (fps)
10.0	0.0250				5.0

Erodible Channel Results:

	w/o Freeboard	w/ Freeboard
Design Discharge:		19.90 cfs
Depth:		0.81 ft
Top Width:		3.25 ft
Velocity:		11.30 fps
X-Section Area:		1.76 sq ft
Hydraulic Radius:		0.464 ft
Froude Number:		2.71

Structure #2 (Pond)*Coal Stockpile Pond*

Pond Inputs:

Initial Pool Elev:	7,211.00 ft
Initial Pool:	0.82 ac-ft

Emergency Spillway

Spillway Elev	Crest Length (ft)	Left Sideslope	Right Sideslope	Bottom Width (ft)
7,217.00	25.00	3.00:1	3.00:1	20.00

Pond Results:

Peak Elevation:	7,216.99 ft
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)
7,210.00	0.779	0.000	0.000	
7,210.01	0.780	0.008	0.000	
7,211.00	0.860	0.819	0.000	
7,212.00	0.928	1.713	0.000	
7,213.00	1.007	2.680	0.000	
7,214.00	1.090	3.729	0.000	
7,215.00	1.175	4.861	0.000	
7,216.00	1.268	6.082	0.000	
7,216.99	1.389	7.391	0.000	0.00 Peak Stage
7,217.00	1.390	7.411	0.000	Spillway #1
7,218.00	1.513	8.862	47.313	
7,219.00	1.632	10.434	170.230	

Detailed Discharge Table

Elevation (ft)	Emergency Spillway (cfs)	Combined Total Discharge (cfs)
7,210.00	0.000	0.000
7,210.01	0.000	0.000
7,211.00	0.000	0.000
7,212.00	0.000	0.000
7,213.00	0.000	0.000
7,214.00	0.000	0.000
7,215.00	0.000	0.000
7,216.00	0.000	0.000
7,217.00	0.000	0.000
7,218.00	47.313	47.313
7,219.00	170.230	170.230

Structure #1 (Null)

Null Below Coal Stockpile Pond

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)
#13	1	2.000	0.007	0.000	0.000	85.000	F	2.84	0.223
	2	2.200	0.037	0.000	0.000	47.000	M	0.00	0.000
	Σ	4.200						2.84	0.223
#12	1	0.200	0.021	0.000	0.000	47.000	M	0.00	0.000
	2	1.000	0.028	0.000	0.000	85.000	F	1.42	0.111
	3	17.000	0.244	0.000	0.000	85.000	F	19.42	1.805
	Σ	22.400						21.84	2.139
#11	Σ	22.400						21.84	2.139
#10	Σ	22.400						21.84	2.139
#9	Σ	22.400						21.84	2.139
#8	1	5.200	0.199	0.000	0.000	85.000	F	6.19	0.550
	2	0.400	0.010	0.000	0.000	98.000	F	0.82	0.081
	Σ	28.000						28.51	2.770
#7	1	0.600	0.025	0.000	0.000	47.000	F	0.00	0.000
	2	1.200	0.018	0.000	0.000	85.000	F	1.70	0.133
	3	6.900	0.071	0.000	0.000	85.000	F	9.79	0.769
	Σ	8.700						11.50	0.903
#6	Σ	0.000						0.00	0.000
#5	1	13.200	0.244	0.000	0.000	85.000	F	15.08	1.402
	Σ	13.200						15.08	1.402
#4	Σ	13.200						15.08	1.402
#3	1	4.400	0.054	0.000	0.000	85.000	F	6.24	0.491
	2	0.100	0.007	0.000	0.000	47.000	M	0.00	0.000
	3	0.200	0.008	0.000	0.000	47.000	M	0.00	0.000
	4	8.400	0.173	0.000	0.000	1.000	0.00	0.000	
	Σ	26.300						19.90	1.892
#2	1	4.400	0.005	0.000	0.000	85.000	F	6.24	0.491
	2	0.800	0.028	0.000	0.000	47.000	M	0.00	0.000
	3	0.300	0.006	0.000	0.000	85.000	F	0.43	0.030
	4	0.900	0.016	0.000	0.000	47.000	M	0.00	0.000
	5	4.400	0.029	0.000	0.000	85.000	F	6.24	0.491
	Σ	73.800						72.82	6.576
#1	Σ	73.800						0.00	0.000

Subwatershed Time of Concentration Details:

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#2	1	5. Nearly bare and untilled, and alluvial valley fans	25.00	22.50	90.00	5.000	0.005
#2	1	Time of Concentration:					0.005
#2	2	3. Short grass pasture	6.00	12.12	202.00	1.950	0.028
#2	2	Time of Concentration:					0.028
#2	3	5. Nearly bare and untilled, and alluvial valley fans	6.00	3.66	61.00	2.440	0.006
#2	3	Time of Concentration:					0.006
#2	4	5. Nearly bare and untilled, and alluvial valley fans	11.00	21.34	194.00	3.310	0.016
#2	4	Time of Concentration:					0.016
#2	5	5. Nearly bare and untilled, and alluvial valley fans	13.00	50.05	385.00	3.600	0.029
#2	5	Time of Concentration:					0.029
#3	1	5. Nearly bare and untilled, and alluvial valley fans	8.00	44.64	558.00	2.820	0.054
#3	1	Time of Concentration:					0.054
#3	2	3. Short grass pasture	7.00	3.78	54.00	2.110	0.007
#3	2	Time of Concentration:					0.007
#3	3	3. Short grass pasture	15.00	13.95	93.00	3.090	0.008
#3	3	Time of Concentration:					0.008
#3	4	5. Nearly bare and untilled, and alluvial valley fans	2.00	17.58	879.00	1.410	0.173
#3	4	Time of Concentration:					0.173
#5	1	5. Nearly bare and untilled, and alluvial valley fans	3.00	45.66	1,522.00	1.730	0.244
#5	1	Time of Concentration:					0.244
#7	1	3. Short grass pasture	8.00	16.79	210.00	2.260	0.025
#7	1	Time of Concentration:					0.025
#7	2	5. Nearly bare and untilled, and alluvial valley fans	12.00	28.20	235.00	3.460	0.018
#7	2	Time of Concentration:					0.018
#7	3	5. Nearly bare and untilled, and alluvial valley fans	6.20	39.74	641.00	2.480	0.071
#7	3	Time of Concentration:					0.071
#8	1	5. Nearly bare and untilled, and alluvial valley fans	2.00	20.27	1,014.00	1.410	0.199
#8	1	Time of Concentration:					0.199
#8	2	7. Paved area and small upland gullies	1.00	0.75	75.00	2.010	0.010
#8	2	Time of Concentration:					0.010
#12	2	5. Nearly bare and untilled, and alluvial valley fans	13.00	47.19	363.00	3.600	0.028
#12	2	Time of Concentration:					0.028
#12	3	5. Nearly bare and untilled, and alluvial valley fans	2.00	24.78	1,239.00	1.410	0.244

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#12	3	Time of Concentration:					0.244
#13	1	5. Nearly bare and untilled, and alluvial valley fans	32.00	46.08	144.00	5.650	0.007
#13	1	Time of Concentration:					0.007
#13	2	3. Short grass pasture	9.00	28.80	320.00	2.400	0.037
#13	2	Time of Concentration:					0.037

EXHIBIT 7, ITEM 23, PART N

Perimeter Area Sediment Control Post Mining

Introduction

Colowyo will have ground disturbance along the perimeter of the Collom Pit during reclamation activities (post mining) that cannot effectively be routed to one of the existing sediment ponds. Colowyo will implement a perimeter sediment control plan for these areas. Generally, this will be ground disturbance on the west and east sides of the pit outside of the Section 25 and 26 sediment pond watersheds as shown on Map 41B. This demonstration will, in accordance with Rule 4.05.2(3)(a), provide an exemption from the requirements of 4.05.2. Therefore, surface water runoff from these reclamation areas will be treated through a grass filter or a combination grass filter and silt fence.

For the model demonstration, SEDCADTM grass filter routine has been used to demonstrate that runoff from this area will meet the effluent standards of 0.5 ml/l in accordance with Rule 4.05.2(7) (US EPA, 40 C.F.R. §434.52). Runoff curve numbers assigned to the undisturbed, disturbed and reclamation areas have been selected in accordance with Table 1 in the Introductory Text for Exhibit 7 in Volume 2D.

The grass filter physical parameters were taken as the defaults in the SEDCAD drop down tables for a good stand of well established rye grass, except that the stem spacing was conservatively increased from 0.67 inches to 2.0 inches, and the roughness coefficient reduced from 0.0121 to 0.008, as described Reference 1, page 568, for a "fair stand" of grass. Both of these revisions produce a more severe loading on the grass filter by allowing the flow velocity to be higher than in a "good stand".

Each specific reclamation area that will require a grass filter or grass filter and silt fence for sediment control has been evaluated individually. Each area is shown on Figure 7-23N-1. These areas for reclamation and timing are also shown on Map 29B.

For each individual grass filter or grass filter and silt fence demonstration included herein, it is demonstrated that these areas will control sediment as required, and all SEDCADTM models indicate effluent limits for each area is below 0.5 ml/l.

References

- 1) Applied Hydrology and Sedimentology for Disturbed Areas, Barfield, Warner and Haan, 1981

2025 Reclamation Area **Sediment Control Demonstration**

Grass Filter

Tony Tennyson

General Information

Storm Information:

Storm Type:	NRCS Type II
Design Storm:	10 yr - 24 hr
Rainfall Depth:	1.800 inches

Particle Size Distribution:

Size (mm)	Colowyo Particle Size
4.7500	100.000%
0.0750	73.000%
0.0400	33.000%
0.0010	20.000%

Structure Networking:

Type	Stru #	(flows into)	Stru #	Musk. K (hrs)	Musk. X	Description
Grass Filter	#1	==>	End	0.000	0.000	2025 Reclamation Area

#1
Grass
Filter

Structure Summary:

		Immediate Contributing Area (ac)	Total Contributing Area (ac)	Peak Discharge (cfs)	Total Runoff Volume (ac-ft)	Sediment (tons)	Peak Sediment Conc. (mg/l)	Peak Settleable Conc. (ml/l)	24VW (ml/l)
#1	In	6.800	6.800	3.50	0.25	49.1	276,149	157.40	75.64
	Out			3.41	0.16	5.7	67,188	0.31	0.12

Particle Size Distribution(s) at Each Structure

Structure #1:

Size (mm)	In	Out
4.7500	100.000%	100.000%
0.0750	73.000%	100.000%
0.0400	33.000%	100.000%
0.0010	20.000%	98.244%

Structure Detail:

Structure #1 (Grass Filter)

2025 Reclamation Area

Grass Filter Inputs:

Roughness Coefficient	Grass Height (in)	Hydraulic Spacing (in)	Infiltration Rate (iph)	Stiffness Factor (N-sq m)	Filter Length (ft)	Filter Width (ft)	Filter Slope (%)
0.0121	3.0	0.67	0.20	20.000	25.0	800.0	14.0

Grass Filter Results:

Total Infiltration Volume:	0.0920 ac-ft
Filter Infiltration Rate:	0.0926 cfs
Peak Flow Depth:	0.049 in
Critical Prone Velocity:	1.0367 fps
Wedge Location:	3.17 ft
Sediment Depth in Zone D:	0.2090 in
Trap Efficiency:	88.3 %

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)
#1	1	6.800	0.038	0.000	0.000	80.000	F	3.50	0.252
Σ		6.800						3.50	0.252

Subwatershed Sedimentology Detail:

Stru #	SWS #	Soil K	L (ft)	S (%)	C	P	PS #	Sediment (tons)	Peak Sediment Conc. (mg/l)	Peak Settleable Conc (ml/l)	24VW (ml/l)
#1	1	0.300	200.00	23.00	0.8000	0.3800	1	49.1	276,149	157.40	75.64
Σ								49.1	276,149	157.40	75.64

Subwatershed Time of Concentration Details:

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#1	1	5. Nearly bare and untilled, and alluvial valley fans	23.00	153.41	667.00	4.790	0.038
#1	1	Time of Concentration:					0.038

2026 Reclamation Area **Sediment Control Demonstration**

Grass Filter & Silt Fence

Tony Tennyson

General Information

Storm Information:

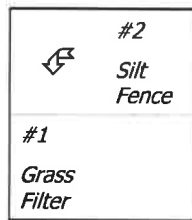
Storm Type:	NRCS Type II
Design Storm:	10 yr - 24 hr
Rainfall Depth:	1.800 inches

Particle Size Distribution:

Size (mm)	Colowyo Particle Size
4.7500	100.000%
0.0750	73.000%
0.0400	33.000%
0.0010	20.000%

Structure Networking:

Type	Stru #	(flows into)	Stru #	Musk. K (hrs)	Musk. X	Description
Grass Filter	#1	==>	End	0.000	0.000	2026 Reclamation Area
Silt Fence	#2	==>	#1	0.000	0.000	S-Fence



Structure Summary:

		Immediate Contributing Area (ac)	Total Contributing Area (ac)	Peak Discharge (cfs)	Total Runoff Volume (ac-ft)	Sediment (tons)	Peak Sediment Conc. (mg/l)	Peak Settleable Conc. (ml/l)	24VW (ml/l)
#2	In	11.400	11.400	5.87	0.42	73.6	249,944	142.42	68.17
	Out			0.81	0.42	17.2	56,851	2.11	1.09
#1	In	0.000	11.400	0.81	0.42	17.2	56,831	2.11	1.09
	Out			0.73	0.34	3.3	8,641	0.00	0.00

Particle Size Distribution(s) at Each Structure

Structure #2 (S-Fence):

Size (mm)	In	Out
4.7500	100.000%	100.000%
0.0750	73.050%	100.000%
0.0400	33.023%	100.000%
0.0010	20.014%	85.826%

Structure #1:

Size (mm)	In	Out
4.7500	100.000%	100.000%
0.0750	100.000%	100.000%
0.0400	100.000%	100.000%
0.0010	85.826%	100.000%

Structure Detail:

Structure #2 (Silt Fence)

S-Fence

Silt Fence Inputs:

Fence Flow Rate (gpm/sq ft)	Width along contour (ft)	Height (ft)	Land Slope (%)	Tie-back distance (ft)
0.3	800.0	2.5	14.00	17.9

**Sediment Storage: 0.00 ac-ft*

**No sediment capacity defined*

Silt Fence Results:

Peak Fence Stage:	1.49 ft
Peak Water Stage:	1.49 ft
Dewater Time:	0.51 days
Trap Efficiency:	76.68 %

Dewatering time is calculated from peak stage to lowest spillway

Stage-Capacity-Discharge Table

Fence Stage (ft)	Water Stage (ft)	Area (ac)	Capacity (ac-ft)	Discharge (cfs)	Dewater Time (hrs)	
0.00	0.00	0.000	0.000	0.000		Top of Sediment
0.10	0.10	0.013	0.000	0.054	0.25	
0.20	0.20	0.026	0.002	0.107	0.30	
0.30	0.30	0.039	0.006	0.161	2.95	
0.40	0.40	0.052	0.010	0.215	1.25	
0.50	0.50	0.066	0.016	0.269	0.85	
0.60	0.60	0.079	0.023	0.323	0.75	
0.70	0.70	0.092	0.032	0.377	0.65	
0.80	0.80	0.105	0.042	0.431	0.60	
0.90	0.90	0.118	0.053	0.485	0.60	
1.00	1.00	0.131	0.065	0.540	0.60	
1.10	1.10	0.144	0.079	0.594	0.55	
1.20	1.20	0.157	0.094	0.649	0.55	
1.30	1.30	0.171	0.111	0.703	0.60	
1.40	1.40	0.184	0.128	0.758	0.65	
1.49	1.49	0.195	0.145	0.805	0.25	Peak Stage
1.50	1.50	0.197	0.147	0.813		

Fence Stage (ft)	Water Stage (ft)	Area (ac)	Capacity (ac-ft)	Discharge (cfs)	Dewater Time (hrs)
1.60	1.60	0.210	0.168	0.868	
1.70	1.70	0.223	0.189	0.923	
1.80	1.80	0.236	0.212	0.978	
1.90	1.90	0.249	0.236	1.033	
2.00	2.00	0.262	0.262	1.089	
2.10	2.10	0.275	0.289	1.144	
2.20	2.20	0.289	0.317	1.200	
2.30	2.30	0.302	0.347	1.255	
2.40	2.40	0.315	0.377	1.311	
2.50	2.50	0.328	0.410	1.367	

Structure #1 (Grass Filter)

2026 Reclamation Area

Grass Filter Inputs:

Roughness Coefficient	Grass Height (in)	Hydraulic Spacing (in)	Infiltration Rate (iph)	Stiffness Factor (N-sq m)	Filter Length (ft)	Filter Width (ft)	Filter Slope (%)
0.0121	3.0	0.67	0.20	20.000	20.0	800.0	14.0

Grass Filter Results:

Total Infiltration Volume:	0.0796 ac-ft
Filter Infiltration Rate:	0.0741 cfs
Peak Flow Depth:	0.020 in
Critical Prone Velocity:	1.0367 fps
Wedge Location:	0.00 ft
Sediment Depth in Zone D:	0.2651 in
Trap Efficiency:	80.5 %

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)
#2	1	11.400	0.109	0.003	0.344	80.000	F	5.87	0.422
	Σ	11.400						5.87	0.422
#1	Σ	11.400						0.81	0.422

Subwatershed Sedimentology Detail:

Stru #	SWS #	Soil K	L (ft)	S (%)	C	P	PS #	Sediment (tons)	Peak Sediment Conc. (mg/l)	Peak Settleable Conc (ml/l)	24VW (ml/l)
#2	1	0.300	400.00	14.00	0.8000	0.3800	1	73.6	250,098	142.55	68.23
	Σ							73.6	249,944	142.42	68.17
#1	Σ							17.2	56,831	2.11	1.09

Subwatershed Time of Concentration Details:

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#2	1	5. Nearly bare and untilled, and alluvial valley fans	14.00	205.66	1,469.00	3.740	0.109
#2	1	Time of Concentration:					0.109

Subwatershed Muskingum Routing Details:

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#2	1	5. Nearly bare and untilled, and alluvial valley fans	14.00	7.00	50.00	3.740	0.003
#2	1	Muskingum K:					0.003

2027 Reclamation Area **Sediment Control Demonstration**

Grass Filter & Silt Fence

Tony Tennyson

General Information

Storm Information:

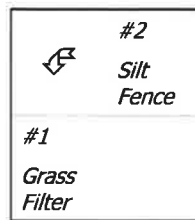
Storm Type:	NRCS Type II
Design Storm:	10 yr - 24 hr
Rainfall Depth:	1.800 inches

Particle Size Distribution:

Size (mm)	Colowyo Particle Size
4.7500	100.000%
0.0750	73.000%
0.0400	33.000%
0.0010	20.000%

Structure Networking:

Type	Stru #	(flows into)	Stru #	Musk. K (hrs)	Musk. X	Description
Grass Filter	#1	==>	End	0.000	0.000	2027 Reclamation Area
Silt Fence	#2	==>	#1	0.000	0.000	S-Fence at Grass Filter



Structure Summary:

		Immediate Contributing Area (ac)	Total Contributing Area (ac)	Peak Discharge (cfs)	Total Runoff Volume (ac-ft)	Sediment (tons)	Peak Sediment Conc. (mg/l)	Peak Settleable Conc. (ml/l)	24VW (ml/l)
#2	In	19.100	19.100	9.84	0.71	131.1	264,167	150.51	72.19
	Out			1.76	0.71	34.6	65,784	4.23	2.28
#1	In	0.000	19.100	1.76	0.71	34.6	65,760	4.23	2.28
	Out			1.67	0.60	11.9	18,839	0.00	0.00

Particle Size Distribution(s) at Each Structure

Structure #2 (S-Fence at Grass Filter):

Size (mm)	In	Out
4.7500	100.000%	100.000%
0.0750	73.067%	100.000%
0.0400	33.030%	100.000%
0.0010	20.018%	75.794%

Structure #1:

Size (mm)	In	Out
4.7500	100.000%	100.000%
0.0750	100.000%	100.000%
0.0400	100.000%	100.000%
0.0010	75.794%	100.000%

Structure Detail:

Structure #2 (Silt Fence)

S-Fence at Grass Filter

Silt Fence Inputs:

Fence Flow Rate (gpm/sq ft)	Width along contour (ft)	Height (ft)	Land Slope (%)	Tie-back distance (ft)
0.3	1,050.0	3.0	35.00	8.6

**Sediment Storage: 0.00 ac-ft*

**No sediment capacity defined*

Silt Fence Results:

Peak Fence Stage:	2.49 ft
Peak Water Stage:	2.49 ft
Dewater Time:	0.49 days
Trap Efficiency:	73.59 %

Dewatering time is calculated from peak stage to lowest spillway

Stage-Capacity-Discharge Table

Fence Stage (ft)	Water Stage (ft)	Area (ac)	Capacity (ac-ft)	Discharge (cfs)	Dewater Time (hrs)
0.00	0.00	0.000	0.000	0.000	Top of Sediment
0.10	0.10	0.007	0.000	0.070	0.10
0.20	0.20	0.014	0.001	0.140	0.15
0.30	0.30	0.021	0.003	0.211	0.10
0.40	0.40	0.028	0.005	0.281	4.40
0.50	0.50	0.034	0.008	0.351	1.20
0.60	0.60	0.041	0.012	0.422	0.60
0.70	0.70	0.048	0.017	0.492	0.45
0.80	0.80	0.055	0.022	0.563	0.45
0.90	0.90	0.062	0.028	0.633	0.35
1.00	1.00	0.069	0.034	0.704	0.30
1.10	1.10	0.076	0.042	0.774	0.30
1.20	1.20	0.083	0.049	0.845	0.25
1.30	1.30	0.090	0.058	0.916	0.20
1.40	1.40	0.096	0.067	0.986	0.25
1.50	1.50	0.103	0.077	1.057	0.25
1.60	1.60	0.110	0.088	1.128	0.25

Fence Stage (ft)	Water Stage (ft)	Area (ac)	Capacity (ac-ft)	Discharge (cfs)	Dewater Time (hrs)
1.70	1.70	0.117	0.099	1.199	0.20
1.80	1.80	0.124	0.111	1.270	0.25
1.90	1.90	0.131	0.124	1.340	0.20
2.00	2.00	0.138	0.138	1.411	0.25
2.10	2.10	0.145	0.152	1.482	0.20
2.20	2.20	0.152	0.166	1.553	0.25
2.30	2.30	0.158	0.182	1.624	0.25
2.40	2.40	0.165	0.198	1.695	0.30
2.49	2.49	0.172	0.214	1.763	0.11 Peak Stage
2.50	2.50	0.172	0.215	1.767	
2.60	2.60	0.179	0.233	1.838	
2.70	2.70	0.186	0.251	1.909	
2.80	2.80	0.193	0.270	1.980	
2.90	2.90	0.200	0.289	2.051	
3.00	3.00	0.207	0.310	2.123	

Structure #1 (Grass Filter)

2027 Reclamation Area

Grass Filter Inputs:

Roughness Coefficient	Grass Height (in)	Hydraulic Spacing (in)	Infiltration Rate (iph)	Stiffness Factor (N-sq m)	Filter Length (ft)	Filter Width (ft)	Filter Slope (%)
0.0121	3.0	0.67	0.20	20.000	20.0	1050.0	14.0

Grass Filter Results:

Total Infiltration Volume:	0.1025 ac-ft
Filter Infiltration Rate:	0.0972 cfs
Peak Flow Depth:	0.027 in
Critical Prone Velocity:	1.0367 fps
Wedge Location:	0.00 ft
Sediment Depth in Zone D:	0.3336 in
Trap Efficiency:	65.8 %

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)
#2	1	19.100	0.081	0.004	0.325	80.000	F	9.84	0.707
	Σ	19.100						9.84	0.707
#1	Σ	19.100						1.76	0.707

Subwatershed Sedimentology Detail:

Stru #	SWS #	Soil K	L (ft)	S (%)	C	P	PS #	Sediment (tons)	Peak Sediment Conc. (mg/l)	Peak Settleable Conc (ml/l)	24VW (ml/l)
#2	1	0.300	400.00	14.00	0.8000	0.3800	1	131.2	264,383	150.69	72.28
	Σ							131.1	264,167	150.51	72.19
#1	Σ							34.6	65,760	4.23	2.28

Subwatershed Time of Concentration Details:

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#2	1	5. Nearly bare and untilled, and alluvial valley fans	14.00	152.74	1,091.00	3.740	0.081
#2	1	Time of Concentration:					0.081

Subwatershed Muskingum Routing Details:

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#2	1	5. Nearly bare and untilled, and alluvial valley fans	10.00	5.00	50.00	3.160	0.004
#2	1	Muskingum K:					0.004

2028 Reclamation Area **Sediment Control Demonstration**

Grass Filter

Tony Tennyson

General Information

Storm Information:

Storm Type:	NRCS Type II
Design Storm:	10 yr - 24 hr
Rainfall Depth:	1.800 inches

Particle Size Distribution:

Size (mm)	Colowyo Particle Size
4.7500	100.000%
0.0750	73.000%
0.0400	33.000%
0.0010	20.000%

Structure Networking:

Type	Stru #	(flows into)	Stru #	Musk. K (hrs)	Musk. X	Description
Grass Filter	#1	==>	End	0.000	0.000	2028 Reclamation Area

#1

Grass Filter

Structure Summary:

	Immediate Contributing Area (ac)	Total Contributing Area (ac)	Peak Discharge (cfs)	Total Runoff Volume (ac-ft)	Sediment (tons)	Peak Sediment Conc. (mg/l)	Peak Settleable Conc. (ml/l)	24VW (ml/l)
#1 In	11.900	11.900	6.13	0.44	46.8	158,450	90.31	42.64
Out			5.95	0.26	3.9	29,654	0.00	0.00

Particle Size Distribution(s) at Each Structure

Structure #1:

Size (mm)	In	Out
4.7500	100.000%	100.000%
0.0750	73.000%	100.000%
0.0400	33.000%	100.000%
0.0010	20.000%	100.000%

Structure Detail:

Structure #1 (Grass Filter)

2028 Reclamation Area

Grass Filter Inputs:

Roughness Coefficient	Grass Height (in)	Hydraulic Spacing (in)	Infiltration Rate (iph)	Stiffness Factor (N-sq m)	Filter Length (ft)	Filter Width (ft)	Filter Slope (%)
0.0121	3.0	0.67	0.20	20.000	20.0	2000.0	14.0

Grass Filter Results:

Total Infiltration Volume:	0.1755 ac-ft
Filter Infiltration Rate:	0.1852 cfs
Peak Flow Depth:	0.039 in
Critical Prone Velocity:	1.0367 fps
Wedge Location:	0.88 ft
Sediment Depth in Zone D:	0.1125 in
Trap Efficiency:	91.6 %

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)
#1	1	11.900	0.036		0.000	80.000	F	6.13	0.440
Σ		11.900						6.13	0.440

Subwatershed Sedimentology Detail:

Stru #	SWS #	Soil K	L (ft)	S (%)	C	P	PS #	Sediment (tons)	Peak Sediment Conc. (mg/l)	Peak Settleable Conc (ml/l)	24VW (ml/l)
#1	1	0.300	150.00	15.00	0.8000	0.3800	1	46.8	158,450	90.31	42.64
Σ								46.8	158,450	90.31	42.64

Subwatershed Time of Concentration Details:

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#1	1	5. Nearly bare and untilled, and alluvial valley fans	15.00	75.30	502.00	3.870	0.036
#1	1	Time of Concentration:					0.036

2029 Reclamation Area **Sediment Control Demonstration**

Grass Filter

Tony Tennyson

General Information

Storm Information:

Storm Type:	NRCS Type II
Design Storm:	10 yr - 24 hr
Rainfall Depth:	1.800 inches

Particle Size Distribution:

Size (mm)	Colowyo Particle Size
4.7500	100.000%
0.0750	73.000%
0.0400	33.000%
0.0010	20.000%

Structure Networking:

Type	Stru #	(flows into)	Stru #	Musk. K (hrs)	Musk. X	Description
Grass Filter	#1	==>	End	0.000	0.000	2029 Reclamation Area

#1

*Grass
Filter*

Structure Summary:

	Immediate Contributing Area (ac)	Total Contributing Area (ac)	Peak Discharge (cfs)	Total Runoff Volume (ac-ft)	Sediment (tons)	Peak Sediment Conc. (mg/l)	Peak Settleable Conc. (ml/l)	24VW (ml/l)
#1 In	7.900	7.900	4.07	0.29	51.2	250,778	142.93	68.42
Out			3.93	0.17	5.3	57,846	0.09	0.04

Particle Size Distribution(s) at Each Structure

Structure #1:

Size (mm)	In	Out
4.7500	100.000%	100.000%
0.0750	73.000%	100.000%
0.0400	33.000%	100.000%
0.0010	20.000%	99.390%

Structure Detail:

Structure #1 (Grass Filter)

2029 Reclamation Area

Grass Filter Inputs:

Roughness Coefficient	Grass Height (in)	Hydraulic Spacing (in)	Infiltration Rate (iph)	Stiffness Factor (N-sq m)	Filter Length (ft)	Filter Width (ft)	Filter Slope (%)
0.0121	3.0	0.67	0.20	20.000	25.0	1200.0	24.0

Grass Filter Results:

Total Infiltration Volume:	0.1250 ac-ft
Filter Infiltration Rate:	0.1389 cfs
Peak Flow Depth:	0.035 in
Critical Prone Velocity:	1.0367 fps
Wedge Location:	1.58 ft
Sediment Depth in Zone D:	0.2191 in
Trap Efficiency:	89.6 %

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)
#1	1	7.900	0.035	0.000	0.000	80.000	F	4.07	0.292
Σ		7.900						4.07	0.292

Subwatershed Sedimentology Detail:

Stru #	SWS #	Soil K	L (ft)	S (%)	C	P	PS #	Sediment (tons)	Peak Sediment Conc. (mg/l)	Peak Settleable Conc (ml/l)	24VW (ml/l)
#1	1	0.300	150.00	24.00	0.8000	0.3800	1	51.2	250,778	142.93	68.42
Σ								51.2	250,778	142.93	68.42

Subwatershed Time of Concentration Details:

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#1	1	5. Nearly bare and untilled, and alluvial valley fans	24.00	150.23	625.95	4.890	0.035
#1	1	Time of Concentration:					0.035

2031 Area 1 Reclamation Area **Sediment Control Demonstration**

Grass Filter

Tony Tennyson

General Information

Storm Information:

Storm Type:	NRCS Type II
Design Storm:	10 yr - 24 hr
Rainfall Depth:	1.800 inches

Particle Size Distribution:

Size (mm)	Colowyo Particle Size
4.7500	100.000%
0.0750	73.000%
0.0400	33.000%
0.0010	20.000%

Structure Networking:

Type	Stru #	(flows into)	Stru #	Musk. K (hrs)	Musk. X	Description
Grass Filter	#1	==>	End	0.000	0.000	2031 Area 1 Reclamation Area

#1
Grass
Filter

Structure Summary:

		Immediate Contributing Area (ac)	Total Contributing Area (ac)	Peak Discharge (cfs)	Total Runoff Volume (ac-ft)	Sediment (tons)	Peak Sediment Conc. (mg/l)	Peak Settleable Conc. (ml/l)	24VW (ml/l)
#1	In	12.900	12.900	6.65	0.48	45.8	144,116	82.14	38.70
	Out			6.46	0.30	5.5	36,324	0.34	0.13

Particle Size Distribution(s) at Each Structure

Structure #1:

Size (mm)	In	Out
4.7500	100.000%	100.000%
0.0750	73.000%	100.000%
0.0400	33.000%	100.000%
0.0010	20.000%	96.426%

Structure Detail:

Structure #1 (Grass Filter)

2031 Area 1 Reclamation Area

Grass Filter Inputs:

Roughness Coefficient	Grass Height (in)	Hydraulic Spacing (in)	Infiltration Rate (iph)	Stiffness Factor (N-sq m)	Filter Length (ft)	Filter Width (ft)	Filter Slope (%)
0.0121	3.0	0.67	0.20	20.000	20.0	2000.0	24.0

Grass Filter Results:

Total Infiltration Volume:	0.1806 ac-ft
Filter Infiltration Rate:	0.1852 cfs
Peak Flow Depth:	0.035 in
Critical Prone Velocity:	1.0367 fps
Wedge Location:	0.60 ft
Sediment Depth in Zone D:	0.2013 in
Trap Efficiency:	88.1 %

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)
#1	1	12.900	0.011	0.000	0.000	80.000	F	6.65	0.477
Σ		12.900						6.65	0.477

Subwatershed Sedimentology Detail:

Stru #	SWS #	Soil K	L (ft)	S (%)	C	P	PS #	Sediment (tons)	Peak Sediment Conc. (mg/l)	Peak Settleable Conc (ml/l)	24VW (ml/l)
#1	1	0.300	50.00	24.00	0.8000	0.3800	1	45.8	144,116	82.14	38.70
Σ								45.8	144,116	82.14	38.70

Subwatershed Time of Concentration Details:

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#1	1	5. Nearly bare and untilled, and alluvial valley fans	24.00	49.20	205.00	4.890	0.011
#1	1	Time of Concentration:					0.011

2031 Area 2 Reclamation Area **Sediment Control Demonstration**

Grass Filter & Silt Fence

Tony Tennyson

General Information

Storm Information:

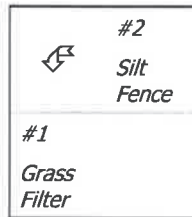
Storm Type:	NRCS Type II
Design Storm:	10 yr - 24 hr
Rainfall Depth:	1.800 inches

Particle Size Distribution:

Size (mm)	Colowyo Particle Size
4.7500	100.000%
0.0750	73.000%
0.0400	33.000%
0.0010	20.000%

Structure Networking:

Type	Stru #	(flows into)	Stru #	Musk. K (hrs)	Musk. X	Description
Grass Filter	#1	==>	End	0.000	0.000	2031 Area 2 Reclamation Area
Silt Fence	#2	==>	#1	0.000	0.000	S-Fence at Grass Filter



Structure Summary:

		Immediate Contributing Area (ac)	Total Contributing Area (ac)	Peak Discharge (cfs)	Total Runoff Volume (ac-ft)	Sediment (tons)	Peak Sediment Conc. (mg/l)	Peak Settleable Conc. (ml/l)	24VW (ml/l)
#2	In	18.800	18.800	9.69	0.70	97.4	204,705	116.67	55.46
	Out			2.23	0.70	25.3	49,925	3.04	1.61
#1	In	0.000	18.800	2.23	0.70	25.3	49,907	3.04	1.61
	Out			2.05	0.51	3.2	8,102	0.00	0.00

Particle Size Distribution(s) at Each Structure

Structure #2 (S-Fence at Grass Filter):

Size (mm)	In	Out
4.7500	100.000%	100.000%
0.0750	73.000%	100.000%
0.0400	33.000%	100.000%
0.0010	20.000%	77.024%

Structure #1:

Size (mm)	In	Out
4.7500	100.000%	100.000%
0.0750	100.000%	100.000%
0.0400	100.000%	100.000%
0.0010	77.024%	100.000%

Structure Detail:

Structure #2 (Silt Fence)

S-Fence at Grass Filter

Silt Fence Inputs:

Fence Flow Rate (gpm/sq ft)	Width along contour (ft)	Height (ft)	Land Slope (%)	Tie-back distance (ft)
0.3	1,950.0	3.0	35.00	8.6

**Sediment Storage: 0.00 ac-ft*

**No sediment capacity defined*

Silt Fence Results:

Peak Fence Stage:	1.71 ft
Peak Water Stage:	1.71 ft
Dewater Time:	0.51 days
Trap Efficiency:	74.03 %

Dewatering time is calculated from peak stage to lowest spillway

Stage-Capacity-Discharge Table

Fence Stage (ft)	Water Stage (ft)	Area (ac)	Capacity (ac-ft)	Discharge (cfs)	Dewater Time (hrs)
0.00	0.00	0.000	0.000	0.000	Top of Sediment
0.10	0.10	0.013	0.000	0.130	0.15
0.20	0.20	0.026	0.002	0.261	4.05
0.30	0.30	0.038	0.006	0.391	2.80
0.40	0.40	0.051	0.010	0.522	1.25
0.50	0.50	0.064	0.016	0.652	0.45
0.60	0.60	0.077	0.023	0.783	0.35
0.70	0.70	0.090	0.031	0.913	0.35
0.80	0.80	0.102	0.041	1.044	0.25
0.90	0.90	0.115	0.052	1.175	0.25
1.00	1.00	0.128	0.064	1.305	0.25
1.10	1.10	0.141	0.077	1.436	0.20
1.20	1.20	0.153	0.092	1.567	0.20
1.30	1.30	0.166	0.108	1.698	0.25
1.40	1.40	0.179	0.125	1.829	0.20
1.50	1.50	0.192	0.144	1.960	0.25
1.60	1.60	0.205	0.163	2.090	0.25

Fence Stage (ft)	Water Stage (ft)	Area (ac)	Capacity (ac-ft)	Discharge (cfs)	Dewater Time (hrs)
1.70	1.70	0.217	0.184	2.221	0.60
1.71	1.71	0.218	0.186	2.229	0.01 Peak Stage
1.80	1.80	0.230	0.207	2.352	
1.90	1.90	0.243	0.231	2.483	
2.00	2.00	0.256	0.255	2.615	
2.10	2.10	0.269	0.282	2.746	
2.20	2.20	0.281	0.309	2.877	
2.30	2.30	0.294	0.338	3.008	
2.40	2.40	0.307	0.368	3.139	
2.50	2.50	0.320	0.399	3.271	
2.60	2.60	0.333	0.432	3.402	
2.70	2.70	0.345	0.466	3.533	
2.80	2.80	0.358	0.501	3.665	
2.90	2.90	0.371	0.537	3.796	
3.00	3.00	0.384	0.575	3.928	

Structure #1 (Grass Filter)

2031 Area 2 Reclamation Area

Grass Filter Inputs:

Roughness Coefficient	Grass Height (in)	Hydraulic Spacing (in)	Infiltration Rate (iph)	Stiffness Factor (N-sq m)	Filter Length (ft)	Filter Width (ft)	Filter Slope (%)
0.0121	3.0	0.67	0.20	20.000	20.0	1950.0	18.0

Grass Filter Results:

Total Infiltration Volume:	0.1876 ac-ft
Filter Infiltration Rate:	0.1806 cfs
Peak Flow Depth:	0.020 in
Critical Prone Velocity:	1.0367 fps
Wedge Location:	0.00 ft
Sediment Depth in Zone D:	0.1738 in
Trap Efficiency:	87.2 %

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)
#2	1	18.800	0.036	0.000	0.000	80.000	F	9.69	0.696
	Σ	18.800						9.69	0.696
#1	Σ	18.800						2.23	0.696

Subwatershed Sedimentology Detail:

Stru #	SWS #	Soil K	L (ft)	S (%)	C	P	PS #	Sediment (tons)	Peak Sediment Conc. (mg/l)	Peak Settleable Conc (ml/l)	24VW (ml/l)
#2	1	0.300	150.00	18.00	0.8000	0.3800	1	97.4	204,705	116.67	55.46
	Σ							97.4	204,705	116.67	55.46
#1	Σ							25.3	49,907	3.04	1.61

Subwatershed Time of Concentration Details:

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#2	1	5. Nearly bare and untilled, and alluvial valley fans	18.00	100.80	560.00	4.240	0.036
#2	1	Time of Concentration:					0.036

2031 Area 3 Reclamation Area **Sediment Control Demonstration**

Grass Filter

Tony Tennyson

General Information

Storm Information:

Storm Type:	NRCS Type II
Design Storm:	10 yr - 24 hr
Rainfall Depth:	1.800 inches

Particle Size Distribution:

Size (mm)	Colowyo Particle Size
4.7500	100.000%
0.0750	73.000%
0.0400	33.000%
0.0010	20.000%

Structure Networking:

Type	Stru #	(flows into)	Stru #	Musk. K (hrs)	Musk. X	Description
Grass Filter	#1	==>	End	0.000	0.000	2031 Area 3 Reclamation Area

#1
Grass
Filter

Structure Summary:

		Immediate Contributing Area (ac)	Total Contributing Area (ac)	Peak Discharge (cfs)	Total Runoff Volume (ac-ft)	Sediment (tons)	Peak Sediment Conc. (mg/l)	Peak Settleable Conc. (ml/l)	24VW (ml/l)
#1	In	3.100	3.100	1.60	0.11	2.8	37,725	21.50	9.98
	Out			1.49	0.05	0.1	2,255	0.00	0.00

Particle Size Distribution(s) at Each Structure

Structure #1:

Size (mm)	In	Out
4.7500	100.000%	100.000%
0.0750	73.000%	100.000%
0.0400	33.000%	100.000%
0.0010	20.000%	100.000%

Structure Detail:

Structure #1 (Grass Filter)

2031 Area 3 Reclamation Area

Grass Filter Inputs:

Roughness Coefficient	Grass Height (in)	Hydraulic Spacing (in)	Infiltration Rate (iph)	Stiffness Factor (N-sq m)	Filter Length (ft)	Filter Width (ft)	Filter Slope (%)
0.0121	3.0	0.67	0.20	20.000	20.0	1200.0	9.0

Grass Filter Results:

Total Infiltration Volume:	0.0669 ac-ft
Filter Infiltration Rate:	0.1111 cfs
Peak Flow Depth:	0.027 in
Critical Prone Velocity:	1.0367 fps
Wedge Location:	0.29 ft
Sediment Depth in Zone D:	0.0106 in
Trap Efficiency:	97.7 %

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)
#1	1	3.100	0.022		0.000	80.000	F	1.60	0.115
Σ		3.100						1.60	0.115

Subwatershed Sedimentology Detail:

Stru #	SWS #	Soil K	L (ft)	S (%)	C	P	PS #	Sediment (tons)	Peak Sediment Conc. (mg/l)	Peak Settleable Conc (ml/l)	24VW (ml/l)
#1	1	0.300	50.00	9.00	0.8000	0.3800	1	2.8	37,725	21.50	9.98
Σ								2.8	37,725	21.50	9.98

Subwatershed Time of Concentration Details:

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#1	1	5. Nearly bare and untilled, and alluvial valley fans	9.00	21.96	243.99	3.000	0.022
#1	1	Time of Concentration:					0.022

LIST OF EXHIBITS – VOLUME 20

Exhibit 10, Item 6	Proposed Collom Coal Mine Project Baseline Vegetation Survey, May 2006, Cedar Creek Associates, Inc.
Exhibit 10, Item 7	Wetlands and Waters of the US Delineation for Collom Project, May 2006, Cedar Creek Associates, Inc.
Exhibit 11, Item 1	Wildlife Survey Report for the Collom Permit Study Area, August 25, 2006, Cedar Creek Associates, Inc.
Exhibit 11, Item 2	2007 Wildlife Monitoring Report for the Collom Permit Study Area, December 20, 2007, Cedar Creek Associates, Inc.
Exhibit 13C	Cumulative Bond Collom Haul Road and Facilities
Exhibit 14, Item 7	Pre-Blast Survey – Structures within ½ Mile of Collom Mining Area (Pending)
Exhibit 14, Item 8	Pre-Blast Survey – Offering Letters Pre-Blast Structure Locations Drawing
Exhibit 23, Item 1	Geotechnical Report for the Temporary Spoil Pile
Exhibit 23, Item 2	Addendum to Geotechnical Analysis
Exhibit 23, Item 3	Geotechnical Report for the Collom out of Pit Dump and Final Reclaimed Surface
Exhibit 25 Item 1	Groundwater Monitoring Well Information
Exhibit 26, Item 1	Alluvial Groundwater Monitoring Well Information
Exhibit 27, Item 1	Collom Haul Road Geotechnical Drilling
Exhibit 27, Item 2	Wilson Reservoir Geotechnical Drilling
Exhibit 27, Item 3	Collom In Pit Drilling
Exhibit 27, Item 4	Collom Topsoil Depth Testing
Exhibit 27, Item 5	Collom Facilities Geotechnical Drilling
Exhibit 27, Item 6	Collom Highwall Mining Geotechnical Design and Operational Considerations

Exhibit 27, Item 7 Addendum Collom and South Taylor Highwall Mining
Geotechnical Design and Operational Considerations

EXHIBIT 23, ITEM 3
GEOTECHNICAL REPORT - COLLOM OUT OF PIT DUMP AND FINAL
RECLAIMED SURFACE

The following report by Agapito Associates, Inc. provides an addendum to the geotechnical report presented in Exhibit 23, Item 1. The location of the excess spoil pile is shown on Map 29C.



March 28, 2022

227-27

Mr. Lee Sampson, P.E.
Senior Mining Engineer
Colowyo Coal Company
5731 State Hwy 13
Meeker, CO 81641-9119

Re: Updated Slope Stability Assessment for the Collom Out-of-Pit Dump and the Final Reclaimed Surface

Dear Mr. Sampson:

This letter report summarizes the results of a slope stability assessment undertaken for the planned finished slopes of the Collom out-of-pit dump area and the final reclaimed surface once mining has finished in the area. The assessment area is shown in Figure 1 and is denoted by the green boundary. The assessment examined the slopes along the two cross-section lines shown in Figure 1 using the limit equilibrium analysis software SLOPE/W.¹

The assessment builds on previous work undertaken by Shannon and Wilson in 2009,² which assessed the stability of the slopes associated with the Collom temporary spoil fill area. This assessment will therefore utilize the results of the original geotechnical investigation in the dump area and consider the geotechnical assumptions used in the original assessment.

The updated temporary spoil fill dump geometry has been provided by the Colowyo Mine and is indicated by the gray contours in Figure 1. Also provided in red in Figure 1, are the proposed contours for the final reclaimed surface once mining is completed.

The report does not consider any underdrain² or surface-water control requirements for either the temporary dump or the final reclaimed surface.

SITE DESCRIPTION

The assessment area shown in Figure 1 is located north and next to the West Collom Box Cut. Colowyo has indicated that the out-of-pit dump area for the Collom pit will be located on top of areas where mining will not occur and topsoil has been removed prior to placing dump material. The existing topography of the dump area dips to the northeast around 5 degrees (°), where it is located on a flatter limb of a northwest–southeast trending asymmetric syncline. At its maximum height, the dump pile is planned to be approximately 175 feet (ft) above the existing ground surface.

¹ GeoStudio (2022), “SLOPE/W Features,” available at <https://www.geoslope.com/products/slopew/features>.

² Shannon & Wilson, INC (2009), “Geotechnical Study Collom Temporary Soil Fill, KCCC – Colowyo Mine,” Report Revision PR-03. August 5th.

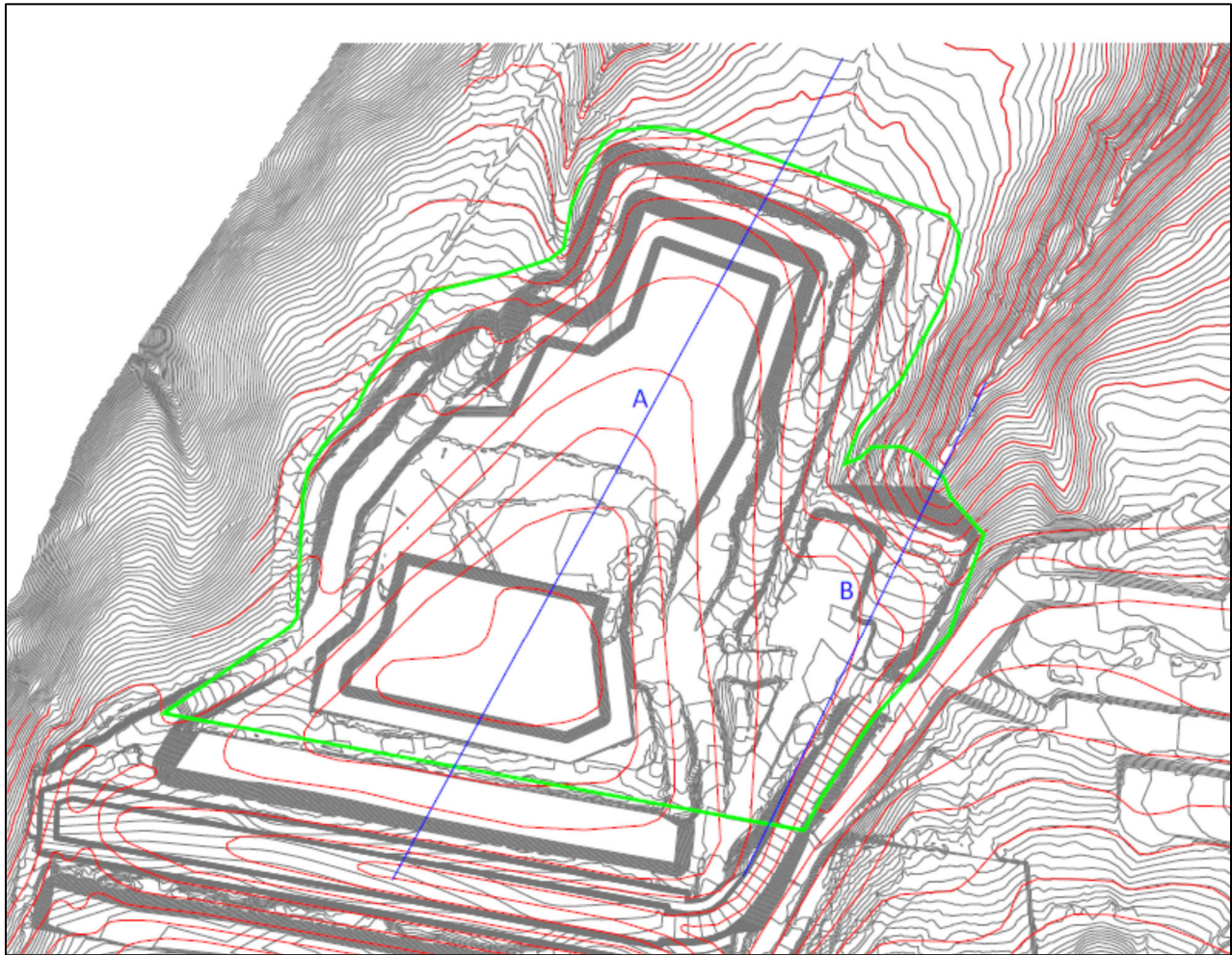


Figure 1. Map Showing Anticipated Maximum Out-of-Pit Dump Profile (gray contours), Final Reclaimed Surface (red contours), and the Sections Lines used for the Stability Analysis (blue lines)

The east side of the dump pit will be partially placed in the Little Collom drainage. Based on the topographic information provided by the mine, the spoil fill site area has side slopes within the valley greater than 20° and would therefore classify as a “valley fill” according to regulations³ for excess spoil fills. Colowyo has constructed a rock lined drainage ditch at the bottom of the valley and it will eventually be covered with spoil.

GEOTECHNICAL ENVIRONMENT

A geotechnical investigation program consisting of four boreholes was conducted in the area of the planned spoil dump in 2009. In terms of geology, the boreholes indicate that the surficial soil

³ Colorado Mined Land Reclamation Board (CMLRB) (2005), “Regulations of the Colorado Mined Land Reclamation Board for Coal Mining,” Denver, Colorado: Colorado Division of Minerals and Geology (now Colorado Division of Reclamation Mining & Safety).

is comprised of 32 to 37 ft of colluvium overlying the bedrock. The soil conditions consist of a medium-stiff to hard, sandy to gravelly clay, with occasional clayey sand or gravelly layers to depths of 7 to 22 ft. At deeper depths, the clay was medium-stiff to stiff down 27 to 37 ft.

The bedrock consists of very low- to moderate-strength interbedded sandstone and claystone. These units are typical of the Williams Fork Formation encountered at the mine site, where the formation consists of interbedded sandstone, siltstone, claystone, shale, and coal.

Groundwater was measured at depths of approximately 16 to 22 ft below the existing ground surface during drilling in the boreholes. Shannon and Wilson² noted that groundwater conditions during drilling were not considered a static measurement, but rather reflect short-term conditions. Therefore, groundwater fluctuations may occur depending on the time of year and local conditions particular to the site.

The spoil itself will comprise excavated bedrock consisting of sandstone, siltstone, and mudstone. The unsorted spoil at the mine has previously been estimated to have the following gradational characteristics⁴:

- Cobbles and boulders 50%
- Gravel 28%
- Sand 2%
- Fines (No. 200 sieve) 20%

Significant sorting of the spoil is however anticipated from end-dumping over the edge of the pile. Previous work at other areas of the mine indicated that the spoil material has a steep overall angle of repose of around 38°. ²

Table 1 summarizes the mean geotechnical properties for the spoil and soil obtained from laboratory testing.² As the geotechnical conditions for the site have not changed since the 2009 study, Agapito considers these properties appropriate for the updated assessment.

Table 1. Mean Spoil and Spoil Properties from Laboratory Testing

Material	Unit Weight (pcf)	Friction Angle (°)	Cohesion (psf)
Spoil	110	35	750
Clay	125	31	0

pcf = pounds per cubic foot; psf = pounds per square foot

SLOPE STABILITY ANALYSIS

The stability analysis was carried out using the limit-equilibrium software SLOPE/W.¹ As this program utilizes a two-dimensional (2D) analysis, two sections lines were selected to assess the

⁴ CTL/Thompson, Inc. (1992), "Underdrain Filter Requirements, West Pit and Section 16 Pit Excess Spoil Fills," letter report to Colowyo Coal Company, job no. 18,683, April 27th.

planned worst-case geometric conditions using Spencer's method of analysis. These conditions include maximum slope height and overall slope angle.

As shown in Figure 1, Section A represents the north-facing slope of the dump pit and the final reclaimed surface. In this area, the height of the proposed slope will be approximately 195 ft and will comprise two benches with inter-slope angles of 38°. The overall slope angle is proposed to be 23°. The final reclaimed surface will comprise a 14° slope at a height of 107 ft.

Also shown in Figure 1 is Section B, which bisects the valley fill. In this area, the height of the proposed dump slope will be 155 ft with a proposed slope angle of around 37°. The final claimed surface will comprise a 19° slope at a height of 225 ft.

A generalized clay thickness of 35 ft has been used for both sections and a 5-ft-thick impenetrable layer of gravel has also been used at the contact with the bedrock. The bedrock was also modeled as impenetrable as deep-seated failures through the bedrock are not considered likely below the base of the fill. The modeled cross-sections are shown in Figures 2 to 5.

United States Geologic Survey (USGS) data indicates that the peak ground acceleration with a 10% probability of exceedance in 50 years is about 0.05g (acceleration of gravity).⁵ On this basis, a version of the analysis was performed for the anticipated seismic conditions using a pseudo-static analysis with a horizontal acceleration 0.05g.

In terms of the modeled groundwater conditions, a base case of 15 ft below the existing ground surface was assumed. Fluctuating groundwater conditions were considered for Section A, and a secondary set of modeling was conducted using a groundwater level of 40 ft above the clay surface. These levels are similar to those assumed in the 2009 assessment.² The rock lined drainage ditch in Section B will limit the groundwater table to the base of the spoil.

In line with CMLRD requirements, a minimum long-term static factor of safety criterion of 1.5 has been used. For seismic analysis, a minimum factor of safety of 1.3 will satisfy the regulatory requirements.

Similar with the 2009 assessment,² two general failure modes were considered for the analysis. The first mode involves failure paths near the toe of the slopes. This is considered the most likely mechanism for the assessed slopes. The second mode involves failure paths further up-slope, typically near the crest.

RESULTS AND RECOMMENDATIONS

The results of the stability assessment are provided in Attachment and summarized in Tables 2 and 3.

⁵ USGS (2002), "Interpolated Probabilistic Ground Motion for the Conterminous 48 States by Latitude-Longitude," 2002 data from USGS web data.

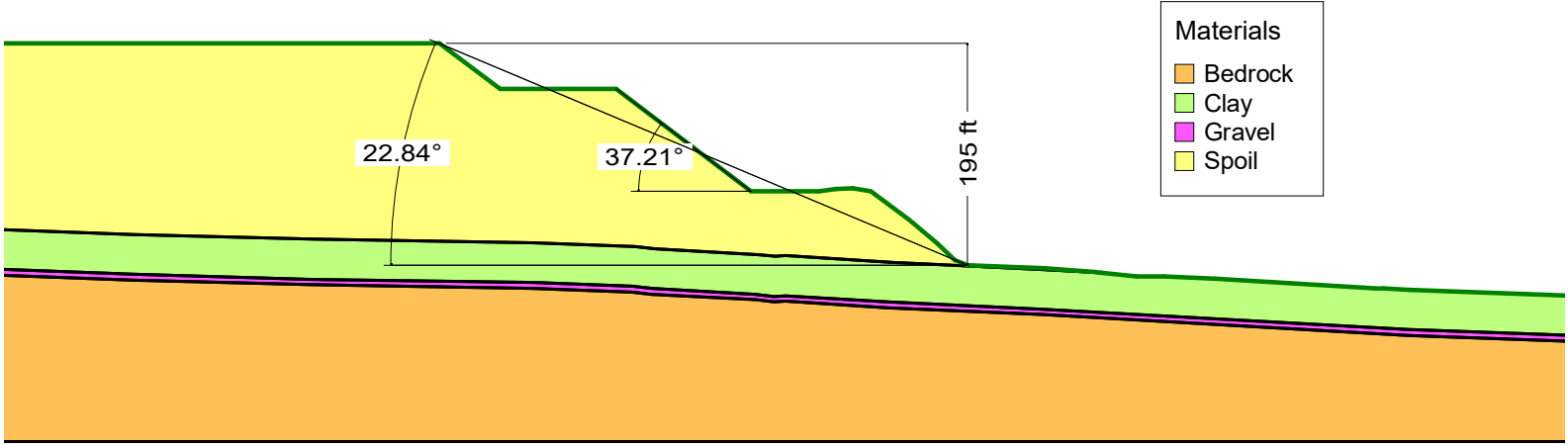


Figure 2. Section A Showing Proposed Out-of-Pit Dump Profile

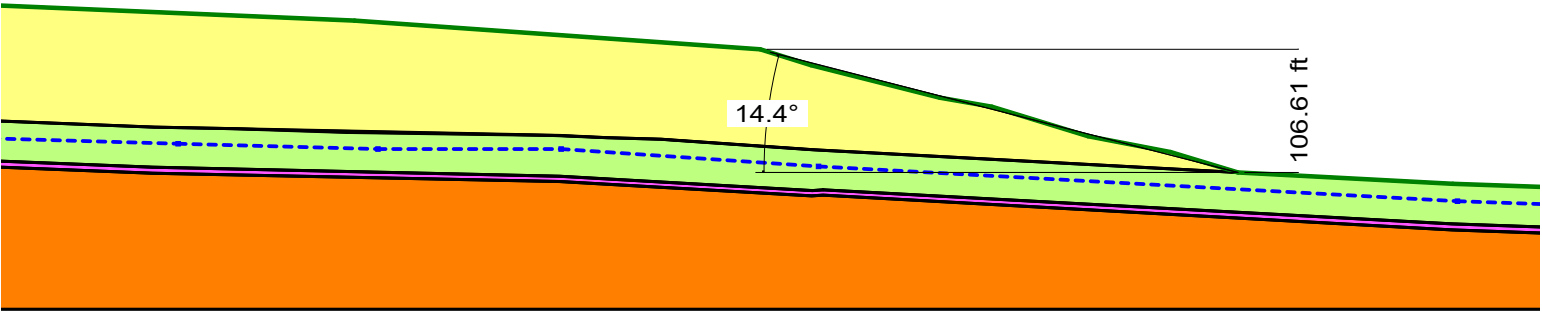


Figure 3. Section A Showing Final Reclaimed Surface Profile

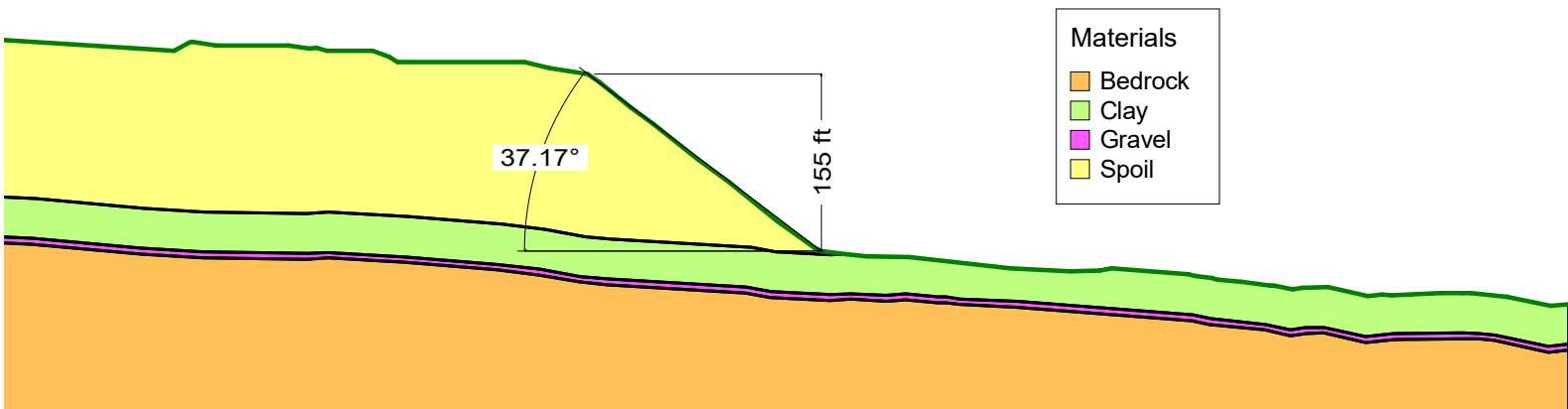


Figure 4. Section B Showing Proposed Out-of-Pit Dump Profile

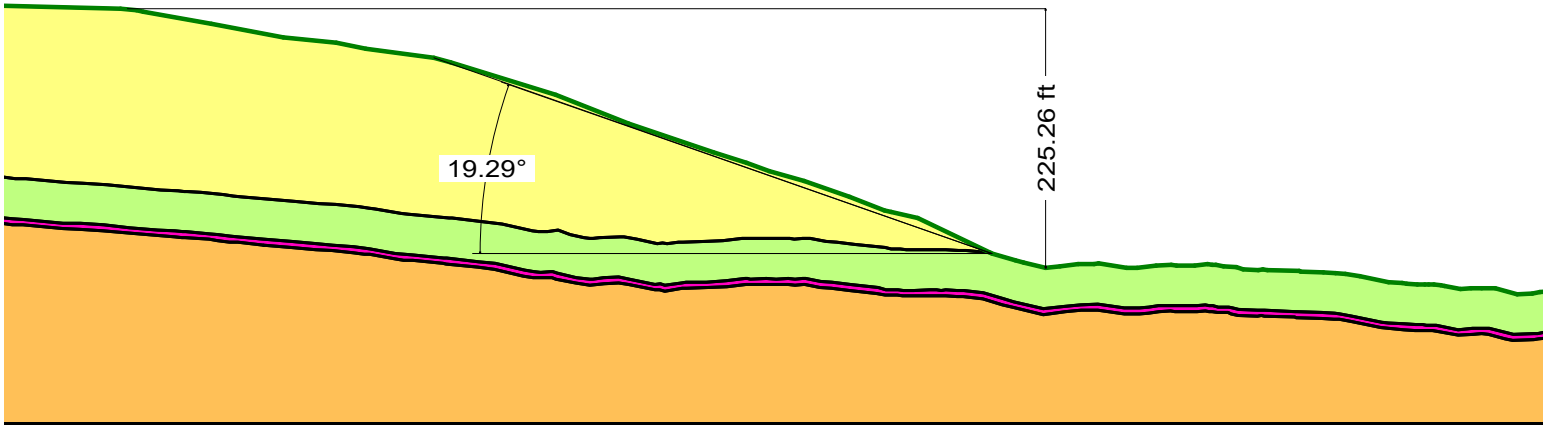


Figure 5. Section B Showing Final Reclaimed Surface Profile

Table 2. Summary of SLOPE/W Results for Sections A and B of the Collom Out-of-Pit Dump

Section	Seismic Conditions	Water Level Relative to Base of Spoil (ft)	Factor of Safety (Toe Failure)	Factor of Safety (Crest Failure)
Section A	Static	-15	3.0	2.1
Section A	Static	+40	2.4	1.6
Section A	Pseudo-static	+40	2.2	1.4
Section B	Static	-15	2.9	1.5
Section B	Pseudo-static	-15	2.4	1.4

Table 3. Summary of SLOPE/W Results for Sections A and B of the Final Reclaimed Surface

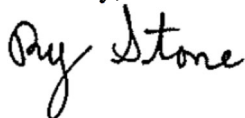
Section	Seismic Conditions	Water Level Relative to Base of Spoil (ft)	Factor of Safety (Toe Failure)	Factor of Safety (Crest Failure)
Section A	Static	-15	3.9	3.0
Section A	Static	+40	2.8	2.0
Section A	Pseudo-static	+40	2.2	1.6
Section B	Static	-15	2.9	2.4
Section B	Pseudo-static	-15	2.2	2.1

In terms of the out-of-pit dump, all assessed conditions for both Sections A and B achieve the minimum stipulated factor of safety of 1.5 against static conditions and 1.3 for seismic conditions and are therefore deemed adequate for temporary stability.

Under all the conditions assessed for the final reclaimed surface, the slopes assessed in both Sections A and B achieve the minimum stipulated factor of safety of 1.5 against static conditions and 1.3 for seismic conditions and are therefore deemed adequate for long-term stability.

If you have any questions, please feel free to contact me.

Sincerely,



Ry Stone, CPEng.
Senior Associate

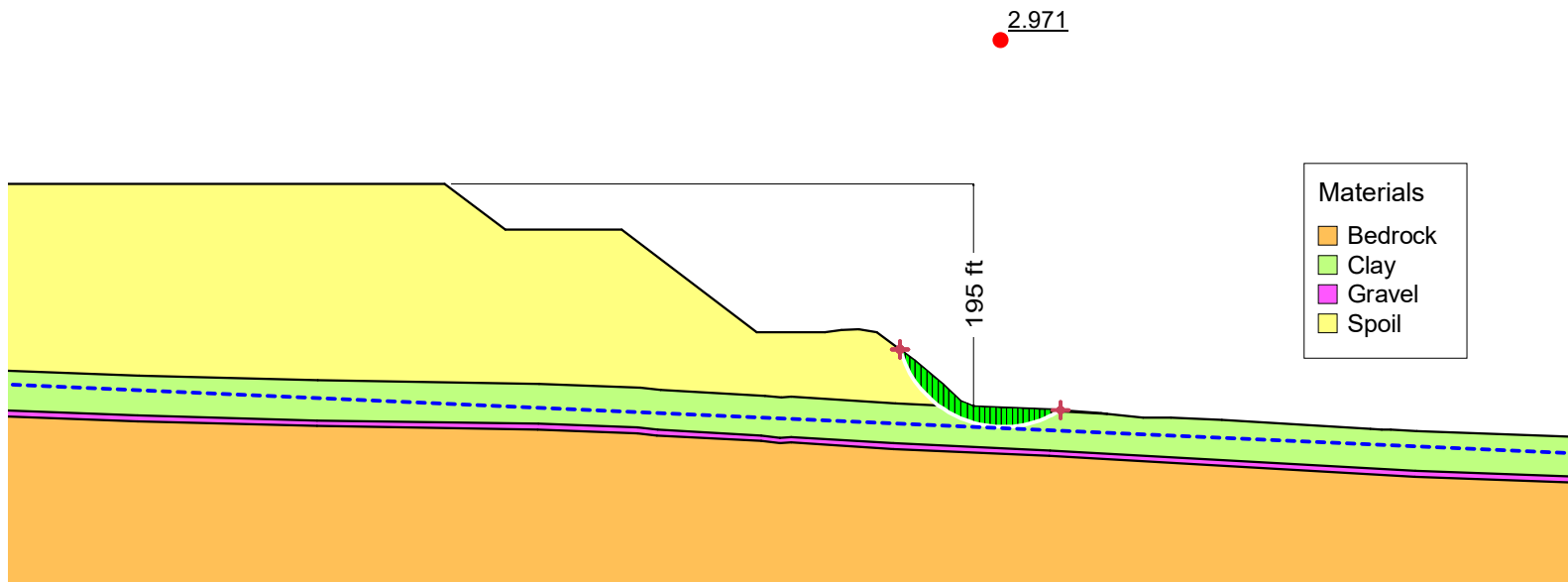
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Attachment: Stability Assessment Results

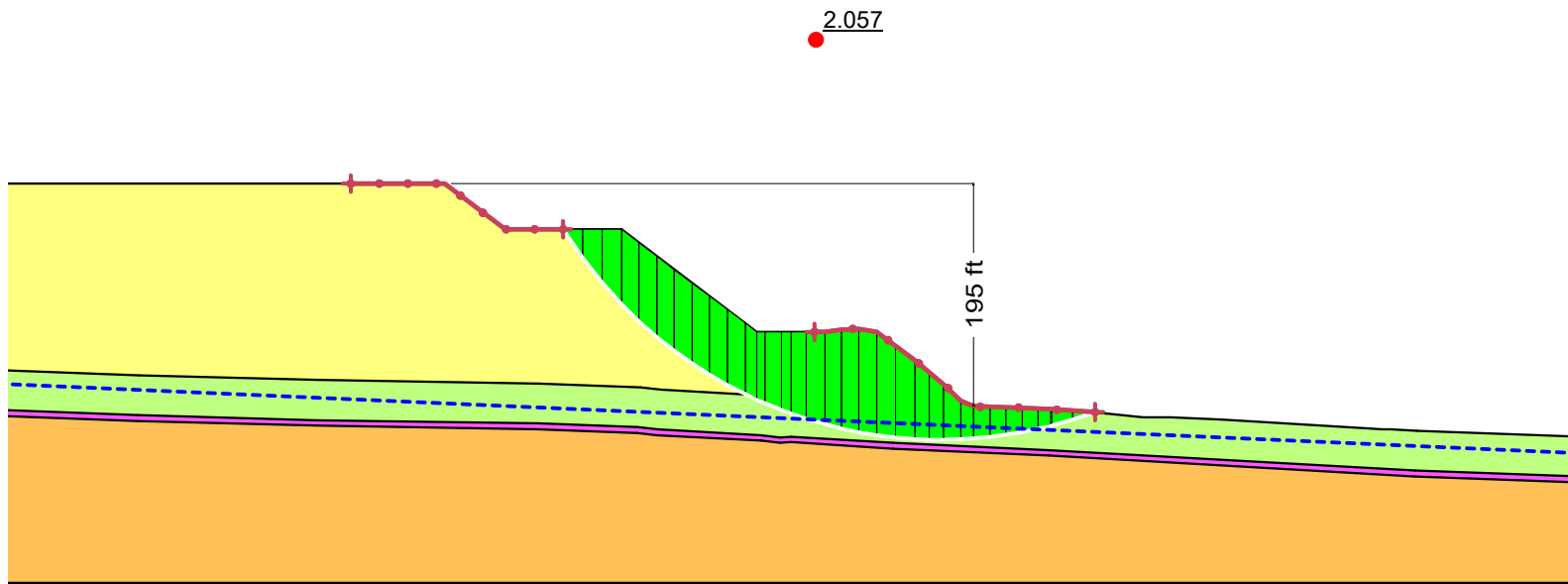
Transmitted in PDF format via email to lsampson@tristate.org

ATTACHMENT

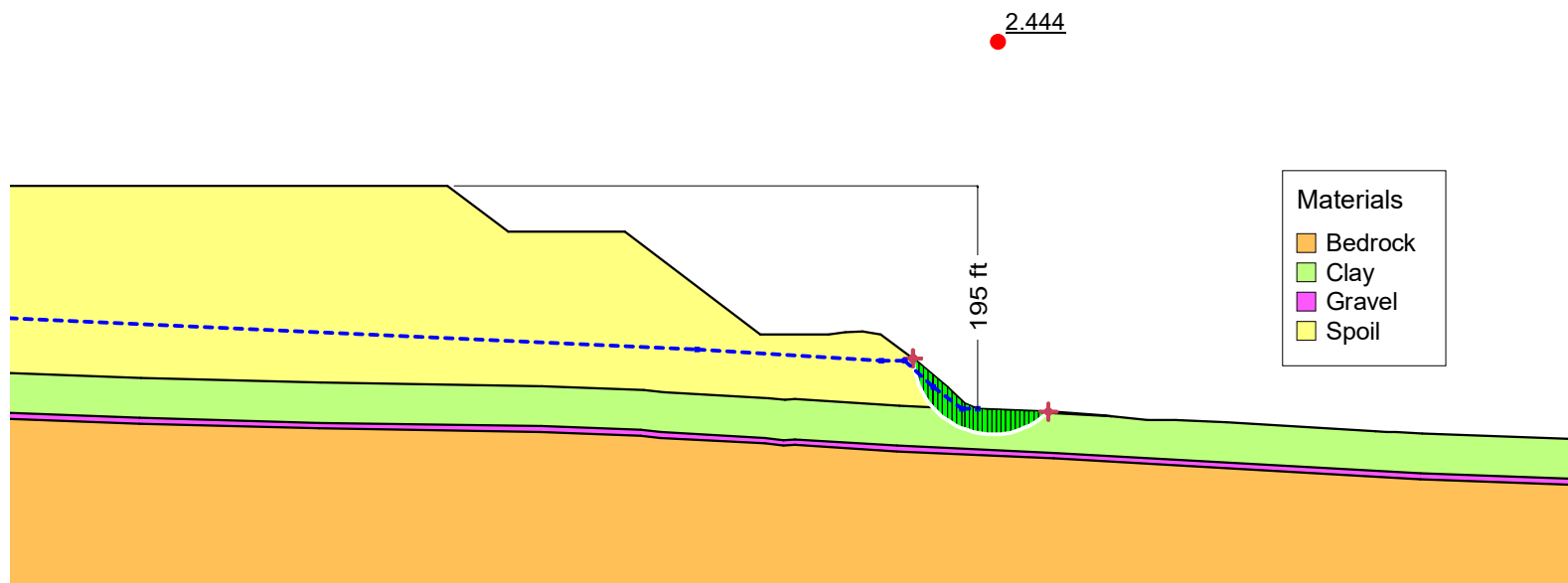
STABILITY ASSESSMENT RESULTS



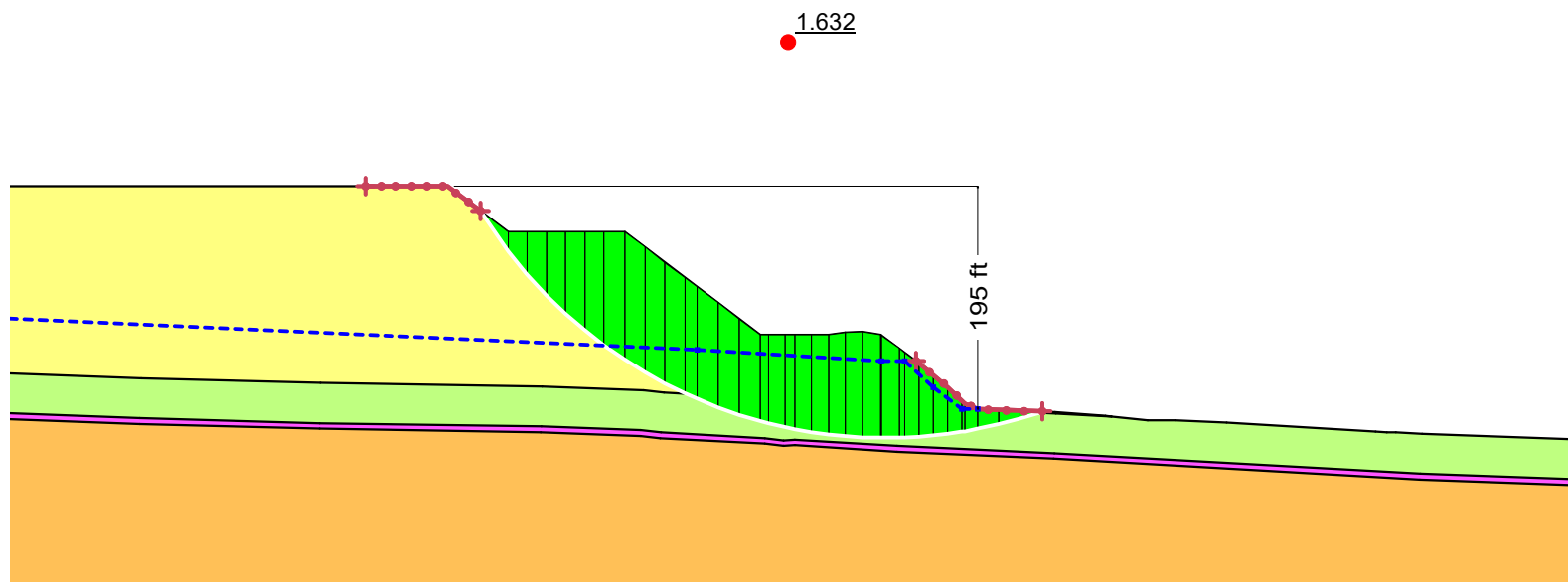
Scenario 1. Section A Dump, Clay, -15 Water, Toe



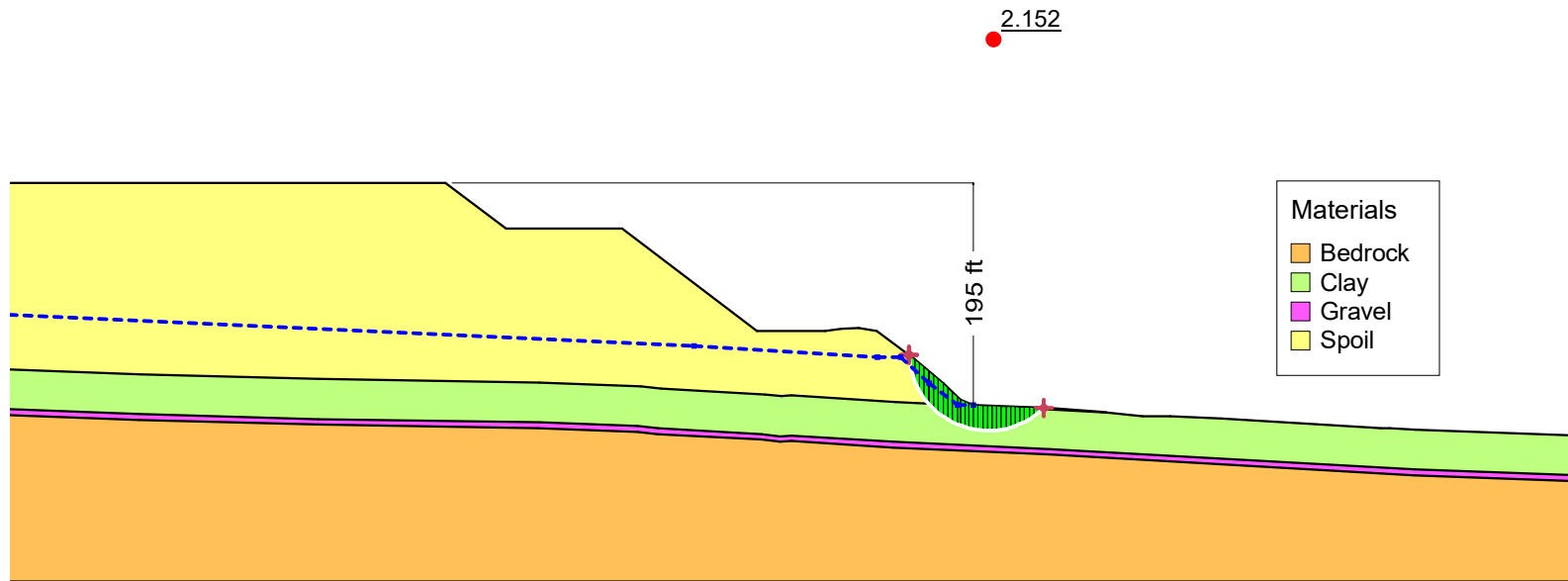
Scenario 2. Section A Dump, Clay, -15 Water, Crest



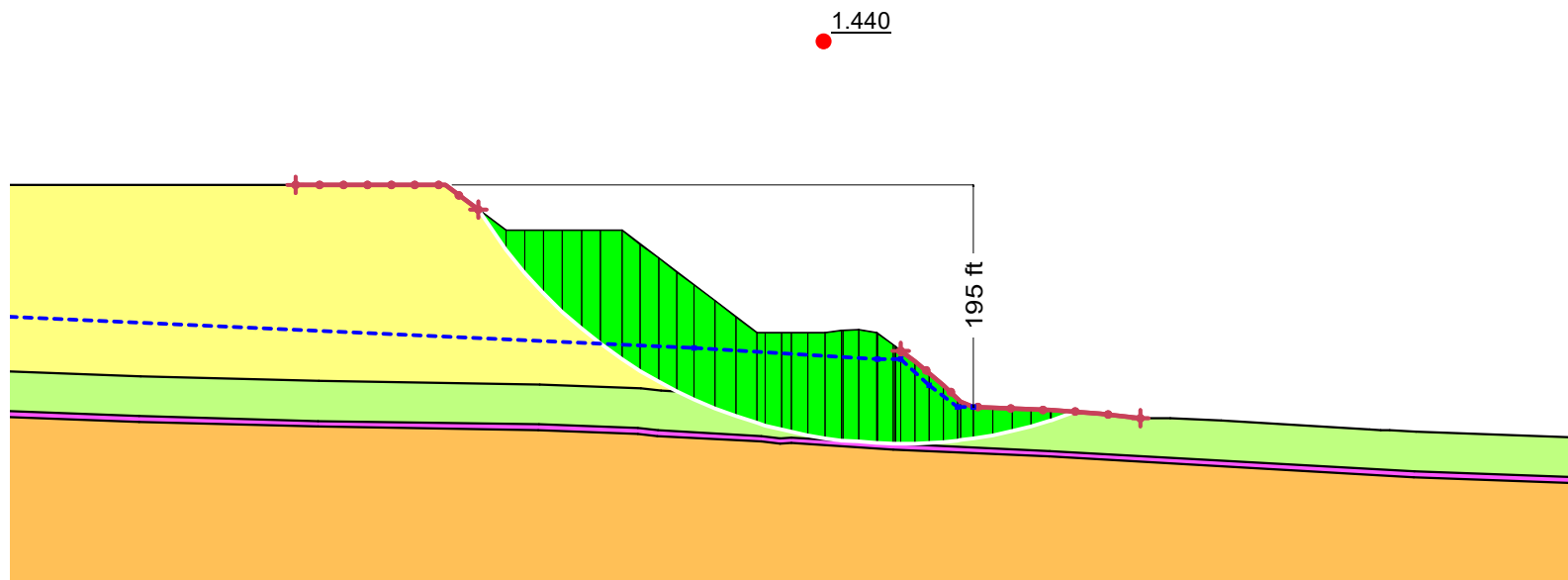
Scenario 3. Section A Dump, Clay, +40 Water, Toe



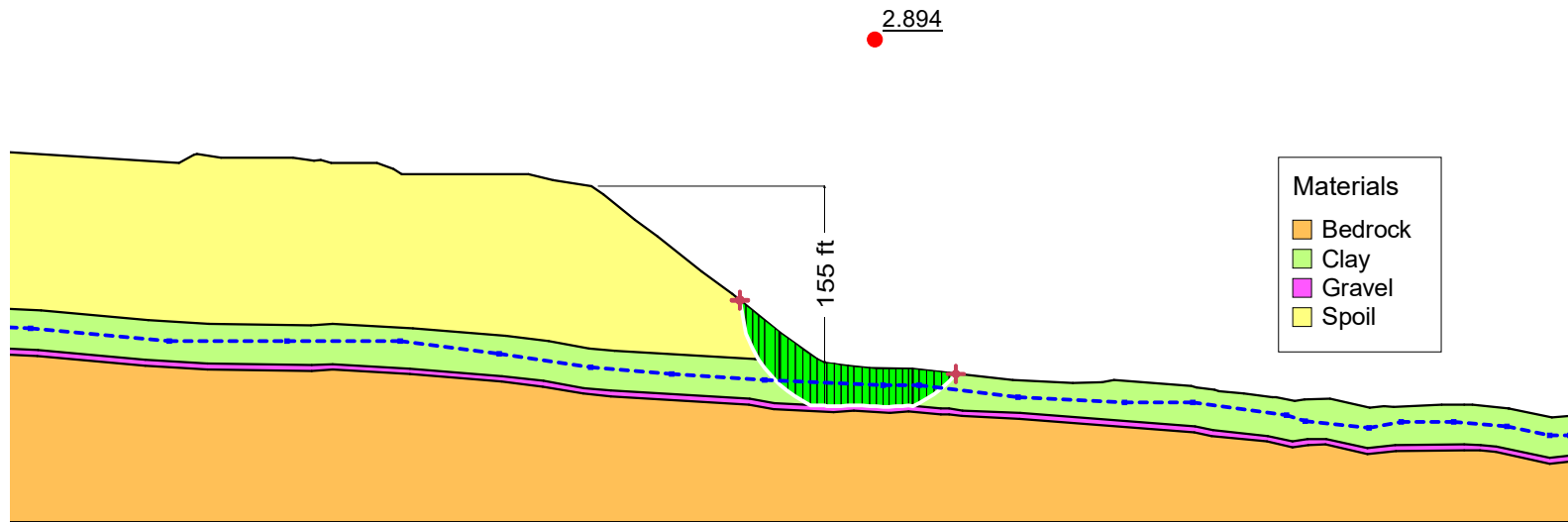
Scenario 4. Section A Dump, Clay, +40 Water, Crest



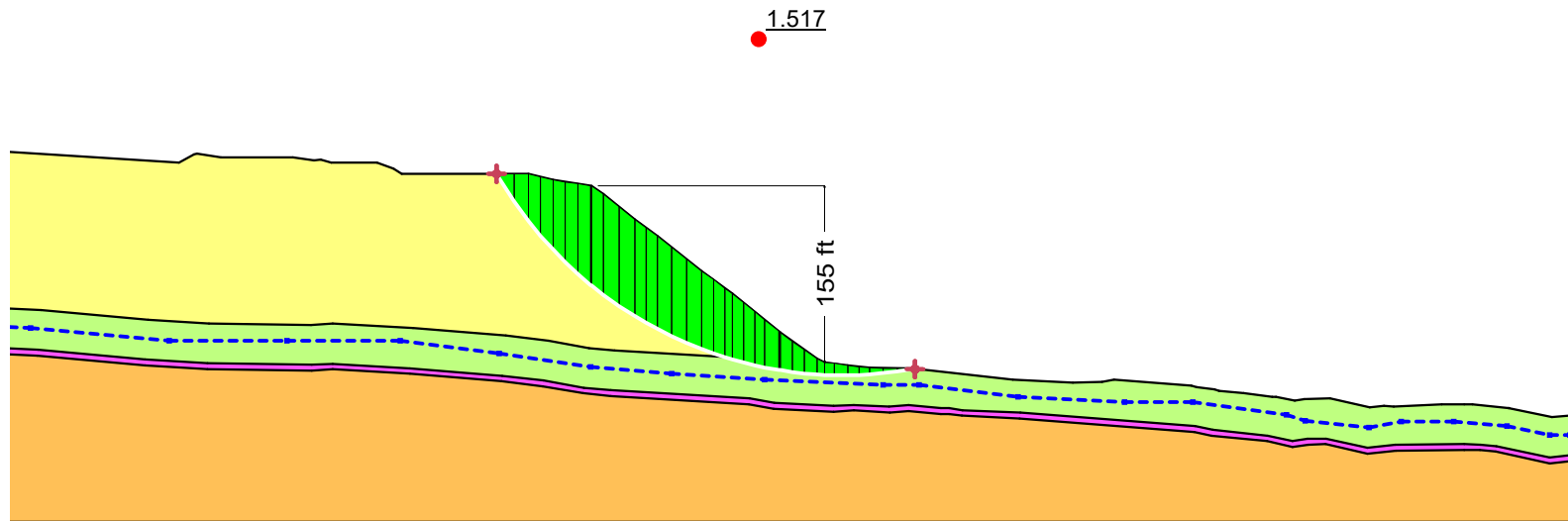
Scenario 5. Section A Dump, Clay, +40 Water, PS, Toe



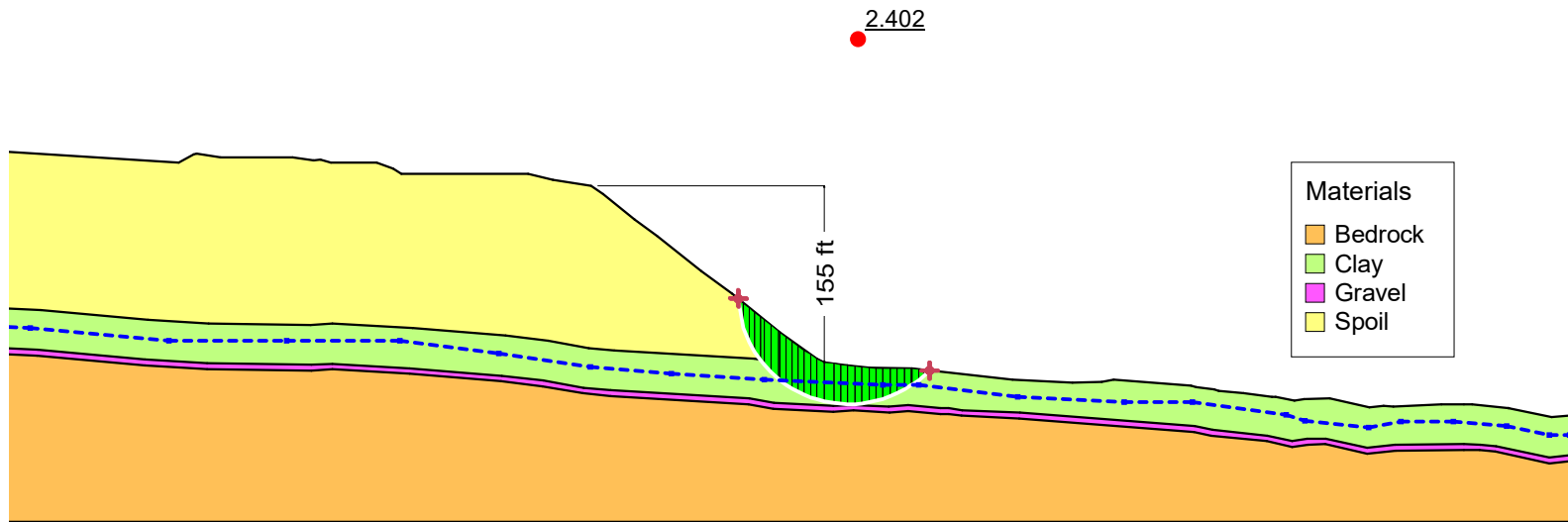
Scenario 6. Section A Dump, Clay, +40 Water, PS, Crest



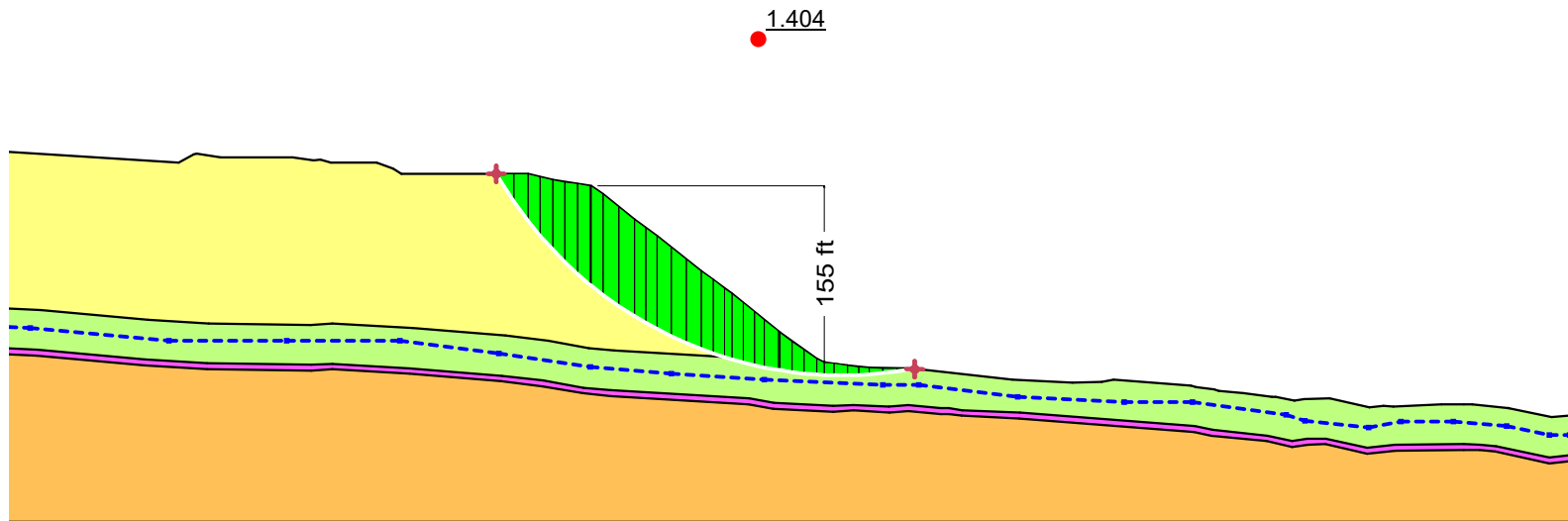
Scenario 7. Section B Dump, Clay, -15 Water, Toe



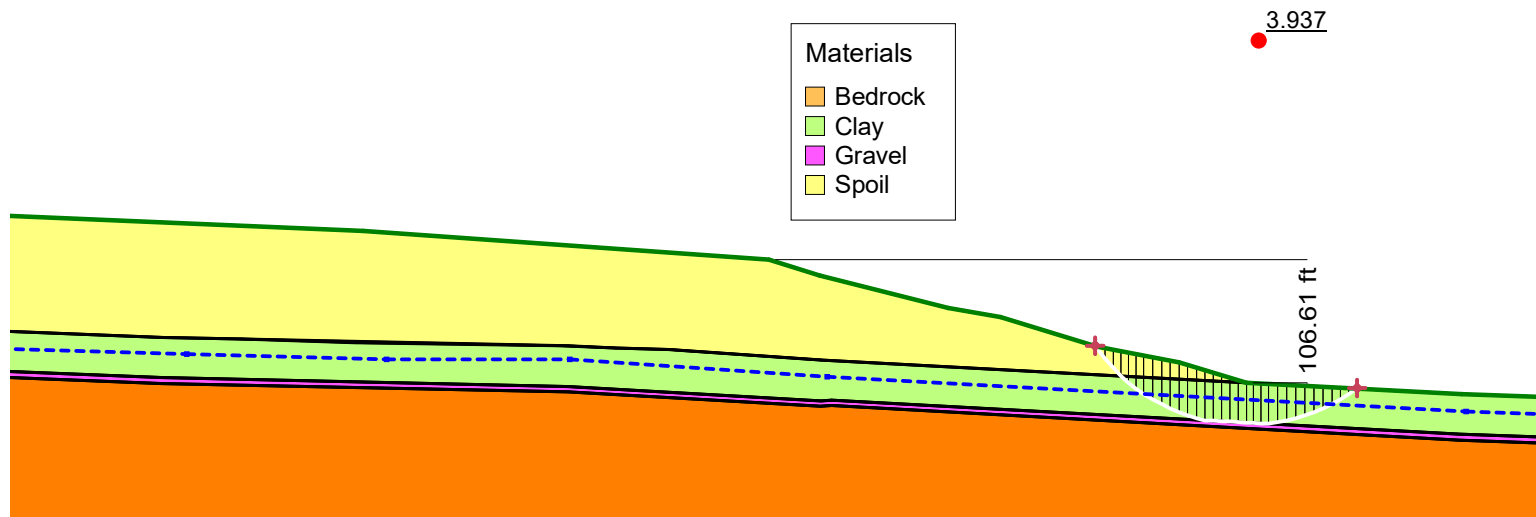
Scenario 8. Section B Dump, Clay, -15 Water, Crest



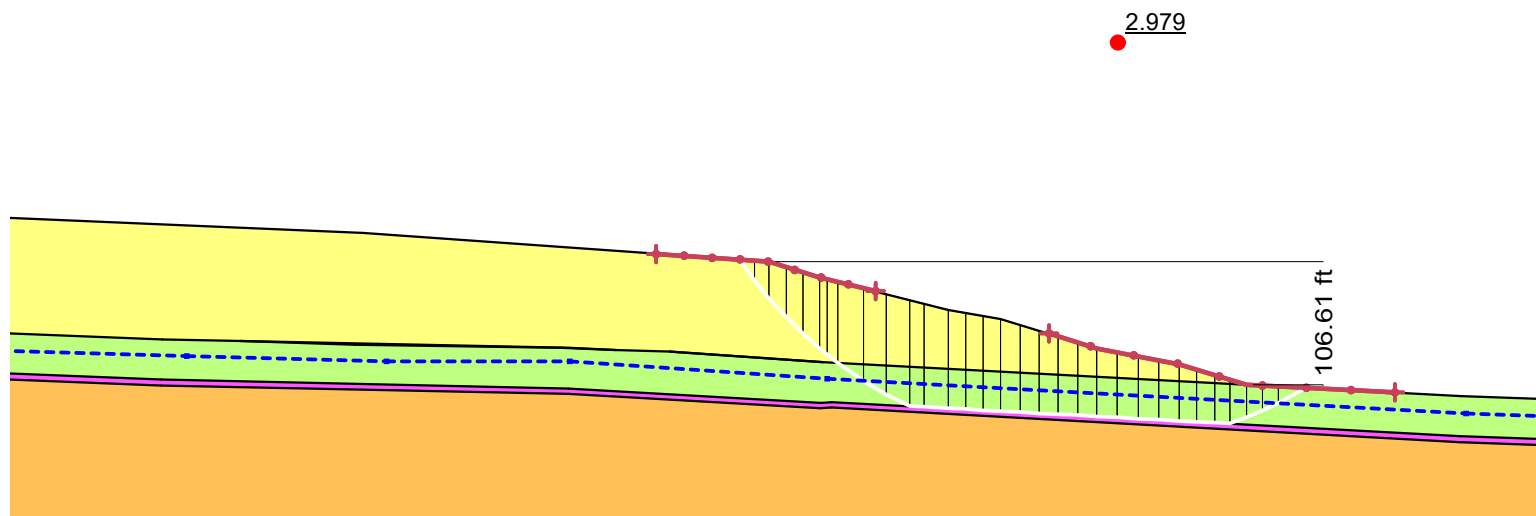
Scenario 9. Section B Dump, Clay, -15 Water, PS, Toe



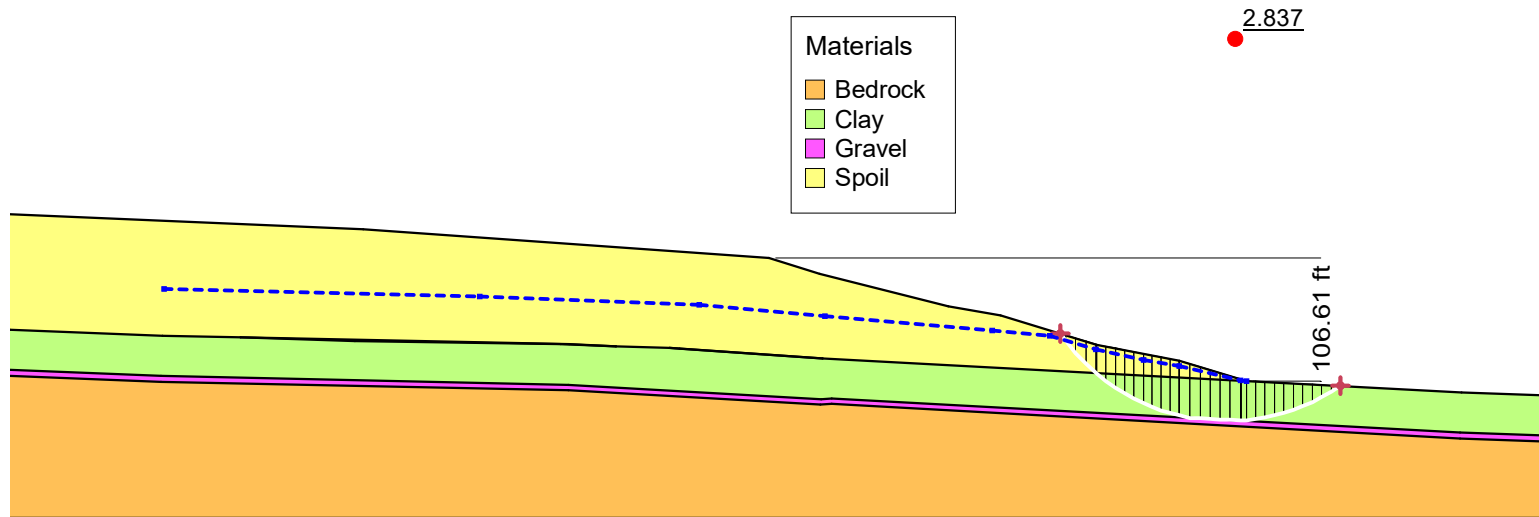
Scenario 10. Section B Dump, Clay, -15 Water, PS, Crest



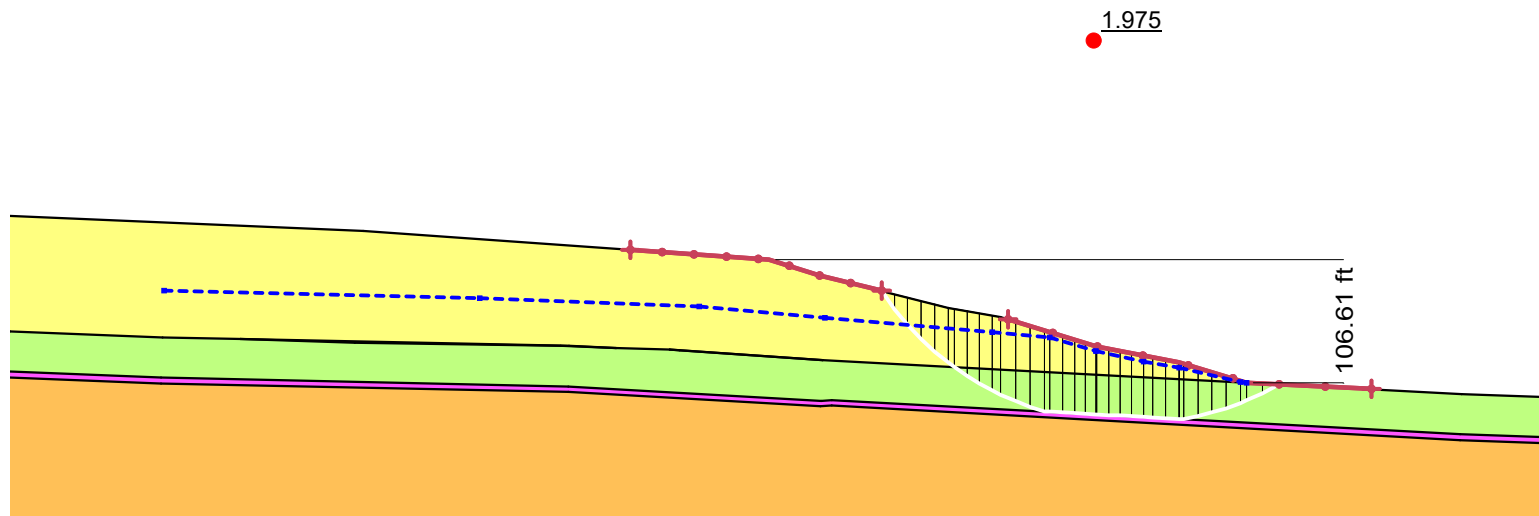
Scenario 1. Section A Final Reclaimed Surface, Clay, -15 Water, Toe



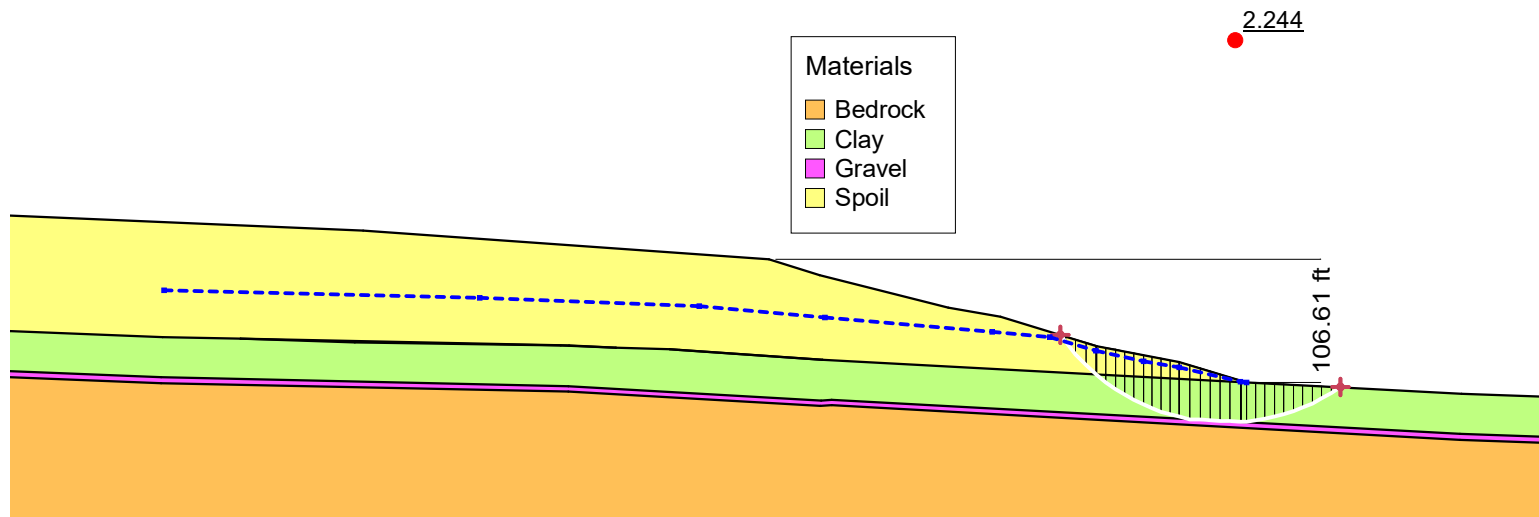
Scenario 2. Section A Final Reclaimed Surface, Clay, -15 Water, Crest



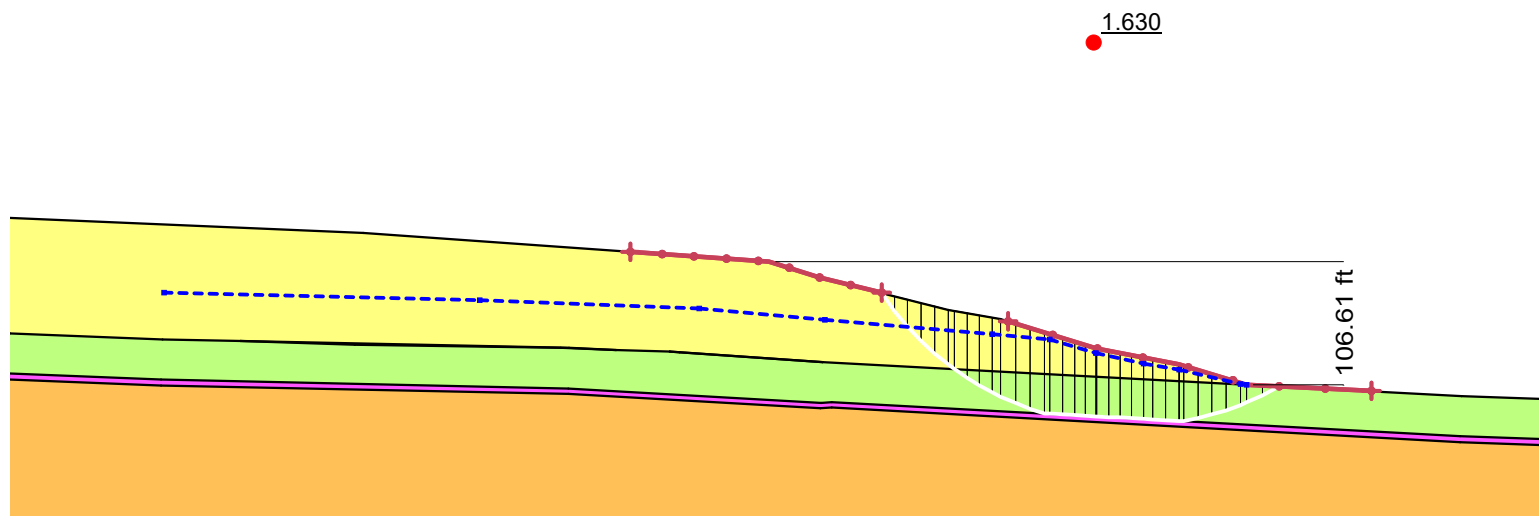
Scenario 3. Section A Final Reclaimed Surface, Clay, +40 Water, Toe



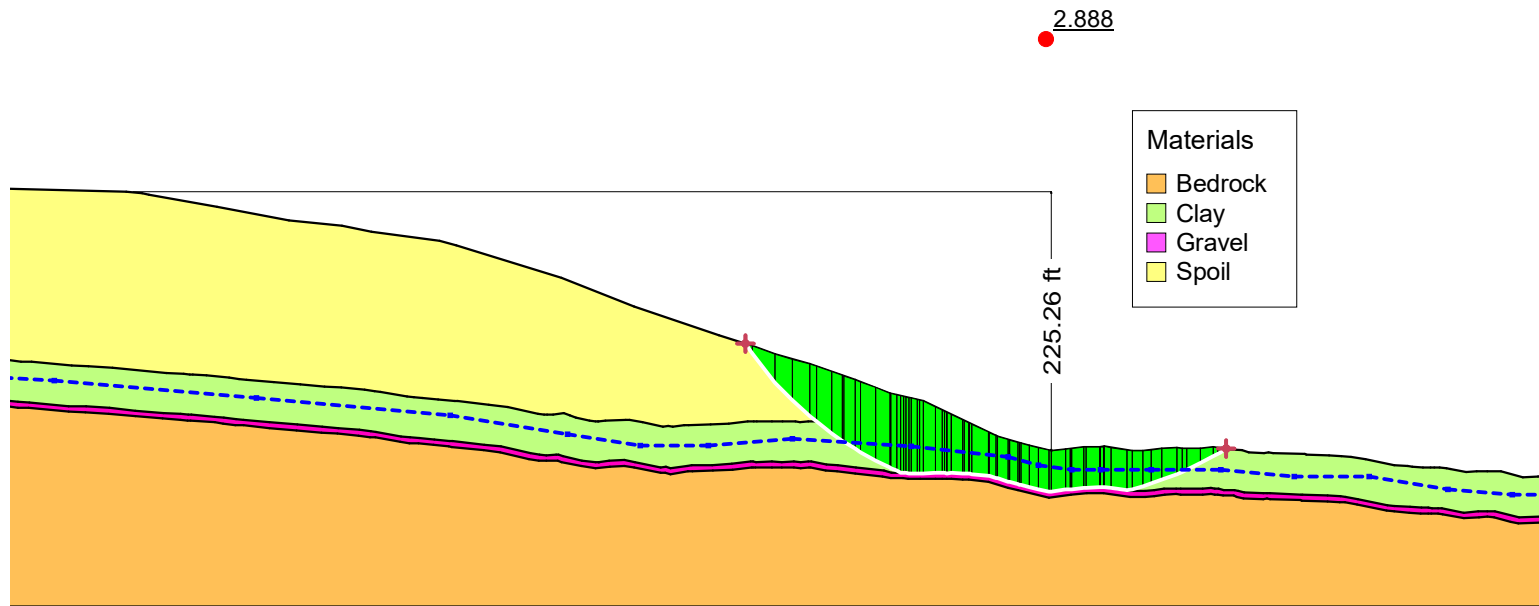
Scenario 4. Section A Final Reclaimed Surface, Clay, +40 Water, Crest



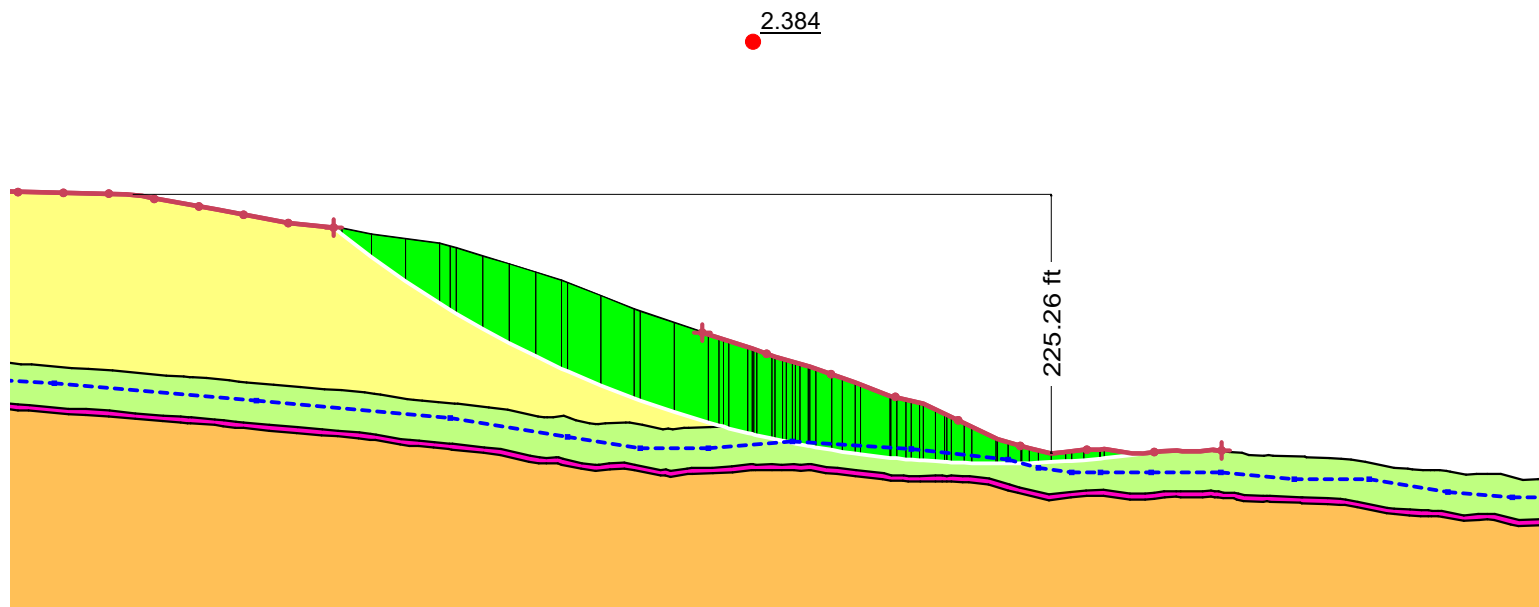
Scenario 5. Section A Final Reclaimed Surface, Clay, +40 Water, PS, Toe



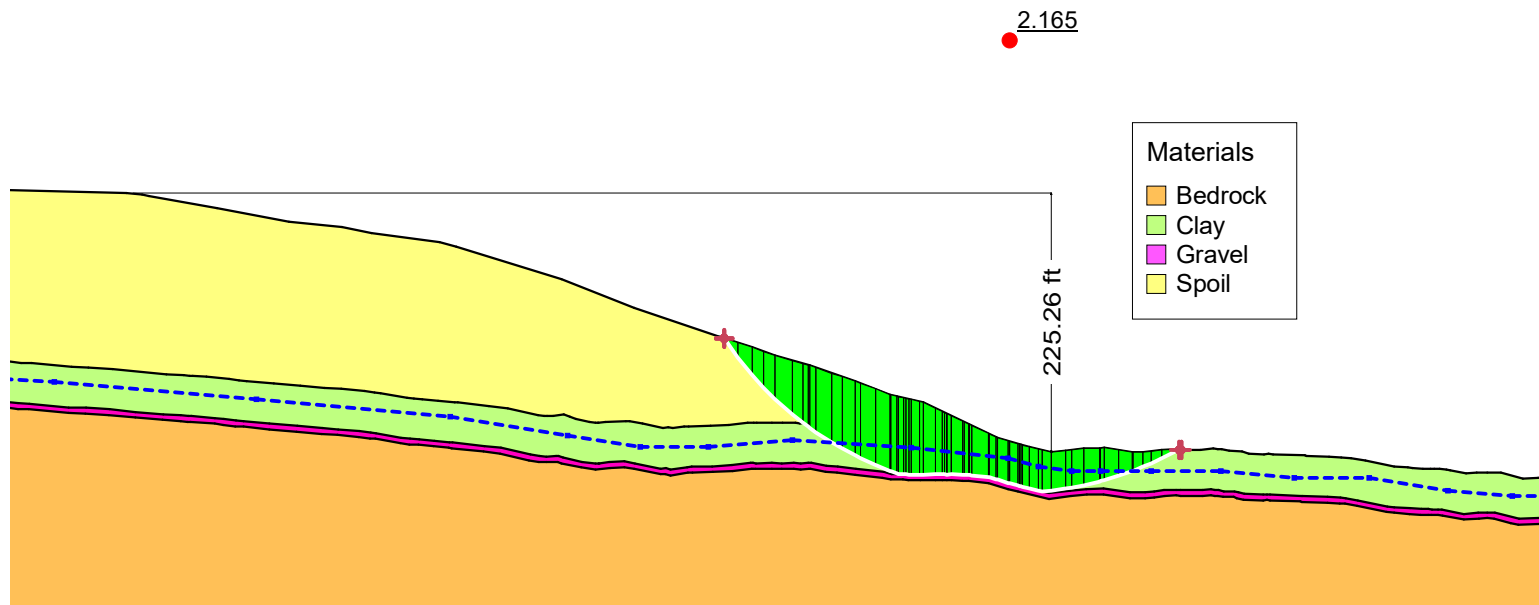
Scenario 6. Section A Final Reclaimed Surface, Clay, +40 Water, PS, Crest



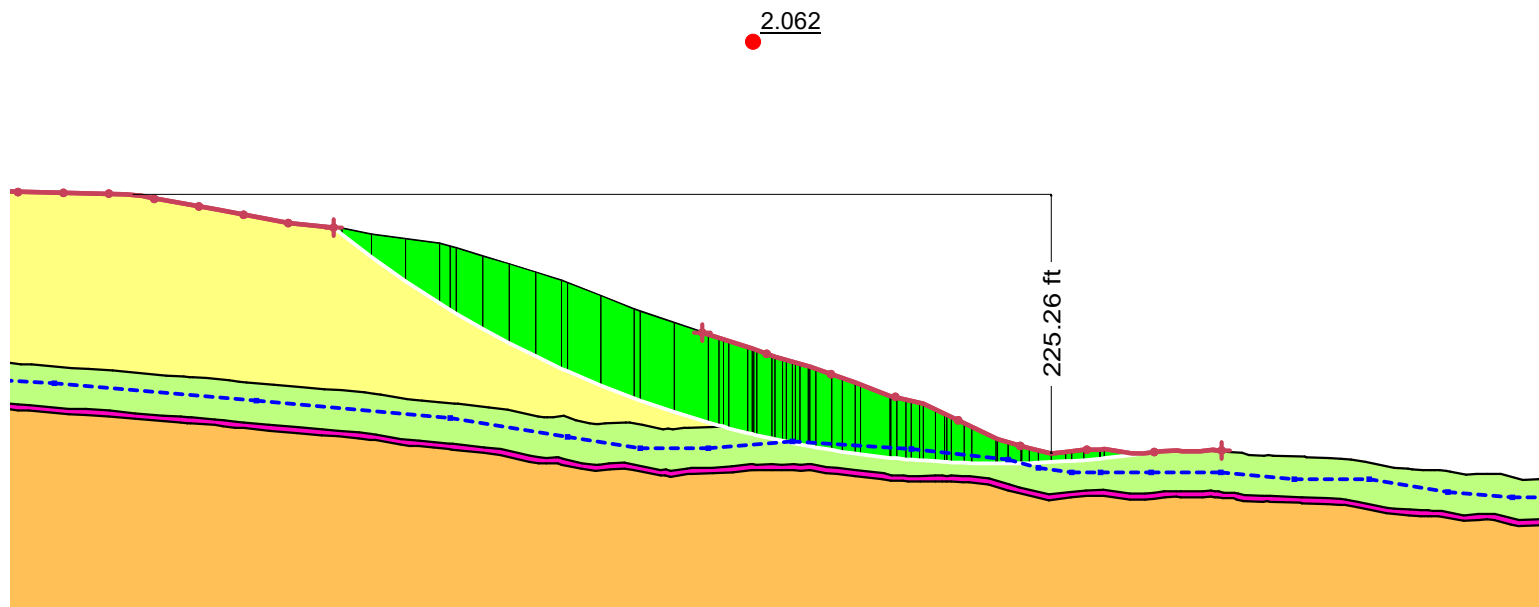
Scenario 7. Section B Final Reclaimed Surface, Clay, -15 Water, Toe



Scenario 8. Section B Final Reclaimed Surface, Clay, -15 Water, Crest



Scenario 9. Section B Final Reclaimed Surface, Clay, -15 Water, PS, Toe



Scenario 10. Section B Final Reclaimed Surface, Clay, -15 Water, PS, Crest

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