List of Attachments
HsB RDS Permit Modification Application

Attachment 1. MR Responses to DEQ January 3, 2022 Preliminary Review Comments

Attachment 2. Horseshoe Bend Rock Disposal Site Stage 1 Drainage System Report (Knight Piesold, Ltd December 6, 2021)

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ATTACHMENT 1

MR RESPONSES to DEQ
JANUARY 3, 2022
PRELIMINARY REVIEW COMMENTS

Horseshoe Bend (HsB) Rock Disposal Site (RDS)
Stage 1 Drainage System Report
Montana Resources, LLP; Operating Permit No. 00030

Montana Resources, LLP
600 Shields Ave
Butte, MT 59701

June 2022

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MR RESPONSES to DEQ JANUARY 3, 2022 PRELIMINARY REVIEW COMMENTS

DEQ Comment 1:

pp. 24 and 25, Section 4.4: "The drainage system discharges into the HsB Pond where flows will continue to be conveyed to the HsB Weir in a manner that limits impacts to the existing water management infrastructure. Construction of the drainage system across the upstream section of the HsB Pond will reduce the existing pond footprint area by approximately 50% to 2.8 acres. The flow length of the pond will also be reduced to approximately 1,000 ft. This size reduction will impact the ponds' ability to attenuate incoming flows and buffer peak storm events but is not expected to impact the water management systems downstream of the HsB Pond."

DEQ Comment 1(a):

If the HSB Pond area and corresponding attenuation capacity will be decreased by ~50%, please further quantify and explain the capacities of the downstream water management and treatment systems. Although the design report states that impacts are "not expected," DEQ needs further details to evaluate potential impacts from large storm events and determine whether the proposed changes to HSB Pond would potentially "conflict with local, state, or federal laws, requirements, or formal plans." (17.4.608(1)(g), Montana Code Annotated, MCA)

MR Response to Comment 1(a):

The HsB ponds proposed to be filled currently offer little flow attenuation (flow equalization capacity) as the stage of these ponds is controlled by the weir at the south end of the ponds. HsB pond water will continue to flow through the weir at the south end of the pond. A diversion structure below the weir allows water to be directed to either the HsB CS or HsB WTP. Flow over the weir controls the storage capacity of these ponds and can only vary by a few inches. True flow equalization to the downstream water management systems occurs in the equalization basin in front of the HsB WTP, which would be unaltered by approval of this permit modification. During upset conditions, an overflow pipe near the diversion structure allows discharge to the Berkeley Pit. MR will consult with the EPA to ensure that there is no conflict with the BMFOU remedy.

MR RESPONSES to DEQ JANUARY 3, 2022 PRELIMINARY REVIEW COMMENTS

DEQ Comment 1(b):

Please also include an explanation of the potential flowpath(s) under upset or overflow conditions (e.g. the Berkeley Pit?), whether due to large storm events or changes/delays with the water treatment facility or mine operations that might affect available capacity.

MR Response to Comment 1(b):

See response to Comment 1(a). As operations currently provide, flows in excess of treatment capabilities whether due to treatment facility downtime or very high flows (which has not occurred since the construction of the HsB CS) would be directed to the Berkeley Pit through existing infrastructure. Approval of this proposed permit modification would not change bypass/overflow management currently authorized by the BMFOU remedy

DEQ Comment 2:

p. 37, Section 6.2: "At the western end of surface water ditch SWD8, the ditch is designed to discharge into a pipe to convey the flows down the 7% Ramp and into the HsB Pond, referred to as Pipeline #1 on Drawing MR-C4526 in Appendix A. The pipe is specified as a nominal diameter (ND) 26-inch DR11 HDPE pipe. The transition from ditch to pipe shall be made via a small surface pond or approved alternative. Surface water ditch SWD7 also transitions to pipe at its western extent beneath the existing access road, referred to as Pipeline #2. The specification for Pipeline #2 is the same as Pipeline #1 (i.e. ND26-inch DR11 HDPE)."

DEQ Comment 2(a):

As part of the permit modification application, please include details about the operation and reclamation of the ditch and pipeline systems. This should include a discussion about the longevity and maintenance/replacement schedule for the pipeline, although DEQ suggests that a pipeline may not be sufficient for long-term, post closure runoff controls.

MR Response to Comment 2(a):

Similar to other pipelines in the permit area, the drainage pipeline system will be monitored during operations and maintained as necessary. After closure, the pipelines will be replaced with ditches. Reclamation of the ditches is addressed in the permit modification application and will be included in the revised Reclamation Plan for the mine. See also response to Comment 2(b).

DEQ Comment 2(b):

Please include an explanation about whether the pipeline would be replaced with surface ditches for post closure water management and explain the appropriate storm event return period for sizing the long-term feature(s) (see related comments).

MR Response to Comment 2(b):

Following mine closure, pipelines 1 and 2 will be replaced with drainage ditches designed for the final site grades.

Stormwater runoff rates are expected to decrease post closure due to regrading, capping and revegetation of disturbed areas. Drainage ditches and structures will be designed based on sizing recommendations of the Engineer of Record with concurrence of the IRP to ensure the long-term functionality of the surface water drainage system.

MR RESPONSES to DEQ JANUARY 3, 2022 PRELIMINARY REVIEW COMMENTS

DEQ Comment 2(c):

Although the HsB RDS and Seep 10 areas may eventually be covered by future expansion of the TSF (pending future agency approval), the interim Reclamation Plan presented with this application should consider a scenario where reclamation needs to be performed for the extent of the RDS at Stage 1 (or Stage 2) without future TSF expansion.

MR Response to Comment 2(c):

The application includes reclamation at Stage 1 conclusion.

DEQ Comment 3:

p. 42, Section 8.0: "It is envisaged that the HsB RDS will be constructed in two stages, with Stage 1 including a nominal crest elevation of EL. 5,900 ft and excludes rockfill placement within the central exclusion zone where existing site infrastructure is located. Stage 2 will extend beyond elevation EL. 5,900 ft and will infill the exclusion zone to cover the complete footprint of the HsB area."

DEQ Comment 3(a):

The permit modification application should be clear about which stage of RDS construction is being proposed at this time, to inform DEQ's scope of impacts evaluation. The "Stage 1 Drainage System Report" briefly mentions Stage 2, but it does not contain figures of the full extent of Stage 2, the incremental construction phases, or estimated timeline for the completion of each stage.

MR Response to Comment 3(a):

The permit modification application covers Stage 1.

MR RESPONSES to DEQ JANUARY 3, 2022 PRELIMINARY REVIEW COMMENTS

DEQ Comment 3(b):

The application should include details for the RDS for the applicable stage(s). Topics should include: the ground preparation/excavation necessary to tie-in existing seeps to the drain system, the phases and timeframe to construct the RDS, the timeframe to complete reclamation, the methods for grading final slopes, placement of capping material, revegetation, and runoff control measures (see comparable features in existing Plan).

MR Response to Comment 3(b):

Figure 2 of the HsB RDS permit modification application shows sequencing of Stage 1; three phases of the drainage system, and 2 phases of the RDS. As discussed with DEQ at a meeting on January 14, 2022, certain activities within the Precipitation Plant exempt area may occur without DEQ approval of a permit modification. These include activities related to water management including demolition, building removal, site grading, ditch, and pipe and drain installation. Placement of non-ore rock in the 5700- and 5900-foot lifts would occur after approval of the permit modification. Phases 1 through 3, which cover the drainage system design, would begin prior to mid-October 2022 as soon as site conditions allow, and would be completed prior to placement of rockfill. Placement of rockfill would begin after the drainage system has been completed, this permit modification is approved, and as non-ore rock is available, and would continue until the 5900 lift was finished.

Reclamation of Stage 1 is presented in the permit modification application and will be included in MR's Reclamation Plan. Post-closure topography is shown on Figure 3 in the permit modification application. Figure 4 shows locations of cross-sections and Figures 5 and 6 show cross-sections of the HsB RDS; these figures will be included in Appendix B to the Reclamation Plan.

MR RESPONSES to DEQ JANUARY 3, 2022 PRELIMINARY REVIEW COMMENTS

DEQ Comment 3(c):

Although the HSB RDS may eventually be covered by future expansion of the TSF (pending future agency approval), the interim Reclamation Plan presented with this application should consider a scenario where reclamation needs to be performed for the extent of the RDS at Stage 1 (or Stage 2) without future TSF expansion.

MR Response to Comment 3(c):

A reclamation plan for Stage 1 is presented in the permit modification application.

DEQ Comment 4:

p. 28, Section 5.2.2: "Estimated infiltration rates through the rockfill were developed for a 1 in 200-year, 24-hour storm event using the computer modelling program HydroCAD." "Conveyance of the infiltration and groundwater discharge will occur within the foundation drainage layer and engineered rock drains." "The lag time between rainfall occurring and infiltration reporting to the rock drains at the base of the RDS is uncertain and no site-specific data is available to constrain the estimate of this parameter at this time." "The actual time for precipitation to report to the rock drains will depend on the heterogenous flow paths through the rockfill material that will range in thickness up to approximately 250 ft thick."

Please include additional information that will assist DEQ with evaluating the drain capacities and potential impacts from large storm events over long-term, post closure conditions:

DEQ Comment 4(a):

Table 2.1 provides precipitation data for various return periods, from 2 to 1,000 years. Please explain the selection of the 1-in-200-year event for infiltration modeling instead of the 1-in-1,000- year event, with the understanding that the HSB RDS drains would be permanent features that convey infiltration and seepage over long-term, post closure conditions.

MR Response to Comment 4(a):

The 1 in 200-year event was determined to be appropriate given the multiple independent drainage systems and installed redundancy in consideration of the long-term design life. The Independent Review Panel (IRP) in their memorandum of December 17, 2021 reviewing the HsB RDS Stage 1 report (Attachment 3) stated (in part):

- The estimates of flow volumes that will enter the HsB area following construction of the RDS are based on sound assumptions, and the values reported appear reasonable.
- The overall design concept, incorporating six independent rock drains within the Stage 1 footprint, and the proposed construction sequence presented by KP, are considered by the IRP to be well suited to site conditions.
- A reasonable basis has been adopted for determination of the drain flow capacity requirement. The design is considered appropriately conservative. Redundancy has been incorporated in the design, given the long-term performance requirement following mine closure. The impact of a potential decline in drain conductance has been considered.

There are numerous conservative design criteria used to determine appropriate drain capacity (see Attachment 4 of the permit modification application). These conservatisms build on each other and are additive, and while each individual design parameter could be made more conservative, the overall design is sufficiently conservative. Specific to the design storm event, the consequence of experiencing a storm event exceeding the design storm event is specific to the life-cycle phase:

- Early during construction, the drains and ditches could be overwhelmed, and excess stormwater would be released to the Berkeley Pit;

- After Stage 1 construction but prior to reclamation, peak flows from stormwater infiltration into the RDS would be significantly attenuated through an average of 155 feet of rockfill and would be within the design capacity of the drains and drain blanket;

- In long-term closure, the reclamation cap and vegetation as well as rockfill attenuation would significantly reduce both stormwater infiltration and peak flows reporting to the drains and blanket drain. Additionally, seepage baseflow will be greatly reduced (from 4.5 MGD to 1.5 MGD) once the YDTI is closed and reclaimed.

DEQ Comment 4(b)

The drain sizing is described in terms of percentiles of flow measurements for the HSB Weir since 2000. This approach seems to be conservative regarding observed baseflow conditions, but the modeled infiltration rates from the 1-in-200-year event could exceed some drain capacities (see below). The HSB Weir monitoring record is one component of seepage forecasting, but if that is presented as the basis for the drain design, it may under-represent the capacities needed for infiltration from large storm events (vs. basing the drain designs directly on storm infiltration). Please provide context for the baseflow observations by identifying comparable storm events that have occurred since 2000, in terms of Table 2.1 return periods.

MR Response to Comment 4(b):

See response to Comment 4(a). The rock drains are designed to convey 9,000 gpm, which exceeds any flow measured at the HsB weir since 2000. Additionally, the design flow capacity for all six drains is approximately 17,000 gpm, which is more than five times greater than the current HsB area flow rates and over three times greater than the 98th percentile flow rate over the past 20 years. Placement of an average of 155 feet of rockfill in the HsB area will attenuate peak flows that have not previously been attenuated. The design also assumes that the foundation base layer (blanket drain) conveys no flow, however, MR has decided to place Pipestone Quarry rock in critical areas of the blanket drain to provide redundant additional drainage capacity in the foundation of the RDS.

Attachment 4 presents a sensitivity analysis of design variables. Additionally, the foundation drainage layer will provide a relatively permeable layer within the base of the RDS.

DEQ Comment 4(c)

There is uncertainty about the infiltration lag time, which is demonstrated to affect the potential flow rates in each drain segment. Table 5.1 shows that the 1-hr peak exceeds the design capacities for D1 (5,700 gpm vs. 4,500 gpm), D2 (4,800 gpm vs. 3,500 gpm), and D4 (1,700 gpm vs. 1,000 gpm). In contrast, all flow rates for the 2-hr peak are within the design capacities.

4(c)(i) What are the potential impacts of exceeding the drain designs for the 1-hr peak scenario?

MR Response to Comment 4(c)(i):

There are numerous conservative design criteria used to determine appropriate drain capacity. These conservatisms build on each other and are additive, and while each individual design parameter could be made more conservative, the overall design is sufficiently conservative. Specific to infiltration lag time, the consequence of experiencing peak flows exceeding the design flows is specific to the life-cycle phase:

- Early during construction, the drains and ditches could be overwhelmed, and excess stormwater would be released to the Berkeley Pit;
- After Stage 1 construction but prior to reclamation, peak flows from stormwater infiltration into the RDS would be significantly attenuated through an average of 155 feet of rockfill and would be within the design capacity of the drains and drain blanket;
- In long-term closure, the reclamation cap and vegetation as well as rockfill attenuation would significantly reduce both stormwater infiltration and peak flows reporting to the drains and blanket drain. Additionally, seepage baseflow is also greatly reduced (from 4.5 MGD to 1.5 MGD) once the YDTI is closed and reclaimed.

4(c)(ii) This capacity evaluation seems to consider the infiltration volume from a given storm event, but not necessarily the underlying baseflow seepage through the HSB area. Please explain and quantify whether the drains are designed to convey infiltration from these storm events in addition to simultaneous/continuous baseflow.

MR Response to Comment 4(c)(ii):

Flows measured at the HSB Weir include both stormwater and base flow seepage. Flow measurements at the HSB Weir are a drain design parameter. Also, with the exception of early construction phases, peak flows to the drains will be reduced from past flow measurements at the HSB Weir via attenuation through thick rockfill and ultimately reclamation of the facility post closure.

The drainage system design includes infiltration, run-off, seepage from the YDTI, and groundwater discharge within the HsB area. See section 5.2.1 of Attachment 2. Table 2 of Attachment 4 presents historical flow rates for combined seepage and stormwater runoff.

MR RESPONSES to DEQ JANUARY 3, 2022 PRELIMINARY REVIEW COMMENTS

4(c)(iii) Please provide additional discussion about the likelihood for the drains to encounter the 1-hr peak flow rates and the rationale for not increasing the design capacity to contain those modeled flows. Is the 1-hr peak model overly conservative, and if so, what is a more realistic timeframe for infiltration to occur through the RDS?

MR Response to Comment 4(c)(iii):

Current flow monitoring at the HSB Weir likely reflects a 1-hr peak flow or less. During early construction phases, 1-hr attenuation is likely to occur, but a 1 in 200-year storm event is unlikely to occur during this short window of time. However, if the drains are overwhelmed, excess stormwater would report to the Berkeley Pit. As rockfill placed in the RDS becomes thicker over the drains, stormwater attenuation time will increase. Literature indicates that 155-feet thick rockfill would have an approximate 13-hr attenuation.

Table 1 of Attachment 4 presents the estimated 1-hour infiltration flow rate. Per footnote 3 on Table 1, flow rates decrease with increasing lift height.

4(c)(iv) Please explain how these modeled flow rates would change under the potential 1-in-1,000-year event and address the adequacy of the drain capacities under such conditions.

MR Response to Comment 4(c)(iv):

A 1-in-1000-year event is most likely to occur post closure when infiltration is significantly lower and flow attenuation through rockfill is maximized (i.e. post closure timeframe is perpetuity, while a 30-year mine life is a relatively short period of time). Table 1 of Attachment 4 presents flows that could be generated during a 1 in 1000-year flow storm event. The attachment also demonstrates that there are numerous conservatisms assumed in other design parameters. Finally, MR will use Pipestone Quarry rock in selected areas of the blanket drain to provide redundant drainage capacity.

4(c)(v) How might the infiltration rate assumptions change for a post closure, reclaimed RDS surface (graded and vegetated)?

MR Response to Comment 4(c)(v):

Infiltration rates on the reclaimed RDS surface should be substantially lower than on unreclaimed RDS surfaces due to evapotranspiration of vegetation. Further, attenuation of peak flow to the drains will be maximized after buildout of the RDS. These factors plus the conservatisms built into other drain design parameters, the significant reduction in base seepage flow rates post closure, as well as increased flow capacity in the blanket drain through the use of Pipestone Quarry rock in selected areas of the blanket drain, provide assurances that the drainage capacity in the foundation of the HSB RDS will be adequate during both active mine operations as well as post closure.

MR RESPONSES to DEQ JANUARY 3, 2022 PRELIMINARY REVIEW COMMENTS

DEQ Comment 4(d):

DEQ recognizes that the foundation drainage layer may provide additional drainage capacity below the drains and address some of the questions raised above. However, if flow through that layer is assumed to be a redundancy or contingency that contributes to the adequate drainage of the HSB area and embankment, then the layer's potential capacity should be quantified/estimated accordingly. Consideration should also be given to the timeframe that the rockfill could serve as a drainage layer before weathering and degradation may reduce transmissivity (see embankment fill properties).

MR Response to Comment 4(d):

The foundation drainage layer is intended to provide a relatively permeable layer within the base of the HsB RDS. The UF rock materials will be end dumped in a single lift up to a maximum height of 30 feet. Specifications for UF rock are presented on Drawing MR-C4511, Attachment 2.

UF rock will be sourced from the best available Continental Pit rock avoiding material known to degrade (based on visual observations at the shovel face). MR is evaluating pit-run rock to determine suitability for use in the foundation drainage layer.

MR has decided to use Pipestone Quarry rock in selected areas of the blanket drain to better ensure its ability to function as a redundant drainage system to the engineered drains. Where Continental Pit rock is used, a principle of "best available" Continental Pit rock will be utilized. Estimation of the drainage capacity of the blanket drain cannot be made until the grain size distribution of the blanket drain rock is known once it is placed.

ATTACHMENT 2

Horseshoe Bend Rock Disposal Site Stage 1 Drainage System Report (Knight Piesold Ltd December 6, 2021)

Prepared for
Montana Resources, LLP
600 Shields Avenue
Butte, Montana
USA, 59701

Prepared by
Knight Piésold Ltd.
Suite 1400 - 750 West Pender Street
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Canada, V6C 2T8

VA101-126/25-3

HORSESHOE BEND ROCK DISPOSAL SITE
STAGE 1 DRAINAGE SYSTEM REPORT

Rev	Description	Date
0	Issued in Final	December 6, 2021

Knight Piésold CONSULTING

Management System Certified by: bsi ISO 9001 ISO 14001 ISO 45001 CERTIFIED

EXECUTIVE SUMMARY

Montana Resources, LLP (MR) operates an open pit copper and molybdenum mine in Butte, Montana. MR has owned and operated the mine site since the mid-1980's and is currently mining the Continental Pit at a nominal concentrator throughput rate of approximately 45,000 tons per day.

Tailings from mine operations are stored in the Yankee Doodle Tailings Impoundment (YDTI). The YDTI is also an integral component of a current water treatment pilot project related to the Butte Mine Flooding Operable Unit (BMFOU) Superfund remedy. The current water surface elevation in the Berkeley Pit is being maintained by introducing Berkeley Pit water into the site water management systems and treatment and release of water from the YDTI. The YDTI supernatant pond provides residence time for water treatment objectives to be achieved prior to final polishing and release of effluent near the confluence of Blacktail and Silver Bow Creeks.

The YDTI was originally constructed in 1963 and the embankments have been continuously constructed to elevation (EL.) 6,400 ft using rockfill from the Berkeley Pit and the Continental Pit. The YDTI comprises a valley-fill style impoundment created by a continuous rockfill embankment. The current maximum embankment height is approximately 750 ft along the southern end of the impoundment upstream of the Horseshoe Bend (HsB) area. The HsB area contains water management infrastructure related to YDTI seepage collection and mine rock leach operations and miscellaneous mine buildings, including the precipitation plant, truck maintenance workshop, and truck wash facilities. With the exception of the mine suspension from 2000 to 2003, drainage collected in the HsB area has been treated and incorporated into the YDTI under the BMFOU remedy since 1996 and will require long-term care following cessation of mine operations.

An amendment to the operating permit was approved in August 2019 to allow for continued use of the YDTI. The long range mine plan indicates that approximately 160 million tons of rockfill will be produced during mining between 2023 and approximately 2031 following construction of the EL. 6,450 ft embankment lift. Selective and strategic use of excess rockfill generated during mining of the Continental Pit to enhance embankment stability was identified as an opportunity during a risk assessment of the YDTI (KP, 2018a). The HsB area was selected as a priority rock disposal site (RDS) location, as it will provide substantial benefit to the tailings facility from an embankment stability and reclamation perspective while also providing economically viable storage for a large volume of rockfill.

The HsB RDS will be constructed in two stages, with Stage 1 including a nominal crest elevation (EL.) at 5,900 ft and excludes rockfill placement within the central exclusion zone where existing site infrastructure is located. Stage 2 extends beyond EL. 5,900 ft and will infill the exclusion zone to cover the complete footprint of the HsB area.

This report presents the details of the Stage 1 Drainage System underlying the planned HsB RDS. The principal design objectives for the drainage system described in this report are to manage surface water runoff in the HsB area and groundwater discharge within the foundation of the RDS during mine operations and in the long-term following closure. Water will continue to be collected and conveyed to the HsB Pond in a manner that limits impacts to the existing water management infrastructure including the HsB Weir and facilities downstream of the HsB Pond, consistent with the BMFOU remedy.

The design includes a foundation drainage layer and a network of independent engineered rockfill drains and surface water diversion ditches. The network conveys flows to the HsB Pond to tie in with the broader site water management system.

The foundation drainage layer will be formed across the ground surface once existing infrastructure has been removed from the Stage 1 footprint and the ponds have been drained down. The rockfill drains will then be formed within and above the foundation drainage layer and will discharge into surface water ditches and ultimately the HsB Pond. The inclusion of multiple independent drainage systems provides redundancy, improving the HsB area water management system in consideration of the long-term design life.

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TABLES

FIGURES

APPENDICES

ABBREVIATIONS

ACC	Anaconda Copper Company
AR	Atlantic Richfield Company
BMFOU	Butte Mine Flooding Operable Unit
BPPS	Berkeley Pit Pumping System
BQM	Butte Quartz Monzonite
CMP	Construction Management Plan
DBR	Design Basis Report
EL	Elevation
EOR	Engineer of Record
ft	feet
GPM	gallons per minute
GPS	Global Positioning System
HsB	Horseshoe Bend
HsB CS	Horseshoe Bend Capture System
HsB WTP	Horseshoe Bend Water Treatment Plant
in	inches
KP	Knight Piésold Ltd.
L.A.	Los Angeles
MCA	Montana Code Annotated
MDEQ	Montana Department of Environmental Quality
MR	Montana Resources, LLP
QPP	Quantitative Performance Parameter
RDS	Rock Disposal Site
RMS	Remote Monitoring System
SI	Site Investigation
TAC	The Anaconda Company
TSF	Tailings Storage Facility
WED	West Embankment Drain
WTP	Water Treatment Plant
YDTI	Yankee Doodle Tailings Impoundment
XRD	X-Ray Diffraction

1.0 INTRODUCTION

1.1 PROJECT OVERVIEW

Montana Resources, LLP (MR) operates an open pit copper and molybdenum mine in Butte, Montana. MR has owned and operated the mine site since the mid-1980's and is currently mining the Continental Pit at a nominal concentrator throughput rate of approximately 45,000 tons per day. The property was acquired from Atlantic Richfield Company (AR) and the former Anaconda Copper Company (ACC) who had previously mined the Berkeley Pit since 1955.

Tailings from mine operations are stored in the Yankee Doodle Tailings Impoundment (YDTI). The YDTI is also an integral component of a current water treatment pilot project related to the Butte Mine Flooding Operable Unit (BMFOU) Superfund remedy. The current water surface elevation in the Berkeley Pit is being maintained by introducing Berkeley Pit water into the site water management systems and treatment and release of water from the YDTI. The YDTI supernatant pond provides residence time for water treatment objectives to be achieved prior to final polishing and release of effluent near the confluence of Blacktail and Silver Bow Creeks.

The YDTI was originally constructed in 1963 and the embankments have been continuously constructed to elevation (EL.) 6,400 ft using rockfill from the Berkeley Pit (until 1982) and the Continental Pit (beginning in approximately 1986 by MR after earlier initiation by AR/ACC). The YDTI comprises a valley-fill style impoundment created by a continuous rockfill embankment that for descriptive purposes is divided into three embankment sections: the North-South Embankment, East-West Embankment and West Embankment. The current maximum embankment height is approximately 750 ft along the southern end of the impoundment upstream of the Horseshoe Bend (HsB) area. The HsB area is shaped like an inverted 'U', bounded to both the east and west by historically leached mine rock and to the north by the East-West Embankment.

The HsB area contains water management infrastructure related to YDTI seepage collection and mine rock leach operations and miscellaneous mine buildings, including the precipitation plant, truck maintenance workshop, and truck wash facilities. With the exception of the mine suspension from 2000 to 2003, drainage collected in the HsB area has been treated and incorporated into the YDTI under the BMFOU remedy since 1996 and will require long-term care following cessation of mine operations. A general arrangement of the mine area is shown on Figure 1.1.

Other key components of the MR mine site include:

- Continental Pit
- Mill and processing facilities
- Leach facilities
- HsB Capture System (HsB CS)
- Berkeley Pit Pumping System (BPPS)
- HsB Water Treatment Plant (HsB WTP)

Knight Piésold Ltd. (KP) has provided engineering services for the YDTI in support of on-going mining operations since 2015. The Engineer of Record (EOR) for the YDTI is currently Mr. Daniel Fontaine, P.E. of KP, who accepted the role in September 2021. Mr. Ken Brouwer, P.E. of KP had previously held the role of EOR since September 2015. The EOR's responsibilities include reviewing designs and documents pertaining to the tailings storage facility (TSF), and certifying and sealing designs or other documents pertaining to the TSF.

Except to the extent of the YDTI's use as a remediation structure for BMFOU, the jurisdiction for the YDTI resides with the Montana Department of Environmental Quality (MDEQ). MR currently holds one MDEQ operating permit.

NOTES:

1. COORDINATE SYSTEM AND ELEVATIONS ARE BASED ON ANACONDA MINE GRID.
2. AERIAL IMAGERY FROM JULY 29, 2021 PROVIDED BY MONTANA RESOURCES, LLP.

SCALE A: 1500 0 1500 3000 4500 6000 7500 ft

MONTANA RESOURCES, LLP

YANKEE DOODLE TAILINGS IMPOUNDMENT

GENERAL ARRANGEMENT

Knight Piésold CONSULTING

P/A NO.	REF NO.
VA101-126/25	3

FIGURE 1.1 REV 0

REV	DATE	DESCRIPTION	DESIGNED	DRAWN	REVIEWED
0	03DEC'21	ISSUED WITH REPORT	KAB	RMM	DDF

SAVED: M:\1\01\00126\25\A\Acad\FIGS\A15, 12/2/2021 10:23:14 AM , RMCLELLAN PRINTED: 12/3/2021 12:42:58 PM, FIG 1.1, RMCLELLAN
XREF FILE(S): 5ft_01_2019-11-12; 5ft_01_2019; 5ft_01_2021-07-29 IMAGE FILE(S): 5ft_01_2018 5ft_01 2021-07-29

1.2 BACKGROUND

An amendment to the operating permit was approved in August 2019 to allow for continued use of the YDTI, which will be facilitated by continued construction of the embankment to a crest elevation of 6,450 ft and operation of the West Embankment Drain (WED). The final permit was issued in early 2020. Construction of the EL. 6,450 ft lift of the embankment is underway and expected to be complete in late 2022.

The long range mine plan indicates that approximately 160 million tons of rockfill will be released during mining between 2023 and approximately 2031 following construction of the EL. 6,450 ft embankment lift. The rockfill release schedule between 2023 and 2031 is being evaluated while considering the potential future embankment construction needs and opportunities for selective and strategic placement of rockfill to further improve embankment stability and support reclamation objectives (KP, 2021a). Selective and strategic use of excess rockfill generated during mining of the Continental Pit to enhance embankment stability was identified as an opportunity during a risk assessment of the YDTI (KP, 2018a). The HsB area was selected as a priority rock disposal site (RDS) location, as it will provide substantial benefit to the tailings facility from an embankment stability and reclamation perspective while also providing economically viable storage for a large volume of rockfill.

Rockfill placement within the HsB RDS will be undertaken as rockfill material becomes available from the Continental Pit. Two stages of RDS development are contemplated as follows:

- The Stage 1 footprint includes the area directly adjacent to the YDTI embankments, rockfill leaching operations, and mine haul ramp (the 7% ramp), but excludes rockfill placement within the central zone of the HsB area where the truck maintenance workshop and other select mine facilities will be preserved during initial development of the RDS.
- The Stage 2 footprint will infill this exclusion zone to cover the complete footprint of the HsB area and will tie into the Stage 1 RDS to form the ultimate HsB RDS.

The HsB area currently includes miscellaneous water management infrastructure for flows reporting to the area from the YDTI, adjacent leach pads, and water pumped from the Berkeley Pit. Flows reporting to the HsB area are primarily monitored by a weir (the HsB Weir) located at the southern end of the HsB Pond and in-line flowmeters at the HsB CS pump houses and/or HsB WTP. Water management within the HsB area is influenced by Superfund remedial action requirements associated with the BMFOU.

1.3 SCOPE OF REPORT

This report presents the design of the Stage 1 Drainage System underlying the planned HsB RDS. The HsB RDS will be developed as rockfill material becomes available from the Continental Pit as part of the fundamental objective for on-going continuous improvement of the safety of the YDTI. The drainage system design was developed for the conceptual Stage 1 RDS footprint described in the previous section while considering future modification associated with the ultimate Stage 2 RDS footprint.

The drainage system for the HsB RDS will comprise a pit-run foundation drainage layer and a network of engineered rock drains and surface water diversion ditches. The drainage measures were designed to convey flows within the HsB area to the HsB Pond with flow measurement continuing at the HsB Weir. This report presents the following:

- Review of the existing infrastructure and water management systems
- The history of the HsB area, and summary of geotechnical and hydrogeological conditions

- An overview of the HsB RDS general concept
- Design basis criteria for the Stage 1 Drainage System
- Foundation preparation requirements, including general specifications for infrastructure decommissioning and surface grading considerations
- Design of the engineered rock drains and surface water collection ditches
- Estimated material quantities required for construction

The design drawings are included in Appendix A. The design basis, outlining the basic criteria for the design and construction of the works, is included as Appendix B. Details related to the sizing of the rock drains are included in Appendix C.

1.4 OVERALL OBJECTIVE

The principal design objectives for the drainage system described in this report are to manage surface water runoff in the HsB area and groundwater discharge within the foundation of the RDS during mine operations and in the long-term following closure. Consistent with BMFOU remedy, water will continue to be collected and conveyed to the HsB Pond in a manner that limits impacts to the existing water management infrastructure downstream of the HsB Pond (e.g. the HsB CS and HsB WTP). The design of the drainage system components has taken into consideration the following requirements:

- Control, collect, and convey infiltration and groundwater discharge within the foundation drainage system to surface water ditches and/or the HsB Pond.
- Control and collect any surface water runoff from the Stage 1 RDS.
- The inclusion of multiple independent drainage systems and installed redundancy to improve the HsB area water management systems in consideration of the long-term design life.
- Staged development of the HsB RDS over the remaining mine life and progressive enhancement of reclamation potential in the HsB area.
- The inclusion of monitoring features to confirm performance goals are achieved and design criteria and assumptions are met.

2.0 REFERENCE DATA

2.1 COORDINATE SYSTEMS

The design of the YDTI references the site coordinate system known as the 'Anaconda Mine Grid' established by The Anaconda Company (TAC) in 1957. The Anaconda Mine Grid is based on the ACC Datum established in 1915. All elevations are stated in Anaconda Mine Grid coordinates with respect to the ACC Vertical Datum unless specifically indicated otherwise. The Montana Resources GPS Site Coordinate System is based on the 'Anaconda Mine Grid' and utilizes International Feet (ft).

2.2 CLIMATE DATA

Climate data have been collected at the site climate station near the YDTI since 2014. Long-term climate and snowpack records are available from regional stations from 1895 to 2020. Climate information for the YDTI area is presented in the standalone Climate Conditions Report (KP, 2021c).

The mean annual temperature at the YDTI is 41 °F. January is the coldest month with an average temperature of 22 °F and July is the hottest month with an average temperature of 64 °F. The average annual precipitation is approximately 16 inches (in). The snowmelt pattern is represented by approximately 44% rain and 56% snow with the majority of snowmelt occurring in April (70%), followed by May (20%) and March (10%). Estimates of extreme 24-hour precipitation events, including consideration for orographic effects and climate change, are shown in Table 2.1.

Table 2.1 Return Period 24-Hour Extreme Precipitation (KP, 2021c)

Return Period Frequency (Years)	2	5	10	25	50	100	200	1,000
YDTI adjusted (in.)	1.3	2.0	2.3	2.7	3.1	3.5	3.9	4.9

3.0 HORSESHOE BEND AREA CONDITIONS

3.1 HISTORICAL DEVELOPMENT ACTIVITIES

Relevant early development activities in the HsB area began pre-1900 with the construction of a so-called 'horseshoe bend' in the Northern Pacific Railway. Subsequently, a diversion channel was constructed to divert and channelize Silver Bow Creek flow around the historical mining and railroad assets and through the HsB area. The diversion channel is referred to as the historical Silver Bow Creek diversion. Historical mining activity within the Silver Bow Creek drainage at the time included several historical underground operations. Tailings from these operations were washed down several natural drainages and accumulated in the general vicinity of Silver Bow Creek to the north and south of the horseshoe bend in the Northern Pacific Railway as shown on Figure 3.1.

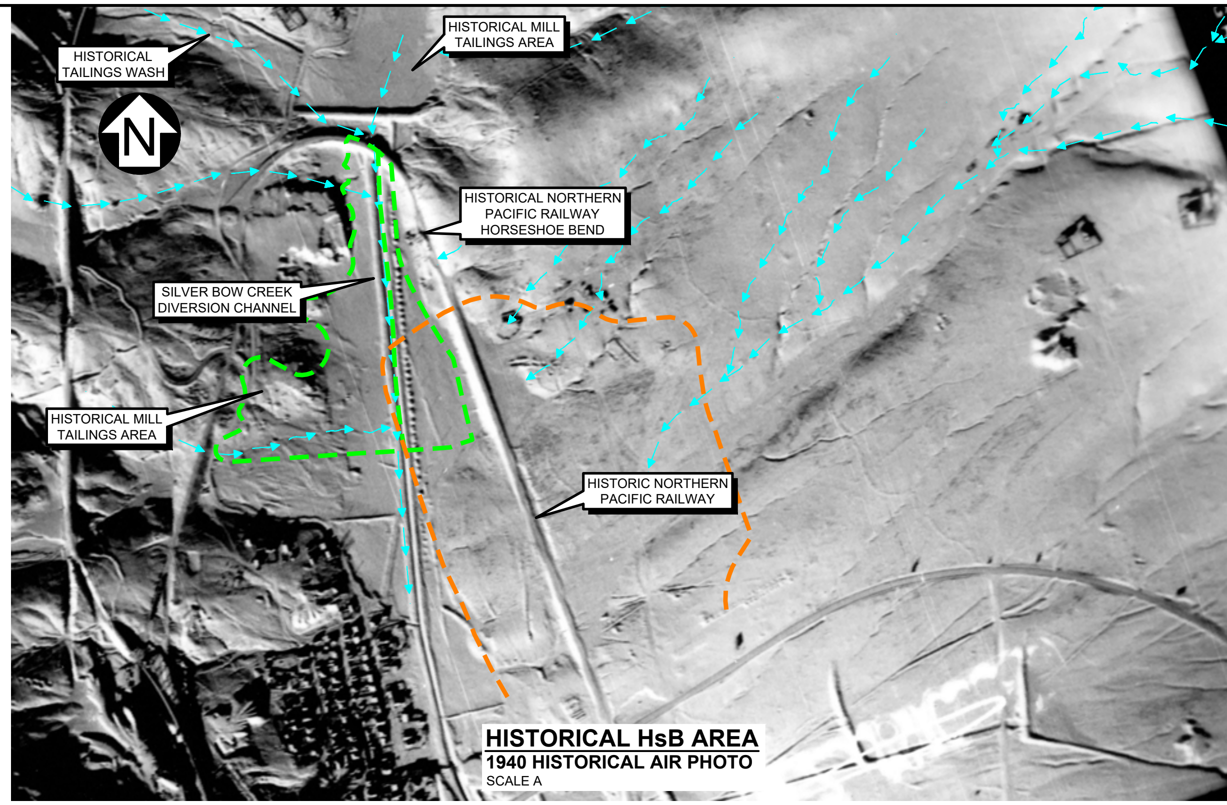
ACC and later AR began to develop infrastructure in the HsB area following the start of mining in the Berkeley Pit in 1955. A truck maintenance workshop was constructed on the hillslope east of the Silver Bow Creek diversion at the location shown on Figure 3.1. Leveling of the workshop pad was completed in 1956 using a cut-fill methodology whereby alluvium and residual soil materials were cut from the hillslope at the eastern side of the pad and used as fill to construct the western part of the pad. Surplus material was disposed in a pile located north of the current Precipitation Plant, referred to as the older alluvium soil stockpile. The infrastructure surrounding the truck maintenance workshop (e.g. rockfill dumps, water management ponds, etc.) was modified periodically resulting from on-going mine operations; however the truck maintenance workshop and other miscellaneous buildings remain in the same location as when they were constructed in the 1950s.

Initial construction of rockfill dumps that bound the HsB area to the north and west began in the early 1960s. The embankment that presently bounds the HsB area to the north of the Precipitation Plant was constructed beginning in approximately 1960 and overlies the historical Silver Bow Creek diversion channel. Historical progress maps indicate the diversion channel was replaced with a 6 ft diameter culvert prior to the rockfill dyke progressing across the channel (KP, 2020b). An upstream drainage trench connecting to the culvert was designed in 1963 (Dames and Moore, 1963) to convey surface water and groundwater through the culvert. The upstream drainage trench is now buried beneath the embankment. These drainage measures continue to contribute flows to the HsB area via the half-round, flat-bottom concrete culvert (also known as the Historical Drain).

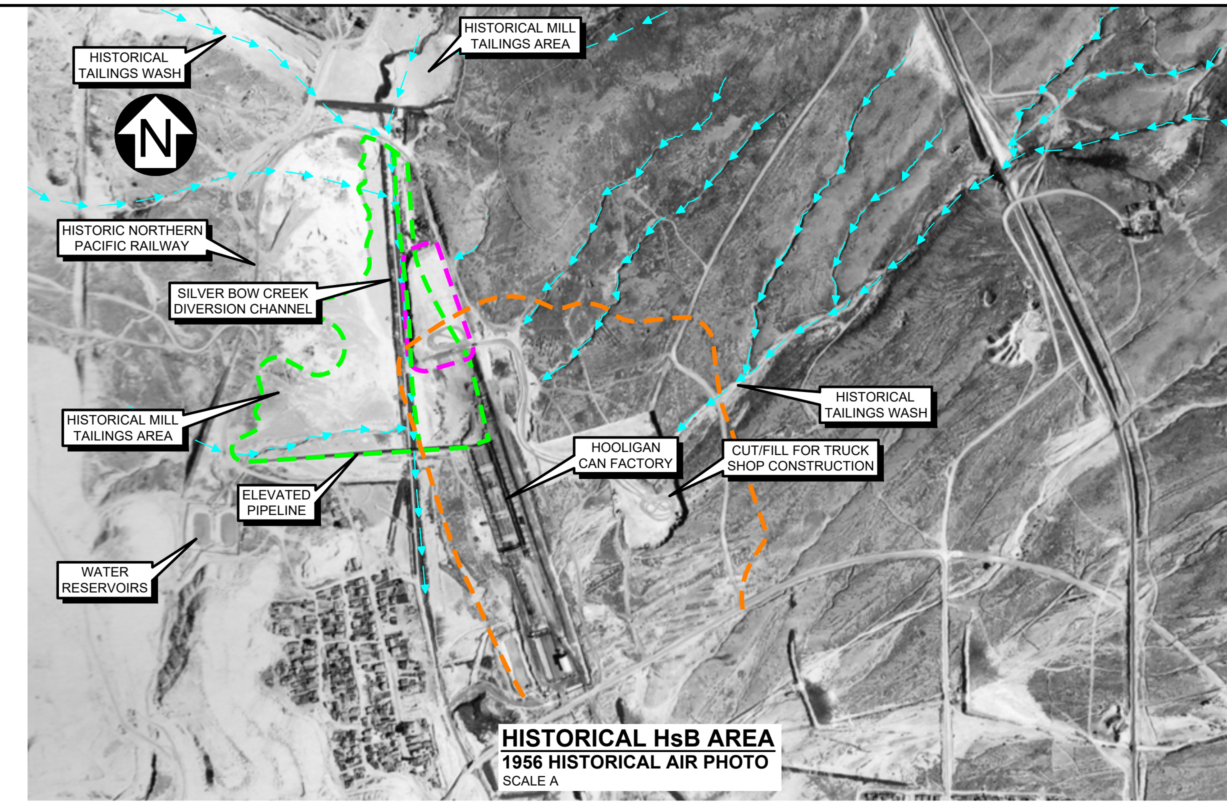
Additional embankment and leach dump construction was completed between the early 1960s and the mid-1970s on all sides of the HsB area. A large mine haul ramp was constructed on the west side of the HsB area by the mid-1970s. This ramp is currently referred to as the '7% ramp' and rises from the current HsB WTP nearly 300 ft to the top of the original downstream dyke (from 1962) buttressing the East-West Embankment in this area.

Berkeley Pit mine development continued with the construction of leach pads and leachate collection ponds along the east side of the HsB area and included the development of a Precipitation Plant to process pregnant leach solution. Construction of the leach pads adjacent to the HsB area to the east began between 1960 and 1964 and were further expanded between 1964 and 1970. The full constructed leach pad configuration is shown on Figure 1.1. Two ponds were constructed along the east side of the HsB area to collect lechate from the leach areas: the Surge Pond and the Holding Pond. The current Precipitation Plant was constructed in approximately 1970.

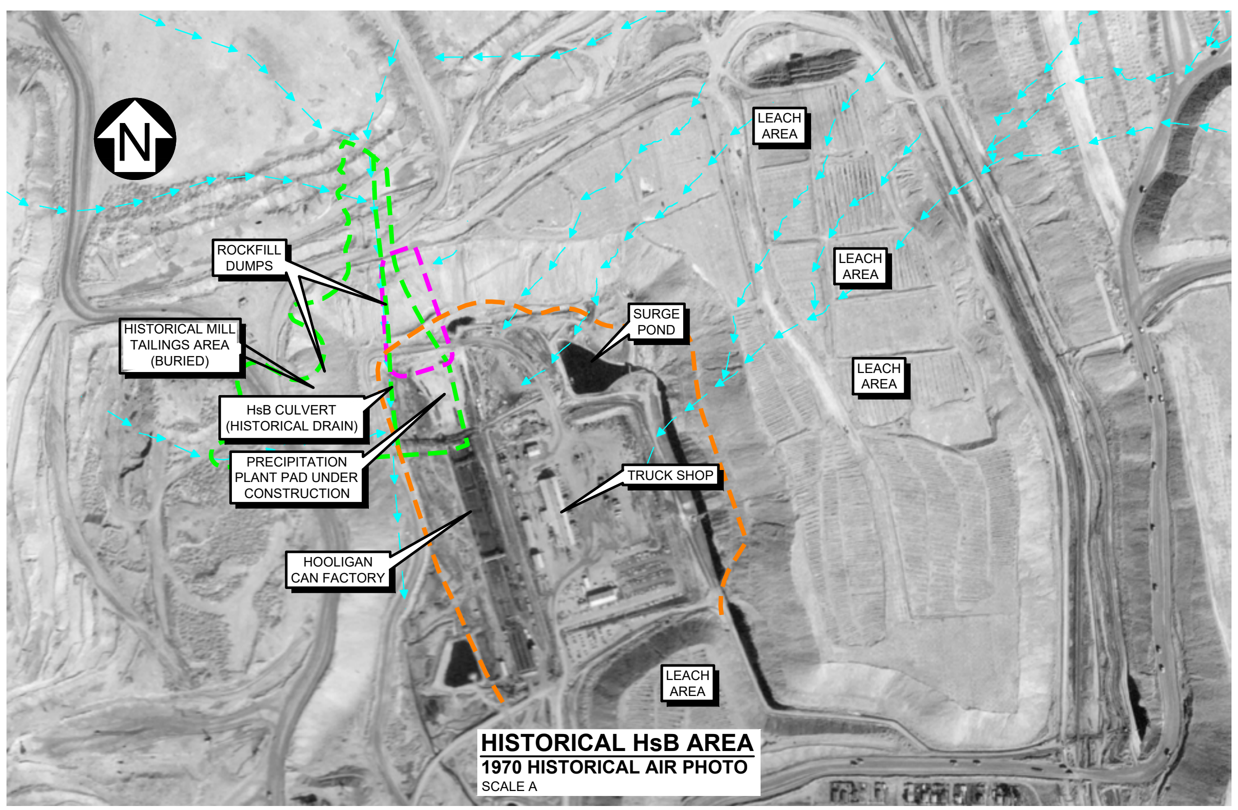
Minor development activities have taken place more recently within the HsB area including placement of local fill materials or excavation for roadways, drill sites, and other mine infrastructure development. The more recent development activities and the existing arrangement of the HsB area water management facilties are described in the sections that follow and are shown on Figure 3.2.



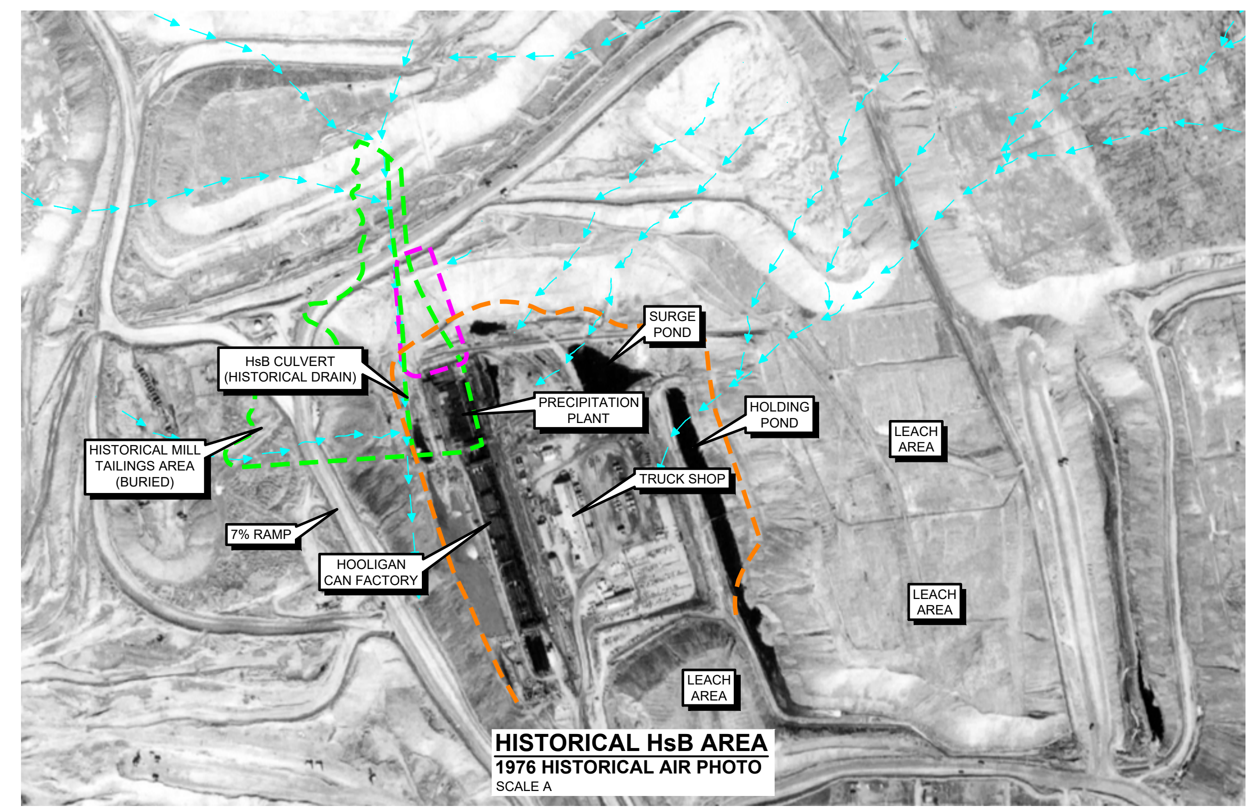
HISTORICAL HsB AREA
1940 HISTORICAL AIR PHOTO
SCALE A



HISTORICAL HsB AREA
1956 HISTORICAL AIR PHOTO
SCALE A



HISTORICAL HsB AREA
1970 HISTORICAL AIR PHOTO
SCALE A



HISTORICAL HsB AREA
1976 HISTORICAL AIR PHOTO
SCALE A

LEGEND:

- HISTORICAL DRAINAGE CHANNELS
- PERIMETER OF HORSESHOE BEND AREA
- HISTORICAL MILL TAILINGS EXTENT
- OLDER ALLUVIUM SOIL STOCKPILES

NOTES:

1. SPATIAL EXTENT OF THE HISTORICAL MILL TAILINGS IS INFERRED FROM REVIEW OF AVAILABLE HISTORICAL PHOTOGRAPHY.

SCALE A: 500 0 500 1000 1500 2000 2500 ft

MONTANA RESOURCES, LLP

YANKEE DOODLE TAILINGS IMPOUNDMENT

HORSESHOE BEND AREA
HISTORICAL AIR PHOTOS

Knight Piésold CONSULTING

P/A NO.	REF NO.
VA101-126/25	3

FIGURE 3.1 REV 0

REV	DATE	DESCRIPTION	DESIGNED	DRAWN	REVIEWED
0	03DEC'21	ISSUED WITH REPORT	KAB	RMM	DDF

LEGEND:

- × FLOW MEASUREMENT
- SEEPS
- PONDS
- EXISTING INFRASTRUCTURE
- BMFOU PUMPING INFRASTRUCTURE
- PIPED FLOW

SCALE A: 300 0 300 600 900 1200 1500 ft

MONTANA RESOURCES, LLP

YANKEE DOODLE TAILINGS IMPOUNDMENT

HORSESHOE BEND AREA
WATER MANAGEMENT FACILITIES

Knight Piésold CONSULTING

P/A NO.	REF NO.
VA101-126/25	3

FIGURE 3.2 REV 0

REV	DATE	DESCRIPTION	DESIGNED	DRAWN	REVIEWED
0	03DEC'21	ISSUED WITH REPORT	KAB	RMM	DDF

SAVED: M:\1\01\00126\25\A\Acad\FIGS\B82, 12/3/2021 2:50:17 PM , RMCLELLAN PRINTED: 12/3/2021 2:58:34 PM, FIG 3.2, RMCLELLAN ACAD VERSION: 23.0S (LMS TECH)

3.2 WATER MANAGEMENT FACILITIES

3.2.1 GENERAL

The HsB area receives runoff from the surrounding disturbed and undisturbed catchment areas, seepage from the YDTI, and drainage from the rockfill leaching areas. The seepage daylights as a number of small seeps at various locations along the downstream toe of the embankment and leach dumps. The flows are collected in surface drainage ditches that convey the water to either the upper HsB area or the Houligan Pond on the west and east sides of the Precipitation Plant, respectively. The current HsB area water management facilities are described below and shown on Figure 3.2.

3.2.2 LEACH OPERATIONS

Three ponds (the Holding Pond, Surge Pond and Houligan Pond) are located along the east and north sides of the HsB area to collect leach facility flows comprising pregnant leach solution and runoff and groundwater discharge resulting from precipitation on the leach areas. Leach flows were historically discharged from these ponds to the Precipitation Plant for processing.

During the historical leach operations, processed water was directed to the Precipitation Plant recirculation pumps, and barren leach solution was acidified and pumped back to the active leach areas. Flow greater than the capacity of the recirculation pumps was directed out of the system and into the HsB Pond via the Precipitation Plant overflow pipeline. This flow has been measured using a calibrated overflow weir plate with water level measurement (the Precipitation Weir) since February 2017; however, unmeasured flow bypasses also occurred due to the system arrangement.

Active leach solution recirculation was gradually reduced and subsequently terminated during 2021 to drain down the leach pads and reduce flows reporting to the HsB area in preparation for construction of the HsB RDS drainage system. An increase in flows reporting to the HsB Pond and measured at the HsB Weir was observed when compared to average flows from previous years. The increased flow corresponded to the reductions in leach solution recirculation but should reduce again to rates lower than pre-suspension rates once draindown of the leach pads is complete.

3.2.3 EMBANKMENT RUNOFF AND SEEPAGE SYSTEMS

Seepage migrates through the free-draining YDTI rockfill embankments and discharges at the toe of the downstream slope in the HsB area. Sources contributing to seepage from the YDTI include tailings slurry water (and HsB CS water) that percolates into the tailings beach, meteoric recharge to the tailings surface, and seepage from the supernatant pond. The seepage daylights as a number of small seeps at various locations along the embankment toe. The seepage flows and drainage from precipitation runoff and groundwater discharge are collected in surface drainage ditches that convey water to either the upper HsB area on the west side of the Precipitation Plant or the Houligan Pond as described above.

Several smaller seeps daylight above the main HsB Seep area, approximately 250 ft above the downstream toe of the embankment. These localized perched seepage flows, known as Number 10 Seep (Seep 10), have been attributed to a buried historical haul ramp. Seepage discharge at this location began in approximately 1989 and flow measurement began in 1991. An underdrain was installed in mid-2012 to capture the flows from Seep 10. Seepage flows are collected along the top of the EL. 5,900 ft lift and conveyed to a small surface pond before discharging into a pipe that conveys the flows to the HsB area on the west side of the Precipitation Plant. The Seep 10 flow rates were historically calculated using a calibrated v-notch weir and manual staff gauge readings near the weir at the outlet of the pond. An ultrasonic level sensor was installed to automatically measure the stilling pond level near the weir and connected to a remote monitoring system in 2019.

A portion of the HsB seeps and drainage collected in the upper HsB area is diverted to the Precipitation Plant via the #10 Cell Pump for processing. Once the water has been processed, it is discharged back into the HsB Pond with flow rates measured using a calibrated Parshall flume (Precipitation Flume). The records associated with this measured flow are not always reliable due to bypasses occurring near the #10 Cell Pump and sediment buildup affecting the flume measurements.

3.2.4 BERKELEY PIT PUMPING SYSTEM

A new water management strategy was implemented at the site in late September 2019 as part of a pilot project associated with the BMFOU of Superfund. This new water management strategy involves maintaining the current water surface elevation in the Berkeley Pit by introducing approximately 3 to 4 million gallons per day (MGPD) of Berkeley Pit water via the BPPS to the site water management system and treatment and release of up to 10 MGPD from the YDTI. The water is further treated at the AR Polishing Plant and the effluent is released near the confluence of Blacktail and Silver Bow Creeks. One goal of the pilot project is to progressively reduce the YDTI supernatant pond volume to approximately 15,000 to 20,000 acre-ft over the next several years.

Berkeley Pit water is pumped using the BPPS, consisting of a floating barge system and land-based pump house, to the Precipitation Plant. The flow is discharged from the Precipitation Plant in an HDPE pipeline and conveyed by pipeline along the west side of the HsB Pond to a small water transfer pond and pump located to the west of the HsB Weir. Leaks from the bulkhead at the Precipitation Plant where the discharge pipelines exit the plant have been observed intermittently resulting in some transfer of flow to the #10 Cell Pump area and ultimately to the HsB Pond.

Flow is pumped from this pond to either the HsB CS or HsB WTP (via the equalization basin or influent pump house). Flow rates are typically measured by an in-line flowmeter on the BPPS.

3.2.5 HORSESHOE BEND POND AND WEIR

Embankment runoff and seepage from the YDTI flows south through the HsB area and joins with the Precipitation Plant overflow discharge and localized surface water runoff in the HsB Pond. HsB Pond is a long, narrow basin approximately 100 ft wide and 2,000 ft long with a total footprint area of approximately 6 acres. Flow rates in the HsB area have been measured regularly since 1996 using a weir plate and level meter (HsB Weir) located at the southern end of the HsB Pond, which was established by the Montana Bureau of Mines and Geology (MBMG). The pond acts to attenuate incoming flows prior to discharging through the HsB Weir.

A diversion structure at the south end of HsB Pond after the HsB Weir diverts water by gravity to either the equalization basin or influent pump house and hence to either the HsB CS or HsB WTP. An overflow pipe near the diversion structure also allows for discharge of flows from this location to the Berkeley Pit. Water treated at the HsB WTP is typically routed to the Concentrator for incorporation into the tailings circuit and additional treatment at the YDTI. Water managed with the HsB CS is conveyed up the East-West Embankment along the 7% ramp using two pump houses. The HsB CS flows are metered into the tailings (which have additional lime to facilitate treatment of this water) at a manifold after the No. 3 (Tailings) Booster Pump House. The combined flow is discharged into the YDTI, and the supernatant pond provides residence time for water treatment objectives to be achieved.

3.3 HORSESHOE BEND AREA FLOWS

3.3.1 HSB WEIR

During MR operations, HsB flows were directed to the Berkeley Pit from approximately 1986 through early 1996 and were recycled directly to the YDTI between 1996 and 2000. Flows were again directed to the Berkeley Pit when MR operations were suspended between July 2000 and November 2003. The HsB WTP was commissioned in November 2003 to treat water recovered at the HsB that previously either flowed into the Berkeley Pit or was pumped back to the YDTI. HsB flows were typically routed to the HsB WTP between November 2003 and September 2019. Recently, the flows have been conveyed either to the HsB WTP or the HsB CS, depending on the operating arrangement associated with the pilot project.

The HsB Weir records are representative of total flows within the HsB area. The total flow rates include YDTI seepage, meteoric inputs from the contributing catchment areas, and any overflow from the leach circuit systems, which was historically dependent on operation of the barren leach solution recirculation pumps. A time series graph of historical daily flow rates recorded at the HsB Weir is provided on Figure 3.3 for the period between 2000 and 2020. This historical data set demonstrates the variations in observed daily flows as well as presenting the 30 day and 90 day moving averages. HsB flows reduced from approximately 3,000 gpm to approximately 1,200 gpm during a temporary period of suspended mine operations between years 2000 and 2003, which is inferred to be generally indicative of flow reductions that can be expected during early closure conditions.

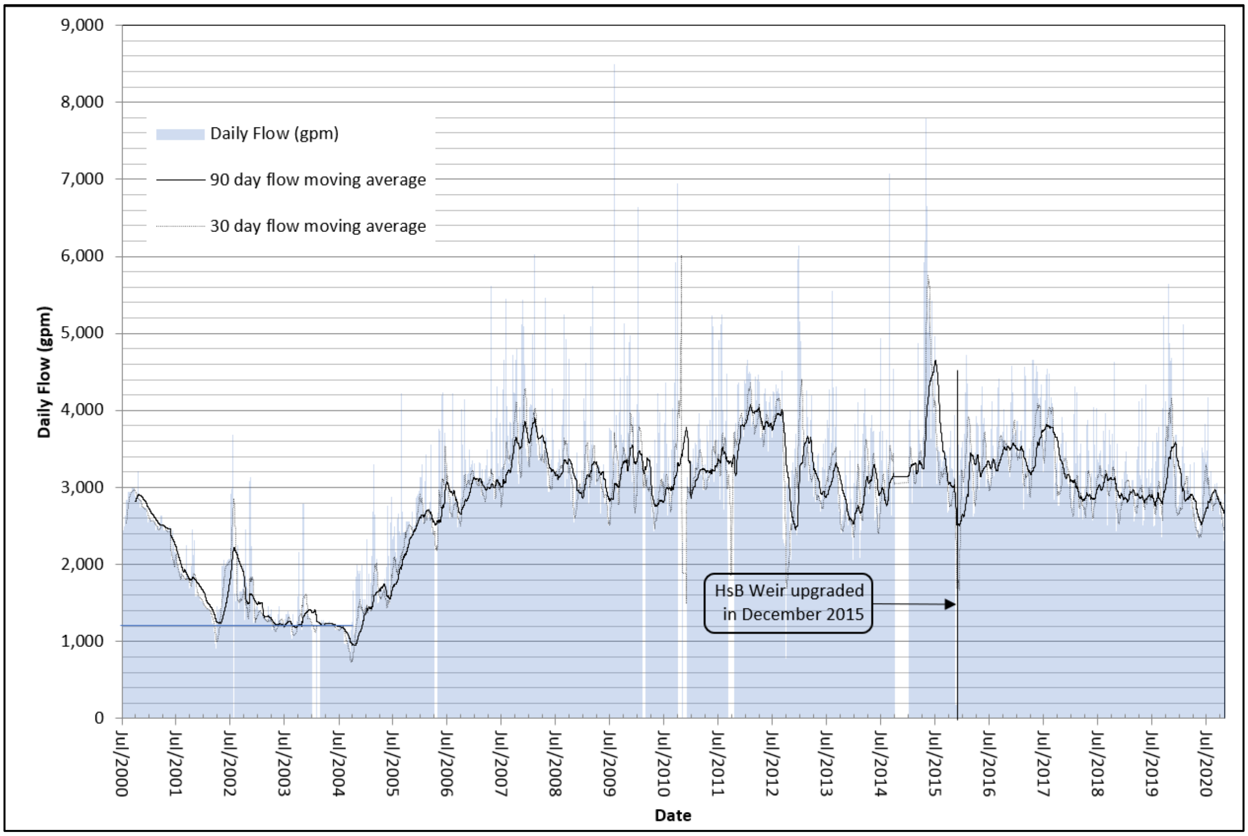


Figure 3.3 Time Series of HsB Weir Historical Flow Rates (2000 – 2020)

The data indicates a gradual reduction in HsB flows since approximately 2016. The monthly average flow rates measured at the HsB Weir from 2015 through 2020 are shown on Figure 3.4. The 2020 average annual flow rate was approximately 2,840 gpm (4.1 MGPD), which is similar to the 2019 annual average flow rate excluding the data affected by the commissioning of the BPPS.

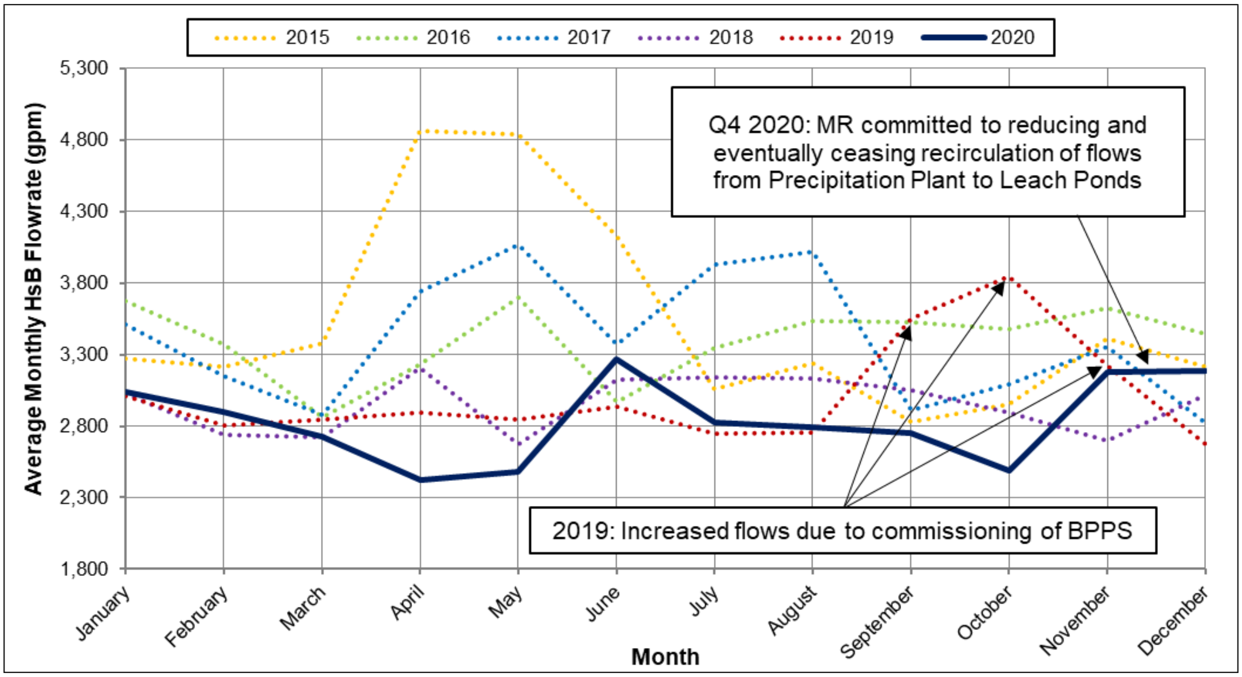


Figure 3.4 Monthly Average HsB Weir Flow Rates (2015 – 2020) (KP, 2021b)

A histogram and cumulative frequency plot of the HsB Weir daily flows between 2000 and 2020 is shown on Figure 3.5. These flow records will be used to inform the selection of rock drain design flow rates.

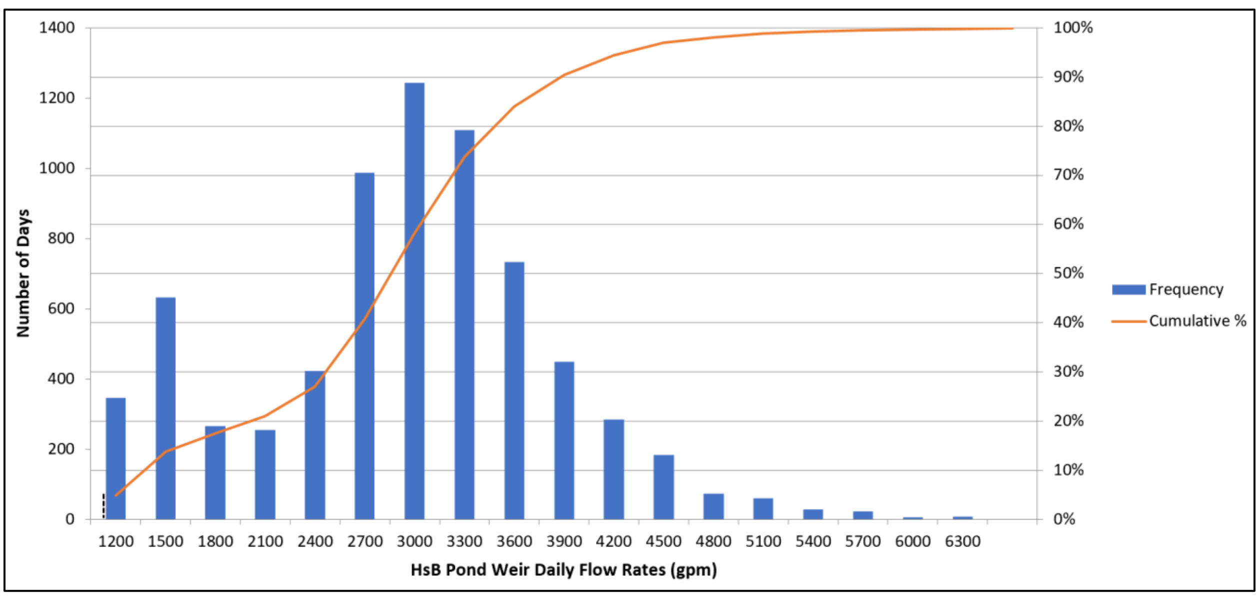


Figure 3.5 Histogram of HsB Weir Historical Flow Rates (2000 – 2020)

3.3.2 SEEP 10 WEIR

The Seep 10 monthly average flow rates from 2015 through 2020 are shown on Figure 3.6. The average annual seepage flow rates have generally been decreasing since July 2017, which is attributed to the transition from a single tailings discharge point to a multi-point discharge strategy at the YDTI. The annual (i.e. seasonal) trend of the Seep 10 flow rates has been similar since approximately 2018 when monitoring practices were modified to improve data collection accuracy. The seasonal trend generally includes lower flow rates during Q1 and Q4 and higher flow rates during Q2 and Q3. The trend is attributed primarily to meteoric recharge with increased flows during freshet and the onset of warmer temperatures and lower flows when precipitation primarily falls as snow. The flows at Seep 10 are expected to continue to follow this seasonal trend in the medium to long-term.

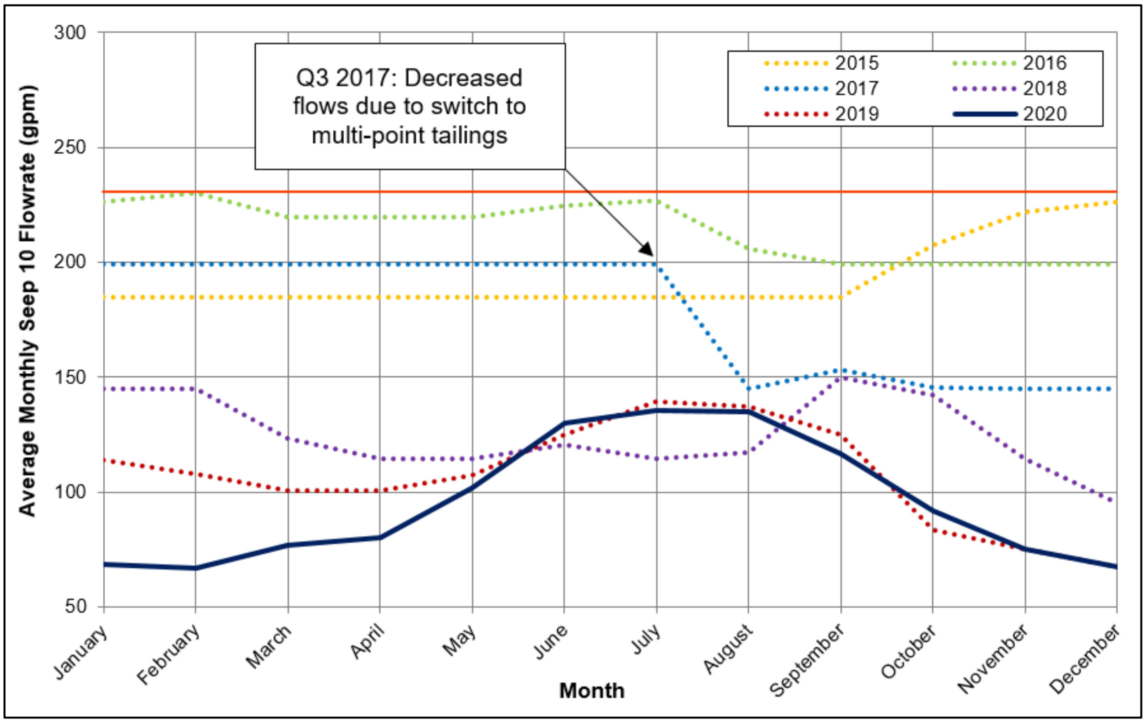


Figure 3.6 Monthly Average Seep 10 Flow Rates (KP, 2021b)

A histogram and cumulative frequency plot of daily flow rates measured at the Seep 10 Weir are presented on Figure 3.7 for the period from 2018 to 2020. Previous years have been excluded from the assessment as the data collection system was upgraded in 2018. The data indicates a 98th percentile flow rate of 165 gpm. This flow rate provides an indicator of the required minimum flow capacity for the surface water ditch and pipeline in this area and also informs the minimum required flow capacity for a rock drain, if required in the future, along the Seep 10 bench area. Further discussion of drain flow capacities is provided in Sections 5 and 6.

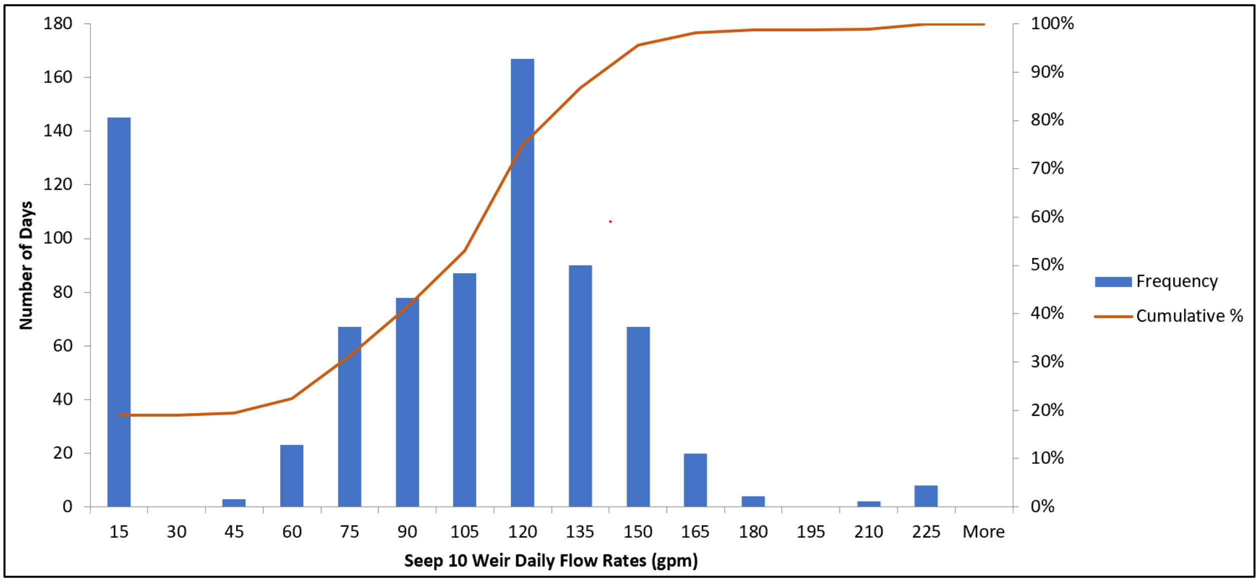


Figure 3.7 Seep 10 Weir Daily Flow Rates (2018 to 2020)

3.3.3 PRECIPITATION PLANT

A component of the total flows measured at the HsB Weir has been measured at the Precipitation Weir since February 2017, as described in Section 3.2.2. The flows measured at the Precipitation Weir are shown on Figure 3.8 along with the concurrent precipitation plant recirculation pump house flow records.

Active leach solution recirculation was gradually reduced and subsequently terminated in mid-July 2021 to drain down the leach pads and reduce flows reporting to the HsB area in preparation for construction of the HsB RDS drainage system. This resulted in increased flows at the Precipitation Weir and reduced flows through the recirculation pumphouse over a period of several months. Flows are now discharged directly to the HsB Pond via the overflow weir (Precipitation Wier); however, unmeasured flow bypasses also occurred due to the system arrangement. These flow bypasses are collected at the HsB Pond prior to measurement of the total flows at the HsB Weir.

The precipitation plant flow records indicate a maximum average monthly flow rate from the leach areas of approximately 5,000 gpm over the period of record and a steady-state average monthly flow rate of approximately 1,500 gpm since pregnant leach recirculation ceased. These flow records will inform the selection of rock drain design flow rates, as discussed further in Section 5.

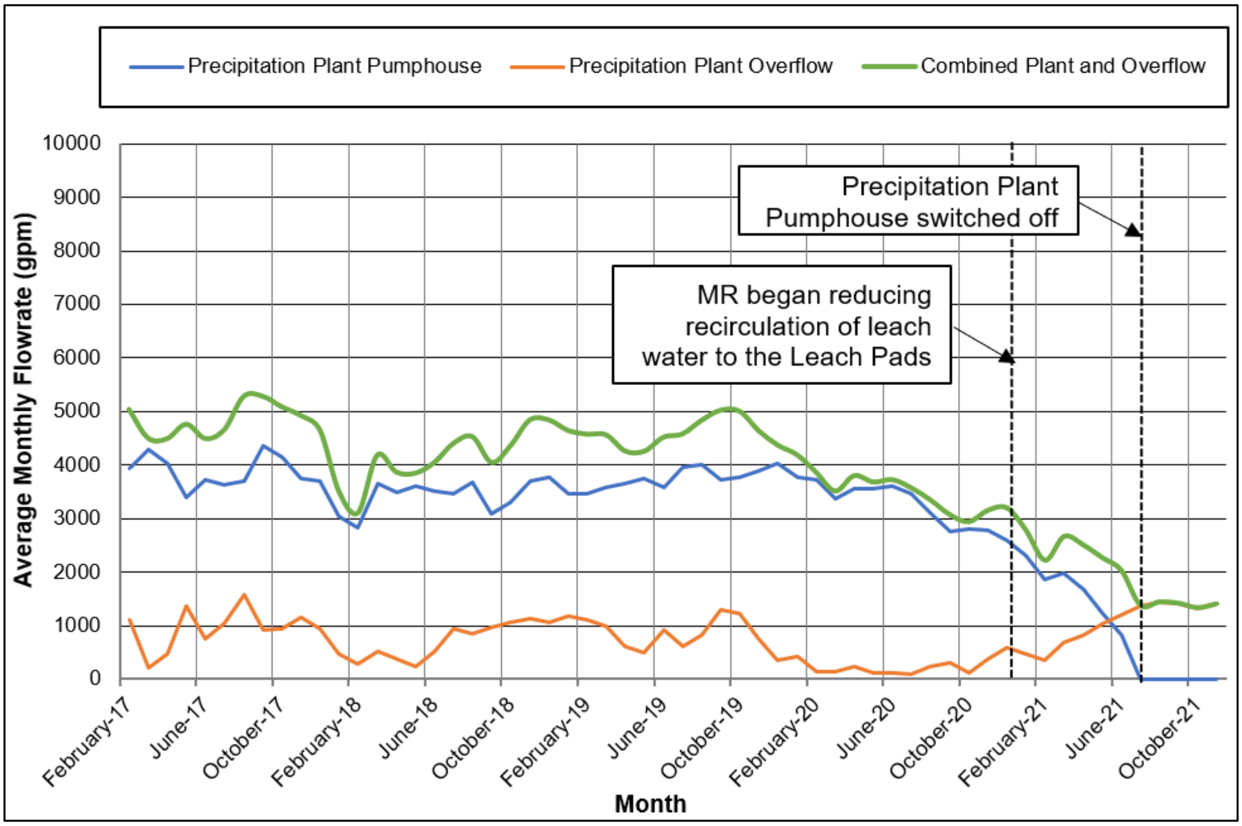


Figure 3.8 Precipitation Plant Flow Rates (2017 to 2021)

3.4 GEOTECHNICAL CONDITIONS

3.4.1 GENERAL

There have been several site investigation programs completed in the general vicinity of the HsB area and within the adjacent YDTI embankments. These investigations span over five decades as described in the Site Characterization Report (KP, 2017a); however, more recent reports have significantly expanded the knowledge base within and surrounding the HsB area (KP, 2018b; KP, 2019a; KP, 2019b; KP, 2020a; KP, 2020b; KP, 2021d). Two geotechnical site investigations (SI) programs were completed in the HsB area between 2018 and 2019. The SI programs were completed to characterize the nature and distribution of soil and bedrock materials within the HsB area. A detailed description of the investigation methods and results is provided in the SI reports, and a brief summary of the investigation methods used in the HsB area is provided below.

The 2018 SI program included drilling and geological logging of twelve (12) vertical drillholes. Drilling was completed using a track-mounted sonic drill rig capable of switching between sonic and rotary-coring drilling methods. Sonic drilling was performed within fill materials, overburden, and highly weathered bedrock. Rotary coring methods were used in competent bedrock. Samples from drilling were collected for laboratory testing. Vibrating wire piezometers (VWPs) were installed in saturated fill, natural soils, and bedrock to monitor pore pressure conditions within the subgrade materials in the HsB area. Surface seismic refraction and resistivity geophysical profiling was completed along nine section lines within the HsB area and along the YDTI embankment bench that bounds the HsB area to the north. Downhole seismic testing was completed within installations completed in two boreholes (KP, 2019b).

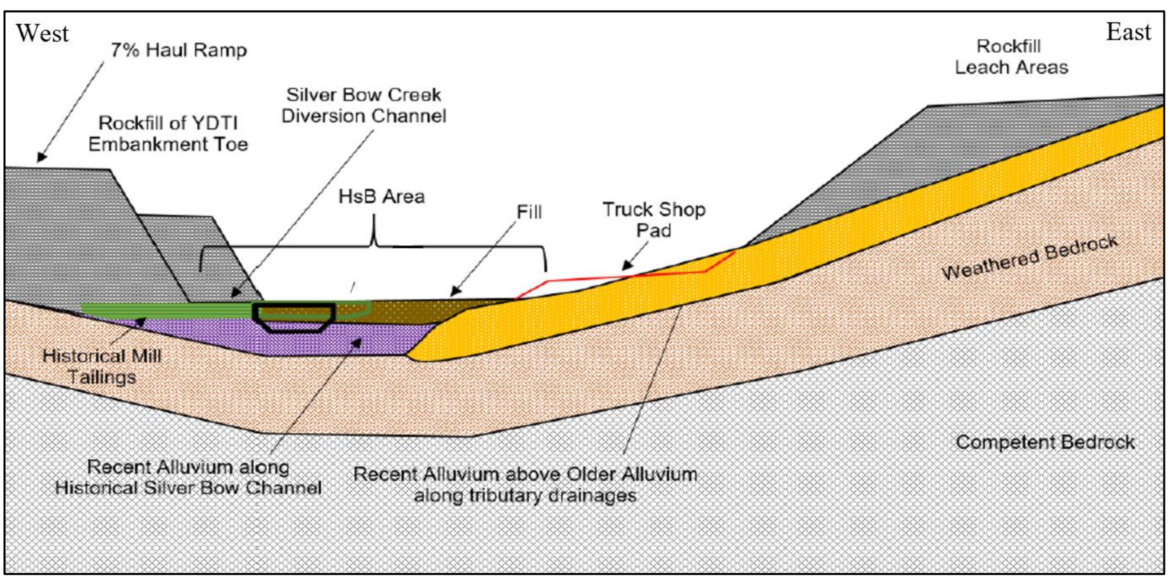
The 2019 SI program included sonic drilling, seismic cone penetration testing (SCPT), soil sampling, and laboratory testing. The investigation techniques were selected to further investigate the geotechnical and hydrogeological conditions in the HsB area and to evaluate the physical and behavioral characteristics of the soils encountered. Results of the SCPT facilitated assessment of in-situ material behavior for the various geological units encountered (KP, 2020b).

3.4.2 FOUNDATION MATERIALS

Geological materials encountered during the 2018 and 2019 HsB SI programs included miscellaneous fill materials derived from mine-run rockfill and natural soils (alluvium and residual soils) overlying alluvium soils (recent and older alluvium) and bedrock. The geotechnical conditions observed during the site investigation programs were generally consistent with preliminary expectations resulting from the review of the historical aerial images and photographs. A schematic of the conceptual geologic model for the HsB area along an east-west trending section (facing north) is shown on Figure 3.9.

The following material types were encountered during the investigations:

- Fill
- Historical Mill tailings
- Recent alluvium
- Older alluvium
- Weathered Butte Quartz Monzonite (BQM) bedrock
- Altered BQM bedrock
- Competent BQM bedrock



Note(s):

1. Copied from Figure 3.1 in the 2018 Horseshoe Bend Geotechnical Site Investigation Report (KP, 2019b).

Figure 3.9 Schematic of HsB Conceptual Geological Model (Looking North)

The near surface fill materials in the HsB area consist primarily of historical mine-run rockfill and natural soil derived fill materials. These fill materials are associated with progressive development of infrastructure within the HsB area between the late 1940s and mid-1970s and from embankment construction beginning in 1962. Fill materials are typically underlain by alluvium materials from two different sources. The weathering profile of the bedrock underlying the alluvium generally comprises completely to highly weathered bedrock nearer to surface, grading from moderately weathered to slightly weathered to fresh with depth.

The following is a high-level summary of material distribution and additional detail is presented in the site investigation reports (KP, 2019b; KP, 2020b):

- Fill materials were encountered throughout the HsB area to depths ranging from 4 to 58 feet below ground surface (ftbgs). Rockfill was encountered within the toe of the YDTI embankment along the northern and western perimeter of the HsB area. Miscellaneous mine-derived fill was encountered within the HsB area resulting from the area being used for local roads and other mine related infrastructure development.
- Older alluvium fill was encountered along a historical railroad alignment through the HsB area and stockpiled older alluvium materials were encountered beneath the embankment rockfill near the northwestern edge of the HsB area. Fill derived from unsuitable spoil material or slag from site grading prior to the mid-1950s is locally present north of the truck maintenance workshop pad and was used to infill topographic low points in the vicinity of the Houligan Pond (KP, 2019a). More degraded fill materials and natural soils are expected to be present in the vicinity of the existing ponds where water with low pH has likely accelerated weathering of the soils.
- Alluvium materials were encountered in all drillholes, and SCPT soundings indicate alluvium thicknesses ranging from 8 to 62 ft. Alluvial soils are inferred to be derived from two sources; older Quaternary alluvium originating as outwash from the topographic highs to the east of the HsB area and more recent alluvial material localized to the historical Silver Bow Creek and its tributary channels. Older alluvium is broadly present throughout the majority of the HsB area and generally contains higher gravel and coarse to medium sand than recent alluvial materials. Older alluvial materials generally also have a lower percentage (by weight) of fine sand and silt grain-sizes. Recent alluvium is present locally within the foundation along the western side of the Precipitation Plant approximately coincident with the location of the series of drainage channels and ponds that convey flows to the HsB Pond.
- Historical mill tailings were encountered in two drillholes and SCPT soundings along the western margin of HsB area at depths of 30 to 51 ft below the toe of the 7% haul ramp, which bounds the western side of the HsB area. This tailings material comprises sand, clay, and silt and corresponds to the area of historical mill tailings that was identified in aerial photographs, where tailings appear to have accumulated in the 1940s and 1950s from nearby small mining operations. The tailings deposits encountered ranged in thickness from 4 to 11 feet.
- Completely to highly weathered Butte Quartz Monzonite (BQM) bedrock is present underlying alluvial soils throughout the HsB area. Weathered bedrock typically resulted in refusal of SCPT; however, SCPT was successfully advanced into weathered bedrock in three of the twelve soundings. Weathered bedrock was encountered at depths ranging from 18 to 105 ftbgs. The bedrock generally becomes stronger with depth and weaker zones correspond with near surface weathering and deeper zones of alteration. Competent bedrock comprising light to medium grey, medium to coarse grained BQM is present throughout the HsB area at depth.

3.4.3 PIEZOMETRIC CONDITIONS

Pore pressures within the YDTI embankment, foundation materials and within the HsB area are actively monitored using an extensive network of piezometric monitoring instruments. Real-time piezometric data from these sites is available to MR and KP via a remote monitoring system (RMS), which was implemented during 2018. Piezometric monitoring is presently performed within standpipes, monitoring wells and vibrating wire piezometers (VWPs). Standpipe piezometers and monitoring wells were installed between the early 1990s and 2016 and were retrofitted with VWPs for continuous time-series monitoring beginning in 2018. Piezometric conditions and trends within the HsB area are presented in the annual data analysis report for the YDTI. The most recent analysis was completed with data through the end of 2020 (KP, 2021b).

The recorded pore pressure elevations with the HsB area are indicative of a relatively shallow phreatic surface that resides within near-surface fill, natural soil and weathered bedrock. The piezometric conditions are inferred to be largely controlled by conditions associated with water storage in the YDTI and at the Berkeley Pit, but are also affected by seasonal recharge, seepage from the YDTI, and leaching activities (when active). Flow gradients are predominantly horizontal with only slight vertical gradients observed. Measured piezometric elevations are generally highest near the YDTI embankment toe, at the northern extent of the HsB area and gradually decrease with distance towards the south. This trend indicates that the predominant groundwater flow direction is from north to south within the HsB area towards the Berkeley Pit, which acts as a regional groundwater low. The natural topography underlying and surrounding the HsB area also drives groundwater flow from the historical hillslopes around the HsB area towards the historical alignment of Silver Bow Creek. Relatively high piezometric elevations are observed to the east and gradually decrease westward towards the historical Silver Bow Creek alignment and the present-day location of the HsB Pond.

4.0 HSB RDS – STAGE 1 DRAINAGE SYSTEM

4.1 OVERVIEW

The HsB area was selected as a priority RDS location, as it will provide substantial benefit to the tailings facility from an embankment stability and reclamation perspective while also providing economically viable storage for a large volume of rockfill. The HsB RDS will buttress the central pedestal area of the YDTI, a 2,000 ft long section of the existing East-West and North-South Embankments. The embankment in this area is the highest embankment section at the YDTI, with a vertical height of up to approximately 800 ft from toe to crest where construction of the EL. 6,450 ft lift is underway. Development of the HsB RDS will be undertaken as rockfill material becomes available from the Continental Pit. The stability of the East-West Embankment will be progressively enhanced as rockfill is placed within the RDS by increasing the mass of rockfill placed along the toe of the embankment, reducing the overall slope angle in the maximum section of the embankment, and increasing the confining pressure within the foundation materials in the HsB area.

The drainage system beneath the RDS will manage surface water runoff and groundwater discharge during mine operations and in the long-term following closure. Water will continue to be collected and conveyed to the HsB Pond consistent with the currently effective and demonstrated strategy for managing water in the area.

The HsB RDS will be developed in two stages as follows:

<u>Stage 1</u>

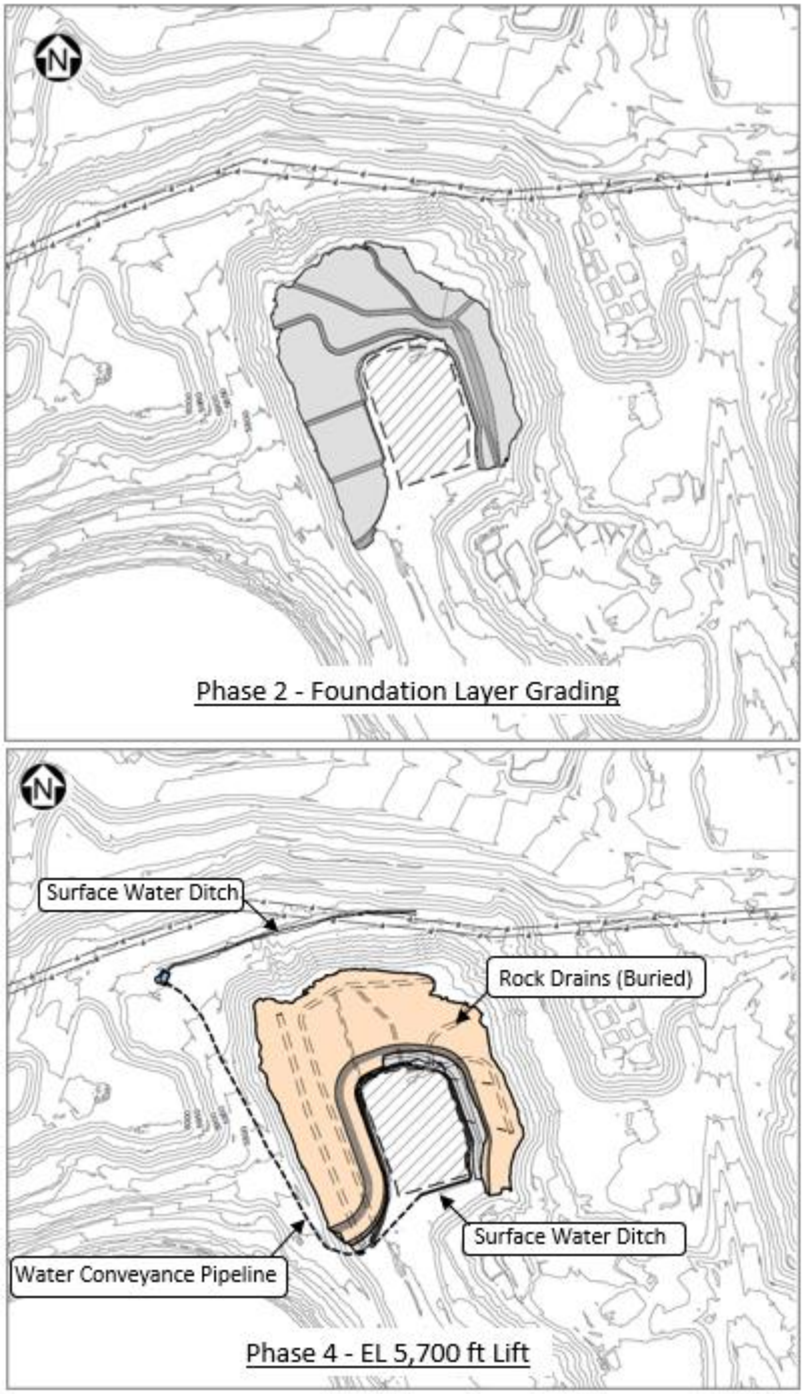
- Development of the Stage 1 Drainage System incorporating the following major activities:
  - foundation preparation, including salvage activities, draindown and breaching of water management ponds, demolition of existing infrastructure, and removal of debris and waste.
  - placement of a foundation drainage layer.
  - construction of engineered rock drains, surface water ditches, and water conveyance pipelines.
  - placement of the initial lift of rockfill up to approximately EL. 5,700 ft to cover the drainage systems and to form an initial RDS area that is ready to receive mine-run rockfill as material becomes available.
- The Stage 1 RDS footprint includes the area directly adjacent to the YDTI embankments, rockfill leaching operations, and mine haul ramp (the 7% ramp), but excludes rockfill placement within the central zone of the HsB area where the truck maintenance workshop and other select mine facilities will be preserved (described in this report as 'the exclusion zone') during initial development of the RDS. The top elevation of the conceptual Stage 1 RDS is approximately EL. 5,900 ft, which is currently limited by a high-voltage transmission lines that extends along the Seep 10 bench at this elevation.

<u>Stage 2</u>

- The Stage 2 footprint will infill the exclusion zone to cover the complete footprint of the HsB area and will tie into the Stage 1 RDS to form the ultimate HsB RDS. The RDS will also be raised along the downstream side of the East-West Embankment as rockfill becomes available to support this activity.

The general arrangements of the RDS following placement of the foundation drainage layer and following construction of the Stage 1 Drainage System, including rockfill placement up to EL 5,700 ft are shown on

Figure 4.1. The conceptual arrangements shown are indicative only as the final geometry and timing of RDS development is subject to material availability.



Note(s):

1. Copied from Phased Construction Sequence Presented on Drawing MR-C4515 in Appendix A.

Figure 4.1 HsB RDS Stage 1 RDS Construction Sequencing

4.2 FOUNDATION DRAINAGE LAYER

The foundation drainage layer at the base of the RDS is intended to provide a trafficable surface for construction equipment while providing a relatively permeable layer within the base of the HsB RDS. The 'UF' materials will be end dumped in a single lift up to a maximum of 30 ft thick, which will also encourage segregation of coarse material at the foundation interface. The layer will be founded on a combination of historically placed pit-run rockfill and miscellaneous fill material.

The foundation drainage layer, Zone UF, will be constructed with hard, durable, and relatively coarse rockfill material selectively sourced from the Continental Pit to satisfy the material specification requirements shown on the drawings. The 'UF' materials will be sourced from the best available rockfill material at the time. Pit materials known to more quickly degrade will be excluded based on visual observations at the shovel face. MR is also in the process of developing a three-dimensional geological model in Leapfrog to further refine the understanding of the spatial distribution of specific geologic units within the Continental Pit. This model may provide additional insight into material selection for Zone UF prior to construction.

The foundation layer grading plan uses a terraced arrangement that was designed to be progressively dumped in a counter-clockwise direction beginning at the southeastern corner of the HsB area. Rockfill placement in this manner will be used to displace any remaining water within the existing water management ponds downgradient to the north and then west. The terraces were arranged in 10 ft benches based on the underlying topography, maximum lift thickness, and the conceptual plan for the engineered rock drains. The terraces will provide a roughly graded surface constructed with mine equipment that will subsequently be modified with smaller equipment to form trenches to facilitate placement of the rock drain materials. The foundation layer grading can be adjusted to improve the rock drain cut and fill balance as required depending on the final drain profiles and construction methodology.

The thickness of the layer will depend on in-situ conditions once infrastructure has been demolished and removed and the existing ponds have been drained down and breached. The layer will be thicker in the footprints of the existing ponds to displace water and softer subgrade materials, compress the foundation materials, and provide a trafficable surface for drain construction.

4.3 DRAINAGE SYSTEM

The drainage system will convey seepage, groundwater and meteoric flows to locations downstream of the HsB RDS. The drainage system will include a series of engineered rock drains and two primary surface water ditches. The alignments of the rock drains were selected based on topography and the understanding of existing and estimated future HsB flow patterns. The rock drains are situated to manage present and anticipated future flows and to discharge into either the surface water ditches or directly into the HsB Pond. The surface water ditches will convey flows around the perimeter of the RDS either to the HsB Pond or into pipelines to convey the flows to the HsB Pond. The design basis criteria and design details for the rock drains and surface water ditches are described in subsequent sections of this report.

4.4 HORSESHOE BEND POND

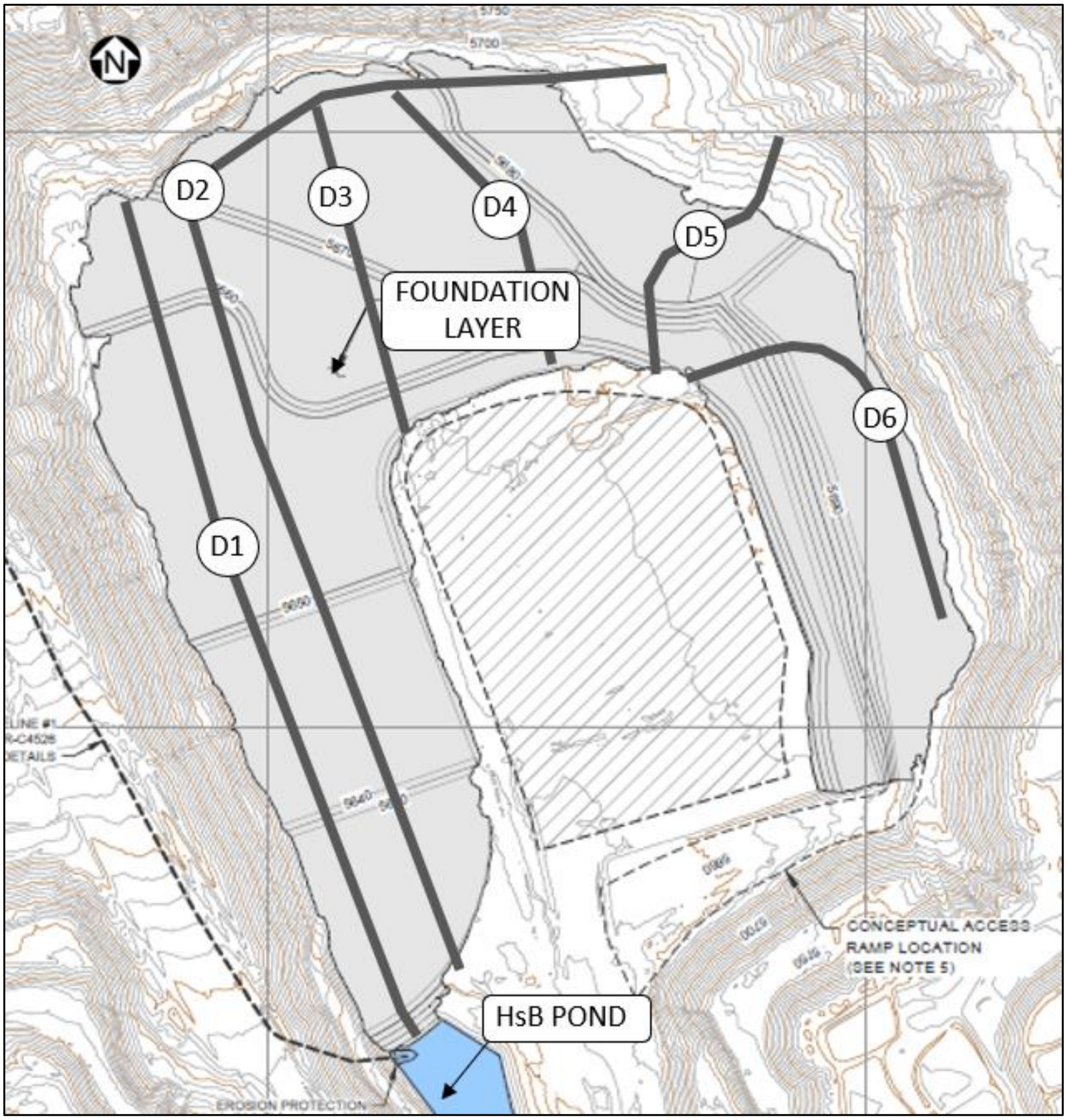
The drainage system discharges into the HsB Pond where flows will continue to be conveyed to the HsB Weir in a manner that limits impacts to the existing water management infrastructure. Construction of the drainage system across the upstream section of the HsB Pond will reduce the existing pond footprint area by approximately 50% to 2.8 acres. The flow length of the pond will also be reduced to approximately

1,000 ft. This size reduction will impact the ponds' ability to attenuate incoming flows and buffer peak storm events but is not expected to impact the water management systems downstream of the HsB Pond.

5.0 ROCK DRAIN DESIGN

5.1 OVERVIEW

The drainage system incorporates six independent engineered rock drains within the Stage 1 RDS footprint. Drain locations and alignments were selected based on the existing surface topography, foundation layer grading plan, and the understanding of the existing drainage pathways in the HsB area. The conceptual drain alignments are shown on Figure 5.1.



Note(s):

1. Modified from Drawing MR-C4514 in Appendix A.

Figure 5.1 Conceptual Rock Drain Alignments

Additional drains were included in critical areas of the drainage system to provide some drainage capacity overlap in consideration of the long-term design life. These installed redundancies include:

- Rock drain D1 and the portion of D2 running parallel approximately north to south on the western side of the HsB area
- Rock drains D3 and D4 running parallel approximately north to south in the central part of the HsB area from the downstream toe of the East-West Embankment

5.2 DESIGN CRITERIA AND INPUTS

5.2.1 DESIGN INFLOW SOURCES

The main sources of water to the drainage system will include infiltration of meteoric water, surface water run-off from upgradient slopes, seepage from the YDTI, and groundwater discharge within the HsB area. Percolation and drainage of water through the RDS was assumed to be non-capillary and relatively channelized for the purpose of sizing the rock drains at the base of the RDS. Some losses due to wetting of the rockfill and disturbed flow paths due to varying hydraulic conductivities through the RDS were also considered. Some groundwater recharge may occur as slight vertical downward gradients are present in the foundation materials; however, the overall regime of groundwater flow beneath the RDS is not expected to be significantly altered in the long-term after construction of the RDS.

A conceptual model for precipitation and seepage flow through the RDS is shown on Figure 5.2. The spatial distribution of drainage is expected to vary across the footprint area of the RDS. These variations may be attributed to a range of factors, including:

- Preferential infiltration within segregated coarser materials. This will occur within the RDS where rockfill will be placed in 25 ft to 50 ft thick lifts causing material segregation at the base of the lift. The coarser materials will form higher permeability zones at the toe of the tipping face.
- Reduced infiltration during the winter months due to snow cover and freezing of surficial rockfill material.

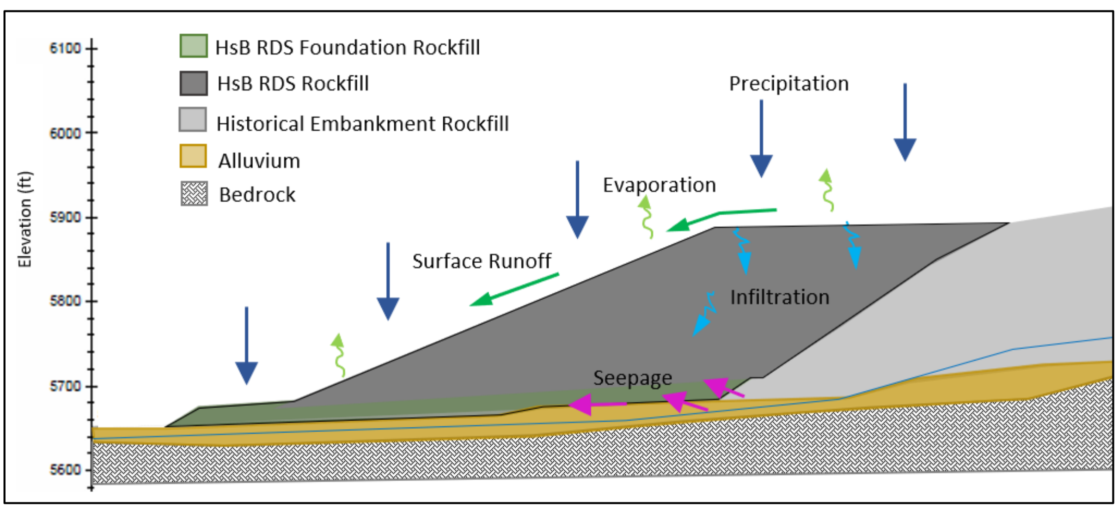


Figure 5.2 Conceptual Hydrogeological Model of the Rockfill Disposal Site

5.2.2 INFILTRATION AND DRAINAGE FLOW ESTIMATES

Estimated infiltration rates through the rockfill were developed for a 1 in 200-year, 24-hour storm event using the computer modelling program HydroCAD. A runoff coefficient (CN) value of 75 was adopted for the RDS rockfill surface, representing disturbed conditions and relatively permeable rockfill material. This value corresponds to approximately 75% of incident rainfall infiltrating into the rockfill surface. This CN value is consistent with the runoff coefficient used in the YDTI water balance model (KP, 2020c) for disturbed areas.

Conveyance of the infiltration and groundwater discharge will occur within the foundation drainage layer and engineered rock drains. Estimates of infiltration into rock drains were made using the catchment areas for each of the proposed rock drains shown on Figure 5.3 and estimated infiltration lag times. The lag time between rainfall occurring and infiltration reporting to the rock drains at the base of the RDS is uncertain and no site-specific data is available to constrain the estimate of this parameter at this time.

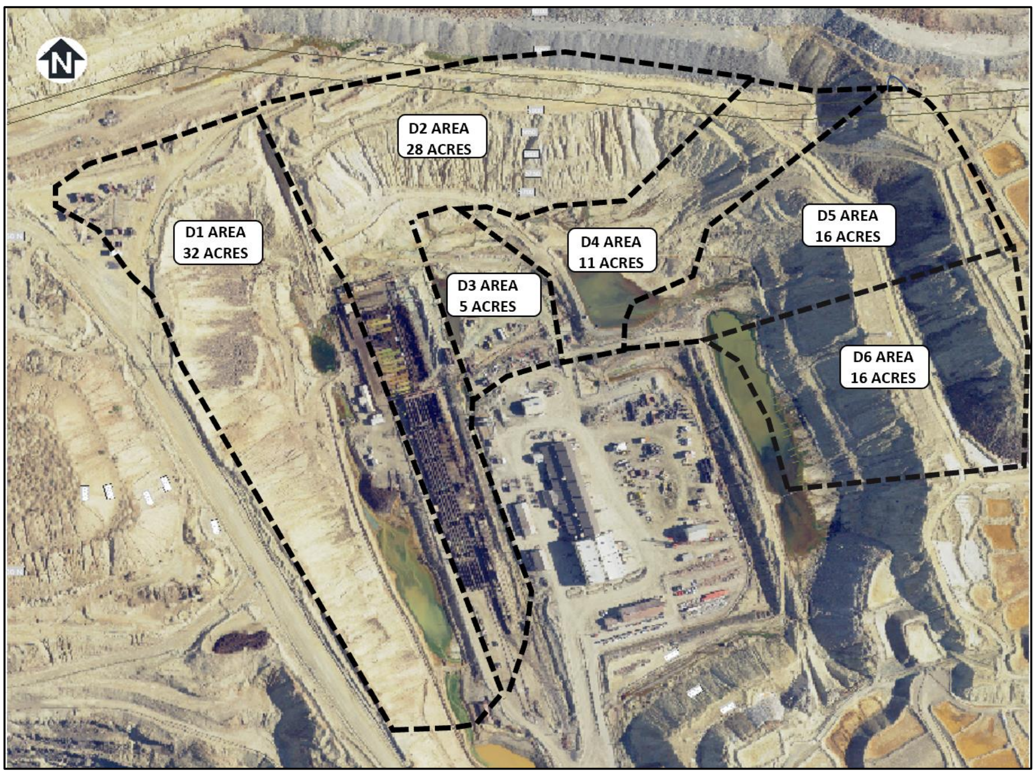


Figure 5.3 Rock Drain Catchment Areas

A sensitivity analysis was undertaken to evaluate precipitation infiltration flows considering one-hour and two-hour time of concentrations. The actual time for precipitation to report to the rock drains will depend on the heterogenous flow paths through the rockfill material that will range in thickness up to approximately 250 ft thick. The results of the sensitivity analysis are presented in Table 5.1.

Table 5.1 Rock Drain Catchment Areas and Estimated Attenuated Flow Rates

Drain I.D.	Catchment Area (acres)	1-hr Peak Flow Rate (gpm)(Note 2)	2-hr Peak Flow Rate (gpm)(Note 3)
D1	32	5,700	3,300
D2	28	4,800	2,900
D3	5	1,000	500
D4	11	1,700	1,000
D5	16	3,000	1,700
D6	16	2,700	1,600

Note(s):

1. Drain I.D. locations provided on Figure 5.1 and shown on Drawing MR-C4514 in Appendix A.
2. Peak flow rate assuming a 1-hour time of concentration.
3. Peak flow rate assuming a 2-hour time of concentration.

5.3 DESIGN FLOWS

The infiltration flow estimates were compared with historical average daily flow rates recorded in the HsB area (historical records were presented previously in Section 3.3) and used to select design flow rates for the rock drains. The selected design basis flow rates are as follows:

- Drain 1 4,500 gpm
- Drain 2, Drain 5, and Drain 6 3,500 gpm
- Drain 3 and Drain 4 1,000 gpm

Drain 1 (D1) was sized for a flow capacity of 4,500 gpm, which is equivalent to the 98th-percentile of daily average flow rates recorded at the HsB Weir since 2000, as shown on Figure 5.4.

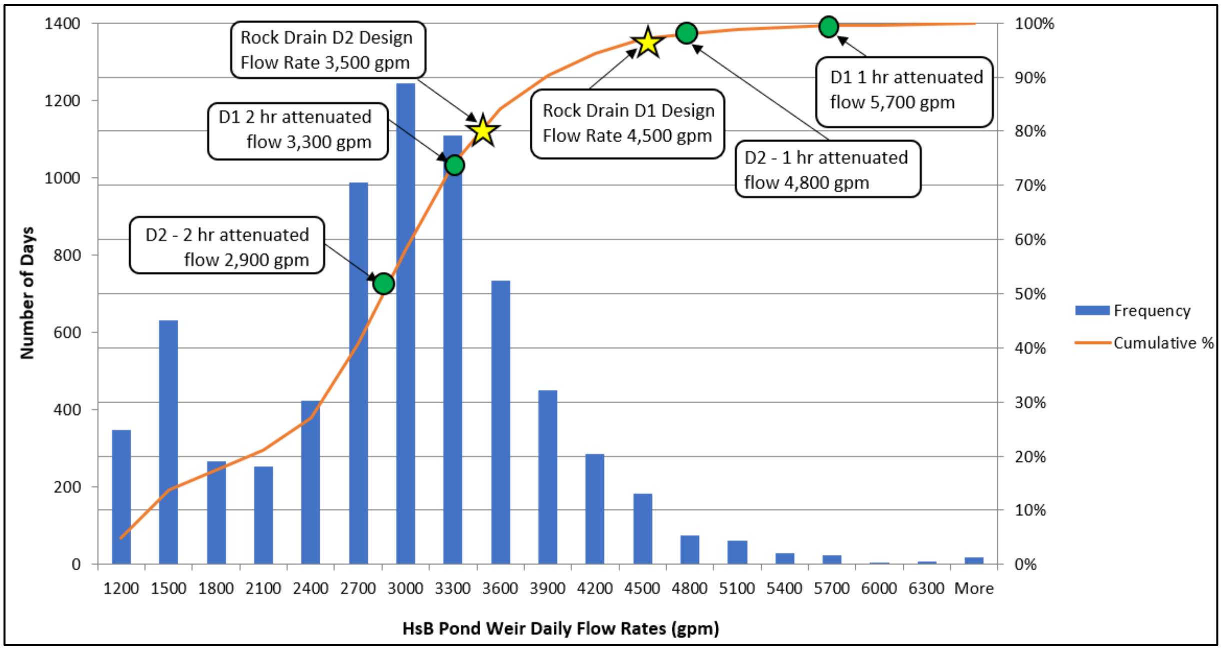


Figure 5.4 Flow Capacity Assessment for Rock Drains D1 and D2

The flows measured at the HsB Weir represent the total flows from the HsB area, and the catchment area for D1 is a subset of the total area. The 98th-percentile flow rate from the HsB Weir of 4,500 gpm is approximately equivalent to the average of the 1-hour and 2-hour attenuated infiltration flow rate for the 1 in 200-year, 24-hour return period storm on the D1 catchment area and 60% higher than the current average annual flow rate at the HsB Weir. This design flow rate was selected because D1 is the lowest elevation rock drain in the drainage system and is located in the area expected to experience the largest flow.

Drain 2 (D2) was sized for a design flow capacity of 3,500 gpm, which is approximately equivalent to the 80th-percentile flow rate recorded at the HsB Weir since 2000, as shown on Figure 5.4. Rock Drains D1 and D2 will have a combined flow capacity of approximately 8,000 gpm, which is well in excess of the historical total flow rates within the HsB area.

Drains 3 and 4 (D3 and D4) were sized for a flow capacity of 1,000 gpm. Drains 5 and 6 (D5 and D6) were sized similarly to D2 with a flow capacity of 3,500 gpm. These four drains will have a combined flow capacity of 9,000 gpm, which is approximately twice as large as the total combined precipitation plant flows observed during active leaching operations between 2017 and 2020. The drainage reporting to drains D3, D4, D5, and D6 is estimated to be substantially less than during the active leaching period and recent flow measurements from late 2021 indicate that a total flow rate of around 1,500 to 2,000 gpm could be expected from these areas. A comparison of these flow capacities with the precipitation plant flow records is included on Figure 5.5.

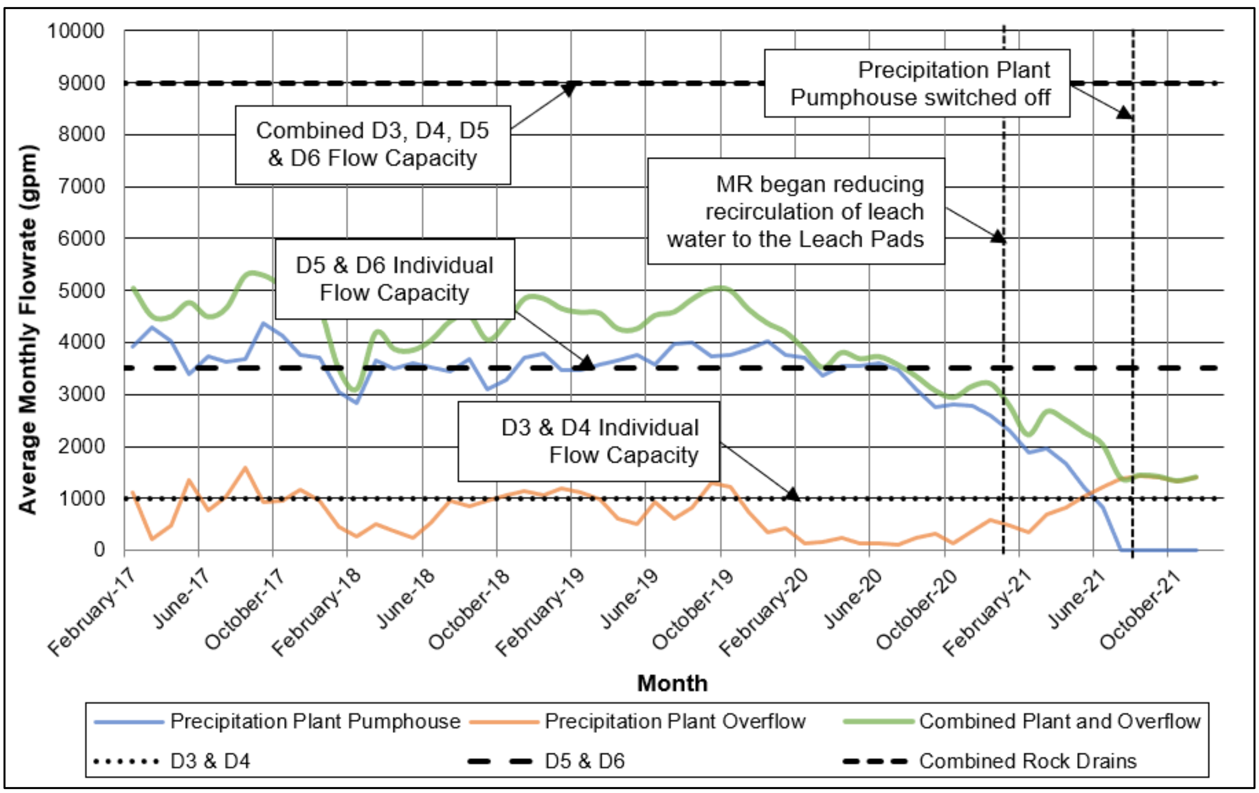


Figure 5.5 Flow Capacity Assessment for Rock Drains D3, D4, D5, and D6

The total design flow capacity for all six drains is approximately 17,000 gpm, which is more than five times greater than the current HsB area flow rates and over three times greater than the 98th-percentile flow rate over the past 20 years (refer to Figure 5.4). It is worth noting that these flow capacity estimates also conservatively ignore the available flow capacity within the foundation grading/drainage layer, which will be constructed with relatively permeable mine-run rockfill. The inclusion of these multiple, independent drainage systems and use of conservative design flow rates provides significant redundancy and improves reliability in consideration of the long-term design life of the basal drainage system for the HsB RDS.

5.4 ROCK DRAIN SIZING

The rock drain cross sectional areas were assessed using the flow rates listed above and Wilkins' equation as presented in Garga et. al (1990) and summarized in Appendix C. The resulting cross sectional area and void flow velocity for each drain size are summarized in Table 5.2.

Table 5.2 Rock Drain Cross Sectional Area and Flow Velocities

Drain I.D.	Parameter	Unit	D1	D2, D5, D6	D3 & D4
Design Flow rate	Q	gpm	4,500	3,500	1,000
Cross sectional area	A	ft^2	200	150	60
Hydraulic gradient	i	ft/ft	0.01	0.01	0.01
Void velocity	Vv	ft/s	0.05	0.05	0.05

The drain geometry for each of the three drain sizes is shown on Drawing MR-C4530 included in Appendix A. The drains will be constructed from four different rock material types, which are detailed further in Section 5.6. The dimensions and cross-sectional areas relate to the higher permeability Zone 3A material. The Zone 2A and Zone 2B materials will act as filters and are not considered in the drain flow capacity assessment although these materials are permeable and will provide additional flow capacity.

Secondary drains have been included in the design to further promote drainage of the Holding Pond across the varying ground conditions, as shown on Drawing MR-C4514. The secondary drains are sized for the 1 in 200-year storm event and include a design cross sectional area of approximately 30 ft^2.

5.5 DESIGN FLOW CAPACITY SENSITIVITY

Rock drain flow velocity is controlled primarily by the hydraulic gradient (slope) of the drain and material characteristics of the drain rock. The slope of the drain is fixed by topographical design constraints. A sensitivity analysis was prepared to evaluate the sensitivity of the flow capacity of the drain to select drain material characteristics assuming the design cross sectional area of 200 ft^2 for drain D1.

Material characteristics considered to be variable and assessed as part of the sensitivity analysis include particle size gradation and porosity. The most suitable and appropriate way to meet the drain design flow requirements is to control the size and quality of the aggregate within the drain.

Considering the equations presented in Appendix C, the porosity of the drain effects hydraulic mean radius used to determine the velocity in the voids and the calculation of flow within the drain. The flow capacity of the drain will increase and decrease with the porosity of the drain. The porosity of the drain material was estimated to be 35%, consistent with typical values for rock armouring and riprap with a ratio between the D_{85} and D_{15} particle sizes of greater than 2 (Look, B.G, 2007). Construction records from the West Embankment Drain (WED) indicate the Zone 3A material manufactured using material sourced from the

Pipestone Quarry includes a D_{85} to D_{15} ratio closer to 2. Porosity was varied between 25% and 45% for the sensitivity analysis presented on Figure 5.6.

The D_{50} particle size also influences the flow capacity of the drain through the determination of the hydraulic mean radius. The fill material specification presented on Drawing MR-C4511 for Zone 3A includes an acceptable D_{50} range between 14 inches for the coarse limit and 5 inches for the fine limit with a median value of 8 inches. A D_{50} particle size of 6 inches was used for the design of the rock drain (black line on Figure 5.6) as it represents the 95th percentile D_{50} particle size based on as-built data from the WED.

The flow capacity of the drain for a porosity of 35% could range between 4,300 and 7,500 gpm depending on the actual D_{50} particle size. The flow capacity in the drain could be between 2,500 and 4,200 gpm even if the porosity of the drain was as low as 25%, and the flow capacity could be substantially higher if the actual porosity is greater than the estimate of 35%.

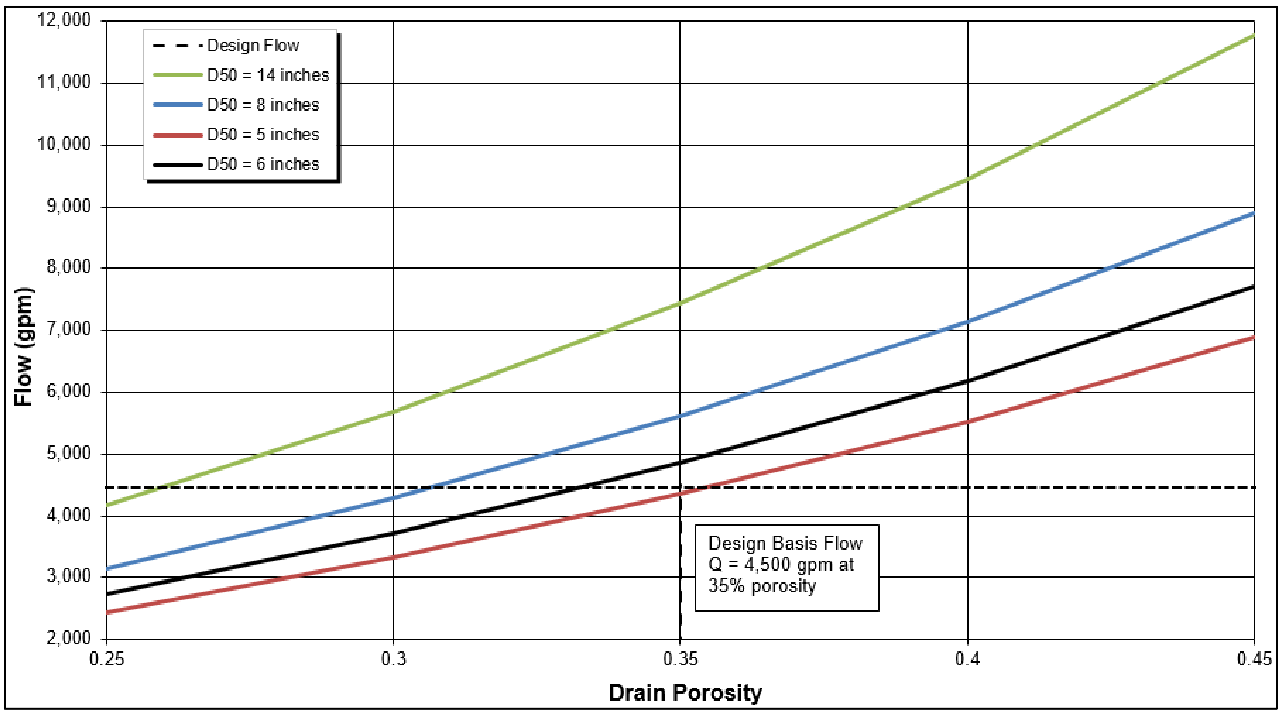


Figure 5.6 Flow Capacity Sensitivity of the WED

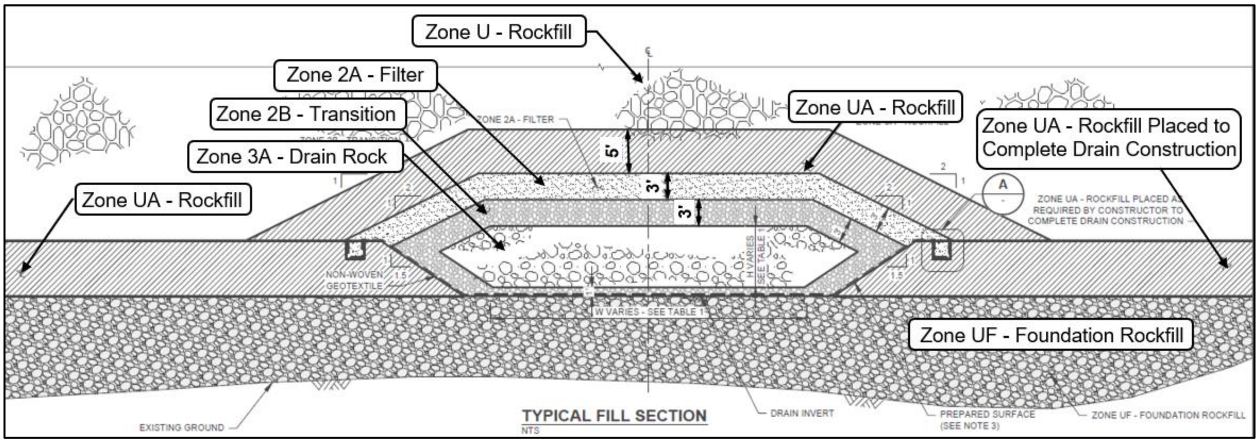
5.6 ROCK DRAIN ZONING

5.6.1 GENERAL

Typical drain cross sections are shown on Design Drawing MR-C4530. The drainage zones, consisting of Zone 3A material will be between 5 ft and 7 ft high with base widths ranging between 5 ft and 20 ft, depending on the design flow rate.

The fill material zones are indicated on Figure 5.7 and described below. The drain rock (Zone 3A) will be covered by a two-stage filter to limit the ingress of fines to the drain zone. The fill material specifications including gradation envelopes for Zone 3A, Zone 2B and Zone 2A are included on Design Drawing MR-C4511. The drain will be placed over a non-woven geotextile and a bedding layer of gravel to prevent ingress of fines from the in-situ materials and to protect the geotextile from damage during placement of the angular drain rock. The Zone UF rockfill material below the drain will be placed across the RDS footprint area as part of the foundation layer. Requirements for foundation preparation are further discussed in Section 7.3.

Once constructed, the rock drains will be covered with material from the Continental Pit as part of rock disposal. The drains will initially be covered with a nominal 5 ft thick layer of UA material to protect the filters, prior to covering with the first 20 ft to 50 ft thick lift of U material.



Note(s):

1. Copied from Drawing MR-C4530 in Appendix A.

Figure 5.7 Typical Drain Cross Section

5.6.2 ZONE 3A DRAIN ROCK

The drain zone of the rock drains will comprise uniformly graded, durable, erosion resistant boulders and cobbles. The coarse limit has a maximum particle (D_{100}) size of 24 inches and the fine limit has a particle (D_{10}) size specification of approximately 1.5 inches.

5.6.3 ZONE 2B - TRANSITION ZONE

A transition zone will surround the Zone 3A drain rock. The Zone 2B transition zone will comprise durable, well graded, cobbles and gravels. The Zone 2B transition zone is designed to be 3 ft thick over the top and exposed sides of the drain zone. The coarse limit has a maximum particle (D_{100}) size of 6 inches and the fine limit has a particle (D_5) size specification of ½ inch.

5.6.4 ZONE 2A - FILTER ZONE

5.6.4.1 MATERIAL GRADATION

A filter zone will be placed above the Zone 2B transition zone to provide a filter relationship that will reduce the risk of fines from the overlying U material washing into the Zone 3A drain rock. The Zone 2A filter zone will consist of a well graded sand and gravel and will be 3 ft thick over the top and exposed sides of the Zone 2B transition zone. The Zone 2A filter zone will be free draining to maintain recharge of the drain. The Zone 2A filter zone has been designed in general accordance with the US Department of Agriculture (2017) and Geotechnical Engineering of Dams (Fell et al 2005). The material gradation for Zone 2A is shown on Drawing MC-C4511.

The gradation limits for Zone 2A and subsequently Zone 2B are based on filtering Zone U (Continental Pit) material. Typical gradation curves for material sourced from the Continental Pit and used in construction of the EL. 6,400 ft embankment are shown on Figure 5.8 (KP, 2021e). The material generally consists of sands, gravels and cobbles with some boulders and trace silt, with up to approximately 17% fines (i.e. <0.075 mm). The Zone 2A Filter Zone was conservatively designed based on the 95th percentile gradation curve of the Continental Pit material.

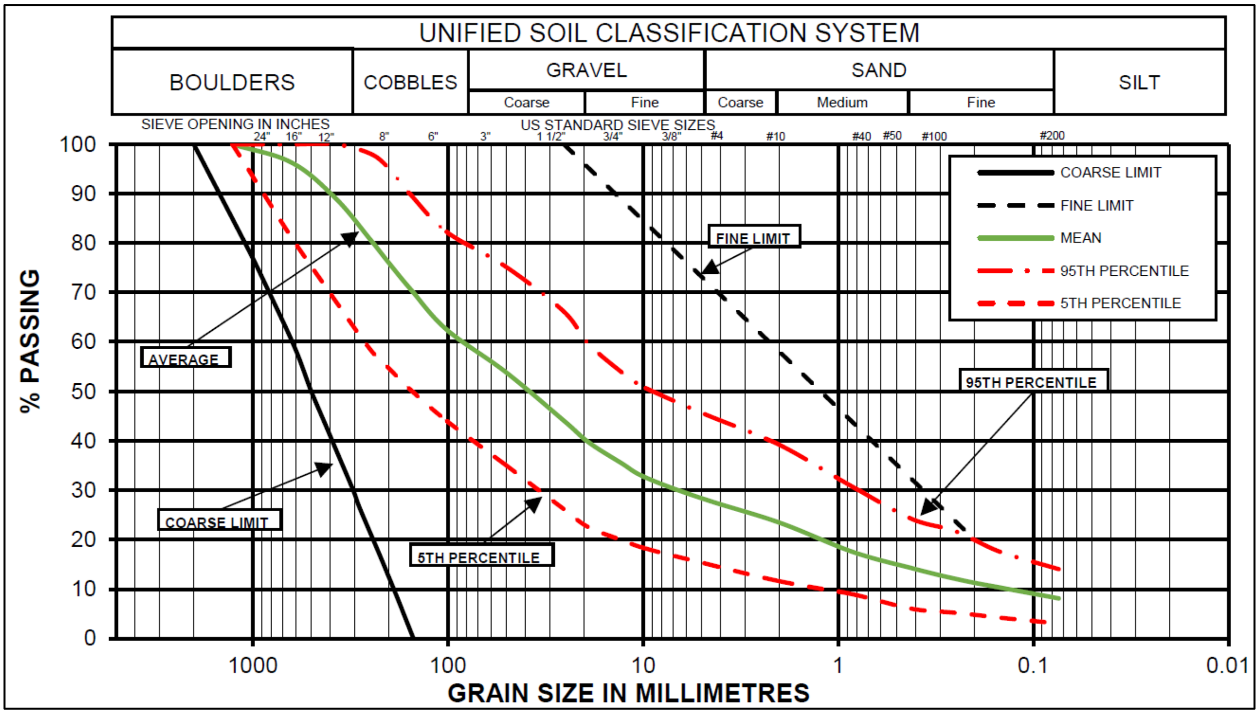


Figure 5.8 Continental Pit Material Gradation (KP, 2021e)

5.6.4.2 COEFFICIENT OF PERMEABILITY

The Zone 2A filter zone is required to be sufficiently free draining so it does not inhibit drain function and encourages drained conditions within the overlying U rockfill. If the filter zone functioned in a manner that was not free draining, it may limit flow into the drain and generate hydrostatic pore pressures (and an increase in hydraulic head) above the filter zone. This condition has been assessed further in relation to the performance of the rock drains.

Groundwater elevations of the HsB RDS are near surface, as summarized in the Section 3.4.3. Assuming no hydrostatic pore pressure above the Zone 2A Filter Zone, the coefficient of permeability of the Zone 2A filter zone is required to be prohibitively high (equivalent to the Zone 3A material).

The design adopts a slightly higher allowable increase in hydrostatic head ($\Delta H_{ALLOWABLE}$) to balance the flow performance of the drain with the filter criteria of the Zone 2A filter zone. An allowable hydrostatic head of 12 inches was selected for the design. The hydraulic conductivity establishes a minimum permeability of the filter zone for reliable drain recharge without the potential for adverse impacts to the piezometric surface within the RDS. The minimum allowable permeability for the filter zone was determined to be 8 x 10^{-6} ft/s (~2x10^{-4} cm/s).

The flows through the rockfill material will be complex and will include zones of varying hydraulic conductivity related to the tipping face and material segregation during placement. Therefore, other zones of higher permeability in addition to the rock drains are expected to occur within the rockfill material. These higher permeability zones, in combination with the rock drains are expected to prevent a phreatic surface build up across the footprint area of the RDS.

Samples of Zone 2A material sourced from Pipestone Quarry were tested for hydraulic conductivity properties during construction of the WED. Testing was undertaken in the laboratory using a flexible wall permeameter, in accordance with ASTM D5084C-Falling Head as reported by KP (KP, 2016a). Testing was undertaken on 10 different samples, with two different test conditions. Nine samples were tested at both a Modified Proctor Maximum Dry Density (MPMDD) of 90% and a Standard Proctor Maximum Dry Density (SPMDD) of 90%. One sample was tested at a SPMDD of 90% only. A comparison of the laboratory hydraulic conductivities under the two different test conditions is provided in Table 5.3.

Table 5.3 Permeability – Laboratory Test Results

Test Sample	Permeability Test Results MPMDD (cm/s)	Permeability Test Results SPMDD (cm/s)
FC1-2A	7x10^{-4}	2x10^{-3}
FC2-2A	1x10^{-3}	2x10^{-3}
FC3-2A	2x10^{-3}	2x10^{-3}
FC4-2A	1x10^{-3}	2x10^{-3}
FC5-2A	6x10^{-4}	7x10^{-4}
FC6-2A	5x10^{-4}	4x10^{-3}
FC7-2A	2x10^{-3}	3x10^{-3}
FC8-2A	7x10^{-4}	4x10^{-3}
FC9-2A	1x10^{-3}	3x10^{-3}
FC10-2A	-	3x10^{-3}
Geometric Mean	9x10^{-4}	2x10^{-3}
Arithmetic Mean	1x10^{-3}	2x10^{-3}

As expected, the test results for samples prepared to 90% SPMDD resulted in a higher hydraulic conductivity in comparison with the 90% MPMDD results for each of the tested specimens. The test results also demonstrate that all samples reported a hydraulic conductivity greater than 6.6 x 10^{-4} ft/s (2x10^{-4} cm/s).

Subsequent to laboratory testing, field verification was also performed using a Guelph permeameter (KP, 2016b). Testing was undertaken for six different compaction methods, as listed:

1. Four (4) passes with smooth drum vibratory roller
2. Four (4) passes with smooth drum roller using static (no vibratory) compaction
3. Two (2) passes with smooth drum vibratory roller
4. Two (2) passes with smooth drum roller using static (no vibratory) compaction
5. Haul truck traffic compaction
6. Excavator bucket compaction

The results indicated hydraulic conductivity ranges between 6.6 $x10^{-2}$ ft/s (2 $x10^{-2}$ cm/s) and 2.6$x10^{-1}$ ft/s (8$x10^{-2}$ cm/s) (KP, 2016b).

Both methods demonstrate that material sourced from Pipestone Quarry and manufactured for use in Zone 2A will achieve a hydraulic conductivity of at least 6.6 $x10^{-4}$ ft/s (2$x10^{-4}$ cm/s).

5.7 ROCK MATERIAL DURABILITY

The rock drain materials are required to be durable and resistant to degradation when exposed to acid drainage. Water quality at the HsB Pond receives water from numerous sources, as discussed in Section 3, and is considered representative of the water quality that will report to the rock drains at the base of the RDS. Historical water quality testing conducted on seepage water collected at the HsB Weir indicates a pH as low as 3 with an Oxidation-Reduction Potential (ORP) of around 400 millivolts.

Durability and mineralogical testing were undertaken prior to construction of the WED to assess the suitability of the Pipestone Quarry aggregates. Durability testing for the WED was undertaken using both clean water and low pH, embankment seepage water reporting to the HsB Pond. Durability testing included Los Angeles (LA) Abrasion testing on split samples of aggregates both before and after saturation of the samples in low pH seepage water. Testing was intended to model the worst-case chemical environment to assess the potential for degradation of the aggregates following long-term exposure to acidic conditions. X-Ray Diffraction (XRD) testing was also undertaken to assess the mineralogy of the aggregate sources.

The Pipestone Quarry material is described as andesite. The results of the Pipestone Quarry material did not show significantly different losses depending on whether samples were exposed to the acidic seepage or not (KP, 2015).

Material sourced from Pipestone Quarry was used in the successful construction of the WED. The performance of the WED in relation to drain rock material properties and long-term performance is being continuously assessed during on-going mine operations; however, initial monitoring indicates the WED is continuing to operate as designed and is reporting flow rates well below its design capacity. The drain is operating in relatively anoxic conditions with minor precipitate build-up at the drain outlet where the rock material is exposed to the atmosphere. This is not considered to be affecting the overall drain performance. The materials sourced from the Pipestone Quarry are expected to be more resistant to wear than typical embankment rockfill and are expected to remain more free draining than embankment rockfill in the long-term following cessation of mine operations. In the event the drains were to partially block from precipitates, Section 5.3 demonstrates the combined flow capacity of the six drains is considerably higher than estimated flows rates reporting to the drains. Steady-state flow rates will further decline following the cessation of mine operations (as observed during the mine suspension period from 2000 to 2003, which builds additional confidence that the drainage system design will be sufficient for the long-term following mine closure.

6.0 SURFACE WATER DITCH DESIGN

6.1 DESIGN OUTLINE

The Stage 1 Drainage System includes two surface water ditches as following:

- SWD7: located at the toe of the Stage 1 RDS
- SWD8: located along the Seep-10 bench

The two surface water ditches have been sized to convey flows up to the 1 in 200-year, 24-hour storm event. Storm peak flow estimates were assessed using the rainfall-runoff modelling software HydroCAD®.

6.2 DITCH SIZING

The stormwater diversion ditches are specified to be trapezoidal shaped ditches, excavated into the existing ground. The same drain geometry has been specified for both drains, as presented in Table 6.1. Ditch sizing analyses were based on a ditch slope of 1%. The design depth of the ditches includes a nominal 1.2 ft to 1.3 ft of freeboard to allow for some sedimentation build-up during operation.

Table 6.1 Diversion Ditch Sizing Assessment

Parameter	Unit	D7	D8
Design Flow	gpm	11,000	14,000
Base Width	ft	7	7
Side Slope	H:1V	2	2
Design Depth	ft	2	2
Flow Depth	ft	0.7	0.8
Freeboard	ft	1.3	1.2
Flow velocity	ft /s	4	5

Surface water ditch SWD7 is conservatively sized as the flows are diverted in two directions from the high point located near the outlets of rock drains RD5 and DR6. Ditch erosion protection was sized for the 1 in 200-year, 24-hour storm event design flows. The analysis indicates a 7 inch thick layer of erosion protection with a D_{50} particle size of 1 inch will resist the shear stresses. Some remediation work may be required following a large storm event.

At the western end of surface water ditch SWD8, the ditch is designed to discharge into a pipe to convey the flows down the 7% Ramp and into the HsB Pond, referred to as Pipeline #1 on Drawing MR-C4526 in Appendix A. The pipe is specified as a nominal diameter (ND) 26-inch DR11 HDPE pipe. The transition from ditch to pipe shall be made via a small surface pond or approved alternative. Surface water ditch SWD7 also transitions to pipe at its western extent beneath the existing access road, referred to as Pipeline #2. The specification for Pipeline #2 is the same as Pipeline #1 (i.e. ND26-inch DR11 HDPE).

7.0 CONSTRUCTION SEQUENCING AND QUANTITIES

7.1 OVERVIEW

Construction of Stage 1 Drainage System is planned to be completed in the following general sequence:

- Removal/decommissioning of existing infrastructure
- Foundation drainage layer placement
- Rock drain, surface water ditch, and pipeline construction
- Covering the drainage system with rockfill to protect the works and to form the initial HsB RDS

The construction sequencing is based on the general development sequence for the HsB RDS described above. Alternative strategies and sequencing may be able to achieve the same design objectives. MR is responsible for the decommissioning and construction activities, including relocation of appropriate infrastructure. The drainage system concept is consistent with the strategy of MR completing a large portion of the foundation preparation works, including placement of the foundation drainage layer. Construction and installation of the rock drains was assumed to be completed by a contractor using smaller equipment. MR may also choose to perform the work or may engage contractors to perform any aspect of the work.

Initial construction access to the HsB RDS is expected to be from the south, via the existing mine haul road and access into the HsB area for haul trucks to reach the truck maintenance workshop. A conceptual location for an access ramp along the south side of the HsB area towards the Holding Pond was identified through discussions with MR and was used to develop the foundation layer grading plan (refer to Drawing C4513). Alternative access strategies may be able to achieve the same objective.

Following initial development of the HsB RDS up to approximately EL. 5,700 ft, continued placement of rockfill to the end of Stage 1 (elevation 5,900 ft) is expected to occur from higher elevation areas, such as the leach area located to the south of the HsB area or from the 7% ramp.

7.2 REMOVAL OF EXISTING INFRASTRUCTURE

MR ceased leach recirculation to the leach dumps in 2021 as described in Section 3.2 and is in the process of decommissioning the Precipitation Plant. Removal of the existing infrastructure from the HsB RDS footprint and draining down the existing Holding, Surge and Houligan Ponds is on-going, and substantial draindown will be completed prior to construction of the foundation layer and drainage system. A conceptual strategy for draining down the ponds is shown in Figure 7.1 and includes excavating a ditch along the northern extent of the Precipitation Plant and allowing water from the ponds to discharge to the HsB Pond via the temporary channel. Alternative strategies may achieve the same objective. It is anticipated that MR will progressively complete the pond drainage and breaching activities over the next several months.

Other existing infrastructure, including miscellaneous low-voltage transmission lines, pipework, laydown yards, the Precipitation Plant structures (excluding concrete pad), impacted weirs and flow diversion structures, and tanks within the foundation area are expected to be demolished as indicated on Drawing MR-C4512. Salvageable material will be recovered, and waste materials removed to the satisfaction of the EOR. The concrete slab at the Precipitation Plant is expected to remain in place and will be covered with rockfill material associated with the HsB RDS. Rock drains will convey seepage around the concrete slab.

The decommissioned precipitation plant will be re-established at the south of the HsB Area, adjacent to the existing HsB WTP.

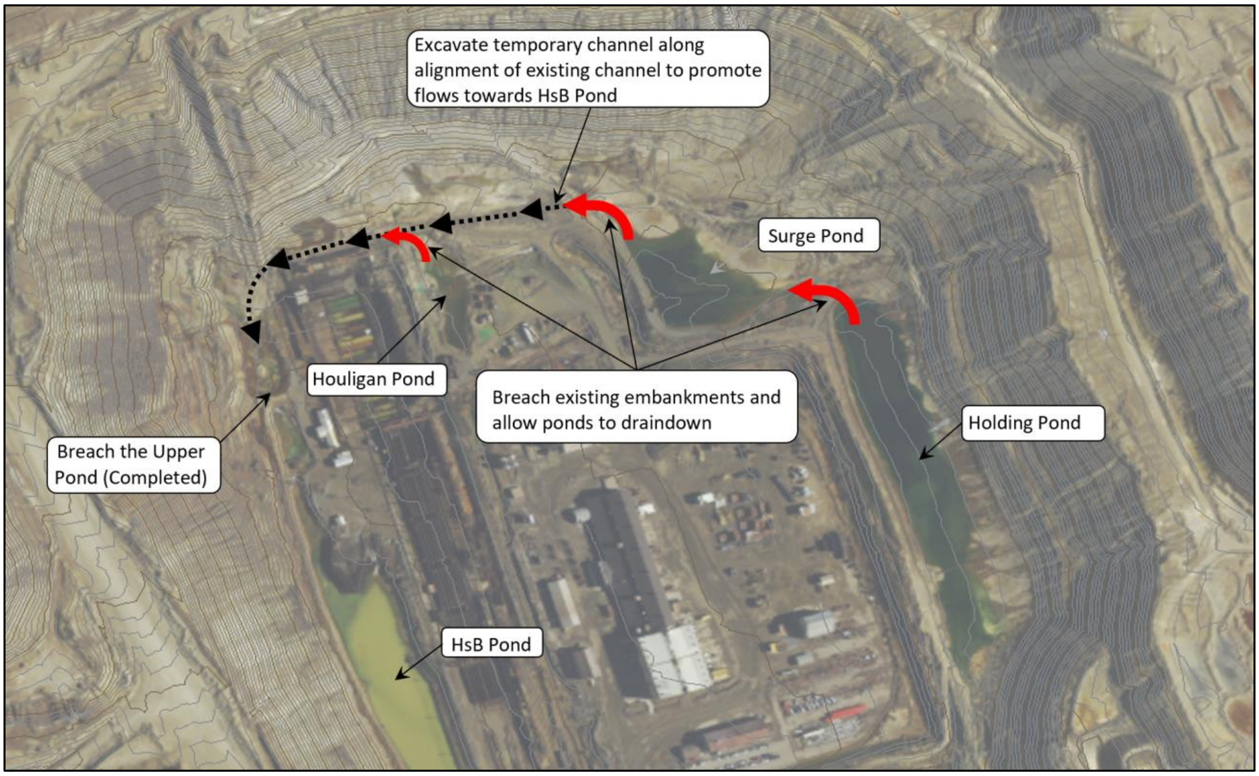


Figure 7.1 Conceptual Pond Draindown Strategy

7.3 FOUNDATION PREPARATION AND FOUNDATION DRAINAGE LAYER

Earthworks and fill placement associated with the foundation drainage layer will be undertaken following the removal of the existing infrastructure within the Stage 1 HsB RDS footprint.

Foundation preparation includes nominal grading works to maintain subgrade surface drainage grades towards the west and south and to limit areas where water can pool within the foundation of the RDS. Foundation preparation is to be completed in accordance with the Construction Management Plan (KP, 2018b) or as approved by the EOR. Excavation works associated with foundation preparation will be limited as phreatic levels are near surface within the HsB area and development of a large excavation along the downstream toe of the YDTI embankments could reduce embankment stability and is therefore undesirable. The rock drains will generally be constructed above the existing, in-situ materials and within the foundation layer.

An indicative foundation layer grading plan is presented on Drawing MR-C4513. The layer will be founded on a combination of historically placed pit-run rockfill and miscellaneous fill material. It is expected that the foundation drainage layer, Zone UF, will be constructed with hard, durable, and relatively coarse rockfill material sourced from the Continental Pit. The ‘UF’ material will be end dumped in a single lift up to a maximum of 30 ft thick, which will encourage segregation of coarse material at the foundation interface.

The foundation layer grading plan uses a terraced arrangement that will be progressively dumped in a counter-clockwise direction beginning at the southeastern corner of the HsB area. Rockfill placement in this manner will be used to displace any remaining water within the existing water management ponds downgradient to the north and then west.

The thickness of the foundation layer will depend on in-situ conditions once infrastructure has been demolished and subsurface grading works are complete. The layer will be thicker in the footprints of the existing ponds to displace water and softer subgrade materials, compress the foundation materials, and provide a trafficable surface for drain construction.

Construction of the foundation layer grading plan will require approximately 0.9 Myd^3 of fill material. The volume estimate was based on aerial survey data, including measurement of the water surface elevation in the existing ponds. Pond bathymetric surveys are not available, and rockfill quantities required for foundation layer grading may vary depending on the actual depth of the ponds and material properties of the in-situ materials which are expected to be relatively compressible due to historical chemical weathering.

7.4 ROCK DRAINS

The rock drains will be constructed within the foundation layer, which will provide a trafficable surface for construction. The drains will be formed using a cut to fill methodology along the foundation layer terraces to form trapezoidal trenches with dimensions as specified on Drawing MR-C4530 and graded as specified in Drawings MR-C4521 and MR-C4522. The trenches will then be lined with non-woven geotextile, and subsequently backfilled with the drain materials as specified in the drawings. This construction methodology was consistently successful during construction of the WED. The foundation layer grading plan described in the previous section may be adjusted to balance rock drain cut and fill quantities depending on final drain profiles and construction methodology.

Three material types are required for construction of the rock drains, Zone 2A, Zone 2B and Zone 3A, as discussed in Section 5.6. The estimated material quantities required for each material type are summarized in Table 7.1. The volume estimates are neat line quantities with no allowance for wastage.

Table 7.1 Preliminary Rock Drain Material Quantity Estimates

Material Type	Volume (yd^3)
Zone 2A	60,000
Zone 2B	65,000
Zone 3A	58,000

7.5 INSTRUMENTATION

Pore pressures within the YDTI foundation and embankment materials are actively monitored using piezometric monitoring instruments connected to a remote monitoring system (RMS), as discussed in Section 3.4.3.

The 2018 HsB SI program included installation of 30 VWPs, installed in ten drillholes throughout the HsB area to monitor pore pressures. There are also several additional VWPs installed in drillholes completed in 2015 and used to retrofit historical standpipes initially installed in the early 1990s. All of these monitoring sites will be covered or impacted by the Stage 1 HsB RDS. Cables from these monitoring sites will initially be trenched and extended to the Stage 1 exclusion area beyond the drainage system works to allow for continual monitoring during and after construction of the initial construction works.

Performance of the rock drains will be monitored using the existing VWPs and new monitoring instrumentation. New VWPs will be installed in or adjacent to the drains to complement the monitoring instrumentation available in the foundation materials and to assess piezometric conditions within the RDS. Cables from the new VWPs will be trenched to the data logging stations outside the footprint area of the Stage 1 RDS and connected to the RMS.

8.0 SUMMARY

An amendment to the operating permit was approved in August 2019 to allow for continued use of the YDTI. The long range mine plan indicates that approximately 160 million tons of rockfill will be produced during mining between 2023 and approximately 2031 following construction of the EL. 6,450 ft embankment lift. Selective and strategic use of excess rockfill generated during mining of the Continental Pit to enhance embankment stability was identified as an opportunity during a risk assessment of the YDTI (KP, 2018a). The HsB area was selected as a priority RDS location, as it will provide substantial benefit to the tailings facility from an embankment stability and reclamation perspective while also providing economically viable storage for a large volume of rockfill.

A drainage system will be constructed underlying the planned HsB RDS. The principal design objectives for the drainage system described in this report are to manage surface water runoff in the HsB area and groundwater discharge within the foundation of the RDS during mine operations and in the long-term following closure. Water will be collected and conveyed to the HsB Pond in a manner that limits impacts to the existing water management infrastructure downstream of the HsB Pond. The design includes a foundation drainage layer and a network of independent engineered rockfill drains and surface water diversion ditches. The network conveys flows to the HsB Pond to tie in with the broader site water management system.

Rockfill placement within the HsB RDS will be undertaken as rockfill material becomes available from the Continental Pit. It is envisaged that the HsB RDS will be constructed in two stages, with Stage 1 including a nominal crest elevation of EL. 5,900 ft and excludes rockfill placement within the central exclusion zone where existing site infrastructure is located. Stage 2 will extend beyond elevation EL. 5,900 ft and will infill the exclusion zone to cover the complete footprint of the HsB area.

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10.0 CERTIFICATION

This report was prepared and reviewed by the undersigned.

Prepared:

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Senior Engineer

Reviewed:

Ken Brouwer, P.E.
Principal Engineer

Reviewed:

Daniel Fontaine, P.E.
Specialist Engineer | Associate
Engineer of Record

Approval that this document adheres to the Knight Piésold Quality System:

APPENDIX A

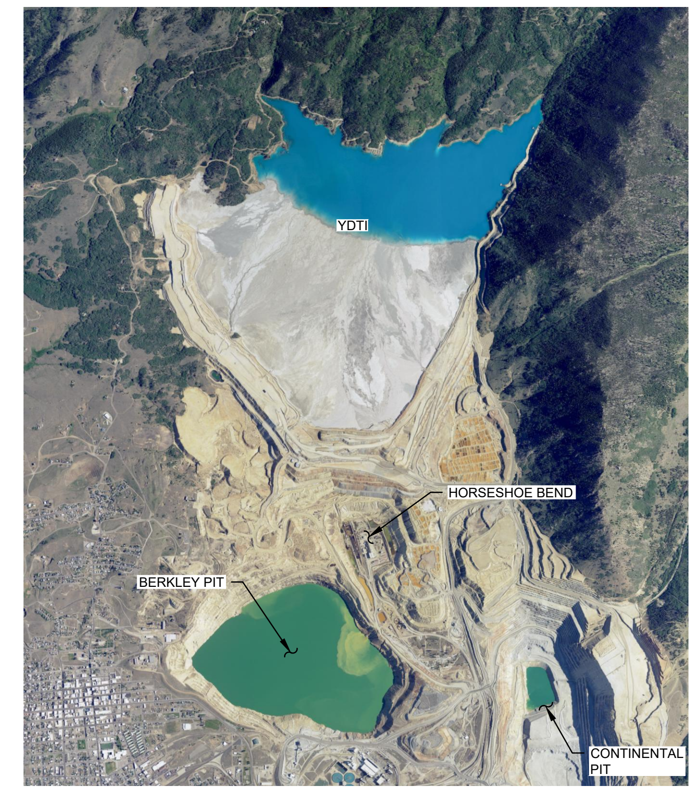
Design Drawings

MR-C4500 Rev 0
MR-C4501 Rev 0
MR-C4502 Rev 0
MR-C4510 Rev 0
MR-C4511 Rev 0
MR-C4512 Rev 0
MR-C4513 Rev 0
MR-C4514 Rev 0
MR-C4515 Rev 0
MR-C4521 Rev 0
MR-C4522 Rev 0
MR-C4526 Rev 0
MR-C4530 Rev 0
MR-C4531 Rev 0

MONTANA RESOURCES, LLP

YANKEE DOODLE TAILINGS IMPOUNDMENT
HORSESHOE BEND ROCK DISPOSAL SITE - STAGE 1 DRAINAGE SYSTEM

DRAWING NO.	DRAWING TITLE	REVISION NO.	ISSUE DATE
MR-C4500	HORSESHOE BEND ROCK DISPOSAL SITE - STAGE 1 DRAINAGE SYSTEM - DRAWING LIST	0	03/12/2021
MR-C4501	HORSESHOE BEND ROCK DISPOSAL SITE - EXISTING SITE LAYOUT	0	03/12/2021
MR-C4502	HORSESHOE BEND ROCK DISPOSAL SITE - EXISTING WATER MANAGEMENT SYSTEM SCHEMATICS	0	03/12/2021
MR-C4510	HORSESHOE BEND ROCK DISPOSAL SITE - STAGE 1 - GENERAL ARRANGEMENT	0	03/12/2021
MR-C4511	HORSESHOE BEND ROCK DISPOSAL SITE - STAGE 1 DRAINAGE SYSTEM - FILL MATERIAL SPECIFICATIONS	0	03/12/2021
MR-C4512	HORSESHOE BEND ROCK DISPOSAL SITE - STAGE 1 DRAINAGE SYSTEM - FOUNDATION PREPARATION - PLAN	0	03/12/2021
MR-C4513	HORSESHOE BEND ROCK DISPOSAL SITE - STAGE 1 DRAINAGE SYSTEM - FOUNDATION LAYER GRADING - PLAN	0	03/12/2021
MR-C4514	HORSESHOE BEND ROCK DISPOSAL SITE - STAGE 1 DRAINAGE SYSTEM - ROCK DRAINS AND DITCHES - PLAN	0	03/12/2021
MR-C4515	HORSESHOE BEND ROCK DISPOSAL SITE - STAGE 1 DRAINAGE SYSTEM - PHASED CONSTRUCTION SEQUENCE	0	03/12/2021
MR-C4521	HORSESHOE BEND ROCK DISPOSAL SITE - STAGE 1 DRAINAGE SYSTEM - ROCK DRAIN PROFILES - SHEET 1 OF 2	0	03/12/2021
MR-C4522	HORSESHOE BEND ROCK DISPOSAL SITE - STAGE 1 DRAINAGE SYSTEM - ROCK DRAIN PROFILES - SHEET 2 OF 2	0	03/12/2021
MR-C4526	HORSESHOE BEND ROCK DISPOSAL SITE - STAGE 1 DRAINAGE SYSTEM - PIPELINE #1 AND 2 - PLAN AND PROFILE	0	03/12/2021
MR-C4530	HORSESHOE BEND ROCK DISPOSAL SITE - STAGE 1 DRAINAGE SYSTEM - SECTIONS AND DETAILS - SHEET 1 OF 2	0	03/12/2021
MR-C4531	HORSESHOE BEND ROCK DISPOSAL SITE - STAGE 1 DRAINAGE SYSTEM - SECTIONS AND DETAILS - SHEET 2 OF 2	0	03/12/2021



PROJECT LOCATION

FOR INFORMATION ONLY

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Knight Piésold CONSULTING

MONTANA RESOURCES, LLP

YANKEE DOODLE TAILINGS IMPOUNDMENT

HORSESHOE BEND ROCK DISPOSAL SITE
STAGE 1 DRAINAGE SYSTEM
DRAWING LIST

DRG. NO.	DESCRIPTION
REFERENCE DRAWINGS	

REV	DATE	DESCRIPTION	DESIGNED	DRAWN	REVIEWED	APPROVED
0	03DEC'2021	ISSUED FOR INFORMATION	KAB	RMM		

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P/A NO. VA101-126/25 | DRAWING NO. MR-C4500 | REVISION 0

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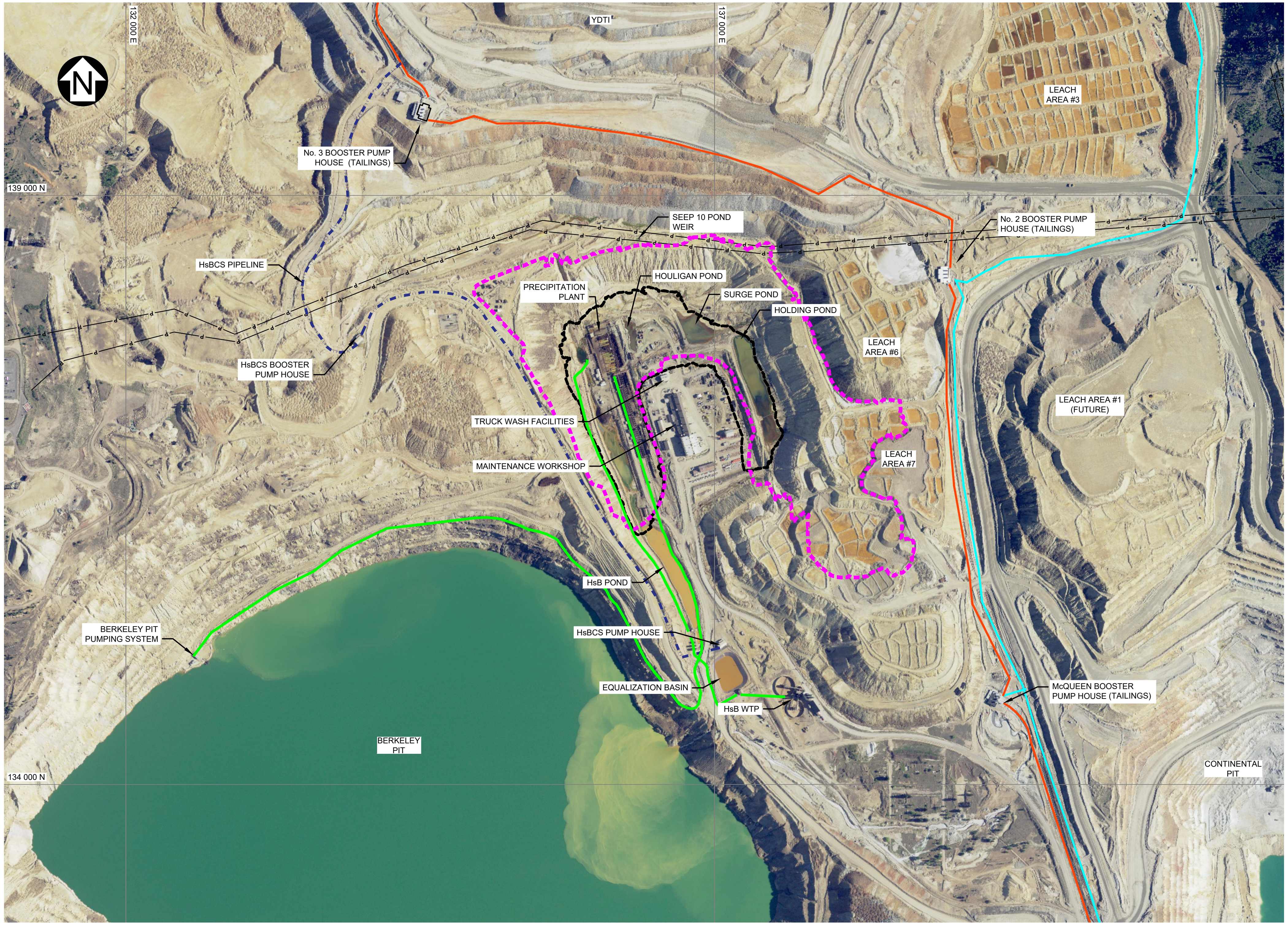

PLAN
SCALE A

LEGEND:

- FOUNDATION LAYER FOOTPRINT
- APPROXIMATE STAGE 1 RDS FOOTPRINT
- HIGH VOLTAGE TRANSMISSION LINE
- TAILINGS PIPELINE
- HsBCS PIPELINE
- BERKELEY PIT PIPELINE
- RECLAIM PIPELINE

NOTES:

1. COORDINATE SYSTEM AND ELEVATIONS ARE BASED ON ANACONDA MINE GRID.
2. AERIAL IMAGERY FROM JULY 29, 2021 PROVIDED BY MONTANA RESOURCES, LLP.

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SCALE A: 500 0 500 1000 1500 2000 2500 ft

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YANKEE DOODLE TAILINGS IMPOUNDMENT

HORSESHOE BEND ROCK DISPOSAL SITE
EXISTING SITE LAYOUT

P/A NO.	DRAWING NO.	REVISION
VA101-126/25	MR-C4501	0

DRG. NO.	DESCRIPTION
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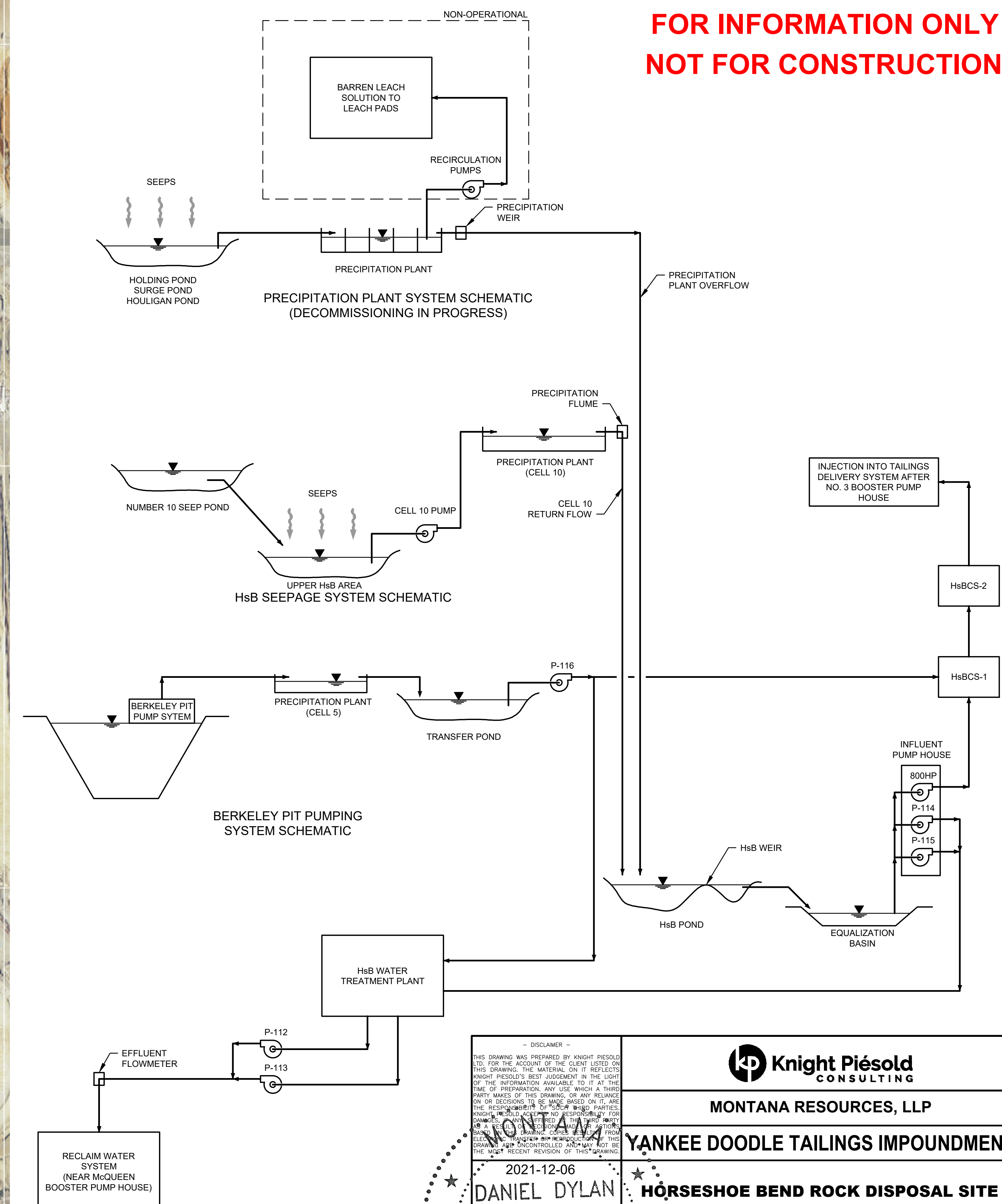

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YANKEE DOODLE TAILINGS IMPOUNDMENT

HORSESHOE BEND ROCK DISPOSAL SITE EXISTING WATER MANAGEMENT SYSTEM SCHEMATIC

P/A NO.	DRAWING NO.	REVISION
VA101-126/25	MR-C4502	0

DRG. NO.	DESCRIPTION
-	-

REFERENCE DRAWINGS

REV	DATE	DESCRIPTION	DESIGNED	DRAWN	REVIEWED	APPROVED

REVISIONS

REV	DATE	DESCRIPTION	DESIGNED	DRAWN	REVIEWED	APPROVED
0	03DEC'21	ISSUED FOR INFORMATION	KAB	RMM		

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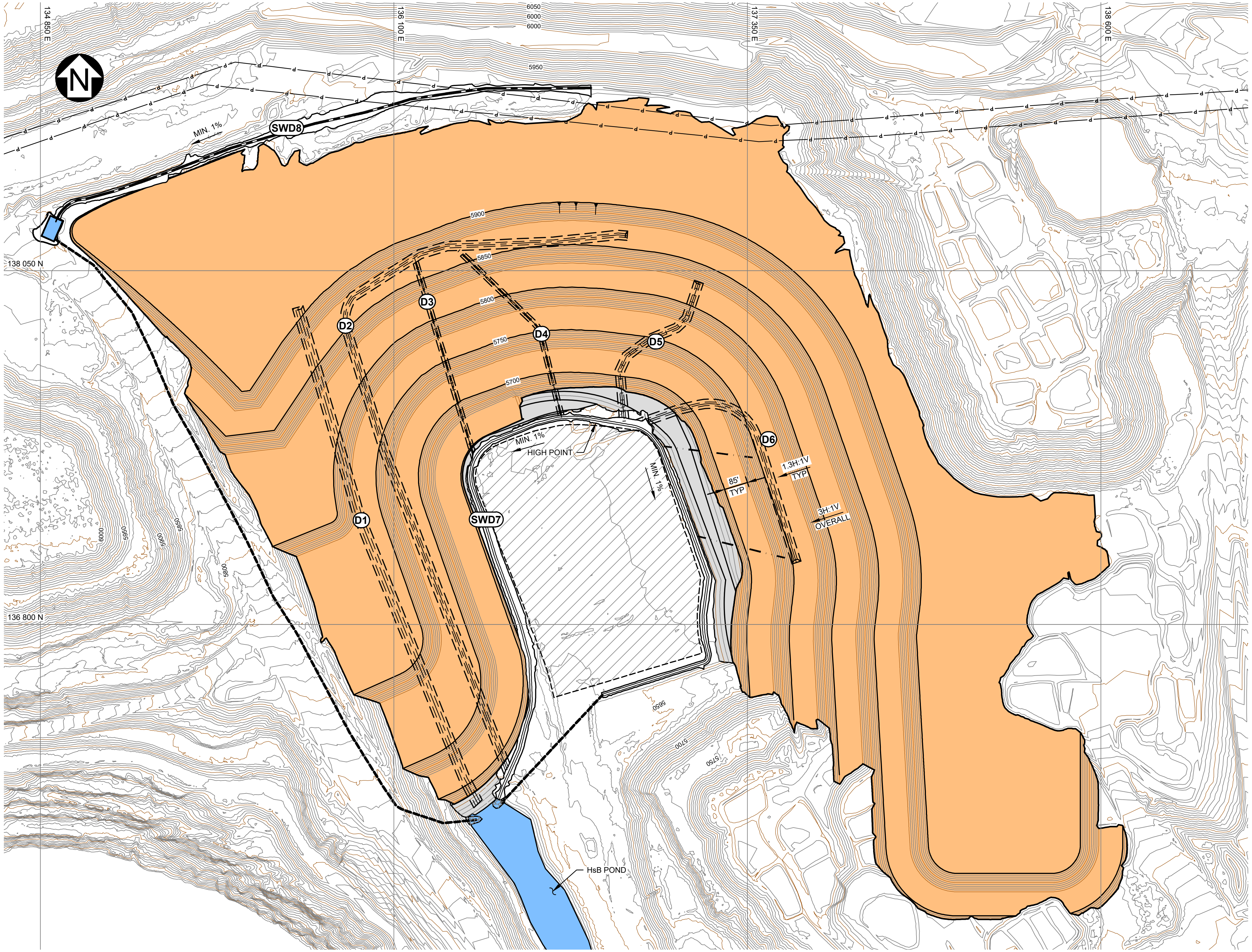
SAVED: M:\1\01\00126\25\A\Acad\DWGS\MR-C4502\MR-C4502, 12/6/2021 10:48:10 AM , RMCLELLAN PRINTED: 12/6/2021 1:30:09 PM, MR-C4502, RMCLELLAN ACAD VERSION: 23.0S (LMS TECH)
XREF FILE(S): 5ft_01_2019-07-01 5ft_01 2021-07-29 IMAGE FILE(S): 5ft_01_2018 5ft_01_2021-07-29



PLAN
SCALE A

LEGEND:

- SURFACE WATER DITCH
- PRIMARY ROCK DRAIN
- SECONDARY ROCK DRAIN
- PIPELINE
- HIGH VOLTAGE TRANSMISSION LINE
- STAGE 1 RDS EXCLUSION AREA (INDICATIVE)
- Dx ROCK DRAIN IDENTIFICATION
- SWDx SURFACE WATER DITCH IDENTIFICATION
- RDS (NOTE 7)
- FOUNDATION LAYER
- HsB POND

NOTES:

1. COORDINATE SYSTEM AND ELEVATIONS ARE BASED ON ANACONDA MINE GRID.
2. TOPOGRAPHY PROVIDED BY MONTANA RESOURCES, LLP. AUGUST 2021.
3. SEE DRAWING MR-C4513 FOR FOUNDATION LAYER GRADING PLAN.
4. SEE DRAWING MR-C-4514 FOR ROCK DRAINS AND SURFACE WATER DITCHES PLAN.
5. PRIMARY ROCK DRAINS INCLUDE D1, D2, D3, D4, D5, AND D6.
6. SURFACE WATER DIVERSION DITCHES INCLUDE SWD7 AND SWD8.
7. RDS SHOWN IS CONCEPTUAL ONLY. FINAL GEOMETRY SUBJECT TO MATERIAL AVAILABILITY.

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NOT FOR CONSTRUCTION

SCALE A: 200 0 200 400 600 800 1000 ft

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2021-12-06
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MONTANA RESOURCES, LLP

YANKEE DOODLE TAILINGS IMPOUNDMENT

HORSESHOE BEND ROCK DISPOSAL SITE
STAGE 1
GENERAL ARRANGEMENT

P/A NO.	DRAWING NO.	REVISION
VA101-126/25	MR-C4510	0

REFERENCE DRAWINGS

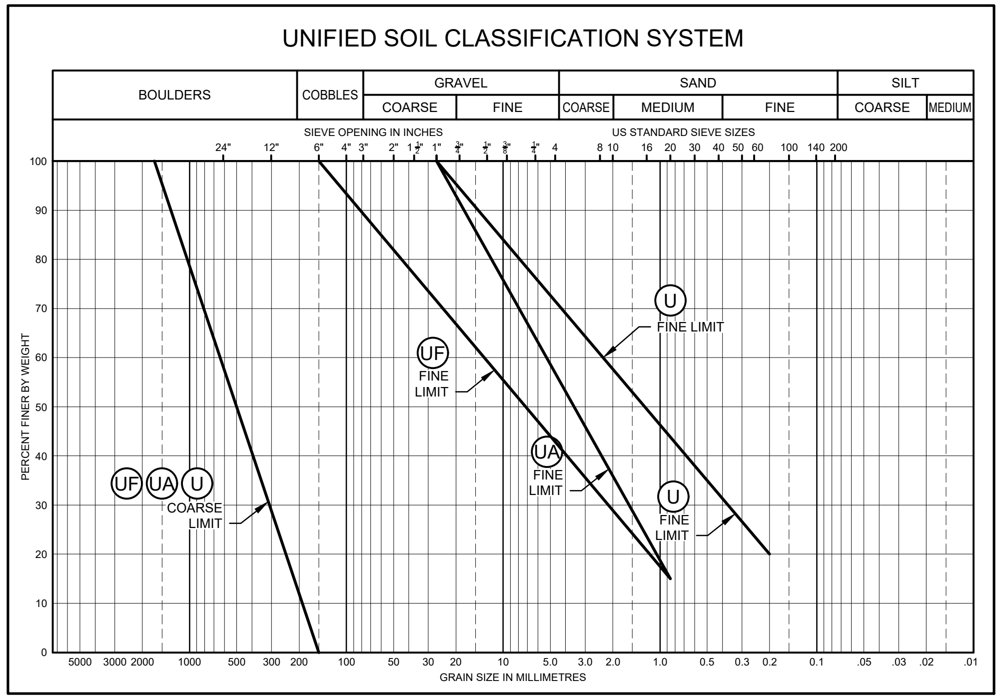
DRG. NO.	DESCRIPTION
MR-C4514	HORSESHOE BEND ROCK DISPOSAL SITE - STAGE 1 DRAINAGE SYSTEM - ROCK DRAINS AND DITCHES - PLAN
MR-C4513	HORSESHOE BEND ROCK DISPOSAL SITE - STAGE 1 DRAINAGE SYSTEM - FOUNDATION LAYER GRADING - PLAN

REVISIONS

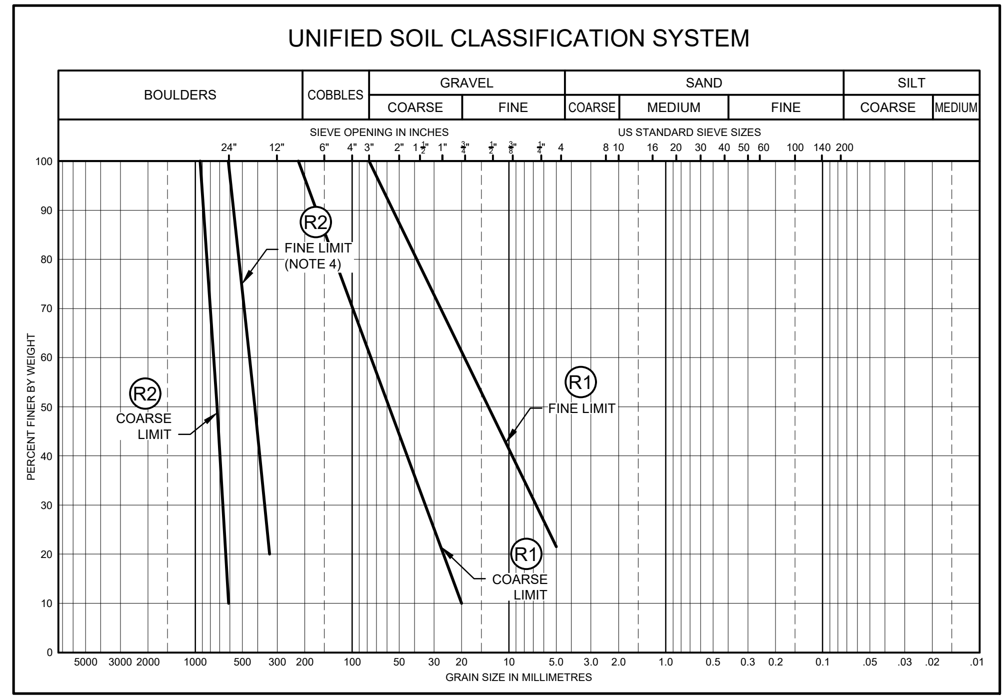
REV	DATE	DESCRIPTION	DESIGNED	DRAWN	REVIEWED	APPROVED

REVISIONS

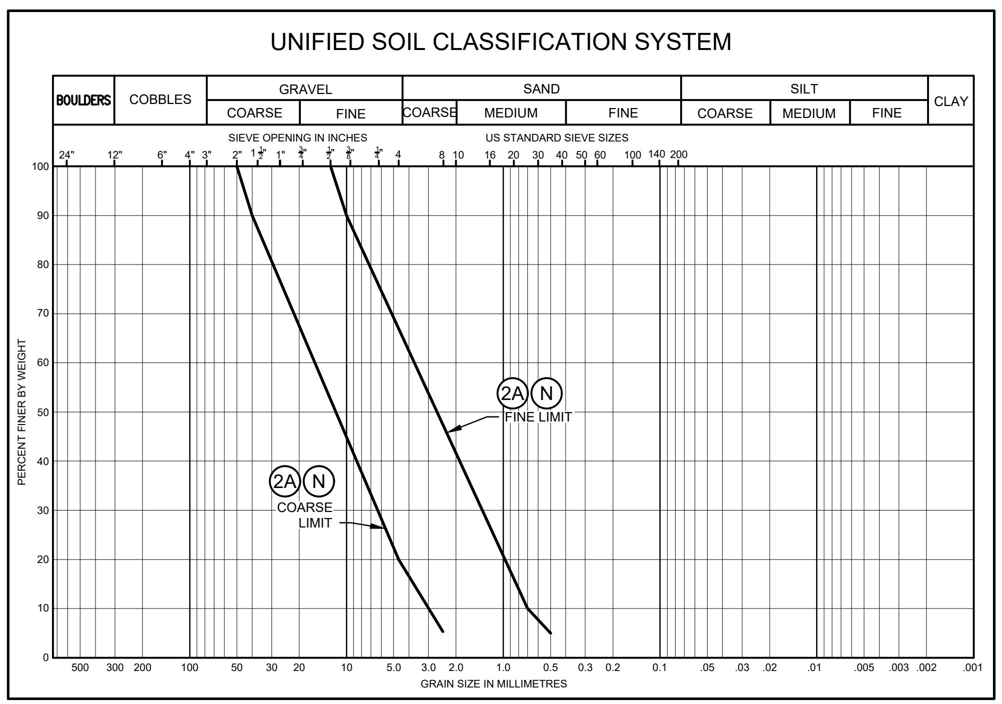
REV	DATE	DESCRIPTION	DESIGNED	DRAWN	REVIEWED	APPROVED
0	03DEC'21	ISSUED FOR INFORMATION	KAB	RMM		



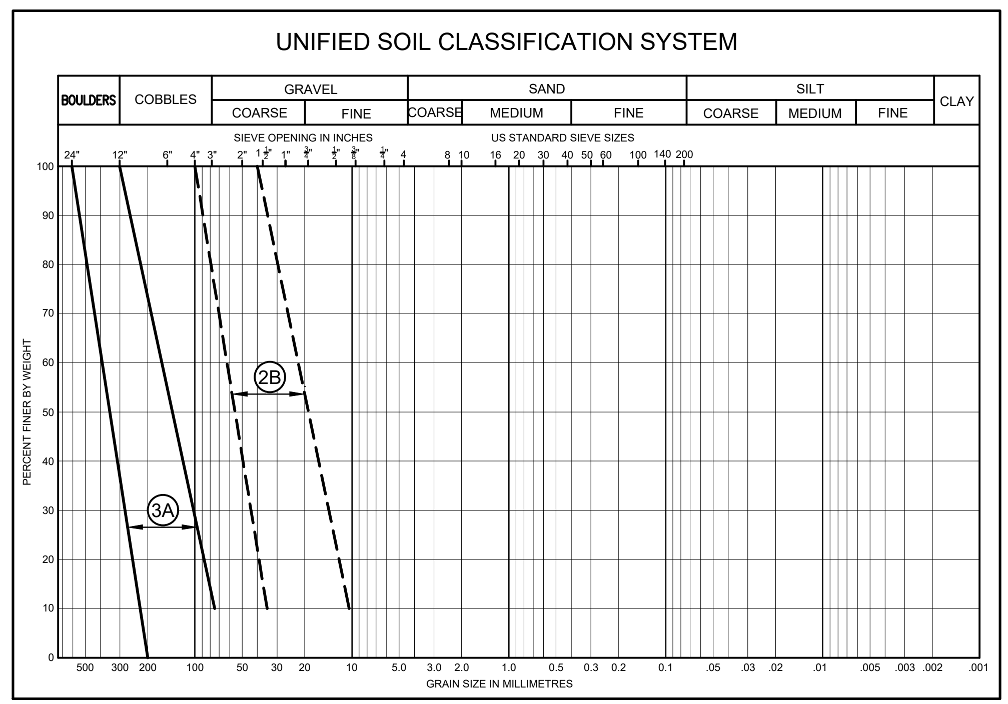
ZONE U / ZONE UA / ZONE UF



RIPRAP TYPE 1 (R1) / RIPRAP TYPE 2 (R2)



ZONE N - INSTRUMENTATION BEDDING /
ZONE 2A - FILTER



ZONE 2B - TRANSITION /
ZONE 3A - DRAIN ROCK

MATERIAL PLACEMENT AND COMPACTION REQUIREMENTS

ZONE AND MATERIAL TYPE	PLACING AND COMPACTION REQUIREMENTS
ZONE U - ROCKFILL	FILL MATERIAL SHALL CONSIST OF HARD, DURABLE, FRESH TO MODERATELY WEATHERED ROCKFILL MATERIAL AND SHALL BE END DUMPED IN 50 ft LIFTS . FILL MATERIAL WILL BE TRAFFIC COMPACTED BY THE MINE HAUL FLEET, EQUALLY DISTRIBUTED OVER THE ENTIRE LAYER WIDTH. THE MATERIAL SHALL CONTAIN A BROAD RANGE OF WELL-GRADED SOILS ACROSS THE ENTIRE SPECIFIED GRAIN SIZE ENVELOPE. COMPACTED RUNNING SURFACES WILL BE CROSS RIPPED PRIOR TO PLACING SUCCESSIVE LIFTS.
ZONE UA - PROTECTIVE CAP	FILL MATERIAL SHALL CONSIST OF HARD, DURABLE, FRESH TO MODERATELY WEATHERED ROCKFILL MATERIAL AND SHALL BE PLACED AND SPREAD IN 5 ft. LIFTS. FILL MATERIAL WILL BE DOZER COMPACTED. THE MATERIAL SHALL CONTAIN A BROAD RANGE OF WELL-GRADED SOILS ACROSS THE ENTIRE SPECIFIED GRAIN SIZE ENVELOPE. COMPACTED RUNNING SURFACES WILL BE CROSS RIPPED PRIOR TO PLACING SUCCESSIVE LIFTS.
ZONE UF - FOUNDATION LAYER	FILL MATERIAL SHALL CONSIST OF HARD, DURABLE ROCKFILL MATERIAL SOURCED FROM THE CONTINENTAL PIT AND SHALL BE END DUMPED IN MAXIMUM 30 ft LIFTS. FILL MATERIAL WILL BE TRAFFIC COMPACTED BY THE MINE HAUL FLEET, EQUALLY DISTRIBUTED OVER THE ENTIRE LAYER WIDTH. THE MATERIAL SHALL CONTAIN A RANGE OF WELL-GRADED SOILS ACROSS THE ENTIRE SPECIFIED GRAIN SIZE ENVELOPE. COMPACTED RUNNING SURFACES WILL BE CROSS RIPPED PRIOR TO PLACING SUCCESSIVE LIFTS.
ZONE N - INSTRUMENTATION BEDDING	FILL MATERIAL SHALL CONSIST OF HARD, DURABLE, FRESH OR NON-WEATHERED MATERIAL. BEDDING TO BE PLACED AND SPREAD IN 1' THICK LIFTS. NOMINAL COMPACTION.
ZONE 2A - FILTER MATERIAL	FILTER MATERIAL SHALL CONSIST OF HARD, DURABLE, FRESH OR NON-WEATHERED MATERIAL. FILTER MATERIAL TO BE PLACED AND SPREAD IN MAXIMUM 2' THICK LIFTS AND COMPACTED WITH 2 PASSES OF THE SPECIFIED SMOOTH DRUM VIBRATORY ROLLER.
ZONE 2B - TRANSITION MATERIAL	TRANSITION MATERIAL SHALL CONSIST OF HARD, DURABLE, FRESH OR NON-WEATHERED MATERIAL. TRANSITION MATERIAL TO BE PLACED AND SPREAD IN MAXIMUM 2' THICK LIFTS AND COMPACTED WITH 2 PASSES OF THE SPECIFICED SMOOTH DRUM VIBRATORY ROLLER
ZONE 3A - DRAIN ROCK	DRAIN ROCK SHALL CONSIST OF HARD, DURABLE, FRESH OR NON-WEATHERED ROCK FILL. DRAIN ROCK TO BE PLACED AND SPREAD IN 3' THICK LIFTS AND COMPACTED WITH 2 PASSES OF THE SPECIFIED SMOOTH DRUM VIBRATORY ROLLER OR AS DIRECTED BY THE ENGINEER.
RIPRAP	RIPRAP SHALL CONSIST OF HARD, DURABLE, FRESH OR NON-WEATHERED ROCK FILL. RIPRAP TO BE PLACED AND COMPACTED WITH 2 PASSES OF THE SPECIFIED SMOOTH DRUM VIBRATORY ROLLER OR AS DIRECTED BY THE ENGINEER.

NOTES:

1. THESE MATERIAL PLACEMENT AND COMPACTION REQUIREMENTS APPLY TO ALL COMPONENTS OF THE WORKS EXCEPT WHERE NOTED OTHERWISE.
2. THE MAXIMUM DIMENSION OF ANY PARTICLE SHALL NOT EXCEED 2/3 OF THE MAXIMUM LIFT THICKNESS.
3. THIS DRAWING SHALL BE READ WITH ACCOMPANYING DRAWINGS AND CONSTRUCTION MANAGEMENT PLAN. QUALITY CONTROL AND RECORD TESTING SHALL BE UNDERTAKEN AT THE FREQUENCIES IDENTIFIED IN THE CONSTRUCTION MANAGEMENT PLAN. THE OWNER OR IT'S CONTRACTOR SHALL IMMEDIATELY CONTACT THE ENGINEER SHOULD UNCERTAINTIES ARISE WITH THE CONSTRUCTION DRAWINGS AND / OR TECHNICAL SPECIFICATIONS CONTAINED IN THE CONSTRUCTION MANAGEMENT PLAN.
4. RIPRAP TYPE 2 FINE LIMIT WAS SELECTED CONSIDERING THE CALCULATED DISCHARGE VELOCITY FROM PIPELINE #1.

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YANKEE DOODLE TAILINGS IMPOUNDMENT

HORSESHOE BEND ROCK DISPOSAL SITE
STAGE 1 DRAINAGE SYSTEM
FILL MATERIAL SPECIFICATIONS

P/A NO.	DRAWING NO.	REVISION
VA101-126/25	MR-C4511	0

DRG. NO.	DESCRIPTION
REFERENCE DRAWINGS	

REV	DATE	DESCRIPTION	DESIGNED	DRAWN	REVIEWED	APPROVED
REVISIONS						

REV	DATE	DESCRIPTION	DESIGNED	DRAWN	REVIEWED	APPROVED
0	03DEC'2021	ISSUED FOR INFORMATION	KAB	RMM		
REVISIONS						

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XREF FILE(S): IMAGE FILE(S):

PLAN
SCALE A

LEGEND:

- RETAIN BUILDINGS
- DRAIN DOWN POND
- REMOVE BUILDINGS
- STAGE 1 RDS EXCLUSION AREA (INDICATIVE)
- FOUNDATION LAYER FOOTPRINT
- HIGH VOLTAGE TRANSMISSION LINE

NOTES:

1. COORDINATE SYSTEM AND ELEVATIONS ARE BASED ON ANACONDA MINE GRID.
2. BUILDING LOCATIONS EXTRACTED FROM AERIAL IMAGERY FROM JULY 9, 2020 PROVIDED BY MONTANA RESOURCES, LLP.
3. SEE DRAWING MR-C4513 FOR FOUNDATION LAYER FOOTPRINT AND GRADING PLAN.
4. SALVAGE MATERIALS AND DEMOLISH AND REMOVE ALL INFRASTRUCTURE WITHIN THE FOUNDATION LAYER FOOTPRINT, UNLESS OTHERWISE SPECIFIED.
5. TOPOGRAPHY PROVIDED BY MONTANA RESOURCES, LLP, AUGUST 2021.

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SCALE A: 250 0 250 500 750 1000 1250 ft

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YANKEE DOODLE TAILINGS IMPOUNDMENT

HORSESHOE BEND ROCK DISPOSAL SITE
STAGE 1 DRAINAGE SYSTEM
FOUNDATION PREPARATION
PLAN

P/A NO.	DRAWING NO.	REVISION
VA101-126/25	MR-C4512	0

REFERENCE DRAWINGS

DRG. NO.	DESCRIPTION
MR-C4513	HORSESHOE BEND ROCK DISPOSAL SITE - STAGE 1 DRAINAGE SYSTEM - FOUNDATION LAYER GRADING - PLAN

REVISIONS

REV	DATE	DESCRIPTION	DESIGNED	DRAWN	REVIEWED	APPROVED

REVISIONS

REV	DATE	DESCRIPTION	DESIGNED	DRAWN	REVIEWED	APPROVED
0	03DEC'21	ISSUED FOR INFORMATION	KAB	RMM		

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XREF FILE(S): HsB Rockfill - Phase 2 Footprint; HsB Rockfill - Phase 1; hsb stage 1 drains; HsB Rockfill - Foundation; 5ft_01_2020; TOPO - 5' - July 2021; HsB Rockfill - Foundation - Stepped IMAGE FILE(S):

PLAN
SCALE A

LEGEND:

- FOUNDATION LAYER
- STAGE 1 RDS EXCLUSION AREA (INDICATIVE)
- PIPELINE
- HIGH VOLTAGE TRANSMISSION LINE
- (SWDx) SURFACE WATER DITCH IDENTIFICATION

NOTES:

1. COORDINATE SYSTEM AND ELEVATIONS ARE BASED ON ANACONDA MINE GRID.
2. TOPOGRAPHY PROVIDED BY MONTANA RESOURCES, LLP., AUGUST 2021.
3. FOUNDATION LAYER SUBJECT TO DESIGN ENGINEER APPROVAL PRIOR TO ROCK DRAIN CONSTRUCTION. SEE DRAWING MR-C4514 FOR ROCK DRAIN PLAN.
4. FOUNDATION LAYER GRADING WILL BE ADJUSTED TO BALANCE ROCK DRAIN CUT AND FILL QUANTITIES DEPENDING ON FINAL DRAIN PROFILES AND CONSTRUCTION METHODOLOGY.
5. ACCESS RAMP TO BE DEVELOPED BY MR, OUTLINE SHOWN IS FOR CONCEPTUAL PURPOSES ONLY.
6. EARLY WORKS ACCESS ROAD TO BE DEVELOPED BY MINE OPERATORS. ALIGNMENT MAY BE MODIFIED TO SUIT CONSTRUCTION EQUIPMENT.

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SCALE A: 250 0 250 500 750 1000 1250 ft

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YANKEE DOODLE TAILINGS IMPOUNDMENT

HORSESHOE BEND ROCK DISPOSAL SITE
STAGE 1 DRAINAGE SYSTEM
FOUNDATION LAYER GRADING
PLAN

P/A NO.	DRAWING NO.	REVISION
VA101-126/25	MR-C4513	0

DRG. NO.	DESCRIPTION
MR-C4526	HORSESHOE BEND ROCK DISPOSAL SITE - STAGE 1 DRAINAGE SYSTEM - PIPELINE #1 AND 2 - PLAN AND PROFILE
MR-C4514	HORSESHOE BEND ROCK DISPOSAL SITE - STAGE 1 DRAINAGE SYSTEM - ROCK DRAINS AND DITCHES - PLAN

REFERENCE DRAWINGS

REV	DATE	DESCRIPTION	DESIGNED	DRAWN	REVIEWED	APPROVED

REVISIONS

REV	DATE	DESCRIPTION	DESIGNED	DRAWN	REVIEWED	APPROVED
0	03DEC'21	ISSUED FOR INFORMATION	KAB	RMM		

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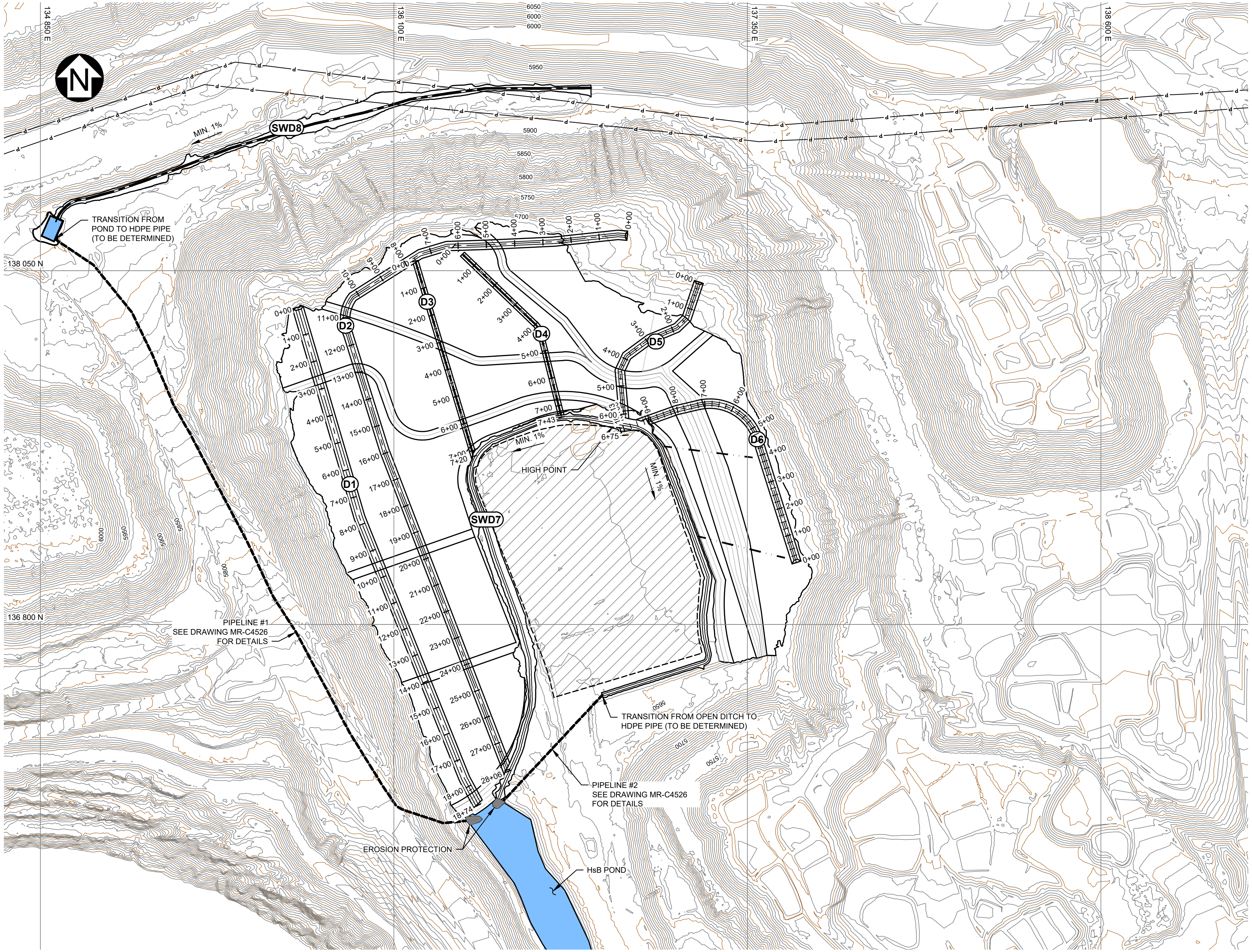
XREF FILE(S): SR_01_2020_HsB Rockfill - Foundation; TOPO - 5 - July 2021 HsB Rockfill - Foundation - Stripped; HsB Stage 1 Drains; PowerLine; IMAGE FILE(S):



PLAN
SCALE A

LEGEND:

- PRIMARY ROCK DRAIN
- SECONDARY ROCK DRAIN
- PIPELINE
- HIGH VOLTAGE TRANSMISSION LINE
- STAGE 1 RDS EXCLUSION AREA (INDICATIVE)
- Dx ROCK DRAIN IDENTIFICATION
- SWDx SURFACE WATER DITCH IDENTIFICATION
- HsB POND

NOTES:

1. COORDINATE SYSTEM AND ELEVATIONS ARE BASED ON ANACONDA MINE GRID.
2. TOPOGRAPHY PROVIDED BY MONTANA RESOURCES, LLP. AUGUST 2021.
3. PRIMARY ROCK DRAINS INCLUDE D1, D2, D3, D4, D5, AND D6. SEE DRAWINGS MR-C4521 AND MR-C4522 FOR DRAIN PROFILES.
4. SURFACE WATER DITCHES INCLUDE SWD7 AND SWD8.

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NOT FOR CONSTRUCTION

SCALE A 200 0 200 400 600 800 1000 ft

MONTANA 2021-12-06 DANIEL DYLAN FONTAINE No. 59785 PE LICENSED PROFESSIONAL ENGINEER

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MONTANA RESOURCES, LLP

YANKEE DOODLE TAILINGS IMPOUNDMENT

HORSESHOE BEND ROCK DISPOSAL SITE
STAGE 1 DRAINAGE SYSTEM
ROCK DRAINS AND DITCHES
PLAN

P/A NO.	DRAWING NO.	REVISION
VA101-126/25	MR-C4514	0

DRG. NO.	DESCRIPTION
MR-C4526	HORSESHOE BEND ROCK DISPOSAL SITE - STAGE 1 DRAINAGE SYSTEM - PIPELINE #1 AND 2 - PLAN AND PROFILE
MR-C4522	HORSESHOE BEND ROCK DISPOSAL SITE - STAGE 1 DRAINAGE SYSTEM - ROCK DRAIN PROFILES - SHEET 2 OF 2
MR-C4521	HORSESHOE BEND ROCK DISPOSAL SITE - STAGE 1 DRAINAGE SYSTEM - ROCK DRAIN PROFILES - SHEET 1 OF 2

REFERENCE DRAWINGS

REV	DATE	DESCRIPTION	DESIGNED	DRAWN	REVIEWED	APPROVED

REVISIONS

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0	03DEC'21	ISSUED FOR INFORMATION	KAB	RMM		

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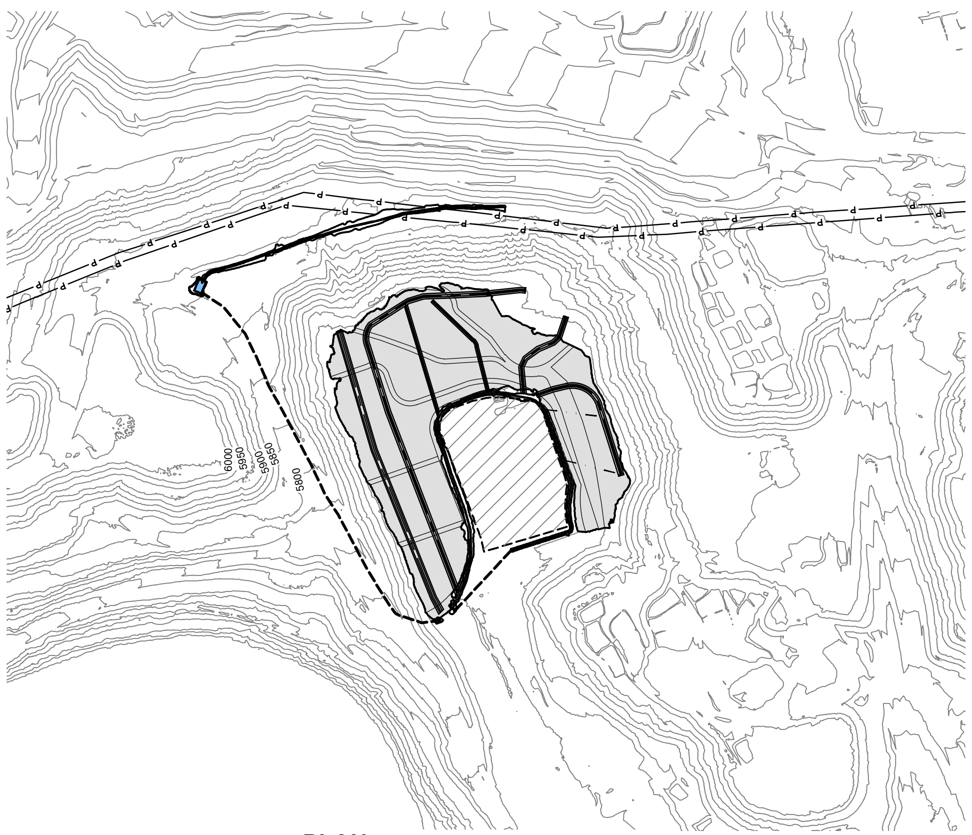
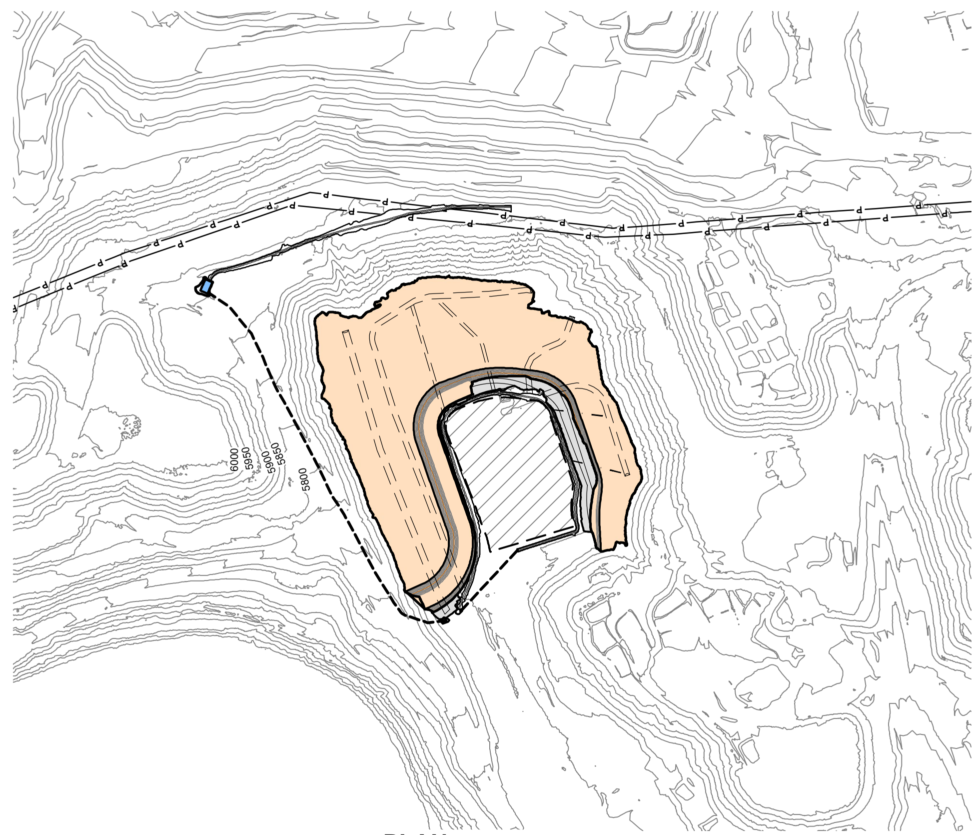
XREF FILE(S): Sft_01_2020; HsB Stage 1 Drains; HsB Rockfill - Phase 1; TOPO - 5' - July 2021; HsB Rockfill - Foundation; TOPO - 5' - EOY 2020; HsB Rockfill - Foundation - Stepped; Power Line IMAGE FILE(S):

PLAN
PHASE 1 - FOUNDATION PREPARATION
SCALE A

PLAN
PHASE 2 - FOUNDATION LAYER GRADING
SCALE A



PLAN
PHASE 3 - ROCK DRAINS AND DITCHES
SCALE A



PLAN
PHASE 4 - EL 5,700 LIFT
SCALE A

LEGEND:

- RETAIN BUILDINGS
- DRAIN DOWN POND
- REMOVE BUILDINGS
- FOUNDATION LAYER
- RDS
- STAGE 1 RDS EXCLUSION AREA (INDICATIVE)
- PRIMARY ROCK DRAIN
- SECONDARY ROCK DRAIN
- PIPELINE
- HIGH VOLTAGE TRANSMISSION LINE

NOTES:

1. COORDINATE SYSTEM AND ELEVATIONS ARE BASED ON ANACONDA MINE GRID.
2. TOPOGRAPHY PROVIDED BY MONTANA RESOURCES, LLP, AUGUST 2021.
3. RDS SHOWN IS CONCEPTUAL ONLY. FINAL GEOMETRY SUBJECT TO MATERIAL AVAILABILITY.
4. SEE DRAWING MR-C4512 FOR FOUNDATION PREPARATION.
5. SEE DRAWING MR-C4513 FOR FOUNDATION LAYER GRADING.
6. SEE DRAWING MR-C4514 FOR ROCK DRAINS AND DITCHES.

FOR INFORMATION ONLY
NOT FOR CONSTRUCTION

SCALE A 500 0 500 1000 1500 2000 2500 3000 ft

DRG. NO.	DESCRIPTION
MR-C4514	HORSESHOE BEND ROCK DISPOSAL SITE - STAGE 1 DRAINAGE SYSTEM - ROCK DRAINS AND DITCHES - PLAN
MR-C4513	HORSESHOE BEND ROCK DISPOSAL SITE - STAGE 1 DRAINAGE SYSTEM - FOUNDATION LAYER GRADING - PLAN
MR-C4512	HORSESHOE BEND ROCK DISPOSAL SITE - STAGE 1 DRAINAGE SYSTEM - FOUNDATION PREPARATION - PLAN

REFERENCE DRAWINGS

REV	DATE	DESCRIPTION	DESIGNED	DRAWN	REVIEWED	APPROVED

REVISIONS

REV	DATE	DESCRIPTION	DESIGNED	DRAWN	REVIEWED	APPROVED
0	03DEC'21	ISSUED FOR INFORMATION	KAB	RMM		

REVISIONS

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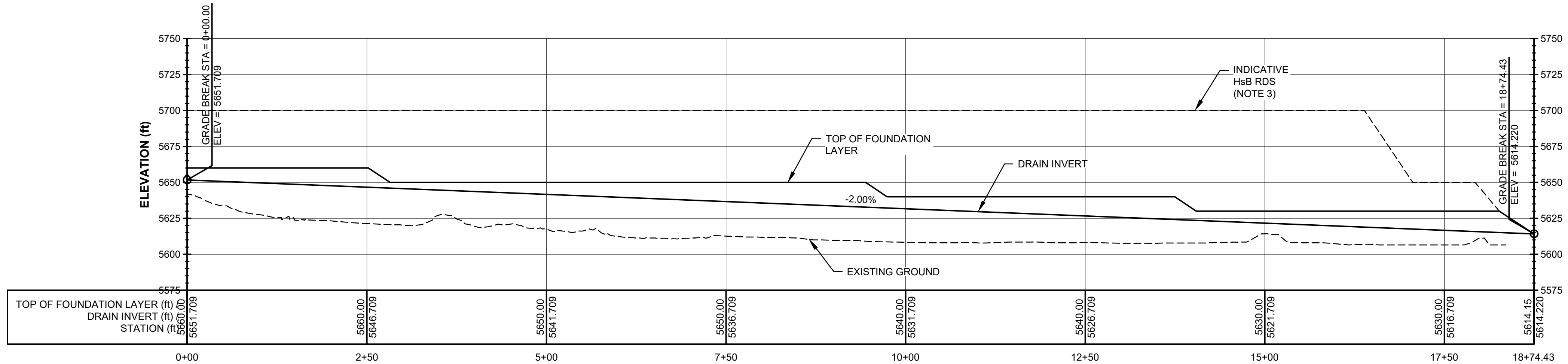
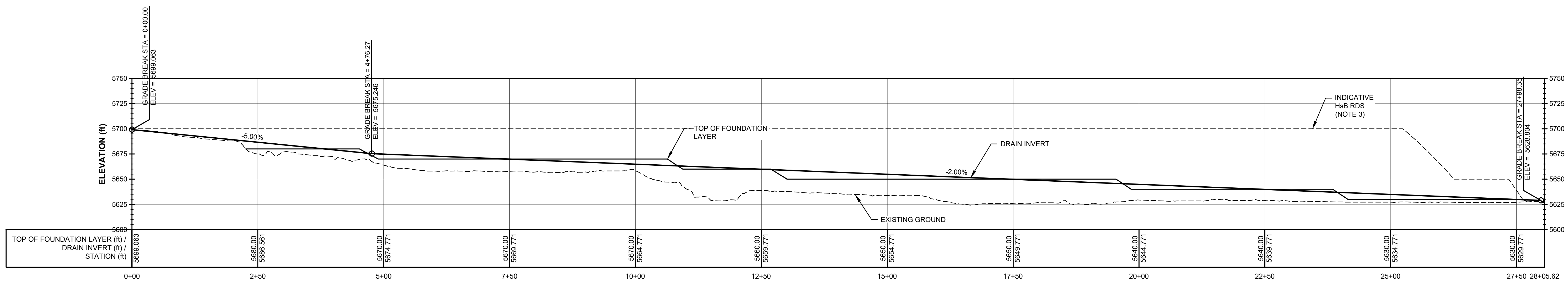
YANKEE DOODLE TAILINGS IMPOUNDMENT

HORSESHOE BEND ROCK DISPOSAL SITE
STAGE 1 DRAINAGE SYSTEM
PHASED CONSTRUCTION SEQUENCE

P/A NO.	DRAWING NO.	REVISION
VA101-126/25	MR-C4515	0



PROFILE
PRIMARY DRAIN D1
HORIZONTAL SCALE A
VERTICAL SCALE B



PROFILE
PRIMARY DRAIN D2
HORIZTONAL SCALE A
VERTICAL SCALE B

FOR INFORMATION ONLY
NOT FOR CONSTRUCTION

NOTES:

1. EXISTING GROUND PROFILE BASED ON TOPOGRAPHIC SURVEY PROVIDED BY MONTANA RESOURCES, LLP, AUGUST 2021..
2. ROCK DRAIN MATERIAL ZONES NOT SHOWN FOR CLARITY.
3. RDS GEOMETRY AS PER PHASE 4 ON DRAWING MR-C4515 SHOWN FOR INDICATIVE PURPOSES ONLY. FINAL GEOMETRY SUBJECT TO MATERIAL AVAILABILITY.
4. EXISTING GROUND SURVEY REPRESENTS WATER ELEVATION AND IS NOT REPRESENTATIVE OF ACTUAL GROUND CONDITIONS IN ARE OF HsB POND.
5. SEE DRAWING MR-C4530 FOR DRAIN SECTION AND DIMENSIONS.

SCALE B: 50 0 50 100 150 200 250 ft
SCALE A: 100 0 100 200 300 400 500 ft

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YANKEE DOODLE TAILINGS IMPOUNDMENT

HORSESHOE BEND ROCK DISPOSAL SITE
STAGE 1 DRAINAGE SYSTEM
ROCK DRAIN PROFILES
SHEET 1 OF 2

P/A NO.	DRAWING NO.	REVISION
VA101-126/25	MR-C4521	0

DRG. NO.	DESCRIPTION
MR-C4530	HORSESHOE BEND ROCK DISPOSAL SITE - STAGE 1 DRAINAGE SYSTEM - SECTIONS AND DETAILS - SHEET 1 OF 2
MR-C4514	HORSESHOE BEND ROCK DISPOSAL SITE - STAGE 1 DRAINAGE SYSTEM - ROCK DRAINS AND DITCHES - PLAN

REFERENCE DRAWINGS

REV	DATE	DESCRIPTION	DESIGNED	DRAWN	REVIEWED	APPROVED

REVISIONS

REV	DATE	DESCRIPTION	DESIGNED	DRAWN	REVIEWED	APPROVED
0	03DEC'21	ISSUED FOR INFORMATION	KAB	RMM		

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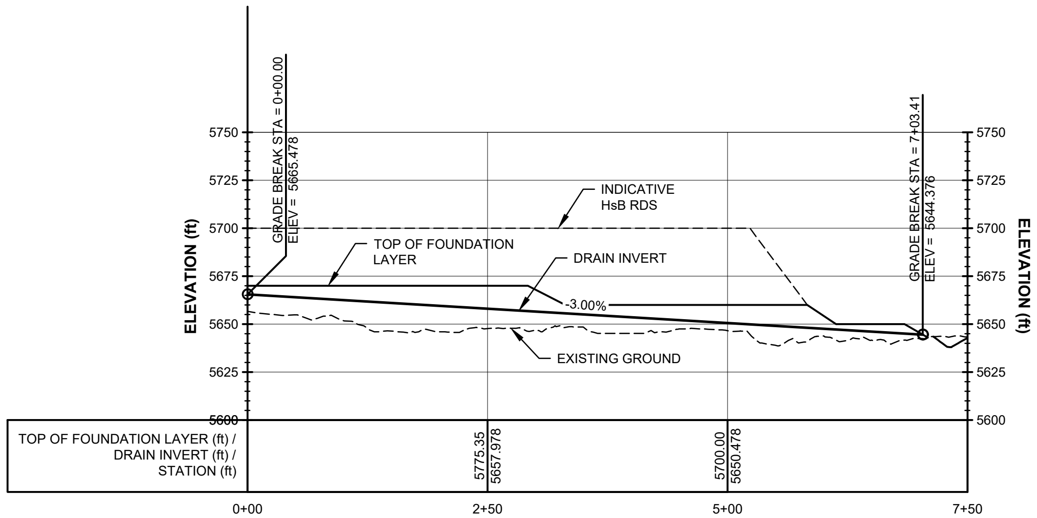
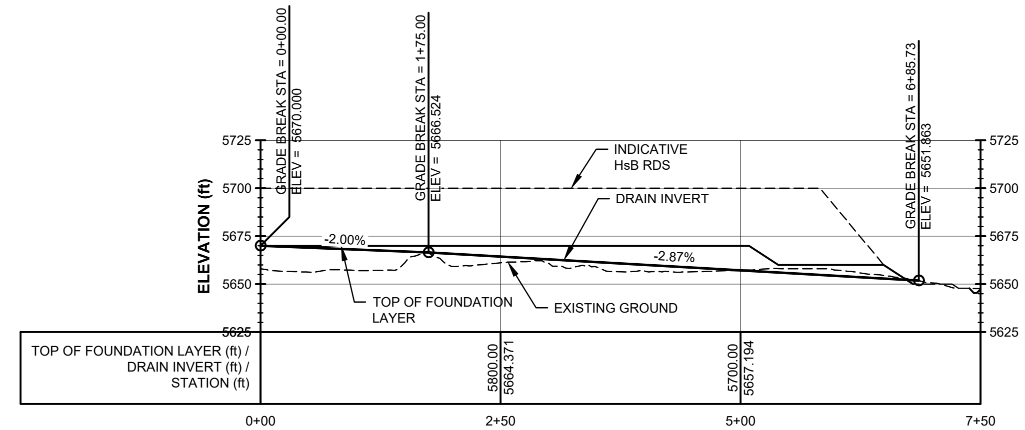
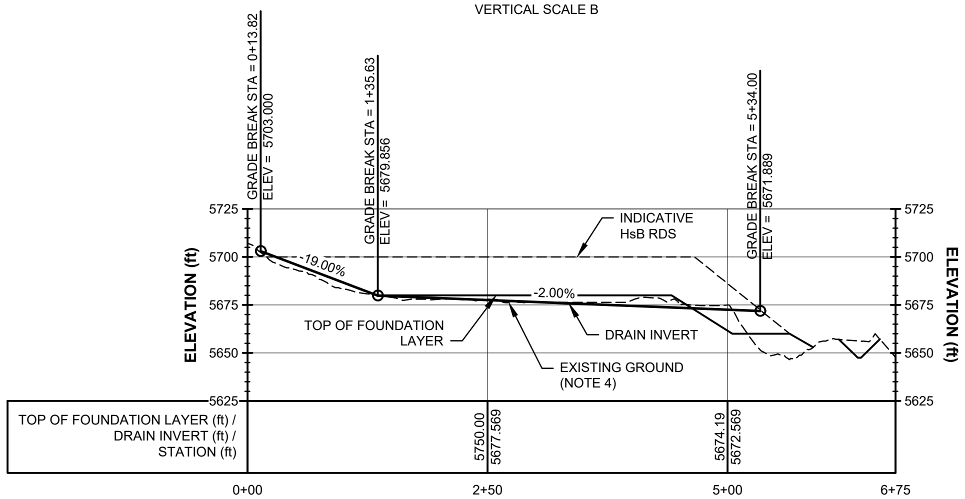


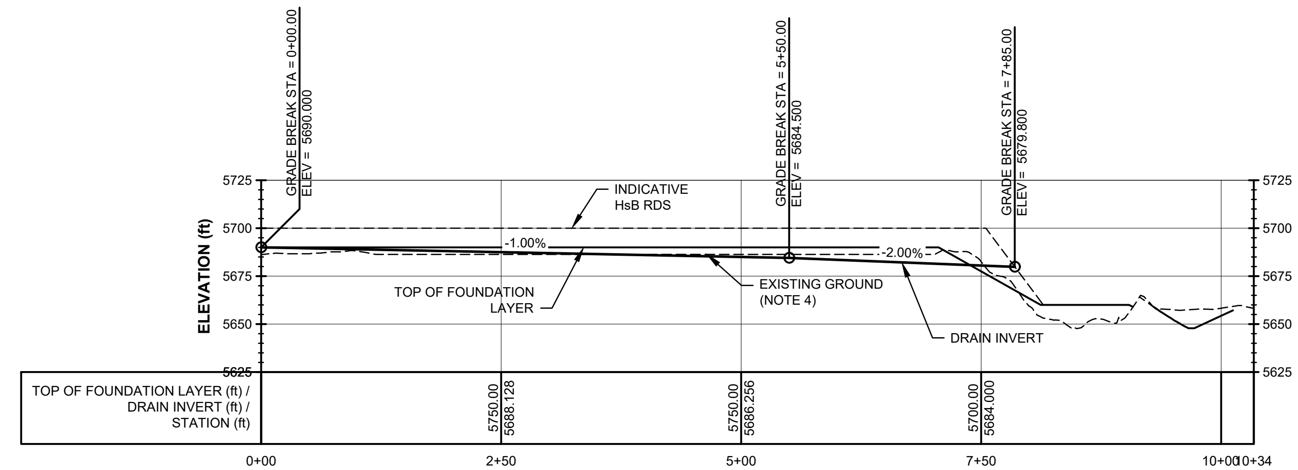
PROFILE
PRIMARY DRAIN D3
HORIZONTAL SCALE A
VERTICAL SCALE B



PROFILE
PRIMARY DRAIN D4
HORIZONTAL SCALE A
VERTICAL SCALE B



PROFILE
PRIMARY DRAIN D5
HORIZONTAL SCALE A
VERTICAL SCALE B



PROFILE
PRIMARY DRAIN D6
HORIZONTAL SCALE A
VERTICAL SCALE B

FOR INFORMATION ONLY
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SCALE B: 50 0 50 100 150 200 250 ft
SCALE A: 100 0 100 200 300 400 500 ft

NOTES:

1. EXISTING GROUND PROFILE BASED ON TOPOGRAPHIC SURVEY PROVIDED BY MONTANA RESOURCES, LLP, AUGUST 2021..
2. ROCK DRAIN MATERIAL ZONES NOT SHOWN FOR CLARITY.
3. FUTURE HsB RDS SHOWN FOR INDICATIVE PURPOSES ONLY. TOP ELEVATION SUBJECT TO ROCKFILL AVAILABILITY.
4. EXISTING GROUND SURVEY REPRESENTS WATER ELEVATION AND IS NOT REPRESENTATIVE OF ACTUAL GROUND CONDITIONS.
5. ROCK DRAIN GRADING WILL DEPEND ON SUBGRADE CONDITIONS FOLLOWING POND DRAIN DOWN.
6. SEE DRAWING MR-C4530 FOR DRAIN SECTIONS AND DIMENSIONS.

DRG. NO.	DESCRIPTION
MR-C4530	HORSESHOE BEND ROCK DISPOSAL SITE - STAGE 1 DRAINAGE SYSTEM - SECTIONS AND DETAILS - SHEET 1 OF 2
MR-C4514	HORSESHOE BEND ROCK DISPOSAL SITE - STAGE 1 DRAINAGE SYSTEM - ROCK DRAINS AND DITCHES - PLAN

REFERENCE DRAWINGS

REV	DATE	DESCRIPTION	DESIGNED	DRAWN	REVIEWED	APPROVED

REVISIONS

REV	DATE	DESCRIPTION	DESIGNED	DRAWN	REVIEWED	APPROVED
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YANKEE DOODLE TAILINGS IMPOUNDMENT

HORSESHOE BEND ROCK DISPOSAL SITE
STAGE 1 DRAINAGE SYSTEM
ROCK DRAIN PROFILES
SHEET 2 OF 2

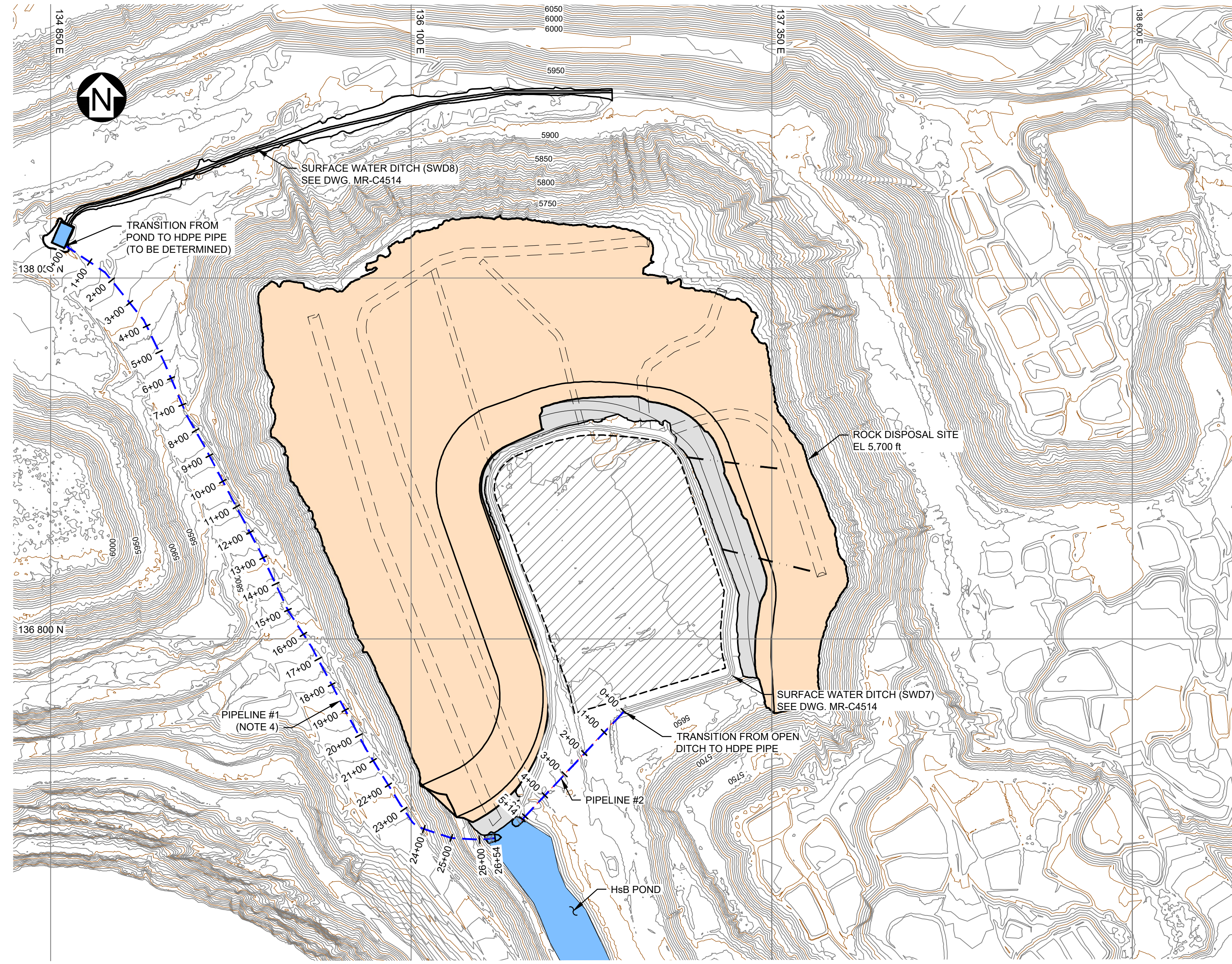
P/A NO.	DRAWING NO.	REVISION
VA101-126/25	MR-C4522	0

LEGEND:

- PIPELINE
- STAGE 1 RDS EXCLUSION AREA (INDICATIVE)
- POND
- FOUNDATION LAYER
- ROCKFILL
- PRIMARY ROCK DRAIN
- SECONDARY ROCK DRAIN

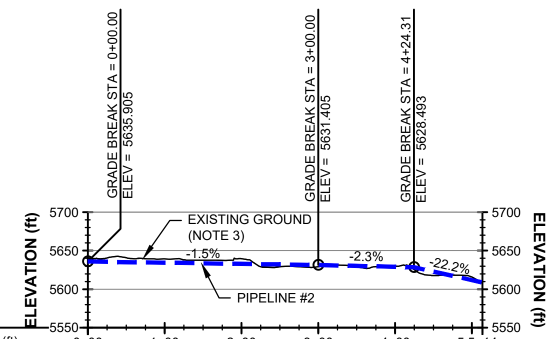
NOTES:

1. COORDINATE SYSTEM AND ELEVATIONS ARE BASED ON ANACONDA MINE GRID.
2. TOPOGRAPHY PROVIDED BY MONTANA RESOURCES, LLP. AUGUST 2021.
3. MINOR REGRADING MAY BE REQUIRED TO PROMOTE POSITIVELY DRAINING PIPE.
4. PIPELINE TO RUN ADJACENT TO ACCESS ROAD. PIPELINE TO BE PROTECTED FROM TRAFFIC WITH EARTH BERM AS REQUIRED.



PLAN

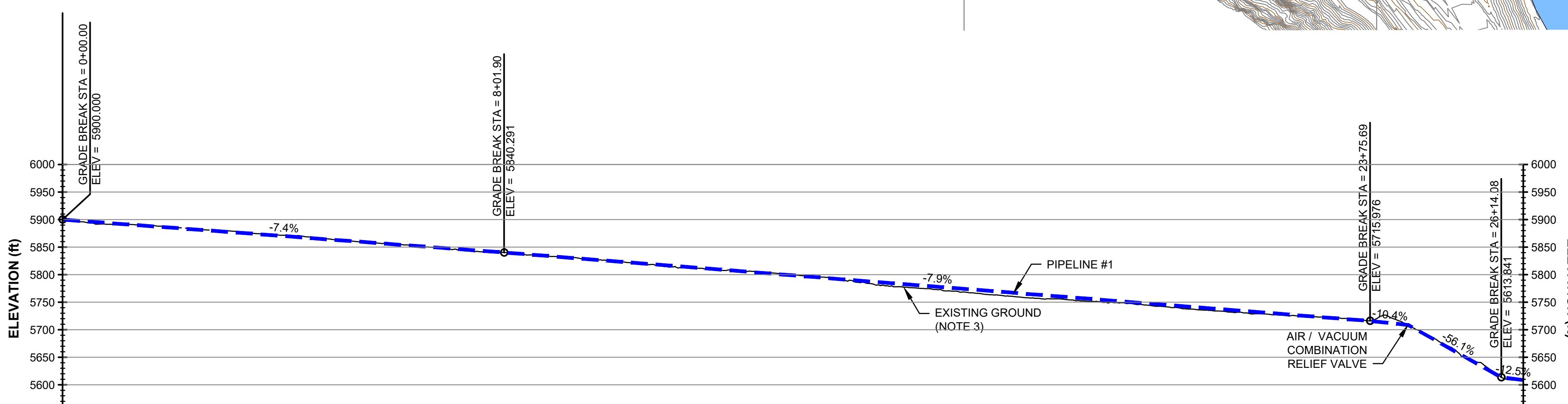
SCALE A



STATION (ft)	0+00	1+00	2+00	3+00	4+00	5 5+14
GROUND ELEVATION (ft)	5639.96	5639.23	5639.60	5629.14	5629.84	5 5608.26
PIPELINE SPECIFICATION	ND 26 in DR 11 HDPE					

PIPELINE #2 PROFILE

SCALE C



STATION (ft)	0+00	1+00	2+00	3+00	4+00	5+00	6+00	7+00	8+00	9+00	10+00	11+00	12+00	13+00	14+00	15+00	16+00	17+00	18+00	19+00	20+00	21+00	22+00	23+00	24+00	25+00	26+0(26+54
GROUND ELEVATION (ft)	5903.33	5891.75	5885.67	5879.72	5871.66	5862.88	5856.77	5845.69	5840.34	5832.55	5824.76	5814.31	5807.70	5802.10	5793.77	5779.42	5770.96	5763.11	5756.14	5748.74	5742.36	5733.99	5727.02	5721.12	5726.61	5679.41	5623. 5610.45
PIPELINE SPECIFICATION	ND 26 in DR 11 HDPE																										

PIPELINE #1 PROFILE

SCALE B

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SCALE C: 125 0 125 250 375 500 625 ft
SCALE B: 150 0 150 300 450 600 750 ft
SCALE A: 250 0 250 500 750 1000 1250 ft

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YANKEE DOODLE TAILINGS IMPOUNDMENT

HORSESHOE BEND ROCK DISPOSAL SITE
STAGE 1 DRAINAGE SYSTEM
PIPELINE #1 AND 2
PLAN AND PROFILE

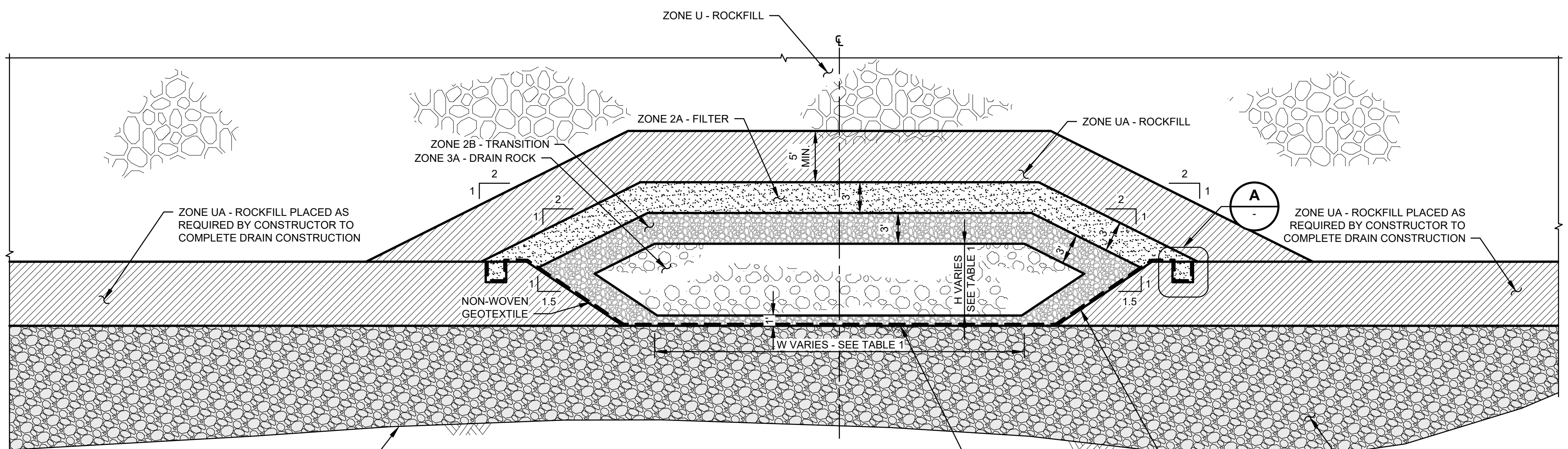
P/A NO.	DRAWING NO.	REVISION
VA101-126/25	MR-C4526	0

DRG. NO.	DESCRIPTION
MR-C4514	HORSESHOE BEND ROCK DISPOSAL SITE - STAGE 1 DRAINAGE SYSTEM - ROCK DRAINS AND DITCHES - PLAN
MR-C4510	HORSESHOE BEND ROCK DISPOSAL SITE - STAGE 1 DRAINAGE SYSTEM - GENERAL ARRANGEMENT

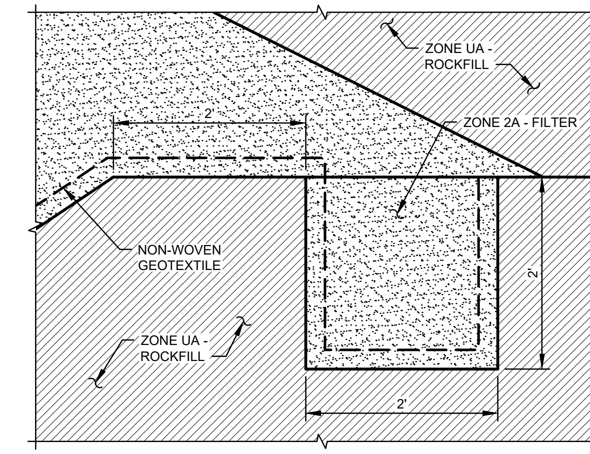
REFERENCE DRAWINGS

REV	DATE	DESCRIPTION	DESIGNED	DRAWN	REVIEWED	APPROVED
0	03DEC'21	ISSUED FOR INFORMATION	NPG	RMM		DDF

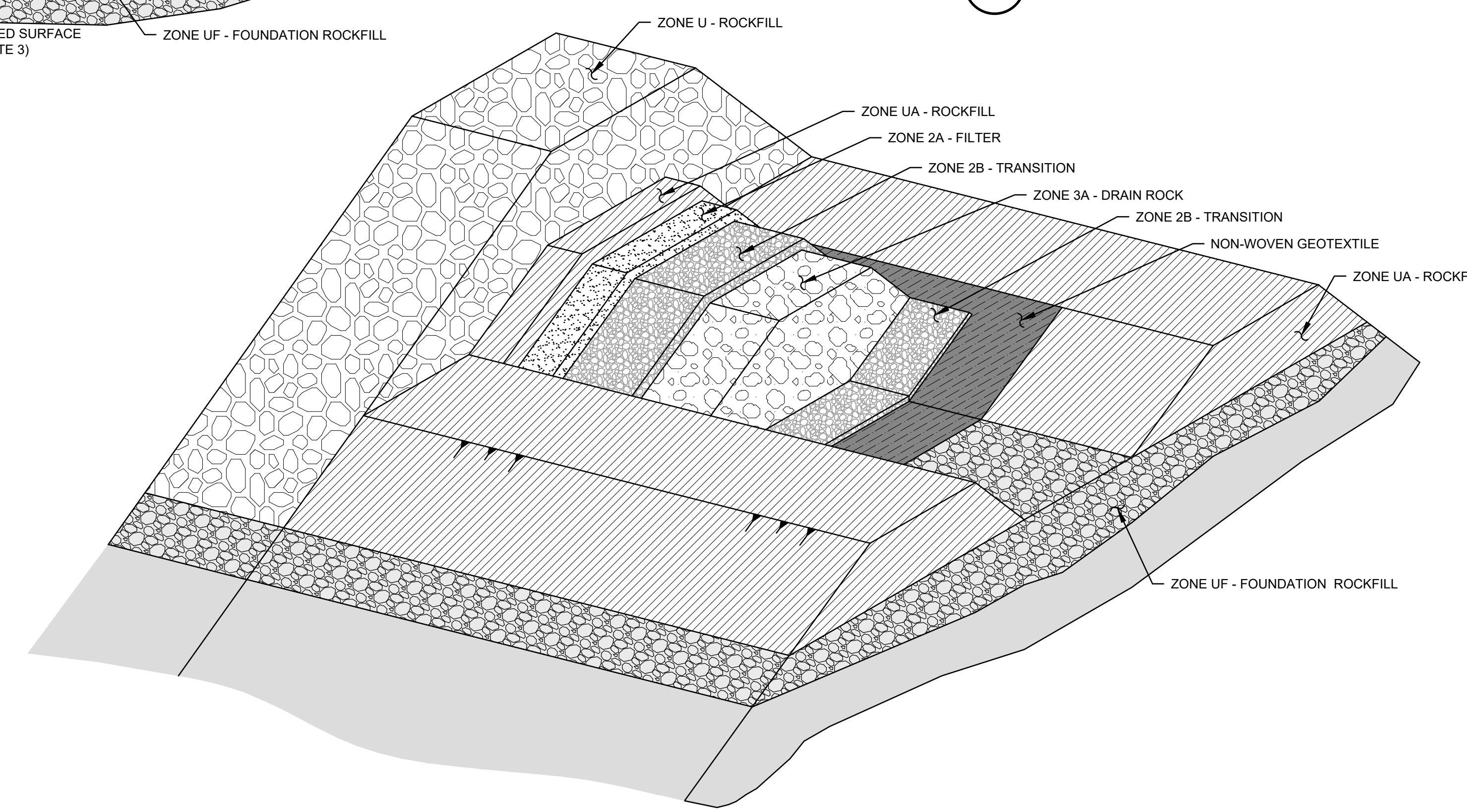
REVISIONS

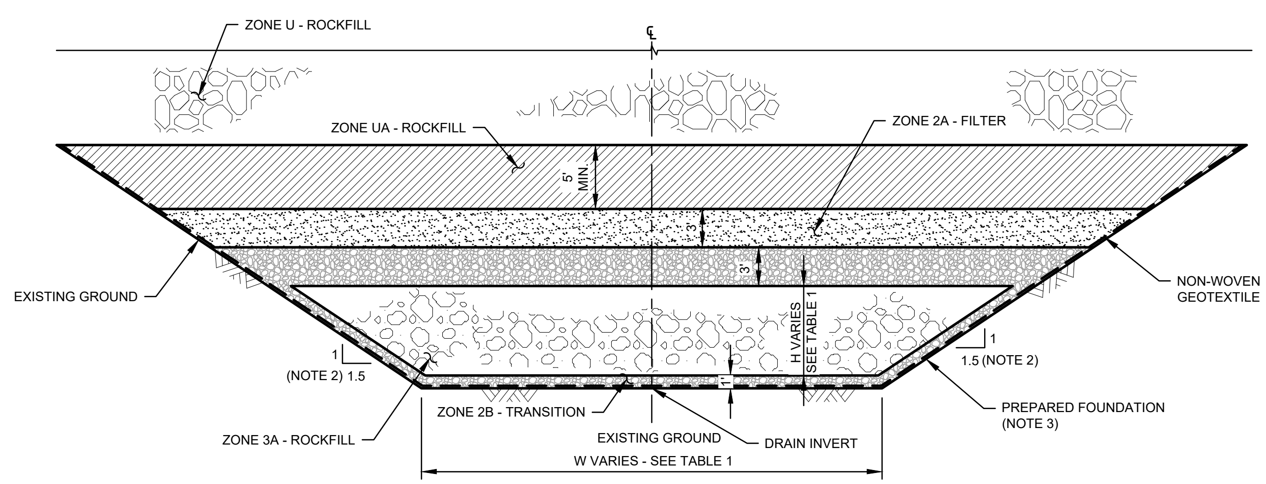


TYPICAL FILL SECTION
NTS



A DETAIL
NTS





TYPICAL CUT SECTION
NTS

ISOMETRIC CUT-AWAY (FILL SECTION)
NTS

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SCALE A 5 0 5 10 15 20 25 ft

TABLE 1 - ROCK DRAIN DIMENSIONS		
ROCK DRAIN ID	W (ft)	H (ft)
D1	20	7
D2	13	7
D3	5	5
D4	5	5
D5	13	7
D6	13	7

LEGEND:

- ZONE U - ROCKFILL
- ZONE UA - ROCKFILL
- ZONE 3A - DRAIN ROCK
- ZONE 2B - TRANSITION
- ZONE 2A - FILTER
- ZONE UF - ROCKFILL
- NON-WOVEN GEOTEXTILE

NOTES:

1. DIMENSIONS AND ELEVATIONS ARE IN FEET, UNLESS NOTED OTHERWISE.
2. MAXIMUM CUT AND FILL SLOPES ARE SHOWN. FLATTER SLOPES CAN BE CONSTRUCTED AT THE CONSTRUCTORS / OWNER DISCRETION TO AID CONSTRUCTION EFFICIENCY.
3. OVERSIZE BOULDERS PROJECTING INTO THE PREPARED FOUNDATION SHALL BE REMOVED AND THE HOLE SHALL BE FILLED WITH ZONE 2A - FILTER MATERIAL TO PROVIDE AN EVEN SURFACE TO RECEIVE THE GEOTEXTILE.
4. THIS DRAWING SHALL BE READ WITH ACCOMPANYING DRAWINGS AND TECHNICAL SPECIFICATIONS CONTAINED IN THE CONSTRUCTION MANAGEMENT PLAN.
5. SEE DRAWING MR-C4511 FOR FILL MATERIAL SPECIFICATIONS.

MONTANA ★ 2021-12-06 DANIEL DYLAN FONTAINE No. 59785 PE LICENSED PROFESSIONAL ENGINEER

DDF

Knight Piésold CONSULTING

MONTANA RESOURCES, LLP

YANKEE DOODLE TAILINGS IMPOUNDMENT

HORSESHOE BEND ROCK DISPOSAL SITE
STAGE 1 DRAINAGE SYSTEM
SECTIONS AND DETAILS
SHEET 1 OF 2

P/A NO.	DRAWING NO.	REVISION
VA101-126/25	MR-C4530	0

DRG. NO.	DESCRIPTION
MR-C4511	HORSESHOE BEND ROCK DISPOSAL SITE - STAGE 1 DRAINAGE SYSTEM - FILL MATERIAL SPECIFICATIONS

REFERENCE DRAWINGS

REV	DATE	DESCRIPTION	DESIGNED	DRAWN	REVIEWED	APPROVED

REVISIONS

REV	DATE	DESCRIPTION	DESIGNED	DRAWN	REVIEWED	APPROVED
0	03DEC'21	ISSUED FOR INFORMATION	KAB	RMM		

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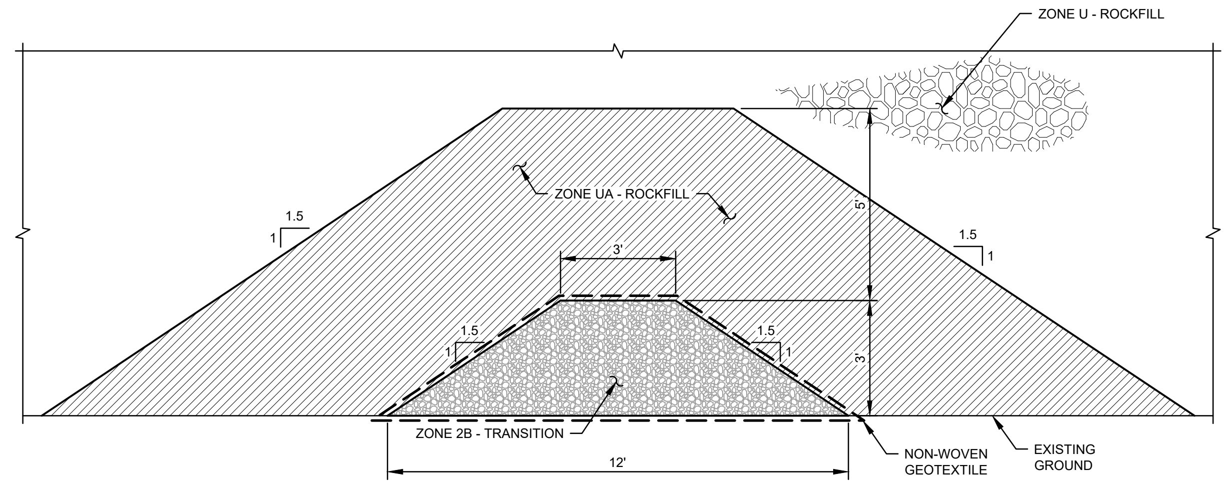
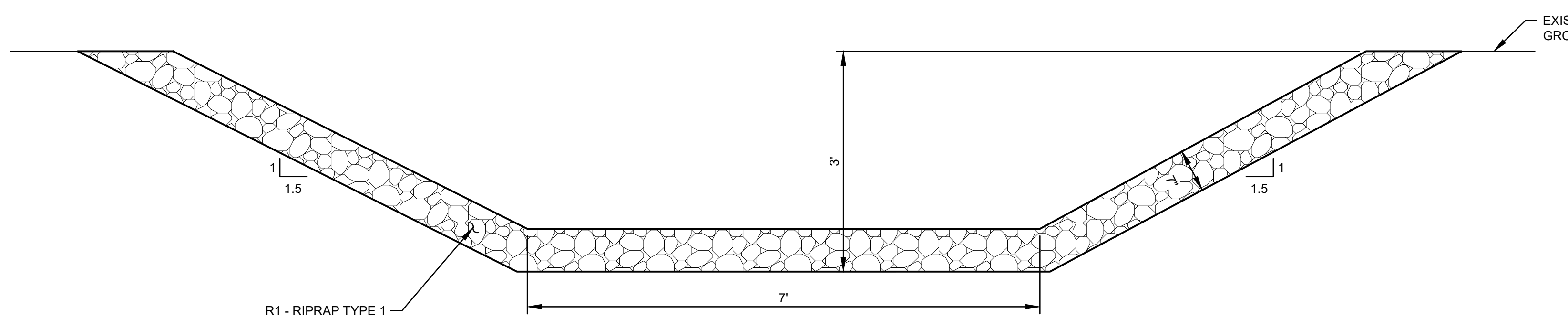
SAVED: M:\1\01\00126\25\A\Acad\DWGS\MR-C4530\MR-C4530, 12/3/2021 12:39:45 PM , RMCLELLAN PRINTED: 12/6/2021 10:27:10 AM, MR-C4530, RMCLELLAN ACAD VERSION: 23.0S (LMS TECH)
XREF FILE(S): IMAGE FILE(S):



SECONDARY DRAIN TYPICAL FILL SECTION
SCALE A



SURFACE WATER DITCH TYPICAL SECTION
SCALE B

LEGEND:

- ZONE UA - ROCKFILL
- ZONE UF - ROCKFILL
- ZONE U - ROCKFILL
- ZONE 3A - DRAIN ROCK
- ZONE 2B - TRANSITION
- ZONE 2A - FILTER
- RIPRAP
- NON-WOVEN GEOTEXTILE

NOTES:

1. COORDINATE SYSTEM AND ELEVATIONS ARE BASED ON ANACONDA MINE GRID.
2. SEE DRAWING MR-C4511 FOR FILL MATERIAL SPECIFICATIONS.

FOR INFORMATION ONLY
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SCALE B: 1.25 0 1.25 2.5 3.75 5 6.25 ft
SCALE A: 2.5 0 2.5 5 7.5 10 12.5 ft

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2021-12-06
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MONTANA RESOURCES, LLP

YANKEE DOODLE TAILINGS IMPOUNDMENT

HORSESHOE BEND ROCK DISPOSAL SITE
STAGE 1 DRAINAGE SYSTEM
SECTIONS AND DETAILS
SHEET 2 OF 2

P/A NO.	DRAWING NO.	REVISION
VA101-126/25	MR-C4531	0

REFERENCE DRAWINGS

DRG. NO.	DESCRIPTION
MR-C4511	HORSESHOE BEND ROCK DISPOSAL SITE - STAGE 1 DRAINAGE SYSTEM - FILL MATERIAL SPECIFICATIONS

REVISIONS

REV	DATE	DESCRIPTION	DESIGNED	DRAWN	REVIEWED	APPROVED

REVISIONS

REV	DATE	DESCRIPTION	DESIGNED	DRAWN	REVIEWED	APPROVED
0	03DEC'21	ISSUED FOR INFORMATION	KAB	RMM		

APPENDIX B

Design Basis Criteria

(Pages B-1 to B-2)

APPENDIX B
DESIGN CRITERIA – HORSESHOE BEND ROCK DISPOSAL SITE – STAGE 1 DRAINAGE SYSTEM

1.0 DESIGN CRITERIA

ABBREVIATIONS							
A	Assumed Data	KP	Knight Piésold Ltd.	ft	feet	TBA	To be Advised
C	Calculation	MR	Montana Resources, LLP	T	Testwork Data	TBC	To be Confirmed
D	Drawings / Archived Data	ft (amd)	Feet Above Mine Datum	V	Vendor Data / Info	TBD	To be Determined
E	Engineering Calculation		(ACC Vertical Datum)	I	Industry Standard		

CRITERIA DESCRIPTION	UNITS	VALUE	BASIS	DETAILS & COMMENTS
1.0 GENERAL SITE DATA				
Project Data				
Project Location	-	Butte, Montana	KP	
Site Coordinates	ft	136,630 E and 137,320 N	KP	Anaconda Mine Grid
Site Elevation	ft	Approximately 5,600 to 6,600	KP	
Climate Conditions				
Mean Annual Precipitation	inches	15.9	KP	KP, 2021 Climate Conditions Report
Mean Annual Pond Evaporation	inches	28.1	KP	KP, 2021 Climate Conditions Report. Includes sublimation
Mean January (coldest month) Temperature	°F	22.3	KP	KP, 2021 Climate Conditions Report.
Mean July (hottest month) Temperature	°F	63.6	KP	KP, 2021 Climate Conditions Report.
Return Period Storm Events				
1 in 10 Year, 24-hr Precipitation	Inches	2.3	KP	KP, 2021 Climate Conditions Report.
1 in 100 Year, 24-hr Precipitation	Inches	3.5	KP	KP, 2021 Climate Conditions Report.
1 in 200 Year, 24-hr Precipitation	Inches	3.9	KP	KP, 2021 Climate Conditions Report.
2.0 HORSESHOE BEND ROCK DISPOSAL SITE				
Dimensions and Layout Criteria				
HSB Base Elevation	ft (amd)	EL. 5,650 ft	E	Site Topography (TOPO - 5'-JULY 2021)
HSB Crest Elevation	ft (amd)	EL. 5,900 ft (Stage 1)	KP	Site Topography (TOPO - 5'- JULY 2021)

CRITERIA DESCRIPTION	UNITS	VALUE	BASIS	DETAILS & COMMENTS
Design Flow Rate	N/A	Selected based on historical flow rates observed in the HsB area while considering storm infiltration analysis	C	See repot text for details
Surplus rockfill material source	N/A	Continental Pit	MR	160 million tons available 2022-2031
RDS Storage Capacity	N/A	~ 20 Mt for the Stage 1 RDS	C	
Stockpile Geometry	N/A	Nominal 3H:1V overall slope angle created by angle of repose slopes and wide benches for every 50 ft lift	KP	
Rockfill Geochemical Properties	N/A	Acid potential varies, but all Continental Pit materials are inferred to be potentially acid generating due to low neutralizing potential	KP & MR	
Rockfill placement lifts	ft	Up to approximately 50 ft (nominal thickness)	MR	Typical waste dump construction practice
2.0 DRAINAGE SYSTEM				
Rock Drains				
Design Storm Event	N/A	1:200 Year Flood (Equivalent to 3.9 inches, including Climate Change adjustment)	KP	KP, 2021 Climate Conditions Report.
Objective	N/A	Convey groundwater discharge (seepage and precipitation infiltration) to the HSB Pond.	KP	
Seepage Water Quality	N/A	Acidic (~pH 3 based on HsB Pond water quality)	MR	
Construction Material	N/A	Specific drain materials sourced from Pipestone Quarry. Select materials from Continental Pit for foundation layer.	KP & MR	
Discharge Location	N/A	HsB Pond or surface water ditches	KP	
Existing Topography	N/A	Grades towards the west and south	E	Site Topography Provided by MR (TOPO - 5'- JULY 2021)
Foundation Preparation	N/A	Remove infrastructure except concrete pads, regrade existing topography as required to promote drainage and limit areas where water can pool in the foundation	KP	KP and MR
Flow Measurement Locations	N/A	Continued total flow monitoring at HsB Weir	KP & MR	To be maintained
Seepage Locations	N/A	HsB seeps, leach seeps, Seep 10 area, and other discharges to the pregnant leach solution collection ponds	KP	MR (Survey)
Seep 10 Historical Flow Rates	gpm	Seep 10 flows from September 2018 - October 2020 (most reliable period)	KP & MR	
Historical Flow Rates	gpm	HsB Weir flow records from 2000 - 2020	KP & MR	
Surface Water Ditches				
Design Storm Event	N/A	1:200 Year Flood (Equivalent to 3.9 inches, including Climate Change adjustment)	KP	KP, 2021 Climate Conditions Report.
Objective	N/A	Collect/convey surface water runoff to the HSB Pond	KP	
Discharge Location	N/A	HsB Pond	KP	

References:

Knight Piésold Ltd (KP) 2021, 'Yankee Doodle Tailings Impoundment Climate Conditions Report', dated September 1, 2021 (ref. VA101-126/24-2)

APPENDIX C

Rock Drain Sizing

(Pages C-1 to C-5)

APPENDIX C

ROCK DRAIN SIZING

1.0 DESIGN APPROACH

The design of the basal rock drains for the Horseshoe Bend (HsB) Rock Disposal Site (RDS) contemplates a flow-through rock drain with a shallow design slope following the Wilkins equation for non-Darcy flow through porous media (Wilkins, J.K., 1956). Considerations for application of the Wilkins equation to rock drain design were further investigated and limitations of the methods have been described by the Department of Civil Engineering at The University of Ottawa (V.K. Garga et al., 1990).

The required design cross sectional area of the rock drains was assessed for three design flow rates, as listed:

- 4,500 gpm
- 3,500 gpm
- 1,000 gpm

The Wilkins equation is formulated in metric units and is described below.

$$V_{VOIDS} = W \times m^{0.5} \times i^{\ 1/N}$$

Where:
V_{VOIDS} = velocity of flow in the voids
W = Wilkins empirical constant = 5.243
m = hydraulic mean radius
i = effective hydraulic gradient = drain slope = minimum 1.0%
N = empirically derived parameter between 1 and 2, typically = 1.852

The following additional equations are required to use the above Wilkins equation to assess the required drain cross sectional area for target design flow:

$$Q = V_{VOIDS} \times n \times A$$

$$m = \frac{e \times D}{6 \times r_e}$$

Where:
Q = design flow (refer Section 5.0 of the Design Report)
n = porosity (%) = 35% = 0.35
A = drain cross sectional area
e = void ratio, where e = n / (1 - n) = 0.538
D = Dominant particle size D_{50} of the rock drain material = 0.15 m
r_e = particle surface area efficiency ratio = 1.15

Reorganizing the equations to solve for the cross-sectional area of the drain:

$$A = \frac{Q}{n \times W \times m^{0.5} \times i^{1/N}}$$

2.0 ROCK DRAIN CROSS SECTIONAL AREAS

The resulting cross sectional areas and velocity of flow in the voids for each drain size is summarized in Table 1.

Table 1 Rock Drain Sizing Results

Drain I.D.	Parameter	Unit	Primary Drain			Secondary Drains
			D1	D2, D5, D86	D3 & D4	
Design Flow rate	Q	gpm	4,500	3,500	1,000	200
Cross sectional area	A	ft^2	200	150	60	30
Void velocity	Vv	ft/s	0.05	0.05	0.05	0.04

3.0 DESIGN FLOW CAPACITY SENSITIVITY

3.1 GENERAL

Rock drain flow velocity is controlled by:

- Hydraulic gradient (slope)
  - Fixed, based on existing topography
- Drain rock characteristics (particle size and porosity)
  - Subject to sensitivity analysis

Sensitivity analyses were undertaken for drain cross sectional areas of 60 ft^2, 150 ft^2 and 200 ft^2 with varying dominant particle sizes and porosity.

3.2 DOMINANT PARTICLE SIZE

The dominant particle size influences the flow capacity of the drain through the assessment of the hydraulic mean radius.

$$m = \frac{e \times D}{6 \times r_e}$$

A range of particle sizes was assessed in the sensitivity analysis, based on the material specification for Zone 3A and particle size distribution testing conducted during construction of the West Embankment Drain (WED), as listed below:

- D_{50} = 5 inches, minimum limit based on as-built data from the WED
- D_{50} = 6 inches, 95th percentile based on as-bult data from the WED
- D_{50} = 8 inches, median based on as-built data from the WED
- D_{50} = 14 inches, maximum limit based on as-built data from the WED

The results are presented on Figures 3.3 to 3.5 and further discussed in Section 3.4.

3.3 POROSITY

Flow capacity of a rock drain increases and decreases with increasing and decreasing porosity, respectively.

- Assumed porosity = 35%, based on D85/D15 > 2 as per Look, B.G, 2007 (refer Figure 3.1) and as-built data of Zone 3A material (refer Figure 3.2).
- Porosity was varied between 25% and 45% for the sensitivity analysis.

Table 17.10 Rock revetments (McConnell, 1998).

Revetment type	*Specification*	*Porosity*	*Thickness*
Rip – Rap	$D_{85}/D_{15} \sim 2$ to 2.5	35 to 40%	2 to 3 stones/rock sizes thick
Rock armour	$D_{85}/D_{15} \sim 1.25$ to 1.75	30 to 35%	2 rock sizes thick

Figure 3.1 Typical Rock Porosities (Look, 2007)

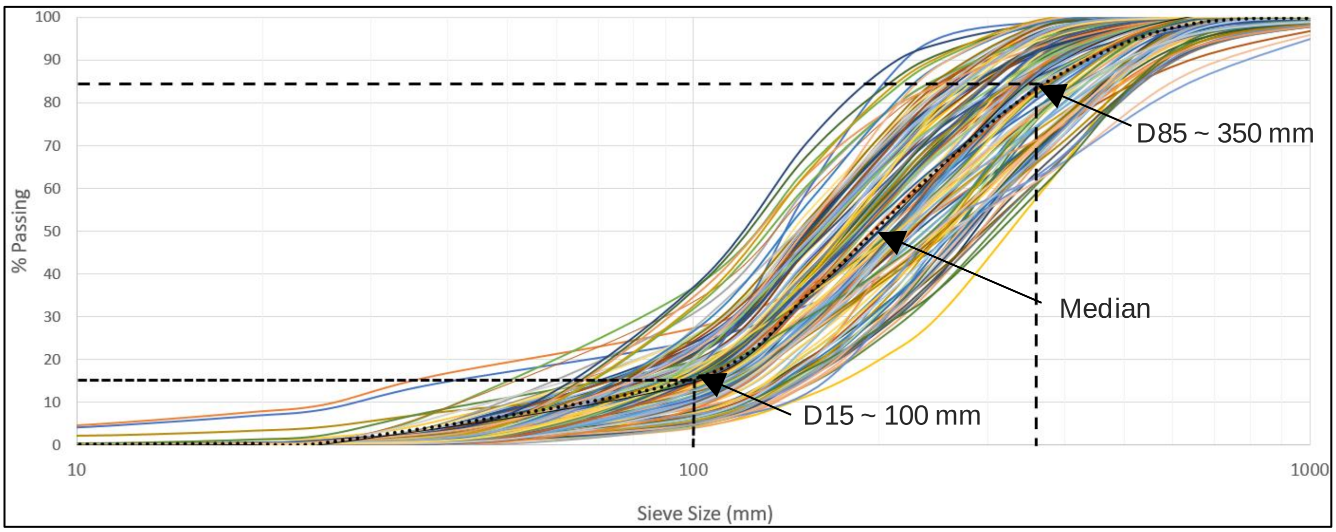

Figure 3.2 Zone 3A As-Built Particle Size Distribution Data (2017-2020)

3.4 SENSITIVITY ANALYSIS RESULTS

The results of the sensitivity analysis are presented on Figure 3.3 for a cross sectional area of 200 ft^2, and indicate the following:

- Assuming a D_{50} of 6 inches (150 mm), the flow rates vary between 2,700 gpm and 7,700 gpm for porosities ranging between 25% and 45%
- Assuming a porosity of 35%, the flow rates vary between 4,300 gpm and 7,500 gpm for D_{50} particle sizes ranging between 5 inches (130 mm) and 15 inches (360 mm)
- Assuming a porosity for 25%, the flow rates vary between 2,500 gpm and 4,200 gpm for D_{50} particle sizes ranging between 5 inches (130 mm) and 15 inches (360 mm)

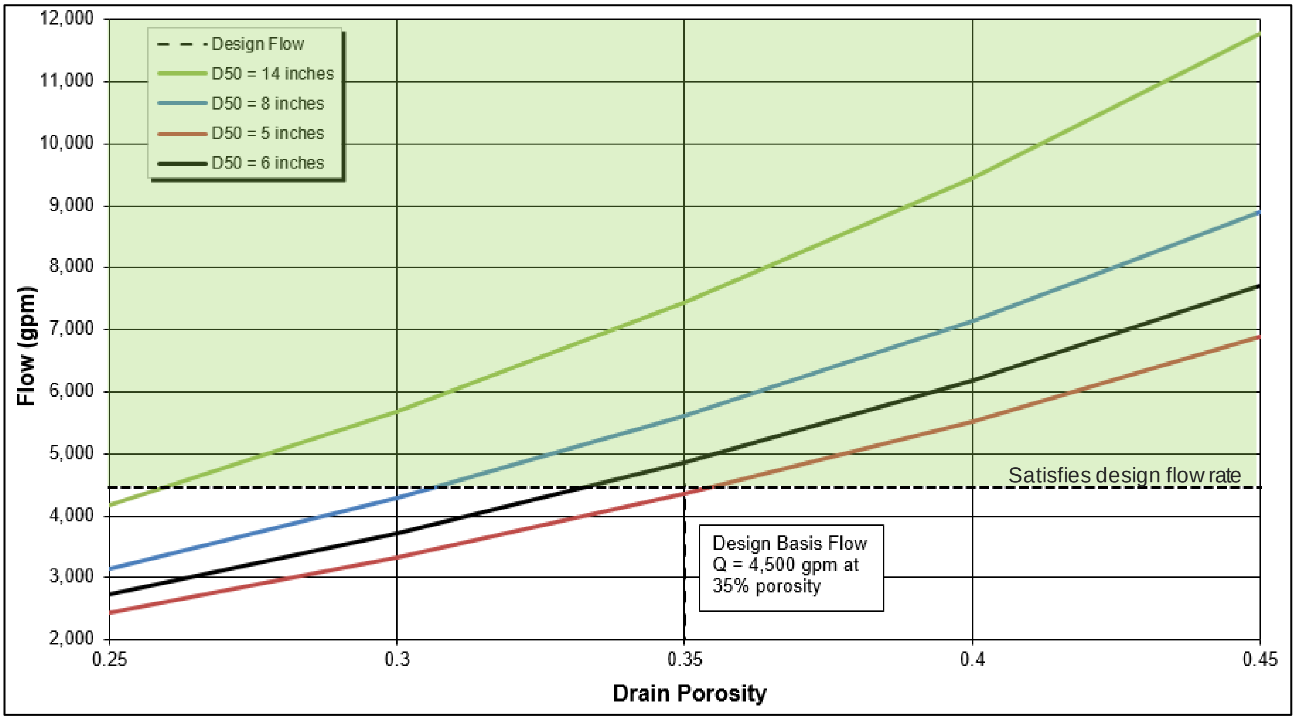

Figure 3.3 Sensitivity Analysis Results (Rock Drain Area = 200 ft^2)

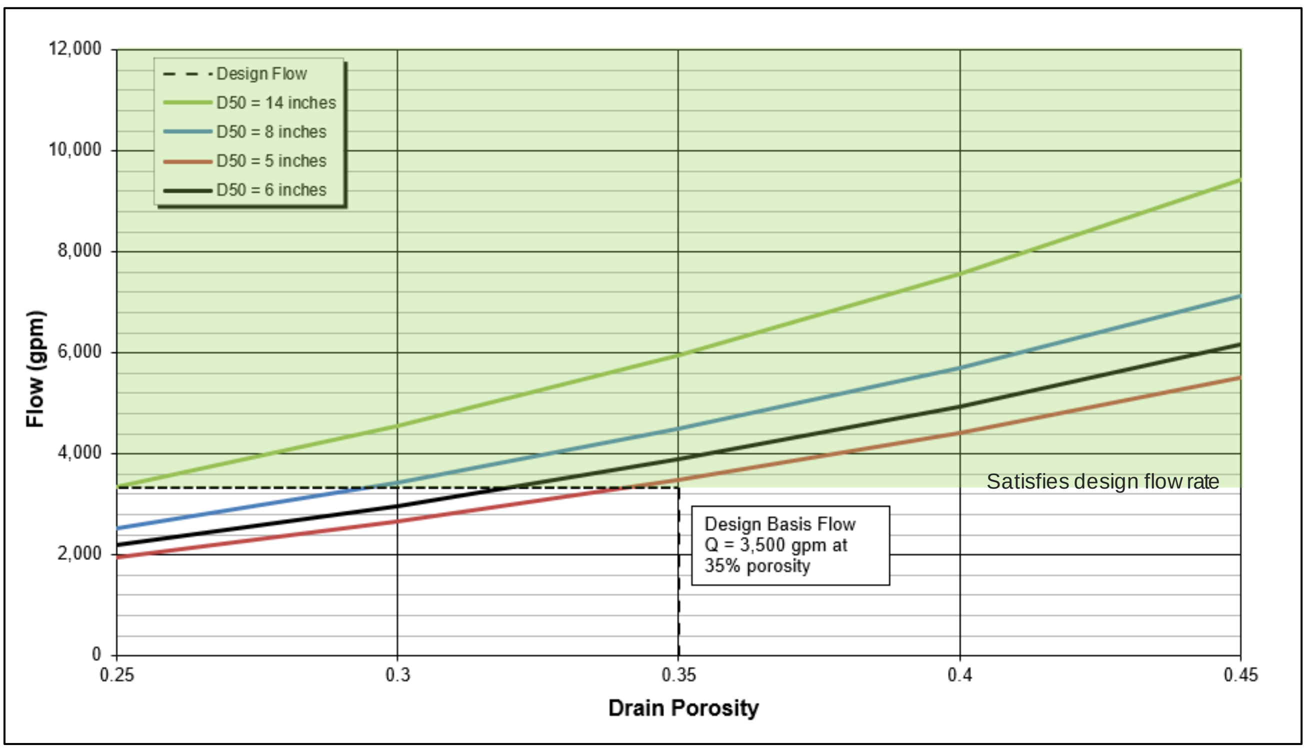

Figure 3.4 Sensitivity Analysis Results (Rock Drain Area = 150 ft^2)

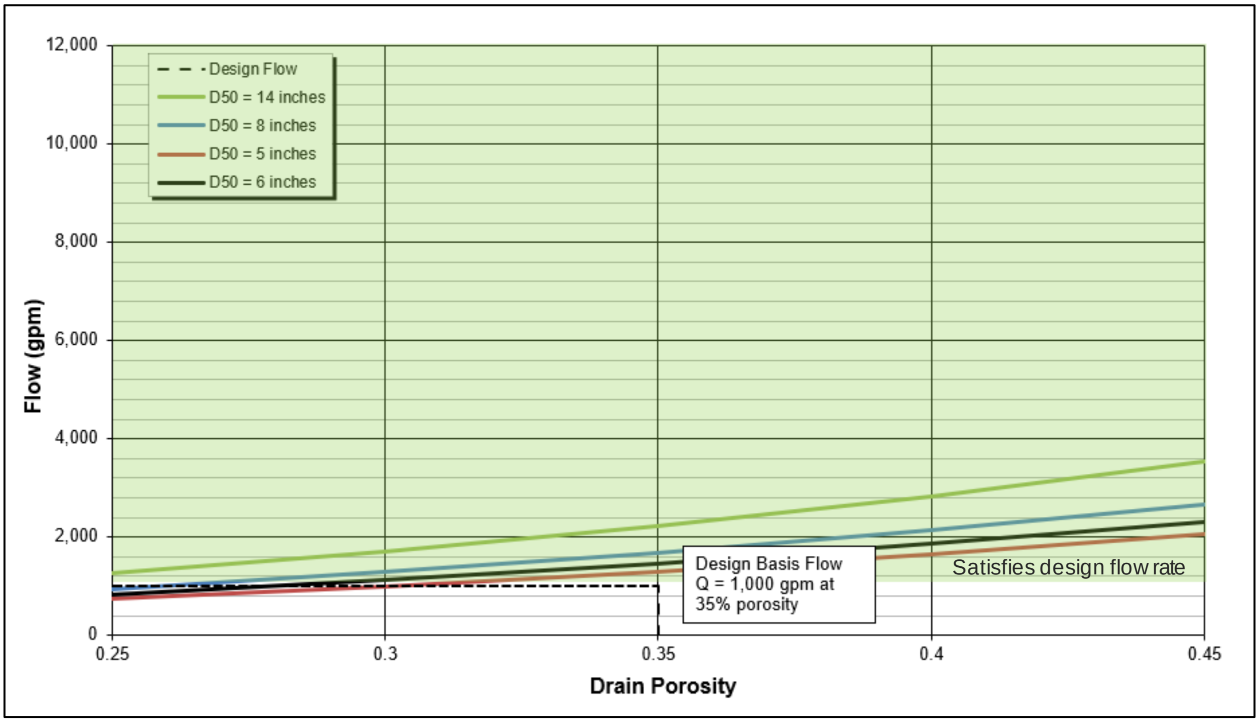

Figure 3.5 Sensitivity Analysis Results (Rock Drain Area = 60 ft^2)

The results presented on Figures 3.3 to 3.5 demonstrate the conservatism provided in the rock drain sizing. The drains sizes generally still have capacity to convey the maximum design flow rates even with slightly varied dominant particle sizes (D_{50}) and porosities.

References:

Garga. V.K, Hansen. D and Townsend. R.D, 1990, 'Considerations on the Design of Flowthrough Rockfill Drains', Proceedings of the 14th Annual British Columbia Mine Reclamation Symposium, Cranbrook, BC.

Look. B, G 2007, 'Handbook of Geotechnical Investigation and Design Tables', Taylor and Francis .

ATTACHMENT 3

Memorandum from the Independent Review Panel (IRP December 17, 2021) Regarding the HsB RDS Stage 1 Drainage System Report

Memorandum

To: Mark Thompson, Vice President of Environmental Affairs, Montana Resources

From: Independent Review Panel (IRP), Yankee Doodle Tailings Impoundment
Dr. Peter Robertson, P.Eng.,
Dr. Leslie Smith, P.Geo.,
Mr. James Swaisgood, P.E.,
Dr. Dirk van Zyl, P.E.

Cc: Mr. Dan Fontaine, Knight Piesold (Vancouver), EOR for YDTI

Subject: Horseshoe Bend Rock Disposal Site: Stage 1 Drainage System Report (Knight Piesold, December 6, 2021)

Date: December 17 2021

On November 23, 2021, the Independent Review Panel (IRP) for the YDTI participated in a meeting with Montana Resources (MR) and Knight Piesold (KP) to discuss the design of the Stage 1 Drainage System for the Horseshoe Bend Rock Disposal Site. The intent of the drainage system is to manage both surface water runoff in the Horseshoe Bend (HsB) area and groundwater discharge into the foundation of the Rock Disposal System (RDS). Initial design concepts were discussed with the IRP at meetings in June and September 2021. Prior to the November 23 meeting, the IRP received a draft copy of the Stage 1 Design Report. Following the November meeting the IRP received a copy of the final design report, dated December 6 2021, that addressed several questions discussed during the November meeting.

The IRP highlights the following observations:

- The IRP has previously expressed strong support of eventual placement of waste rock in the Horseshoe Bend area as a risk reduction measure to augment the stability of the YDTI embankment in the central pedestal area and to support eventual reclamation activities. Excess waste rock becomes available in 2023 and this is projected to continue through 2031. Basal drains to control the elevation of the phreatic surface within the foundation of the RDS and to collect contaminated seepage in the area are an essential component of the RDS.

- Foundation conditions in the HsB area are known in sufficient detail to support the design concept at this stage of the project.

- The RDS foundation layer is to be constructed of selectively sourced coarse, fresh to moderately weathered rock from the Continental Pit. Rock from Pipestone Quarry is to be used to construct the rock drains placed within the foundation layer. This material selection is considered appropriate.

- The layout and design capacity of the surface water diversion ditches to direct flow around the RDS is considered reasonable.

- The estimates of flow volumes that will enter the HsB area following construction of the RDS are based on sound assumptions, and the values reported appear reasonable.

- The overall design concept, incorporating six independent rock drains within the Stage 1 footprint, and the proposed construction sequence presented by KP, are considered by the IRP to be well suited to site conditions.

- A reasonable basis has been adopted for determination of the drain flow capacity requirement. The design is considered appropriately conservative. Redundancy has been incorporated in the design, given the long-term performance requirement following mine closure. The impact of a potential decline in drain conductance has been considered

- Montana Resources has considerable experience in the construction of the proposed rock drains, as the drains are based on a very similar design implemented within the WED on the west side of YDTI. To date, the WED drains have functioned according to design.

Peter Robertson

Leslie Smith

James Swaisgood

Dirk van Zyl

ATTACHMENT 4

Knight Piesold Tables 1-3
HsB Drainage Design - Sensitivity Analysis of Design Variables
(in response to DEQ Comment 4(a)-(c))

Knight Piésold CONSULTING

TABLE 1

MONTANA RESOURCES, LLP
YANKEE DOODLE TAILINGS IMPOUNDMENT

HSB RDS DRAINAGE SYSTEM - SENSITIVITY ANALYSIS OF DESIGN VARIABLES
VARIABILITY OF PRECIPITATION INFILTRATION FLOW RATE

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Design Variable	Design Value	Infiltration Flow Rates (gpm)	Design Infiltration Flow Rate (gpm)
Infiltration	75% Infiltration	40% Infiltration = 250	11,000
40% - 85% (Note 1)		85% Infiltration = 17,300	
Rainfall Event	200 yr	100 Year = 9,000	11,000
100 year – 1,000 year		1,000 Year = 16,800	
Rockfill Attenuation	2 hr		11,000
10 ft – 155 ft thick rockfill (Note 2)		155 ft, 13 hrs. = 2,600	
1 hr – 13 hrs. (Note 3)		10 ft, 1 hr = 19,200	

\\KPL\VA-Prj$\1\01\00126\25\A\Correspondence\VA22-00461 - HsB RDS Summary Tables\[Table 1 to 3.xlsx]Table 1 Precip Infiltration

NOTES:

1.WATER BALANCE INDICATES AVERAGE RUNOFF COEFFICIENT OF 25% (I.E., 75% INFILTRATION) FOR YDTI EMBANKMENT / DISTURBED AREAS (KP REFERENCE VA20-00440). INDUSTRY REPORTED TRIALS INDICATE INFILTRATION MAY VARY BETWEEN APPROXIMATELY 40% AND 85%, AS REPORTED IN WILLIAMS D. AND RHODE T., 2008 'RAINFALL INFILTRATION INTO AND SEEPAGE FROM ROCK DRAINS - A REVIEW', SEMINAR ON THE MANAGEMENT OF ROCK DUMPS, STOCKPILES AND HEAP LEACH PADS.

2. 10 FT THICKNESS REPRESENTS EARLY CONSTRUCTION, 155 FT THICKNESS REPRESENTS AVERAGE ROCKFILL THICKNESS AT COMPLETION OF STAGE 1.

3.ASSESSMENT COMPLETED ASSUMING ROCKFILL HYDRAULIC CONDUCTIVITY OF 3X10-3 FT/S. WHEN CONSIDERING 5% FINES, ATTENUATION TIME RANGES BETWEEN 2 DAYS (10 FT) AND 30 DAYS (155 FT), RESULTING IN FURTHER REDUCED PEAK INFILTRATION FLOW RATES. MATERIAL SPECIFICATION FOR ZONE U NOMINALLY ALLOWS UP TO 5% FINES.

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REV	DATE	DESCRIPTION	PREP'D	RVW'D

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TABLE 2

MONTANA RESOURCES, LLP
YANKEE DOODLE TAILINGS IMPOUNDMENT

HSB RDS DRAINAGE SYSTEM - SENSITIVITY ANALYSIS OF DESIGN VARIABLES
HSB WEIR FLOW DATA

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Weir Flow Design Range (Note 1)	Design Value	Historical Flow Rates (gpm)	Design Flow (gpm)
50th – 99th Percentile	98th Percentile	50th percentile = 2,900	4,500
		99th percentile = 5,200	

\\KPL\VA-Prj$\1\01\00126\25\A\Correspondence\VA22-00461 - HsB RDS Summary Tables\[Table 1 to 3.xlsx]Table 2 HsB Weir Data

NOTES:

1. AVERAGE DAILY FLOW RATES RECORDED AT THE HSB WEIR BETWEEN 2000 AND 2021. FLOW RATES REPRESENT COMBINED SEEPAGE AND STORMWATER RUNOFF

REV	DATE	DESCRIPTION	PREP'D	RVW'D
B	23MAR'22	ISSUED WITH TRANSMITTAL VA22-00461	KAB	RD

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TABLE 3

MONTANA RESOURCES, LLP
YANKEE DOODLE TAILINGS IMPOUNDMENT

HSB RDS DRAINAGE SYSTEM - SENSITIVITY ANALYSIS OF DESIGN VARIABLES
VARIABILITY OF ROCK DRAIN SIZING PARAMETERS

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Selected Wilkin's Equation Parameter (Note 1)	Design Value	Drain Flow Capacity Range	Drainage System Design Flow Capacity
		(gpm)	(gpm)
D50 Particle Size	6”	5” = 15,700	17,000 (Note 2)
5” – 14” (Note 3)		14” = 31,500	
Drain Slope	1%	1% = 17,000	17,000 (Note 2)
1% - 5% (Note 4)		5% = 40,600	
Porosity	0.35	0.3 = 13,000	17,000 (Note 2)
0.3 – 0.4 (Note 5)		0.4 = 26,000	

\\KPL\VA-Prj$\1\01\00126\25\A\Correspondence\VA22-00461 - HsB RDS Summary Tables\[Table 1 to 3.xlsx]Table 3 Rock Drain Para.

NOTES:

1. ROCK DRAINS SIZED IN ACCORDANCE WITH WILKIN'S EQUATION AS PRESENTED IN GARGA V., HANSEN. D AND TOWNSEND. R, 1990 'CONSIDERATIONS ON THE DESIGN OF FLOWTHROUGH ROCKFILL DRAINS', PROCEEDINGS OF THE 14TH ANNUAL BC MINE RECLAMATION SYMPOSIUM.
2. EXCLUDES CAPACITY OF FOUNDATION DRAINAGE BLANKET LAYER.
3. 5" REPRESENTS MINIMUM D50 AND 14" REPRESENTS MAXIMUM D50 SPECIFIED FOR ZONE 3A DRAIN ROCK MATERIAL. 6" REPRESENTS 95TH PERCENTILE D50 PARTICLE SIZE FOR ZONE 3A MATERIAL BASED ON CONSTRUCTION RECORDS FROM THE WEST EMBANKMENT DRAIN.
4. 1% REPRESENTS MINIMUM DESIGN GRADE FOR ROCK DRAIN AND 5% REPRESENTS MAXIMUM DESIGN GRADE BASED ON TOPOGPRAPHIC SURVEY DATA DATED AUGUST 2021. IN-SITU GRADES WILL BE SUBJECT TO THE OUTCOMES OF FOUNDATION PREPARATION WORKS.
5. POROSITY VALUES SELECTED BASED ON TYPICAL ROCKFILL POROSITIES AS PRESENTED BY LOOK B., 2007 'HANDBOOK OF GEOTECHNICAL INVESTIGATION AND DESIGN TABLES'

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REV	DATE	DESCRIPTION	PREP'D	RVW'D

ATTACHMENT 5

List of Revisions and New/Revised Pages, Figures, and Exhibits Associated With the HsB RDS Permit Modification - Montana Resources' December 10, 2021 Consolidated Operations and Reclamation Plans

Attachment 5A. Table 1 Consolidated Operations Plan Revisions - HsB RDS

Table 1. New/Revised Pages, Figures and Exhibits to MR's December 10, 2021 Operations Plan Due to HsB RDS Permit Modification Application		
Page No.	**Section/Table/ Figure**	**Revisions**
OP-vi	-	Add "HsB RDS" to List of Acronyms and Abbreviations
OP-1-1	Section 1.1	Add HsB RDS to list of permit modifications
OP-2-1	Section 2.1	Remove Precipitation Plant
OP-2-2	Section 2.3	Change Precipitation Plant exempt area discussion
OP-2-2	Section 2.3 (last paragraph)	Exceptions for the HsB RDS
OP-2-3	Table OP-2-1	Change acreages
OP-3-2	Figure OP-3-1	Delete Precipitation Plant label
OP-3-14	Section 3.3	Add new Section 3.3.9 HsB RDS
OP-3-15	Section 3.4.2	Embankment done in 2022 then rock to HsB RDS and other RDS's
OP-5-7	Figure OP-5-3	Delete Precipitation Plant
OP-5-8	Figure OP-5-4	Revise to show HsB RDS
OP-5-13	Section 5.3.5	Revise to reflect HsB drainage system
OP-6-1 to OP-6-3	Section 6.2	Leaching operations to be revised
OP-6-2	Figure OP-6-1	Delete
OP-7-2	Figure OP-7-1	Delete Precipitation Plant label
OP-8-3	Section 8.4	Bullets: add HsB drainage plan, revise Precipitation Plant circuit
OP-8-4	Figure OP-8-1	Revise to delete Precipitation Plant
OP-8-5 to OP-8-6	Section 8.4.2 - 8.4.4	Add new Section 8.4.2 (Horseshoe Bend Drainage System); new figure OP-8-2; re-number sections
OP-18-2	Section 18.0	Add KP HsB Report and IRP Memorandum
Exhibit OP-1	-	Add citation for HsB RDS
Exhibit OP-2	-	Change infrastructure to reflect HsB RDS

Attachment 5B. Table 2 Consolidated Reclamation Plan Revisions - HsB RDS

Table 2. New/Revised Pages, Figures and Exhibits to MR's December 10, 2021 Reclamation Plan Due to HsB RDS Permit Modification Application		
Page No.	**Section/Table/ Figure**	**Revisions**
RP-vi	-	Add "HsB" to List of Acronyms and Abbreviations
RP-1-1	Section 1.1	Add Minor Amendment HsB RDS to second paragraph
RP-1-1	Section 1.1	Add HsB drainage system design to last paragraph
RP-1-5	Section 1.5	Add bullet referencing William Schafer
RP-1-7	Table RP-1-1	Add Section 8.2.9 HsB RDS to table
RP-3-1	Section 3.2	Revise paragraph 1
RP-3-2	Section 3.2	Revise paragraph 1 (E-W Embankment)
RP-3-3	Section 3.2.1	Add new paragraph regarding Stormwater Discharge permit
RP-6-2	Figure RP-6-1	Revise to delete "Precipitation Plant"
RP-7-1	Section 7.0	Paragraph 2, delete reference to "riprapped areas"
RP-8-1	Section 8.1.1	Delete sentences referring to riprap
RP-8-2	Figure RP-8-1	Revise to delete riprapped slope
RP-8-3	Figure RP-8-2	Revise to delete riprapped slope
RP-8-10	Figure RP-8-5	Revise to add HsB RDS
RP-8-12	Figure RP-8-6	Revise to add HsB RDS and delete Precipitation Plant
RP-8-14	Section 8.2.9	Add new Section 8.2.9 HsB RDS
RP-8-18	Section 8.5.1	Paragraph 1, bullet 4: revise reference to Precipitation Plant
RP-8-19	Section 8.5.2	Revise reference to Precipitation Plant in first sentence
RP-8-21	Section 8.10	Consider revisions pertaining to HsB RDS/drainage
RP-9-2	Table RP-9-1	Add HsB RDS and timeframe
RP-11-1	Section 11.0	Revise reference to Precipitation Plant in "Pre-1971"
RP-12-1	Section 12.0	Add citation for KP 2021 Stage 1 HsB RDS Report
Appendix RP-B	Figures RP-B-25 through 28	Add HsB RDS Site Cross-Sections
Exhibit RP-1	-	Revise "Continental Mine Facilities" to reflect changes associated with site preparation and location of HsB RDS
Exhibit RP-2	-	Revise "Post-Closure Topography" to incorporate HsB RDS