# APPENDIX Q: Tailings Management Alternatives Evaluation

# APPENDIX Q

# Tailings Management Alternatives Evaluation
# Black Butte Copper Project
# Meagher County, Montana

Prepared for:

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July 18, 2016

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## APPENDIX A

## 1.0 INTRODUCTION

Tintina Resources, Inc. is the owner of the Black Butte Copper Project a proposed underground copper mine located approximately 15 miles north of White Sulphur Springs in Meager County, Montana. The project is currently in the permitting phase and a Mine Operating Permit Application was submitted to the Montana DEQ's Hard Rock Bureau in December of 2015.

As part the project, and as a result of these tailing alternative studies, Tintina plans to manage produced tailings using a combination of two standard mining industry methods. Specifically, approximately 45 percent of the tailings will be mixed with 4 percent cement and other binders (fly ash and slag) and used as cemented paste backfill in mined-out underground stopes and mining access drifts during mining operations. The remaining 55 percent of the produced tailings are proposed to be mixed with 0.5 to 2% cement and binders and placed as cemented paste tailings in a surface impoundment (Cemented Tailings Facility - CTF) at the mine site.

Various tailings management facility (TMF) alternatives were identified by Knight Piésold (KP) (2013) with respect to the method used to manage and store the tailings on surface. In addition, several different surface locations for the facilities were reviewed. The pros and cons for each of the alternatives were evaluated and a final preferred tailings management method and facility location was selected. This document summarizes this management alternative analysis and reviews the surface location selection process.

Detailed evaluations by Knight-Piésold (2013, 2015, and 2016a) and Tintina (2015) as well as geographical and geotechnical site investigations (Knight-Piésold, 2016b) have been completed at the Black Butte Copper Project on feasible alternatives for both the method used for above-ground tailings management and the location of a management facility. In addition, a tailing pipeline alternatives and alternative pipeline routes were studied by MG Engineering Inc. (2016).

## 2.0 MANAGEMENT METHOD ALTERNATIVES

A large working group composed of 18 scientists and engineers from Tintina Resources, Inc., SRK Consulting, Geomin Resources Inc., Enviromin Inc., Knight Piésold, Tetra Tech Inc., and International Metallurgical Inc., was formed in 2015 to identify feasible tailings storage methods for the Black Butte Copper operations and rank the alternatives in order to select the most appropriate method specific to the project.

### 2.1 Method Identification Criteria

The working group identified six separate scenarios under which project tailings could be effectively yet efficiently managed. The criteria used to identify the six scenarios were:

- Tailings management,
- Water management,
- Waste rock management, and
- Miscellaneous other criteria relevant to tailings storage not included in the first three criteria.

In its consideration of alternatives, the working group examined a number of factors affecting tailings and tailings management for the project, including:

- Proposed operation of facilities,
- Ore body, location, geometry, size tonnage, and grade,
- Tailings characterization, including known rheological characteristic and geochemistry,
- Waste rock characterization, including geochemistry,
- Site location alternatives, geometry / distance from mill and other support facilities, and
- Costs.

### 2.2 Management Methods

For tailings management, both onsite and offsite options were considered. Onsite options included:

- Lined impoundment material type
    - Conventional slurry
    - Thickened slurry
    - Paste
    - Cemented paste
    - Wet cake
    - Dry cake
- Deposition
    - Subaqueous deposition
    - Pyrite encapsulation,
    - Chemical stabilization
    - Biological stabilization
- Acceleration of pyrite oxidization
- Underground storage

Offsite options included:

- Subaqueous deposition
- Pyrite isolation or encapsulation
- Recycling (i.e., road construction)
- Anoxic lake deposition
- Quarry fill

Water management options included:

- Site drainage management (i.e., ditches and diversion)
- Optimize usage, isolate and separate underground water (i.e., grouting)
- Excess water management (i.e., water sales, underground injection, infiltration galleries and enhanced evaporation)
- Minimize onsite water use
    - Recycle
    - Dewatering, concentration and recycle
    - Filter tailings and recycle
    - Cover ponds to minimize evaporation

Waste rock management options included:

- Minimize waste rock production
- Use in construction
    - Roads
    - Berms
    - Buildings
    - Dry stack buttress
    - Visual barriers
    - Landscaping
- Place in tailings impoundment
    - Sub-aqueous
    - Comingle with tailings
    - Co-disposal with solids
    - Tailings buffer
    - Crush for cover use, or foundation drains
    - Liner cushions and basin drains

Other waste rock management methods included:

- Offsite waste disposal
- Mine plan modifications
    - Open pit mining
    - Underground waste disposal
    - Barite resource recovery
    - Pyrite resource recovery
- Processing modifications
    - Custom offsite milling
    - Refine for co-pyrite roasting (energy source)
    - Second flotation of pyrite for (on-site or offsite) acid manufacturing.

## 2.3 Method Alternatives

Using the results of the method identification and management methods evaluation, the working group identified six potentially feasible tailings management alternatives for the project. Each of the six alternatives is described below, and pros and cons along with implications for costs are summarized in Table A (in Appendix A). Some of these methods are also described in greater detail in Knight-Piésold (2016a).

### 2.3.1 Conventional Tailings Slurry Deposition

This alternative involves the subaqueous deposition of whole tailings in a lined impoundment where anoxic conditions under water prevent or significantly reduce the rate of pyrite oxidation. The tailings would first be thickened to reduce water content going into the impoundment. The impoundment would also serve as a source of makeup water for the project mill. Waste rock would be stored in a separate lined facility and would be used to cover the tailings impoundment at mine closure.

This alternative would employ a proven method for controlling acid rock drainage (ARD), and also provides for additional water storage capacity. However, this alternative requires the largest embankment of the six alternatives and would also require pond management and long-term monitoring, and the separate waste rock facility would increase the disturbance footprint. Waste rock would also have to be selectively mined to produce suitable non-acid generating material for the cover.

### 2.3.2 Dry Stack Tailings

Dry stack tailings disposal would involve thickening the tailings followed by filtering to reduce water content after which the dried tailings would be deposited in at a nearby disposal site with trucks that would continue to "stack" the tailings in lifts. The extracted water would be recycled and used in processing. In this alternative, waste rock would be co-disposed in the same site, eliminating the need for a separate storage facility and thus further minimizing the disturbance footprint. This waste facility would be sufficiently stable to eliminate the need for a retaining dam.

The tailings from the Black Butte operation are expected to be very fine, and there is a risk that the tailings could not be sufficiently dewatered to create a material suitable for dry stacking. However, even if the tailings could be desiccated enough for dry stacking, this alternative has potential air quality issues, requires storage of contaminated process water, and is complex with high capital and operating costs. Waste rock may also not be suitable for construction of berms for facility.

### 2.3.3 Depyritized Ultra-Thickened Sub-Aqueous Deposition

Pyrite would be removed from the tailings during ore-processing in this alternative, after which the pyrite would be deposited underground as a paste backfill and the depyritized tailings would be thickened and deposited under water in a lined surface impoundment cell.

Because the run-of-mine ore contains approximately 30 percent pyrite, removing sufficient amounts of pyrite to fully neutralize the acid generating potential of the remaining tailings could be challenging. However, if sufficient pyrite could be removed, this alternative could generate large volumes of pyrite concentrate, necessitating barite mining to provide sufficient space for the underground pyrite disposal.

Further complications of this alternative include:

- The need to first adjust the pH of process water downward for pyrite flotation, then adjust the pH back upward for copper flotation, which would increase lime consumption. and scaling could also pose issues to the pyrite circuit operation; and

- The requirement for an additional circuit in the mill, presenting a risk to copper recovery.

### 2.3.4 Two-Cell Ultra-Thickened Depyritized and Pyrite Concentrate

This alternative is similar to the depyritized ultra-thickened sub-aqueous alternative but differs in that the separated pyrite would not be deposited underground but instead would be stored in a separate sub-aqueous surface impoundment cell.

The complications identified for the depyritized ultra-thickened sub-aqueous alternative apply here, in addition to pond management as identified for the conventional tailings slurry alternative.

### 2.3.5 Paste Tailings with Underground Paste Cement Content (~4%)

This alternative is one of two that involve mixing cement with the tailings to generate a physically stable cement tailings or tailings "paste" and placing the paste in lifts in a lined surface impoundment. In this alternative, the tailings would be mixed with the same 4 percent cement used for underground tailings disposal that creates a tailings deposit sufficiently stable to maintain structural integrity in the event of an embankment failure. Included in this alternative was inclusion of waste rock with the tailings. This alternative requires a separate process water storage pond.

A concern that the working group identified for this method is the potential for oxidation on the surface on the impoundment materials during the time a deposit lift is laid down and another is laid on top of it. However, the group concluded that the cement would slow acidification for a period following deposition and the next deposit would be laid down before acidic conditions developed.

On the plus side, the working group determined this alternative would reduce embankment costs, reduce dust generation and reduce evaporative water losses. On the downside, the central and eastern TMF alternatives are associated with higher operating, process and storm water costs than some of the other alternatives. In addition, the central TMF alternative would require relocation of a county road.

### 2.3.6 Paste Tailings with Reduced (~2%) Cement Content

The only difference between this alternative and the other paste tailings alternative is that this alternative uses approximately 2 percent cement rather than 4 percent, and all of the pros and cons identified for the 4 percent paste tailings alternative were also identified for the 2 percent alternative. The one difference between the two paste tailings alternatives is that the 2 percent alternative has a lower operating cost than does the 4 percent alternative while still providing sufficient structural integrity for the deposited cemented paste.

## 2.4 Selected Method Alternative

After evaluating the six identified alternatives, the working group ranked the alternatives using a weighted average for each selection. Each member was asked to select first, second and third

choices in addition to identifying the alternative considered prohibitive (most unappealing) and generally not meeting the selection criteria. Specifically, the first selection was given a score of +3, second +2, third +1 and least attractive given a -1 score and the results were summed for each alternative. The weighted average alternative results are ranked in order in Table 1 below. As the rankings indicate, the 2 percent paste tailings was the number 1 ranking tailings management alternative.

**Table 1. Tailings Management Method Alternatives Working Group Rankings**

| Score [(1)] | Ranking | Alternative |
|---|---|---|
| 30 | 1 | Paste Tailings with Reduced Cement Content (<2%) |
| 19 | 2 | Dry Stack Tailings |
| 11 | 3 | Conventional Tailings Slurry Deposition |
| 10 | 4 | Paste Tailings with Underground Paste Cement Content (4%) |
| 1 | 5 | Depyritized Ultra-Thickened Sub-Aqueous Deposition |
| -1 | 6 | Two-Cell Ultra-Thickened Depyritized and Pyrite Concentrate |

Notes:
1) Weighted average Group Scores
2) See Appendix A of this document for additional information

## 3.0 MANAGEMENT FACILITY LOCATION ALTERNATIVES

In 2011 and 2013, Knight Piésold, Ltd. (KP) conducted an alternatives evaluation for the location of a tailings management facility (impoundment) for the Black Butte Copper project from which potentially feasible locations were identified using the following design criteria:

- Mass storage capacity of approximately 3.75 million tonnes (4.13 M tons) of tailings (55 percent of the total estimated 13.2 Mt or 14.5 M tons of ore planned for processing over the life of the mine);

- Assumed tailings density of 1.7 tonnes per cubic meter (tonnes/$m^3$) for a resulting total volume capacity of 2.88 million cubic yards (2.2 $Mm^3$)(this number has changed since the original report was written);

- Approximately 100,000 tonnes (110,231 tons) of waste rock (this number has changed since the original report was written) with an assumed density of 2.0 tonnes/$m^3$ will be co-deposited with the tailings, increasing the required mass capacity to 3.85 million tonnes (4.24 M tons) and volume capacity to 2.94 million cubic yards (2.25 $Mm^3$);

- All waste rock generated from the underground workings and tailings were assumed to be potentially acid generating (PAG); and

- The final facility will be a lined, excavated impoundment developed in stages, beginning with a "starter" impoundment with a capacity to hold tailings and underground waste rock through the first two years of the mine operation.

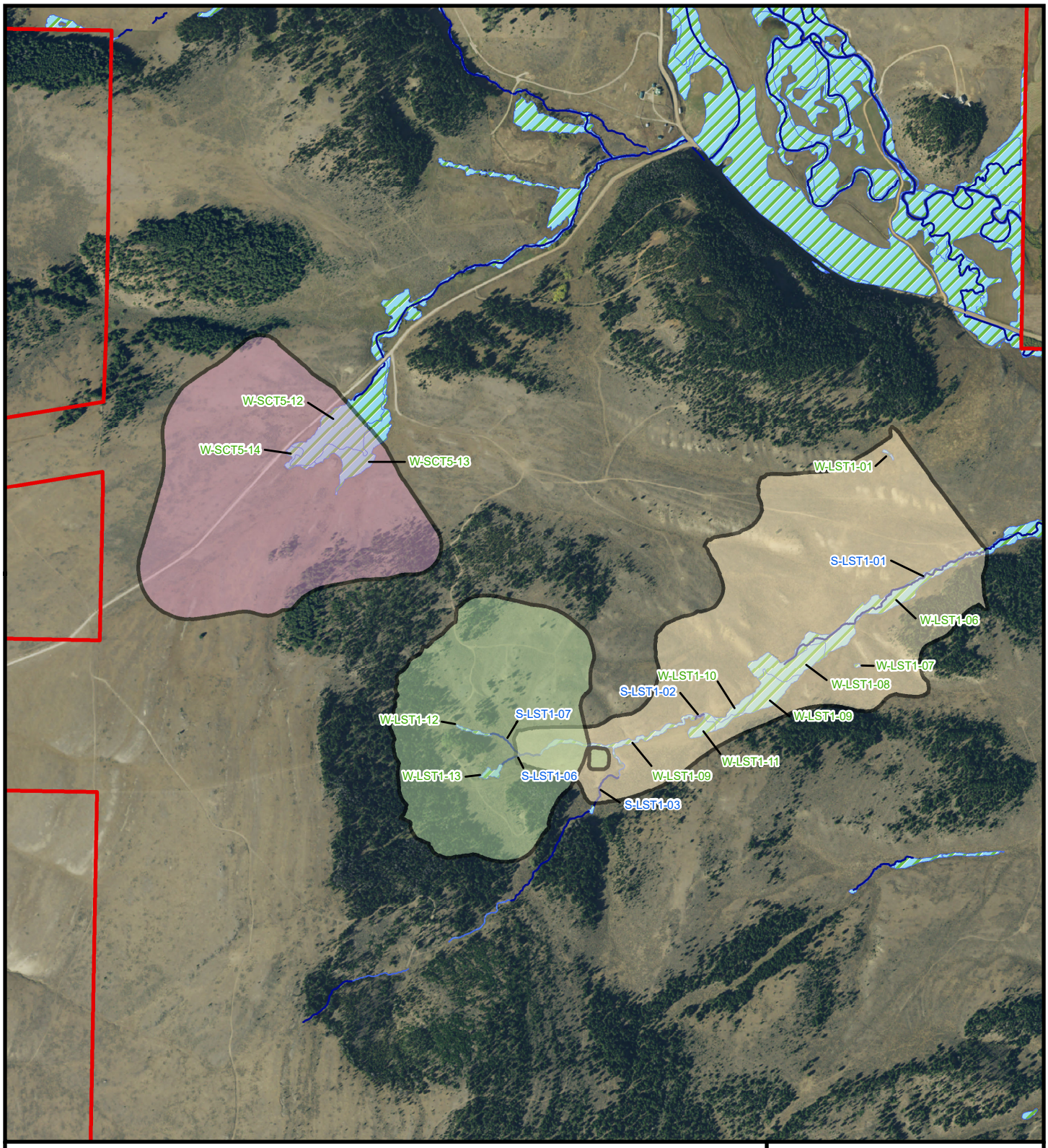
### 3.1 Evaluation Criteria

The following were the primary criteria used by Knight-Piésold to evaluate the impoundment location alternatives:

- Reason for consideration
- Storage capacity
- Expansion capacity
- Disturbance footprint
- Wetlands areas
- Minimize environmental risks
- Minimize the number of drainage basins with facilities
- Number of catchments (separate tributary drainages)
- Catchment area
- Length of delivery pipeline
- Surface hydrology implications
- Costs

### 3.2 Facility Alternatives

Three initial alternative site locations were identified for the tailings impoundment by Knight-Piésold (2012) as shown in Figure 1 and geotechnical drilling and soil test pit excavations were conducted on each site. These three alternatives were identified as the West, Central and East Impoundments. The locations and configurations of these alternative impoundments are shown on Figure 2 (Knight-Piésold, 2013). Knight-Piésold's final Tailings Management Plan (TMP) and




## Legend

- Cemented Tailings Facility (CTF) Preferred Alternative
- Central Tailings Impoundment Alternative
- East Tailings Impoundment Alternative
- Study Area Boundary
- Streams
- Wetlands

Aerial: 2015 NAIP

0 600 1,200 2,400

Feet

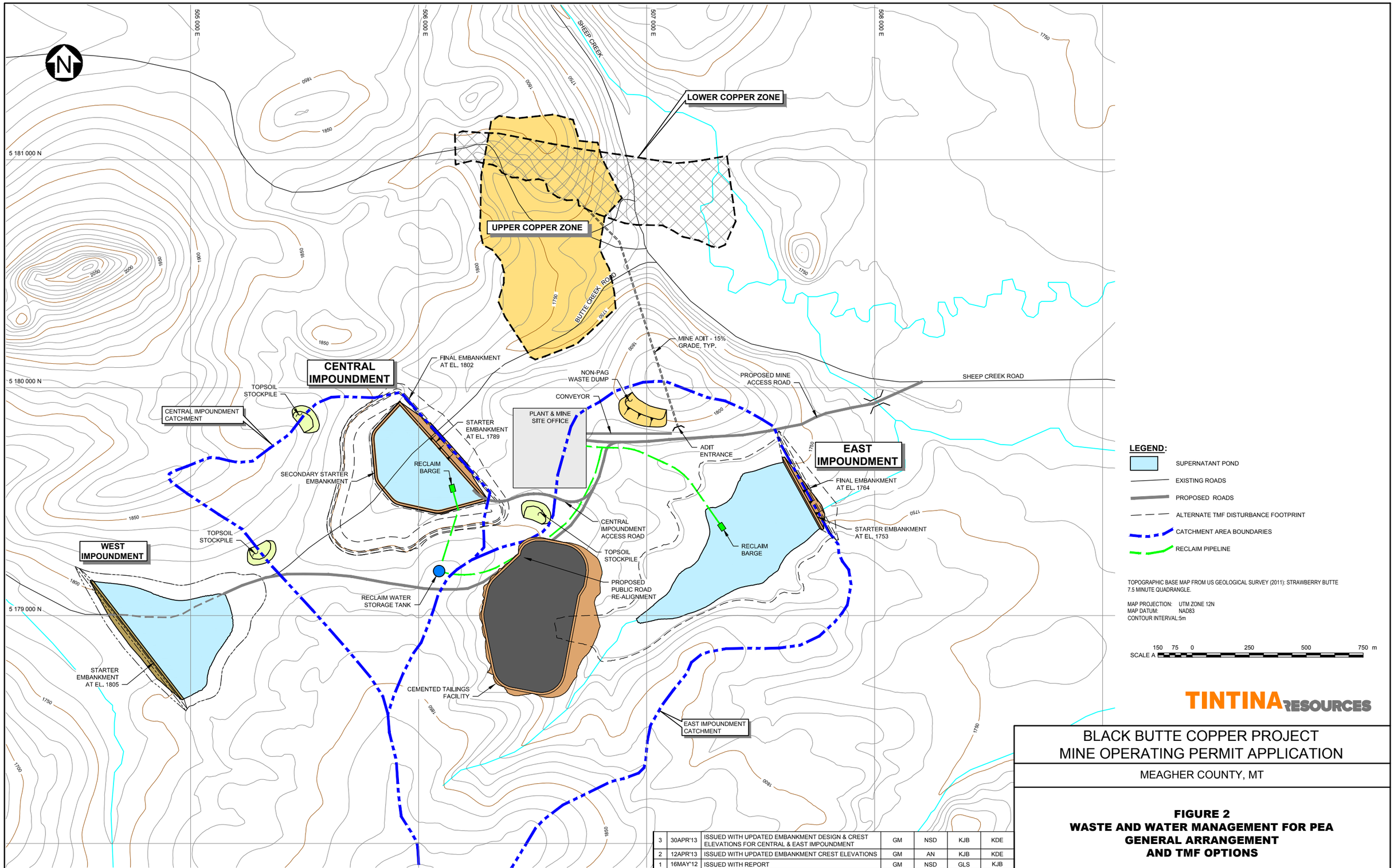
TINTINA RESOURCES

Black Butte Copper Project

**Figure 1**
**Alternative Tailings Facility Footprints**

WESTECH ENVIRONMENTAL SERVICES
406-442-0950 | P.O. Box 6045 | Helena, MT 59604

7/15/2016 | BBC16_Wetlands_Tailings_Alts.mxd | 1:14,400




TINTINA RESOURCES

# BLACK BUTTE COPPER PROJECT
# MINE OPERATING PERMIT APPLICATION

MEAGHER COUNTY, MT

## FIGURE 2
## WASTE AND WATER MANAGEMENT FOR PEA GENERAL ARRANGEMENT AND TMF OPTIONS

| REV | DATE | DESCRIPTION | DESIGNED | DRAWN | REVIEWED | APPROVED |
|---|---|---|---|---|---|---|
| 3 | 30APR'13 | ISSUED WITH UPDATED EMBANKMENT DESIGN & CREST ELEVATIONS FOR CENTRAL & EAST IMPOUNDMENT | GM | NSD | KJB | KDE |
| 2 | 12APR'13 | ISSUED WITH UPDATED EMBANKMENT CREST ELEVATIONS | GM | AN | KJB | KDE |
| 1 | 16MAY'12 | ISSUED WITH REPORT | GM | NSD | GLS | KJB |
| 0 | 06FEB'12 | ISSUED WITH REPORT | GM | NSD/PP | GLS | KJB |

REVISIONS

REVISED DATE: MAY 2016

DRAWING BY KNIGHT PIESOLD: Report No. VA101-460/1-1 Rev 2

SOURCE FIGURE NUMBERS: B03_r3

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geotechnical report was completed in 2013 and later included as part of a Preliminary Economic Evaluation (PEA) (Tetra Tech, 2013).

Subsequent to Knight-Piésold's 2013 evaluation, the preferred location was identified by Tintina which encompassed a smaller total wetlands area as discussed below. This preferred location is called the Cemented Tailings Facility (CTF) and is included in the mine operating permit application (Tintina, 2015).

In 2013, 2015 and early in 2016, numerous geotechnical drill holes and soil test pits were advanced at prospective locations of mine facilities, including all of the tailings impoundment alternatives, and a number of alternative pond, reservoir and waste storage facility locations. The locations of the facilities and the boreholes and test pits are shown on Figure 3 (from the revised 2015 mine operating permit application) and included in this document below. This figure identities and approximates the footprints for the West, Central, East and CTF impoundments. Details regarding each of the alternative areas are discussed in the following sections and are summarized in Table B (in Appendix A).

### 3.2.1 West Impoundment

The West Impoundment alternative is located in a short valley approximately 1.2 km (0.7 mi) southwest of the 2013 proposed mill site (Figure 1), and was selected as an alternative primarily because: 1) it is not visible from most publicly traveled access roads in the area, 2) a single earthen embankment could close off the shallow valley and 3) there were no wetlands or streams located in the footprint of the facility.

However, while this impoundment would have an initial storage capacity of 0.77 million cubic yards (0.59 $Mm^3$) which would be sufficient for the first two years of the mine operation, it has limited expansion capacity (requiring additional extensive excavation) and is therefore too small to hold the tailings and waste rock from mining of the identified resource. It was also one of Tintina's major concerns that all facilities be located in one drainage basin. The West Impoundment is located to the west of most of the proposed mine facilities and is located in a separate drainage basin (Black Butte Creek). For these reasons, Knight-Piésold did not further evaluate this alternative.

### 3.2.2 Central Impoundment

The Central Impoundment would be located in a tributary valley to Sheep Creek only 0.3 km (0.2 mi) from and to the south of the proposed 2013 mill site location (Figure 2), and that location proximal to the plant was one of the primary reasons it was considered. It can also be closed off by a single downgradient earthen embankment. The Central Impoundment has a lightly traveled county road through the middle of it that would have to be relocated.

The Central Impoundment has a total impoundment capacity of 8.67 million cubic yards (6.63 $Mm^3$). It has a moderate disturbance footprint of 97.7 acres, (39.6 ha) a relatively short tailings delivery pipeline of 1.5 km, a moderately large catchment area of 233.6 acres (94.5 ha) — the smaller the catchment the more desirable because less surface water diversion is required — and a moderate total cost of $33.8 million (in current U.S. dollars). The Central alternative does not block or cover any ponds or streams, but it would disturb 6.56 acres (2.65 ha) of designated wetlands.

### 3.2.3 East Impoundment

The East Impoundment would be located in a long valley approximately 1.4 km (0.9 mi) southeast of the 2013 proposed mill site (Figure 2). The East Impoundment could be closed off with a single embankment that would be smaller than the embankments required for the West and Central alternatives. The embankment for this facility would be visible from Sheep Creek along a well-traveled county road.

Compared to the Central Impoundment, the East Impoundment has the same 8.67 million cubic yards (6.63 $Mm^3$) total impoundment storage capacity. It has a larger disturbance footprint of 128.9 acres (52.2 ha), a longer tailings delivery pipeline of 2.3 km (1.4 mi), a considerably larger catchment area of 590.5 acres (239.0 ha), and a comparable total cost of $35.3 million. This alternative footprint covers an intermittent stream and 11.05 acres (4.47 ha) of designated wetlands.

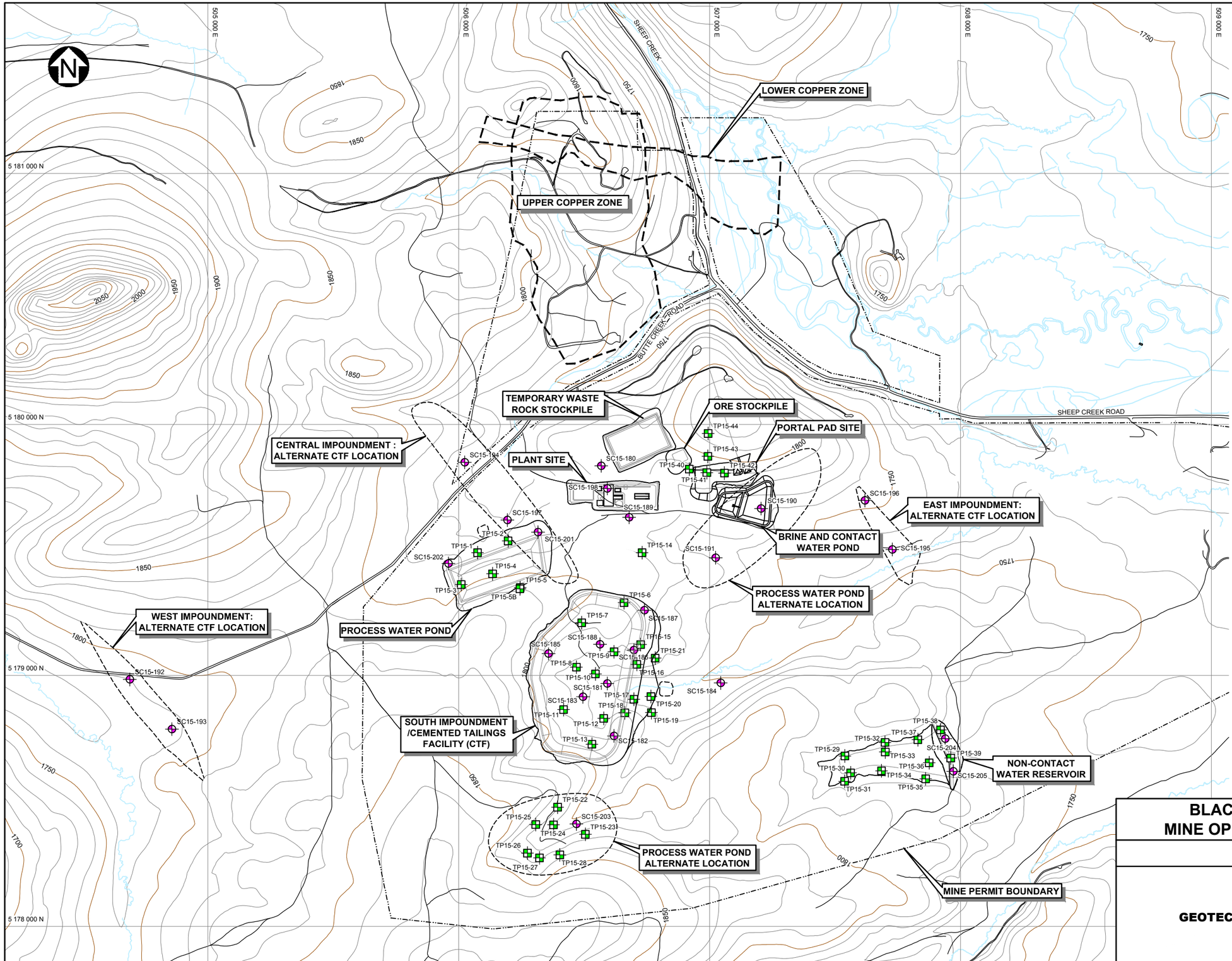
### 3.2.4 Cemented Tailings Facility

The CTF is located approximately 0.3 km (0.2 mi) directly south of the proposed 2015 mill site (Figure 3), has no public access visibility, and like the other alternatives can be closed off with a single embankment. This alternative has the lowest wetlands impact with only 0.71 acres (0.29 ha) of wetland within the footprint, an order of magnitude below the other alternatives. The CTF alternative also has the lowest catchment area at 87.7 acres (39.45 ha), and is smaller than the either of the Central or East impoundment areas. At 1.4 km (0.9 mi), the CTF also requires the shortest tailings pipeline length among the alternatives.

Regarding capacity, the CTF is designed for a total capacity of 5.62 million cubic yards (4.3 $Mm^3$), which is sufficient for the 4.66 million cubic yards (3.56 $Mm^3$) of tailings, 0.46 million cubic yards (0.35 $Mm^3$) of waste rock, and 0.39 million cubic yards (0.30 $Mm^3$) of storm water in a Probable Maximum Flood (PMF) event, leaving an excess capacity of 0.12 million cubic yards (0.09 $Mm^3$).

As shown in Figure 3 and in Table B (in Appendix A), the CTF location underwent a more thorough geotechnical evaluation than the other alternative locations with a total of 15 geotechnical test pit excavations, 5 geotechnical boreholes, and one monitoring well installation. The preferred CTF site has had four additional monitor wells installed in 2016, to investigate the necessity of excavation into the groundwater table.

Estimated total costs for the CTF alternative are estimated at US$44.8 million. This cost is markedly higher than total costs of US$33.8 million and US$35.3 million estimated for the Central and East alternatives, respectively.




# BLACK BUTTE COPPER PROJECT
# MINE OPERATING PERMIT APPLICATION

## MEAGHER COUNTY, MT

## FIGURE 3
## GEOTECHNICAL SITE INVESTIGATION DRILL HOLE AND TEST-PIT MAP

| REV | DATE | DESCRIPTION | DESIGNED | DRAWN | REVIEWED | APPROVED |
|---|---|---|---|---|---|---|
| REVISIONS | | | | | | |

REVISED DATE: JULY 2017

DRAWING BY KNIGHT PIESOLD: Report No. VA101-460/3-1 Rev 2

SOURCE FIGURE NUMBERS: FIGURE D1.1_r2

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### 3.2.5 Selected Location Alternative

The CTF site was ultimately selected as the preferred impoundment location alternative since it impacts the smallest total acres of wetland that require the placement of fill and the lowest total catchment area disturbance. As previously described, the CTF alternative footprint impacts 0.71 acres (0.29 ha) of wetlands and 87.70 acres (39.45 ha) of catchment area disturbance. The CTF site alternative was selected even though the total cost is significantly higher than the Central and East alternatives.

Knight-Piésold's 2013 alternatives evaluation report did not include the CTF alternative site; however, this report recommended the Central Impoundment as the preferred site location alternative. Knight-Piésold (2015) recommended additional geotechnical soil/rock investigations inside the footprints. Additional site investigation boreholes were completed in the CTF preferred alternative area in 2016 (Hydrometrics, 2016), many of which were converted into monitoring wells.

## 4.0 SUMMARY

Detailed evaluations by Knight-Piésold (2013, 2015) and site investigations (executed in 2013, 2015 and 2016) have been completed at the Black Butte Copper Project for feasible alternatives for both the method used for above-ground tailings management and the location of a management facility. As a result of this work, cemented paste tailings using 0.5 to 2 percent cement was selected as the preferred management method in an impoundment (CTF) located just south of the mill site (Figure 3). The primary reason for selecting these alternatives is minimizing potential environmental impacts including facility stability, environmental risk and minimizing impacts to wetlands. The tailings paste method using reduced 0.5 to 2 percent cement has the least impact to nearby designated wetlands. In addition, the CTF location alternative is associated with the smallest catchment area footprint. The cemented tailings paste and CTF site location are the preferred alternatives despite the markedly higher total cost of paste tailings disposal relative to the other evaluated methods.

In addition, a tailing pipeline alternatives and alternative pipeline routes were studied by MG Engineering Inc. and are presented in a final report (MG Engineering, 2016).

## 5.0 REFERENCES


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# Appendix A
Matrix Tables

**Table A. Method Alternative Matrix**

| | Method Alternative | Pros | Cons | Implications for Costs |
|---|---|---|---|---|
| 1 | **Whole Tailings Slurry Deposition** | Proven method for controlling ARD<br>Flexible to take paste when it's not needed<br>Water storage capacity<br>Lower cost<br>Simplicity | Requires pond management<br>Does not provide for pyrite recovery<br>Tailings could acidify if they dry<br>Largest embankment<br>Long-term monitoring | Lower costs because tailings/processing system not required<br>is not required<br>Fully double-lined impoundment increases costs<br>Higher pumping costs for reclamation water |
| 2 | **De-Pyritized and Ultra-Thickened Subaqueous Tailings** | Placing pyrite back underground<br>Established tailings management methods for<br>safety purposes and environmental risk | Storing waste rock for closure<br>Cost of pyrite removal<br>Uses more functional wetlands<br>Requires road relocation<br>Potential for tailings seepage | Over $20 million above other options |
| 3 | **Dry Stack Tailings** | Can be located on slopes/uplands away from wetlands<br>Reduced site footprint<br>Reduced water usage<br>Reduced water treatment costs<br>Provides for segmented closure/reclamation<br>No additional access roads required | Air quality issues<br>Higher capital costs<br>Higher operating costs<br>Complex operating plan<br>Requires four full-time equivalents<br>Requires process water pond<br>Requires storage of contaminated process water | Approximately double the cost of subaqueous option |
| 4 | **Thickened DePy and PyCon in Two Cells** | No large pond required<br>Requires less make-up water<br>Removes ARD potential following closure<br>Pyrite separation | Complicated process<br>Depends on pyrite flotation and removal at closure<br>Requires storage of contaminated process water<br>Run-off management | Pyrite separation expensive<br>Dewatering and paste plant doubles cost<br>Transport costs<br>Bonding cost for depositing pyrite underground |
| 5 | **Paste Tailings - Cement Content 4% Same as UG Paste** | Non-flowing tailings<br>Reduced embankment construction costs<br>Reduced dust potential<br>Reduced water loss to evaporation<br>Limits short-term ARD potential<br>Facilitates placement of closure cover | Requires road relocation<br>Higher construction costs<br>Higher operating costs<br>Higher process and storm water costs | Operating cost approximately $25 per tonne<br>$10 to $15 million in impoundment and reservoir costs |
| 6 | **Paste Tailings - Reduced Cement Content (2%)** | Same as Scenario/Method 5 | Same as Scenario/Method 5 | Operating costs lower than Scenario / Method 5 |

**Table A**
**Method Alternatives Matrix**
**Tailings Management Facility**
**Black Butte Copper Project**

**Table B. Tailings Management Facility Alternative Characteristics by Location.**

| Evaluation Criteria | Cemented Tailings Facility (Preferred Alternative) | Central Impoundment Alternative | West Impoundment Alternative | East Impoundment Alternative |
|---|---|---|---|---|
| **Proximity to Mill Site** | 0.3 km (0.2 miles) south of mill site | 0.3 km (0.2 miles) west of mill site | 1.2 km (0.7 miles) southwest of 2013 mill site | 1.4 km southeast of mill site |
| **Reasons for Consideration** | Minimal wetlands impacts.<br>Single earthen embankment.<br>No public access visibility.<br>Proximity to mill. | Proximity to mill.<br>Visible from limited travel county road<br>Valley location allows for single earthen embankment. | Visible from limited travel county road<br>Valley location allows for single earthen embankment.<br>No wetland impacts | Long valley location allows for single earthen embankment. |
| **Storage Capacity from Depth Area Capacity (DAC) Relationship** | All tailings plus 100 percent of waste rock brought to surface of 15-year mine life | Total tailings, plus 100,000 tons of PAG waste rock storage. | Three years. KP excluded this TMF location option due to lack of storage capacity | Total tailings, plus 100,000 tons of PAG waste rock storage. |
| **Final Total Impoundment Storage Capacity ($m^3$)** | 4.3 million $m^3$ (Plans call for 3.56 $Mm^3$ tailings, 0.35 $Mm^3$ waste rock, and 0.3 $Mm^3$ PMF flood event storm water, leaving an access capacity of 0.09 $Mm^3$) | 6.63 million $m^3$ [3] | 0.59 million $m^3$ [3] | 6.63 million $m^3$ [3] |
| **Disturbance Footprint** | 71.91 ac (29.10 ha) | 97.7 ac (39.6 ha) | Not evaluated by KP per DAC above | 128.9 ac (52.2 ha) |
| **Wetlands Area** | 0.71 ac (0.29 ha) | 6.56 ac (2.65 ha) | 0.0 | 11.05 ac (4.47 ha) |
| **Wetland Fill by Cowardin Type**[1] | 100% PEM | 6% PEM/94% PSS | NA | 67% PEM/33% PSS |
| **Wetland Fill by Wetland Quality**[2] | 100% Category III (46% score) | 100% Category III (61% score) | NA | 100% Category II (67% score) |
| **Volume of Fill Placed in Wetlands ($yds^3$)** | 6,915 | 63,501 | NA | 106,964 |
| **Stream Fill (Length in Feet)** | 696 | 0 | NA | 3,099 |
| **Fill Placed in Stream (Volume in Cubic Yards) by Type (perennial/intermittent/ephemeral)** | 928 (Intermittent) | NA | NA | 4,132 (Perennial) |
| **Catchment Area** | 87.70 ac (39.45 ha) | 233.6 ac (94.5 ha) | Not evaluated by KP per DAC above | 590.5 ac (239.0 ha) |
| **Catchments** | 1 | 1 | Not evaluated by KP per DAC above | 1 |
| **Delivery Pipeline (length)** | 1.4 km | 1.5 km | Not evaluated by KP per DAC above | 2.3 km |
| **Surface Hydrology Implications** | Presence of intermittent stream that flows into Little Sheep Creek. Embankment requires fill of wetlands and intermittent streams. | Embankment requires fill of wetlands | Not evaluated by KP per DAC above | Presence of perennial stream that flows into Little Sheep Creek. Embankment and footprint requires placement of fill into wetlands and streams |
| **2015 Geotechnical Test Pits** | 15 | 0 | Not evaluated by KP per DAC above | 0 |
| **2015 Geotechnical Drill Holes** | 7 | 3 | Not evaluated by KP per DAC above | 2 |
| **2015 and 2016 Monitoring Wells** | 5 | 1 | Not evaluated by KP per DAC above | 0 |
| **Total Capital Costs in US Currency**[4] | $44.8 million | $33.8 million | Not evaluated by KP per DAC above | $35.3 million |
| **Disadvantages (Environmental Effects)** | Presence of intermittent stream and wetlands. | Will require realignment of existing county road, thus requiring an additional easement;<br>Presence of wetlands as noted above. | Limited expansion capacity<br>Additional drainage basin | Presence of perennial stream (Brush Creek) and wetlands. Embankment visible from highly traveled county road. |

Notes:

[1] Per Cowardin et al. (1979): PSS = Palustrine Scrub-Shrub; PEM = Palustrine Emergent.

[2] Per Berglund and McEldowney (2008).

[3] The reported volumes for the east, west, and central impoundment storage capacities were for an earlier mine plan than the current one in this MOP Application

[4] Total capital cost includes capital, sustaining capital, and operating expenses and have been estimated by Knight Piesold. The Central and East Impoundment alternative capital costs were calculated in April 2013 in Canadian dollars and have been adjusted to 2016 US dollar currency equivalent using a cumulative inflation rate of $1.05 (using the calculator at http://www.usinflationcalculator.com) and a US-Canadian dollar conversion of 1:1. Characteristics taken from Figure 2 (General Arrangement and TMF options)

PMF = Probable Maximum Flood event

Alternative Locations
Tailings Management Facility
Black Butte Copper Project, MT