

MONTANA RESOURCES, LLP YANKEE DOODLE TAILINGS IMPOUNDMENT



RECLAMATION OVERVIEW

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**MONTANA RESOURCES, LLP
YANKEE DOODLE TAILINGS IMPOUNDMENT**

**RECLAMATION OVERVIEW
VA101-126/12-8**

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0	Issued in Final	January 17, 2017
1	Issued with updates for 6450 Embankment	August 16, 2017
2	Issued with update to WED post-closure reclamation	September 7, 2017
3	Issued with updated Table 3.2	October 5, 2017
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5	Issued with revisions for consistency within the report	May 2, 2018

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EXECUTIVE SUMMARY

Montana Resources, LLP (MR) operates an open pit copper and molybdenum mine located within the northeastern part of Butte, Montana. The Yankee Doodle Tailings Impoundment (YDTI) is the tailings storage facility for the mine. MR is preparing a Permit Amendment (Amendment) application to provide for continued mining beyond 2020. The proposed Amendment involves raising the crest elevation of the YDTI West Embankment to 6,450 feet (ft) and commencing operation of the West Embankment Drain (WED). The proposed Amendment will provide approximately 12 years of additional mine life.

The Reclamation Overview provides a summary of the current reclamation plan for the YDTI, identifies new reclamation strategies for facility components not considered in the current reclamation plan and post-reclamation monitoring and inspection considerations.

The current post-closure reclamation plan for the YDTI is outlined in the 2015 5-year bond review, which was prepared by the Montana Department of Environmental Quality (MDEQ). The 2015 Bond considers the YDTI as having three reclamation components: the Embankment, the Tailings Beach and the Tailings Pond. The general reclamation strategies include regrading, placing an amended alluvium cap and revegetation. An existing closure system includes a stormwater retention pond with adjacent wetland area on the north side of the facility is currently planned for the tailings impoundment.

The proposed Amendment closure arrangement consists of four key reclamation components for the YDTI:

- Additional embankment acreage
- Additional impoundment acreage
- Closure spillway, and
- West Embankment Drain (WED).

The proposed YDTI components will be reclaimed using the existing reclamation strategies where applicable. Features not amenable to current reclamation strategies will be reclaimed using new methods conceptually described in this report. The goal of new reclamation strategies will be to limit post-closure maintenance requirements to the greatest extent practicable.

The construction of the YDTI embankments to EL. 6,450 ft will result in a total impoundment area of approximately 1,804 acres and a total embankment area of approximately 491 acres. The new embankment slope acreage will be reclaimed using the same grading, capping and revegetation strategies as outlined in the 2015 Bond. The West Embankment slopes will be reclaimed concurrently during mine life wherever practical. The crest areas will be designated as either Access Road or Embankment and reclaimed accordingly.

The tailings beach reclamation will include surface shaping to compensate for settlement, placement of a 28-inch thick amended alluvium cap, and revegetation. The tailings beach areas susceptible to wind erosion will also initially be covered with a dust control layer of rockfill shortly after the cessation of operations.

A closure spillway is included in the Amendment as part of the YDTI closure plan to provide a water management system for releasing excess water from the impoundment to the Continental Pit. The

▲ R4

spillway will passively manage the maximum extent of the pond in closure preventing water pooling adjacent to the embankment. The spillway will not be operated as a routine water discharge system, and in all likelihood will never convey flow. It will only convey flow if an exceptionally unlikely sequence of storm events were to occur.

The WED is a gravity controlled subsurface seepage collection drain located along the upstream toe of the West Embankment. The WED is designed to intercept seepage migrating west of the YDTI above elevation 6,350 ft. Seepage collected by the drain will passively drain to a lined Extraction Pond, which will then be pumped back to the YDTI during operations. The WED will continue to be required for hydrodynamic containment following closure for a period of approximately 20 years until the closure pond elevation decreases below the potentiometric low in the West Ridge.

▲ R2

A detailed plan identifying site-specific needs for monitoring, inspection and review will be prepared following completion of the YDTI reclamation program. The plan will include details such as the monitoring requirements, monitoring frequency and minimum qualifications of monitoring personnel.

The Engineer of Record (EOR) will be retained for the YDTI post-closure and will be responsible for reviewing new documents and designs pertaining to the YDTI. The EOR will conduct Annual Inspections of the YDTI until reclamation is complete and the Independent Review Panel (IRP) is convened for a Periodic Review. It is anticipated the IRP will be convened within five years of closure to evaluate the performance of the facility relative to dam safety standard of practice. The frequency of inspections and future involvement of the EOR and IRP thereafter will be discussed during the first Periodic Review following closure and will be incorporated in the detailed closure monitoring plan.

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Appendix A	Summary of Montana Resources Current Closure Reclamation Strategy for the YDTI		
Appendix B	Closure Spillway: Design Criteria and Conceptual Configuration		▲ R4

ABBREVIATIONS

ACC	Anaconda Copper Company
E.....	East
EL.....	elevation
EOR	Engineer of Record
EPA.....	Environmental Protection Agency
HsB	Horseshoe Bend
IRP	Independent Review Panel
KP	Knight Piésold Ltd.
MCA	Montana Code Annotated
MDEQ	Montana Department of Environmental Quality
MR	Montana Resources, LLP
N	North
NW.....	Northwest
PMF	Probable Maximum Flood
QPP	Quantitative Performance Parameter
S.....	South
W.....	West
WED.....	West Embankment Drain
WTP	Water Treatment Plant
YDTI.....	Yankee Doodle Tailings Impoundment

1 – INTRODUCTION

1.1 PURPOSE AND SCOPE

Montana Resources, LLP (MR) operates an open pit copper and molybdenum mine located adjacent to the city of Butte, Montana in Silver Bow County. The mine produces copper sulfide concentrate, molybdenum disulfide concentrate and copper precipitate (cement copper). MR is currently mining the Continental Pit at a nominal Concentrator throughput rate of approximately 50,000 tons per day.

MR is preparing a Permit Amendment (Amendment) application to provide for continued mining beyond 2020. The proposed Amendment involves raising the crest elevation of the YDTI West Embankment to 6,450 feet (ft) and commencing operation of the West Embankment Drain (WED). The proposed Amendment will provide approximately 12 years of additional mine life. The YDTI general arrangement with the proposed 6,450 ft embankment crest is shown on Figure 1.1.

The Reclamation Overview has been prepared as part of the Amendment technical design document, as required by Title 82, Chapter 4, Part 3, Section 376 of the Montana Code Annotated (MCA). MCA 82-4-376 requires the design document include identification and consideration of the following post closure reclamation details for the YDTI:

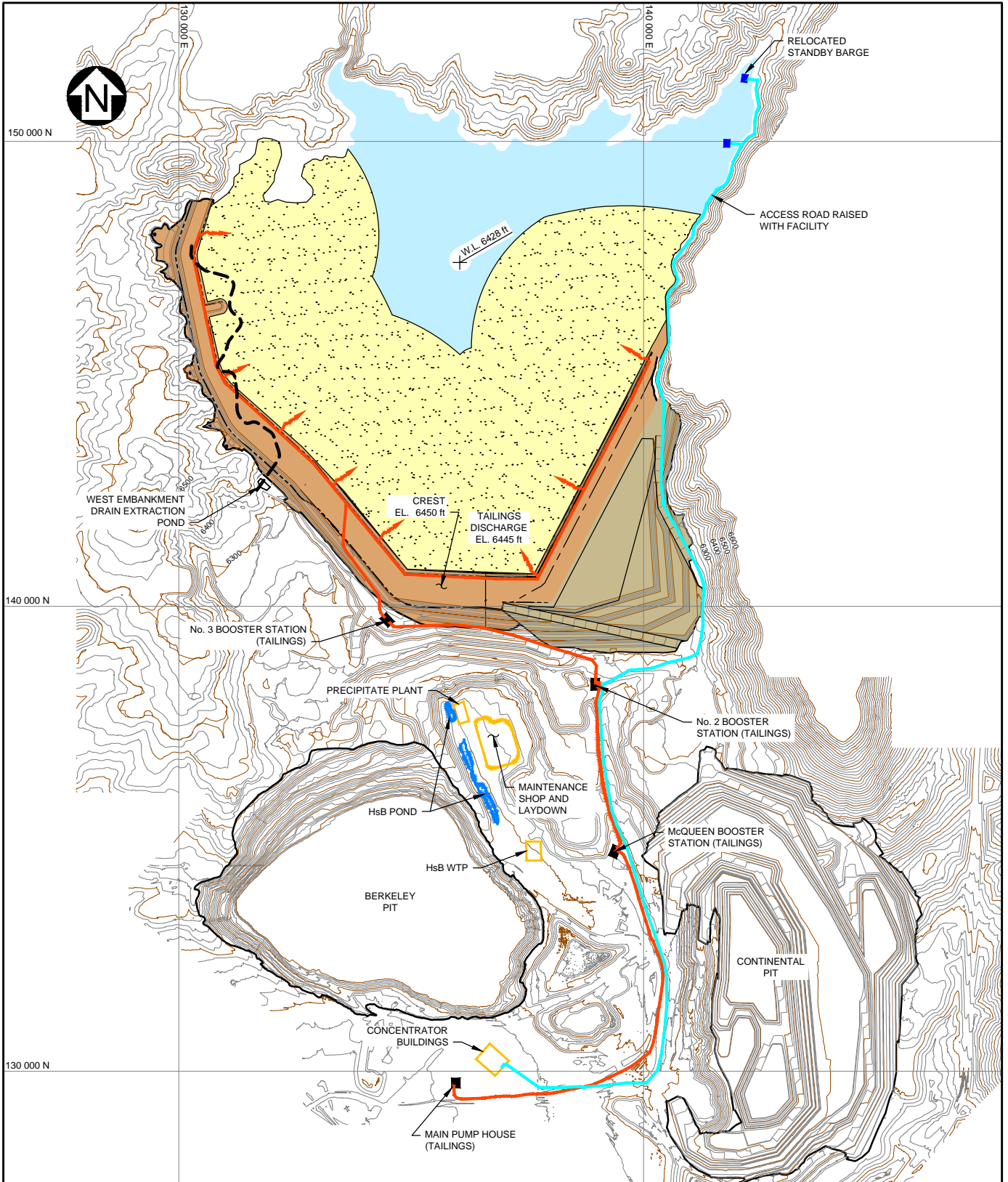
- Design integration with a closure plan that maximizes maintenance-free closure to the greatest extent possible, and
- Requirements for post-closure monitoring, inspections and reviews.

This Reclamation Overview also provides an overview of the current reclamation plan for the YDTI, identifies new reclamation strategies for facility components not previously considered in the current reclamation plan and presents post-reclamation monitoring and inspection considerations.

The report does not include consideration of the reclamation of mine facilities or infrastructure outside the scope of the proposed Amendment.

1.2 COORDINATE SYSTEM AND ELEVATIONS

The design of the YDTI references the site coordinate system known as the ‘Anaconda Mine Grid’ established by The Anaconda Company in 1957. The Anaconda Mine Grid is based on the Anaconda Copper Company (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.

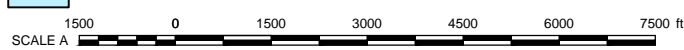


NOTES:

- 1. COORDINATE SYSTEM AND ELEVATIONS ARE BASED ON MINE GRID.

LEGEND:

	TAILINGS BEACH		TAILINGS DEPOSITION		WEST EMBANKMENT DRAIN
	EMBANKMENT FILL		TAILINGS PIPELINE		RECLAIM PIPELINE
	ROCK DISPOSAL SITE		RECLAIM BARGE		
	MINE WATER				



MONTANA RESOURCES, LLP							
YANKEE DOODLE TAILINGS IMPOUNDMENT							
FUTURE FACILITY LAYOUT							
<i>Knight Piesold</i> CONSULTING	<table border="1" style="width: 100%; font-size: small;"> <tr> <td>PIA NO. VA101-126/12</td> <td>REF NO. 8</td> </tr> <tr> <td colspan="2">FIGURE 1.1</td> </tr> <tr> <td>REV</td> <td>1</td> </tr> </table>	PIA NO. VA101-126/12	REF NO. 8	FIGURE 1.1		REV	1
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FIGURE 1.1							
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2 – SUMMARY OF EXISTING RECLAMATION PLAN

The current post-closure reclamation plan for the YDTI is outlined in the 2015 5-year bond review, which was prepared by the Montana Department of Environmental Quality (MDEQ). The 2015 Bond was calculated based on the estimated costliest reclamation condition the facility will experience in the five years following the bond review (through 2019). A summary of the reclamation concepts included in the 2015 Bond is presented in Appendix A ‘*Summary of Montana Resources Current Closure Reclamation Strategy for the YDTI*’ (KP, 2017a). The 2015 Bond considers the YDTI as three reclamation components: the Embankment (329 acres), the Tailings Beach (680 acres) and the Wetland and Pond (798 acres).

▲ R5

The reclamation plan for the embankment includes regrading the downstream slopes to 2.7H:1V (except for a portion of the embankment slope adjacent to the Precipitation Plant), placing a 20-inch thick amended alluvium cap and revegetation. The access road along the embankment crest will remain for post closure monitoring. Ditches and swales will be constructed at 100 ft intervals on the regraded slopes to promote drainage and reduce erosion risk of the reclamation cap.

The section of the embankment adjacent to the Precipitation Plant will be reclaimed by covering the constructed (steeper) slopes with coarse rockfill material (i.e. riprap). The riprap slope protection is 2,000 feet long, 450 feet high and 3 feet thick. The riprap material is coarse (18-inch minus), durable, non-acid generating rock sourced from off-site.

The tailings beach areas susceptible to wind erosion will be covered after cessation of operations with a 6-inch thick layer of rockfill, comprised of leached capping material, and seeded for dust control. Reclamation of the tailings beach areas will follow, which includes placing a 28-inch thick amended alluvium cap and revegetation. A partial wet closure scenario is planned for the northern portion of the tailings impoundment consisting of a pond and adjacent wetland area periodically inundated as the seasonal pond water level fluctuates.

The alluvium sourced for reclamation will be from the area between the Berkeley and Continental Pits (known as the Central Zone). Amendment of the alluvium and leach capping will be undertaken as per the MDEQ approved 2002 Minor Amendment (MR 02-001) for reclamation of the Woodville Dump. The cover soil recipe includes the addition of lime (pH adjustment) and compost (organic material content). The amount of amendment required depends on the characteristics of the capping material and the quality of lime and organic material. Testing to confirm the required amendment specifications will be undertaken at the time of reclamation.

Revegetation of the reclaimed slopes will be undertaken using primarily native and introduced grasses and forbs. Species that are locally adapted to a relatively wide range of cover material conditions are emphasized.

3 – AMENDMENT RECLAMATION INTEGRATION

3.1 GENERAL

The Amendment design of the YDTI will require consideration of four additional or altered reclamation components:

- Additional embankment acreage
- Additional impoundment acreage
- Closure spillway, and
- West Embankment Drain (WED).

The following sections detail the relevant conceptual reclamation strategies proposed for these components. Table 3.1 summarizes the YDTI acreages associated with the 2015 Bond, current permitted limits and the proposed Amendment. The reclamation areas are shown on Figure 3.1.

Table 3.1 YDTI Reclamation Acreages: 2015 Bond, Current Permit and Proposed Amendment

Location	Area (acres) ^{1,2,3}		
	Bonding	Current Permitted Design	6450 Embankment Design
N-W and E-W Embankment Slopes	329	273	218
West Embankment Slope		126	30
Reclaimed Slope (Riprap)		14	14
Reclaimed Crest		166	229
Reclaimed Beach	680	638	1,217
Wetland/Transition	305	292	477
Pond	493	668	110
TOTAL	1,807	2,177	2,295

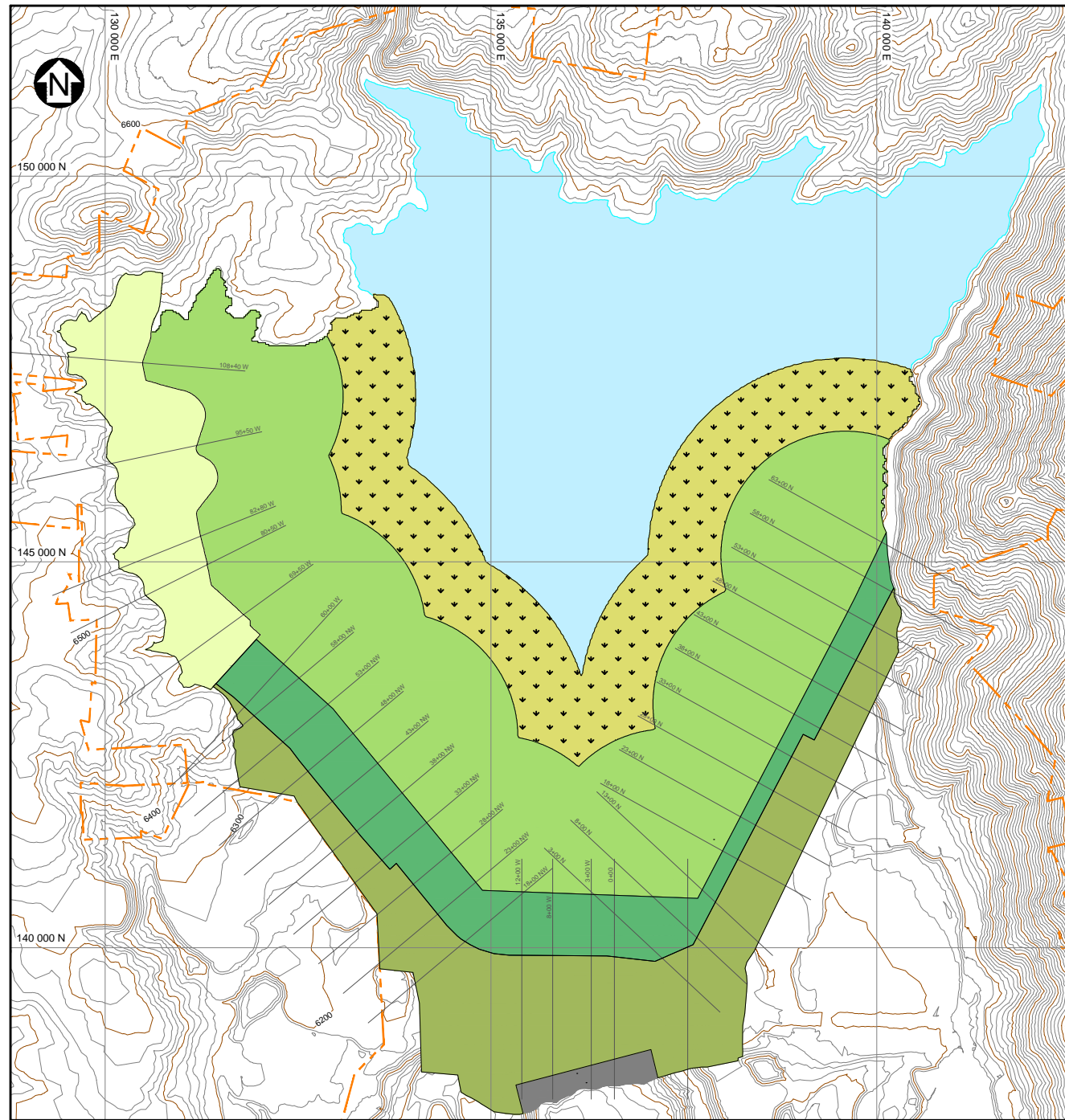
▲ R4

NOTES:

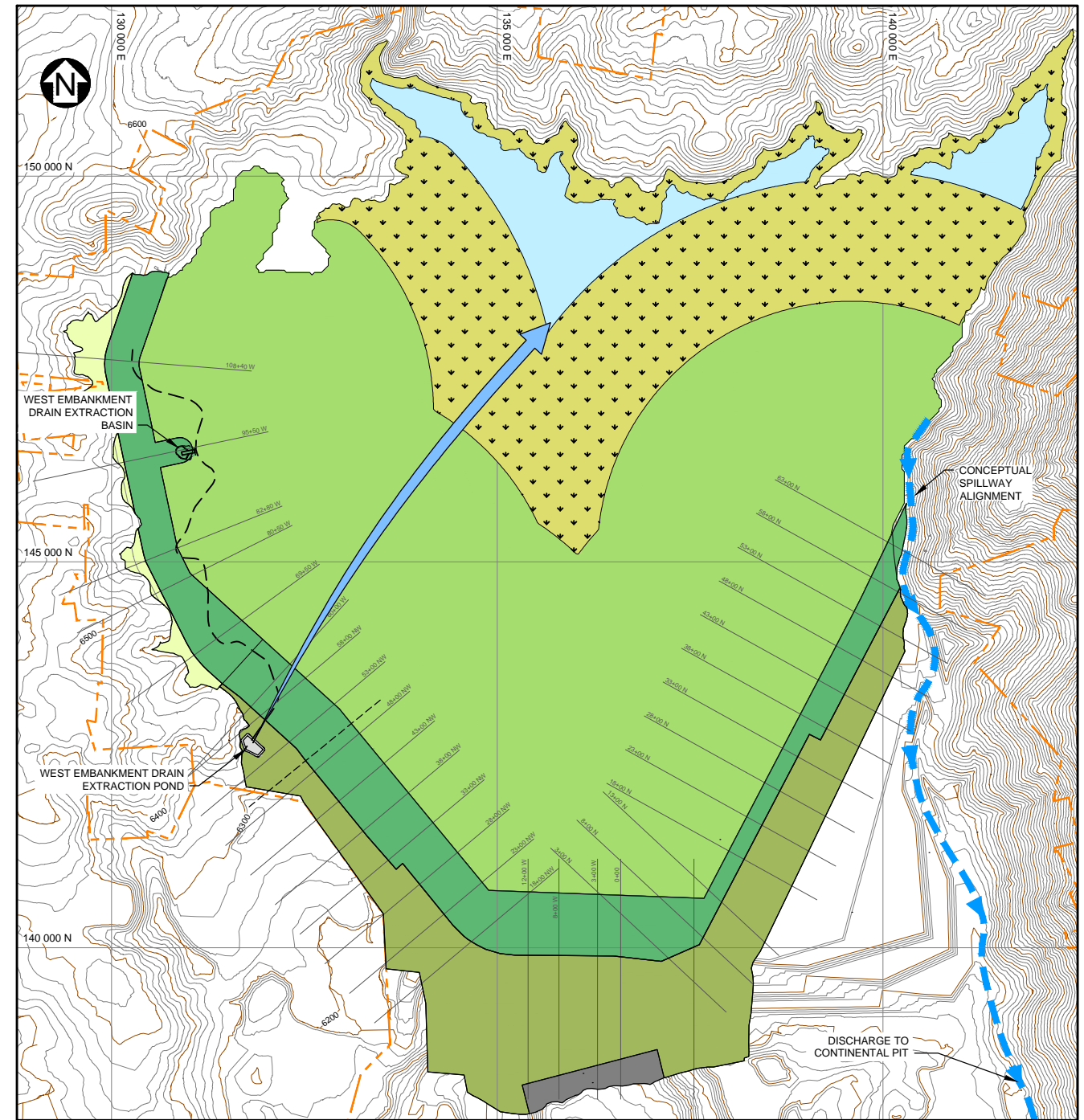
1. Bonding areas sourced from MDEQ 2015 5-Year Bond Review. The bond is calculated as the costliest reclamation condition the facility will experience in the five years following the bond review (i.e. through 2019).
2. Current Permitted Design and 6450 Embankment Design reclamation areas are presented on Figure 3.1.
3. Areas are plan areas not sloped areas.
4. The Embankment Slope and Crest Areas are not differentiated in the 2015 Bond.

▲ R3

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YDTI: CURRENT PERMITTED ARRANGEMENT
 ELEVATION: NORTH - SOUTH EMBANKMENT - 6450
 EAST - WEST EMBANKMENT - 6450
 WEST EMBANKMENT - 6405
 TAILINGS POND - 6360
 SCALE A



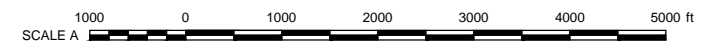
YDTI: 6450 EMBANKMENT ARRANGEMENT
 ELEVATION: EMBANKMENT CREST - 6450
 TAILINGS POND - 6428
 SCALE A

LEGEND:

- PROPERTY BOUNDARY
- SPILLWAY
- WEST EMBANKMENT DRAIN (WED)
- RECLAIMED SLOPE (2.7H:1V)
- RECLAIMED SLOPE (3H:1V)
- RECLAIMED SLOPE (RIPRAP)
- RECLAIMED CREST
- RECLAIMED BEACH
- WETLAND
- POND
- WED PUMPBACK

NOTES:

1. COORDINATE GRID IS ANACONDA MINE GRID.
2. GROUND CONTOUR INTERVAL IS 20 FEET.
3. DIMENSIONS AND ELEVATIONS ARE IN FEET UNLESS NOTED OTHERWISE.



REV	DATE	DESCRIPTION	DESIGNED	DRAWN	REVIEWED
2	05OCT17	ISSUED WITH REPORT	RSS	RM	KJB
1	16AUG17	ISSUED WITH REPORT	RSS	KJM	KJB
0	16JAN17	ISSUED WITH REPORT	RSS	KJM	KJB

MONTANA RESOURCES, LLP	
YANKEE DOODLE TAILINGS IMPOUNDMENT	
RECLAMATION OVERVIEW CONCEPTUAL CLOSURE ARRANGEMENT	
Knight Piésold CONSULTING	P/A NO. VA101-126/12 REF NO. 8 FIGURE 3.1
	REV 2

Constructing the North-South, East-West and West Embankments to EL. 6,450 ft will result in a total of 262 acres of slope requiring reclamation. The North-South and East-West Embankment down-gradient slopes (218 acres area) will typically be regraded to 2.7H:1V with ditch and swale drainage, unless otherwise indicated in the reclamation plan. The slopes will be capped with 20 inches of amended alluvium, and revegetated using the approved seed mixture as per the existing Reclamation plan. ▲ R5

The West Embankment downstream slope will be concurrently reclaimed as the embankment is raised wherever practicable using the same capping and revegetation strategies as outlined in the 2015 Bond. The West Embankment downstream rockfill zone (Zone D1) will be constructed in 3 to 5 ft layers, with a downstream slope of approximately 3H:1V. Ditch and swale drainage will be constructed at 100 feet spacing along the slope, the slope capped with suitable or amended alluvium and revegetated.

Construction of the YDTI embankments to EL. 6,450 ft will result in a total embankment crest area of 229 acres. The embankment crest will be capped with 28 inches of suitable or amended alluvium unless mine rock scheduling allows the direct-haul of the final capping layer. The access road along the top of the embankment crest will be retained for post-closure monitoring. Any designated access roads will be preserved and retained with driving surfaces. ▲ R5

The construction of the YDTI embankments to EL. 6,450 ft will have no impact on the area immediately upstream of the Precipitation Plant between Stations 3+00N to 12+00W that is currently designated for riprap slope protection during remediation. This embankment area is outside the construction footprint for the EL 6,450 ft raise. This 14 acre area will still require capping with coarse 18-inch minus (riprap) material during remediation.

3.2 ADDITIONAL BEACH AND POND ACREAGE

3.2.1 General

The current reclamation plan considers reclamation of the impoundment as two components: tailings beach and tailings pond.

The Amendment design is projected to produce a total impoundment area of approximately 1,804 acres. This area is approximately 206 acres more than the acreage of the currently permitted facility. The Amendment design tailings beach will occupy approximately 94% of the total impoundment area, which is a larger beach and smaller pond as compared to both the 2015 bonded and currently permitted configurations. The KP Report entitled '*Design Basis Report*' (KP, 2017b) further describes the tailings multiple discharge point configuration strategy. ▲ R5

3.2.2 Tailings Beach

The tailings slurry will be discharged from the YDTI embankments using multiple discharge points, which will result in extensive beaches along the upstream side of the YDTI embankments. The total tailings beach area is projected to be approximately 1,420 acres at closure, which is approximately 782 acres greater than the currently permitted design. This larger beach is due to the growing footprint of the YDTI, the revised beach configuration that is developed by discharging tailings from multiple points around the embankments, and a smaller post-closure pond volume predicted by more recent water balance modelling (KP, 2017c). ▲ R5

The character of the beaches will be similar to those considered in the current reclamation plan. The reclamation activities for the coarse tailings beach includes; surface shaping to compensate for settlement, placement of a 28-inch-thick amended alluvium cap, and revegetation of the final surface.

3.2.3 Tailings Pond

The new multiple point discharge strategy and overall smaller post-closure pond area will result in the tailings pond being positioned further to the north side of the facility and away from the YDTI embankments as compared to the arrangement incorporated in the 2015 Bond. The post-closure tailings pond will be essentially a storm water retention pond, with the water volume and surface area controlled by precipitation events and runoff. The post closure tailings pond volume was modelled in the YDTI Water Balance (KP, 2017c) and presented in the Water Management Report (KP, 2017d). The water balance model estimated the 50th percentile average annual tailings pond volume will be approximately 500 acre-ft in 30 years following closure. The small surface pond at closure will primarily be a result of contributing runoff from three upstream catchments that drain into the YDTI on the north side of the facility.

▲ R5

The post-closure YDTI will have a spillway as detailed further in Section 3.3. The spillway will passively control the maximum allowable pond elevation and volume to ensure the beaches do not become flooded and ponded water does not contact the embankments.

3.2.4 Reclamation Alluvium and Leach Capping Quantities

The alluvium sourced for reclamation of the YDTI embankments and beach will be from the area between the Berkeley and Continental Pits (known as the Central Zone). Table 3.2 summarizes the quantity of alluvium material for reclamation of the YDTI embankments and beaches as presented in the 2015 Bond, and estimated quantities for the currently permitted limits as well as the proposed Amendment. The quantities assume an additional 8% increase to compensate for the difference between plan area and slope area, which is consistent with the 2015 Bond calculation.

Table 3.2 YDTI Reclamation Capping Quantities: 2015 Bond, Current Permit and Proposed Amendment

▲ R5

Location	Volumes (M yd ³) ^{1,2}		
	2015 Bond	Current Permitted Arrangement	6450 Embankment Arrangement
N-W and E-W Embankment Slopes	0.53	0.79	0.63
West Embankment Slope		-	0.13
Reclaimed Slope (Riprap)		0.04	0.04
Reclaimed Crest		0.22	0.62
Reclaimed Beach	3.1	2.9	4.58
Wetland/Transition	-	-	1.80
Pond	-	-	-
TOTAL	3.6	4.0	7.8

NOTES:

1. Bonding areas sourced from MDEQ 2015 5-Year Bond Review. The bond is calculated as the costliest reclamation condition the facility will experience in the five years following the bond review (i.e. through 2019).
2. Current Permitted Design and 6450 Embankment Design reclamation alluvium volumes are based on the areas presented on Figure 3.1.
3. Quantities are approximate and include an 8% increase to compensate for embankment slopes.

▲ R3

3.3 CLOSURE SPILLWAY

The Amendment arrangement incorporates proposes a closure spillway to be constructed following cessation of operations to integrate a closure plan that enhances dam safety. A conceptual layout of the spillway is presented in the KP letter '*Closure Spillway: Design Criteria and Conceptual Configuration*', presented in Appendix B (KP, 2018).

▲ R4

The objective of the closure spillway is an emergency water management system designed primarily to prevent overtopping of the embankment, but which also serves to prevent pooling of water adjacent to the embankment and thereby prevent the uncontrolled ingress of water into the pervious rockfill embankment. The closure spillway will not be operated as a routine water discharge system, and will only convey flow if an unlikely sequence of storm events occurs in combination with a starting pond volume equal to the 95% percentile wet steady state pond volume. The sequence of storm events required to activate spillway discharge would need to result in the generation of a runoff volume larger than 26,000 acre-ft, which is equivalent to a 1 in 1,000 year 30-day storm event and the post-closure Probable Maximum Flood (PMF) event occurring consecutively. The spillway concept proposed has sufficient capacity to pass the runoff from a subsequent 1 in 1,000 year 24-hour rainfall event. Thus, the spillway and associated in-facility storage have been sized to withstand a very conservative combination of the PMF that is followed by another extreme 1 in 1,000 year rainfall event.

The spillway was modelled as a trapezoidal channel cut into bedrock on the east abutment of the YDTI North-South Embankment. The channel was modelled with a grade of 1% to facilitate flow

while minimizing the depth of rock cut required to maintain the grade. Beyond the North-South Embankment, the spilled water will flow freely according to the local topography east of the North Rock Disposal Site and discharge into the Continental Pit. The proposed spillway channel in bedrock has an approximate length of 5,000 ft and the total flow length between the intake and the Continental Pit is approximately 13,000 ft. Limited spillway maintenance will be required in the long term, although periodic inspection is necessary to verify the spillway can become operational.

The spillway configuration is presented at a conceptual level, with further detail and evaluation required to develop the detailed design and the construction strategy. The final design details will depend on the final elevation and configuration of the facility at closure.

3.4 WEST EMBANKMENT DRAIN

3.4.1 General

Construction of the West Embankment Drain (WED) was permitted in Amendment 9 as approved by the MDEQ in February 2015. The operation of the WED however was not included as the maximum operational supernatant pond elevation in Amendment 9 was 6,360 ft, and therefore the WED was not required as a hydraulic containment feature. The post-closure use of the WED therefore has not been described previously in reclamation planning.

A short summary of the WED design basis and a description of the long-term use of the WED is presented in this section. Note, the WED will continue to function after closure and therefore there is no strategy or schedule for decommissioning or reclamation following cessation of mine operations.

3.4.2 Design Summary

The WED is a subsurface aggregate drain, which is designed to intercept seepage migrating west of the YDTI above elevation 6,350 ft. The WED will be constructed along the upstream toe of the West Embankment with a -0.25% grade to facilitate gravity drainage south, beyond the topographic boundary known as 'Rocky Knob', to a permanent Extraction Pond. Water recovered in the Extraction Pond will be pumped back to the YDTI. The KP Report entitled '*West Embankment Drain – Design Report*', July 2017 (KP, 2017e) describes the design basis and design features of the WED.

The WED will connect and work in conjunction with other seepage management features of the West Embankment, including the Extraction Basin and contingency drain pods. The Extraction Basin will be constructed adjacent to the WED alignment in a topographic low that coincides with the area of the locally depressed water table on the West Ridge. The Extraction Basin was included to have an operations ready alternative pumping option as a redundant seepage water recovery system.

Two contingency drain pods, Drain Pods 1 and 2, are included in the WED arrangement to provide the capacity to further control the piezometric surface within the West Embankment in the unlikely event of a blockage or flow constriction within the WED. The drain pods are located in topographic lows along the WED alignment and are hydraulically connected to the WED in a similar manner as the Extraction Basin. Pumping from the drain pods will be achieved, if necessary, by installing drill holes from the West Embankment crest to the base of the drain pods. A screened well with a submersible pump system would be installed in each drillhole. Seepage entering the drain pods would be extracted in a manner similar to the Extraction Basin and conveyed into the YDTI.

3.4.3 Long-Term Operational Requirements

▲ R2

A significant component of seepage flow collected in the drain during operations is anticipated to originate from percolation below the active tailings beaches when tailings are discharged along the West Embankment. This recharge from active tailings deposition will cease after closure and the seepage rates will decline as the tailings mass drains. The WED will continue to provide hydraulic containment along the West Ridge for approximately 20 years post-closure intercepting water from the draining tailings mass, seepage from the closure tailings pond, groundwater discharge from the West Ridge and percolation due to recharge from rainfall events. The tailings pond post-closure will passively reduce in size and volume as the tailings mass drains and the impoundment water inflows and outflows equilibrate. The closure pond water surface elevation will decrease and after approximately 20 years is expected to be below the potentiometric low in the West Ridge. The WED at this stage is no longer required for maintenance of hydrodynamic containment on the West Ridge; however, the WED will continue to flow due to contributions from groundwater discharge, surface recharge, and seepage. The WED connection to the Extraction Pond may be decommissioned by grouting the section of gravity drain through the topographic boundary 'Rocky Knob'. The WED upstream of the grout-plug will continue to function as a West Ridge hydraulic containment contingency measure. Pumping of the WED in the event of an unforeseen drop in groundwater levels or rise in closure pond levels can be managed using the Extraction Basin stand-by pumping option, if required. Alternatively, the WED can remain open and will allow passive drainage by gravity in the long-term in closure if alternative uses are deemed appropriate.

Bonding for the maintenance and continued operation of the WED should include consideration of the following:

- Maintaining the Extraction Pond including pond lining, removal of accumulated solids, maintenance of slopes and mechanical systems for approximately 20 years following closure
- Maintaining of the stand-by mechanical and electrical systems for the Extraction Basin
- Maintaining and/or periodically replacing piezometers and monitoring wells
- Supplying electricity for pump operation at the Extraction Pond for approximately 20 years
- Grouting a portion of the WED to prevent flow past Rocky Knob in the long-term, and
- Installing contingency extraction wells in the drain pods (if required).

4 – POST CLOSURE MONITORING, INSPECTION AND REVIEW

4.1 GENERAL

A detailed closure monitoring plan identifying site-specific needs for monitoring, inspection and review will be prepared prior to closure. The plan will include details such as the monitoring requirements, monitoring frequency and minimum qualifications of monitoring personnel. The plan will include a section describing monitoring and mitigation measures for response to unusual occurrences or emergency conditions.

The reclaimed YDTI facilities initially will be inspected and maintained regularly following closure to verify that any changes to site conditions and facility performance do not compromise the integrity and safety of the impoundment. The performance of the reclamation aspects not directly related to dam safety (i.e. dust generation, revegetation coverage, and surface drainage etc.) is under the jurisdiction of the MDEQ or Environmental Protection Agency (EPA) and are not included in this conceptual plan.

4.2 QUANTITATIVE PERFORMANCE PARAMETERS

Quantitative Performance Parameters (QPPs) are parameters that can easily be measured and evaluated on-site without complex calculation of data interpretation. QPPs are a good reference to quickly assess the performance of the YDTI. The QPPs shown in Table 4.1 remain relevant in the long-term following closure. These preliminary QPPs may be updated as part of the detailed closure monitoring plan if conditions at that time warrant changes.

Table 4.1 Preliminary QPPs - Long-Term Following Closure

Location	QPP	Value
YDTI Embankment	Crest Width	≥ 200 ft
	Downstream Overall Slope	No steeper than 2H:1V
	Pond Elevation (below embankment crest)	≥ 20 ft
YDTI Beach	Minimum Beach Length ¹	No ponded water within 800 ft of the embankment crest
Spillway	Condition and Integrity	Potential flow to Continental Pit not obstructed

NOTES:

1. The Minimum Beach Length of 800 ft allows time to respond and mitigate water approaching the embankment. The spillway should be positioned to passively maintain the Minimum Beach Length criteria.

4.3 MONITORING FREQUENCY

The frequency of monitoring for the reclaimed YDTI will vary depending on the final reclamation plan implemented and the required functionality of each facility component. A post-closure monitoring program and schedule will be prepared following completion of the YDTI reclamation program.

The initial monitoring frequency will be higher following reclamation, while the regraded slopes stabilize, tailings consolidate and vegetation establishes. Amendment of the monitoring schedule may be considered once monitoring baselines have been established and the reclamation system performance is demonstrated. Table 4.2 presents post-closure YDTI monitoring components that

may be included in the post-closure monitoring program. The routine inspections and monitoring of the reclaimed facility will be undertaken by personnel familiar with the reclamation objectives and expectations.

Table 4.2 Post-Closure Monitoring Considerations

Location	Inspection	Frequency ¹
Capped Surfaces (Embankment and Beach)	Inspect for cracking, slumping/deformation, erosion, slope failure, and any other changes in the embankment shape and tailings surface. Inspect the upstream slope, downstream slope and embankment crest.	Quarterly
	Inspect for daylighting seeps on the downstream embankment slope/benches, water pooling/ponding, soft/wet areas	Monthly
	Inspect beach surface for dusting risk/potential ²	Monthly ²
	Measure water levels in the monitoring wells and piezometers	Monthly
	Reclaimed beach slope/settlement survey ²	Annually ²
	Vegetation survey for noxious weeds, die-off and disease ²	Annually ²
Pond and Wetland	Measure pond water level ²	Monthly ²
	Evaluate pond water storage volume ²	Annually ²
	Inspect wetland plants for noxious weeds, die-off and disease ²	Annually ²
Spillway	Inspect spillway intake, channel base and side slopes for erosion, blockage, damage, slope failure, and any other changes in the shape and surface of the spillway.	Quarterly and after large storm events
HsB Seepage Collection System ³	Record the HsB Weir flowrate ³	Monthly ³
	Record the Seep 10 flowrate ³	Monthly ³
West Embankment Drain	Record WED extraction pump operating hours and flowrate	Monthly
Site Wide Water Management	Inspect surface drainage ditches and culverts for erosion, blockage, damage ²	Quarterly and after large storm events ²

NOTES:

1. The frequency of monitoring may be reduced once the reclamation system performance has been established and a monitoring baseline has been established.
2. Inspection requirements and inspection frequency are under the jurisdiction of the MDEQ, this component has been included in the table for completeness.
3. Inspection requirements and inspection frequency are under the jurisdiction of the Environmental Protection Agency (EPA), this component has been included in the table for completeness.

4.4 INSPECTIONS AND REVIEWS

4.4.1 Engineer of Record

The Engineer of Record (EOR) role for the YDTI will be retained post-closure. The role and required qualifications for the post-closure EOR will be consistent with those of the EOR as defined in MCA

82-4-375. The post-closure EOR is responsible for reviewing new documents and design features pertaining to the YDTI, conducting annual inspections and notifying when the facility is under performing or poses a threat to human health or the environment.

The EOR will conduct an Annual Inspection, which considers both the geotechnical and reclamation performance of the closed facility. The EOR will prepare a report describing the scope of the inspection and actions recommended to document the closed facility is being properly maintained. The EOR will submit the report to MR and the MDEQ and immediately notify the MDEQ if the facility presents an imminent threat or when there is the potential for an imminent threat to human health or the environment.

The EOR will conduct Annual Inspections of the YDTI until reclamation is complete and the Independent Review Panel (IRP) is convened for a Periodic Review. The frequency of inspections and future involvement of the EOR and IRP thereafter will be discussed during the first Periodic Review following closure and will be incorporated in the detailed closure monitoring plan.

The EOR may be required to conduct additional inspections or monitoring following any unusual event (e.g., earthquake or extreme rainfall event) or as a result of key observations made during a routine inspection or monitoring.

4.4.2 Independent Review Panel

The IRP will be convened within five years of closure to evaluate the performance of the facility relative to dam safety standard of practice. The frequency of inspections and future involvement of the EOR and IRP thereafter will be discussed during the first Periodic Review following closure and will be incorporated in the detailed post-closure monitoring plan.

5 – REFERENCES

- Knights Piésold Ltd. (KP, 2017a). Summary of Montana Resources Current Closure Reclamation Strategy for the YDTI (KP Reference No. VA17-01363), August 10, 2017. ▲ R5
- Knights Piésold Ltd. (KP, 2017b), 2017. Yankee Doodle Tailings Impoundment, Design Basis Report (KP Reference No. VA101-126/12-1), Vancouver, BC.
- Knights Piésold Ltd. (KP, 2017c). Montana Resources – Updated Yankee Doodle Tailings Impoundment Water Balance Model (KP Reference No. VA17-00828), July 6, 2017. ▲ R5
- Knights Piésold Ltd. (KP, 2017d), 2017. Yankee Doodle Tailings Impoundment, Water Management Report (KP Reference No. VA101-126/12-7), Vancouver, BC. ▲ R5
- Knights Piésold Ltd. (KP, 2017e). West Embankment Drain – Design Report (KP Reference No. VA101-126/13-3), Vancouver, BC. ▲ R4
- Knights Piésold Ltd. (KP, 2018). Closure Spillway: Design Criteria and Conceptual Configuration. (KP Reference No. VA18-00426), March 12, 2018.
- Montana Code Annotated (MCA), 2015. Title 82: Minerals, Oil, and Gas, Chapter 4: Reclamation, Part 3: Metal Mine Reclamation.
Available at: http://leg.mt.gov/bills/mca_toc/82_4_3.htm
- Montana Department of Environmental Quality. (MDEQ, 2015), 2015. Montana Resources Comprehensive Bond Review (Excel Workbook 'MR2015.xlsx'), Helena, MT

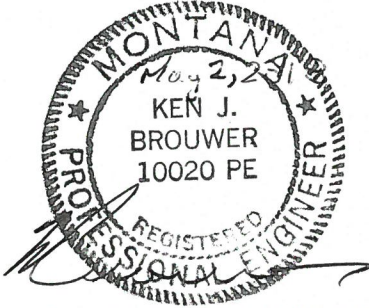
6 – CERTIFICATION

This report was prepared and reviewed by the undersigned.

Prepared:

DI/A
for
Roanna Stewart, P.Eng.
Senior Engineer

Reviewed:


Ken Brouwer, P.E.
President

This report was prepared by Knight Piésold Ltd. for the account of Montana Resources, LLP. Report content reflects Knight Piésold's best judgement based on the information available at the time of preparation. Any use a third party makes of this report, or any reliance on or decisions made based on it is the responsibility of such third parties. Knight Piésold Ltd. accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions based on this report. Any reproductions of this report are uncontrolled and might not be the most recent revision.

Approval that this document adheres to Knight Piésold Quality Systems: 

APPENDIX A

**SUMMARY OF MONTANA RESOURCES CURRENT CLOSURE RECLAMATION STRATEGY
FOR THE YDTI**

(Pages A-1 to A-4)

August 10, 2017

File No.:VA101-00126/12-A.01
Cont. No.:VA17-01363

Mr. Mark Thompson
Vice President - Environmental Affairs
Montana Resources, LLP
600 Shields Avenue
Butte, Montana
USA, 59701

Dear Mark,

Re: Summary of Montana Resources Current Closure Reclamation Strategy for the YDTI

1 – INTRODUCTION

Montana Resources, LLP (MR) is applying for a permit amendment to provide for continued mining beyond 2020. A review of the applicability of the current reclamation strategies for the expanded tailings facility is required as part of the permitting process.

This letter presents a summary of the reclamation plan currently proposed for the YDTI at closure as outlined in the most recent 2015 Bond calculations as prepared by the Montana Department of Environmental Quality (MDEQ). Only the proposed reclamation plans outlined for the YDTI including the Embankment, Tailings Beach and Tailings Pond are considered in this letter as only these are relevant to the permit amendment. The reclamation plan for the remainder of the mine is not presented.

2 – EMBANKMENT

The reclamation strategy for the embankment as contemplated for the 2015 Bond includes:

- **Regrading** – The downstream embankment slope will be regraded to 2.7H:1V (except for a portion of the embankment slope adjacent to the Precipitation Plant as discussed below).
- **Capping** – The embankment slopes will be capped with 20 inches of amended alluvium sourced from the Central Zone (except for a portion of the embankment slope adjacent to the Precipitation Plant as discussed below). The access road along the top of the embankment will remain for post closure monitoring.
- **Capping Amendment** – The Central Zone alluvium will be amended with organic matter. Lime amendment of the alluvium is not required. The organic material will be sourced off-site as required to meet the organic matter specification of 1.5% (by weight) or 23 tons per acre. The alluvium will be sampled during placement and tested for paste pH, total metals, Cu, Zn and organic content to confirm that the reclamation requirements are met.
- **Revegetation and Weed Control** – Revegetation and ongoing care and maintenance tasks will be performed to preserve the reclaimed slopes. These tasks include seeding, weed spraying, minor erosion repair, and fertilizer application.
- **Surface Water Management** – Surface water swales/ditches will be constructed every 100 feet along the long regraded reclaimed slopes to break up the slopes. The reclamation concept includes grass lined swales within the upper reaches transitioning to riprap lined ditches within the lower reaches with plunge pools. The ditch sections will be approximately 20 feet wide and roughly trapezoidal. The 2015 Bond estimated approximately 30% of the total ditch length will require lining with riprap. The riprap will be locally sourced; and any large riprap will be sourced from on-site stockpiles.
- **Riprap Slope (Adjacent to Precipitation Plant)** – A section of the embankment adjacent to the Precipitation Plant will be reclaimed by covering the constructed (steeper) slopes with coarse rockfill material (i.e. riprap). The riprap slope area is approximately 2,000 feet long, 450 feet high and 3 feet thick. The riprap material will

be coarse (18-inch minus), durable, non-acid generating rock sourced from off-site. The riprap will be placed by end-dumping with construction of a berm at the toe of the slope.

- **Amendment #9 Area** – Similar to the existing facility, the 5,000 feet of new embankment crest associated with Amendment #9 (MR, 2015) will be ripped to alleviate compaction, capped with 28 inches of soil, seeded and weed sprayed. The capping soil will be sourced from the Bumtown Soil Stockpiles. This soil does not need to be amended. Revegetation and ongoing care and maintenance tasks include seeding, weed spraying, minor erosion repair, and fertilizer application to preserve the reclaimed surface.

3 – TAILINGS BEACH

The 2015 Bond reclamation strategy for the tailings beach includes:

- **Dust Control** – A 6-inch layer of leach capping material will be placed over tailings surface areas that are susceptible to wind erosion. Placement will occur soon after the deposition of tailings and water into the impoundment has stopped. The layer will be seeded following placement.
- **Resloping** – Resloping of the tailings surface will not be required as water will drain northwards to the final wetland area and post closure pond.
- **Capping** - The tailings beach area will be capped with 28 inches of alluvium sourced from the Central Zone.
- **Capping Amendment** – The alluvium from the Central zone used to cap the tailings surface will be amended with organic matter, sampled during placement, and tested as outlined above for the embankment.
- **Revegetation and Weed Control** – The revegetation and ongoing care and maintenance tasks as outlined above for the embankment will be performed on the reclaimed cap placement on the tailings.
- **Monitoring Tailings Surface for Settlement and Cap Repair** – The cap surface will be repaired as the tailings dry and consolidate post-closure. The tailings surface will be monitored for settlement annually on a 250 ft by 250 ft elevation grid survey for five years post closure. In addition, two aerial mapping surveys will be conducted during this period. Localized settled areas will be backfilled with alluvium and/or leach capping and seeded (assumed to be approximately 10% of the capped area).

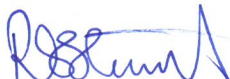
4 – TAILINGS POND


The 2015 Bond reclamation strategy for the northern end of the tailings impoundment consists of a pond and adjacent wetland area. The reclamation may include the construction of dikes, rip rap revetment, infiltration galleries, geosynthetics, spillways and lined areas, etc. Note, a conceptual design has not been developed.


5 – CONCLUSION

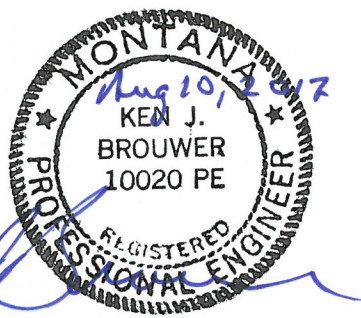
The YDTI post-closure reclamation plan as outlined in the 2015 Bond considers three reclamation areas including the Embankment, Tailings Beach and Tailings Pond. The general reclamation plan includes regrading, placing an amended alluvium cap and revegetation. The tailings beach areas susceptible to wind erosion are quickly covered with a dust control leach capping layer after the cessation of deposition of tailings and water into the impoundment. The northern Tailings Pond portion of the tailings impoundment will be reclaimed as a pond and adjacent wetland area.


Yours truly,
Knight Piésold Ltd.

Prepared: 
Roanna Stewart, P.Eng.
Senior Engineer

Reviewed: 
pv: Reagan McIsaac, Ph.D., P.Eng.
Senior Engineer

Reviewed: 
Ken Brouwer, P.E.
President



Approval that this document adheres to Knight Piésold Quality Systems: 

Attachments:

Table 1 Rev 0 Summary of Reclamation Strategies

References:

Montana Department of Environmental Quality, 2015, 2015 Bond Review Calculations. March, 2015.

Montana Resources, LLP (MR), 2015. Minor Amendment 00030A-14-002, Butte, MT.

TABLE 1

**MONTANA RESOURCES, LLP
YANKEE DOODLE TAILINGS IMPOUNDMENT**

SUMMARY OF RECLAMATION STRATEGIES

Print: Aug/10/2017 10:53:54

Feature	Strategy	2015 Bond Calculations ¹
YDTI Embankment	Regrading	Regrade downstream embankment slopes to 2.7H:1V.
	Capping	20" organic ammended alluvium on slopes.
	Capping Amendment	Testing performed during cap placement to confirm ammendment specifications are being met. Assumes compost is added to meet organic matter specification. Assumes capping material is sourced from the Central Zone alluvium and lime addition is not required.
	Revegetation and Weed Control	Seeding, weed spraying, minor erosion repair, fertilizer application and application of any best management practices to all slopes.
	Surface Water Management	Drainage swales developed in 100 foot vertical increments down the slope. Grass lined swales for the upper portions, riprap protected channels with plunge pools for lower portions.
	Additional Considerations	Embankment slope up-gradient of the Precipitation Plant: Coarse clean rockfill placed at angle of repose (2000 ft length x 450 ft high x 3 ft thick) Amendment 9 Area: Embankment crest ripped, capped with 28" alluvium, seeded and weed sprayed. Organic ammendment of soil cap not required.
YDTI Beach	Dust Control	Placement of 6" leach capping material and seeded.
	Regrading	Not required.
	Capping Layer	Capping with 28" of organic ammended alluvium. Testing performed during cap placement to confirm ammendment specifications are being met.
	Capping Amendment	Same as Embankment capping ammendment. Testing performed during cap placement to confirm ammendment specifications are being met. Ammendment requirements to be confirmed based on testing. Assumes compost is added to meet organic matter specification. Assumes capping material is sourced from the Central Zone alluvium and lime addition is not required.
	Revegetation and Weed Control	Seeding, weed spraying, minor erosion repair, fertilizer application and implementation of relevant best management practices.
	Additional Considerations	Spot-infilling of low-lying settled areas with alluvium or leach cap and seed.
YDTI Pond	Wet Closure Arrangement	Wet closure area with pond and constructed wetlands. Reclamation may include dikes, riprap revetment, infiltration galleries, geosynthetics, a spillway and lined areas.

M:\1101\00126\12\VA\Correspondence\VA17-01363 - Reclamation Bonding Summary\Attachments\[Table 1 - Reclamation Summary_RSS_KJB.xlsx]Table 1

NOTES:

1. BOND CALCULATIONS UNDERTAKEN FOR 2015 DEQ COMPREHENSIVE BOND REVIEW (DEQ, 2015)
2. THE TABLE ONLY SUMMARIZES KEY RECLAMATION DETAILS AND SHOULD BE READ IN CONJUNCTION WITH LETTER VA16-01165.

0	9AUG'17	ISSUED WITH LETTER VA17-01363	RSS	RSM
REV	DATE	DESCRIPTION	PREP'D	RVW'D

APPENDIX B

CLOSURE SPILLWAY: DESIGN CRITERIA AND CONCEPTUAL CONFIGURATION

(Pages B-1 to B-7)

March 12, 2018

File No.:VA101-00126/12-A.01
Cont. No.:VA18-00426

Mr. Mark Thompson
Vice President - Vice President - Environmental Affairs
Montana Resources, LLP
600 Shields Avenue
Butte, Montana
USA, 59701

Dear Mark,

Re: Closure Spillway: Design Criteria and Conceptual Configuration

Montana Resources, LLP (MR) is preparing a Permit Amendment application (Amendment) to extend the operational life of the Yankee Doodle Tailings Impoundment (YDTI) by approximately 12 years. Reclamation strategies for the updated facility are required as part of the application process. MR will include a spillway as part of the post-closure systems for the updated YDTI configuration.

This letter presents the design criteria and conceptual configuration for the post-closure spillway that will be designed and constructed as part of the mine reclamation activities for the updated YDTI. A closure spillway for the facility was not included with the previous YDTI closure plans that were submitted to the Montana Department of Environmental Quality (MDEQ). The spillway concept presented in this letter is a large and deep rock-cut spillway channel in the left abutment of the North-South embankment of the YDTI. This is presented at a conceptual level, with further detail and evaluation required to develop the detailed design and the construction strategy. The final design details will depend on the final elevation and configuration of the facility at closure.

Note that all elevations presented in this letter are Anaconda Mine datum (ACM).

1 – SPILLWAY OBJECTIVE

The post-closure YDTI spillway is an emergency water management system designed primarily to prevent overtopping of the embankment, but which also serves to prevent pooling of water adjacent to the embankment and thereby prevent the uncontrolled ingress of water into the pervious rockfill embankment. The spillway is considered to be a contingency emergency measure; the primary dam safety and flood management tool for the YDTI is the massive storm storage available in the facility. The YDTI spillway will not be operated as a routine water discharge system, and in all likelihood will never convey flow. It will only convey flow if an exceptionally unlikely sequence of storm events were to occur in combination with a starting pond volume equal to the 95% percentile wet steady state pond volume. This storm sequence involves the 1 in 1,000 year 30-day rainfall event immediately followed by the Probable Maximum Flood (PMF) event (probable maximum precipitation plus snowmelt), which is in turn immediately followed by an additional storm event. The spillway invert is set at the resulting maximum PMF flood level of approximately 6,430 ft, so the spillway would not be required to discharge flows during the PMF, but only if an additional rainfall event were to immediately occur. The spillway is sized with sufficient capacity to pass flows from storms exceeding the 1 in 1,000 year 24-hour rainfall event (over and above storage of the PMF event), while maintaining a minimum beach length of 800 ft (as selected by the Engineer of Record) between the maximum water level in the YDTI and the embankment crest. This minimum beach length corresponds to a maximum allowable water level of approximately 6,434 ft. The spillway invert is set below this to allow for the temporary surcharge of water during spillway discharge.

2 – SPILLWAY SIZING CRITERIA

The YDTI spillway will discharge water when the storage volume exceeds approximately 26,000 ac-ft.

The design criteria for the spillway concept at the assumed final impoundment arrangement shown on Figure 1 are:

- YDTI normal water storage capacity of 8,000 ac-ft, which sets the starting pond level for the PMF event at 6,392 ft
- YDTI maximum capacity for temporary water storage, including the PMF runoff = 26,000 ac-ft
- Spillway invert elevation = approximately 6,430 ft
- Maximum allowable temporary pond water elevation = approximately 6,434 ft (max allowable depth above the spillway invert = 4 ft)
- Spillway location = northern end of N-S Embankment, and
- Spillway storm event = 1 in 1,000 year 24 hr storm event immediately following the PMF.

The above elevations are relative to the final impoundment configuration and will be adjusted as appropriate depending on the final tailings beach elevations. The following sections detail the selection and justification for the above criteria.

2.1 YDTI NORMAL WATER STORAGE CAPACITY

The water storage capacity below the spillway invert has been set at 8,000 ac-ft and consists of two components:

1. Steady-state wet pond volume post-closure (2,000 ac-ft)
2. Incremental storm storage volume of the 1,000 year 30-day rainfall (6,000 ac-ft)

These two components provide allowance for the storage of runoff from unusually wet conditions over an extended period, in addition to storage of runoff from an exceptional storm or series of storms, prior to occurrence of the PMF event. Storage of 8,000 ac-ft of water in the YDTI corresponds to a water level of approximately 6,392 ft. This was selected as the starting pond level for modeling the management of the PMF event.

2.1.1 Steady-State Wet Pond Volume Post-Closure

The YDTI water balance model '*Montana Resources – Updated Yankee Doodle Tailings Impoundment Water Balance Model*' (VA17-00828) was used to evaluate pond volumes with different likelihoods of occurrence, and in particular was used to identify those associated with unusually dry (5th percentile), average (50th percentile) and unusually wet (95th percentile) conditions. The 95th percentile result indicates that under unusually wet conditions the post-closure pond volume will be approximately 2,000 ac-ft once the pond has reached a 'steady state' condition. The 95th percentile volume was adopted for this conceptual design as a conservative measure.

2.1.2 Incremental Storm Storage

The primary objective of the YDTI spillway is to prevent water from overtopping the embankment. The post-closure YDTI configuration includes storage capacity for storm runoff to prevent spillway discharge under all but the most extreme storm event scenarios, with the intent of slowly releasing storm water by evaporation under all rational scenarios. Specification of what constitutes an appropriately extreme starting water level for the PMF routing analysis considered the probability of storm occurrence and the associated runoff volume generated, as well as a review of industry best practices.

The review identified that there are no industry standards for specifying a post-closure minimum storm storage capacity as the starting pond condition for evaluating the effects of the PMF.

KP completed an extreme storm event evaluation, '*Montana Resources – Extreme Precipitation Estimates*' (VA15-03332), and from this the 1,000 year 30-day rainfall event of 9.2 inches was selected for determining an appropriate starting pond level for the PMF analysis. This event was selected because the likelihood of occurrence of larger storm events is acceptably low, and because the retention of runoff from smaller storm events is practical given the size and configuration of the YDTI. On this basis, and considering the total YDTI upstream and direct catchment area of 7,600 acres, a minimum storm storage capacity of 6,000 ac-ft was determined for the post-closure facility. For comparison, the 1 in 1,000 year 24-hour rainfall depth of 5.3 inches required a storage volume of approximately 3,300 ac-ft, while the 24-hour Probable Maximum Precipitation (PMP) ('*Review of PMF*

Evaluation for the Yankee Doodle Tailings Impoundment' - VA15-03210) depth of 14.4 inches required a storage volume of approximately 9,100 ac-ft.

2.2 SPILLWAY INVERT ELEVATION

The spillway invert elevation was determined to be approximately 6,430 ft by considering a storage capacity of 8,000 ac-ft (as detailed above), plus a PMF runoff volume of approximately 18,000 ac-ft and the tailings beach-pond profile modelled at closure. The maximum allowable temporary level in the YDTI pond is specified at 6,434 ft to ensure a minimum beach length of 800 ft between the maximum flood level and the embankment face; the spillway invert is set below this to allow for the temporary surcharge of water during the spillway discharge of an event occurring immediately after the PMF, up to and including the 1 in 1,000 year 24-hour rainfall event.

2.3 MAXIMUM TEMPORARY POND WATER ELEVATION

In the extremely unlikely event that water will be discharged through the spillway, the water level in the YDTI pond will temporarily rise above the spillway invert. The level of rise will depend on the available storage, the inflow hydrograph, and the dimensions of the spillway. The maximum allowable temporary pond water level was selected to ensure that there is no risk of completely flooding the beaches or allowing ponded water to contact the embankments. The spillway size was then selected to ensure that water in the pond would not rise above this maximum level even if a large storm event were to occur immediately following the PMF.

The maximum temporary pond water elevation is governed by the minimum acceptable beach length. A post-closure temporary minimum beach length of 800 ft was selected by the Engineer of Record. The YDTI post-closure tailings deposition model identified that a beach length of 800 ft between the embankment upstream toe and the pond occurs when the pond level is at approximately elevation 6,434 ft. Accordingly, this elevation was selected as the maximum allowable temporary pond level during spillway discharge.

2.4 SPILLWAY LOCATION

The northern end of the N-S Embankment was determined to be the best location for the post-closure spillway because it provides the shortest spill flow length to the Continental Pit (the ultimate receiving environment). The spillway will be excavated in bedrock.

2.5 SPILLWAY STORM EVENT

An effective closure spillway must be configured to pass the largest peak flow that could possibly ever occur. The YDTI facility has a massive storage capacity, and is able to store the PMF volume even when conservatively assuming a starting pond volume of 8,000 ac-ft. The invert for the YDTI post-closure spillway was therefore set at the maximum PMF flood level, and the spillway was sized to pass the peak flow resulting from an additional 1 in 1,000 year 24 hr rainfall event assuming that it occurs immediately following the PMF. This assumption is more conservative than generally required by industry standards, which typically specify the PMF as the closure design event. However, it is prudent practice to include a spillway in a closure design, and therefore it was necessary to specify a spillway design event. The 1 in 1,000 year 24 hr rainfall event was selected for the spillway design because the likelihood of occurrence of larger storm events is acceptably low, particularly when considered to occur immediately following a PMF event and a 1 in 1,000 year 30 day rainfall event.

3 – SPILLWAY CONCEPTUAL LAYOUT

HydroCAD modeling software was used to simulate the design storm hydrograph, to assess the attenuating effects of the YDTI pond, and to determine the approximate spillway inlet and channel dimensions required to safely pass the design flows.

3.1 STORM EVENT AND CATCHMENT DETAILS

3.1.1 Probable Maximum Flood (PMF)

The PMF hydrograph is comprised of PMP runoff, snowpack melt runoff, and water releases from the upstream Moulton Reservoir. The PMP was modelled considering a Type II precipitation distribution curve. The snowpack melt was modelled assuming that the entire 100 year snowpack melts in 24 hours: 25% in the first 8 hours, 50% in the second 8 hours, and 25% in the final 8 hours. Release of the total Moulton Reservoir volume (540 acre-ft) was assumed to occur at a constant rate during the first 4 hours of the PMP event.

Seven upstream and direct catchments were considered in the HydroCAD model. Model inputs included catchment area, slope and flow routing length. Effective runoff depths were calculated assuming a USDA SCS curve number of 90, and times of concentration were based on the USDA SCS lag time equation. The PMF hydrograph has a runoff volume of approximately 18,000 ac-ft and a peak flow rate of 63,000 cfs. The PMF runoff volume will be fully stored within the YDTI facility.

3.1.2 1 in 1,000 year 24-hour Rainfall Event

The 1 in 1,000 year 24-hr Rainfall depth is 5.3 inches (Design Basis Report, VA101-126/12-1, Rev 2). The corresponding 1,000 year hydrograph has a runoff volume of 3,500 ac-ft and a peak flow rate of 23,900 cfs. This storm hydrograph will be passed through the spillway after attenuation in the YDTI pond.

3.2 SPILLWAY DETAILS

The spillway was modelled as a trapezoidal channel cut into bedrock on the left abutment of the YDTI embankment. The channel was modelled with a grade of 1% to facilitate flow while minimizing the depth of rock cut required to maintain the grade. It is envisioned that this shallow grade will be maintained until the natural topography dictates that a steeper grade be used to optimize the spillway alignment for minimising cut volumes during spillway construction. The spillway channel will extend past the toe of the North Rock Disposal Site to a point where the local topography creates a flow path leading to the Continental Pit.

The inlet of the channel has the same basic dimensions as the channel itself, but given the slope of the tailings beach and the need to maintain a low rock separation between the channel and the beach, the effective length of the channel inlet will increase as water rises in the YDTI pond. Based on preliminary calculations, the maximum spillway flow depth required to pass the 1,000 year flood hydrograph is approximately 3.5 ft. Because of the channel inlet configuration required with a sloping tailings beach, this same 3.5 ft rise will occur in the pond, and under this scenario, and with a 1% beach slope, the inlet will essentially behave as a side channel inlet with an effective length of approximately 350 ft, with the overflow depth ranging linearly from 3.5 ft at one end to 0 ft at the other. The inlet therefore has a very large flow capacity, and as such, the outflow through the spillway is controlled by the channel dimensions and roughness rather than by the inlet characteristics. The maximum surcharge water level allowed with the YDTI pond is 4 ft, and therefore the maximum allowable flow level in spillway channel is 4 ft. As such, the spillway can pass flows in excess of those from the 1,000 year rainfall event.

The proposed spillway and free flow alignment connecting the YDTI pond (water source) to the Continental Pit (ultimate discharge location) are presented on Figure 1. Note that this alignment is conceptual and it will need to be optimized for hydraulic considerations in the next phase of the design.

The conceptual/approximate spillway intake and channel details are as follows:

- Intake
 - Invert elevation = 6,430 ft
 - Assumed base width = 10 ft
 - Maximum allowable flow depth = 4 ft
 - Estimated maximum flow depth for 1,000 year event = 3.5 ft (water level ~6,433.5 ft)
 - Side slopes = 1Horizontal:1Vertical
 - Maximum discharge = ~330 cubic feet per second (cfs) with 1,000 year rainfall event

- Maximum discharge capacity = ~400 cfs
- Spillway Channel
 - Base width = 10 ft
 - Cut in rock: Manning's n = 0.040
 - Maximum allowable flow depth = 4 ft
 - Estimated maximum flow depth for 1,000 year event = 3.5 ft (water level 6,433.5 ft)
 - Minimum grade = 1%
 - Side slopes = 1 H:1V
 - Maximum depth of cut: ~50 ft on the west side and ~300 ft on the east side
 - Length = ~5,000 ft
- Approximate total flow length between intake and the Continental Pit = ~13,000 ft

4 – SPILLWAY CONCEPT DEVELOPMENT

The conceptual spillway configuration presented in this letter was developed and sized considering the assumed final layout of the YDTI 6,450 ft expanded facility. The dimensions of the spillway were specified with consideration of the maximum allowable water level rise in the pond and the need to minimize the spillway construction costs. Note that the current spillway dimensions represent a “reasonable” design but that an optimization study directly considering construction costs has not been conducted.

Detailed design of the spillway configuration and alignment must be undertaken once the facility closure is imminent and details of the YDTI closure conditions (pond and beach) are available.

5 – CONCLUSIONS

The post-closure YDTI spillway provides a water management system for preventing overtopping of the embankment, but also serves to prevent pooling of water adjacent to the embankment and thereby prevent any uncontrolled ingress of water into the embankment.

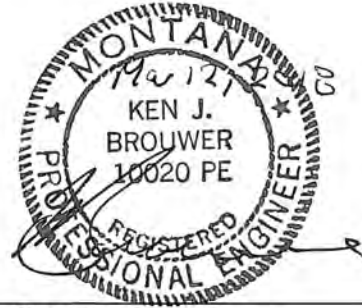
The total YDTI pond water storage capacity post-closure, before spilling, is 26,000 ac-ft. The YDTI post-closure spillway will discharge excess water from the pond only during exceptionally wet conditions that include an unusual accumulation of water over time, plus the occurrence of one or more extreme storm events that collectively generate more than 6,000 ac-ft of pond inflow, plus the PMF, plus a subsequent storm event. The spillway has sufficient capacity to pass the runoff from a storm event that is greater than the 1 in 1,000 year 24-hour rainfall event. Thus, the spillway and associated storm water management system have been sized to withstand a very conservative combination of the PMF that is followed by another extreme 1 in 1,000 year rainfall event.

The proposed spillway alignment passes around the northern end of the N-S Embankment and will be cut into bedrock. Beyond the North Rock Disposal Site, spilled water will flow freely according to the local topography and then discharge into the Continental Pit. The proposed spillway channel has an approximate length of 5,000 ft and the total flow length between the intake and the Continental Pit is approximately 13,000 ft.

Detailed design of the spillway configuration and alignment may only be undertaken once the facility closure is imminent and details of the YDTI closure conditions (pond and beach) are available.

We trust that the information presented in this letter meets your present needs. If you have any questions or concerns please contact the undersigned.

Yours truly,
Knight Piésold Ltd.



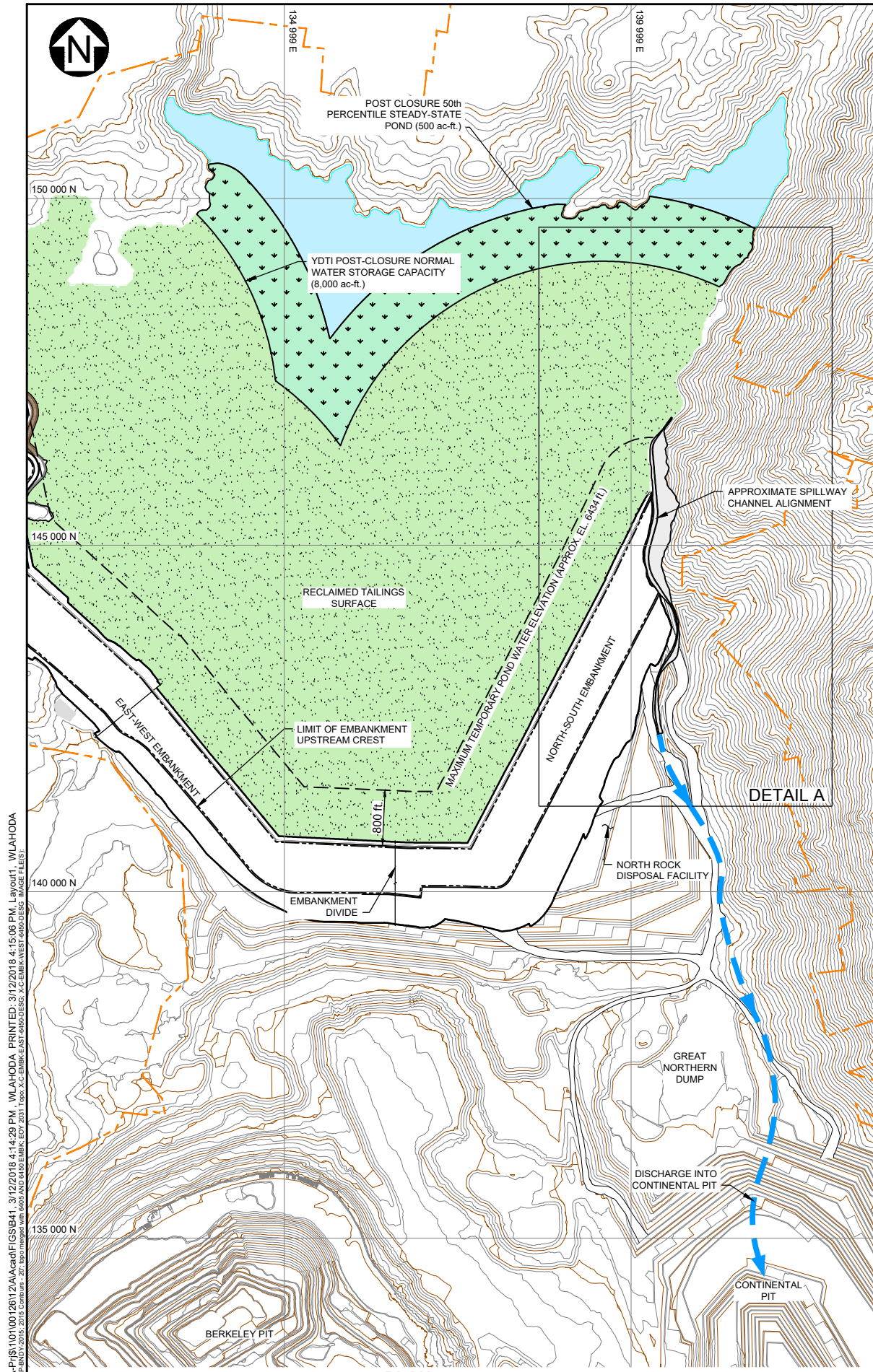
Prepared: *Jaime Cathcart*
Jaime Cathcart, Ph.D., P.Eng.
Specialist Hydrotechnical Engineer

Reviewed: _____
Ken Brouwer, P.E.
President

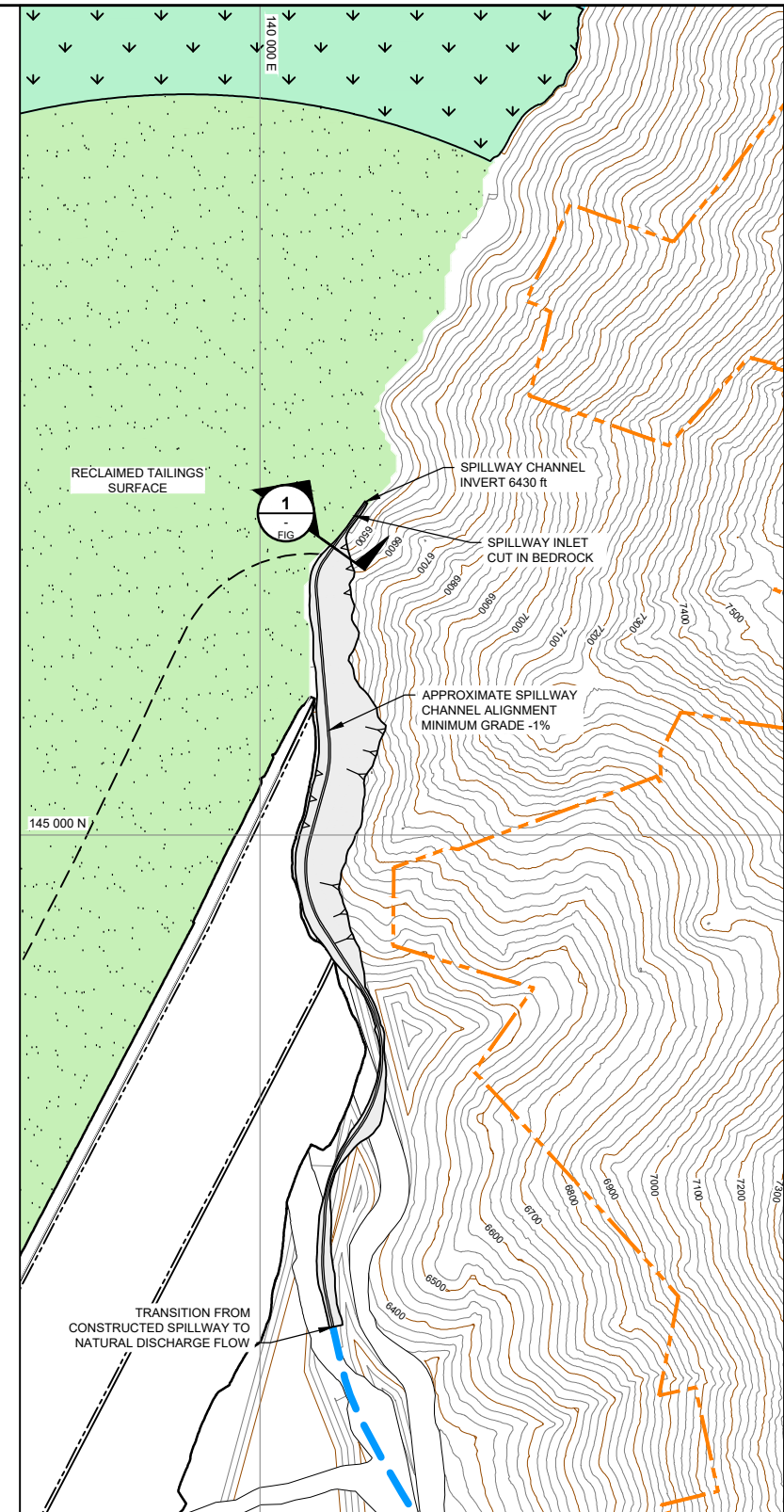
Approval that this document adheres to Knight Piésold Quality Systems: *EIS*

Attachments:
Figure 1 Rev 0 Conceptual Closure Spillway

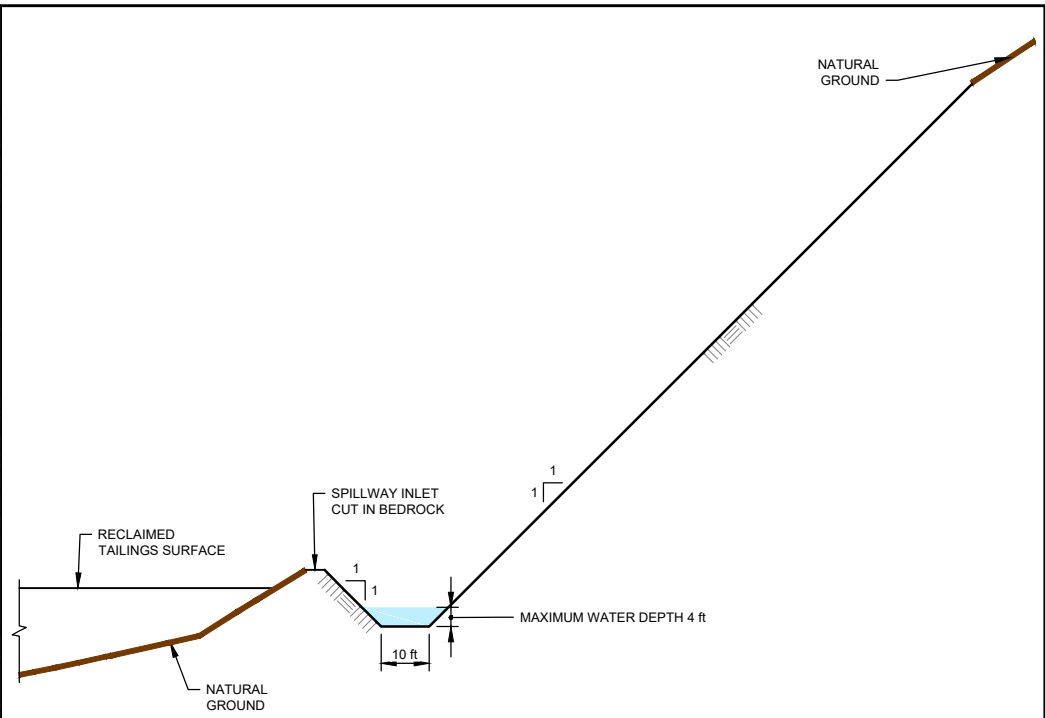
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PLAN
SCALE A



DETAIL
SPILLWAY
SCALE B



SECTION
TYPICAL SECTION (CUT INTO BEDROCK)
NTS

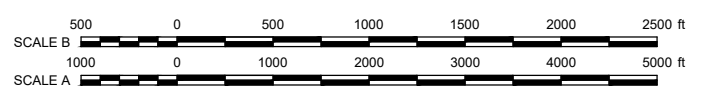
LEGEND:

- PROPERTY BOUNDARY
- SPILLWAY CONSTRUCTED IN BEDROCK
- DISCHARGE FLOW TO CONTINENTAL PIT

NOTES:

1. COORDINATE GRID IS ANACONDA MINE GRID.
2. THE NORTH TERRACE LOCATION AND LAYOUT WAS PROVIDED BY MR IN NOVEMBER 2015. THE CONTINENTAL YR 2040 EXTENTS WERE PROVIDED BY MR AUGUST 2016.
3. ALIGNMENT IS CONCEPTUAL AND WILL REQUIRE OPTIMIZATION FOR HYDRAULIC CONSIDERATIONS IN NEXT PHASE OF DESIGN.
4. CONTOUR INTERVAL IS 25 ft.

**CONCEPTUAL
ARRANGEMENT ONLY
NOT FOR CONSTRUCTION**



MONTANA RESOURCES, LLP	
YANKEE DOODLE TAILINGS IMPOUNDMENT	
CONCEPTUAL CLOSURE SPILLWAY	
<i>Knight Piésold</i> CONSULTING	<small>P/A NO.</small> VA101-126/12 <small>REF NO.</small> VA18-00426 FIGURE 1 <small>REV</small> 0

SAVED: \\P1\VA-P1\B110110012612AAcad\FIGS\B41_3122018 4:14:29 PM - WLAHODA PRINTED: 3/12/2018 4:15:06 PM - Layout1 - WLAHODA
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REV	DATE	DESCRIPTION	DESIGNED	DRAWN	REVIEWED
0	12MAR18	ISSUED WITH LETTER	SCR	KJM/WAL	JGC