Mine Operating Permit Application
Black Butte Copper Project, Meagher County, MT

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GLOSSARY OF TERMS

acre	a land measure based on the U.S. survey foot, one acre is approximately 43,560 square feet or 4,046.873 square meters.
adit	a horizontal entrance to an underground mine
amorphous	a mineral having no crystalline structure

anoxic	absence or reduced supply of oxygen
aquifer	a body of saturated rock through which water can easily move
barite	BaSO4, generally colorless barium sulfate mineral
carbonate mineral	containing the carbonate ion (CO32-)
chalcopyrite	(CuFeS2) a copper sulfide mineral
conglomerate	coarse grained sedimentary rock composed of rounded fragments within a matrix of finer grained material
Cretaceous	a period in geologic time occurring between 145 and 65 million years ago
cut-off grade	level of mineral in an ore below which is not economically feasible to mine.
Darcy's Law	an empirically derived equation that describes the flow of water through a porous medium
debris flow	rapid movement of soil and weathered debris above a bedrock surface
decline	a downward-sloping underground tunnel for access to ore-bearing mine workings
drift	horizontal or gently dipping underground mine tunnel that is cut parallel to or in the mineralized zone
ephemeral drainage	a gulch or coulee that contains flowing water only part of the year or only during "wet" years; sometimes referred to as an intermittent drainage
exploration license	a license issued by the State of Montana Department of Environmental Quality that authorizes the licensee to explore for minerals
fault	a planar fracture or discontinuity in a volume of rock across which there has been significant displacement along the fractures as a result of earth movement.
formation	a grouping of rock strata that have comparable lithology, facies or other properties and can be correlated across wide distances between outcrops and exposures of rock strata
foot wall	the body of rock lying below a fault plane
gossan	sulfide mineral deposit, formed as the remaining remnant of intense surface oxidation of sulfides and the leaching of sulfur and metals
hanging wall	the body of rock lying above a fault plane
hectare	a unit of surface, or land, measure equal 10,000 square meters: equivalent to 2.471 acres
Herth and Arndts	an empirically derived equation that describes groundwater linear steady state flow
hydrothermal vent	a fissure in the planet's surface from which geothermally heated water issues, common near volcanically or tectonically active places

hydraulic conductivity	a property of soil or rock that describes the ease with which water can move thorough pore spaces or fractures
Hydrophytic	plant-life that thrives in wet conditions; used as an indicator of wetlands
ICP-MS	a type of analytical technique which is capable of detecting metals and some non-metals at concentrations as low as one part per trillion
Indicated resource	economic mineral occurrences where an estimate of contained metal, grade tonnage, shape or other physical characteristics have been made based on sampling from outcrops, trenches, pits or drill holes
Igneous	rocks that have cooled and crystallized from magma (previously molten rock)
igneous intrusion	rocks that were previously melted, then squeezed into and between (intruded) older rocks before crystallizing
laminations	fine layers or laminae that occur in sedimentary rocks
Laramide Orogeny	a period of mountain building events in western North America responsible for the creation of the Rock Mountains beginning approximately 70-80 million years ago and ending 35 to 55 million years ago
LECOS	a brand of carbon/sulfur combustion furnace equipped with infrared detection used for measurement of sulfur concentration in rock, soil, and organic materials over a wide concentration range
lithic scatters	archaeological sites that consist solely of flaked stone artifacts
lithology or lithologies	rock type or types
massive	thick units of homogeneous (alike; consistent) material
measured resource	indicated resources that have gone through further sampling such that a competent person, usually a geologist, has declared the resource to be an acceptable estimate of the grade, tonnage, shape, densities and physical characteristics at high degrees of confidence
middle Proterozoic	geological era from 1600 to 1000 million years ago
mil	one/thousandth of an inch
mineralization	the formation of ore bodies or lodes of important economic minerals
mining claim	a parcel of land that the claimant has asserted a right of possession
normal fault	a fault where the hanging wall has moved downward relative to the footwall
NP:AP ratio	balance between the acid consumption potential and the acid production potential of a rock
ore	naturally occurring rock that contains minerals that can be extracted at a profit
oxidation	alteration of a rock by the addition or in the presence of oxygen
oxide	mineral group that contains oxygen

paralithic	weathered bedrock
potentiometric surface	a map that contours the distribution of groundwater elevations data and indicates the direction of groundwater flow
pyrite	(FeS2): an iron sulfide mineral
quartzite	is a hard, non-foliated metamorphic rock which was originally pure quartz sandstone
sedimentary rock	rocks formed from fragments of other rock (sediment) that are weathered, transported, deposited, and lithified
Specific Conductance	an electrical measure of the amount of dissolved substances in water
subsidence	settling or collapse of the ground surface
sulfide	mineral group that contains reduced sulfur
TCLP	a soil sample extraction method for chemical analysis to simulate leaching through a material for hazardous contaminants
thrust fault	a low angle reverse fault dipping 45 ° or less
transmissivity	a measure of how much water can be transmitted through an aquifer which is dependent on aquifer thickness and hydraulic conductivity
raise	vertical mine workings usually constructed from the bottom up
silicification	alteration process of petrification where rocks become saturated with silica
shale	laminated sediment comprised principally of clay sized particles
stratigraphy	the branch of geology focused on the study of rock layers and manner of layering
stratigraphically	concerned with the distribution and spatial association of rock layers and layering
subaqueous	occurring, appearing, deposited or formed underwater
TCLP	is a soil sample extraction method for chemical analysis employed as an analytical method to simulate leaching
TDS	a measure of the amount of dissolved substances in water
TKN	Total Kjeldahl Nitrogen; an analytical test that measures all forms of reduced nitrogen in waste water. Method cannot measure nitrate or nitrite nitrogen.
ton	a unit of measure defined to be 2,000 pounds
tonne	metric unit defined as being a metric ton equal to a mass of 1000 kg
turbidite	a turbidity or soft sediment density flow deposit
turbidity	a measure of water clarity or how much material is suspended in the water
unconformity	The contact between sedimentary rocks that are significantly different in age, or between sedimentary rocks and older, eroded igneous or

	metamorphic rocks. Unconformities represent gaps in the geologic record; periods of time that are not represented by any rocks.
vent biota	specialized microorganisms adapted to thrive on and around deep sea volcanic vents

ACRONYMS

AA	Assessment Area
AADT	Annual Average Daily Traffic
ANFO	Ammonium Nitrate/Fuel Oil
ARM	Administrative Rules of Montana
ASTM	American Society for Testing and Materials
ATR	Automatic Traffic Recorder
BHP	Broken Hill Proprietary Limited
BMP	Best Management Practices
CAI	Cominco American Inc.
CTF	Cemented Tailings Facility
DEQ	Department of Environmental Quality
DNRC	Department of Natural Resources and Conservation
EA	Environmental Assessment
FAA	Federal Aviation Administration
FEMA	Federal Emergency Management Administration
FMEA	Failure Modes Effects Analysis
FWP	Fish, Wildlife and Parks
G&A	General & Administrative
GWIC	Groundwater Information Center
HDPE	High Density Polyethylene
ICOLD	International Commission On Large Dams
ICP-MS	Inductively Coupled Plasma-Mass Spectrometry
LAD	Land Application Disposal System.
LCZ	Lower Copper Zone
LSZ	Lower Sulfide Zone
MBMG	Montana Bureau of Mines and Geology

MCE	Maximum Credible Earthquake
MDT	Montana Department of Transportation
MEPA	Montana Environmental Policy Act
MPDES	Montana Pollution Discharge Elimination System
MRL	Montana Rail Link
MSDS	Material Safety Data Sheet
MSHA	Mine Safety and Health Administration
PEA	Preliminary Economic Assessment
PWP	Process Water Pond
NAG	Non-Acid-Generating
NCWR	Non-Contact Water Reservoir
NRCS	Natural Resource Conservation Service
NRHP	National Register of Historic Places
PAG	Potentially Acid-Generating
PMF	Probable Maximum Flood
PMP	Probably Maximum Precipitation event
RO	Reverse Osmosis
SAG	Semi-Autogeneous Grinding
SAP	Sampling and Analysis Plan
SC	Specific Conductance
SHPO	State Historic Preservation Office
SPCC	Spill Prevention Control and Countermeasures Plan
SWPPP	Storm Water Pollution Prevention Plan
TCLP	Toxicity characteristic leaching procedure
TDS	Total Dissolved Solids; water
TOMS	Tailings Operations, Monitoring, and Surveillance
TKN	Total Kjeldahl Nitrogen.
UCZ	Upper Copper Zone
USACE	U.S. Army Corps of Engineers
USGS	U.S. Geological Survey
USZ	Upper Sulfide Zone
WTP	Water Treatment Plant

ABBREVIATIONS

Ag	Silver
Al	Aluminum
As	Arsenic
Ba	Barium
Be	Beryllium
Ca	Calcium
Cd	Cadmium
cfs	cubic feet per second (rate of flow)
Cr	Chromium
cm3	cubic centimeters
Co	Cobalt
Cu	Copper
cu ft.	cubic feet
cu yds.	cubic yards
DO	Dissolved oxygen
Fe	Iron
g	grams
gpm	gallons per minute (rate of flow)
ha	hectares
Hg	Mercury
K	Potassium
Lpm	liters per minute
m3	cubic meters
Ma	Millions of years before present (as a point in time)
Mg	Magnesium
mg/L	milligram per liter; approximately equal to parts per million (ppm).
Mn	Manganese
Mo	Molybdenum
N	Nitrate

Na	Sodium
Ni	Nickel
ppb	parts per billion; approximately equal to micrograms per liter (µg/L)
ppm	parts per million; equal to milligrams per liter (mg/L)
Pb	Lead
Se	Selenium
Sr	Strontium
TDS	Total Dissolved Solids
TSS	Total Suspended Solids
Tl	Thallium
Sb	Antimony
Sc	Specific Conductivity
SO4	Sulfate
U	Uranium
µg/L	micrograms per liter; approximately equal to parts per billion (ppb)
Zn	Zinc

This Mine Operating Permit Application has been reviewed and approved by Jerry Zieg, Vice President of Exploration for Tintina Resources Inc., who is a qualified person for the purposes of National Instrument 43-101 *Standards of Disclosure for Mineral Projects* (NI 43-101). However, readers are cautioned that this document was prepared for submission to the Montana Department of Environmental Quality Permitting and Compliance Division – Hard Rock Program for review and approval under the Montana *Metal Mine Reclamation Act*. It is not a "technical report" under NI 43-101 and may not be compliant with NI 43-101.

1.0 INTRODUCTION AND PROJECT OVERVIEW

Tintina Montana Inc., (Tintina) a wholly owned subsidiary of Tintina Resources Inc. proposes to develop and operate an underground mine and mill at its Black Butte Copper Project (Project) location (Figure 1.1). The Project will produce and ship copper concentrate mined from both the upper and lower Johnny Lee deposit zones. All operations will occur within a Mine Permit boundary encompassing 1,690 acres (684 ha) of privately owned ranch land under lease to Tintina (Figure 1.2). Total surface disturbance required for construction and operation of all mine related facilities and access roads (Figure 1.3) comprises 285 acres (115 ha) (Table 3-2).

The proposed operation will mine a total of approximately 15.3 million tons (13.9 million tonnes (Mt)) of rock. This includes 14.5 million tons (13.2 Mt) of copper-enriched rock with an average grade of 3.1% copper, and 0.8 million tons (0.7 Mt) of waste. Mining will occur at a rate of approximately 1.3 million tons/year (1.2 Mt/year) or 3,600 tons (3,300 tonnes) of copper-enriched rock per day, over a mine life of approximately 19 years (including construction and reclamation). The mine will directly employ approximately 240 workers, with an additional 24 contract miners working at the site during the first four years of mining. It will require a maximum of approximately 144 sub-contracted employees during the initial 30 to 36 months of the support facility construction.

All rock will be brought to surface through a single mine portal along a decline (tunnel) with additional lower ramp access to both the upper and lower Johnny Lee zones (Figure 1.3). The mine portal lies approximately 170 feet (52 m) above the regional groundwater table. Four ventilation raises constructed to surface will also be collared above the regional groundwater table. Therefore, all surface access to the mine will be located well above the groundwater table to eliminate the possibility of water discharge from any of the mine workings after closure.

Mining will use a drift and fill method. Approximately 45% of the mill tailings will be mixed with cement to form a paste, and used to backfill all production workings during the mining of sequential drifts. This paste backfill method allows maximum extraction of copper-enriched rock without the need to leave pillars for structural support. The backfill also eliminates the risk of subsidence to surface, and minimizes groundwater contact with mineralized rock both during operations and after closure. The use of paste backfilling and the drift and fill mining method minimizes the underground mineral deposit exposed (a few percent) to circulating air and moving groundwater at any given time during the mine life.

Although much of the waste rock that will be trucked to surface will be non-acid generating, as a safeguard, all waste rock will be assumed to contain sulfide minerals and will be treated as potentially acid-generating. A geotextile lined, temporary waste rock storage (WRS) facility will be constructed between the portal and the mill. It will receive all of the waste rock generated until construction of the cemented tailings facility (CTF) is completed (Figure 1.3). The completed cemented tailings facility will

receive crushed waste rock for use as a protective cushion layer over the uppermost of the double high-density polyethylene (HDPE) liners. All future waste rock will be placed into the cemented tailings facility along with the mill tailings. The temporary waste rock storage facility will be completely reclaimed in year three. No waste rock will be left on the surface after closure. The cemented tailings facility will be dewatered (if any is present) sealed with a cover of HDPE, and reclaimed in closure. A separate stockpile on a smaller lined pad will be constructed off of the northwest corner of the portal pad (Figure 1.3) near the end of the construction period to contain a reserve of copper-enriched rock for mill feed.

Dewatering of underground mine workings will provide all water required for mining and milling (approximately 210 gallons per minute [gpm] [or 795 Lpm] 0.47 cubic feet per second). Excess water pumped from the mine will be treated to non-degradation standards and be released through an underground infiltration gallery to shallow bedrock. A permitted public water supply well will provide potable water.

Tintina must obtain a water right for groundwater beneficially used in the milling process, and Tintina must apply for a groundwater appropriation permit before using any groundwater. Since the Project is located in a closed basin, a mitigation plan to offset potential adverse effects on or decrease in surface water due to the consumptive use portion of the groundwater right will be prepared and submitted by the Department of Natural Resources and Conservation (DNRC). Tintina is in the process of developing a groundwater appropriation permit and corresponding draft mitigation plan. Tintina has designed an unlined Non-Contact Water Reservoir (NCWR) (Figure 1.3) as an option for storing mitigation water for its subsequent release back to the local shallow groundwater by infiltration or direct discharge to the stream. This reservoir could be filled using water rights during the irrigation period of the year, to off-set consumptive use during the non-irrigation months of the year. However, it is not known how much depletion the DNRC will determine needs to be mitigated and whether the final mitigation plan (and therefore the final construction plan) will include the NCWR.

Milling (Figure 1.3) will use a grinding/flotation process and will produce approximately 440 tons (400 tonnes) per day of copper-rich concentrate. Concentrate will be shipped by truck in closed shipping containers to a regional railhead facility in Montana. The use of shipping containers eliminates the need for multiple handling stages during transport.

A double HDPE lined process water pond (PWP) with an underlying foundation drain and pond will store water needed for milling. Water will be recycled between the process water pond and the mill during operations. A paste plant in the mill complex will mix fine-grained tailings from the milling process with cement for deposition both underground and in the cemented tailings facility. The plant will mix approximately 45% of the tailings with approximately 4% cement and other binders to be used as paste backfill in the mine workings.

The other 55% of the tailings will be mixed with 0.5 to 2% cement and other binders to form a non-flowable mass which will be pumped to the cemented tailings facility. The use of cemented tailings inhibits dust formation. The small amount of free water that collects in the CTF from cemented tailings seepage, precipitation and snowmelt is pumped to the PWP for reuse in the mill. Water not needed in the mill will be pumped directly to the reverse osmosis water treatment facility for treatment and then released to the underground infiltration galleries.

Both the CTF and the PWP will use bottom liner systems comprised of a high-flow geonet-layer sandwiched between two layers of 100 mil HDPE geomembrane liner. Both facilities will also incorporate foundation drains beneath the liners. The cemented tailings facility will also have an internal basin underdrain system.

The cemented tailings facility and the process water pond are designed to contain the Maximum Probable Flood event (approximately 33 inches [84 cm] of precipitation and snowmelt in a single storm event) and to withstand the Maximum Credible Earthquake and/or the1 in 10,000 year earthquake event. In addition to its own storm water influx, the PWP will have capacity to store excess storm water from the cemented tailings facility while operationally remaining less than half full. The cemented tailings facility also has approximately 32 additional feet (10 meters) of freeboard over its 70.2 acre footprint for water storage. Storm water excesses from the PWP and the CTF are designed to quickly transfer through the water treatment system and into the underground infiltration gallery. Construction of the CTF and PWP will be overseen by three professional engineers in accordance with the Montana Metal Mine Reclamation Act, as revised by Senate Bill 409.

Tintina has aggressively sought out and implemented a number of process variations and modifications to facility siting and construction. These reduce risks to human health and the environment. They were formulated using a Failure Modes and Effects Analysis, and resulted in the development of a number of mitigation measures. Process variations employed include using cemented paste tailings (both underground and at the cemented tailings facility), sealed shipping containers, underground grouting, and lined ditches or HDPE pipe for transport of contact water. Facility siting modifications used include locating mine openings above the water table, locating all facilities to reduce impacts to wetlands, and relocation of the decline to minimize the amount of sulfides brought to surface. Facility construction changes include foundation drains, double HDPE-lined foundations with a geonet layer between, an internal basin drain at the cemented tailings facility, designs to accommodate very large precipitation and earthquake events (and even more freeboard), and use of foundation factors of safety well in excess of what is needed to avoid risk of a facility geotechnical failure. In addition, tailings will be transported in double walled pipe, and Best Management Practices (BMPs) will be used to route storm water around the facilities to discharge points and sediment collection basins.

Ongoing geochemical, weather, aquatic, and water resource monitoring will continue during construction and production. Tintina proposes an additional 3 surface water sties, 6 paired water monitor wells, and 5 new wetland piezometers be installed during the permitting process. An additional 5 monitoring wells and 15 infiltration gallery piezometers are recommended for installation during construction. Air quality and noise monitoring will resume once construction begins.

The closure and reclamation plan has been carefully designed to return the site to pre-mining beneficial uses. The primary objective of these activities is to assure the physical and chemical stability of all facilities, and that water quality and quantity is maintained. No waste rock will be left on surface in closure. Mine closure and reclamation will remove, treat, and dispose of water from the tailings facility (if any is present), and from the process water pond, and contact water pond (CWP). Water treated during closure will meet non-degradation criteria, and discharge to an underground infiltration gallery system or surface LAD area. Closure work will involve progressive reclamation and revegetation of the embankments and any other disturbed surfaces. Closure and reclamation will focus on removal of surface infrastructure and exposed liner systems, and covering exposed tailings. Reclamation plans include removal of all buildings and their foundations and surface facilities including the portal pad, copper mineralized stockpile pad, process water storage pond, CWP, mill site, and reservoir. Plans also include re-contouring, subsoil and soil replacement, and re-vegetating all the sites with an approved seed mix. Reclamation will include covering the CTF with a welded HDPE cover, adding fill, subsoil and topsoil (at a slope or shape designed to preclude standing water), and re-grading and re-vegetation. Tintina plans to leave the water treatment plant (WTP) on-site and pumps in the cemented tailings facility after closure for monitoring. Water produced from the CTF in closure (if any) will go directly to the water treatment plant. This will continue

into closure while water quality and flow are monitored, with gradually decreased monitoring until sufficient data is available to evidence that final closure objectives have been met.

Tintina herein submits this Mine Operating Permit Application to the Montana Department of Environmental Quality Permitting and Compliance Division – Hard Rock Program for review and approval under the Montana Metal Mine Reclamation Act.

1.1 Project Location

The Project site is located about 15 miles (24 km) north of White Sulphur Springs (population 984), in Meagher County, Montana (Figure 1.1). The project is accessed from US 89, an all-weather state-maintained highway, by traveling west along 1.5 miles (2.4 km) of well-maintained gravel county road (Figure 1.2). Figure 1.1 is a general project location map, and Figure 1.2 presents a larger scale Site Vicinity Map showing the Mine Permit Area and deposits. Figure 1.3 is a site facility map.

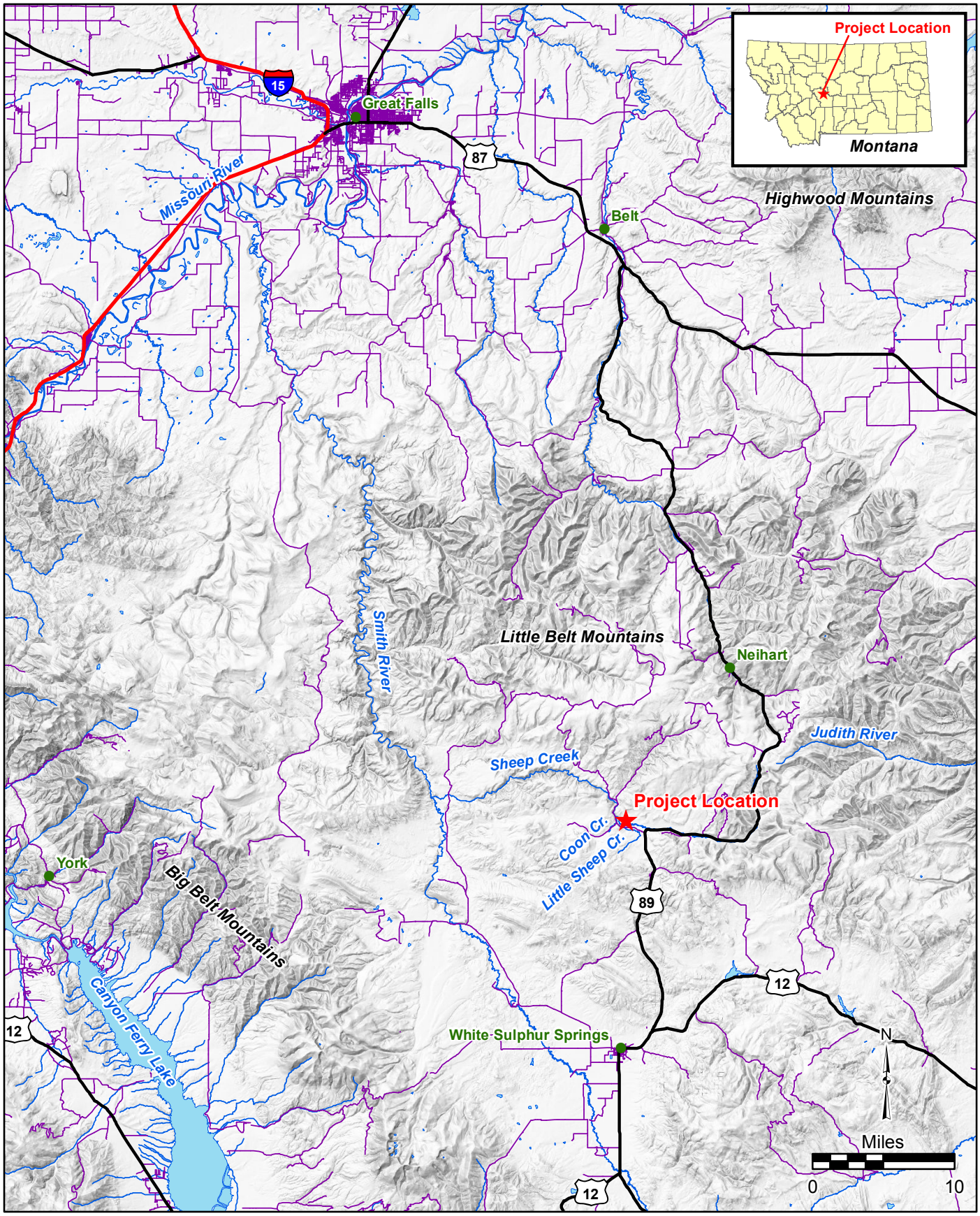
1.2 Brief Project History

Mineral exploration in the Project area began with limited small scale underground development for copper mineralization in 1894 (Weed, 1899). In the early 1900s, focus switched to development of iron resources in locally extensive gossans (Goodspeed, 1945; Roby, 1950). R & S Mining Company began production of small quantities of iron ore from near Iron Butte, west of the Project area, in 1972.

Homestake Mining Company carried out the first modern exploration work for non-ferrous metals on the property in 1973 and 1974. Cominco American Inc. (CAI) resumed exploration in the district in 1976 joint ventured the property with Broken Hill Proprietary Company Limited (BHP) in 1985. The Cominco/BHP JV drilled the discovery hole for the “Johnny Lee” deposit beside Johnny Lee’s (a former homesteader and miner) long abandoned root cellar. BHP operated the joint venture through early 1988, after which time operatorship reverted back to CAI. After reclaiming all exploration disturbances, CAI dropped the leases in the mid-1990s. The CAI and the CAI/BHP joint venture completed approximately 66 exploration core holes in the current lease areas (Resource Modeling Inc., 2010).

Tintina acquired the rights to mine the property in May of 2010, and has conducted surface exploration activities at the Project site under Exploration License No. 00710 since September 2010. Section 1.5 below contains descriptions of these exploration activities. Tintina has, through extensive core drilling, established ‘Inferred’, ‘Indicated and ‘Measured’ resources, described further below in the Mineral Resources section (Section 1.4.6).

On November 7, 2012, Tintina submitted an application to amend its exploration license to gain underground access to the mineral deposit by constructing an exploration decline into the upper Johnny Lee zone. DEQ conducted an Environmental Assessment of Tintina's application to amend its exploration license under the Montana Environmental Policy Act (MEPA). The environmental review culminated in the January 2014 issuance of the Final Mitigated Environmental Assessment (EA) and approval by DEQ to proceed with construction of the exploration decline. However, Tintina made a corporate decision to proceed directly to submission of an Application for a Mine Operating Permit (this document) for consideration by DEQ.



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Prepared by Tetra Tech, Inc. 2015

Legend

- Project Location
- City
- Interstate
- U.S. Route
- Local Road
- Stream
- Lake

TINTINA RESOURCES

Figure 1.1
Project Location
Black Butte Copper Project
Meagher County, Montana

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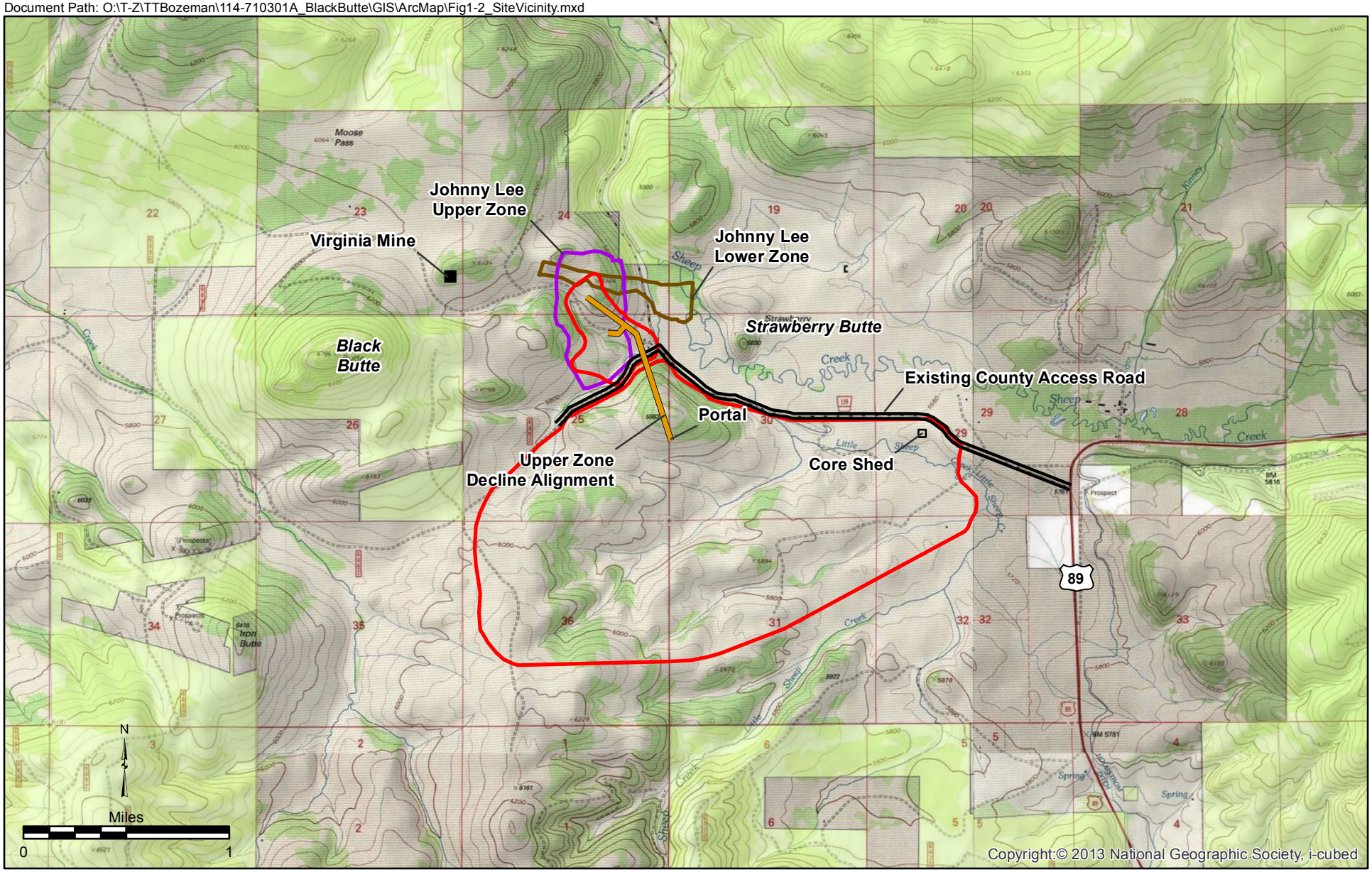

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Legend

- Decline Alignment
- Existing Road
- Mine Permit Boundary
- Lower Zone
- Upper Zone
- US Forest Service

TINTINA RESOURCES

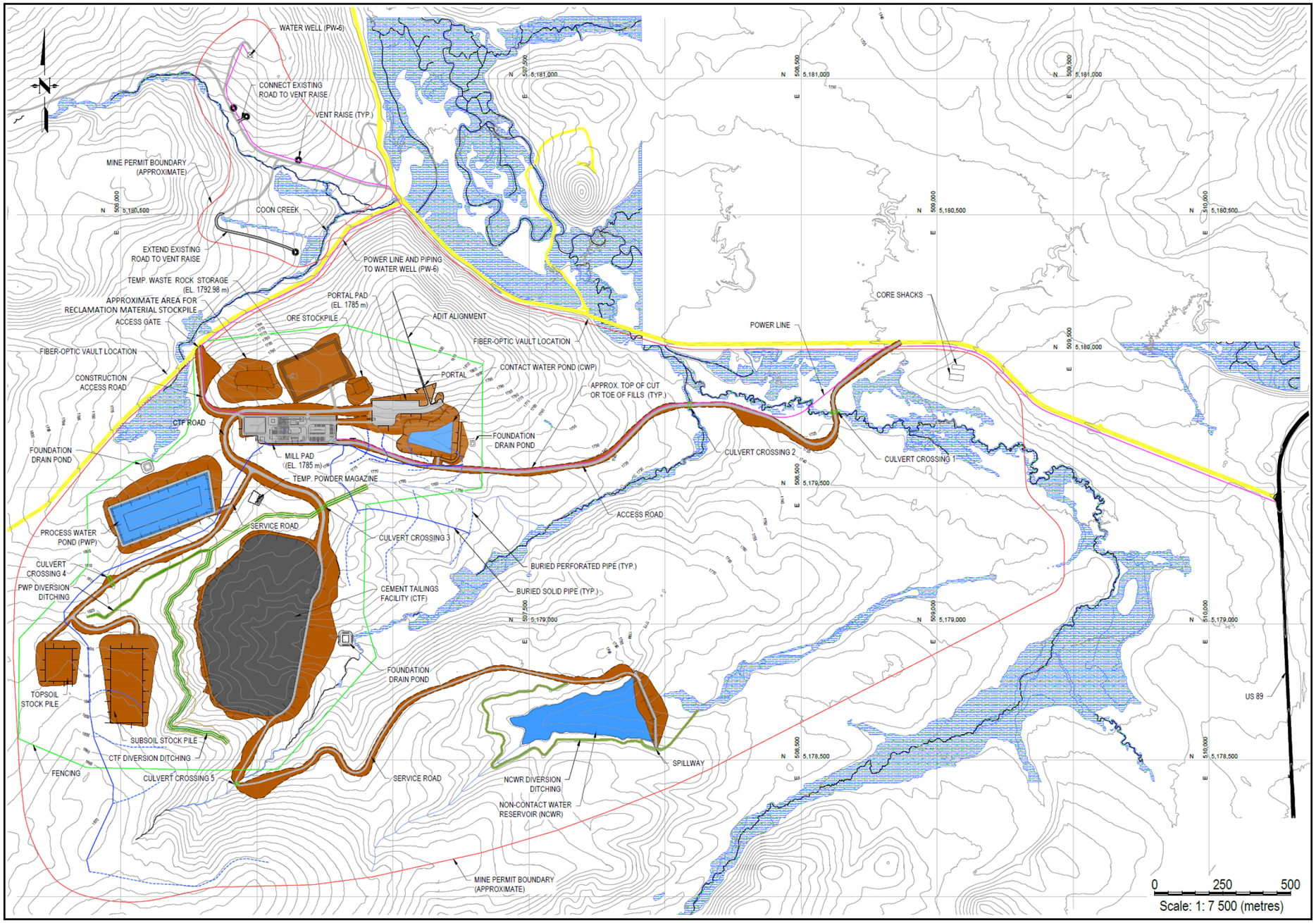
Figure 1.2

Site Vicinity Map with Mine Permit Boundary

Black Butte Copper Project

Mine Operating Permit Application

Meagher County, Montana



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LEGEND

- STREAMS
- WETLANDS
- POWER LINE ROUTE
- APPROX. TOES / TOP OF CUT
- PROPOSED CULVERT
- MINE PERMIT BOUNDARY (APPROX.)
- FENCE
- EXTENSION OF UNDERGROUND DRAIN FIELD

TINTINA RESOURCES

FIGURE 1.3
Facilities Site Plan
Black Butte Copper Project
Mine Operating Permit Application
Meagher County, Montana

1.3 Land Status

All activities proposed in the Operating Permit Application and all surface disturbances will occur on privately owned ranch land (Figure 1.2, shows private land shaded in a light grey overlay, as well a plan map of the upper and lower Johnny Lee deposits). Tintina has entered into agreements with surface, mineral and water rights owners on 7,684.28 acres (3,110 ha) of private lands, and also controls 525 mining claims contiguous with the fee simple (leased) lands (Figure 1.4). Figure 1.4 also shows the proposed mine permit boundary and the location of the Johnny Lee deposit.

Tintina acquired its initial surface and mineral leases in May of 2010 on approximately 4,720 acres (1,908 ha) of ground in the Project area with the Bar Z Ranch (Figure 1.4). Later that year, the Holmstrom Ranch lease was acquired encompassing an additional 2,120 acres (858 ha). This lease has recently changed ownership and is now called the Short and Davis Lease (Figure 1.4). In 2011, Tintina acquired a mining and surface lease for a 2,970-acre (1,202 ha) property contiguous with the Bar Z Ranch called the Buckingham, Johnson, and Bodell lease (Figure 1.4).

Tintina's leases include land located in sections 23, 24, 25, 26, 27, 28, 30, 32, 33, 34, 35, and 36, Township 12 North, Range 6 East; sections 19, 29, 30, 31, and 32, Township 12 North, Range 7 East; and sections 1 and 12 in Township 11 North, Range 5 East; sections 1, 2, 3, 4, 5, 6, and 7, 8, 9, 10, 11, 12, 13, and 14, Township 11 North, Range 6 East; and sections 5, 6, 7, 8, and 18, Township 11 North, Range 7 East, and sections 1 and 12 in Township 11 North, Range 5 East (Figure 1.4).

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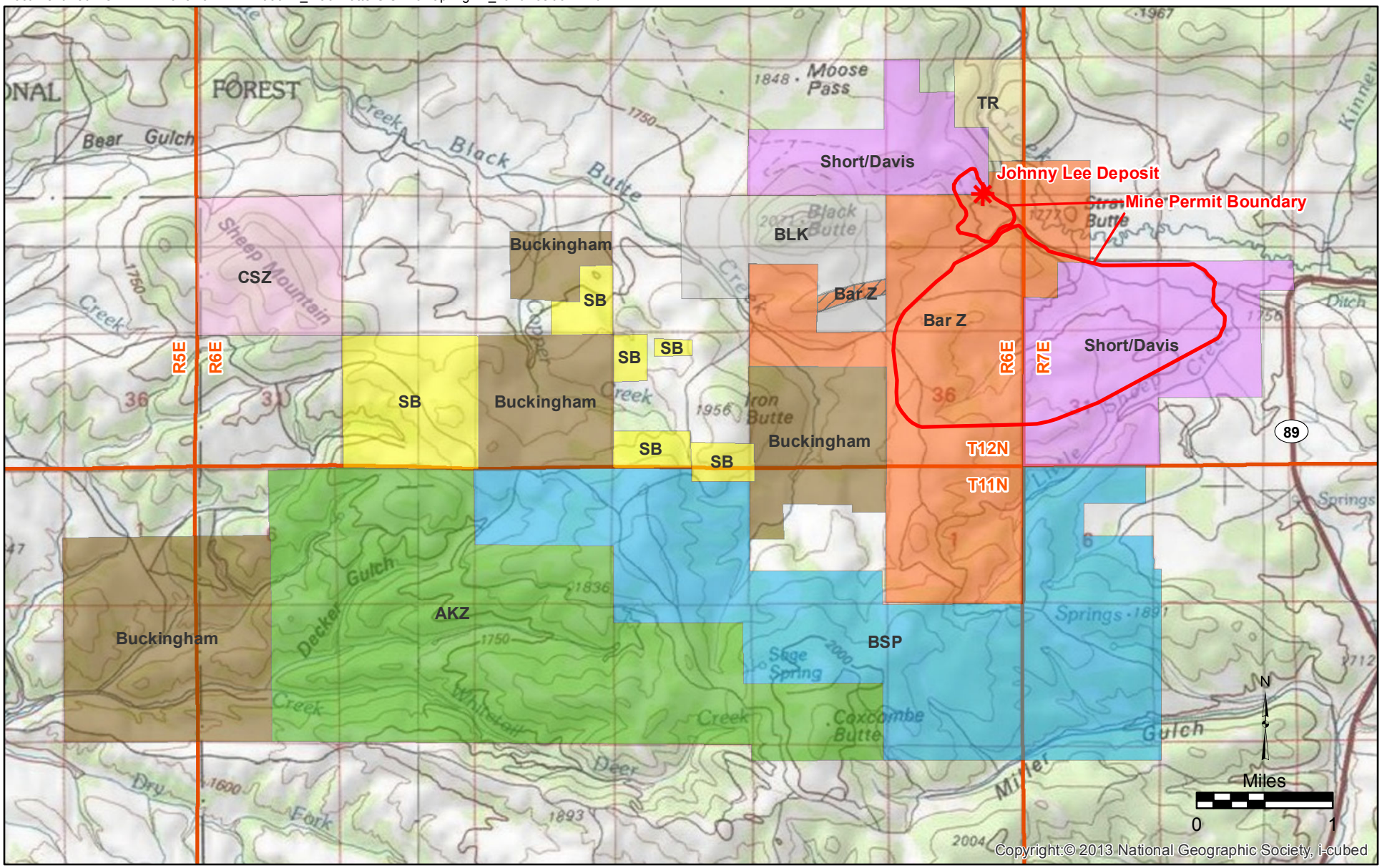

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Legend

- BSP Claims (USFS S & M)
- SB Claims (USFS S & M)
- AKZ Claims (USFS S & M)
- CSZ Claims (USFS S & M)
- BLK Claims (USFS S & M)
- TR Claims (USFS S & M)
- Bar Z Ranch (S) Hanson, Hanson, Dupea (M)
- Bar Z Ranch (s) BLK Claims (M)
- Short/Davis (S & M)
- Buckingham (S) Johnson, Buckingham, Bodell (M)

TINTINA RESOURCES

Figure 1.4
Tintina Land Position Map
Black Butte Copper Project
Mine Operating Permit Application
Meagher County, Montana

1.4 Geology

Resource Modeling, Inc. (RMI, 2010) summarized the geologic setting, deposit types, and mineralization in the Project area. The sections immediately below contain a modified summary, with the addition of more recent information. Figure 1.5 shows a geologic map of the Project area, Figure 1.6 includes a stratigraphic section, and Figure 1.7 shows a geologic cross section through the Project area.

1.4.1 Regional Geologic Setting

The copper deposits of the Project area occur in middle Proterozoic (~1.4 billion year old) sedimentary rocks of the Belt Supergroup (Zieg and Leitch, 1993). During subsidence and filling of the Belt sedimentary basin, a deep water calcareous shale facies (Newland Formation) was deposited in the Helena embayment (a trough-like seaway which extended eastward into the craton through central Montana) (Godlewski and Zieg, 1984). The northern depositional boundary of the deeper water sediments of the Helena embayment lay along the southern flank of the Little Belt Mountains, north of White Sulphur Springs, Montana (Figure 1.1). During the Cretaceous Laramide orogeny (approximately 65 million years ago), renewed faulting along the ancestral northern margin of the Helena embayment formed the Volcano Valley thrust fault (Winston, 1986). The Black Butte Copper deposits lay along the northern margin of the Helena embayment, and along the reactivated Volcano Valley fault zone (Figure 1.5).

The Newland Shale hosts the Black Butte copper deposits (Figure 1.6). It's evenly laminated shale formed from deposition of micro-turbidites (small-scale turbidity or density flow deposits) in a sub-wave base depositional setting. Debris flow conglomerates occur in the sedimentary section along the northern margin of the embayment (Resource Modelling, Inc., 2010) and record larger mass wasting events from a shallow water shelf to the north.

1.4.2 Local Geologic Setting

Alluvial deposits lay beneath the stream channels and along the axis of larger drainages. They rest on the thick sequence of dolomitic and silicic shales of the Proterozoic Newland Formation (Figure 1.6) that dip gently to the southeast. The above-described prominent northeast-trending, southerly dipping low-angle Volcano Valley Fault (*VVF*) forms a northern boundary to Newland Formation exposures within the Project area (Figure 1.5). Paleozoic (middle Cambrian) Flathead sandstone (Figure 1.6) outcrops at the surface on the north side of the *VVF.* It lies unconformably over Proterozoic Newland Formation, Chamberlain shales, Neihart quartzite, and Precambrian crystalline basement rock (Figure 1.7). A separate northeast verging segment of the *VVF* thrust fault called the Black Butte Fault (*BBF*) lies south of the Johnny Lee copper deposit (Figure 1.5). The area between the *BBF* and the *VVF* contains all of the known copper resources within the Project area.

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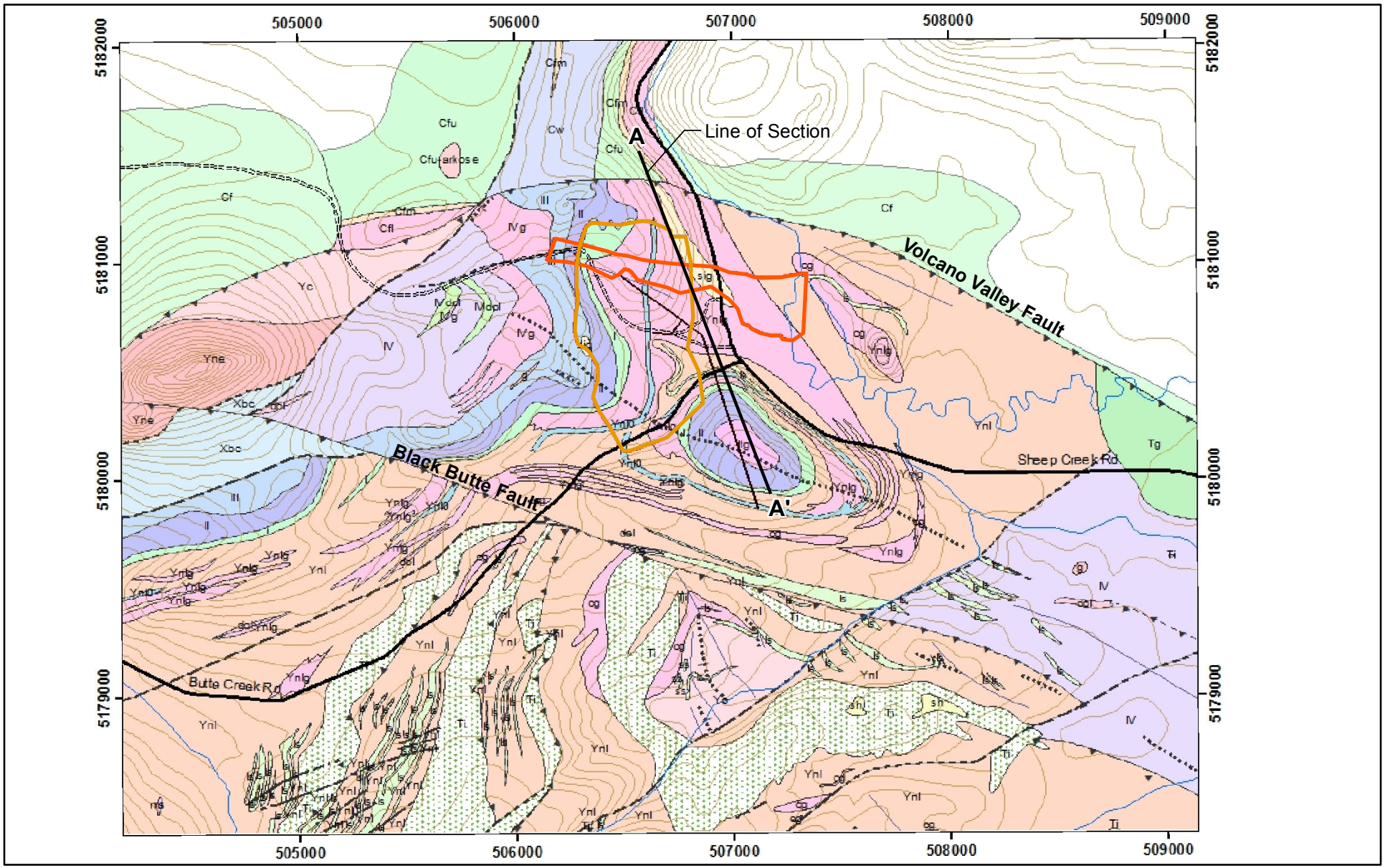

Prepared by Tetra Tech, Inc. 2015

TINTINA RESOURCES

Figure 1.5

Regional Geologic Map Showing Ore Deposits

Black Butte Copper Project

Meagher County, Montana

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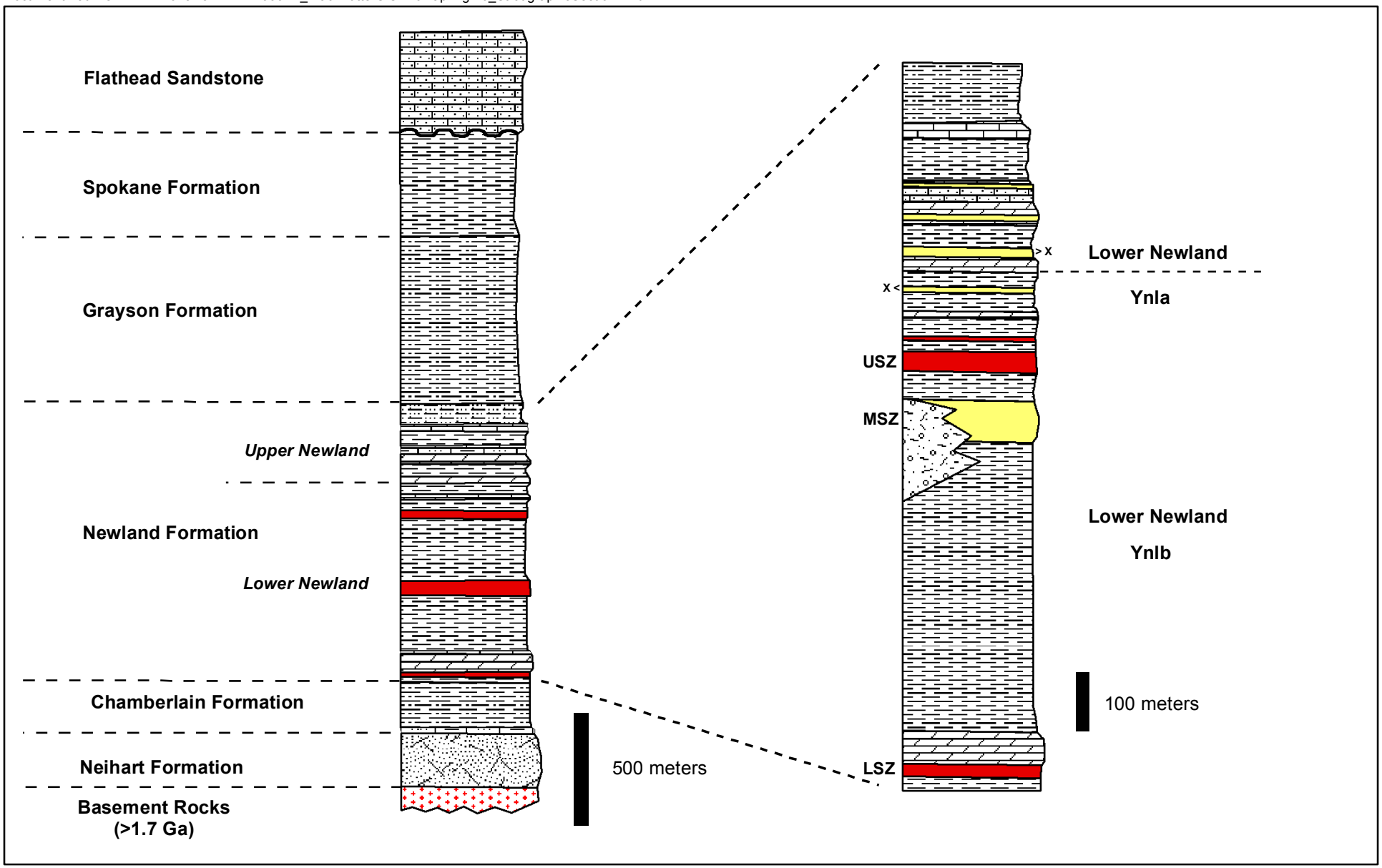

Prepared by Tetra Tech, Inc. 2015

Figure 1.6
Stratigraphic Section
Black Butte Copper Project
Meagher County, Montana

TINTINA RESOURCES

Legend

Pyrite-rich Sulfide Zone
Copper-rich Sulfide Zone

USZ = Upper Sulfide Zone
MSZ = Middle Sulfide Zone
LSZ = Lower Sulfide Zone

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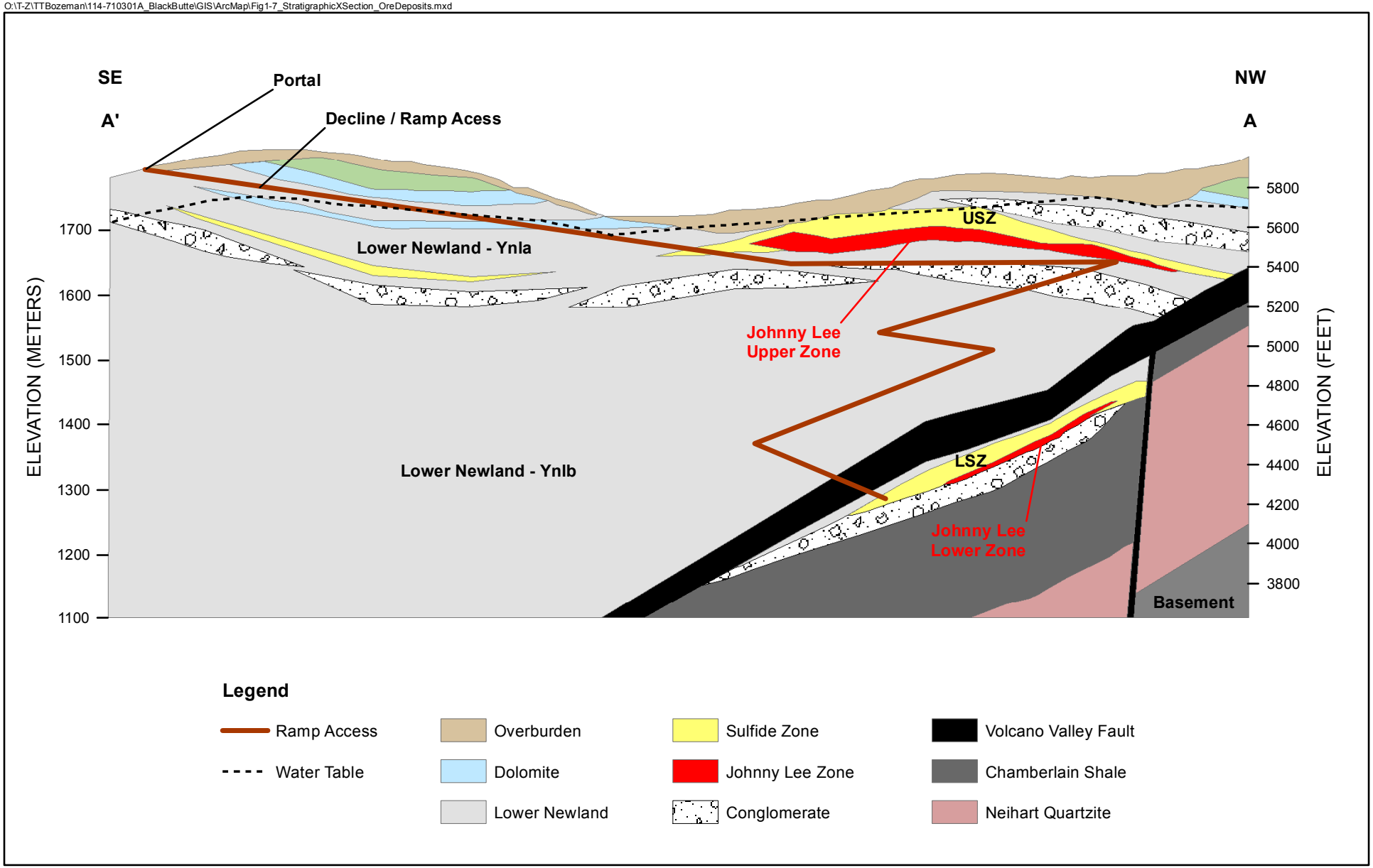

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Figure 1.7

Stratigraphic Cross Section with Ore Deposits and Ramp Access

Black Butte Copper Project

Mine Operating Permit Application

Meagher County, Montana

TINTINA RESOURCES

The Johnny Lee copper deposit consists of two stratabound lenses of mineralization, an upper copper zone (*UCZ*) and lower copper zone (*LCZ*), each contained within the Upper and Lower Sulfide Zones (*USZ and LSZ* respectively) of the lower Newland Formation (Figure 1.6 and Figure 1.7). The *UCZ* lies at a depth of approximately 65 to 625 feet (20 to 190 m) below ground surface and occurs within shale and dolostone of the upper part of the Lower Newland Formation. The southward dipping *VVF* cuts through the entire Newland formation. A thin slice of the Lower Newland Formation lies below the *VVF* and contains the *LCZ,* which is at a depth of approximately 985 to 1,640 feet (300 to 500 m) below ground surface (Figure 1.7). The *LCZ* and enclosing Lower Newland shale lie on the Chamberlain Formation. The Buttress Fault carries both Chamberlain and Newland shales on its south side downward against Early Proterozoic gneiss and Neihart Quartzite on its north side (Figure 1.7). The Volcano Valley Fault truncates the Buttress Fault, and Cambrian sedimentary rocks cover it to the north such that it has no surface expression (Figure 1.5), and likely has a Proterozoic age.

1.4.3 Deposit Type

Geologists classify the Black Butte Copper deposit as a sediment-hosted deposit. Bedded pyrite shows higher concentrations in several discrete, semi-continuous, and laterally extensive stratigraphic horizons (Figure 1.6) that locally contain copper enrichments.

1.4.4 Mineralization

Bedded pyrite horizons within dolomitic shale of the lower Newland Formation host tabular sheets of copper mineralization. Exploration drilling has outlined two separate lenses containing copper resources which are called the Johnny Lee Upper Copper Zone and the Johnny Lee Lower Copper Zone. Below are descriptions of both the copper zones and the more widespread host sulfide halo.

Johnny Lee Upper Sulfide Zone

The Johnny Lee Upper Sulfide Zone (*USZ*) consists of a lens of fine-grained bedded pyrite (FeS_2) as thick as 285 feet (87 m), and containing two or three chalcopyrite-bearing ($CuFeS_2$) horizons all capped by a barite ($BaSO_4$)-rich pyritic stratigraphy. Himes and Petersen (1990) describe microscopic textures and various sulfide minerals (primarily from copper-enriched horizons) and Graham and others (2012) and White and others (2014) have completed more recent work. Pyrite occurs as laminations and beds of very fine-grained pyrite, as micro-crystals, and spheroidal aggregates (1 to 25 microns in diameter). Pyrite and rarely marcasite (FeS_2) aggregates contain rims, patches, and sometimes interior cores of chalcopyrite and tennantite [$Cu_3(As,Sb)S_8$] and in many cases amorphous Cu, Co, Ni, and As-rich material. Chalcopyrite occurs as coarser grained veinlets and clots, in parallel bedded layers and bands, in quartz veinlets, and in barite veins and masses.

While local silicification occurs within the USZ, most of the copper mineralization occurs within unsilicified bedded pyrite. The USZ zone reaches its greatest thicknesses in the south central portion of the Johnny Lee deposit. Strontium-rich minerals celestine ($SrSO_4$) and stronianite ($SrCO_3$) occur in some places toward the base of the USZ and below the copper-enriched horizons. Barite concentrations cap the copper zone, and includes a sulfide-free shale horizon called the ‘barite marker horizon’.

Johnny Lee Lower Sulfide Zone

The Johnny Lee *LSZ* lies in the footwall (below) the southward-dipping *VVF* (Figure 1.6). Johnny Lee *LSZ* mineralization consists of pyrite and rare marcasite, with high concentrations of chalcopyrite and local occurrences of siegenite ($(Ni,Co)_3S_4$) and cobaltite (CoAsS). The Johnny Lee Lower Zone contains no identifiable barite or strontium-rich minerals. Coarse-grained dolomite alteration is abundant on the margins and above the pyritic zone. Silicification overprints much of the Cu-mineralized area, as well. A

silicified debris flow conglomerate underlies the *LSZ* with disseminated chalcopyrite, and chalcopyrite also occurs in quartz veinlets. Most sulfide textures show replacement of both pre-existing dolomite alteration and of earlier generations of sulfide mineralization. Some pyrite is bedded, even at the base of the *LSZ.*

The Volcano Valley fault dips more steeply south than the underlying *LSZ* and truncates the zone (Figure 1.6) to form its south boundary. The 'buttress' fault truncates the *LSZ* on the north. Because of fault truncations on its north and south, the *LSZ* retains little evidence of its presumably broader scale mineralogical zoning patterns.

1.4.5 Deposit Geometry

The Johnny Lee Upper Copper Zone *(UCZ)* comprises 78% of the total tonnage of the Johnny Lee deposit copper resource. The *UCZ* measures 3,280 feet (1000 m) in a north-south direction and approximately 2,165 feet (660 m) in an east-west direction (Figure 1.6), and ranges in depth from 65 to 625 feet (20 to 190 m) from the surface. The *UCZ* ranges in thickness from 10 to 85 feet (3 to 26 m) and varies in dip from 0° to 20° to the west. In some areas the mineralized zone consists of single lens. In other areas it consists of two sub-parallel lenses separated by 6 to 53 feet (1.8 to 16 m) of lower grade material.

The Lower Copper Zone (*LCZ*) comprises 22% of the total tonnage of the Johnny Lee copper resource. It measures approximately 3,300 feet (1,005 m) from west to east, and ranges from 160 to 660 feet (49 to 201 m) from north to south (Figure 1.6). The *LSZ* dip varies from 20° to 37° to the south and ranges in depth from 985 to 1,640 feet (300 to 500 m) from surface. The mineralized zones range in thickness from 8 to 57 feet (2.5 to 17.3 m).

1.4.6 Mineral Resources

Figure 1.6 and cross-section Figure 1.7 illustrate the location of both the Upper and Lower Copper Zones of the Johnny Lee Deposit. Resource Modelling, Inc. recently recalculated mineral resources (February 2013) using 2010 through 2012 drill data including drill hole logs, geologic correlations, and assays to create a block model of the deposit zones.

Table 1-1 presents the measured and indicated copper resources of the Johnny Lee deposit upper and lower zones. A measured bulk density value of 3.99 g/cm^3 (8.03 cu ft./ton), a cutoff grade of 1.6% copper, a copper price of US$2.75 per pound, and an estimated copper metallurgical recovery of 81% was used for the UCZ. A measured bulk density of 3.49 g/cm^3 (9.18 cu ft. /ton), a cut-off grade of 1.5% copper ,a copper price of U.S. $2.75 per pound (0.45 kg), and an estimated copper recovery of 84% was used for the *LCZ*.

Table 1-1. Measured and Indicated Copper Resources of the Johnny Lee Deposit

	Copper Cutoff (%)	Tonnes/ (Tons) (000)	Copper (%)	Copper Lbs. (M)	Cobalt (%)	Cobalt Lbs. (M)	Silver g/t.	Silver oz. (000)
UCZ Measured	1.6	2,659 (2,931)	2.99	175	0.118	6.9	16.3	1,393
UCZ Indicated	1.6	6,520 (7,188)	2.77	398	0.125	18.0	15.5	3,249
LCZ Indicated	1.5	2,387 (2,631)	6.40	337	0.033	1.7	4.5	345
Avg. or Total	**1.6**	**11,566 (12,749)**	**3.57**	**910**	**0.100**	**26.6**	**13.4**	**4,987**

Note: Resource data from Updated NI 43-101 Technical Report and PEA (Tetra Tech, 2013)

1.5 Work Completed to Date under Exploration License

Tintina acquired the property in May of 2010 and has conducted surface exploration activities at the Project site under Exploration License No. 00710 since that time. The Project is currently approved and bonded for surface disturbances related to drilling various types of borings and test pit excavations for mineral exploration, groundwater monitoring, and for hydrologic, geotechnical, metallurgical and soil testing.

Tintina has used surface drilling methods to complete a total of 205 core holes (including metallurgical and geotechnical test holes) to define the mineral resources and estimate the feasibility of mining and milling the copper deposits. Several rounds of ongoing exploration drilling have been approved over time by DEQ following the submittal of Notices of Resumption of Exploration Activities by Tintina. Tintina has hydraulically plugged 193 of these holes in accordance with ARM 17.24.106 to prevent aquifer cross contamination. Twelve holes remain open for use as water level observation wells for hydrologic testing and characterization of aquifers.

Between 2011 and 2013, Tintina drilled a total of twelve groundwater monitoring wells, including eight of which are paired wells with one completion in surficial material and an adjacent well completed in bedrock. Ten pumping wells were also drilled to determine groundwater levels, to collect geologic samples, and primarily to use for pump tests to define bedrock unit aquifer characteristics. A licensed water well driller drilled and completed these wells in accordance with State regulations. In addition, Tintina installed 12 very shallow piezometers in alluvial valley fill sediment or in wetlands to monitor seasonal changes in water levels, and to test for draw down properties during pump testing of nearby bedrock wells. The Water Resources Baseline section (Section 2.2) presents a map showing locations of environmental test wells and piezometers (Figure 2.2), and a table listing sampling frequency (Table 2-7). In 2014 and 2015, Tintina completed 21 relatively shallow geotechnical drill holes and excavated 39 test pits to evaluate foundation materials underlying proposed and alternate facility locations (Figure 3.9). Other excavations include a number of small soil test pits for soil sampling and infiltration testing.

Surface disturbances related to exploration, environmental, and geotechnical drill holes, and access roads and drill pads to date have totaled 6.0 acres (2.4 ha), all of which have been reclaimed. The reclamation includes initial stockpiling of soil, re-contouring of drill sumps, pads and access roads, replacing stockpiled soil, and re-vegetation. All temporary disturbances have been re-contoured and re-vegetated in accordance with State requirements, and seeded with a seed mixture approved by DEQ. All funds posted for reclamation bonding since the initiation of the project remain in place with DEQ.

1.6 Regulatory Compliance

This Operating Permit Application has been designed to meet the requirements of the Montana Metal Mines Reclamation Act (Title 82, Chapter 4, Part 3, MCA) and the Rules and Regulations governing the act. Compliance with regulatory requirements is cross-referenced with components of this Operating Permit Application in Table 1-2.

Table 1-2. Permit Application Cross-Referenced with Regulatory Compliance

SECTION	RULES (ARM)/ACT (MCA) CITATION
1.0 INTRODUCTION	
1.1 Project Location	ARM 17.24.115(k) MCA 82-4-337(1)(a) MCA 82-4-335(5)(f) through (h) ARM 17.24.116(3)(i)
1.2 Brief Project History	
1.3 Land Status	
1.4 Geology	
2.0 EXISTING CONDITIONS/ ENVIROMENTAL BASELINE STUDIES	
2.1 Climate, Metrological Data & Air Quality	ARM 17.24.116(3)(a)
2.2 Water Resources	
2.3 Wetlands Resources	
2.4 Environmental Geochemistry	
2.5 Soil Resources	
2.6 Terrestrial Wildlife Resources	ARM 17.24.116(3)(a)
2.7 Aquatic Resources	
2.8 Vegetation Resources	MCA 82-4-335(5)(f) through(h)
2.9 Cultural Resources	
2.10 Socio-economic Resources	
2.11 Noise	
2.12 Transportation Resources	
2.13 Land Use	
3.0 OPERATING PLAN	
3.1 Introduction	ARM 17.24.116(3)
3.1.1 Mine Permit Boundary	ARM 17.24.116(3)(d) and (e)
3.1.2 List of Facilities with Surface Disturbance Acres	ARM 17.24.116(3)(d)
3.2 Underground Mine Operations and Mining Methods	ARM 17.24.116(3)(f)
3.2.2 Tintina's Underground Mine Plan	
3.2.2.5 Equipment	ARM 17.24.116(3)(j)
3.3 Mineral Production	
3.3.1 Processing Method	ARM 17.24.116(3)(g): ARM 17.24.116(3)(p)
3.3.2 Mining Operations and Schedule	
3.3.3 Mill Support Facilities	
3.4 Mine Site – General Construction	
3.4.1 Overview and Disturbance Acres	
3.4.2 Construction of Facilities	
3.5 Engineering Evaluations	
3.51 Geotechnical Foundation Evaluations	MCA 82-4-301, 82-4-303, 82-4-305, 82-4-335, 82-4-336, 82-4-337, and 82-4-342
3.5.2 Design Standards	MCA 82-4-301, 82-4-303, 82-4-305, 82-4-335, 82-4-336, 82-4-337, and 82-4-342
3.5.3 Seismicity	MCA 82-4-301, 82-4-303, 82-4-305, 82-4-335, 82-4-336, 82-4-337, and 82-4-342
3.5.4 Tailings Characteristics	ARM 17.24.116(3)(d), MCA 82-4-335(5)(n)
3.5.5 Stability Analysis	MCA 82-4-301, 82-4-303, 82-4-305, 82-4-335, 82-4-336, 82-4-337, and 82-4-342
3.5.6 Seepage Analysis	
3.6 Infrastructure Support and Waste and Water Management Facilities	
3.6.1 Roads	ARM 17.24.116(3)(h) & (r), MCA 82-4-335(5)(i)
3.6.2 Portal Pad	
3.6.3 Ventilation Raises	

SECTION	RULES (ARM)/ACT (MCA) CITATION
3.6.4 Temporary Waste Rock (WRS) & Operational Storage	ARM 17.24.116(3)(d), MCA 82-4-335(5)(n)
3.6.5 Process Water Pond (PWP)	MCA 82-4-301, 82-4-303, 82-4-305, 82-4-335, 82-4-336, 82-4-337, and 82-4-342
3.6.6 Contact Water Pond (CWP)	
3.6.7 Cemented tailings Facility (CTF)	MCA 82-4-301, 82-4-303, 82-4-305, 82-4-335, 82-4-336, 82-4-337, and 82-4-342; ARM 17.24 116(3)(g); SB-209: MCA 82-4 335(5)(l)
3.6.8 Non-Contact Water Reservoir (NCWR)	
3.6.9 Stockpiles	
3.6.10 Pipelines	
3.6.11 Equipment & Contract Manpower Required for Support Facility Construction	
3.7 Water Management	
3.7.1 Introduction	ARM 17.24.116(3)(k); MCA 82-4-336(5) ARM 17.24.116(3)(b); ARM 17.24.115 (a-(d) and (k)(iv) MCA 82-4-336(2)
3.7.2 Water Supply	
3.7.3 Water Balance	
3.7.4 Water Treatment	
3.7.5 Treated Water Disposition	
3.7.6 Storm Water	
3.7.7 Erosion Control & Best Management Practices (BMP)	
3.8 Management of Other Operational Elements	
3.8.1 Total Project Employment with Subcontractors	ARM 17.24.116(3)(q)
3.8.2 Accommodations for Employees and Subcontractors	
3.8.3 Projected Construction & Operational Traffic	
3.8.4 Waters of the US (WOTUS)	
3.8.5 Air Quality & Dust Control	ARM 17.8.308; 17.24.115(1)(h)
3.8.6 Visual Resource Assessment	
3.8.7 Operational Noise	
3.8.8 Fire Protection	ARM 17.24.116(3)(m): 17.24.116(3)g)
3.8.9 Solid Waste Disposal	ARM 17.24.115(i); ARM 17.24.116(3)(c)
3.8.10 Sewage Treatment	ARM 17.24.116(3)(o)
3.8.11 Hazardous Materials Disposal	
3.8.12 Emergency Response Plan	ARM 17.24.116(3)(n)
3.8.13 Site Security	
3.8.14 Lighting	
3.8.15 Noise	ARM 17.24.116(3)(a): ARM 17.24.116(3)(s)
3.8.16 Cultural Resource Protection	ARM 17.24.116(3)(t)
4.0 MODELLING STUDIES	
4.1 Hydrologic Conceptual Model	
4.2 Summary of Groundwater Modeling Assessment	
4.3 Geochemistry	

SECTION	RULES (ARM)/ACT (MCA) CITATION
5.0 MITIGATIONS	
6.0 MONITORING	
6.2 Ongoing Baseline Monitoring	
6.3 Operational Monitoring	
6.3.1 Water Quality & Quantity Monitoring	ARM 17.24.116(3)(l), MCA 82-4-335(5)(m)
6.3.2 Facility Operational Monitoring	
6.3.3 Waste Rock Geochemistry Monitoring	
6.3.4 Air Quality Monitoring	ARM 17.8.308; 17.24.115(1)(h)
6.3.5 Wetlands Monitoring	
6.3.6 Aquatic Resource Monitoring	
6.3.7 Noise Monitoring	ARM 17.24.116(3)(s)
6.3.8 Reclamation Monitoring	
6.4 Post Operational Closure Monitoring	
6.4.1 Facility Closure Monitoring	ARM 17.24.115(1)(m)
6.4.2 Water Quality Monitoring	ARM 17.24.115(1)(d),(e,(f),(n);17.24.116(3)(l)
6.4.3 Reporting	
7.0 RECLAMATION & CLOSURE	ARM 17.24.116(5)
7.2 Detailed Plan for Permanent Reclamation & Closure	ARM 17.24.150
7.2.1 Post Mining General Construction Measures	
7.2.2 Post Mining Building & Solid Waste Disposal	ARM 17.24.115(1)(i) & (m), MCA 82-4-303(15)(e)
7.2.3 Site-specific Facility Closure	ARM 17.24.115(1)(m)
7.2.4 Soil Salvage Placement	
7.2.5 Revegetation	ARM 17.24.115(1)(c), (k)(iii) & (l) MCA 82-4-303(15)(c)
7.3 Reclamation Schedule	MCA 82-4-303(15)(i); 82-4-336(3)
7.4 Bond Release	MCA 82-4-338(1),
8.0 REFERENCES	

2.0 EXISTING CONDITIONS / ENVIRONMENTAL BASELINE STUDIES

Existing condition data describe and evaluate attributes of the environment at the project site, while baseline studies involve conducting research and gathering/analyzing physical or chemical data associated with resources that might be affected by facility construction or mine operations. Collection of both types of information facilitates the evaluation of possible impacts, and provides a benchmark against which potential future changes could be measured. Evaluations typically compare existing condition physical and chemical data with state standards, regulations or guidelines.

An initial consultation between DEQ and Tintina identified the types of baseline assessments, information and data quality anticipated to be necessary to evaluate this application. This section of the Permit Application summarizes resources selected for baseline study. Table 2-1 lists these baselines assessments or study citing the location of the summary sections in this Permit Application document and the location of detailed technical reports providing supporting information on the resources that are included as appendices to this Permit Application.

Table 2-1. Reference Sections for Environmental/Baseline Studies

Baseline Resource	Summary Section This Report	Detailed Technical Report as Appendix
Geology	1.4	---
Climate, Meteorology and Air Quality	2.1	A-1
Meteorology Monitoring Data	2.1.2	A-2
Air Quality	2.1.5	---
Water Resources	2.2	B
Water Resources Monitoring Data	---	B-A
Water Resources Quality Statistics	---	B-B
Hydrologic Modeling	4.0	M
Wetland Resources	2.3	---
Wetland Delineation Report	2.3.1	C-1
Wetland Functionality Report	2.3.7	C-2
Environmental Geochemistry	2.4	D-1
Geochemical Modeling	4.2	N
Soil Resources	2.5	E
Terrestrial Wildlife Resources	2.6	F
Aquatic Resources	2.7	G
Vegetation Resources	2.8	H
Weed Plan	2.8.4	O
Cultural Resources	2.9	I
Socio-Economic Resources	2.10	---
Noise	2.11	J
Transportation Resources	2.12	---
Visual Resources	3.8.7	---
Land Use	2.13	---

Tintina initiated collection of data characterizing the existing site conditions and site-specific environmental baseline studies by as early as 2010. Tintina will continue to collect data through ongoing baseline investigations during the permitting phase, and will monitor conditions throughout operations and into closure as mandated by DEQ (described in Section 2.2.4). For most studies, Tintina's leased property boundary usually forms a boundary, but select resources required larger study areas. Section 1.3 above describes the boundary of the leased property which includes approximately 7,684acres (3,109 ha) (Figure 1.4).

2.1 Climate, Metrological Data and Air Quality

2.1.1 Climate

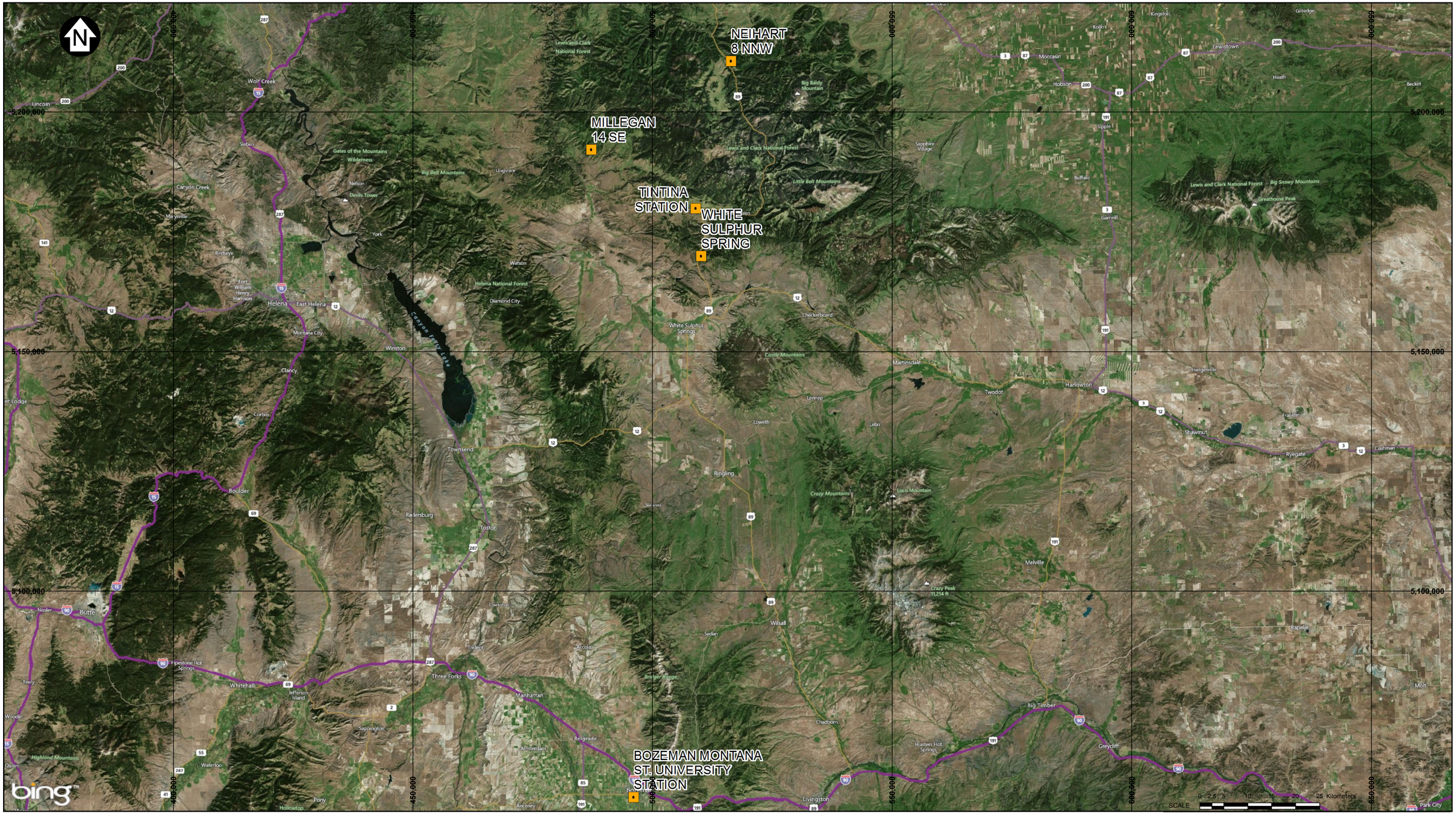
The Project area occurs in a cold, semi-arid or steppe climate (Köppen- Gieger climate classification, http://www.eoearth.org/view/article/162263/; Finlayson and others 2007) that receives annual precipitation below potential evapotranspiration. These, cold, semi-arid climates are located in temperate zones and are typically found in continental interiors, some distance from large bodies of water and locally can include areas of high elevation. These climate zones typically have hot summers and cold winters, usually see snowfall during the winter, and at higher latitudes tend to have dry winters and wetter summers. They are often subject to major temperature swings between day and night, sometimes by as much as 36°F (approximately 20ºC) or more. This climate zone tends to support short or scrubby vegetation, usually dominated by either grasses or shrubs but locally in upland portions of the Project area, forest communities of Douglas-fir and lodge pole pine occur where thin soils cover near-surface bedrock.

2.1.2 Meteorological Data Collection

In April, 2012, Tintina established an ambient meteorological monitoring station at an elevation of 5,699 feet (1,737 m) just west of the core shed (Figure 1.2 and Figure 2.1) to measure wind speed, wind direction, standard deviation of wind direction, temperature at 30 feet and 6 feet (9 and 1.8 m), delta temperature (calculated difference in temperature between 30 and 6 foot (9 and 1.8 m) stations), solar radiation, barometric pressure and precipitation. On June 23, 2015, Tintina installed an evaporation pan measuring device. The monitoring station accurately characterizes the local meteorology has collected baseline data to provide information for this the mine operating permit application and supports various ongoing environmental and water balance engineering studies. Bison Engineering, Inc., of Helena MT operates the meteorological station. Tintina has received quarterly reports of daily data since the second quarter of 2012 and these are attached to this Operating Permit Application as Appendix A-1 (Bison Engineering, Inc., 2015) on a compact disc.

2.1.3 Meteorological Data Analysis

The Tintina meteorological station (Figure 2.1) has collected 32 months' worth of data (through Dec 2014, the last complete year of data; this data can be updated for annual average data at the end of 2015). Months that had fewer than 20 days of recorded data were excluded from the summaries as shown in Table 2-2 below. The precipitation and temperature records have 27 and 30 monthly values respectively. The precipitation record for March 2013 contains a one-day event in which approximately 4 inches (102 mm) of precipitation was recorded. Analysis of this meteorological data (Knight Piésold, 2015; Appendix A-2) generated long-term estimates of precipitation and evaporation for use in preparation of the site-wide water balance.



SAVED: M:\1\01\00460\03\A\GIS\Figs\VA15-02445 Climate\Fig1_ClimateStations_r0.mxd; Apr 13, 2015 11:04 AM; kirauszova

Date: November 4 2015 Source: Knight Piesold (2015)

TINTINA RESOURCES

LEGEND:

- CLIMATE STATION

NOTES:

1. BASE MAP: BING ONLINE.

2. COORDINATE GRID IS IN METRES.
COORDINATE SYSTEM: NAD 1983 UTM ZONE 12N.

3. THIS FIGURE IS PRODUCED AT A NOMINAL SCALE OF 1:750,000 FOR 11x17 (TABLOID) PAPER. ACTUAL SCALE MAY DIFFER ACCORDING TO CHANGES IN PRINTER SETTINGS OR PRINTED PAPER SIZE.

Figure 2.1
Regional Meteorological Stations Black Butte Copper Project

Meagher County, Montana

Table 2-2. Tintina Weather Station Precipitation and Temperature Monthly Data

Precipitation (in.)													
Year	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Annual**
2012					2.48	3.46	1.77	0.47	0.16	1.8	1.10	0.28	-
2013	0.70	1.34	7.24	0.91	2.68					0.4	0.75	1.34	-
2014	1.61	0.16	3.11	1.85	0.83	5.67	1.22	3.23	1.46	0.75	0.51		-
Average	1.14	0.75	5.20	1.38	2.01	4.57	1.50	1.85	0.79	0.9	0.79	0.83	21.73
Temperature (°F)													
Year	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Annual**
2012					42.0		62.4	59.2	49.6	34.7	28.4	17.6	-
2013	17.6	19.0	24.8	31.5	45.5	52.9	62.1		52.2	31.3	26.1	13.6	-
2014	18.0	8.2	25.0	33.4	44.6	48.2	60.4	56.8	47.7	41.2	21.2	20.3	-
Average	17.8	13.6	24.9	32.4	44.6	50.5	16.5	61.7	49.8	35.7	25.2	17.2	35.9

Blank cells had fewer than 20 days of recorded data

The measured records at Tintina station indicate a mean annual precipitation of 21.73 inches (552 mm) and a mean annual temperature of 35.9° F (2.2° C). The monthly temperature data were used with the Thornthwaite equation to estimate a mean annual potential evapotranspiration of 17.4 in. (441 mm), as shown in Table 2-3 (Knight Piésold, 2015). Potential evapotranspiration is considered to be generally equivalent to pond evaporation.

Table 2-3. Tintina Station Potential Evapotranspiration (in.)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
2012					1.9		4.8	4.1	2.5	0.5	0	0	**-**
2013	0	0	0	0	2.4	3.5	4.8		2.8	0	0	0	**-**
2014	0	0	0	9	2.3	2.9	4.5	3.8	2.2	1.3	0	0	**-**
Average	0	0	0	4	2.2	3.2	4.7	3.9	2.5	0.6	0	0	**17.4**

Four regional climate stations were investigated for comparison with the Tintina station. The locations of these stations are shown on Figure 2.1 and the mean annual meteorological values are summarized in Table 2-4 and Appendix A-2 (Knight-Piésold, 2015) presents the detailed analysis of this data (including pond evaporation estimates, and long-term temperature and precipitation data) and compares results among the four meteorological stations.

Table 2-4. Regional Meteorological Station Summary

Station	Elevation (amsl)	Period of Record	Mean Annual Precipitation (mm)	Mean Annual Temperature (°C)	Mean Annual Pan Evap. (mm)
Bozeman	4,862	1892 - 2015	18.5	43.1	36.8
Millegan 14 SE	4,970	1984 - 2015	18.6	41.0	-
White Sulphur Spring	5,440	1949 - 1981	15.8	-	-
Neihart 8 NNW	5,320	1967 - 2013	21.3	41.7	-

Two synthetic series of monthly precipitation and temperature generated for the Project site (Tintina meteorological station, elevation 5,699 feet (1,737 m)) allow the best possible estimate of precipitation, temperature, and evaporation. For the period 1892 to 2015 a synthetic series includes data generated from the Bozeman station, and for the period 1984 to 2015 includes data from the Millegan station (Knight-Piésold 2015, Appendix A-2). The calculated mean annual precipitation values for the Project site were 20.0 in. (508 mm) and 16.4 in. (417 mm), respectively. These are lower than the mean annual precipitation recorded at the Tintina station in 2012 to 2014. The Millegan station, located close to the Project site, indicated that the 2012–2014 period was wetter than the long-term average, whereas the Bozeman station indicated that the 2012–2014 period deviated less from the long-term average conditions. Because the Millegan station is located closer to the Project site, and is considered more representative of Project site weather patterns, this study adopted the long-term precipitation estimate based on the Tintina-Millegan comparison for water balance calculations. In addition, the Tintina-Millegan estimate yielded a more conservative result with respect to water supply availability used in the site-wide water balance. Statistical graphs of correlations for temperature and precipitation data between the Tintina-Bozeman and the Tintina-Millegan sites are included in Knight-Piésold's report (Knight-Piésold 2015).

The study generated three estimates of long-term mean annual pond evaporation for the Project site. The study based two estimates on temperature values and the Thornthwaite equation. Analysis using the Tintina-Bozeman temperature series yielded a mean annual potential evapotranspiration of 17.2 in. (437 mm); and analysis using the Tintina-Millegan temperature series yielded a mean annual potential evapotranspiration of 16.7 in. (424 mm) The third estimate, which was based on pan evaporation at the Bozeman station scaled to the Project site, yielded a mean annual pond evaporation value of 20.2 inches (513 mm). Given the level of uncertainty in the evaporation estimates, as with the precipitation, the study applied the most conservative approach to the water balance analyses, and used the highest evaporation estimate (20.2 in., 513 mm) for the Project site for modeling purposes. Tintina installed a pan evaporation measuring station at the project site in June 2015.

The values presented in Table 2-5 represent those considered most representative of the Project site when using the most conservative approach, with respect to water availability. The values below represent an average annual water deficit of 3.9 in. (96 mm).

Table 2-5. Long-Term Project Precipitation and Pond Evaporation Data

Parameter	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Precipitation (in.)	0.8	0.67	1.1	1.5	2.3	2.8	1.8	1.5	1.2	1.1	0.9	0.9	16.4
Precipitation (mm)	20	17	28	38	58	71	46	38	30	28	23	23	417
Pond Evaporation (in.)	0	0	0	1.9	3.0	3.3	4.4	3.9	2.4	1.4	0	0	20.2
Pond Evaporation (mm)	0	0	0	48	76	84	112	99	61	36	0	0	513

2.1.4 Wet and Dry Return Periods for Project Site Precipitation

Table 2-6 presents the wet and dry annual precipitation values up to the 1:100 year return period. These values are calculated based on the mean annual precipitation, and the standard deviation of annual precipitation values, using the annual precipitation values from the Tintina-Millegan precipitation series (Knight-Piésold 2015). The analysis assumes a normal distribution. The Tintina weather station will

continue meteorological data collection to provide a longer period of record for comparison to the regional stations.

Table 2-6. Wet and Dry Return Period Project Precipitation

Return Period	Annual Precipitation (in. / mm)
1:100 year **wet** (mean + 2.326 s.d.)	24.6 / 625
1:50 year **wet** (mean + 2.054 s.d.)	23.6 / 599
1:20 year **wet** (mean + 1.645 s.d.)	22.1 / 561
1:10 year **wet** (mean + 1.282 s.d.)	20.9 / 531
Mean Annual Precipitation	**16.4 / 417**
1:10 year **dry** (mean - 1.282 s.d.)	11.9 / 302
1:20 year **dry** (mean - 1.645 s.d.)	10.6 / 269
1:50 year **dry** (mean - 2.054 s.d.)	9.2 / 234
1:100 year **dry** (mean - 2.326 s.d.)	8.2 / 208

NOTE: 1. The standard deviation was calculated to be 3.5 in.(89 mm)

2.1.5 Air Quality

Meagher County, in which the Project is located, is classified for air quality purposes as "Unclassifiable or Better Than National Standards" for all criteria pollutants (40 CFR 81.327 and DEQ website http://deq.mt.gov/AirQuality/Planning/AirNonattainment.mcpx). This classification indicates that the MDEQ has not monitored the area's air quality but that, based on the Department's experience, the area is presumed to meet the ambient air quality standards. Specifically regarding the recently revised 8-hour ozone standard, EPA has published information indicating that all of Montana currently meets the new standard or is presumed to do so (EPA website:

http://ozoneairqualitystandards.epa.gov/OAR_OAQPS/OzoneSliderApp/index.html#).

As noted above, DEQ has not measured ambient air pollutant concentrations in or near the Project area. The most representative data have been collected at the Sieben Flats monitoring station located approximately 50 miles west of the Project between Helena and Great Falls. This is a National Core (NCore) Multipollutant Network monitoring station that monitors background air quality on a regional scale as part of a national air quality trends network. The NCore site and the Project site are both rural locations that are quite similar, and this similarity supports the "Unclassifiable or Better Than National Standards" classification determination (Sieben Flats NCore data can be accessed at this EPA website: http://www3.epa.gov/airdata/ad_rep_mon.html).

There are no significant sources of air pollution in the vicinity of the Project area. The nearest significant source is the Graymont Indian Creek Lime Plant which is located approximately 40 miles southwest of the mine. White Sulphur Springs is approximately 15 miles south of the mine site and does not have any significant emitting sources. The nearest large population centers are the cities of Great Falls, Bozeman and Helena, located at distances of approximately 50 and 80 miles from the Project.

In addition, Tintina received an air quality permit from DEQ's Air Quality Bureau for its Amendment to Exploration License to Construct and Exploration Decline. This application concludes that recent emission air pollutant rates from the Projects exploration activities are quite low and are not expected to

substantially degrade surrounding air quality. Potential emission rates for criteria pollutants, as reported in the exploration decline air quality permit (MAQP #4978-00) are all well below EPA thresholds for "significant emission rates." The air quality permit states on page 4 of the analysis section that "…the potential emissions expected from operating the facility (exploration decline) at its maximum throughput on a continuous basis would not violate ambient air quality standards."

Tintina will submit an application for and acquire a Montana Air Quality Permit under the Montana Clean Air Act prior to construction and mining activities at the site that specifies requirements for applicable State and Federal air quality standards. The air quality permit application requires that the applicant demonstrate compliance with all applicable state and federal regulations and ambient air quality standards. As part of that application, a list of equipment and specifications for all stationary emissions sources would be compiled for submittal to DEQ's Air Quality Bureau for review and final determination of permitting needs once specific pieces of equipment have been selected for the mining operation. The conditions of the Air Quality Permit will specify monitoring and reporting requirements in detail and may specifically require air quality monitoring for particulates.

2.2 Water Resources

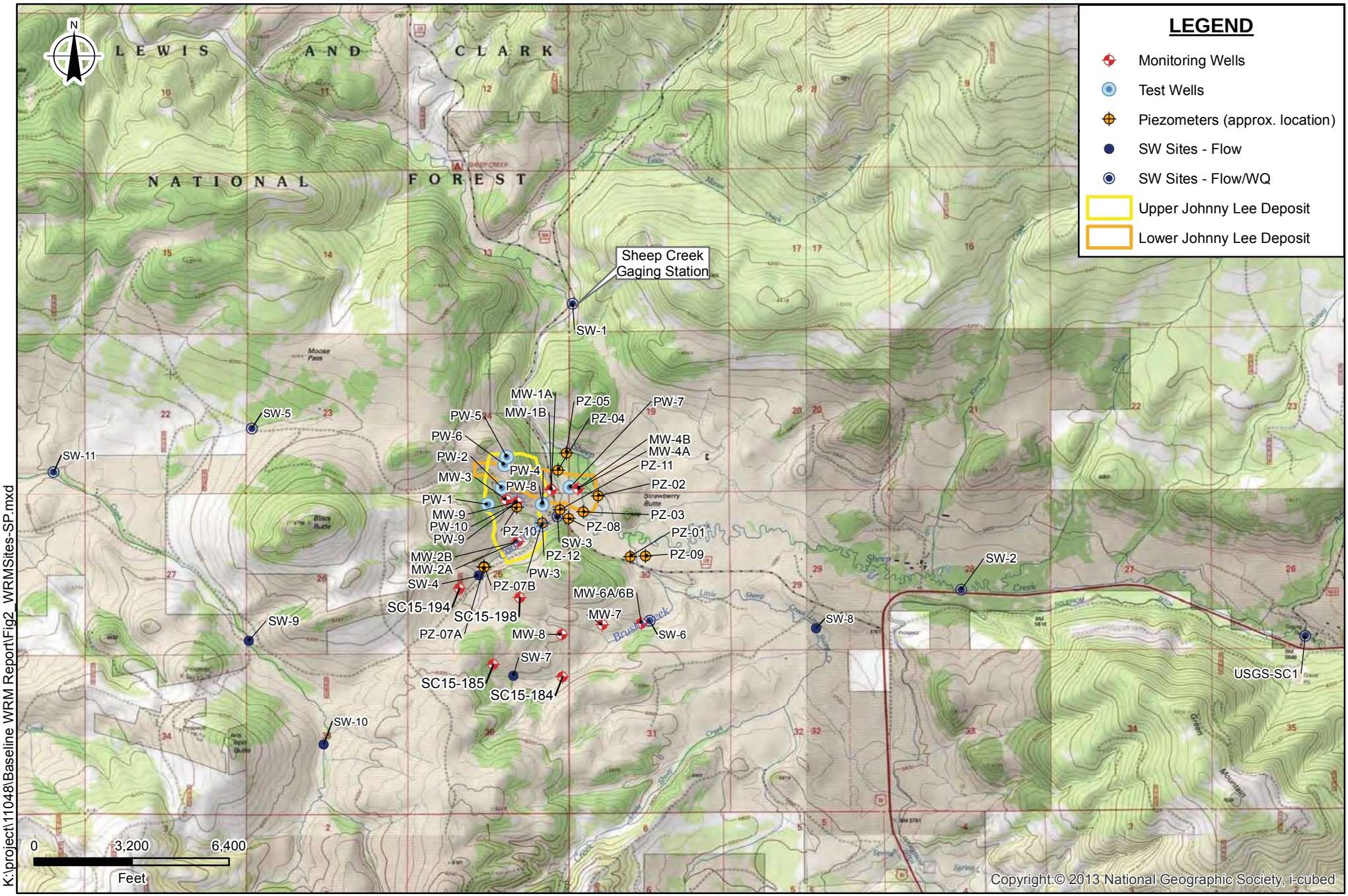
2.2.1 Water Resources Study Area and Methods of Study

Tintina has conducted both water resource baseline monitoring and hydrologic investigations for the Project. They initiated the baseline monitoring program in May of 2011 and it includes measurement of flow, water levels, and water quality at surface water, groundwater, and spring and seep monitoring sites in the Project area. The baseline monitoring program includes the following:

- Quarterly monitoring at 11 surface water sites. Beginning in 2013, Tintina monitored three of these sites located on Sheep Creek on a bi-weekly/weekly schedule during spring run-off and then monthly since 2014.
- Quarterly groundwater monitoring at 12 monitoring well sites and 22 additional test wells and piezometer sites (Figure 2.2).
- Annual spring and seep monitoring which includes monitoring of flow and field parameters at 16 springs and water quality sampling and analysis at 11 sites (Figure 2.3). Field parameters are also monitored annually at 10 seep locations.

Figure 2.2 shows the location of water resource monitoring sites. Table 2-7 summarizes the type of baseline data available and period of record at each of the baseline monitoring sites.

In addition to baseline monitoring, Tintina conducted a number of groundwater investigations to characterize the hydro-stratigraphic units in the Project area (Hydrometrics, August 2012, 2013, and April 2015). Investigations have also examined groundwater/surface water interactions for a possible Land Application Disposal (LAD) area (Hydrometrics, November 2013), and have included two synoptic surveys on Sheep Creek between Little Sheep Creek and downgradient monitoring site SW-1 (Figure 2.2).



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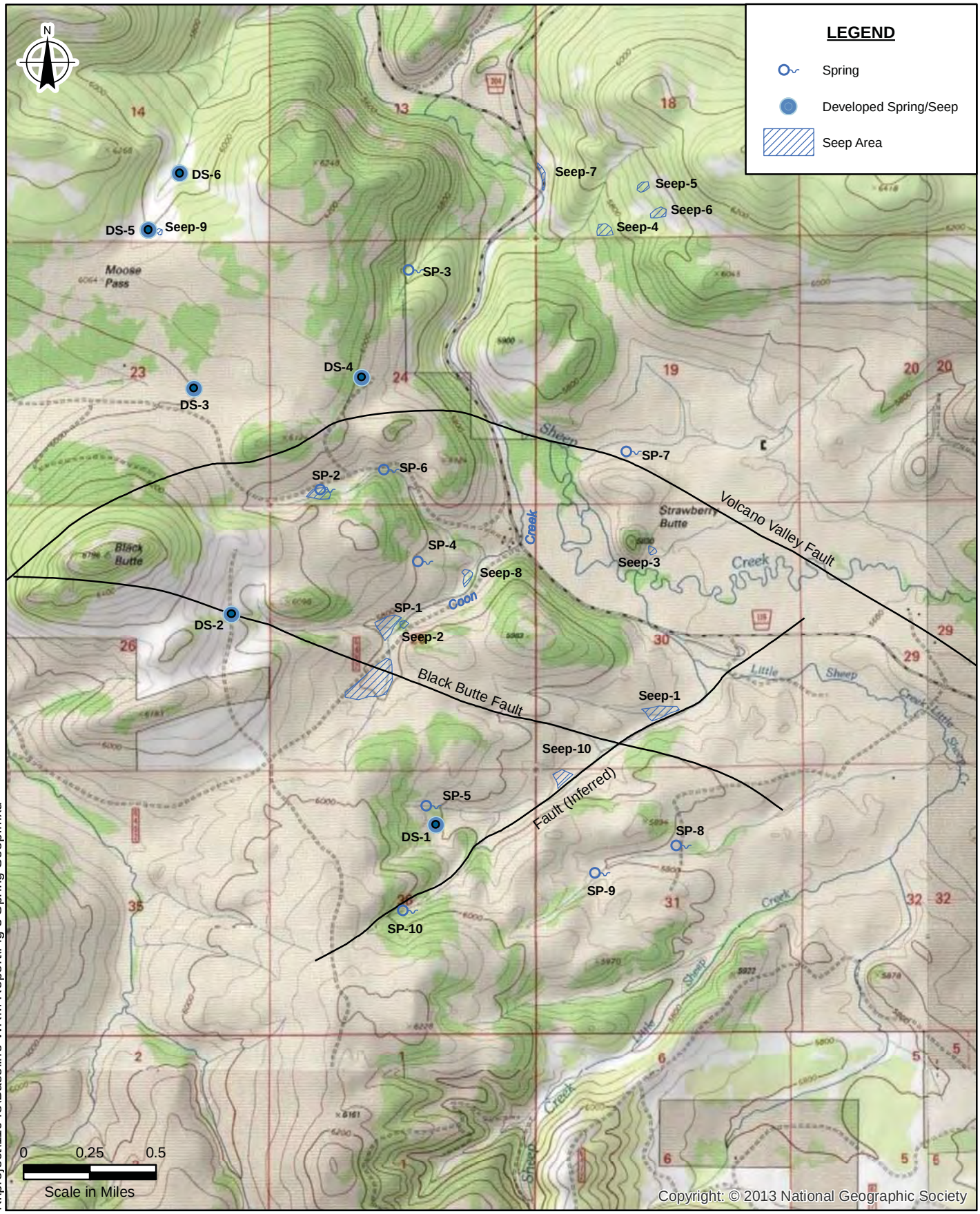
Prepared by Hydrometrics 2015

TINTINA RESOURCES

Figure 2.2
Water Resource Monitoring Sites
Black Butte Copper Project
Meagher County, Montana



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Date: November 3, 2015 Source: Hydrometrics (2015)

TINTINA RESOURCES

Figure 2.3
Baseline Seep and Springs Sites
Black Butte Copper Project
Meagher County, Montana

Table 2-7. Water Sampling Summary for Baseline Monitoring Sites

Monitoring Site	Easting (meters)	Northing (meters)	Monitoring Frequency	Period of record	Flow or Water Level	Field Parameters	Lab Parameters	Comments
	UTM-WGS 1984 Zone 12							
Developed Springs								
DS-1	506507.0804	5178870.812	Annual	2011-2015	X	X	2015	
DS-2	505263.4901	5180150.611	Annual	2011-2015	X	X	2011, 2014	
DS-3	505037.6171	5181520.613	Annual	2011-2015	X	X	2014-2015	
DS-4	506056.5319	5181588.636	Annual	2011-2015	X	X	2011,14,15	
DS-5	504761.4473	5182484.963	Annual	2011-2014	X	X	--	
DS-6	504949.6587	5182827.876	Annual	2011-2014	X	X	--	
Seeps								
Seep-1	507876.19	5179570.54	Annual	2011-2014	--	X	--	
Seep-2	506310.6	5180089.2	Annual	2012-2014	--	X	--	
Seep-3	507821.16	5180537.25	Annual	2012-2014	--	X	--	
Seep-4	507530.57	5182486.29	Annual	2012-2014	--	X	--	
Seep-5	507768.38	5182748.77	Annual	2011-2014	--	X	--	
Seep-6	507853.49	5182587.27	Annual	2011-2014	--	X	--	
Seep-7	507155.4	5182821.06	Annual	2011-2014	--	--	--	
Seep-8	506701.44	5180381.64	Annual	2011-2014	--	X	--	
Seep-9	504825.48	5182475.68	Annual	2012-2014	--	X	--	
Seep-10	507270.05	5179164.8	Annual	2012-2014	--	X	--	
Springs								
SP-1	506273	5180099	Annual	2011-2015	X	X	2011,14,15	
SP-2	505833.974	5180907.344	Annual	2011-2015	X	X	X	2013, no Lab Data
SP-3	506370.5798	5182241.552	Annual	2011-2015	X	X	X	
SP-4	506425.1743	5180468.941	Annual	2011-2015	X	X	X	
SP-5	506478.8216	5178985.422	Annual	2011-2015	X	X	--	
SP-6	506219.5828	5181027.89	Annual	2011-2015	X	X	X	
SP-7	507693.6926	5181137.92	Annual	2011-2015	X	X	2015	
SP-8	507995.8872	5178745.244	Annual	2012-2014	X	X	--	
SP-9	507502.0319	5178577.924	Annual	2012-2014	X	X	--	
SP-10	506335.423	5178351.003	Annual	2012-2014	X	X	--	

Monitoring Site	Easting (meters)	Northing (meters)	Monitoring Frequency	Period of record	Flow or Water Level	Field Parameters	Lab Parameters	Comments
	UTM-WGS 1984 Zone 12							
Surface Water Sites								
SW-1	507148	5182710	Monthly	2011-2015	X	X	X	Hourly water level data since 2012; High flow bi-weekly/weekly Flow
SW-2	511040	5179844	Monthly	2011-2015	X	X	X	High flow bi-weekly/weekly Flow
SW-3	506996	5180581	Quarterly	2011-2015	X	X	X	
SW-4	506308	5180114	Quarterly	2011-2015	X	X	--	
SW-5	503914	5181465	Quarterly	2011-2015	X	X	X	Typically Dry
SW-6	507919	5179536	Quarterly	2011-2015	X	X	X	
SW-7	506420	5179000	Quarterly	2011-2015	X	X	2012,15	
SW-8	509575	5179476	Quarterly	2011-2015	X	X	--	
SW-9	503944	5179271	Quarterly	2011-2015	X	X	--	
SW-10	504665	5178322	Quarterly	2011-2015	X	X	2015	Added Lab WQ for TMDL
SW-11	501951	5181021	Quarterly	2011-2015	X	X	X	
USGS-SC1	514509	5179419	Monthly	2014-2015	X	X	X	High flow bi-weekly/weekly Flow
Monitoring Wells								
MW-1A	506935.22	5180841.55	Quarterly	2011-2015	X	X	X	
MW-1B	506934.19	5180845.46	Quarterly	2011-2015	X	X	X	
MW-2A	506598.18	5180331.93	Quarterly	2011-2015	X	X	X	
MW-2B	506596.96	5180328.73	Quarterly	2011-2015	X	X	X	
MW-3	506484.1	5180740.2	Quarterly	2011-2015	X	X	X	
MW-4A	507201.5	5180855.4	Quarterly	2012-2015	X	X	X	
MW-4B	507200.1	5180858.5	Quarterly	2012-2015	X	X	X	
MW-6A	507809.2	5179492.9	Quarterly	2013-2015	X	X	X	
MW-6B	507792.8	5179490.7	Quarterly	2013-2015	X	X	X	
MW-7	507451.7	5179500.7	Quarterly	2013-2015	X	X	X	
MW-8	507036.0	5179398.3	Quarterly	2013-2015	X	X	X	
MW-9	506593.0	5180725.5	Quarterly	2014-2015	X	X	X	
SC15-184	507047.3	5178972.5	Quarterly	2015	X	X	X	first monitoring July 2015
SC15-185	506355.5	5179094.2	Quarterly	2015	X	X	X	first monitoring July 2015
SC15-194	506014.1	5179854.9	Quarterly	2015	X	X	X	first monitoring July 2015
SC15-198	506621.4	5179854.9	Quarterly	2015	X	X	X	first monitoring July 2015

Monitoring Site	Easting (meters)	Northing (meters)	Monitoring Frequency	Period of record	Flow or Water Level	Field Parameters	Lab Parameters	Comments
	UTM-WGS 1984 Zone 12							
Test Wells								
PW-1	506301.4	5180698.4	Quarterly	2011-2015	X	One Time	One Time	Lab Data from Pumping Test
PW-2	506443.2	5180865.0	Quarterly	2011-2015	X	One Time	One Time	Lab Data from Pumping Test
PW-3	506846.4	5180479.4	Quarterly	2012-2015	X	twice	twice	Lab Data from Pumping Test
PW-4	506901.8	5180688.3	Quarterly	2012-2015	X	One Time	One Time	Lab Data from Pumping Test
PW-5	506490.7	5181172.8	Quarterly	2013-2015	X	--	--	
PW-6	506468.1	5181097.9	Quarterly	2012-2015	X	--	--	Lab Data from Pumping Test
PW-6N	506468.1	5181097.9	Quarterly	2015	X	--	--	
PW-7	506846.2	5180695.5	Quarterly	2013-2015	X	twice	twice	Lab Data from Pumping Test
PW-8	506598.4	5180721.9	Quarterly	2014-2015	X	twice	twice	Lab Data from Pumping Test
PW-10	506593.6	5180721.9	Quarterly	2014-2015	X	twice	twice	Lab Data from Pumping Test
Piezometers								
PZ-01	507650.0	5180255.6	Quarterly	2012-2014	X	--	--	
PZ-02	507400.7	5180778.8	Quarterly	2012-2014	X	--	--	
PZ-03	507249.2	5180618.9	Quarterly	2012-2015	X	--	--	
PZ-04	506991.7	5181110.8	Quarterly	2012-2015	X	--	--	
PZ-05	507080.0	5181214.7	Quarterly	2012-2015	X	--	--	
PZ-07A	506258.4	5180074.7	Quarterly	Nov-14	X	--	--	
PZ-07B	506258.5	5180075.0	Quarterly	Nov-14	X	--	--	
PZ-08	507090.3	5180573.8	Quarterly	2014-2015	X	--	--	
PZ-09	507883.8	5180178.6	Quarterly	2014-2015	X	--	--	
PZ-10	ND	ND	One-Time	Nov-14	X	--	--	PW-8 Aq Test temporary piezometers
PZ-11	ND	ND	Twice	Nov-14, Mar-15	X	--	--	PW-8 Aq Test temporary piezometers
PZ-12	ND	ND	One-Time	Nov-14	X	--	--	PW-8 Aq Test temporary piezometers

Notes for comments column:

- High flow bi-weekly/weekly flow means - there is bi-weekly or weekly flow monitoring during the high flow season
- Added lab WQ for TMDL means- began water quality monitoring at the request of the TMDL program

Appendix B-1 (Hydrometrics, 2015b) of this Permit Application provides a more comprehensive Baseline Water Resources Report. The remainder of this section describes the hydrologic setting of the Project area and summarizes the results of baseline and other water resources monitoring programs.

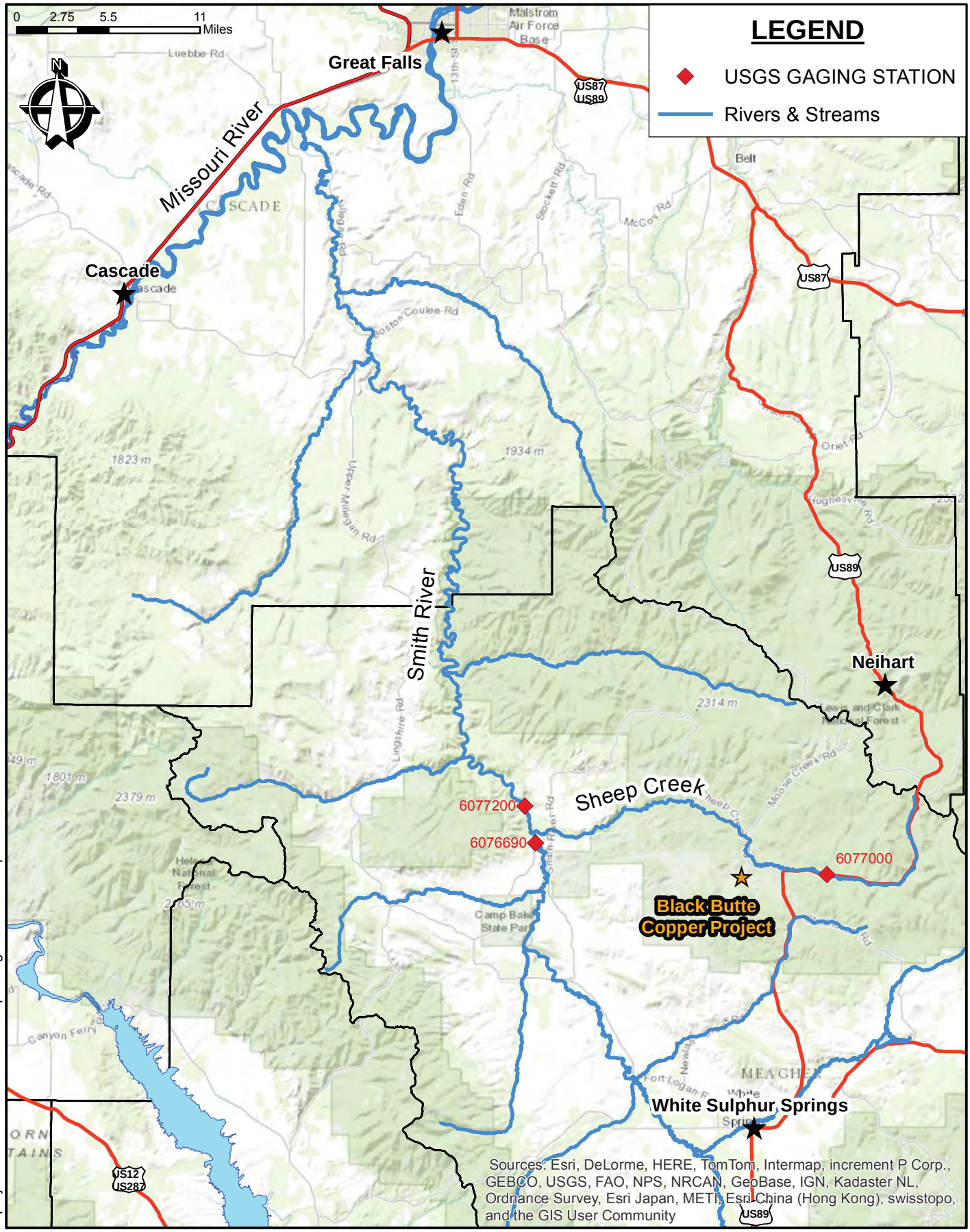
2.2.2 Surface Water

The Project area is in the upper portion of the Sheep Creek drainage, a tributary to the Smith River, which in turn is a tributary of the Missouri River (Figure 2.4). Sheep Creek is a fifth order stream draining a total of approximately 194 square miles (502 square km). Sheep Creek originates in the Little Belt Mountains at an elevation of approximately 7,400 feet (2,255 m) and discharges to the Smith River approximately 34 river miles (55 km) to the west at an elevation of 4,380 feet (1,335 m). The Project area is located in the approximate upper third of the drainage approximately 19 river miles (30.5 km) above the confluence with the Smith River. Sheep Creek is a high quality stream that flows in a meandering channel through a broad alluvial valley upstream of the Project site but enters a constricted bedrock canyon just downstream. It is used principally for stock water and fishing (RMI, 2010).

Primary tributaries to Sheep Creek in the immediate Project area include Little Sheep Creek and Coon Creek (Figure 2.5). To the west of the project area is Black Butte Creek, also a tributary to Sheep Creek. Black Butte Creek flows to the northwest and joins Sheep Creek approximately 7 miles (11 km) to the west-northwest of the Project area. There is a small unnamed tributary that joins Sheep Creek on the north side of Strawberry Butte that collects water from springs on the north flank of the Sheep Creek Valley. Another small un-named tributary flows westward from the northern side of Black Butte (the geographic feature) into Black Butte Creek. Flow in these tributary drainages is only perennial on their lower reaches and ephemeral upstream.

The United States Geological Survey (USGS) historically operated a gaging station on Sheep Creek (USGS 06077000) that was located approximately 4 miles (6.4 km) upstream of the Project area (Figure 2.4 and Figure 2.5). This site provided stream flow data for Sheep Creek from 1941 through 1978 and the USGS reports average monthly base flows ranging from approximately 9 cfs to 115 cfs (254 to 3,256 L/sec; 0.5 to 3.26 m^3/sec). The nearest active USGS gaging stations (USGS 06076690 and 06077200) are located on the Smith River near Fort Logan above the confluence with Sheep Creek and just below the confluence with Sheep Creek and Eagle Creek (Figure 2.4). The upstream gaging station (06076690) provided continuous data from October 1977 to the end of September 1996 and intermittent data since then. The downstream gaging station (06077200) has run continuously since October 1, 1996. Base flows on the Smith River at the upstream gaging site range from 18 to 3,200 cfs (510 to 90,613 L/sec; 0.5 to 90 m^3/sec) and at the downstream gaging site from 30 to 3,800 cfs (0.85 to 107.6 m^3/sec). The percentage of flow from Sheep Creek is unknown as there are additional tributary drainages between the two USGS gaging stations.

The Holmstrom Ditch is a significant man-made hydrologic feature effecting flows in Sheep Creek. It has diverted Sheep Creek water for irrigation use into the Newlan Creek drainage since 1935. The diversion point for the ditch is just downstream of the former USGS-SC1 gaging station (Figure 2.5). While the local ranchers continue to use the ditch for seasonal irrigation diversions, the Newlan Creek Water District also uses the ditch as a source of water for the Newlan Reservoir.



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Date: November 3, 2015 Source: Hydrometrics (2015)

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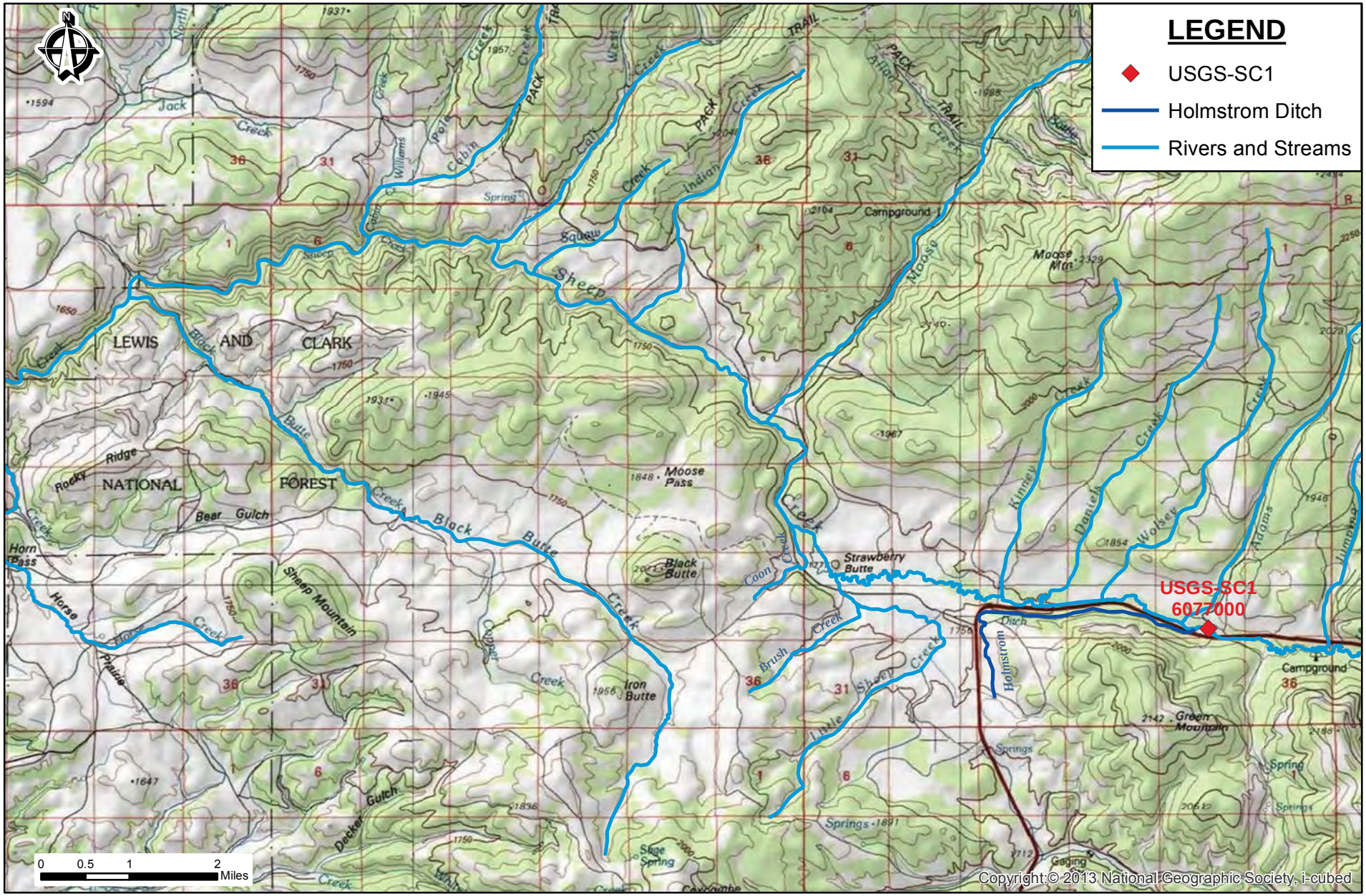
Figure 2.4

Plan Map of Sheep Creek, Smith River, and Missouri River

Black Butte Copper Project

Meagher County, Montana



Date: November 3, 2015 Source: Hydrometrics (2015)

TINTINA RESOURCES

Figure 2.5
Plan Map of Major Streams and Tributaries in the Project Area
Black Butte Copper Project
Meagher County, Montana

2.2.3 Groundwater

Quaternary alluvial deposits that occupy the axes of the major drainages, colluvium deposits (highly weathered shallow bedrock that flank these drainages) and the underlying more competent bedrock formations all contain groundwater in the project area. Primarily low permeability dolomitic and silicic shales and argillaceous dolomites of the Newland Formation from the bedrock of the Project area. A review of available information in the Groundwater Information Center (GWIC) database (Montana Bureau of Mines and Geology; MBMG) indicates wells completed in the area generally produce low yields. There is limited historical information on the hydrogeology of the Project area. Previous exploration drilling in some holes (RMI, 2010) in the deeper bedrock units underlying the Sheep Creek Valley encountered artesian flow.

2.2.4 Water Resources Baseline Monitoring

Tintina has conducted surface water and groundwater monitoring to establish baseline stream flows, groundwater potentiometric elevations, and water quality in the Project area. This work has included analyses of surface water and groundwater (Table 2-8) quality samples for physical parameters, common ions, and nutrients, as well as a comprehensive suite of trace metals.

Table 2-8. Parameter, Methods, and Detection Limits for Baseline Water Monitoring

Parameter	Analytical Method(1)	Project-Required Surface Water Detection Limit	Project-Required Groundwater Detection Limit
Physical Parameters			
TDS	SM 2540C	4 mg/L	10 mg/L
TSS	SM 2540C	4 mg/L	10 mg/L
Common Ions			
Alkalinity	SM 2320B	4 mg/L	4 mg/L
Sulfate	300.0	1 mg/L	1 mg/L
Chloride	300.0/SM 4500CL-B	1 mg/L	1 mg/L
Fluoride	A4500-F C	0.1 mg/L	0.1 mg/L
Calcium	215.1/200.7	1 mg/L	1 mg/L
Magnesium	242.1/200.7	1 mg/L	1 mg/L
Sodium	273.1/200.7	1 mg/L	1 mg/L
Potassium	258.1/200.7	1 mg/L	1 mg/L
Nutrients			
Nitrate+Nitrite as N	353.2	0.003 mg/L	0.1 mg/L
Total Persulfate Nitrogen	A 4500-N-C	0.04 mg/L	--
Total Phosphorus	E365.1	0.003 mg/L	--
Trace Constituents (SW - Total Recoverable except Aluminum [Dissolved], GW - Dissolved)(2)			
Aluminum (Al)	200.7/200.8	0.009 mg/L	0.009 mg/L
Antimony (Sb)	200.7/200.8	0.0005 mg/L	0.0005 mg/L
Arsenic (As)	200.8/SM 3114B	0.001 mg/L	0.001 mg/L
Barium (Ba)	200.7/200.8	0.003 mg/L	0.003 mg/L
Beryllium (Be)	200.7/200.8	0.0008 mg/L	0.0008 mg/L
Cadmium (Cd)	200.7/200.8	0.00003 mg/L	0.00003 mg/L
Chromium (Cr)	200.7/200.8	0.01 mg/L	0.01 mg/L
Cobalt (Co)	200.7/200.8	0.01 mg/L	0.01 mg/L
Copper (Cu)	200.7/200.8	0.002 mg/L	0.002 mg/L

Parameter	Analytical Method(1)	Project-Required Surface Water Detection Limit	Project-Required Groundwater Detection Limit
Iron (Fe)	200.7/200.8	0.02 mg/L	0.02 mg/L
Lead (Pb)	200.7/200.8	0.0003 mg/L	0.0003 mg/L
Manganese (Mn)	200.7/200.8	0.005 mg/L	0.005 mg/L
Mercury (Hg)	245.2/245.1/200.8/SM 3112B	0.000005 mg/L	0.000005 mg/L
Molybdenum (Mo)	200.7/200.8	0.002 mg/L	0.002 mg/L
Nickel (Ni)	200.7/200.8	0.001 mg/L	0.001 mg/L
Selenium (Se)	200.7/200.8/SM 3114B	0.0002 mg/L	0.0002 mg/L
Silver (Ag)	200.7/200.8	0.02 mg/L	0.02 mg/L
Strontium (Sr)	200.7/200.8	0.0002 mg/L	0.0002 mg/L
Thallium (Tl)	200.7/200.8	0.0002 mg/L	0.0002 mg/L
Uranium	200.7/200.8	0.008	0.008
Zinc (Zn)	200.7/200.8	0.002	0.002
Field Parameters			
Stream Flow	HF-SOP-37/-44/-46	NA	NA
Water Temperature	HF-SOP-20	0.1 °C	0.1 °C
Dissolved Oxygen (DO)	HF-SOP-22	0.1 mg/L	0.1 mg/L
pH	HF-SOP-20	0.1 s.u.	0.1 s.u.
Specific Conductance (SC)	HF-SOP-79	1 µmhos/cm	1 µmhos/cm

(1) Analytical methods are from *Standard Methods for the Examination of Water and Wastewa*ter (SM) or EPA's *Methods for Chemical Analysis of Water and Waste* (1983).
(2) Samples to be analyzed for dissolved constituents will be field-filtered through a 0.45 µm filter.

2.2.4.1 Surface Water Monitoring

Tintina established eleven surface water stations as baseline monitoring sites (Figure 2.2) and began monitoring at these sites in May 2011 with subsequent quarterly monitoring events scheduled in the months of August, November, March, and May of each year. Monitoring includes flow, stage, and field parameters (temperature, pH, and specific conductivity (SC)) at all of these sites and collection of water quality samples at six of the sites during quarterly monitoring. Beginning in 2014, Tintina began monthly sampling of sites on the main stem of Sheep Creek.

2.2.4.2 Stream Flow

Table 2-9 summarizes flow monitoring results for each of the surface water monitoring sites. Flows estimated for Sheep Creek during May/June have ranged from approximately 100 to more than 800 cfs (2.8 to 22.7 m^3/sec). Base flow in Sheep Creek during late summer/fall ranges from 10 to 30 cfs (0.28 to 0.85 m^3/sec) at the upstream monitoring site SW-2 and 15 to 34 cfs (0.42 to 0.96 m^3/sec) at the downstream monitoring site SW-1. Individual measurements typically showed an increase in flow by 25% to 50% between SW-2 to SW-1. Stream flow declines rapidly in late June/early July averaging 10 cfs to 30 cfs (0.28 to 0.85 m^3/sec) by late summer and 10 to 15 cfs (0.28 to 0.42 m^3/sec) by late winter.

Tintina has installed a stilling well with a transducer at monitoring site SW-1 that allows collection of seasonal baseline stage and discharge monitoring in Sheep Creek. Data collected at this site shows flows in excess of 100 cfs (2.8 m^3/sec) in Sheep Creek from mid-May-through mid-June, with high flows of 200 to more than 800 cfs (5.66 to more than 22.65 m^3/sec).

In addition to the flow monitoring at baseline monitoring sites, Tintina has also measured stream flow on a monthly basis in Sheep Creek at the former upstream USGS-SC1 gaging site since May 2014 with concurrent measurements at SW-1 and SW-2 to allow correlation of the stream flows between the sites. Stream flow in Sheep Creek increases between the upstream USGS-SC1 site and downstream SW-1 by a factor of up to 2.5 during spring runoff, after which time the increased flow diminishes and flows at the two sites become nearly equal in late August when tributary inflows downstream of USGS-SC1 are diverted for irrigation. Downstream flows increase after the irrigation season ends and the flow measurements show an approximately 50% increase in stream flow between USGS-SC-1 and SW-1 during base flow periods in early spring.

Table 2-9. Summary of Stream Flow Monitoring Data

Monitoring Station	Stream	March	May/June	August/Nov
		Measured Stream Flow (cfs)		
SW-1	Sheep Creek	30-41	111-613	10-34
SW-2	Sheep Creek	Frozen	98-250	7-30
SW-3	Coon Creek	0.22	0.3-5	0.08-0.34
SW-4	Coon Creek	0.16	0.2-2	0.01-0.4
SW-6	Unnamed tributary to Black Butte Creek	0.04-0.26	0.5-4	0.17-0.33
SW-7	Unnamed tributary to Black Butte Creek	0-0.4	0-0.3	0.001-0.01
SW-8	Little Sheep Creek	1.7	1-9	0.2-1
SW-9	Black Butte Creek	0.3-1.8	2.3-12.7	0.3-0.8
SW-10	Black Butte Creek	Frozen	1.7-15.2	0.3-0.5
SW-11	Black Butte Creek	1.0-2.9	1.6-21.4	0.4-1.0

The observed increase in stream flow between SW-2 and SW-1 is accounted for during high flow season by inflow from Little Sheep Creek; however, during base flow periods the increase is not accounted for by Little Sheep Creek or other monitored tributaries and is likely attributable to inflow from groundwater and unmonitored springs and tributaries on inaccessible private property to the north of Sheep Creek.

2.2.4.3 Surface Water Quality

Appendix B (Hydrometrics, 2015b) of this Permit Application is a Baseline Water Resources Report and Appendix B-2 of this Application provides electronic water quality data (Hydrometrics, 2015 on CD) for each of the surface water monitoring sites. Appendix B-3 of this Application (Hydrometrics, 2015, on CD), contains water quality statistics for individual sites in the Baseline Report (Hydrometrics 2015a). Analytical results for surface water samples collected from within the Project area show neutral to slightly alkaline pH values (6.8 to 8.6), and low to moderate specific conductance (49 to 487 µmhos/cm). Calcium and bicarbonate dominate the major ion chemistry of waters. Hardness typically ranges from approximately 73 to 256 mg/L. Metals data show infrequent excursions above DEQ-7 water quality

standards for selected metals (aluminum and iron) during high runoff events. The following constituents showed surface water standard exceedances:

- Total recoverable iron exceeded the chronic aquatic criteria of 1 mg/L during peak runoff periods at all sites except SW-6 and SW-11 (2011) and SW-3 (2012).
- Dissolved aluminum concentrations often exceeded the chronic aquatic criteria of 0.087 mg/L during periods of high runoff in Sheep Creek (SW-1, SW-2, and USGS SC-1) and in Black Butte Creek (SW-11).
- Thallium exceeded the human health surface water standard of 0.00024 mg/L at SW-3 during three separate monitoring events in 2011.

Sheep Creek is included in MDEQs 303(d) list of impaired streams for dissolved aluminum, total recoverable iron, and Escherichia coli. The exceedances of dissolved aluminum and total recoverable iron occur during spring runoff near peak flow, when turbidity is high. Elevated total recoverable iron and aluminum values from highly turbid water are not unusual, and have been observed in many different geographic areas, during high flow events under what are “natural” conditions. Nonetheless, MDEQ conducted a broad monitoring program in the Sheep Creek drainage for further data collection that could be used for development of a TMDL if deemed necessary. MDEQ has not issued a completion schedule for establishing a TMDL.

2.2.4.4 Groundwater Monitoring

Section 1.4 of this Permit Application provides a description of the surficial and bedrock geology of the Project area. Monitoring wells and test wells completed within shallow and deep stratigraphic units to define baseline water levels, groundwater flow directions and ground-water quality within the Project area. A series of paired monitoring wells (MW-1A,-1B, MW-2A,-2B, MW-4A, -4B, and MW-6A, -6B) installed between 2011 and 2013 help document baseline conditions within the unconsolidated Quaternary/Tertiary clayey gravel deposits and in the underlying shallow bedrock groundwater system (Figure 2.2). In addition to these monitoring wells, 10 test wells (PW-1 through PW-10) installed for aquifer testing provide information on both the hydrologic characteristics and water quality within representative stratigraphic units (Figure 2.2). Figure 2.6 shows a generalized north-south geologic cross-section depicting completion units for all of the monitoring and test wells. Table 2-10 includes the completion details of each of these wells.

Twelve piezometers allow monitoring of the groundwater levels in the alluvial/colluvial systems of Sheep Creek, Coon Creek, and Dry Creek (Figure 2.2).

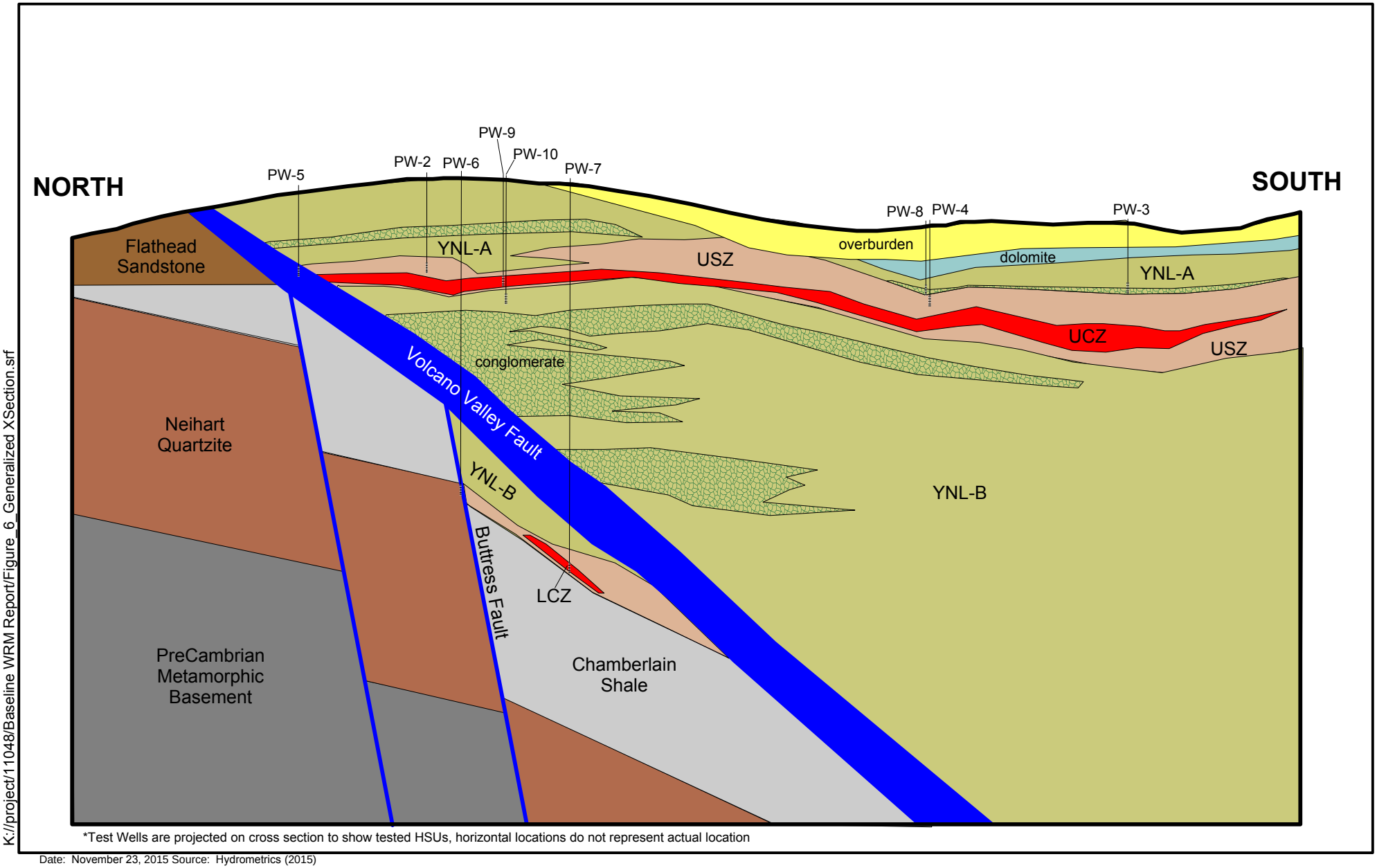
2.2.4.5 Groundwater Flow Directions

Figure 2.7 shows a compilation of water level data from the May 2015 sampling round. The potentiometric surface shows an eastward trending flow direction in the bedrock groundwater system within the Project area consistent with the general topographic trend in the greater area. The potentiometric contours of the bedrock hydrologic system indicate an average hydraulic gradient of approximately 0.08. Groundwater in the Sheep Creek alluvium generally flows parallel to the creek; then turns northwest and finally turns to the north as Sheep Creek bends to the north around Strawberry Butte (Figure 2.7). Groundwater continues to flow north towards Sheep Creek as the creek crosses the northern extents of the alluvial system and enters a small canyon. The hydraulic gradient in the alluvial system is relatively flat (0.008) through most of the monitoring area and then increases slightly to 0.013 in the northern portion of the valley. Water level elevations at PZ-04 and PZ-05 (located in the northern portion of the alluvial valley, see Figure 2.7) typically rest near or above the ground surface. The increased gradient and near surface

water level elevations in this area are indicate that the alluvial groundwater system discharges to surface water as the alluvium thins and then pinches out against the less permeable bedrock which forces the water upward as Sheep Creek flows over the bedrock rise and downstream into the canyon.

Well pairs MW-1A/1B and PZ-07A/7B have downward hydraulic gradients that indicate that the surficial groundwater systems are likely perched systems that are not fed by the deeper bedrock aquifers in these areas. In contrast, all of the other well pairs (MW-2A/2B, MW-4A/4B and MW-6A/6B) show upward hydraulic gradients. In addition, there is one set of triplet wells on site, PW-9, PW-10, and MW-9, completed in the Upper Copper Zone (*UCZ), Ynl-B*, and *Ynl-A* stratigraphic units (Figure 2.6), respectively. Water level elevations at these wells show a large upward gradient between the Upper Sulfide Zone (*USZ*, PW-9) to *Ynl-A* and a downward gradient from *USZ* to *Ynl-B* bedrock system. Note that *Ynl-A* and *Ynl-B* refer to hydrostratigraphic units, not geologic units, though they presumably follow geologic boundaries. *Ynl-A* refers to the Lower Newland shale above the Upper Sulfide Zone and below the Upper Newland carbonates, while *Ynl-B* refers to the Lower Newland rocks below the Upper Sulfide Zone and above the Volcano Valley fault. The hydrologic investigations define a separate hydrostratigraphic unit coincident with the Upper Sulfide Zone (*USZ*).

Figure 2.6 is a schematic diagram showing the relationship of well completion depth intervals with geologic and hydro-stratigraphic units (as shown on geologic cross-section).



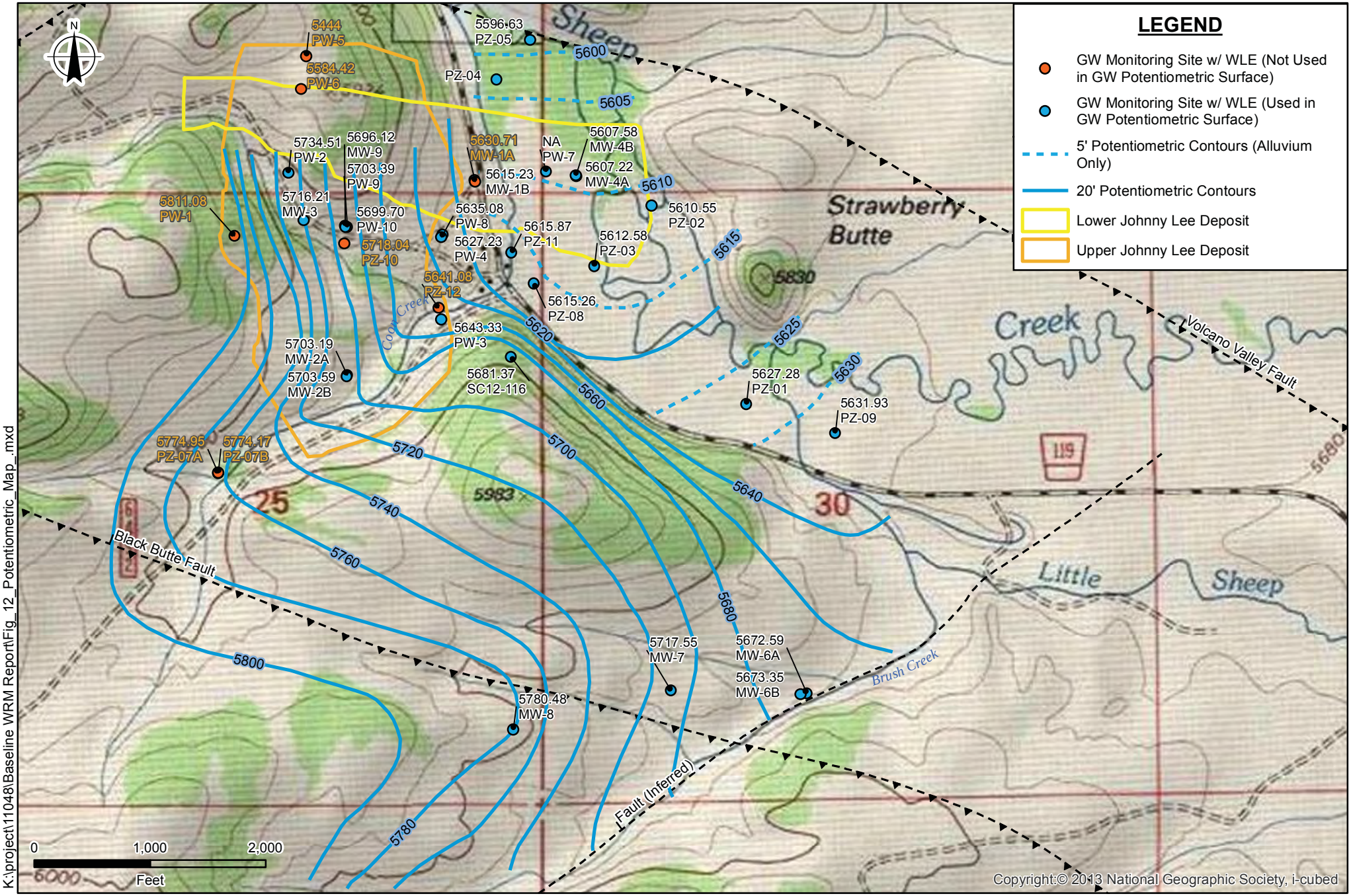
*Test Wells are projected on cross section to show tested HSUs, horizontal locations do not represent actual location

Date: November 23, 2015 Source: Hydrometrics (2015)

K://project/11048/Baseline WRM Report/Figure_6_Generalized XSection.srf

TINTINA RESOURCES

Figure 2.6
Generalized Cross-Section with Well Locations Black Butte Copper Project
Meagher County, Montana



K:\project\11048\Baseline WRM Report\Fig_12_Potentiometric_Map_.mxd

Date: November 3, 2015 Source: Hydrometrics (2015)

TINTINA RESOURCES

Figure 2.7
Potentiometric Surface Map
Black Butte Copper Project
Meagher County, Montana

Table 2-10. Well Completion Data

Well Name	Northing (meters)	Easting (meters)	Ground Surface Elev.	Measuring Point Elev.	Borehole Total Depth	Well Total Depth	Screen Interval	Hydro-stratigraphic Unit	Year Drilled	Purpose
			(feet, amsl)							
	UTM Zone 12 North				(feet, bgs)					
Monitoring Wells										
MW1A	5180841.55	506935.22	5635.81	5637.73	38	34	25 - 34	Shallow Bedrock	2011	Baseline
MW1B	5180845.46	506934.19	5636.14	5637.9	98	98	88 - 98	YNL-A		East of USZ
MW2A	5180331.93	506598.18	5743.72	5745.31	62	62	52 - 62	Shallow Bedrock	2011	Baseline East of Coon Creek
MW2B	5180328.73	506596.96	5743.44	5745.53	80	80	70 - 80	YNL-A		
MW3	5180740.22	506484.07	5760.06	5762.17	305	305	285 - 305	USZ	2011	Baseline USZ
MW4A	5180855.43	507201.47	5610.12	5612.12	23	23	14-23	Sheep Creek	2012	Baseline Sheep Cr. Alluvium
MW4B	5180858.49	507200.12	5610.07	5612.07	59	59	39-59	YNL-A	2012	Baseline YNL-A below Sheep Cr. Alluvium
MW-5	Not Drilled									
MW-6A	5179492.85	507809.18	5680.08	5681.87	20	15	5-15	Quarternary	2013	Proposed UG LAD
MW-6B	5179490.71	507792.76	5683.41	5685.31	50	50	40-50	Dolostone	2013	
MW-7	5179500.71	507451.7	5747.48	5749.46	50	50	40-50	Dolostone	2013	Proposed UG LAD
MW-8	5179398.31	507036	5809.1	5810.93	80	80	70-80	Dolostone	2013	Proposed UG LAD
MW-9	5180725.46	506592.96	5744.35	5745.8	143.7	128	108-128	YNL-A	2014	Baseline YNL-A Characterization
Test Wells										
PW-1	5180698.4	506301.42	5912.07	5913.74	213	211	140-211	YNL-A - Perched	2011	Previous Decline
PW-2	5180865.03	506443.15	5793.08	5794.88	215	212	132 - 212	USZ	2011	Previous Decline
PW-3	5180479.42	506846.43	5655.21	5657.42	131	127	90-127	YNL-A	2012	Expl Decline
PW-4	5180701.75	506849.44	5678.13	5680.01	242	239	200-239	USZ	2012	Expl Decline
PW-5	5181172.77	506490.68	5913.22	5915.49	555	500	515-555	Volcano Valley Fault	2013	Volcano Valley Fault Hydrologic Characteristics

Well Name	Northing (meters)	Easting (meters)	Ground Surface Elev.	Measuring Point Elev.	Borehole Total Depth	Well Total Depth	Screen Interval	Hydro-stratigraphic Unit	Year Drilled	Purpose
			(feet, amsl)							
	UTM Zone 12 North				(feet, bgs)					
Monitoring Wells										
PW-6	5181085.67	506477.44	5895.43	5897.4	1234	1204	1164-1204	Buttress Fault	2013	Buttress Fault Hydrologic Characteristics
PW-6N	5181085.67	506477.44	5895.43	5897.4	1358	1358	Open borehole 1234-1358	Niehart Quartzite	2015	Baseline YNE Hydrologic Characterization
PW-7	5180867.59	507122.89	5609.11	5611.15	1350	1346	1306-1346	LCZ	2013	Baseline LCZ Characterization
PW-8	5180695.53	506846.19	5679.12	5680.6	184	178.5	138.5-178.5	YNL-A	2014	Baseline YNL-A Characterization
PW-9	5180721.88	506598.38	5743.59	5745.05	255.5	255.5	215.5-255.5	UCZ	2014	Baseline UCZ Characterization
PW-10	5180721.88	506593.55	5743.57	5744.84	369.5	358.5	318.5-358.5	YNL-B	2014	Baseline YNL-B Characterization
SC15-184*	507047	5178973	5747	5747	99	85	55-85	Granodiorite	2015	Project Facilities Baseline Characterization
SC15-185*	506355	5179094	5917	5917	99	80	60-80	Granodiorite	2015	Project Facilities Baseline Characterization
SC15-194*	506014	5179855	5878	5878	99	80	60-80	YNL-A	2015	Project Facilities Baseline Characterization
SC15-198*	506621	5179762	5815	5815	99	70	60-70	YNL-A	2015	Project Facilities Baseline Characterization

*Northings, Eastings, and elevations are approximate.

2.2.4.6 Groundwater Quality

Groundwater in shallow alluvial wells and shallow bedrock wells is calcium/magnesium bicarbonate type water with near neutral pH and moderately low dissolved solids. One exception is well MW-1B, which has calcium/magnesium sulfate type water with a lower pH range (6.02 to 6.51 s.u.) and moderate dissolved solids (336 to 425 mg/L). The water quality at MW-1B completed in *Ynl-A* stratigraphic unit (Figure 2.6) is similar to MW-3 and test well PW-4, both of which are completed in the Upper Sulfide Zone.

Wells completed in alluvium, shallow unconsolidated overburden, and highly weathered bedrock include MW-1A, MW-4A, and MW-6A. These wells have neutral pH water (6.24 to 7.66 s.u.) with generally low to non-detectable concentrations of dissolved metals. MW-1A, however, periodically exhibits variable water quality with some excursions of arsenic, barium, iron, lead, manganese, and thallium above Human Health standards. Well MW-1A is screened in fine-grained sediments and monitoring events which detected metals at higher concentrations may reflect breakthrough of particulate through the filters due to the very high turbidity.

Wells completed in shallow bedrock above the Upper Sulfide Zone include MW-2A and MW-2B, MW-4B, MW-6B, MW-7, MW-8, MW-9, and test wells PW-1, PW-3, and PW-8. Dissolved trace constituents that are present at detectable concentrations in these wells include arsenic, barium, iron, manganese, strontium, thallium, and uranium. The concentration of thallium at MW-2B (0.0024-0.004 mg/L) exceeds the human health standard of 0.0024 mg/L. Thallium concentrations at the other shallow bedrock wells fall below regulatory limits. All other parameters in the shallow aquifer meet applicable regulatory limits. While thallium exhibits detectable concentrations in MW-3 and PW-4, it does not exceed the human health standard.

Wells completed in the Upper Sulfide Zone (MW-3, PW-4, PW-9) have the highest concentrations of dissolved solids and sulfate compared to the other wells. As previously discussed, MW-1B has similar water quality to these Upper Sulfide Zone wells. The pH of water at these Upper Sulfide Zone wells ranges from 6.04 to 7.31 s.u. which is slightly lower than other wells. Detectable dissolved trace constituents in the upper sulfide zone wells include antimony, arsenic, barium, cobalt (MW-1B only), iron, lead, manganese, mercury, molybdenum, nickel, strontium, thallium, uranium, and zinc. Strontium concentrations range from 8.08 to 16.2 mg/L at MW-3 and PW-4 and exceed the human health standard of 4 mg/L. Arsenic concentrations at MW-1B, MW-3 and PW-4 range from 0.054 mg/L to 0.09 mg/L and exceed the human health standard of 0.010 mg/L. Arsenic speciation of samples from MW-1B and MW-3 indicate that the majority of the arsenic is present in reduced form as As (III), which would likely oxidize in contact with atmospheric oxygen and co-precipitate with iron as a ferri-hydroxide complex. Concentrations of thallium at MW-1B (0.013 mg/L) also exceed the human health groundwater standard of 0.002 mg/L.

Analytical results from PW-7 (completed in the Lower Sulfide Zone) indicate a sodium/potassium bicarbonate type water with highly basic pH (10.77 to 11.58 s.u.), and with higher concentrations of chloride and lower concentrations of sulfate than other wells on site. Trace constituents detected above the reporting limit include aluminum, antimony, arsenic barium, molybdenum, selenium, strontium, and zinc. Dissolved aluminum concentrations (0.187 to 1.03 mg/L) were much higher than observed at other wells on the site. Antimony was the only trace constituent that exceeded the groundwater human health standard. This sample provides an initial assessment of the water quality in PW-7. However, the well did not produce sufficient water to allow for field parameter stabilization and drill mud was found in the well during the initial water level measurements and in subsequent monitoring events. These factors along

with the atypical water quality including elevated aluminum, chloride, and sodium suggest the water quality from PW-7 may be contaminated from drilling muds and fluids.

2.2.4.7 Seeps and Springs

A field inventory completed in 2011 (Hydrometrics, 2011a) identified and mapped nine seeps and 13 springs in the Project area and included sampling of some annually in the spring for water quality and flow. A field survey collected a second series of flow measurements and water quality samples of seeps and springs during July 2012. A number of springs discharge along the Volcano Valley Fault where the Flathead Quartzite lies in contact with the Newland formation (Chen-Northern, 1989). Seeps and springs are identified on Figure 2.3.

Identified small springs or seeps are typically located in ephemeral channels in the headwaters of small, unnamed tributaries. These springs form small boggy areas with limited flow and generally re-infiltrate within a few hundred feet downstream. A number of these springs (indicated by a DS designator (developed spring), Table 2-11) have been developed for stock watering and feed small livestock watering tanks. Slightly larger springs and seeps identified along the lower reaches of Coon Creek and on Little Sheep Creek support perennial downstream flow. Observed flow rates at the springs ranged from less than 1 gpm to over 100 gpm (4 to 379 Lpm) (Table 2-11).

Table 2-11. Summary of Spring Flow Data

Sta. Name	Flow Rate (gpm)			Sta. Name	Flow Rate (gpm)		
	min	max	avg		min	max	avg
SP-1	1.4	65	22	DS-1	<0.5	35	12
SP-2	2.2	9.4	6.9	DS-2	<0.5	12	4.7
SP-3	0.6	5.4	2.8	DS-3	4.9	117	38
SP-4	5.4	27	13	DS-4	2.2	20	8.7
SP-6	0.9	3.0	1.8	DS-5	<1	18	6.7
SP-7	9.4	112	38	DS-6	<0.5	18	7.3
SP-8	8.1	8.1	8.1				
SP-9	5.4	15	9.4				
SP-10	3.6	8.1	5.8				

Water samples from five of the primary spring sites (SP-1, SP-2, SP-3, SP-4, and SP-6) surrounding the proposed facility area, and from two surface water locations (G-1 and G-2) where gossan (an iron-oxide deposit) is exposed in outcrop in the streambed generally, exhibit neutral to slightly alkaline pHs (6.20-8.21 s.u.) with moderate to high alkalinities (50-240 mg/L). Background nitrate concentrations are low (<0.1 - 0.68 mg/L) at all of the spring sites. Metals concentrations are all within regulatory limits. However, SP-3 exhibits slightly higher concentrations of some dissolved metals (aluminum, copper, and chromium), but all are well below regulatory standards. Springs originating from gossan sites have similar water quality as the other springs, however, Thallium at one of the gossan sites (G-2) exceeds the numeric drinking water standard.

2.2.5 Aquifer Characterization Investigations

Tintina conducted a series of aquifer tests, including both slug tests and short-term and long-term pumping tests at the site to characterize the hydrogeologic characteristics of the principal stratigraphic

units and the fault systems that bound the copper-rich deposits. Table 2-13 presents information for each test and the estimated aquifer characteristics derived from test results.

Aquifer testing at MW-4A indicates the Sheep Creek alluvial groundwater system is highly permeable with an estimated hydraulic conductivity of approximately 200 feet (61 m) per day. Underlying bedrock units exhibit much lower permeabilities. The highest permeabilities within the lower Newland Formation occur within the *Ynl-A,* above the *Upper Sulfide Zone*, which exhibits hydraulic conductivities ranging from 1 to 5 feet per day (0.3 to 1.5 m/day). The permeability of the bedrock decreases by one to two orders of magnitude in the underlying *USZ* with hydraulic conductivities ranging from 0.01 to 1 ft. /day (0.003 to 1.52 m/day). The permeability of the *LSZ* is also low with hydraulic conductivities of 0.1 to 0.2 ft./day (0.03 to 0.06 m/day).

Aquifer testing of wells completed in the Volcano Valley Fault and the Buttress Fault yielded hydraulic conductivity estimates of 0.09 to 0.004 ft. /day (0.027 to 0.001 m/day). However, effects from the well casing and well annulus storage dominated these tests and were difficult to isolate. Therefore the actual permeability of the faults may be substantially lower. To further assess the permeability of the Volcano Valley Fault, Tintina carried out Flexible Wall Permeameter tests on five samples of the gouge material within the fault zone, from three separate exploration cores. The testing yielded extremely low hydraulic conductivity estimates ranging from 7.1×10^{-4} to 1.5×10^{-5} ft. /day with an average hydraulic conductivity of 2.8×10^{-5} ft. /day.

In addition to the aquifer testing discussed above, deepening of well PW-6 in the spring of 2015 helped evaluate the hydrologic characteristics of the Neihart quartzite on the north side of the Volcano Valley Fault. Since quartzite units can contain higher permeability zones when fractured, Tintina deepened well PW-6N into the Neihart Formation adjacent to the Buttress fault. Air testing of the open borehole in the Neihart quartzite at this location produced 500 plus gallons (1,893 L) per minute and confirmed that there are high permeability fractures within the Neihart quartzite adjacent to the Buttress Fault. This resulted in a change in mine planning.

Hydraulic conductivity is the rate at which water can move through various (usually natural) media, and in this document it is typically measured in feet/day. Because interpreting the results of aquifer testing using hydraulic conductivity is not always intuitive to everyone, Table 2-12 is used to illustrate hydraulic conductivities of some natural materials to help to put some of the values cited above and elsewhere in this document into perspective. Note that Table 2-12 has rows ranking relative permeability (pervious, semi-pervious and impervious) and the character of the resulting aquifer (good, poor and none). Color coded on this table are various material types discussed throughout this document. Going from high to low hydraulic conductivity these units are:

1. Blue - Highly fractured shallow bedrock unit into which the proposed underground infiltration galleries will discharge treated water (flow range from hundreds of feet per day to a few thousand feet per day).
2. Yellow – the sand and gravel alluvial aquifer of Sheep Creek (flows around 200 feet (60 m) per day).
3. Tan – the range of hydraulic conductivity in various lower Newland Formation bedrock units (flows range from 1/1,000th to 1/100,000th of a foot per day),
4. Green – both cemented and un-cemented tailings material (flows on the order of 1/1,000,000,000; a billionth of a foot per day).

Table 2-12. Hydraulic Conductivities of Natural and Project Specific Materials

		Underground Infiltration Galleries		Alluvium					Range of lower Newland Formation Bedrock						Backfill
K (cm/s)	10^{2}	10^{1}	$10^{0}=1$	10^{-1}	10^{-2}	10^{-3}	10^{-4}	10^{-5}	10^{-6}	10^{-7}	10^{-8}	10^{-9}	10^{-10}	10^{-11}	10^{-12}
K (ft/day)	10^{5}	10,000	1,000	100	10	1	0.1	0.01	0.001	0.0001	10^{-5}	10^{-6}	10^{-7}	10^{-8}	10^{-9}
Relative Permeability	Pervious				Semi-Pervious				Impervious						
Aquifer	Good					Poor				None					
Unconsolidated Sand & Gravel	Well Sorted Gravel		Well Sorted Sand or Sand & Gravel			Very Fine Sand, Silt, Loess, Loam									
Unconsolidated Clay & Organic					Peat		Layered Clay			Fat / Un-weathered Clay					
Consolidated Rocks	Highly Fractured Rocks				Oil Reservoir Rocks			Fresh Sandstone		Fresh Limestone, Dolomite		Fresh Granite			

Source: modified from Bear, 1972

Table 2-13. Summary of Aquifer Test Results

Observation Well	Analysis Method	Pumping Test	Hydraulic Conductivity (ft/day)	Hydraulic Conductivity (cm/sec)	Storativity
Alluvium					
MW-4A	Springer-Gelhar	MW-4A (slug)	216	7.6E-02	NA
	Springer-Gelhar		210	7.4E-02	NA
	Springer-Gelhar		208	7.3E-02	NA
Perched Aquifer					
PW-1	Theis	PW-1	0.07	2.5E-05	NA
	Moench		0.03	1.1E-05	NA
	Theis-Rec.		0.07	2.5E-05	NA
YNL-A					
MW-4B	Hvorslev	MW-4B (slug)	7.4	2.6E-03	NA
			7.0	2.5E-03	NA
	Hvorslev		7.3	2.6E-03	NA
PW-3	Theis	PW-3	2.1	7.4E-04	NA
	Moench		1.6	5.6E-04	NA
	Theis-Rec.		1.1	3.9E-04	NA
	Theis	PW-8	5.8	2.0E-03	1.00E-04
	Moench		5.5	1.9E-03	8.00E-06
	Theis-Rec.		4.6	1.6E-03	NA
PW-8	Theis	PW-8	2.3	8.1E-04	NA
	Moench		1.0	3.5E-04	NA
	Theis-Rec.		1.3	4.6E-04	NA
USZ/UCZ					
PW-2	Theis	PW-2	0.06	2.1E-05	NA
	Moench		0.3	8.8E-05	NA
	Theis-Rec.		0.1	3.9E-05	NA
PW-4	Theis	PW-4	0.02	7.1E-06	NA
	Moench		0.01	3.5E-06	NA
	Theis-Rec.		0.02	7.1E-06	NA
PW-9	Theis	PW-9	0.2	8.5E-05	NA
	Moench		0.2	7.1E-05	NA
	Theis-Rec.		0.7	2.5E-04	NA
MW-3	Theis	PW-2	0.3	1.0E-04	2.70E-06
	Moench		0.3	8.8E-05	1.20E-04
	Theis-Rec.		0.2	7.1E-05	NA
	Theis	PW-9	0.7	2.5E-04	9.00E-05
	Moench		1.0	3.4E-04	6.00E-05
	Theis-Rec.		0.4	1.6E-04	NA
	Hvorslev	MW-3 (slug)	1.1	3.9E-04	NA
	Bouwer-Rice		1.1	3.9E-04	NA
YNL-B					
PW-10	Moench	PW-10	0.007	2.5E-06	NA
	Barker		0.006	2.1E-06	NA
	Theis-Rec.		0.001	3.5E-07	NA
LCZ					
PW-7	Bouwer	PW-7 (slug)	0.2	7.4E-05	NA
	Barker-Black		0.1	3.2E-05	NA
	Moench	PW-7	0.0003	1.1E-07	NA
	Barker		0.001	3.5E-07	NA
	Theis-Rec.		0.0003	9.9E-08	NA
Faults					

Observation Well	Analysis Method	Pumping Test	Hydraulic Conductivity (ft/day)	Hydraulic Conductivity (cm/sec)	Storativity
PW-5 (*VVF*)	Papadopolus	PW-5	0.09	3.2E-05	NA
	Barker		0.02	5.3E-06	NA
	Theis-Rec.		0.04	1.3E-05	NA
SC-11-008 (*VVF*)	Permeameter	NA	0.00003	1.00E-08	NA
SC-11-036 (*VVF*)	Permeameter	NA	0.00002	8.10E-09	NA
SC-12-129 (*VVF*)	Permeameter	NA	0.00002	5.40E-09	NA
SC-14-164 (*VVF*)	Permeameter	NA	0.00006	2.10E-08	NA
SC-14-170 (*VVF*)	Permeameter	NA	0.0007	2.50E-07	NA
PW-6 (Buttress Fault)	Papadopolus	PW-6	0.04	1.4E-05	NA
	Moench		0.01	3.5E-06	NA
	Theis-Rec.		0.004	1.3E-06	NA
	Barker		0.06	2.1E-05	NA
Core holes					
AH-4	Theis	PW-1	0.6	2.1E-04	2.20E-05
	Moench		0.03	1.1E-05	8.00E-05
SC11-044	Theis	PW-2	0.3	1.1E-04	2.70E-06
	Moench		0.3	1.1E-04	1.20E-04
	Theis-Rec.		0.3	1.1E-04	NA
SC12-116	Theis	PW-3	1.2	4.2E-04	NA
	Moench		1.3	4.6E-04	NA
	Theis-Rec.		1.7	6.0E-04	NA

Tintina conducted a long term (31 day) aquifer test on well PW-8 in July and August 2014. Well PW-8 is completed in *Ynl-A* shale just above the contact with the *USZ*. In addition to characterizing the permeability of the *USZ*, the purpose of the extended test included an assessment of the extent to which prolonged pumping would affect water levels in overlying units and at nearby surface water sites. Three temporary piezometers installed in the Coon Creek, Sheep Creek, and Dry Creek alluvial systems (Figure 2.2) and existing surface water sites allowed additional monitoring. The PW-8 aquifer test ran for 31 days. The test produced no drawdown in the shallow groundwater system or at observation sites associated with Sheep Creek, Coon Creek and Dry Creek. Pumping well PW-8 recovered to pre-test levels within two days of shutting down the pump.

Tintina also conducted a long-term aquifer test on well PW-9 in the Upper Sulfide Zone. Pumping of the well for 19 days achieved drawdown stabilization in the pumping well and observation wells. Tintina collected flow and stage measurements at three surface water sites (SW-14-1, SW-14-2, and SW-3) and one spring (SP-06). Pumping of PW-9 produced limited drawdown in nearby well PW-10, completed below the Upper Sulfide Zone, and MW-9, completed above the Upper Sulfide Zone, suggesting that the hydro-stratigraphic units above and below the Upper Sulfide Zone are only partially or poorly connected to the Upper Sulfide Zone. Weekly surface water flow and/or stage monitoring conducted at three surface water sites (SW-3, SW-14-1, and SW-14-2) and in piezometers completed in the shallow alluvial systems during both the PW-8 and PW-9 aquifer tests showed no influence from extended pumping of the bedrock aquifer at the proposed development depths.

2.2.6 Groundwater – Surface Water Interactions

2.2.6.1 Sheep Creek

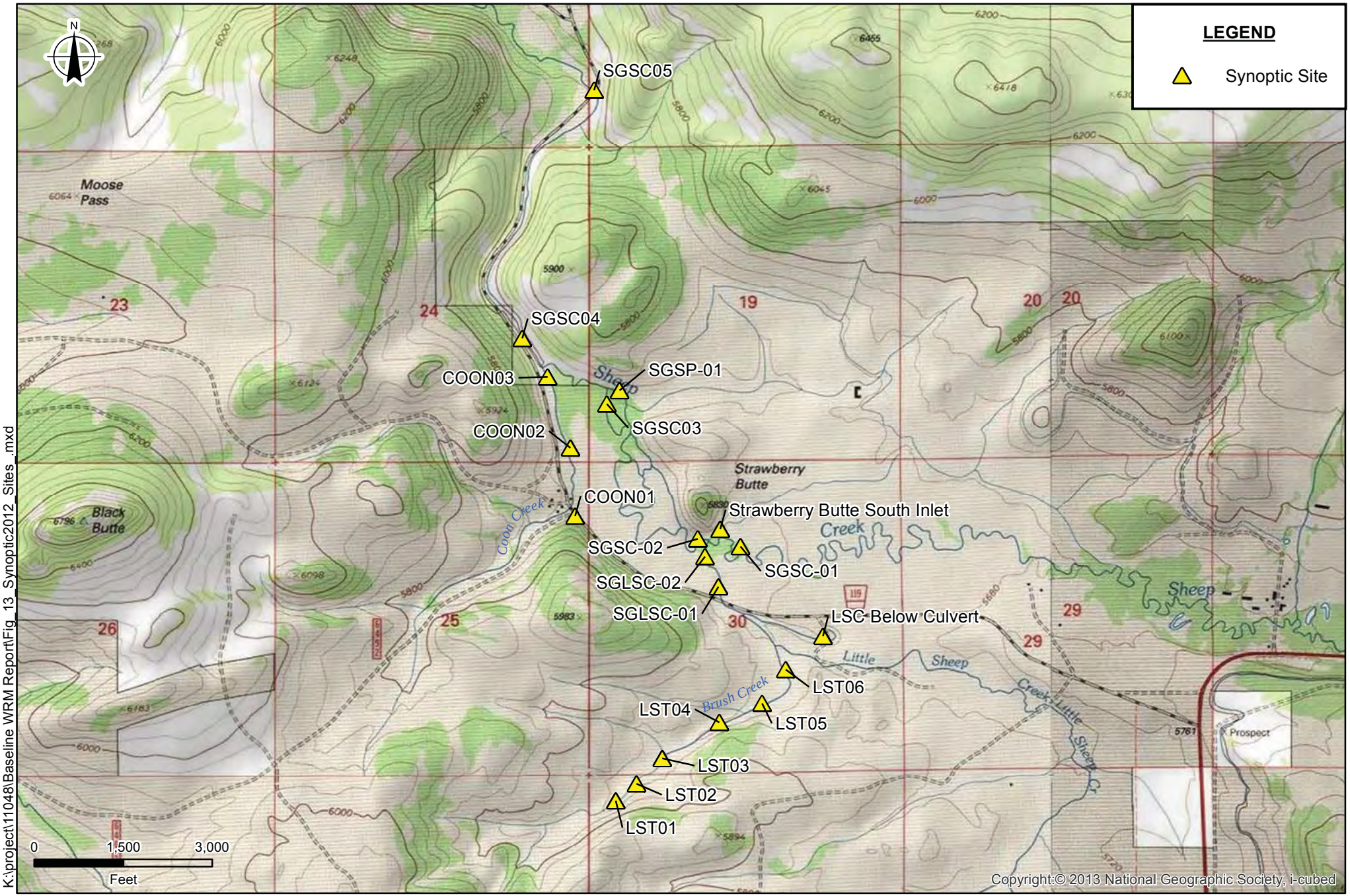
Potentiometric data indicate that Sheep Creek is hydrologically connected with the alluvial aquifer in the Sheep Creek Valley, however, synoptic surveys show that the contribution from the alluvial aquifer to

Sheep Creek is minimal. Surface water monitoring data show a general increase in flow from upstream monitoring sites (USGS-SC1 & SC-2) to downstream (SC-1); however, the majority of that increase appears to be attributable to tributary inflow. Tintina conducted two synoptic surveys in August and October 2012 to characterize groundwater inflows to Sheep Creek. Figure 2.8 shows synoptic survey sites. The results of the August 2012 synoptic survey (Table 2-14) showed large decreases and increases in flow along Sheep Creek that can be accounted for by inflow from groundwater and unmonitored springs and tributaries on inaccessible private property to the north of Sheep Creek. In addition, the synoptic survey was conducted shortly after discontinuation of irrigation in the hay meadow which may have influenced hydrologic conditions.

Table 2-14. August 2012 Synoptic Survey Results

Site	Sheep Creek Discharge (cfs)	Tributary Discharge (cfs)	Sum of Sheep Creek and Tributary Flow (cfs)	Notes
SGSC-01	14.03	--	--	Sheep Creek above Strawberry Butte South Inlet, most upstream Sheep Creek Site
Strawberry Butte South	--	1.3	15.33	Mouth of Strawberry Butte South Inlet upstream of Sheep Creek Confluence
SGLSC-01	--	2.2	17.53	Little Sheep Creek downstream of the Sheep Creek Rd culvert
SGSP-01	--	1.33	--	Mouth of Spring Creek before Sheep Creek confluence
Coon-03	--	0.52	--	Mouth of Coon Creek upstream of Sheep Creek confluence
SGSC-04	13.02	--	--	Sheep Creek downstream of Coon Creek confluence in canyon north of hay meadow
SGSC-05	15.24	--	--	Sheep Creek at quarterly monitoring site SW-1

Tintina conducted a second synoptic survey in October 2012 to further evaluate the groundwater/surface water interaction on Sheep Creek and two small drainages (Coon Creek and Brush Creek; Figure 2.8 adjacent to the Project area (Figure 2.5)). Table 2-15 shows a tabulation of the results of the October 2012 survey. Measured changes in discharge to Sheep Creek were much smaller during the second synoptic survey (generally within the measurement error of 10-15%). Tributary inflows appear to account for most increases in stream flow in Sheep Creek during the October 2012 synoptic survey. The survey was unable to measure groundwater inflow to Sheep Creek within the Project area which indicates that groundwater contributions to the stream account for less than 10 to 15% of the total flow rate on this reach of Sheep Creek. Darcy's flow calculations confirm that groundwater inputs to Sheep Creek from the alluvial aquifer are too small to physically quantify using open channel flow measurement techniques as described below and in greater detail in Appendix B (Hydrometrics 2015b) of this Permit Application.



K:\project\11048\Baseline WRM Report\Fig_13_Synoptic2012_Sites_.mxd

Date: November 3, 2015 Source: Hydrometrics (2015)

TINTINA RESOURCES

Figure 2.8
2012 Synoptic Survey Sites
Black Butte Copper Project
Meagher County, Montana

Table 2-15. October 2012 Synoptic Flow Results

Site	Sheep Creek Discharge (cfs)	Tributary Discharge (cfs)	Sum of Sheep Creek and Tributary Discharge (cfs)	Notes
Brush Creek Survey				
LST-01	--	Dry	--	Most upstream site on Brush Creek
LST-02	--	0.07	--	Moving downstream ↓
LST-03	--	0.09	--	
LST-04	--	0.1	--	
LST-05	--	0.1	--	
LST-06	--	0.16	--	Most downstream site on Brush Creek
Coon Creek Survey				
Coon-01	--	0.1	--	Coon Creek just as it enters the hay meadow, SW-3
Coon-02	--	0.22	--	Coon Creek mid-point in the hay meadow
Coon-03	--	0.19	--	Coon Creek immediately upstream of Sheep Creek confluence
Sheep Creek Survey				
2SGSC-01	21.5	--	--	Most upstream site in hay meadow
SGSC-02	22.2	--	--	Sheep Creek upstream of Little Sheep Creek confluence (includes discharge from un-named tributary south of Strawberry Butte
SGLSC-02	--	1.12	23.32	Little Sheep Creek before Sheep Creek confluence
SGSC-03	19.51		--	Sheep Creek upstream of Spring Creek confluence
SGSP-01	--	0.44	--	Spring Creek before Sheep Creek confluence
Coon-03	--	0.19	20.14	Coon Creek upstream of Sheep Creek confluence
SGSC-04	20.57	--	--	Sheep Creek downstream of Coon Creek confluence in canyon north of hay meadow
SGSC-05	19.05	--	--	Sheep Creek at quarterly monitoring site SW-1

A simple Darcy's flow calculation confirms that the estimated groundwater flux from the Sheep Creek alluvial groundwater system to Sheep Creek in this lower reach is consistent with the small fluctuations

shown in the synoptic results. Darcy's Law can be used to estimate flow rate given a hydraulic conductivity (K), hydraulic gradient (I) and flow cross sectional area (A) where:

$$\text{Discharge (Q)} = K \times I \times A$$

Drilling and test data indicate a thickness of approximately 16 feet (4.9 m) for Sheep Creek alluvium near MW-4A, with a maximum alluvial deposit width of 1500 feet (457 m), an average hydraulic gradient (I) of groundwater of 0.008, and an average alluvial hydraulic conductivity (K) of 200 feet/day (61 m/day). Using these values Darcy's Law yields a discharge estimate of 200 gpm (757 Lpm; 0.44 cfs) of groundwater flow through the alluvium towards Sheep Creek. This would be equivalent to just over 2% of the base flow observed in Sheep Creek during the synoptic survey and confirms that groundwater inputs to Sheep Creek from the alluvial aquifer are too small to physically quantify using open channel flow measurement techniques.

2.2.6.2 Brush Creek and Coon Creek

A synoptic survey on Brush Creek (Figure 2.8) indicates discharge of shallow groundwater at the head of the draw and then no measureable change in flow between sites LST-02 and LST-05. There was a small increase (0.06 cfs) between LST-05 and LST-06 as Brush Creek approaches the Little Sheep Creek alluvial system. Water quality data help further assess groundwater and surface water interactions on Brush Creek in the 2013 investigation, and that evaluation found that the water quality in Brush Creek was not indicative of groundwater from the shallow bedrock groundwater system in the vicinity of the proposed underground infiltration gallery area (see Figure 1.3; and Section 3.7.4). The source of the small increase in flow below LST-05 is unknown but may be associated with the Little Sheep Creek alluvial system.

Tintina conducted a synoptic survey on the lower reach of Coon Creek where it enters the Sheep Creek alluvial system. The discharge in Coon Creek at the furthest upstream site (COON-01) was approximately 0.1 cfs. Coon Creek discharge approximately doubled between sites COON-01 and COON-02, and the discharge remained near 0.2 cfs until its confluence with Sheep Creek (Table 2-15). Data from the drilling at PW-3 and the PW-8 pumping test and water level elevation data provide evidence that above SW-3 Coon Creek is not in direct connection with the deeper bedrock groundwater system.

2.3 Wetlands Resources

2.3.1 Wetland Study Area and Methods

Wetlands are areas where the frequent and prolonged presence of water at or near the soil surface results in the formation of hydric soils and hydrophytic (water-loving) plants. Westech Environmental Services, Inc. (Westech) delineated wetlands and waterbodies and completed a functional analysis of wetlands within the Project area including all areas under lease agreements with private landowners (Figure 1.4) and all areas within the mine permit boundary area (Figure 1.3). This inventory/assessment was the basis for initiation of Clean Water Act Section 404 Permit Application activities with the U.S. Army Corps of Engineers (USACE). USACE is currently reviewing the detailed technical wetland delineation report (Appendix C-1; Westech, 2014) and functional analysis report (Westech, 2015a, Appendix C-2 of this report). Tintina has asked USACE to provide jurisdictional determinations of Waters of the U.S. (WOTUS). Some of the wetlands discussed in this report may not be jurisdictional.

Westech Environmental, Inc. obtained background and supplementary sources of data for the wetland delineation and functional analysis from various environmental baseline studies conducted for the Project and publicly available data including:

- Hydrology, wetlands, and soils data, are contained in the Amendment to Exploration License 00710 Tintina Alaska Exploration, Inc. Exploration Decline for Underground Drilling and Bulk Sampling Black Butte Copper Project, Meagher County, Montana (Tintina 2013);
- High-resolution aerial photographs (true color and IR);
- USGS topographic maps;
- National Wetland Inventory mapping;
- Natural Resource Conservation Service (NRCS) soils mapping;
- Baseline wetland and waterbody inventory for the Black Butte Copper Project (WESTECH 2015);
- Baseline fish and wildlife resources inventory for the Black Butte Copper Project (Stagliano and Farmer on-going);
- Background hydrology and wetland mapping for the Black Butte Copper Project (Tintina 2013);
- Montana Natural Heritage Program (MTNHP) plant and animal species of concern report (MTNHP 2014); and
- MTNHP list of ecological communities for Montana (MTNHP 2002).

2.3.2 Wetland Delineation Methods

Westech identified and delineated wetlands using the routine on-site approach described in the 1987 U.S. Army Corps of Engineers (USACE) *Wetland Delineation Manual* (Environmental Laboratory 1987) and the final *Regional Supplement to the Corps of Engineers Manual: Western Mountains, Valleys, and Coast Region (Version 2.0)* (USACE 2010). They classified wetlands according to the Cowardin classification system (Cowardin *et al*. 1979), and classified non-wetland waterbodies, such as streams, according to flow regime (perennial, seasonal, etc.) and substrate (e.g., unconsolidated bottom, rock bottom, etc.) as outlined in the Cowardin system (Cowardin *et al*. 1979). The wetland delineation report (Westech 2015a), attached as Appendix C-1 (Westech, 2014) to this report describes technical delineation and mapping methods used in this study.

2.3.3 Wetland Indictors

Evaluators of wetlands use Wetland hydrology indicators, hydric soils indicators, and hydrophytic vegetation in combination to determine whether an area meets USACE criteria for wetlands (Environmental Laboratory 1987; USACE 2010). Generally, consideration as a wetland requires the presence of indicators of all three wetland components.

Hydrologic indicators of repeated, extended episodes of inundation or soil saturation (e.g., surface water, saturation, oxidized rhizospheres along living roots, drainage patterns, geomorphic position, and frost-heave hummocks) infer the presence of wetland hydrology (USACE 2010). Wetland hydrology indicators within the Project occur adjacent to waterbodies, in sub-irrigated meadows, and at numerous springs and seeps. One indicator is flowing surface water recorded in Sheep Creek, Little Sheep Creek, and Black Butte Creek and in many of the tributaries to these streams. Another is standing surface water noted at most wetlands throughout the Project, although in very limited quantities at many sites.

Hydric soils are defined as soils that are saturated, flooded, or ponded long enough during the growing season to develop anaerobic conditions in the upper part (USDA Soil Conservation Service 1991). Generally, hydric soils are saturated, flooded, or ponded for one week or more during the period when soil temperatures are above biologic zero (41 degrees Fahrenheit or 5 degrees Celsius), as defined in USDA Soil Conservation Service (1975). These soils typically support hydrophytic vegetation and exhibit distinctive characteristics that result from repeated, extended periods of saturation; these characteristics tend to persist in the soils during both wet and dry periods. Hydric soils occur within the sub-irrigated

zone around Sheep Creek, Little Sheep Creek, Black Butte Creek, in various tributaries to these waterbodies, and springs and seeps. In most of these locations the soils consist of finely textured clays and clay-loams.

The USACE wetlands delineation methodology uses a plant community approach to determine whether a site is dominated by hydrophytic vegetation, which are species that require or can tolerate prolonged inundation or soil saturation during the growing season (Environmental Laboratory 1987; USACE 2010). Hydrophytic vegetation within the 7,768 acre Project lease study area was divided almost equally between shrub wetlands (Palustrine Scrub-Shrub) and herbaceous wetlands (Palustrine Emergent). Forested wetlands (Palustrine Forested) and un-vegetated potholes or ponds (Palustrine Unconsolidated Bottom) occurred in very limited areas. Table 2-16 lists the acreage of each wetland type according to its Cowardin classification as well as the percentage of each type within the Project area.

Table 2-16. Wetland acreage and Percent by Cowardin Type

Cowardin Type[1]	Acres	Percent of Total Wetlands Acres
Palutrine Emergent (Herbaceous wetland)	152.6	46.4
Palustrine Scrub-Shrub (Willow dominated)	90.8	27.6
Palustrine Scrub-Shrub (Shrubby cinquefoil dominated)	82.8	25.2
Palustrine Forested (Englemann spruce dominated)	1.9	0.6
Palustrine Unconsolidated Bottom (Excavated pond)	0.5	0.1
Palustrine Unconsolidated Bottom (Natural depression)	0.2	0.1
TOTAL	**328.8**	**100.0**

[1] Cowardin *et al.* (1979)

2.3.4 Water Bodies

Guidance in searching for water bodies (often termed “streams” by the USACE even if flowing water is not present) comes from the *U.S. Army Corps of Engineers Jurisdictional Determination Form Instructional Guidebook* (USACE and EPA 2007) in conjunction with the definition of OHWM in §33 CFR 328.3(e) which states:

> “The term *ordinary high water mark* means that line on the shore established by the fluctuations of water and indicated by physical characteristics such as clear, natural line impressed on the bank, shelving, changes in the character of soil, destruction of terrestrial vegetation, the presence of litter and debris, or other appropriate means that consider the characteristics of the surrounding areas.”

Surveyors mapped non-wetland waterbodies using sub-meter GPS, or drew the waterbody onto high-quality aerial imagery where the feature was large enough to accurately map on a photo. Classification of each waterbody according to hydrologic regime (perennial, seasonal, intermittent, and ephemeral) and substrate followed the criteria of Cowardin *et al.* (1979). Several waterbodies occur within the Project boundary. Sheep Creek is the largest stream, by flow volume, within the Project while Little Sheep Creek is the longest stream within the Project. Very little stream length of Black Butte Creek occurs within the Project. Several tributaries to these streams occur within the Project. Most waterbodies within the Project area have an unconsolidated bottom with at least 25 percent streambed cover of particles smaller than stones and vegetative cover less than 30 percent. Sheep Creek has the highest amount of rock cover, but most stones are cobbles and gravels, not bedrock or boulders, placing this stream within the unconsolidated bottom type similar to most other waterbodies within the Project area.

2.3.5 Potential Waters of the US

Waters of the U.S. (WOTUS), as defined in 33 CFR Part 328, encompass all major streams and their tributary streams, ponds, and adjacent wetlands. These waters have been determined to have significant nexus with a traditional navigable water by rule, and are considered per se jurisdictional waters without the need for additional study. Additional investigation, delineation, and avoidance/mitigation measures to comply with Section 404(b)(1) of the Clean Water Act which provides regulations for all WOTUS to determine where a “significant nexus” (connection) exists between other waters and a traditional navigable water. USACE regulators, typically following a site visit with the Project team, may determine that a water is “isolated” and not “jurisdictional”, and therefore not subject to regulation under Section 404. A non-jurisdictional determination is only applicable for Section 404 compliance—other federal or state regulations may still apply. Tintina is currently working with the USACE on developing a jurisdictional determination for the Project area.

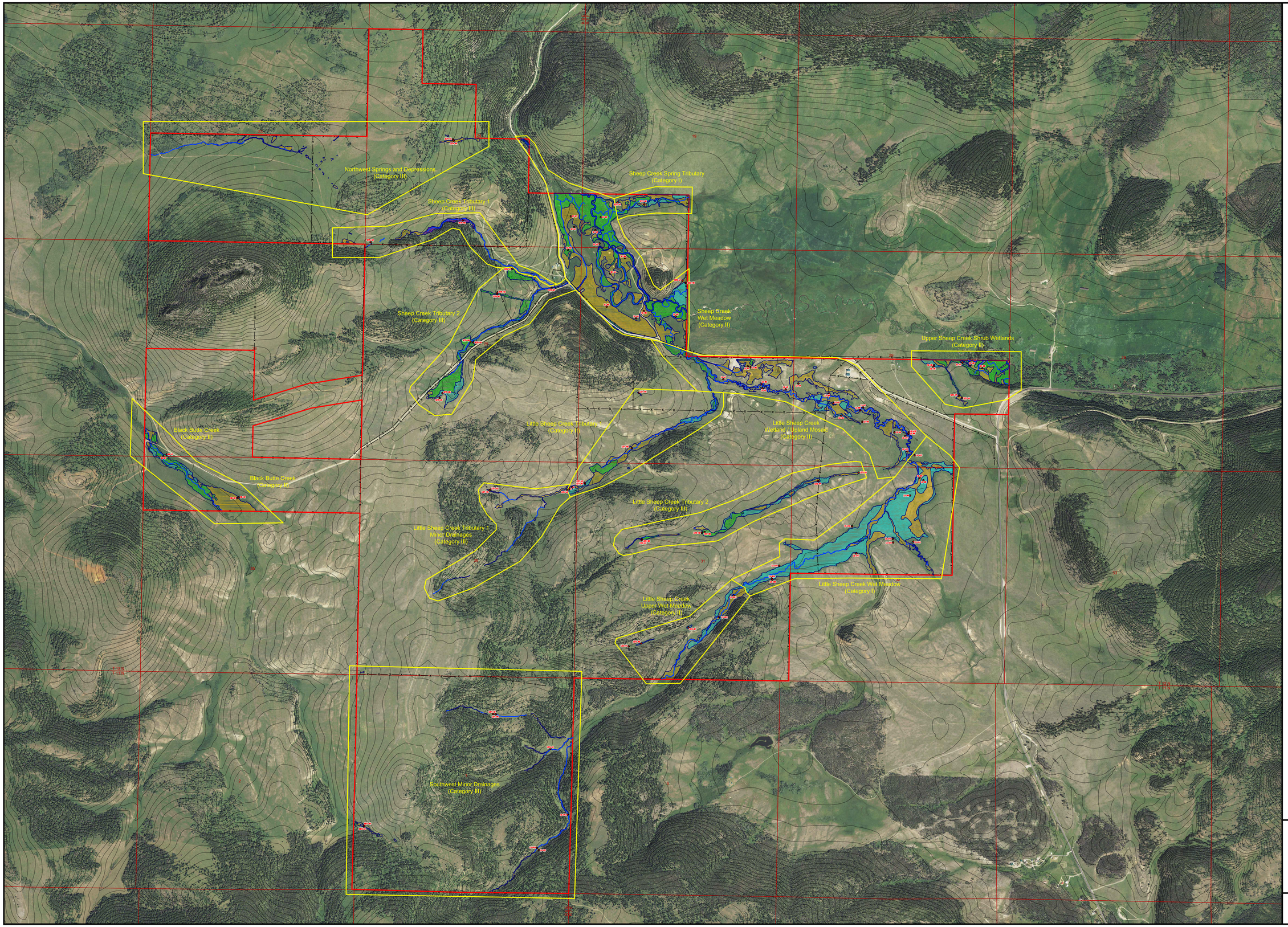
2.3.6 Wetland Delineation Summary

The wetland delineation and waterbody survey of the Project area (Westech, 2015a) identified 328.8 acres of wetlands within the Project’s leased lands boundary (Figure 2.9 and listed in and shown on the larger scale three (3) sheets entitled Wetland Delineation and Waterbody Survey) (Westech, 2015a). The largest wetlands occur within the sub-irrigated herbaceous meadows and willow- or shrubby cinquefoil-dominated wetlands surrounding Sheep Creek and Little Sheep Creek. Upland areas within these sites are highly mesic (high moisture content), and the boundary between wetland and upland is often indistinct. Surveyors estimated that approximately five percent of the area within these wetlands is comprised of upland pockets. At the upper reaches, these wetlands generally transition to wider, dry channels and swales where wetland features (hydrophytic vegetation and supporting hydrology) become isolated and/or absent. Very small pockets of wetland also occur within the uplands at these sites, but were estimated to account for less than 1 percent of upland area and were too small or indistinct to delineate.

The majority of the remaining wetlands in tributaries to Sheep Creek and Little Sheep Creek, as well as the wetlands surrounding Black Butte Creek, are a mosaic of shrub and herbaceous vegetation types. The hydrology at most of these wetlands appears primarily groundwater driven. Small streams are present but are themselves a function of local springs and do not appear to have enough water within them to support the relatively large wetlands surrounding them. Based on observations during the delineation, it appears that few of the wetlands within the Project are specifically dependent on streamflow hydrology. Stockmen have developed many of the localized wetlands in the immediate vicinity of upper drainage springs and seeps for livestock water and cattle have heavily trampled these areas.

Various species of willow or shrubby cinquefoil dominate approximately half of the wetlands within the Project area by. Wetlands dominated by sedges as well as native and non-native grasses comprise the majority of the remaining wetlands within the Project. The survey also delineated one, small forested wetland dominated by Engelmann spruce; a series of small, wetland depressions with minimal vegetation; and an excavated pond.

Surveyors recorded wetlands with fen characteristics within three (3) wetlands on the Project, wetlands W-SCT1-02, W-LS-11, and W-LST1-06 (Westech, 2015a). Fens are a relatively rare wetland type in Montana and can result in a high wetland functional rating.



LEGEND

- Project Boundary
- Fence
- Assessment Area
- Plot Location
- Stream

Wetlands

- Palustrine Emergent
- Palustrine Forested
- Palustrine Scrub-Shrub (Willow)
- Palustrine Scrub-Shrub (Shrubby Cinquefoil)
- Palustrine Unconsolidated Bottom

Aerial: 2013 NAIP
Topo: 20' Generated from ⅓ second NED

Category Rating Number per Montana Wetland Assessment Method (MWAM) (Berglund and McEldowney 2008). Categories are rated I to IV, with I the highest and IV the lowest.

Scale 1" = 1000'

0 500 1000 2000

Feet

TINTINA RESOURCES

Black Butte Copper Project

Wetland Delineation and Functional Assessment Map

Date: November 4 2015
Source: Westech (2015)

Figure 2.9

Sheet 1 of 1

02/10/15 Wetlands_AA_Facilities.dwg 1:12,000

Table 2-17 summarizes wetland acreage within the Project. Table 2-18 summarizes stream length (feet) within the Project. The tables summarize acreages and lengths by the local watershed for each wetland or stream. Watershed names allow organization, identification and location of individual wetlands and stream segments within the Project area, and equate to the USACE terminology of "Local Waterways" (Westech 2014, Appendix A of the Westech report). With the exception of Black Butte Creek and Sheep Creek, these watersheds do not relate to larger order watersheds.

Table 2-17. Wetland Acreage by Cowardin Type and Watershed

Project Watershed[1]	Cowardin Type[2]					Total by Project Watershed (acres)
	Palustrine Emergent	Palustrine Shrub (Willow)	Palustrine Shrub (Shrubby Cinquefoil)	Palustrine Forested	Palustrine Unconsolidated Bottom	
Black Butte Creek	10.69	7.86	1.61	0.00	0.00	20.16
Black Butte Creek Total	**10.69**	**7.86**	**1.61**	**0.00**	**0.00**	**20.16**
Black Butte Creek Tributary 1	2.06	0.00	0.00	0.00	0.14	2.20
Black Butte Creek Tributary 2	0.02	0.00	0.00	0.00	0.00	0.02
Black Butte Creek Tributary 3	0.71	0.15	0.00	0.00	0.00	0.86
Black Butte Creek Tributaries Total	**2.79**	**0.15**	**0.00**	**0.00**	**0.14**	**3.08**
Little Sheep Creek	51.03	5.16	62.95	0.00	0.09	119.23
Little Sheep Creek Total	**51.03**	**5.16**	**62.95**	**0.00**	**0.09**	**119.23**
Little Sheep Creek Tributary 1	8.57	3.33	3.13	0.00	0.00	15.03
Little Sheep Creek Tributary 2	4.12	3.59	5.33	0.00	0.00	13.04
Little Sheep Creek Tributary 3	0.00	0.00	0.35	0.00	0.00	0.35
Little Sheep Creek Tributary 4	1.27	0.00	0.00	0.00	0.00	1.27
Little Sheep Creek Tributary 5	10.62	0.47	0.00	0.00	0.38	11.47
Little Sheep Creek Tributary 7	0.01	0.00	0.00	0.00	0.00	0.01
Little Sheep Creek Tributaries Total	**24.59**	**7.39**	**8.81**	**0.00**	**0.38**	**41.17**
Sheep Creek	52.77	53.87	0.00	0.00	0.00	106.64
Sheep Creek Total	**52.77**	**53.87**	**0.00**	**0.00**	**0.00**	**106.64**
Sheep Creek Tributary 1	4.32	0.81	1.87	0.00	0.00	7.00
Sheep Creek Tributary 2	0.94	0.00	3.51	0.00	0.00	4.45
Sheep Creek Tributary 3	1.17	1.04	0.94	0.00	0.00	3.15
Sheep Creek Tributary 4	0.93	0.00	0.00	0.00	0.00	0.93
Sheep Creek Tributary 5	3.38	14.56	3.15	1.86	0.00	22.95
Sheep Creek Tributaries Total	**10.74**	**16.41**	**9.47**	**1.86**	**0.00**	**38.48**
Project Total	**152.61**	**90.84**	**82.84**	**1.86**	**0.61**	**328.76**

[1] Project watersheds are the specific, in many cases very small, watersheds within the Project area. With the exception of Sheep Creek and Black Butte Creek these watersheds do not correspond to larger order watersheds. In some cases, (e.g., Little Sheep Creek Tributary 6) a tributary is not listed in sequential order indicating that there were no wetlands, only streams, within that tributary.

[2] See Cowardin *et al.* (1979) for further discussion. Note that emergent wetlands are dominated by herbaceous species such as sedges and grasses. Unconsolidated bottom wetlands are those with a mud/silt bottom with limited vegetation.

Table 2-18. Summary of Stream Length (feet) by Cowardin Type and Project Watershed

Project Watershed[1]	Cowardin Type[2]					Total by Project Watershed
	R3UB	R3RB	R3SB	R3AB	R4SB	
Black Butte Creek	3,256	0	0	0	0	3,256
Black Butte Creek Total	**3,256**	**0**	**0**	**0**	**0**	**3,256**
Black Butte Creek Tributary 1	0	3,226	0	0	852	4,078
Black Butte Creek Tributaries Total	**0**	**3,226**	**0**	**0**	**852**	**4,078**
Little Sheep Creek	29,606	0	0	0	0	29,606
Little Sheep Creek Total	**29,606**	**0**	**0**	**0**	**0**	**29,606**
Little Sheep Creek Tributary 1	4,862	0	0	0	2,903	7,765
Little Sheep Creek Tributary 2	713	0	0	0	0	713
Little Sheep Creek Tributary 4	0	0	0	0	2,307	2,307
Little Sheep Creek Tributary 5	1,215	0	0	0	0	1,215
Little Sheep Creek Tributary 6	709	0	0	0	0	709
Little Sheep Creek Tributary 7	0	0	0	0	1,373	1,373
Little Sheep Creek Tributaries Total	**7,499**	**0**	**0**	**0**	**6,583**	**14,082**
Sheep Creek	6,663	0	0	0	0	6,663
Sheep Creek Total	**6,663**	**0**	**0**	**0**	**0**	**6,663**
Sheep Creek Overflow	0	0	0	0	9,446	9,446
Sheep Creek Overflow Total	**0**	**0**	**0**	**0**	**9,446**	**9,446**
Sheep Creek Overflow Tributaries	710	0	0	0	0	710
Sheep Creek Overflow Trib. Total	**710**	**0**	**0**	**0**	**0**	**710**
Sheep Creek Tributary 1	3,699	0	0	401	0	4,100
Sheep Creek Tributary 2	889	0	0	0	0	889
Sheep Creek Tributary 5	11,451	0	0	0	2,150	13,601
Sheep Creek Tributaries Total	**16,039**	**0**	**0**	**401**	**2,150**	**18,590**
Project Total	**63,773**	**3,226**	**0**	**401**	**19,031**	**86,431**

[1] Project watersheds are the specific, in many cases very small, watersheds within the Project area. With the exception of Sheep Creek and Black Butte Creek these watersheds do not correspond to larger order watersheds. In some cases, (e.g., Little Sheep Creek Tributary 3) a tributary is not listed in sequential order indicating that there were no streams, only wetlands, within that tributary.

[2] See Cowardin *et al.* (1979) for further discussion. Note: R = Riverine; 3 = Upper Perennial; 4 = Intermittent; UB = Unconsolidated Bottom; RB = Rock Bottom; SB = Streambed; and AB = Aquatic Bed.

2.3.7 Functional Assessment of Wetlands

Based on a wetland delineation of the Project area completed by Westech (2015a), as well as data from publicly available sources and Project-specific surveys, wetlands within the Project area group into functional Assessment Areas based on similar ecologic and hydrologic indicators. Rating of each Assessment Area followed the Montana Department of Transportation (MDT) Montana Wetland Assessment Method (MWAM) method, which provides relative ratings of each wetland or group of wetlands for as many as 12 wetland functions including:

- Habitat for federally listed or proposed threatened or endangered species
- Habitat for MTNHP S1, S2, or S3 Species of Concern
- General wildlife habitat
- General fish habitat
- Flood attenuation
- Surface water storage
- Sediment/nutrient/toxicant retention/removal
- Sediment/shoreline stabilization
- Production export/terrestrial and aquatic food chain support
- Groundwater discharge/recharge
- Uniqueness
- Recreation/education potential

MDT and Montana Fish, Wildlife and Parks (FWP) first developed this wetland evaluation method in 1989 and have revised it several times based on field-testing at several hundred wetlands (Berglund and McEldowney 2008). Montana Wetland Assessment Method is widely used in Montana and elsewhere. In a 2004 evaluation of state- and tribe-developed wetland functional assessment methodologies, EPA found Montana Wetland Assessment Method was one of seven systems (of forty evaluated) that met all of EPA's criteria for consideration as a model for development of functional assessment methods (Fennessy *et al.* 2004). The most recently available version of the MDT Montana Wetland Assessment Method data form and guidance was used (Berglund and McEldowney 2008; on-line at:

http://www.mdt.mt.gov/other/environmental/External/wetlands/2008_wetland_assessment/2008_mwam_manual.pdf).

The functionality report includes ratings for a total of 14 Assessment Areas. Figure 2.10 and on 3 larger scale map sheets entitled Wetland Delineation and Waterbody Survey Assessment Map (Westech 2015b) show the locations of these area. Each Assessment Area consists of ecologically similar wetlands that are hydrologically connected or adjacent to one another. In some cases, large, contiguous wetlands were divided to better represent the qualities within a specific wetland reach. For example, in the Little Sheep Creek watershed, wetlands were parceled into three groups for assessment purposes. The wetland functional assessment report (Westech 2015b) provides further information on the methodology for assessing wetland functions, forms, and photos.

Based on the hydrological, ecological, and biological properties of the wetlands and uplands within an Assessment Area, each Assessment Area groups within one of four categories:

- Category I: exceptionally high quality wetlands, generally rare to uncommon in the state or important from a regulatory standpoint; includes any Assessment Area that is documented primary habitat for a federally listed threatened or endangered species

- Category II: more common wetlands than Category I; provide habitat for rare species and/or provide high-quality fish or wildlife habitat, and/or have high values for other wetland functions
- Category III: more common and generally less diverse wetlands than Categories I and II
- Category IV: generally small, isolated wetlands that lack vegetative diversity, provide little wildlife habitat, and are often anthropogenically disturbed.

A total of 14 Assessment Areas were rated. Table 2-19 lists each assessment area's category designation.

Table 2-19. MWAM Wetland Rating by Assessment Area

Assessment Area	Category Rating Number[1]
Black Butte Creek Wetlands	II
Little Sheep Creek Wet Meadow	I
Little Sheep Creek Upper Wet Meadow	II
Little Sheep Creek Wetland/Upland Mosaic	II
Little Sheep Creek Tributary 1	II
Little Sheep Creek Tributary 1 Minor Drainages	III
Little Sheep Creek Tributary 2	III
Sheep Creek Wet Meadow	II
Sheep Creek Tributary 1	III
Sheep Creek Tributary 2	III
Sheep Creek Spring Tributary	I
Upper Sheep Creek Shrub Wetlands	II
Northwest Springs and Depressions	III
Southwest Minor Drainages	III

[1] Category Rating Number per Montana Wetland Assessment Method (MWAM) (Berglund and McEldowney 2008). Categories are rated I to IV, with I the highest and IV the lowest.

Two Assessment Areas were rated Category I, Little Sheep Creek Wet Meadow and Sheep Creek Spring Tributary (Figure 2.9). Both of these Assessment Areas likely contain fens (wetlands W-LS-11 and W-SCT1-02 respectively), resulting in a high rating for Uniqueness. Both Assessment Areas also have high ratings for General Fish Habitat and Groundwater Discharge/Recharge, and contained documented or suspected habitat for MTNHP Species.

Six Assessment Areas rated Category II (Figure 2.9). Important attributes of these Assessment Areas included: Groundwater Discharge/Recharge, Sediment/Nutrient/Toxicant Removal, Habitat for MTNHP species, Sediment/Shoreline Stabilization, and in the case of Assessment Areas containing Sheep Creek, Recreational/Educational Potential due to the Sheep Creek fishery. The primary difference between Category I and II Assessment Areas is the probable fens within the Category I wetlands resulting in a higher total rating. One other Assessment Area, Little Sheep Creek Tributary 1, also may contain small fens within the overall wetlands but rated lower on other functions, primarily the lack of fish or rare species habitat, and thus scored a Category II.

Six Assessment Areas were rated Category III (Figure 2.9). These Assessment Areas differ from Category I and II Assessment Areas primarily in the extent of wetlands within the Assessment Area (Little Sheep Creek Tributary 1 Minor Drainages Assessment Area, Sheep Creek Tributary 1 Assessment Area, Northwest Springs and Depressions Assessment Area, and Southwest Minor Drainages Assessment

Area), the lack of connection to other wetlands (Little Sheep Creek Tributary 2 and Northwest Springs and Depressions), and the general lack of consistent water or other habitat features. In general, the Category III wetlands appear to fit the concept of that category well: they are common types of wetlands in the region, are not notably diverse, and generally do not provide high-quality wildlife or fish habitat, yet they clearly provide greater functional values than a Category IV wetland. Two exceptions are the Little Sheep Creek Tributary 2 Assessment Area and the Sheep Creek Tributary 2 Assessment Area. Both of these Assessment Areas contain well-developed willow and herbaceous wetlands, numerous springs and seeps, and documented or suspected habitat for MTNHP species. Both Assessment Areas scored a 61 percent, near the criterion of 65 percent to rate as a Category II wetland. The Little Sheep Creek Tributary 2 Assessment Area rated lower due to lack of connection to other wetlands as the water from this Assessment Area goes subsurface resulting in an upland barrier between this Assessment Area and the remainder of the Little Sheep Creek Assessment Areas. Consequently, this Assessment Area did not receive a score for General Fish Habitat or Flood Attenuation, and a low score for Export/Food Chain Support. The Sheep Creek Tributary 2 Assessment Area likewise did not receive a score for these functions as the stream is very minor and does not result in flooding or shoreline stabilization. Further, the stream is isolated from Sheep Creek by at least 2 culverts preventing fish passage into this Assessment Area.

2.4 Environmental Geochemistry

2.4.1 Introduction

The acid generation and metal release potential of waste rock, construction rock, and tailings to be produced by the Project has been characterized using static multi-element analysis, acid-base accounting, net acid generation potential, and kinetic methods. Mineralogical analyses of metal residence and asbestiform mineral analyses were also completed. Results are reported through October 2015, with some tests ongoing. Table 2-20 summarizes the number of tests completed by method, lithotype, and tonnage for waste rock and construction materials in, and Table 2-21 provides a summary for tailings. These test methods and their results are provided in detail in Appendix D (Enviromin, 2015) and are summarized below.

Tintina proposes to mine waste rock from the Lower Newland Formation (*Ynl*), which contains both the Upper Sulfide Zone (*USZ*) and the Lower Sulfide Zone (*LSZ*). Enviromin has defined operational geochemical units for testing purposes based on mineralization and hydrogeology. Tintina's proposal includes mining waste rock from the footwall of the Lower Sulfide Zone (*LZ-FW*, 35% of waste rock tonnage), the Lower Newland dolomitic shale and conglomerate below the *USZ and above* the Volcano Valley Fault in the Johnny Lee deposit area (*Ynl B*, 32%), portions of the *USZ* containing no copper (*USZ*, 28%), and from the Lower Newland above the *USZ* (*Ynl*, 4%). Moving upward stratigraphically, the *LZ-FW* represents a silicified conglomerate, stratigraphically below the LSZ, that consists of shale clasts from both the lowermost Newland Formation and the Chamberlain Formation. The *Ynl B* consists of interbedded dolomitic shale and shale-clast conglomerate and lies beneath the *USZ*, which consists of stratabound bedded pyrite and contains the Upper Copper Zone. Undifferentiated dolomitic shale and shaley dolomites of the upper part of the Lower Newland Formation (*Ynl*) overlie the *USZ*.

Specific tonnages for each waste lithotype are listed in Table 2-20. This rock will be exposed in underground access workings and, temporarily, in active stopes. It will also be stockpiled for up to 2 years on a lined surface pad prior to being co-disposed with cemented tailings early in mine life. Additional waste lithotypes representing tonnages below 1% (including *IG, Ynl 0, Yne*, and *Yc)* have also been characterized (Appendix D)(Enviromin, 2015); those results are not discussed further here.

Excavation and construction activities will involve shallow, weathered, near-surface bedrock deposits of the *Ynl* and sill-form granodiorite intrusives and to address the nature of this material, an additional eight (8) static ABA and NAG tests, as well as SPLP and asbestiform mineral characterization on composites of granodiorite are underway. These tests were initiated subsequent to determination of final facility locations in October 2015, and results will be available at a later time.

Operationally, tailings will be produced via flotation and blended with cement/binders to create cemented paste tailings. Tintina proposes to use a drift and fill mining method, placing 45% of produced tailings mixed with 4% cement as backfill into mined out underground stopes and access headings during operations. The remaining tailings (approximately 55%) will be amended with approximately 2% cement (and binder), and transferred as paste into a double lined and monitored surface tailings impoundment (the CTF). The tailings impoundment design allows little or no water storage on the facility. Most waste rock will be produced during construction of the decline and will be placed into the lowermost CTF, where it will subsequently be covered by paste tailings. Crushed waste rock placed around the sump will develop a drain within the CTF, which will be encapsulated with paste tailings at closure. To provide information for the alternatives analysis that will be required under MEPA, raw (non-amended) tailings were therefore tested along with cemented paste tailings with 2% and 4% binders, as well as 4% cement binder mixed with 10% (by weight) waste rock (identified in figures and lab reports as “4%+ROM”) to simulate alternative disposal methods. Tailings treatments were tested under both subaerial weathering and saturated conditions.

2.4.2 Waste Rock Geochemistry

2.4.2.1 Static Testing of Waste Rock

Four-acid digestions followed by ICP-AES multi-element analysis (method MEMS61) to quantify whole rock metal content were completed by ALS Laboratories (Sparks, NV). A total of 7,497 samples were statistically analyzed to characterize overall geochemical variability within multiple lithotypes and to identify representative sample subsets for static testing. Appendix D summarizes these data.

A total of 156 static tests of acid generation potential, using both acid-base accounting (ABA) and net acid generation (NAG) methods, were completed by ALS Laboratories (Sparks NV) for the dominant waste rock lithotypes. Results of ABA and NAG tests (Figure 2.10) indicate that the majority of *Ynl B* and *Ynl* samples (90%) are unlikely to form acid, while many *USZ* and *LZ-FW* samples have an uncertain potential or are likely to generate acid. Comparison of neutralization (NP) and acidification potential (AP) in Figure 2.11 shows a similar relationship.

Energy Laboratories (Billings MT) completed static tests of metal mobility for composites of the 2012 *Ynl B*, *Ynl*, and *USZ* lithotypes using EPA Method 1312, the synthetic precipitation leachability procedure (SPLP). Because these tests show elevated pH values (> pH 9.5, a result of the presence of carbonate mineralization), these results were considered to be an unrealistic prediction of pH-sensitive metal concentrations. While they are presented and discussed in Appendix A of the 2015 Baseline Environmental Geochemistry Baseline Report (Appendix D of this MOP) (Enviromin, 2015), they are not discussed further here.

Asbestiform mineral testing was completed for all waste rock lithotypes by R.J. Lee Associates (Monroeville, PA). Although these types of minerals are highly unlikely to occur in the lithotypes that will be mined from the Project, these tests were conducted to meet regulatory requirements. No asbestiform minerals were identified in any lithotype to be mined from the Project. Appendix D (Enviromin, 2015) provides detailed methods and results for these tests

Table 2-20. Black Butte Copper Project Waste Rock Tonnage and Environmental Geochemical Analyses by Lithotype

Lithotypes	Description	Tonnage	Waste rock % Tonnage	ICP	ABA/ NAG	SPLP	Minerals	AM	HCT
LZ-FW	Silicified shale and debris flow	247,300	35	542	15	0	*0**	1	*1*
Ynl-B	Lower Newland basal conglomerates	226,100	32	1334	35	2	1	2	*2*
USZ	Lower Newland upper sulfide	197,800	28	3590	49	2	1	2	*2*
Ynl	Undifferentiated Lower Newland	28,250	4	1129	57	2	1	2	1
GD	Granodiorite (construction rock)	tbd	nr	123	*8*	*1*	*0**	*1**	*0**

Italicized text indicates ongoing testing
AM=Asbestos Mineral testing
**Tests planned*
Construction rock to be excavated will be 1:1 Ynl and Granodiorite
Nr=not relevant tbd=to be determined

Table 2-21. Black Butte Copper Project Tailings Treatments and Related Testing

Tailings Test Table	ABA	NAG	ICP metals	Sat. HCT	Unsat HCT	Diffusion Test
Raw tailings	X	X	X	*X*	*X*	-
Paste tailings 2%	X	X	X	-	*X**	-
Paste tailings 4%	X	X	X	-	*X**	X
Paste tailings 4% and Waste Rock	-	-	-	-	*X**	X

**Unsaturated HCTs conducted on intact cylinders, not crushed materials, as is indicated in the ASTM standard.*
Italicized text indicates ongoing testing

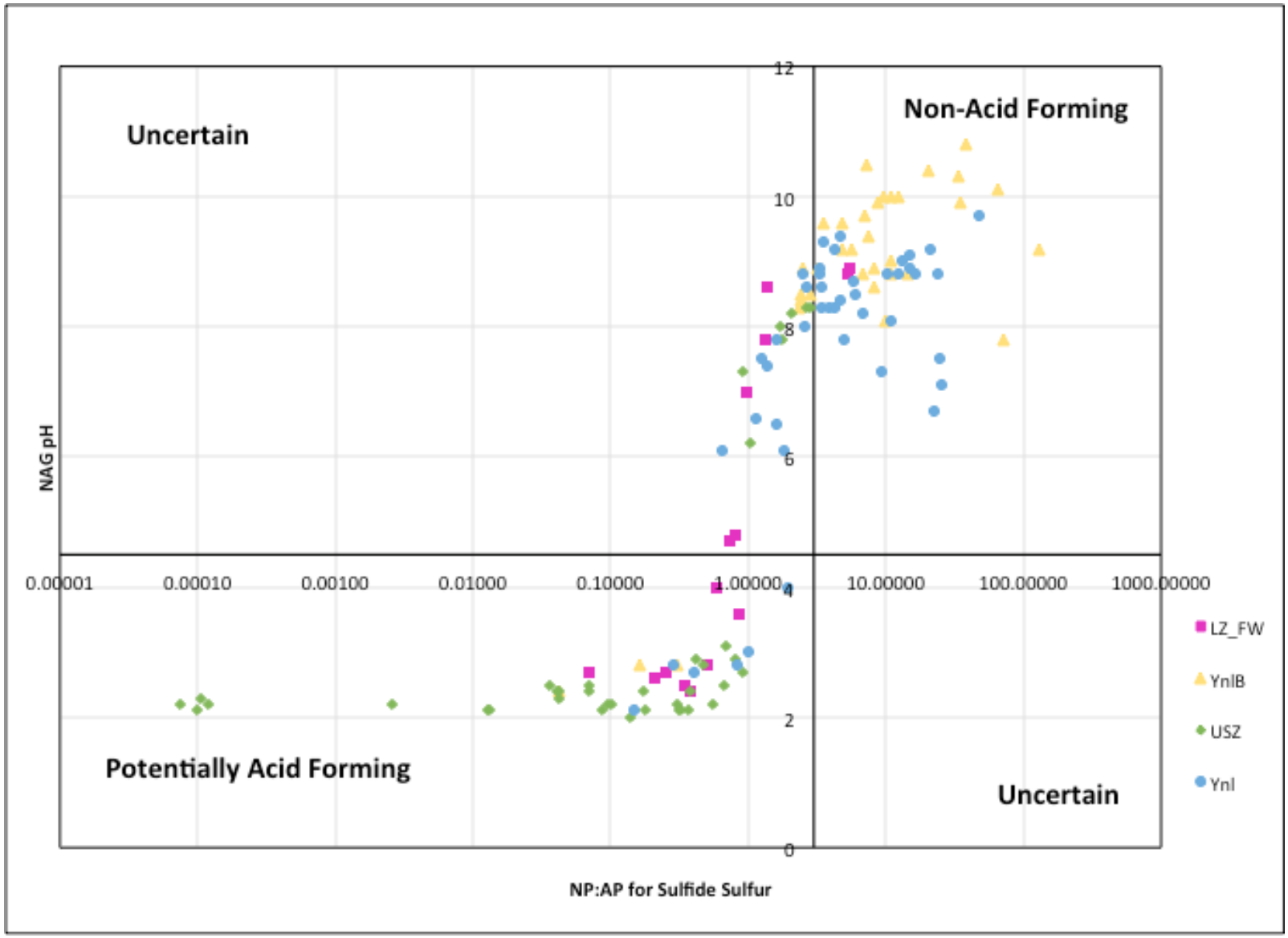


Figure 2.10. Comparison of NAG pH and NP:AP Data for Major Waste Rock Lithotypes

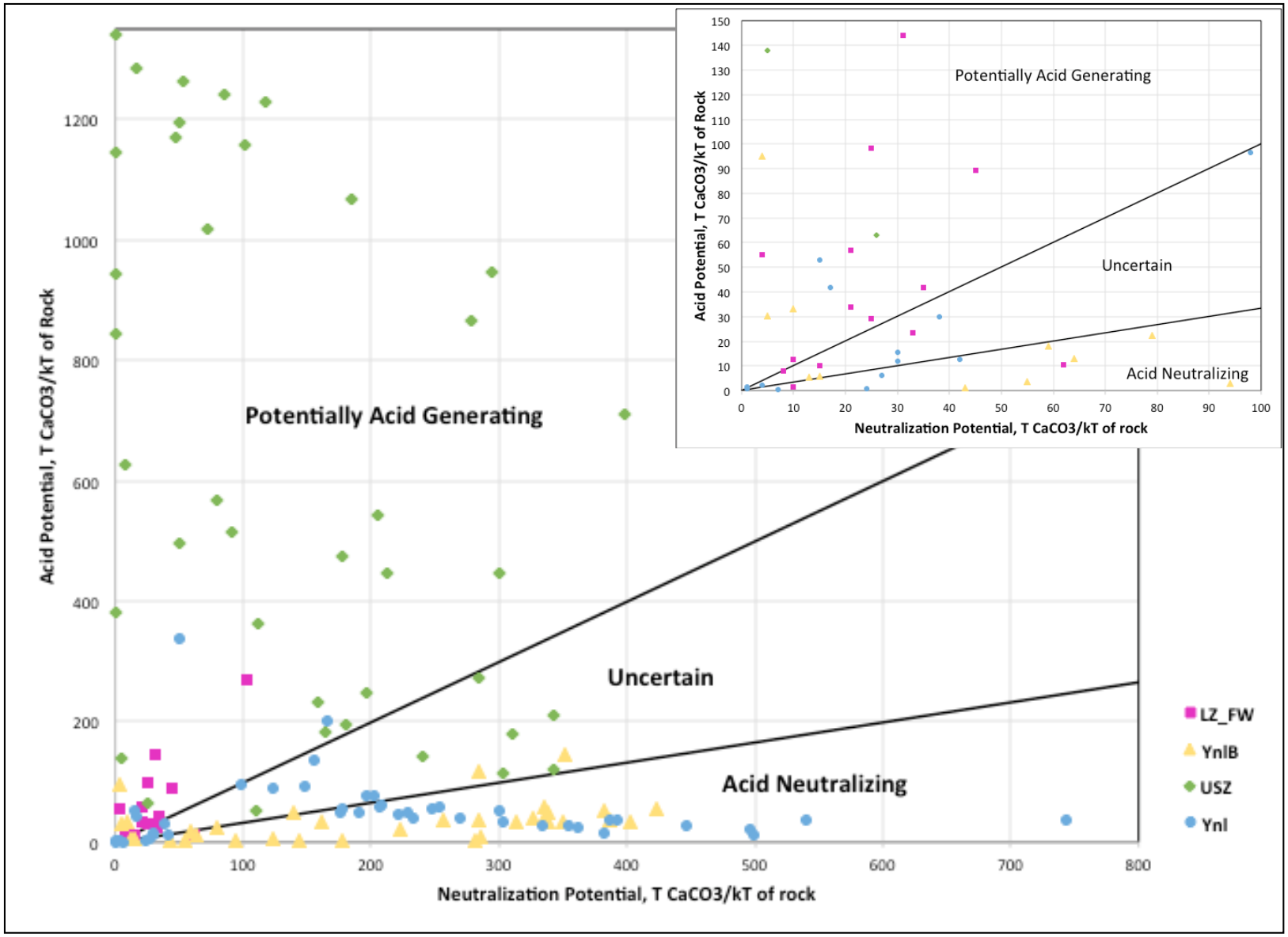


Figure 2.11. Comparison of NP vs. AP Data for Major Waste Rock Lithotypes

2.4.2.2 Kinetics Testing of Waste Rock

Kinetic tests of waste rock acid generation and metal release potential are currently underway at McClelland Laboratories (Sparks, NV), following ASTM protocol D5744 for humidity cell tests (HCTs). McClelland Laboratories also conducted the 2013 kinetic test work. This test exposes samples to alternating dry and humidified air, followed by weekly flushing to remove oxidation products; pH, alkalinity, acidity, dissolved iron, and sulfate are measured weekly as indications of sulfide oxidation and acid generation potential. All waste rock kinetic tests were conducted on composites of static test subsamples from the individual lithologies.

Kinetic tests of *Ynl B*, *USZ*, and *Ynl* waste rock collected from the vicinity of the previously proposed Johnny Lee decline were conducted between 2013 and 2014. The *Ynl* composite tested in 2013 consisted of subsamples that were representative of this lithotype site wide, but the *Ynl B* and *USZ* composites did not have adequate site-wide representation. To address this limitation, additional tests of these two waste rock units were initiated in 2015, using representative subsamples collected site wide. Also, as a result of 2015 changes to the mine plan, *LZ-FW* was identified as roughly one-third of the waste rock tonnage to be produced; and Tintina expanded geochemical characterization to include analysis and compositing of representative samples for this unit as well. These three ongoing kinetic tests are currently in week 19 (*USZ* and *LZ-FW*) and 17 (*Ynl B*) (as of 10/30/2015). As was done with the 2013 tests, and to ensure that all testing objectives have been met, these samples will remain online until they attain steady state geochemical conditions and Tintina obtains regulatory approval for termination of testing.

Results of all kinetic tests of waste rock material are summarized in Figure 2.12. Sulfide oxidation was observed in HCT tests for the four volumetrically significant waste rock units. However, consistent with static test results and the presence of abundant carbonate minerals, oxidation in the *Ynl B, Ynl, and LZ-FW* tests has not produced sufficient acidity to deplete alkalinity nor have these tests produced acidic pH values. Despite indications of sulfide oxidation, depleted alkalinity and increased acidity with lower pH was only evident in the 2015 *USZ* test. Some of these tests are ongoing and, therefore, interpretation is subject to change.

All assessments of metal release potential for waste rock lithotypes (tonnage >1%) and tailings have been based on metal concentrations measured in kinetic test effluents in weeks 0, 1, 2, 4, and every 4 weeks thereafter. Appendix D (Environ, 2015) provides a detailed summary of metal release for kinetic tests completed in 2013 and conducted in 2015.

Despite maintaining neutral pH in the test cells, the *Ynl B and Ynl* units showed potential to exceed surface water quality standards for some metals in early weeks of kinetic testing. However, they do not exceed groundwater standards after week 2. Transient concentrations of cadmium and iron, were observed to exceed surface water standards and nickel exceeded the groundwater standard in week 0 of *Ynl* testing. With no further evidence of release of these metals during the test, these week 0 exceedances were most likely related to sample preparation rather than to weathering in the column. Selenium was observed to exceed surface water standards in weeks 0, 1, and 2, but not thereafter, while thallium was detected in concentrations that exceeded groundwater standards in weeks 0, 1, and 2, and in concentrations that exceed surface water standards thereafter. The *Ynl B,* in 2013 and 2015 tests, exhibited release of lead, selenium, antimony, and thallium in excess of surface water quality standards primarily in early weeks of testing (0, 1, and 2). The composites tested in 2012 and 2015 only exceeded the groundwater standard for antimony and thallium, respectively, in week zero. The *LZ-FW,* though pH

is neutral, has shown potential for release of several metals at concentrations above surface water quality standards through week 16, and has exceeded groundwater standards in multiple weeks for antimony, arsenic, and uranium, and for nickel in week 0. The *USZ* has also shown potential for release of multiple metals in excess of surface water standards in multiple weeks. In week 1 of the 2015 test, concentrations began to drop off, and by week 8 only cadmium, copper, lead and nickel remained at concentrations exceeding surface water standards, while strontium and thallium exceeded both surface water and groundwater (Appendix D) (Enviromin, 2015). With the exception of week 0, no groundwater criteria were exceeded in leachate from the *USZ* 2012 test, but the 2015 sample did exceed groundwater standards for arsenic, cadmium, beryllium, copper, lead, mercury, and nickel in weeks 0-2 of testing, and for Sr and Tl throughout the test.

Because each of the waste rock lithotypes has some, if not significant, potential to generate acid or release concentrations of metals in excess of water quality standards, all mined waste rock will be encapsulated in paste tailings in the lined CTF impoundment. Furthermore, Tintina proposes to collect all seepage from the waste rock stockpile, the cemented paste tailings impoundment, and the underground workings for treatment to non-degradation standards for groundwater prior to discharge. Potential for impact to surface and groundwater is therefore low.

In 2014, MT Tech Center for Advanced Mineral Processing completed mineralogical analyses using the Mineral Liberation Analysis/scanning electron microscopy method on samples of waste rock, both pre- and post-weathering, to evaluate the mineral residence of metals of interest, such as thallium and selenium. The *Ynl B* (2013 sample) was comprised of quartz, dolomite, muscovite, potassium feldspar and pyrite (1.6%); the *Ynl* sample showed similar composition, but also contained biotite, barite and 10.8% pyrite. The *USZ*, like the other *Ynl* units, contained quartz, dolomite, muscovite, and potassium feldspar; it also contained 45% pyrite. No discrete mineral phases containing thallium or selenium were identified, but analysis of the thallium and selenium content of heavy liquid separates (which separated the lighter minerals, e.g., feldspars from the heavy sulfides) suggested that these elements which occurred commonly in humidity cell effluent occur as trace substitutes in the sulfides. Appendix D Enviromin, 2015) provides details on these analyses and results.

Predictive models of water quality in the underground workings during operations and at closure, on the waste rock stockpile, and in the tailings impoundment sump are also being developed and will be reported at a later time.

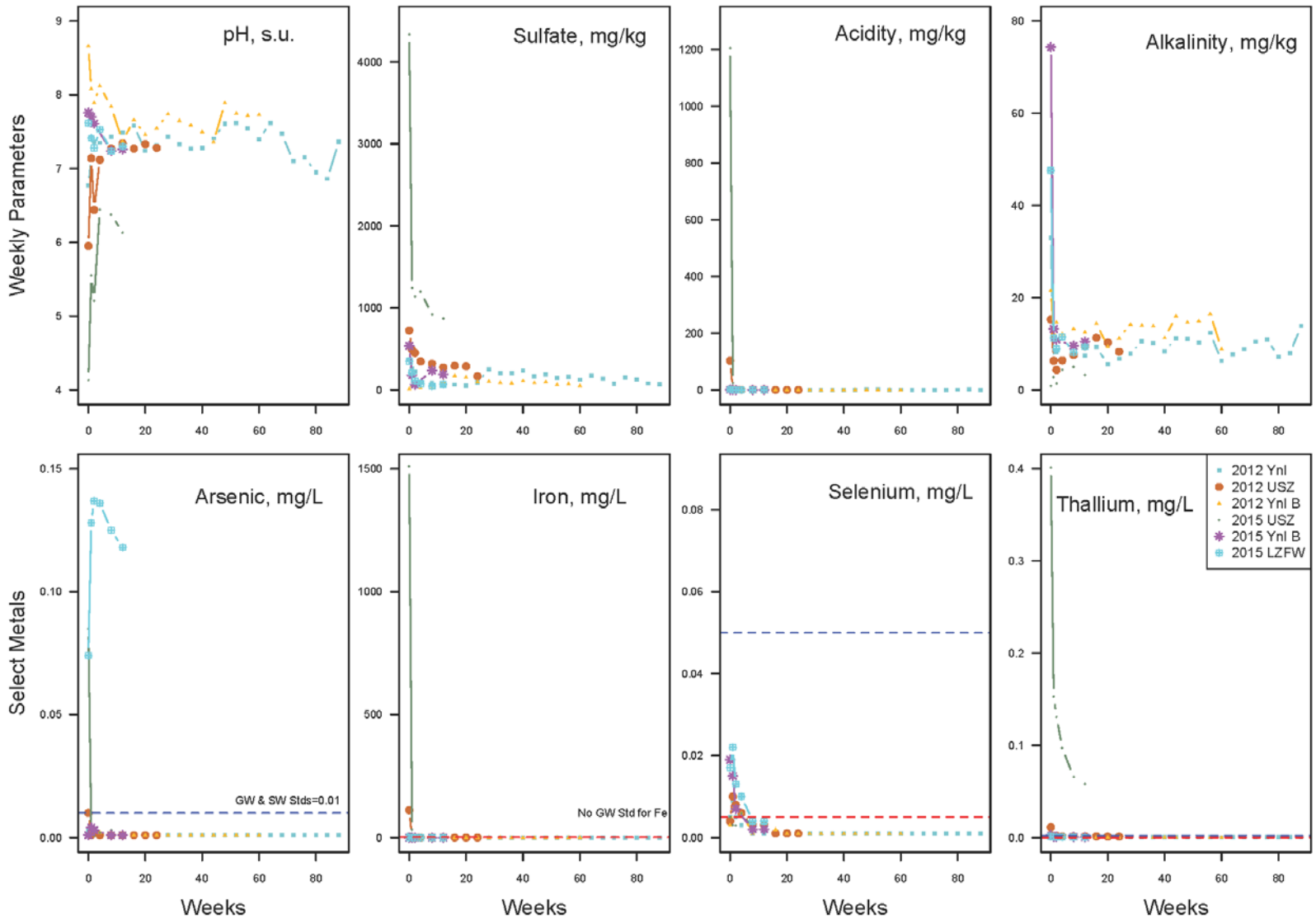


Figure 2.12. Comparison of Select Parameters from Waste Rock Kinetic Humidity Cells - showing surface water quality standards and groundwater standards in blue for select metals with exceedances.

2.4.3 Tailings Geochemistry

2.4.3.1 Static Testing of tailings

Splits of homogenized tailings reject produced in bench-scale metallurgical testing were used for all tests. While there is some variation in AP and NP, ABA and NAG tests indicate that the tailings will have a strong potential to generate acid with or without cement amendment (Table 2.22). The neutralization potential resulting from the addition of 2% to 4% cement is not sufficient to neutralize the sulfide in the tailings, although this was not the intent of cement addition. Cement was added to provide structural strength in support of drift and fill mining methods underground, and to change the physical properties of the material to a stable, non-flowable material with low hydraulic conductivities on the order of 10^{-9} m/sec in both surface and underground settings.

2.4.3.2 Kinetic Testing of tailings

Kinetic tests of raw (non-amended) tailings are ongoing at McClelland Laboratories and cemented paste tailings tests are ongoing at Western Environmental Testing Laboratory (WETLab, Sparks NV). Table 2-24 summarizes the tailings characteristics, testing methods and conditions, and ultimate disposition of tailings in various scenarios represented by each kinetic test. Cemented paste tailings cylinders were tested (without crushing) in conventional ASTM method D5744 (as described above for kinetic testing of waste rock) humidity test cells to simulate sub-aerial weathering and were also tested using ASTM C1308 diffusion tests to simulate diffusion through backfill in saturated underground workings. The ASTM C1308 diffusion test involves the submergence of paste tailings cylinders (with a height:diameter ratio of 2:1) in 14 sequential deionized water baths over a period of 11 days; the test is designed to predict sulfide reactivity and solute release as a result of diffusion. Raw (non-amended) tailings were also tested using ASTM method D5744 (as described above for kinetic testing of waste rock), both sub-aerially and in a modified, saturated test, to represent dry stack surface placement and subaqueous deposition impoundment scenarios, respectively.

Acid generation parameters for all kinetic tests of tailings are shown in Figure 2.13, and Appendix D (Enviromin, 2015) provides detailed results. In the diffusion tests, the 4% cemented paste (4%) and 4% cemented paste with waste rock (4% + ROM, in figures and lab reports) cylinders showed differences in sulfide oxidation. The 4% cemented paste cylinder maintained a variable but overall higher pH between 6.5 and 9.5, and produced more alkalinity throughout the test than the 4% cemented paste with waste rock cylinder. Sulfate and acidity was low in diffusion tests of both materials, however. A similar relationship was observed in the aerated HCT tests of these materials, which exhibited higher overall oxidation. The 4% cemented paste maintained a pH between 5.0 and 5.5 through week 10 and the 4% cemented paste with waste rock column declined to a pH of 4 in week 6. This indicates that the additional of more neutralizing waste rock did not reduce sulfide oxidation.

Acid and sulfate production varied between the cemented paste treatments, with the 2% test exhibiting greater oxidation than the 4% or the 4% cemented paste with waste rock test. All tests began at a pH above 6, which was maintained for 1-4 weeks depending on treatment; the 4% cemented paste had a pH of nearly 5 in week 9. The 4% cemented paste with waste rock test held a pH over 6 in week 3, which declined to pH 4 by week 6. Although the weakly cemented 2% test cylinder generated less sulfate and acidity than the raw (non-amended) tailings in the conventional, unsaturated HCT, its pH also dropped to less than 3 by week 9. Given the fact that the 2% and 4% cemented pastes have very similar NNP and NP/AP characteristics with obvious potential for acid generation (Table 2-22), the elevated acidity of the 2% test cylinder is explained by its disaggregation under leach in the HCT, which exposed significantly greater amounts of sulfide to oxidation. The presence of rock fragments in the 4% cemented paste with

waste rock cylinder also appears to have produced higher rates of sulfide oxidation by altering the massive character of cemented paste tailings which controls sulfide exposure, as the pH of the 4% cemented paste with waste rock cylinder was lower than that of the more strongly indurated 4% cemented paste cylinder in HCT effluent. Raw (non-amended) tailings weathered in a conventional, subaerial humidity cell were strongly acidic and showed a correspondingly high potential to generate sulfate and acidity at low pH. In contrast, as of week 19, the saturated kinetic test showed much lower sulfide oxidation and had maintained a circum-neutral pH of 6.9.

Tintina proposes to place 0.5 to 2% cement amended paste materials in its surface CTF, and to collect and remove water from that impoundment continuously. Discharge of tailings seepage to surface water is unlikely because mine-affected water will be treated prior to discharge to groundwater. The following discussion, therefore, compares results to groundwater standards, with the exception of the saturated humidity cell test of raw tailings, which represents surface water in a subaqueous tailings facility pond.

Metal release data for tailings kinetic tests are summarized in Figure 2.14 for select metals and provided in detail in tables and figures in Appendix D (Enviromin, 2015). Although the initial rate of metal release for cemented paste tailings was lower than raw tailings for most metals, the release rates of many metals from the 2% cement paste HCT approached that of the unsaturated raw tailings HCT after 8 weeks, as a result of disaggregation during testing. Metal concentrations in effluent from the 4% paste cement backfill were lowest, and only exhibited isolated groundwater exceedances for copper, nickel and thallium. Similarly, the 4% cemented paste with waste rock exceeded the groundwater quality standard for thallium in all weeks of testing thus far, with isolated exceedances of copper and nickel. In the unsaturated HCT of raw (non-amended) tailings, metal release potential was high, with regular groundwater exceedances observed for numerous constituents. At the lower oxidation rate in the saturated HCT of raw (non-amended) tailings, which is intended to represent tailings deposited in a subaqueous impoundment, fewer metals exceeded relevant surface water quality standards and they were detected at much lower concentrations. These tests remain online, and all interpretation is subject to change based on future results.

Table 2-22. Static ABA and NAG pH Test Results for Raw and Paste tailings

Sample Identification		NAG @pH 4.5	NAG @pH 7.0	NAG pH	Fizz Rating	AP	NP	NNP	NP/AP	Paste pH	Total S (%)	NaOH-leachable S (%)	HCl-leachable S (%)	Sulfide S (%)	Total Carbon (%)	Carbonate (%)
						tCaCO3/Kt										
Raw tailings	CA12185-JUN15	NA	NA	NA	1	802	2.0	-800	0.003	3.23	25.5	NA	<0.01	25.7	0.372	0.220
	CA15079-JUL15	NA	NA	NA	1	935	*0.1*	-937	0.00001	3.30	28.9	NA	<0.01	29.9	0.304	0.100
	CA12531-JUL15	NA	NA	NA	1	781	*0.1*	-783	0.00001	3.31	24.1	NA	<0.01	25.0	0.459	0.145
	CA15000-AUG15	NA	NA	NA	1	845	9.4	-836	0.01	3.58	28.3	NA	1.29	27.0	0.406	0.295
	CA14523-AUG15	NA	NA	NA	1	554	61.1	-493	0.11	3.92	21.4	NA	3.70	17.7	1.19	3.20
	Enviromin Tails Sample	282	406	2.2	1	775	*0.1*	-780	0.00001	4.0	24.8	0.71	0.68	24.1	NA	NA
Paste tailings	C601-15 (2% Binders)	131.5	182	2.1	1	741	*0.1*	-749	0.00001	3.8	23.7	2.08	1.15	21.6	NA	NA
	C586-15 (4% Binders)	124	179.5	2.3	1	744	9	-738	0.012	7.9	23.9	1.99	1.19	21.9	NA	NA

Negative NPs converted to 0.01 for calculation and graphing.

Table 2-23. Tailings Characteristics, Kinetic Test Methods and Facility Scenarios

tailings Characteristics	Test Method	Lab	Represented Facility	Action Scenario
4% binder	ASTM C1308 diffusion	WETLab	Backfilled in flooded workings	Proposed
4% with waste co-disposal	ASTM C1308 diffusion	WETLab	Backfilled in flooded workings	Alternative
2% binder	ASTM method D5744 unsaturated	WETLab	Cement paste in CTF, subaerial weathering	Proposed
4% binder	ASTM method D5744 unsaturated	WETLab	Cement paste in CTF, subaerial weathering	Alternative
4% with waste co-disposal	ASTM method D5744 unsaturated	WETLab	Cement paste in CTF, subaerial weathering	Proposed
Raw (non-amended)	ASTM method D5744 modified saturated	McClelland	Saturated tailings e.g., subaqueous impoundment	Alternative
Raw (non-amended)	ASTM method D5744 unsaturated	McClelland	Subaerial weathering, e.g., dry stack tailings pile	Alternative

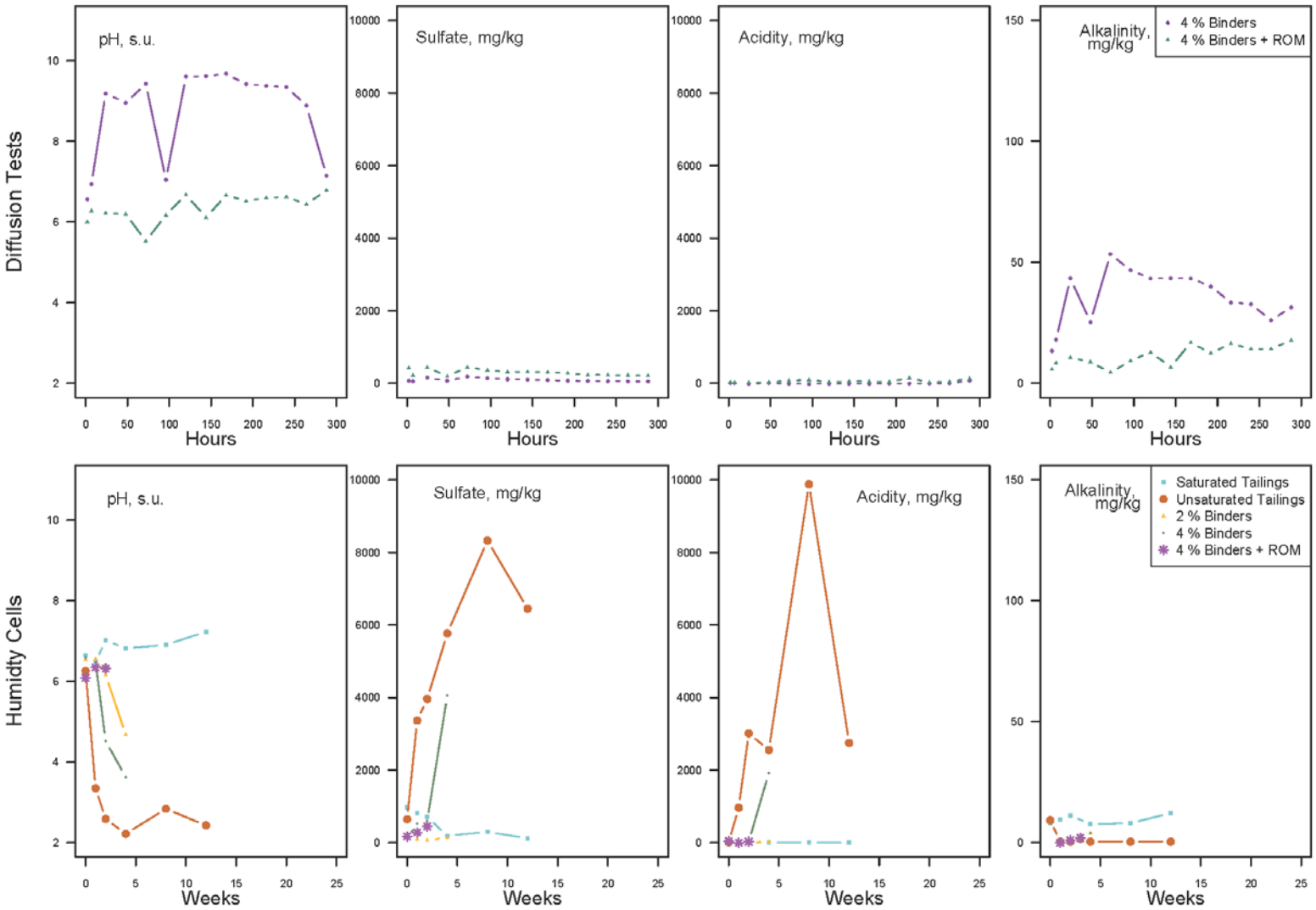


Figure 2.13. Kinetic Test Results for Tailings with pH, Alkalinity, Acidity, and Sulfate.

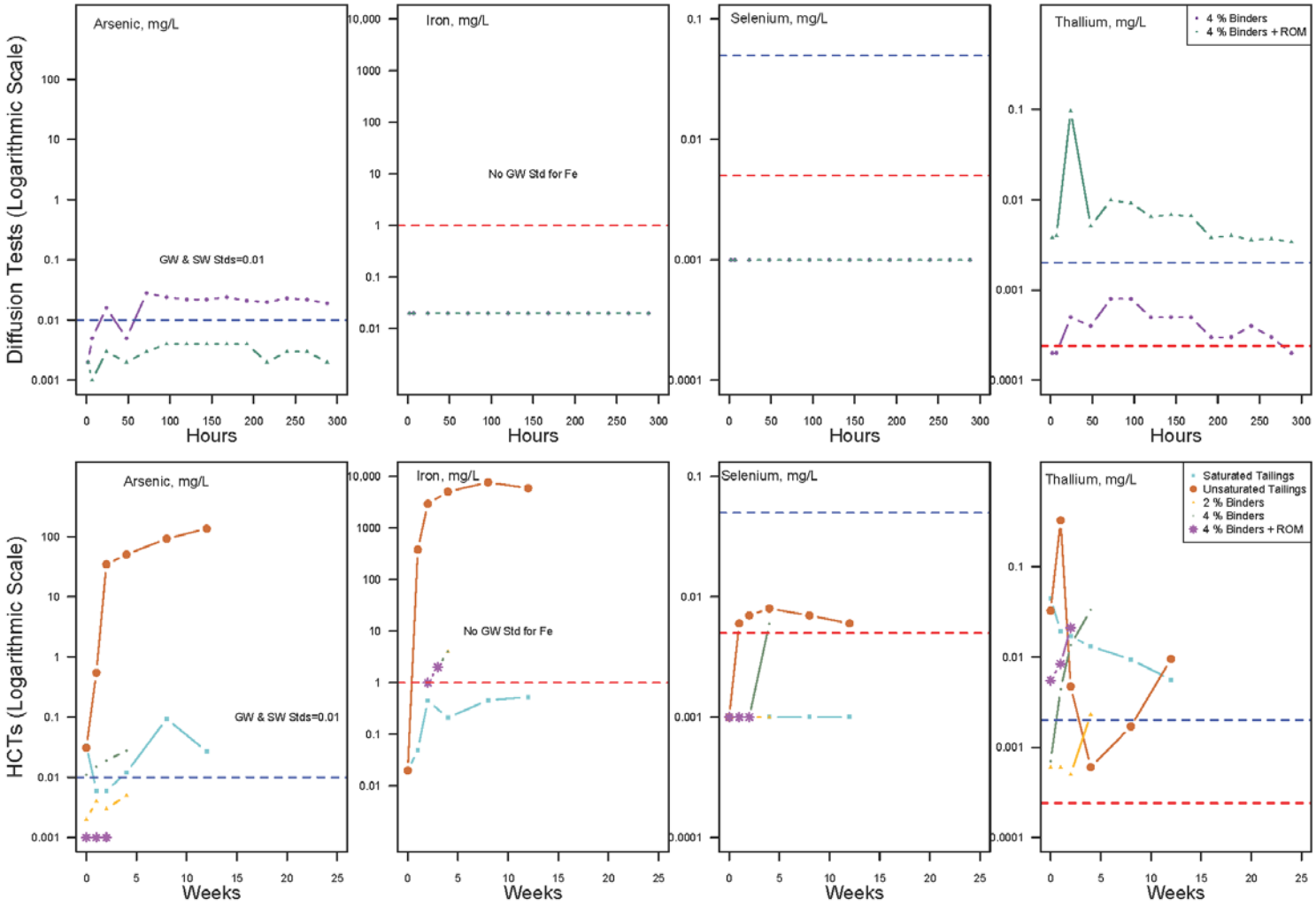


Figure 2.14. Kinetic Test Results for Tailings with Select Metals

2.4.4 Environmental Chemistry Conclusions

The four volumetrically significant waste rock units have shown evidence of sulfide oxidation in the HCT tests. However, consistent with the static test results and the presence of abundant carbonate mineralization, acid generation from waste rock HCTs has been limited. Furthermore, metal production from waste rock HCTs has been restricted to primarily isolated exceedances of ground and surface water standards, with some elements, such as thallium, and selenium, occurring more frequently.

Due to the potential for release of various metals at different times in the expected weathering process, waste rock will be encapsulated in paste tailings in the lined CTF impoundment. Furthermore, Tintina proposes to collect all seepage from the temporary waste rock stockpile, the CTF, and the groundwater from the underground workings for treatment to non-degradation standards prior to discharge via underground infiltration galleries. Potential for impact to surface and groundwater is therefore low.

Results of the diffusion kinetic tests indicate that saturated 4% cemented paste tailings Tintina plans to use for backfill is unlikely to become acidic and has potential to release only Tl in concentrations above groundwater standards. Also, because of the extremely low hydraulic conductivity of this material, potential to impact groundwater in a backfill setting is low. Results indicate that all of the cemented paste amended tailings treatments have potential to oxidize after a lag time and to release at least some sulfate, acidity, and metals if left exposed to air and water. Importantly, this is not observed immediately in test cells, and the rate of weathering in a humidity cell is recognized to be up to 10 times greater than in the field. Given Tintina's proposed drift and fill method of mining, backfilled material will be exposed to less air, thus reducing the production of sulfate, acidity, and metals. At closure, the backfill material will be submerged in groundwater, reducing oxygen availability and resulting sulfide oxidation by orders of magnitude.

Additionally, in the CTF, each new lift of cemented paste tailings will behave as a massive block of material with low transmissivity, with a thin upper surface that will be exposed to some degree of oxidation before being covered by fresh cement-amended paste tailings within days of placement. The unsaturated kinetic tests of cemented paste tailings reflect the type of oxidation to be expected along this surface, while the diffusion tests better represent the majority of tailings placed in each lift. If waste rock is scattered throughout tailings, the 4% cemented paste with waste rock cylinder will be most representative. For waste rock placed locally and encapsulated by massive cemented paste tailings, the outer rim is best represented by the 2% cement-amended cylinder HCT data, while the interior of the paste tailings is best represented by 4% diffusion tests. If material is covered in a timely manner (on the scale of weeks), relatively less oxidation, acidity, and leaching of metals is expected to occur and it would be limited to the immediate surface of the cemented paste tailings. Also, any water interacting with oxidized tailings will react with dominantly net neutralizing waste rock before being collected in a sump within a lined facility for treatment.

At closure, the CTF will be covered with a geotextile membrane, which will be welded to the lower liner, eliminating long-term exposure of the final lifts to oxygen and water. The double lined CTF with drainage collection is designed to prevent discharge to surface water and groundwater. Thus, any solutes resulting from oxidation and release of metals by cemented paste tailings within the CTF are unlikely to reach or affect surface water or groundwater.

As an alternative to Tintina's proposed scenario for placement of 4% cement-amended tailings in saturated underground workings, subaqueous placement of tailings appears to be most effective at limiting sulfide oxidation. However, if a subaqueous impoundment alternative were to be considered, some release of metals to the tailings pond would be expected to occur in concentrations that exceed

surface water standards. Significant acid rock drainage would be expected to develop in subaerially weathered, fine-grained “raw” tailings, suggesting that a “dry stack” management method for tailings is not an ideal alternative scenario. Therefore, for management of surface placed tails as cemented paste, with addition of waste rock, appears significantly superior to the subaqueous and dry stack alternatives.

2.5 Soil Resources

2.5.1 Soils Study Area

Tintina conducted an Order 2 soil survey within a 3,368 acre (1,363 ha) area which includes 285 acres (115 ha) planned for construction of mine facilities (herein referred to as “Study Area,” Figure 2.15). The survey provided descriptions, classifications of soil profiles to the family level, correlations these families to map unit names provided in the existing NRCS soil survey. Additionally, collection of soil samples from representative horizons allowed for analysis of physical and chemical properties in order to assess soil suitability for reclamation. The remainder of this section summarizes the survey methods and results while Appendix E (Westech, 2015b) provides a more detailed description including analytical data and photos.

2.5.2 Soils Methods

Tintina completed an Order 2 soil survey in accordance with procedures developed by the NRCS (USDA, 1993). The survey began with a review of existing soils information (i.e. NRCS soil survey data, aerial photographs, geologic maps, and other information) to identify the dominant soil series in the area and to develop a preliminary soils map that included 28 proposed soil sample sites.

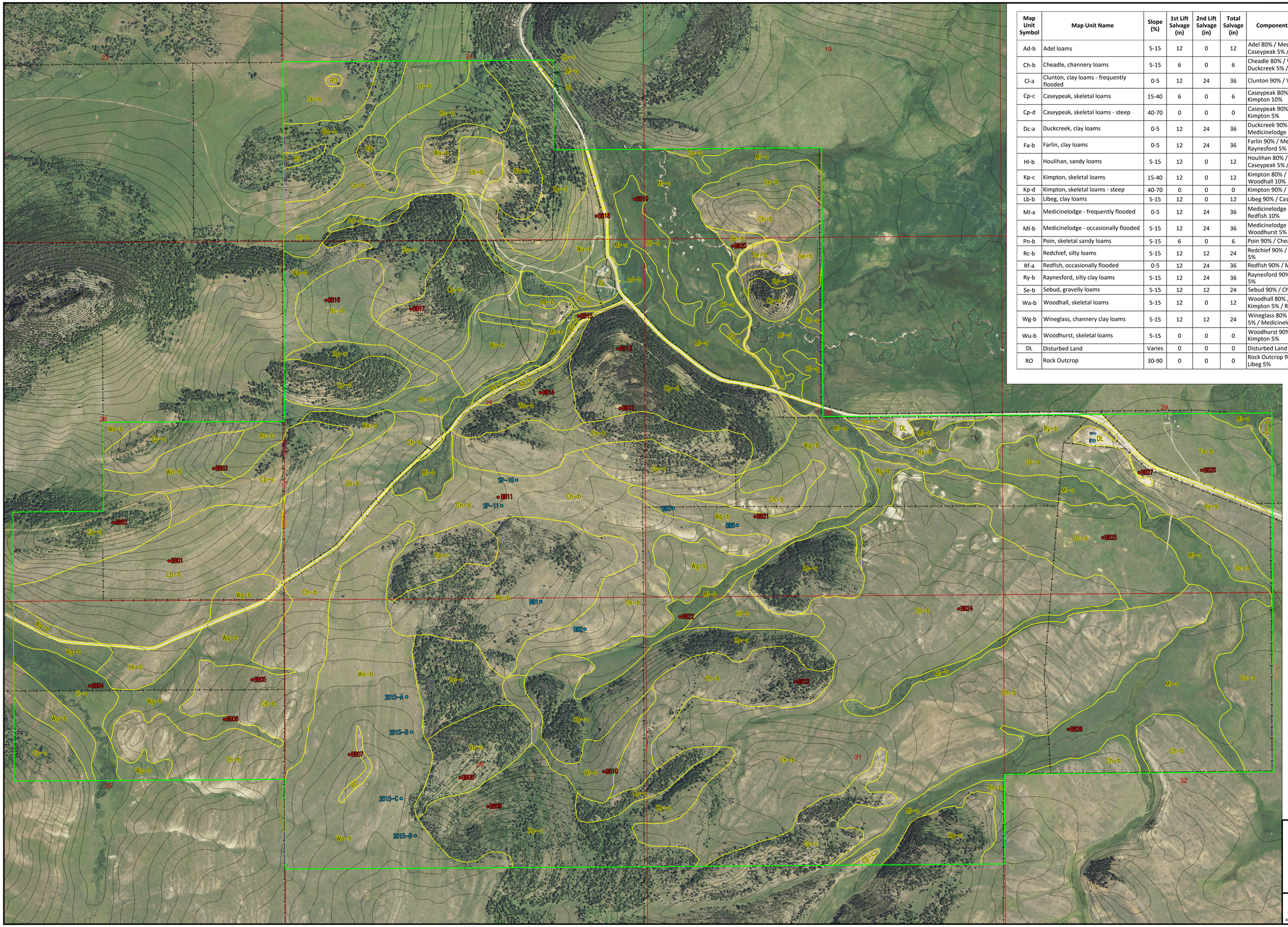
Field inventory activities completed in July 2015 included soil profile (pedon) observations, soil sampling, and refinement of preliminary map unit boundaries. Soil samples collected from discreet horizons at each of the 28 sample sites received analysis of soil texture, organic matter content, coarse fragment content, pH, salinity/conductivity, and total arsenic, cadmium, copper, lead, and zinc concentrations.

Surveyors identified preliminary map unit boundaries in the field based on the results of pedon descriptions and development of conceptual map units. A review of all available information including laboratory results and final pedon classifications allowed a refinement of soil map unit descriptions and boundaries

In addition to the Order 2 soil survey, surveyors completed field investigations to determine the hydraulic properties of soils and shallow bedrock to support site selection for underground infiltration galleries (Tintina Alaska, Inc. 2012, Appendix E). This work included constant head tests (ASTM D 3385-88 using a double-ring infiltrometer) to measure saturated hydraulic conductivity of surface soil and shallow subsoil to evaluate suitability for operation of surface and shallow surface LAD systems such as sprinkler irrigation systems. Deep (approximately 12 feet [3.7 m] (below ground surface) falling head percolation test pits allowed measurement of hydraulic conductivity of underlying geologic materials to evaluate the suitability underground infiltration galleries. Additionally, analysis of composite samples for saturated paste extractable metal concentrations helped evaluate the potential for metal release from soils during water application.

2.5.3 Soils Results

The study identified eighteen soil series in the Study Area and from these composed 23 map units (Figure 2.15). Table 2-24 lists the map units, their composition (i.e., the proportion of the map unit occupied by each soil series), and other data.



Map Unit Symbol	Map Unit Name	Slope (%)	1st Lift Salvage (in)	2nd Lift Salvage (in)	Total Salvage (in)	Components and Proportions (%)	Acres in Study Area	Percent of Study Area
Ad-b	Adel loams	5-15	12	0	12	Adel 80% / Medicinelodge 10% / Caseypeak 5% / Kimpton 5%	26.9	0.8%
Ch-b	Cheadle, channery loams	5-15	6	0	6	Cheadle 80% / Wineglass 10% / Duckcreek 5% / Medicinelodge 5%	798.5	23.7%
Cl-a	Clunton, clay loams - frequently flooded	0-5	12	24	36	Clunton 90% / Wineglass 10%	26.5	0.8%
Cp-c	Caseypeak, skeletal loams	15-40	6	0	6	Caseypeak 80% / Woodhall 10% / Kimpton 10%	220.3	6.5%
Cp-d	Caseypeak, skeletal loams - steep	40-70	0	0	0	Caseypeak 90% / Woodhall 5% / Kimpton 5%	79.3	2.4%
Dc-a	Duckcreek, clay loams	0-5	12	24	36	Duckcreek 90% / Cheadle 5% / Medicinelodge 5%	138.0	4.1%
Fa-b	Farlin, clay loams	0-5	12	24	36	Farlin 90% / Medicinelodge 5% / Raynesford 5%	46.5	1.4%
Hl-b	Houlihan, sandy loams	5-15	12	0	12	Houlihan 80% / Kimpton 10% / Caseypeak 5% / Cheadle 5%	55.6	1.7%
Kp-c	Kimpton, skeletal loams	15-40	12	0	12	Kimpton 80% / Caseypeak 10% / Woodhall 10%	329.7	9.8%
Kp-d	Kimpton, skeletal loams - steep	40-70	0	0	0	Kimpton 90% / Poin 5% / Woodhall 5%	127.7	3.8%
Lb-b	Libeg, clay loams	5-15	12	0	12	Libeg 90% / Caseypeak 5% / Cheadle 5%	197.8	5.9%
Ml-a	Medicinelodge - frequently flooded	0-5	12	24	36	Medicinelodge 80% / Duckcreek 10% / Redfish 10%	256.4	7.6%
Ml-b	Medicinelodge - occasionally flooded	5-15	12	24	36	Medicinelodge 90% / Wineglass 5% / Woodhurst 5%	71.7	2.1%
Pn-b	Poin, skeletal sandy loams	5-15	6	0	6	Poin 90% / Cheadle 5% / Kimpton 5%	200.8	6.0%
Rc-b	Redchief, silty loams	5-15	12	12	24	Redchief 90% / Kimpton 5% / Woodhall 5%	86.5	2.6%
Rf-a	Redfish, occasionally flooded	0-5	12	24	36	Redfish 90% / Medicinelodge 10%	31.5	0.9%
Ry-b	Raynesford, silty clay loams	5-15	12	24	36	Raynesford 90% / Duckcreek 5% / Farlin 5%	67.5	2.0%
Se-b	Sebud, gravelly loams	5-15	12	12	24	Sebud 90% / Cheadle 10%	35.7	1.1%
Wa-b	Woodhall, skeletal loams	5-15	12	0	12	Woodhall 80% / Caseypeak 10% / Kimpton 5% / Redchief 5%	297.8	8.8%
Wg-b	Wineglass, channery clay loams	5-15	12	12	24	Wineglass 80% / Cheadle 10% / Clunton 5% / Medicinelodge 5%	166.4	4.9%
Wu-b	Woodhurst, skeletal loams	5-15	0	0	0	Woodhurst 90% / Caseypeak 5% / Kimpton 5%	58.2	1.7%
DL	Disturbed Land	Varies	0	0	0	Disturbed Land 100%	36.9	1.1%
RO	Rock Outcrop	30-90	0	0	0	Rock Outcrop 90% / Woodhall 5% / Libeg 5%	11.3	0.3%
						Total	**3367.5**	**100%**

LEGEND

- Soils Study Area
- Fence
- Soil Ma□ Unit Boundary
- Soil Sur□ey Site
- Infiltration Test Pit Site

Aerial: 2013 NAIP
To□o: 20' Generated from ½ second NED

Scale 1" □ 600'

0 300 600 1200
Feet

TINTINA RESOURCES

Black Butte Copper Project

Baseline Soil Survey Map

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

Figure 2.15

Sheet 1 of 1

11/23/15 · BBC15_Soils_Baseline_Infil.cd · g · 1:7,200

Table 2-24. Summary of Map Units in Black Butte Copper Study Area

Map Unit Symbol	Map Unit Name	Slope (%)	Map Unit Composition (% by Soil Series)	Acres in Study Area	Percent of Study Area
Ad-b	Adel loams	5-15	Adel 80% / Medicinelodge 10% / Caseypeak 5% / Kimpton 5%	26.9	0.8
Ch-b	Cheadle, channery loams	5-15	Cheadle 80% / Wineglass 10% / Duckcreek 5% / Medicinelodge 5%	798.5	23.7
Cl-a	Clunton, clay loams	0-5	Clunton 90% / Wineglass 10%	26.5	0.8
Cp-c	Caseypeak, skeletal loams	15-40	Caseypeak 80% / Woodhall 10% / Kimpton 10%	220.3	6.5
Cp-d	Caseypeak, skeletal loams - steep	40-70	Caseypeak 90% / Woodhall 5% / Kimpton 5%	79.3	2.4
Dc-a	Duckcreek, clay loams	0-5	Duckcreek 90% / Cheadle 5% / Medicinelodge 5%	138.0	4.1
Fa-b	Farlin, clay loams	0-5	Farlin 90% / Medicinelodge 5% / Raynesford 5%	46.5	1.4
Hl-b	Houlihan, sandy loams	5-15	Houlihan 80% / Kimpton 10% / Caseypeak 5% / Cheadle 5%	55.6	1.7
Kp-c	Kimpton, skeletal loams	15-40	Kimpton 80% / Caseypeak 10% / Woodhall 10%	329.7	9.8
Kp-d	Kimpton, skeletal loams - steep	40-70	Kimpton 90% / Poin 5% / Woodhall 5%	127.7	3.8
Lb-b	Libeg, clay loams	5-15	Libeg 90% / Caseypeak 5% / Cheadle 5%	197.8	5.9
Ml-a	Medicinelodge - frequently flooded	0-5	Medicinelodge 80% / Duckcreek 10% / Redfish 10%	256.4	7.6
Ml-b	Medicinelodge - occasionally flooded	5-15	Medicinelodge 90% / Wineglass 5% / Woodhurst 5%	71.7	2.1
Pn-b	Poin, skeletal sandy loams	5-15	Poin 90% / Cheadle 5% / Kimpton 5%	200.8	6.0
Rc-b	Redchief, silty loams	5-15	Redchief 90% / Kimpton 5% / Woodhall 5%	86.5	2.6
Rf-a	Redfish, occasionally flooded	0-5	Redfish 90% / Medicinelodge 10%	31.5	0.9
Ry-b	Raynesford, silty clay loams	5-15	Raynesford 90% / Duckcreek 5% / Farlin 5%	67.5	2.0
Se-b	Sebud, gravelly loams	5-15	Sebud 90% / Cheadle 10%	35.7	1.1
Wa-b	Woodhall, skeletal loams	5-15	Woodhall 80% / Caseypeak 10% / Kimpton 5% / Redchief 5%	297.8	8.8
Wg-b	Wineglass, channery clay loams	5-15	Wineglass 80% / Cheadle 10% / Clunton 5% / Medicinelodge 5%	166.4	4.9
Wu-b	Woodhurst, skeletal loams	5-15	Woodhurst 90% / Caseypeak 5% / Kimpton 5%	58.2	1.7
DL	Disturbed Land	Varies	Disturbed Land 100%	36.9	1.1
RO	Rock Outcrop	30-90	Rock Outcrop 90% / Woodhall 5% / Libeg 5%	11.3	0.3
			Total	**3,367.5**	**100**

The following sections summarize relevant physical and chemical properties of the map units, which may limit the suitability of these soils for salvage operations. Appendix E (Westech, 2015b) provides more detailed descriptions of the suitability of individual map units.

The DEQ (1998) and EPA provide soil salvage suitability guidelines are provided by which include such characteristics as coarse fragment content (i.e., greater than 50 % coarse fragments are unsuitable for salvage), slope steepness (slopes greater than 2 to 1 are unsuitable), and other characteristics.

2.5.3.1 Physical Properties of Soils

Physical soil properties that can affect suitability for salvage include texture, coarse fragment content, depth to bedrock, depth to groundwater, slope, organic matter content, and erosion potential.

Certain soil textures such as clay, silty clay, sand, and others can pose suitability problems in regards to soil handling and site stability. Three of the 28 pedon locations observed in the Study Area contained horizons with unsuitable clay textures. However, undesirable soil textures will not significantly impact the reclamation potential of soils due to the limited distribution of these soils in the Study Area. Mechanical mixing of soils during the salvage and redistribution processes will result in soils with suitable textures upon reclamation.

Coarse fragment concentrations greater than 50 % can inhibit reclamation success. Thirteen of the 28 observed pedons included horizons with coarse fragment concentrations ranging from 50 % to 90 %. The majority of these coarse fragments consisted of gravels less than 3-in in diameter, which often do not impede salvage potential. However, Adel, Caseypeak, Poin, and Woodhurst soils also contain larger sized fragments that can limit soil suitability.

Shallow depths to bedrock or groundwater can limit salvage suitability by providing a relative lack of soil or restricting equipment operation. Eleven of the observed pedons occurring in the Caseypeak, Cheadle, Kimpton, Poin, Redchief, and Woodhall soil types had shallow depths to bedrock ranging from 3 to 30 in below ground surface. The Clunton, Medicinelodge, and Redfish soils had shallow depths to groundwater ranging from 10 to 32 in below ground surface.

Slopes greater than 50%, such as those found in or near dissected drainages, steep ridges, or rock outcrops, limit soil salvage operations due to safety hazards associated with heavy equipment use. The Caseypeak soil type within Map Unit Cp-d and the Kimpton soil type within Map Unit Kp-d both occur on slopes ranging in steepness from 40% to 70%.

Organic matter content is considered a beneficial soil characteristic as it is directly related to soil fertility. Guidelines describing minimum desirable organic matter content vary, however 2% or greater is generally considered suitable for salvage and reclamation. The soils sampled in the Study Area had organic matter contents that ranged from 1.9% to 49.4% and averaged 9.7% in the upper 12 inches (30.5 cm) of the soil profile. Deeper horizons averaged 5.1%. No soils within the study area are considered unsuitable based on organic matter content.

Susceptibility to wind and water erosion negatively affects soil suitability for salvage. The soil erodibility factor (K-Factor) allows assessment of erosion potential due to water while Wind Erodibility Group rating (WEG) (USDA, 2009 and 2013) allows assessment of wind erodibility. Appendix E (Westech, 2015b) gives a more detailed description of K-Factor and WEG. Soils in the Study Area generally exhibit low to moderate susceptibility to erosion.

2.5.3.2 Chemical Properties of Soils

Chemical properties affecting soil suitability for reclamation include pH, electrical conductivity, and concentrations of certain metals or metalloids including arsenic, cadmium, copper, lead, and zinc.

Soils with pH values below 5.5 s.u. or above 8.5 s.u. are not recommended for plant growth or establishment and are considered unsuitable for salvage (Brady and Weil, 1999). This study measured suitable pH values in all samples except for acidic pH values measured in one horizon each from the Kimpton, Liberg, Medicinelodge, Redchief, and Woodhall soils. An additional pedon excavated in the Poin soil had acidic pH values in the three horizons occupying the 0 to 16 inch (0 to 41 cm) depth increment. This study indicates no adverse impacts on vegetation from salvaged soil due to the prevalence of neutral pH in the majority of soils in the Study Area, despite the presence of some acidic soil horizons.

Electrical conductivity measures the concentration of soluble salts, or salinity, in the soil. Elevated salinity can hinder plant establishment and growth by preventing uptake of water by plant roots. Soils with electrical conductivity values greater than 4 mmhos/cm are considered undesirable for topsoil while soils with values greater than 8 mmhos/cm are undesirable for subsoils (DEQ, 1998). No soils in the Study Area exhibit electrical conductivity values that exceed DEQ topsoil or subsoil guidelines.

The study measured concentrations of arsenic, cadmium, copper, lead, and zinc for comparison to DEQ and EPA screening levels or action thresholds (EPA, 2015 and DEQ, 2005). Three pedons contained horizons with arsenic concentrations above the 40 mg/kg DEQ action threshold, two horizons had copper concentrations above the 310 mk/kg and 410 mg/kg EPA residential and industrial screening levels, and three horizons exceeded various EPA screening levels for lead. No samples exceeded guidelines for cadmium or zinc. The bulk of the limitations listed above occurred at pedon location BB-18 excavated in the Woodhurst soil type.

2.5.3.3 Suitability of Soils by Soil Series

The primary physical properties limiting soil salvage are high coarse fragment content, shallow bedrock, and shallow groundwater. Chemical properties limiting salvage include low pH and elevated metal/metalloid concentrations. A review of each of the soil pedon descriptions determined the most appropriate salvage depth for each soil series in consideration of the various limitations. Table 2-25 presents the recommended salvage depth for each soil series, the map unit that the series occurs in, and the limitations which formed the basis for the salvage depth determination was based.

Table 2-25. Summary of Recommended Salvage Depths

Soil Series	Map Unit Symbol[1]	1st Lift Depth[2] (Inches)	2nd Lift Depth[2] (Inches)	Limitation
Adel	Ad-b	12	--	Coarse fragments, arsenic
Caseypeak	Cp-c, *Cp-d*	6	--	Coarse fragments, bedrock, slope
Cheadle	Ch-b	6	--	Coarse fragments, bedrock,
Clunton	Cl-a	12	36	None[3]
Duckcreek	Dc-a	12	36	None
Farlin	Fa-b	12	36	Clay
Houlihan	Hl-b	12	--	Coarse fragments
Kimpton	Kp-c, *Kp-d*	12	--	Coarse fragments, pH, slope
Liberg	Lb-b	12	--	Coarse fragments, pH
Medicinelodge	Ml-a, Ml-b	12	24	Coarse fragments, shallow groundwater
Poin	Pn-b	12	--	Coarse fragments, pH, bedrock
Raynesford	Ry-b	12	24	Clay
Redchief	Rc-b	12	12	Coarse fragments, pH
Redfish	Rc-b	12	24	Coarse fragments, shallow groundwater
Sebud	Sb-b	12	12	Coarse fragments
Wineglass	Wg-b	12	12	Coarse fragments
Woodhall	Wa-b	12	--	Coarse fragments, arsenic, pH
Woodhurst	Wu-b	--	--	Coarse fragments, arsenic, copper, lead

[1] Italicized font indicates that the soil series is present in, but should not be salvaged from, the respective map unit.

[2] Listed depths are measured from non-disturbed soil surface. In other words, if Lift 1 = 12 inches and Lift 2 = 36 inches, a 24-inch thickness of material should be salvaged for Lift 2.

[3] Upper 6 inches of this soils are accumulated organic material that should not be included in mineral soil volume calculations.

2.5.3.1 Hydraulic Properties of Soil and Shallow Bedrock

The study included deep percolation tests completed at six locations and double-ring infiltrometer tests completed at nine locations in areas in the vicinity and representative of the locations proposed for the underground infiltration gallery construction (Figure 2.15). These locations occur within map units Ch-b, Pn-b, and Wg-b.

In general, surface soil horizons within map units Ch-b and Wg-b had limited ability to infiltrate water due to clay concentrations that increased with depth and resulted in decreased hydraulic conductivity in the typically shallow subsoil. Therefore, land application via surface irrigation or shallow drain fields would not provide optimum efficiency in these areas and may only be possible on a seasonal basis or of limited duration. This finding is consistent with NRCS data which rates these soils' ability to infiltrate water as "very limited" due to slow water movement based on modeled results (NRCS, 2011). Conversely, soils in map unit Pn-b of a more sandy texture infiltrated water much more quickly compared to other soils. This map unit is preferred for water disposal strategies involving surface irrigation. At test area BB1 within map unit Pn-b the soil surface and the underlying bedrock had similar hydraulic conductivities, approximately 10.3 feet/day (3.1 m) which equates to a water disposal capacity of approximately 2,300 gpm (8,700 Lpm) per acre (3,480 L/ha) of land surface (Tintina Alaska, Inc. 2012, Appendix E).

Soils within map unit Ch-b (test sites SP-10, SP-11, and BB2), Wa-b (test sites 2015-A, -B, -C and –D) and map unit Wg-b (test sites BB3 and BB5) were shallow but overlay highly fractured shale parent material. This shallow bedrock had relatively high hydraulic conductivities and therefore these map units are preferred as sites to construct underground infiltration galleries. Infiltration capacities of the shallow bedrock within map units Ch-b and Wg-b were similar and on average equated to a water disposal capacity of 6,000 gpm per acre (9,080 L/ha) of underground infiltration gallery trenching. Infiltration capacities measured in Map Unit Wa-b were somewhat less and average 1,765 gpm per acre (2,670 L/ha). It is important to note that it is not technically possible to discharge water evenly across the entire land surface area using a subsurface piping system. Therefore the discharge rates described for such a system should be considered the maximum volume possible per unit trenching area and not the amount possible per total unit land surface area.

This study submitted a composite sample of the A and B horizons from map unit Ch-b for analysis of saturated paste extractable metals. Metal concentrations were below the practicable quantification limits for most metals. Table 2-26 lists detected metal concentrations and Appendix E (Westech, 2015b) includes the laboratory report with limit values for non-detected metals. These data show that aluminum, barium, copper, iron, and manganese can be mobilized from area soils but it is not clear whether in-situ conditions would result in concentrations exceeding pertinent standards in run-off or seepage from LAD areas or underground infiltration galleries.

Table 2-26. Summary of Saturated Paste Extractable Metal Analysis

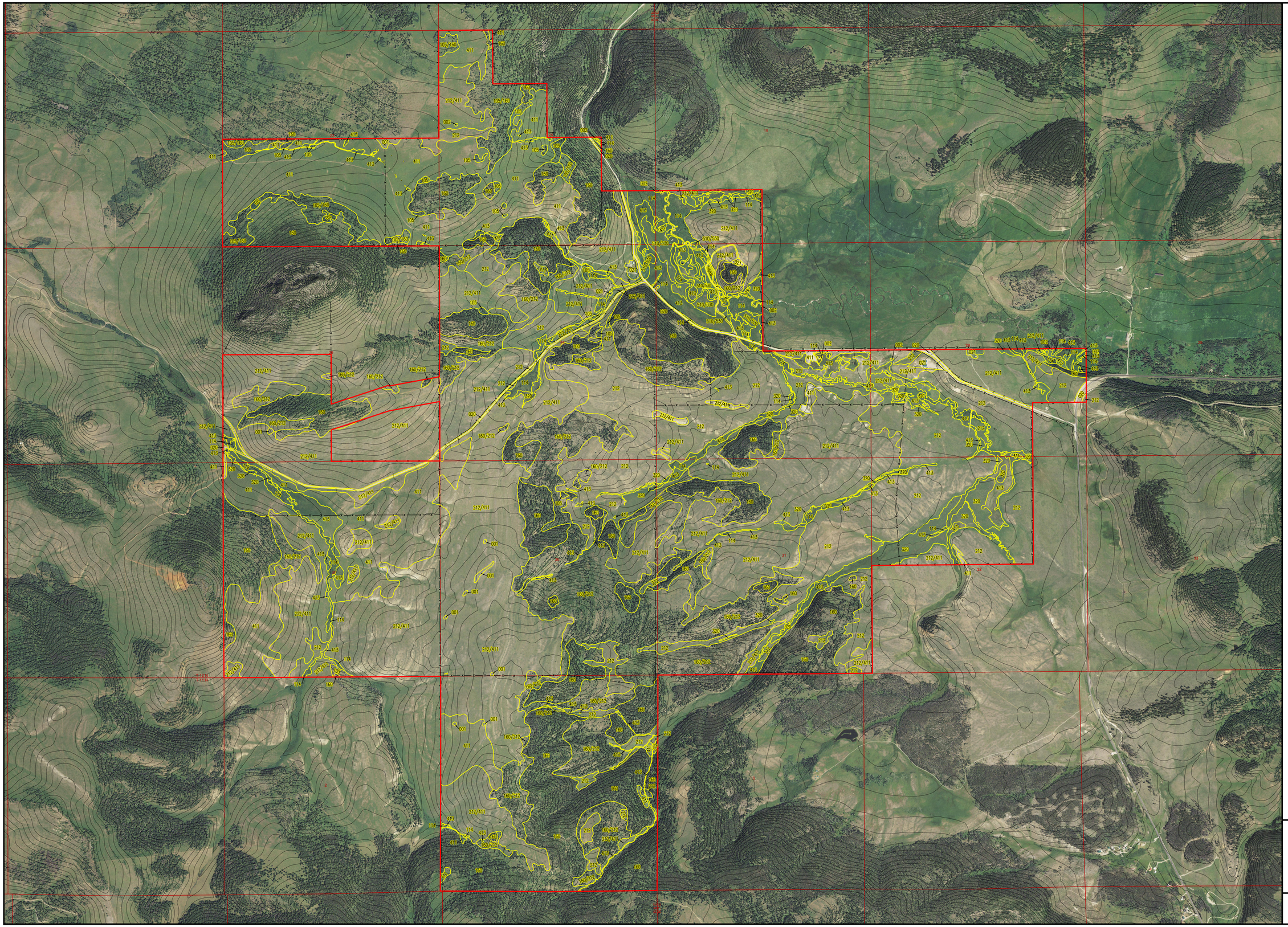
Identification	Horizon	Aluminum	Barium	Copper	Iron	Manganese
		Saturated Paste Extract Concentration (mg/L)				
Map Unit Ch-b	A	3.3	0.4	0.02	2.98	0.18
	B	3.9	0.3	0.01	5.81	0.53

2.6 Terrestrial Wildlife Resources

2.6.1 Wildlife Study Area and Methods

Terrestrial wildlife resources in the Project vicinity were evaluated for four seasons in 2014-2015 (Farmer 2015). A study area of approximately 5,290 acres (2,141 ha) ranged from the Sheep Creek bottomlands south and west through the adjacent uplands, and encompassed the permit area and associated facilities areas. Incidental observations near the study area were also recorded.

Elevations in the area are comparatively high, ranging from approximately 5,400 feet (1,646 m) in the east to approximately 6,200 feet (1,890 m) in the south, and averaging approximately 5,700 feet (1,737 m). Consequently, winters are comparatively long and cold, with deep snows, while summers are cool. Wildlife habitat diversity (Figure 2.16) (primarily Douglas-fir, sagebrush and bunchgrass with several minor types) in the study area is considered to be good, but the high elevations and harsh seasonal conditions appear to limit both wildlife species richness and favor limited seasonal use. A wildlife resources technical report is included as Appendix F (Westech, 2015c).



LEGEND

Pro□ect Boundary

Fence

Habitat Ty□e Boundary

Ma□

Symbol	Habitat Ty□e
001	Rock outcro□
002	Water
020	Road
021	Building
105	As□en
114	Willo□
160	Douglas-fir
212	Sagebrush
320	Lo□ mesic shrub
411	Bunchgrass
413	Ri□arian grass
510/530	Hay / tame □asture

Aerial: 2013 NAIP
To□o: 20' Generated from ⅓ second NED

Scale 1" □ 1000'

0 500 1000 2000

Feet

TINTINA RESOURCES

Black Butte Copper Project

Wildlife Habitat Map

Date: November 4 2015
Source: Westech (2015)

Figure 2.16

Sheet 1 of 1

09/18/15 - BBC15_Wild_Habitat.d□g □1:12,000

2.6.2 Wildlife Observed

The study recorded a total of 83 species (0 amphibians, 1 reptile, 20 mammals and 62 birds) in the study area in 2014-2015. Although the area has limited habitat availability for some species, all of the species recorded during the study were expected, based on habitat availability. The total number of species is undoubtedly low because many species are difficult to observe by the methods employed during the evaluation. Nevertheless, the Project area is considered to support good wildlife species richness.

The evaluation recorded no amphibians (although see Section 2.7.7 that identified a Columbian Spotted Frog (*Rana columbiana*) near Sheep Creek during aquatic sampling). Appropriate breeding habitat in the study area was limited to several small ponds, most of which were seasonal. The study noted no adults, egg masses or larvae at any of these sites. The only reptile observed was the common garter snake (*Thamnophis elegans*), which was recorded in a drainage near wetlands.

Big game species recorded in 2014-2015 include pronghorn, elk, mule deer, white-tailed deer and black bear. Pronghorn inhabited upland, non-forested habitats from spring through early autumn, and wintered at lower elevations several miles to the west. The study area is transitional range for elk; few were present in summer, and most use occurs in spring and autumn when elk move to/from winter range at lower elevations to the west. Mule deer inhabit the area in low numbers year-round and white-tailed deer were present in low numbers from spring through autumn, particularly along Sheep and Little Sheep Creeks. The study noted occasional reports of black bear from spring through autumn; and no one has documented denning in the study area.

The study recorded only the dusky grouse as an upland game species observed was, which some regard as uncommon.

The study recorded eleven species of raptors (vultures, eagles, hawks, falcons and owls) in the vicinity in 2014-2015: bald eagle, golden eagle, red-tailed hawk, ferruginous hawk, rough-legged hawk, northern harrier, sharp-shinned hawk, northern goshawk, American kestrel, great horned owl and great gray owl. The study located no nests of any raptors in the area.

2.6.3 Proposed or Candidates for Listing under the Endangered Species Act

The USFWS (2015) identified three terrestrial wildlife species that are listed or proposed candidates for listing under the Endangered Species Act for Meagher County. These include: Canada lynx (listed threatened), greater sage-grouse (candidate) and Sprague's pipit (candidate).

The dominant vegetation constituting lynx habitat in the Northern Rocky Mountains is subalpine fir, Engelmann spruce and lodgepole pine. Dry forest types (*e.g.*, dry Douglas-fir found in the Project area) do not provide lynx habitat (USFWS 2014). The Project area does not have the preferred habitat for the Canada lynx and the probability of a sighting in the area is considered to be very low. The USFWS (2014) delineated Designated Critical Habitat for the Canada lynx in Montana does not include Meagher County.

The greater sage-grouse (sage-grouse) is considered to be a sagebrush-dependent species (e.g., Connelly et al. 2011). There are known sage-grouse leks (display sites) 10-13 miles from the Project area, but there are no occurrences recorded within 10 miles (MTNHP 2015b).

Sprague's pipits prefer flat-to-gently rolling native mixed-grass prairie with intermediate height grasses (4-10 inches, 10 to 20 cm), little bare ground or club moss, no or few shrubs and no trees. They do not nest in patches of habitat less than 70 acres (28 ha), and prefer patches greater than 350 acres (142 ha) in size. Based on this description, the Project terrestrial wildlife study areas do not have the preferred requirements of the Sprague's pipit habitat.

2.6.4 Montana Vertebrate Species of Concern

Montana has established lists of vertebrate animal Species of Concern (MTNHP and FWP 2015). These lists comprise three categories: Species of Concern are "…considered to be "at risk" due to declining population trends, threats to their habitats, and/or restricted distribution." Potential Species of Concern are "…animals for which current, often limited, information suggests potential vulnerability or for which additional data are needed before an accurate status assessment can be made." Special Status Species "…have some legal protections in place, but are otherwise not recognized as federally listed under the Endangered Species Act and are not Montana Species of Concern."

The study area eleven such species were recorded in 2014-2015 field work:

- **Special Status Species:** the study recorded a single sighting of a transient bald eagle.
- **Potential Species of Concern:** The study recorded occasional evidence of porcupine (chews) in Douglas-fir habitat, and noted rufous hummingbirds in the area in August, but noted no nesting sites.
- **Species of Concern:** The study recorded occasional sightings of great blue herons along Sheep Creek but no nesting in or near the area; three sightings of transient golden eagles; and one sighting of a northern goshawk in spring but no nests noted. The study also included two observations of transient ferruginous hawks, both in autumn; and a single sighting of a great gray owl, in early autumn. The study area and vicinity has suitable habitat available, but the study recorded no owls in the area during the nesting season. Clark's nutcrackers inhabit the study area on a regular basis; Baird's sparrows inhabit big sagebrush and bunchgrass habitats in spring; and bobolinks enjoy the hay and tame pasture in late summer. The study considered both Baird's sparrows and bobolinks as migrants.

2.7 Aquatic Resources

It is important to document existing water quality, baseline aquatic community surveys, and stream habitat conditions in the study area prior to any actual mine development. In this study, habitat evaluations were based on the health and diversity of aquatic populations of fish, mussels, macroinvertebrates and periphyton.

2.7.1 Aquatics Study Area and Methods

Morrison-Maierle conducted initial Baseline Aquatic Surveys during the fall of 2014 and the spring and summer of 2015. The first year of seasonal baseline surveys for the assessment of fish, mussels, macroinvertebrates, periphyton and habitat evaluation at sites in the Project area and Sheep Creek drainage basin used Tenderfoot Creek as a reference reach. Project goals were:

1. Standardized surveys and collection of baseline information on the aquatic communities present at stream sites associated with established surface water-quality monitoring sites prior to mine development, and
2. An assessment of aquatic community integrity with key indicators comparing these against biotic thresholds of reference condition standards.

These 2014 and 2015 data represent the first year of a multi-year, seasonal, reach-scale baseline conditions to be completed prior to proposed mine activity (i.e., pre-impact sampling design).

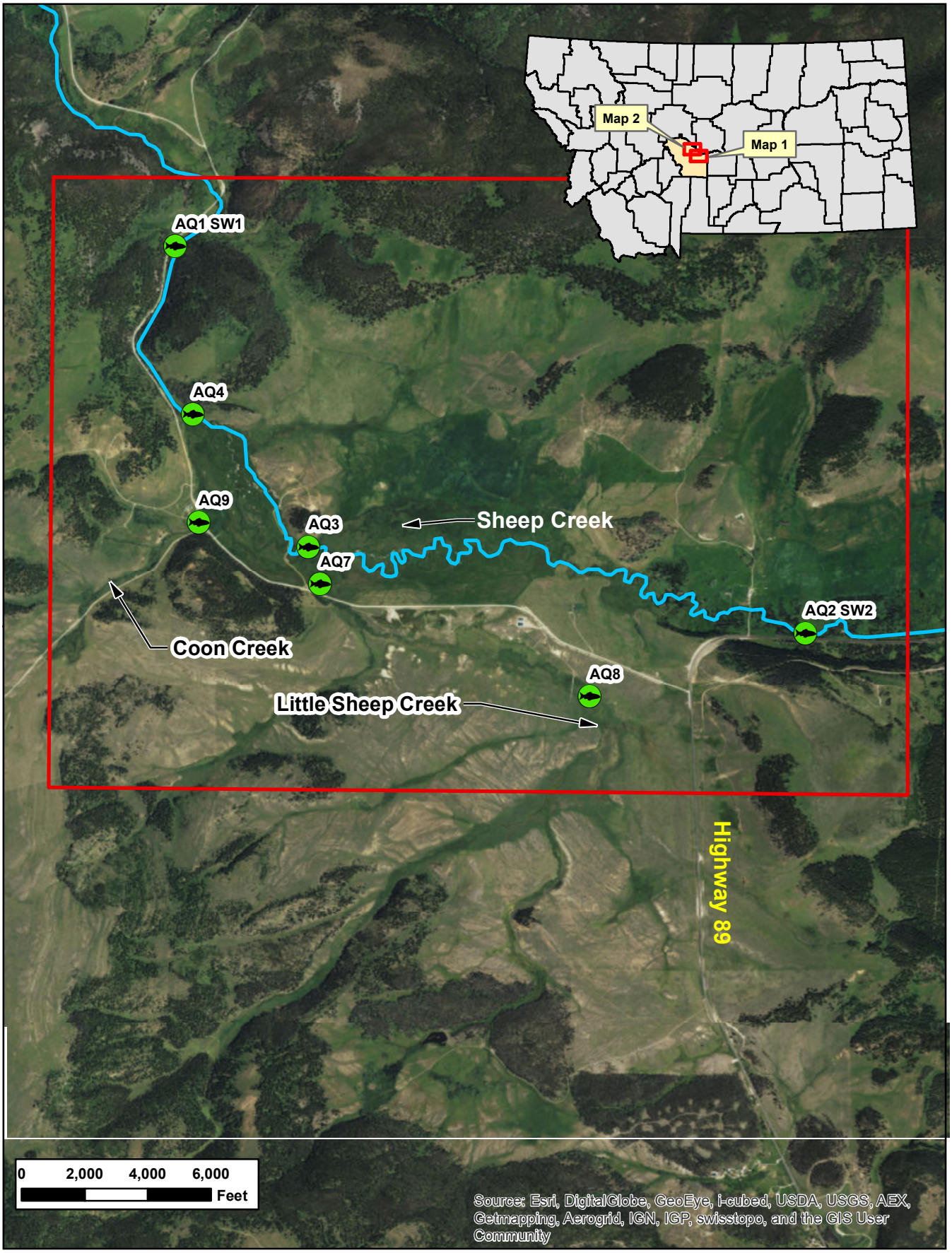
Surveyors performed habitat assessments, and macroinvertebrate, mussel, periphyton and fish surveys on similar dates along the same stream reaches of Sheep, Little Sheep and Tenderfoot Creeks in both 2014 and 2015. Figure 2.17 and Figure 2.18 are maps of baseline aquatic survey sampling sites for the Sheep Creek and Tenderfoot drainages, respectively. These surveys used a Before, After, Control and Impact (BACI) sampling design with Before, After, and Control sample sites both at upstream and at off site reference locations; and Impact sample sites both within and downstream of proposed mine activity. Surveyors sampled Coon Creek, another potential impact site, for fish in 2014 and macroinvertebrates in 2015. In total, surveyors sampled nine stream reaches in 19 fish sampling events, and collected nine macroinvertebrate and eight periphyton samples at established water quality sampling sites during the survey visits. The survey included visual inspection of all stream reaches for mussels and amphibians. Calculations for biological community integrity for nine survey reaches and 19 fish surveys used fish Integrated Biotic Indices (IBIs) and Observed/Expected models (O/E), while assessments of the nine macroinvertebrate and eight periphyton samples used DEQ's multi-metric indices (MMIs). Appendix G (Morrison-Maierle, 2015) contains a detailed technical report on aquatic resources.

2.7.2 Habitat and Water Quality Evaluations

Hydrometrics, Inc. has conducted water quality sampling at four aquatic community (AQ) sampling sites quarterly over a four year period beginning in the spring of 2011. Of the nine aquatic sampling reaches evaluated in the study area, the survey found five in Proper Functioning Condition (PFC) with a stable trend, and found four it deemed Functional at Risk (FAR). Sites received a FAR ranking either because they had riparian habitat altered by cattle (Little Sheep AQ8, Sheep Creek AQ2, Tenderfoot AQ5) or by human stream manipulation (Sheep Creek AQ1 and AQ2). The study, using both the BLM Habitat and Proper Functioning Condition (PFC) Assessment methods, gave the highest site integrity scores to the Sheep Creek upper (AQ3) and lower (AQ4) reaches and Tenderfoot Creek (AQ6). It is important to note that the riparian habitat of the lower reference reach on Tenderfoot Creek (AQ5) is moderately degraded.

2.7.3 Fish Communities

Overall, the study identified seven fish species and one hybrid (four native / four introduced) from 3,862 individuals collected during 19 stream reach surveys (Morrison- Maierle, 2014 and 2015). The average number of fish species per site across the study area was 3.6 with a standard error of ± 0.6, while the average number of native fish species was 1.5 with a standard error of ± 0.4. Rocky mountain sculpin comprised the highest proportion of total individuals collected at 72%, and had 100% site occupancy (n=8); and at the other extreme, the study showed that Coon Creek has no fish. The other native species, mountain whitefish, longnose dace and white sucker, had site occupancy rates of 38 %, 13 %, and 13 %, respectively. Sheep Creek (AQ3), the most diverse fish site in the study area has seven species, four of which are native. The surveys identified no fish species of concern (SOC). The surveys collected rainbow trout at seven of eight 8 sites, and reported brook trout at four sites (Little Sheep Creek and Sheep Creek AQ2 and AQ3). Rainbow trout densities during fall 2014 in Sheep Creek (AQ1) (avg. 1,968 per mile) were most similar to the reference reach, Tenderfoot Creek (avg. 1,075 per mile). Seasonal salmonid densities at all sites varied significantly. The study developed significant length / weight relationships and size-frequency tables for sculpin, rainbow, brook and brown trout as baseline population indicators.



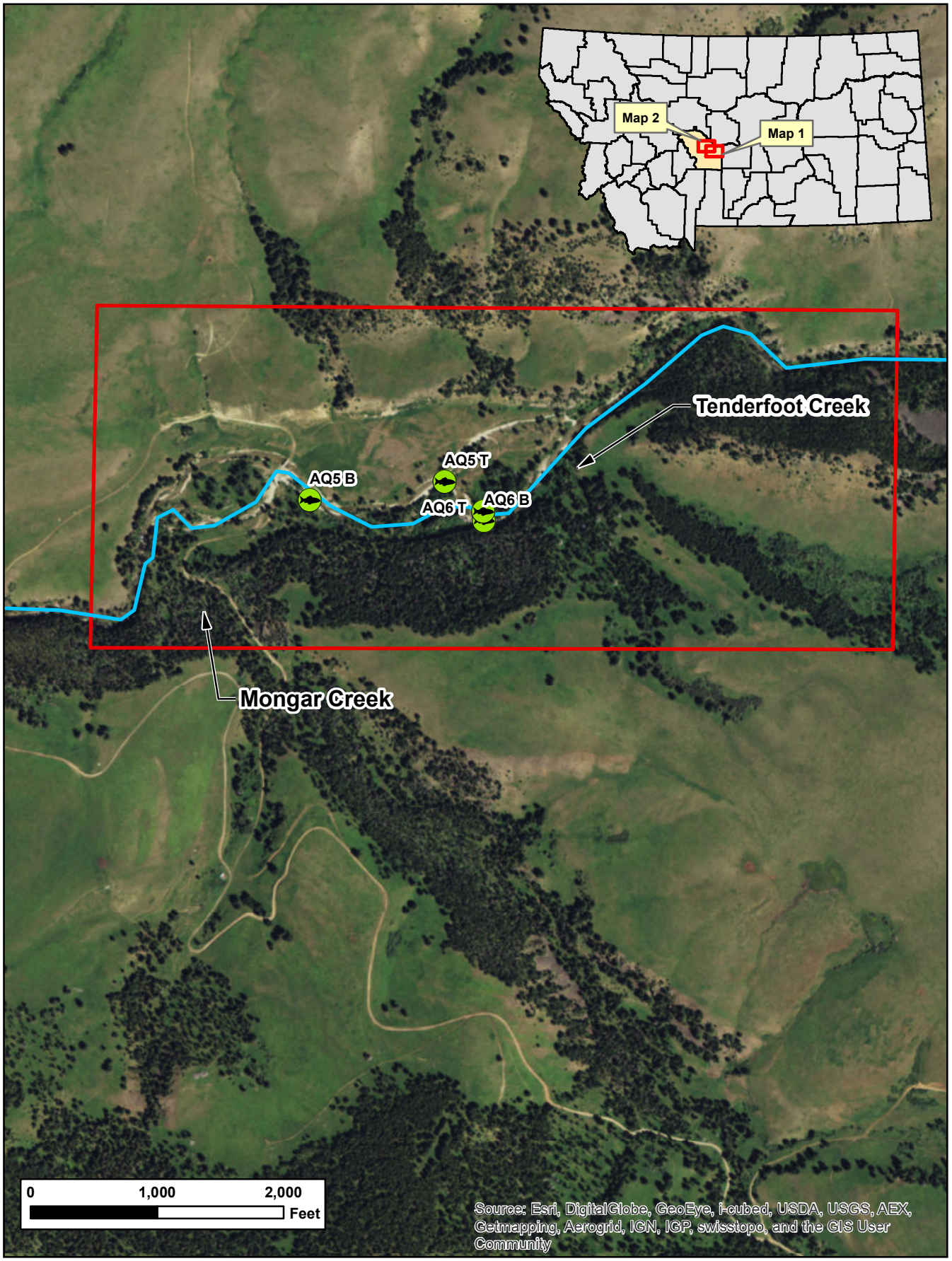
Date: November 3, 2015 Source: Morrison Maierle (2015)

Legend

- Aquatic Sample Points
- Investigation Area
- Sheep Creek

TINTINA RESOURCES

Figure 2.17
Sheep Creek Aquatic Sampling Sites
Black Butte Copper Project
Meagher County, Montana



Date: November 3, 2015 Source: Morrison Maierle (2015)

Legend

- Aquatic Sample Points
- Investigation Area
- Tenderfoot Creek

TINTINA RESOURCES

Figure 2.18
Tenderfoot Creek Aquatic Sampling Sites
Black Butte Copper Project Meagher County, Montana

2.7.4 Mussel Surveys

Within the Project area, no previous surveys identified the western pearlshell mussel (WEPE), a Montana SOC well documented in the Smith River basin. Therefore, the study included a specific search for WEPE in all stream reaches (approximately 1 man-hour per 980 feet (300m reach)) with aqua-scopes using a longitudinal transect survey technique covering all stream geomorphic units. This provided no evidence of WEPE presence (live or dead shells) during the surveys in Sheep, Little Sheep or Tenderfoot (Morrison-Maierle, 2015) Creeks. In addition, the study found no shell fragments which would have indicated earlier historic populations.

2.7.5 Macroinvertebrate Communities

This study records one hundred and twelve (112) unique macroinvertebrate taxa from the eight macroinvertebrate assessment samples collected in 2014 and the one sample collected in 2015. The study collected no Montana SOC invertebrates, but the macroinvertebrate community at the Sheep Creek AQ4 site had very high integrity that resembled the integrity of the reference Mountain Stream (Tenderfoot Creek). Sheep Creek AQ4 also reported the highest taxa richness (60 species) and the highest number of combined mayfly, caddisfly, and stonefly taxa (EPT) at 19 species. The EPT Index uses three orders of aquatic insects that are easily sorted and identified and is commonly used as an indicator of water quality. Tenderfoot Creek reported the highest integrity scores ranked by DEQ MMI protocols (avg. 70), while Sheep Creek sites averaged 61.4, which was significantly lower, and ranked slightly impaired by DEQ thresholds. Average macroinvertebrate richness across all sites was 44.7 taxa, while EPT taxa averaged 15 per site. Both Little Sheep Creek sites ranked impaired by DEQ Mountain MMI with scores <63, but ranked unimpaired with the Low Valley MMI with scores >48. The DEQ MMI ranked upstream and downstream reaches of the Sheep Creek treatment sites similarly.

2.7.6 Periphyton Communities

Overall, eight periphyton assessment samples collected in 2014 contained 146 unique diatom and algae taxa from eight periphyton assessment samples collected in 2014. No periphyton species are listed as SOC in Montana. Diatoms were the most dominant taxa in six of eight study sites. Sheep Creek AQ3 reported the highest taxa richness (71 spp.), while the average peripyton richness per site was 57 taxa. Based on Teply's Diatom Index (TDI), the lower site Sheep Creek AQ1 had the highest probability (61.4%) of impairment, and other Sheep and Little Sheep Creek sites had less than a 33% chance of being impaired. Sites that the TDI ranked least likely to be impaired (<17%) were both of the Tenderfoot Creek reference sites.

2.7.7 Amphibian and Reptile Incidentals

The only amphibian and reptilian species observed or collected in conjunction with the aquatic assessment surveys are one amphibian species, the Columbian Spotted Frog (*Rana columbiana*) at Sheep Creek AQ4, and one reptilian species, a terrestrial garter snake (*Thamnophis elegans*). Previous work recorded a Montana SOC amphibian species, the western toad (*Anaxyrus boreas*), near the Sheep Creek AQ2 site, but these surveys found none.

2.7.8 Conclusions

Aquatic communities surveyed in 2014 and 2015 on the Sheep Creek (impact and control) sites and the Tenderfoot Creek (reference) sites showed similarities. Aquatic communities at all sites are exhibiting signs of nutrient enrichment, likely due to cattle ranching. Riparian habitat at three sites (AQ2, AQ5 and AQ8) ranked degraded because of alterations by cattle. Fish species richness and diversity were higher in the Sheep Creek sites than the Tenderfoot reference reaches, and were similar between the upstream

control reaches and the downstream impact reaches of the study. In contrast, initial baseline biotic integrity of macroinvertebrate and periphyton communities was significantly higher in the Tenderfoot Creek reaches. Overall fish densities were highest in the Tenderfoot Creek reference reach, except for brook trout which reported high average densities in Little Sheep Creek AQ7.

2.8 Vegetation Resources

The study based the Project area vegetation classification on published classifications of vegetation types developed statewide for Montana. Figure 2.19 is a vegetation Habitat Map. Table 2-27 lists habitat and community types for each physiognomic classes sampled in the Vegetation study area in 2015. Appendix H (Westech, 2015d) presents a list of vascular plant species identified for the Project baseline vegetation inventory.

2.8.1 Vegetation Habitat Types

This survey identified four native Grassland habitat types in two series including the *Festuca idahoensis* (Idaho fescue) and *Festuca campestris* (rough fescue) series (Table 2-27). The study also identified an Upland Altered Grassland community type dominated by non-native perennial grasses *Poa pratensis* (Kentucky bluegrass) and *Phleum pratense* (common timothy).

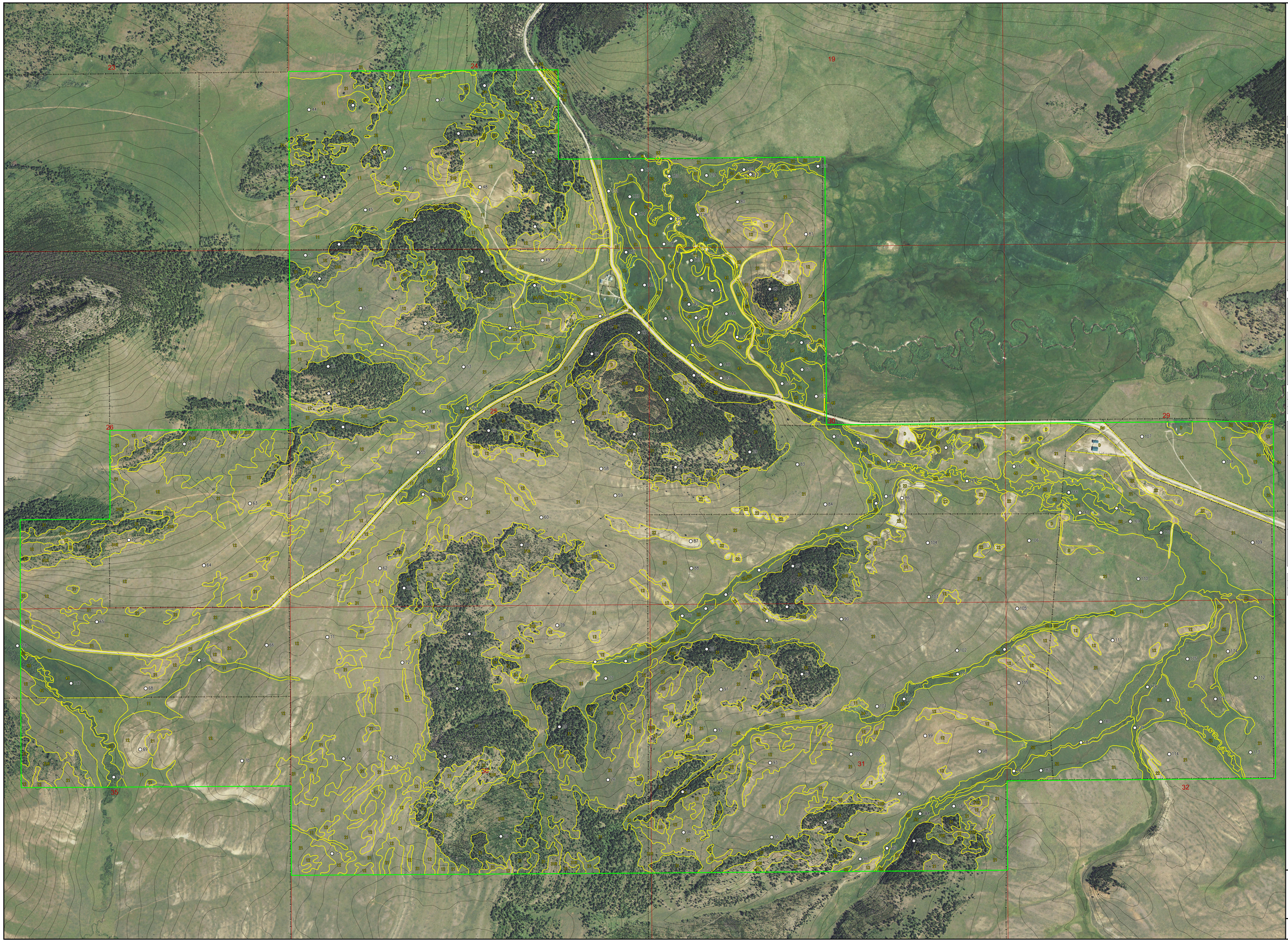
The study sampled six Upland Shrubland types, dominated either by *Artemisia tridentata* (big sagebrush) or *Dasiphora fruticosa* (shrubby cinquefoil). *Festuca idahoensis, Festuca campestris,* and *Poa pratensis* dominated or variously distinguished understories.

Of seven Conifer Forest and Woodland habitat types identified, six were in the *Pseudotsuga menziesii* (Douglas-fir) series, and one in the *Picea engelmannii* (Engelmann spruce) series. *Festuca idahoensis, Festuca campestris, Juniperus communis* (common juniper), *Calamagrostis rubescens* (pinegrass), *Symphoricarpos albus* (common snowberry), and *Linnaea borealis* (twinflower) dominate understories.

The survey sampled a Lowland Altered Grassland or Hay Meadow type at 16 sites, primarily on the Sheep Creek floodplain.

The survey classified, according to physiognomic type, three primary Riparian-Wetland types including Herbaceous, Shrub and Deciduous Tree. The Herbaceous Riparian-Wetland type samples came from mesophytic/ hydrophytic habitat types or community types dominated by various associations of *Juncus balticus* (Baltic rush), *Carex nebrascensis* (Nebraska sedge), and *Carex utriculata* (southern beaked sedge). The Shrub Riparian-Wetland type includes three mesophytic or hydrophytic low shrub community types in the *Dasiphora fruticosa* series, and two hydrophytic tall shrub community types dominated by *Salix bebbiana* (Bebb willow) or *Salix geyeriana* (Geyer willow). The Deciduous Tree Riparian-Wetland type was comprised of one community type and one habitat type in the *Populus tremuloides* (quaking aspen) series.

The diversity of community types in the inventory area is largely representative of other, lower to middle elevation study areas in central Montana, as listed in the literature review table in Appendix H, Sub-Appendix B (Westech, 2015d). All vegetation types identified in this study have been documented in previous studies in the region under the same or similar type names, as reviewed and summarized from published literature and unpublished technical reports.



LEGEND

- Study Area Boundary
- Vegetation Ty e Boundary
- Vegetation Sam le Site
- Fence

MAP UNIT	VEGETATION TYPE
	UPLAND GRASSLAND
11	**Upland Altered Grassland c.t.**
12	**Upland Native Grassland**
	Festuca idahoensis / Agropyron spicatum h.t.
	Festuca idahoensis / Stipa richardsonii h.t.
	Festuca campestris / Agropyron spicatum h.t.
	Festuca campestris / Festuca idahoensis h.t.
	UPLAND SHRUBLAND
21	*Artemisia tridentata / Poa pratensis* c.t.
	Artemisia tridentata / Festuca idahoensis h.t.
	Artemisia tridentata / Festuca campestris h.t.
	Artemisia tridentata - Dasiphora fruticosa / Poa pratensis c.t.
	Dasiphora fruticosa - Artemisia tridentata / Festuca campestris c.t.
22	Mixed Shrub-Shale Outcrop c.t.
	CONIFER FOREST AND WOODLAND
31 and 31R*	*Pseudotsuga menziesii / Festuca idahoensis* h.t.
	Pseudotsuga menziesii / Festuca campestris h.t.
	Pseudotsuga menziesii / Juniperus communis h.t.
	Pseudotsuga menziesii / Calamagrostis rubescens h.t.
	Pseudotsuga menziesii / Symphoricarpos albus h.t.
32 and 32R*	*Pseudotsuga menziesii / Linnaea borealis* h.t.
	Picea engelmannii / Linnaea borealis h.t.
	LOWLAND ALTERED GRASSLAND
41	Noxious Weed Tailings c.t.
42	Lowland Altered Grassland c.t.
43	Hay Meadow
	RIPARIAN AND WETLAND (RW)
51	**Herbaceous RW types**
	Juncus balticus c.t.
	Carex nebrascensis c.t.
	Carex utriculata h.t.
52	**Low Shrub (Cinquefoil) RW types**
	Dasiphora fruticosa / Poa pratensis c.t.
	Dasiphora fruticosa / Deschampsia cespitosa c.t.
	Dasiphora fruticosa / Carex utriculata c.t.
53	**Tall Shrub (Willow) RW types**
	Salix bebbiana series
	Salix geyeriana series
54	**Deciduous Forest (Aspen) RW types**
	Populus tremuloides / Osmorhiza occidentalis h.t.
	Populus tremuloides / Poa pratensis c.t.
	MISCELLANEOUS
D	Disturbed
Rd	Road
W	Water

* R = immature stands of seedling, sapling, pole-sized trees in logged areas with conifer recruitment or where conifers are encroaching into grassland and shrubland areas.

Note: Acreage for com osite ma units (mosaic of vegetation ty es) is generated using the follo ing percentages:

Ma Unit	Percent of Acreage
X/Y	60/40

Aerial: 2013 NAIP
To o: 20' Generated from ½ second NED

Scale 1" = 400'

0 100 200 300 Feet

TINTINA RESOURCES

Black Butte Copper Project

Vegetation Habitat Map

Date: November 4 2015
Source: Western (2002)

Figure 2.19

I:\229-15 - BBC\16_Vegetation.ai - g - 11.4.2015

Table 2-27. Vegetation Types Identified in the Black Butte Project Baseline Study Area

VEGETATION TYPE[1]	PLOT NUMBERS	n
UPLAND GRASSLAND		**28**
Upland Altered Grassland c.t.	44, 45, 46, 47, 50, 52, 67, 78, 85	9
Festuca idahoensis/Agropyron spicatum h.t.	63, 68, 69	3
Festuca idahoensis /Stipa richardsonii h.t.	61, 107	2
Festuca campestris/Agropyron spicatum h.t.	48	1
Festuca campestris/Festuca idahoensis h.t.	56, 62, 64, 65, 66, 70, 71, 72, 73, 74, 75, 93, 108	13
UPLAND SHRUBLAND		**44**
Artemisia tridentata/Poa pratensis c.t.	51, 53, 54, 57, 77, 83, 84, 88, 92, 95, 97, 100, 101	13
Artemisia tridentata/Festuca idahoensis h.t.	99, 105, 111	3
Artemisia tridentata/Festuca campestris h.t.	49, 55, 58, 59, 60, 76, 79, 81, 90, 91, 94, 98, 102, 103, 104, 114, 115	17
Artemisia tridentata-Dasiphora fruticosa/Poa pratensis c.t.	89, 96, 109, 110, 112, 116	6
Dasiphora fruticosa-Artemisia tridentata/Festuca campestris c.t.	80, 106, 113	3
Mixed Shrub-Shale Outcrop c.t.	86, 87	2
CONIFER FOREST AND WOODLAND		**40**
Pseudotsuga menziesii/Festuca idahoensis h.t.	13	1
Pseudotsuga menziesii/Festuca campestris h.t.	11, 12, 15, 17, 19, 20, 23, 28, 34, 38, 42, 43	12
Pseudotsuga menziesii/Juniperus communis h.t.	14, 24, 25, 26, 29, 32, 33, 40	8
Pseudotsuga menziesii/Calamagrostis rubescens h.t.	31, 35	2
Pseudotsuga menziesii/Symphoricarpos albus h.t.	1, 4, 5, 7, 16, 18, 27, 30, 36, 37, 39	11
Pseudotsuga menziesii/Linnaea borealis h.t.	10, 21, 22, 41	4
Picea engelmannii/Linnaea borealis h.t.	6, 9	2
LOWLAND ALTERED GRASSLAND		**17**
Noxious Weed tailings c.t. (2014/2015)	162	1
Lowland Altered Grassland (Hay Meadow) c.t.	117, 133, 134, 135, 138, 139, 140, 141, 143, 144, 145, 148, 151, 152, 153, 165	16
RIPARIAN AND WETLAND (RW)[3]		**56**
Herbaceous RW types		(15)
Juncus balticus c.t.	129, 149, 163, 164, 176	5
Carex nebrascensis c.t.	127, 166	2
Carex utriculata h.t.	126, 146, 167, 168, 172, 174, 178, 179	8
Shrub RW types		(37)
Dasiphora fruticosa/Poa pratensis c.t.	82, 118, 160, 169, 170, 177	6
Dasiphora fruticosa/Deschampsia cespitosa c.t.	175, 180, 182, 185	4
Dasiphora fruticosa/Carex utriculata c.t.	155, 173	2
Salix bebbiana series	120, 122, 123, 125, 156, 157, 158, 159, 161, 171, 181, 183, 184	13
Salix geyeriana series	119, 121, 128, 130, 131, 132, 136, 137, 142, 147, 150, 154	12
Deciduous Forest RW types		(4)
Populus tremuloides/Osmorhiza occidentalis h.t.	8	1
Populus tremuloides/Poa pratensis c.t.	2, 3, 124	3
	TOTAL SAMPLE SITES	**185**

[1]Grassland and shrubland habitat types were identified following Mueggler and Stewart (1980); Forest habitat types follow Pfister *et al.* (1977), and Wetland/ Riparian types follow Hansen *et al.* (1995), with minor modifications. In these classifications, vegetation types are named according to the following:
A slash (/) indicates a separation of species dominating one or more strata, namely the herbaceous, shrub and/or tree layers; c.t. = community type, h.t. = habitat type n = sample size (number of 0.01-acre canopy cover plots.

2.8.2 Vegetation Productivity and Utility

The primary land uses in the vegetation study area are livestock grazing (rangeland) and hay production (lowland altered grassland). The NRCS (2003) presents recommended stocking rates for the applicable soils in Meagher County, relative to good-excellent condition in the perceived "Historic Climax Plant Community." Additionally, NRCS (2003) gives long-term irrigated and non-irrigated hay yields by soils mapping unit that can be expected under a high level of management. (Appendix H) (Westech, 2015d) summarizes information pertinent to the vegetation study area.

2.8.3 Vegetation Species List/MT National Heritage Program- Listed Species

The 2015 inventory of the vegetation study area identified a total of 398 vascular plant taxa during, with forbs (278 species) comprising the majority (70 percent). Forbs included 235 perennial taxa (213 native, 16 introduced and 6 fern allies), and 43 annual/biennial taxa (31 native and 12 introduced). The 82 grasses and grass-like plants identified (21 percent of the total plant taxa), included 78 perennial taxa (66 native and 12 introduced), and 4 annual taxa (2 native and 2 introduced). The 38 woody plant taxa (9 percent of the total plant taxa) recorded in the study area included 31 shrubs and vines, and 7 tree species.

No federally listed or proposed endangered or threatened plant species are known to occur in the vicinity of the Project area, and the 2015 baseline vegetation inventory recorded none. A search of the MTNHP (2015) website for plant SOCs in Meagher County found that one had previously been identified in the vegetation study area, *Cirsium longistylum* (long-styled thistle).

2.8.4 Weeds

State-listed noxious weeds are given on the "Montana Noxious Weed List, Effective December, 2013" (Montana Department of Agriculture 2014). The baseline vegetation inventory encountered four state-listed weed species (all Priority 2B), and one Priority 3 regulated plant species (*Bromus tectorum*, cheatgrass) in the study area. Noxious weeds in the vegetation study area included *Centaurea maculosa* (spotted knapweed), *Cirsium arvense* (Canada thistle), *Cynoglossum officinale* (common houndstongue) and *Leucanthemum vulgare* (oxeye daisy).

Another potentially problematic weed species recorded (but not listed as noxious), *Carduus nutans* (musk thistle), was more common than the listed noxious weed species, occurring in almost every vegetation physiognomic type present in the study area, occasionally in dense patches.

2.9 Cultural Resources

2.9.1 Cultural Resources Introduction and Methods

Prior to submitting an application to the Montana DEQ for an amendment to their Montana Exploration License in 2011, DEQ encouraged Tintina to conduct cultural resource inventories of areas targeted for mine disturbance. Even though cultural resource inventories are not required on private property, Tintina contracted Tetra Tech, Inc. (Tetra Tech) to conduct these inventories in support of Tintina's Mine Operating Permit Application (this document). Appendix I (Tetra Tech, 2015) presents a complete technical baseline Cultural Resource Inventory report to this Application. Previous cultural assessment data from work associated with a nearby road improvement project (Wood, 1994) and a Central Montana Communications buried cable project (Brumley 2010 and 2011) also support the current studies.

Project archaeologists used a Trimble GeoXT to ensure they accurately followed inventory boundaries. The Trimble also recorded locations of cultural resources and Tetra Tech staff differentially corrected this

data with Pathfinder Office software at the Tetra Tech office. All cultural properties identified were recorded on Montana Cultural Resources Information (CRIS) forms. The surveyors collected no artifacts in the field.

2.9.2 Cultural Resources Inventoried and Study Area

Cultural resource inventories examined a total of 1500 acres (607 ha) in the Project area and documented 14 prehistoric and 6 historic sites (Figure 2.20 and Table 2-28). Prehistoric sites consist of 13 lithic scatters (a surface scatter of cultural artifacts and debris that consists entirely of lithic (i.e., stone) tools and chipped stone debris). The proposed mine facilities will likely impact four lithic scatters (24ME164, 24ME165, 24ME1108, and 24ME1109). Additionally, disturbance may occur at four lithic scatters (24ME162; 24ME1105; 24ME1107; 24ME1110), as these sites occur 25 to 65 feet (8 to 20 m) from proposed mine facilities. In 2012, lithic scatter at site 24ME163 was tested by archaeological excavation prior to the proposed construction of an exploration road project.

Testing identified the existence of an intact, subsurface cultural deposit, and 24ME163 archaeologists recommended this site as eligible to the National Register of Historic Places (NRHP) (Tetra Tech 2013b). However, they did not excavate or further study this site since road modification work within the site boundary consisted of laying down a layer of fill material, thus avoiding any project impacts.

Historic properties identified in the Project area include a log structure, a mining site, two roads, a homestead, and a sheepherder's rock cairn. With the exception of the sheepherder's cairn, this study recommends historic sites (24ME158, 24ME159, 24ME925, 24ME936, and 24ME940) as not eligible for NRHP listing, and recommends no further work. This study recommends the sheepherder's cairn, 24ME1104, as eligible for NRHP listing under Criterion C. This feature lies approximately ¼-mile (400 m) from the nearest proposed mine feature, suggesting avoidance of this cairn is possible.

2.9.3 Cultural Resource Recommendations

Mining construction should avoid any site determined NHRP eligible, or if this is not possible, site impacts should be mitigated through archaeological excavation and the recovery of cultural material that will broaden the understanding of prehistoric lifeways along Sheep Creek. (Figure 2.20) shows the locations of the cultural resources in relation to the proposed facility construction areas. Tintina has indicated some mine features may be moved to avoid cultural sites. If avoidance is not possible, sites not previously tested, should receive evaluation for NRHP eligibility, and if recommended eligible, impacts should be mitigated through archaeological excavation and recovery of cultural material. To date, only sites 24ME163 and 24ME1104 were tested and found NRHP eligible.

Table 2-28. Cultural Resources in the Black Butte Copper Project Area

Site Number	Site Type	Possible Mine Feature/Facility Disturbance	NRHP Recommendations
24ME158	Historic Log Structure	None	Not eligible under Criteria A-D.
24ME159	Historic Mining	None	Not eligible under Criteria A-D.
24ME160	Lithic Scatter	None	Archaeological testing to determine eligibility under Criterion D.
24ME161	Lithic Scatter	None	Archaeological testing to determine eligibility for Criterion D.
24ME162	Lithic Scatter	A vent raise (16-ft. in diameter) is planned for the vicinity of 24ME162. Site avoidance is possible.	Archaeological testing to determine eligibility under Criterion D.
24ME163	Lithic Scatter	No mine features are proposed to date. If this changes, 24ME163 needs to be avoided or mitigated.	Site tested and recommended eligible to the NRHP.
24ME164	Lithic Scatter	Located within the Process Water Pond boundary.	Archaeological testing to determine eligibility/ Criterion D.
24ME165	Lithic Scatter	Located within the Process Water Pond boundary.	Archaeological testing to determine eligibility/ Criterion D.
24ME166	Lithic Scatter	None; site occurs 50 meters (164 ft.) from Access Road and 75 meters (246 ft.) from Process Water Pond boundary.	Archaeological testing to determine eligibility under Criterion D.
24ME925	Historic Road- Sheep Creek	None	Not eligible under Criteria A-D.
24ME936	Historic Road- Butte Creek	None	Not eligible under Criteria A-D.
24ME940	Historic Homestead	None	Not eligible under Criteria A-D.
24ME1104	Historic Sheepherder's Cairn	None; Diversion Channel and Cemented tailings Facility approximately ¼ mile to the east.	Eligible under Criterion C.
24ME1105	Lithic Scatter	Disturbance is possible as 24ME1105 lies 20 meters (66 feet) from the Process Water Pond Diversion channel. Tintina may relocate channel to avoid this site.	Archaeological testing to determine eligibility under Criterion D.
24ME1106	Lithic Scatter	None; 300 meters (984 ft.) from Cemented tailings Facility.	Archaeological testing to determine eligibility under Criterion D.

Site Number	Site Type	Possible Mine Feature/Facility Disturbance	NRHP Recommendations
24ME1107	Lithic Scatter	Disturbance is possible as Main Access Road lies 10 meters south of 24ME1107. Tintina may alter road alignment to avoid this site.	Archaeological testing to determine eligibility under Criterion D.
24ME1108	Lithic Scatter	Main Access Road bisects 24ME1108.	Archaeological testing to determine eligibility under Criterion D.
24ME1109	Lithic Scatter	An Access Road bisects this site. Additionally, the Mill Pad and Temporary Storage of Waste Rock will likely disturb 24ME1109.	Archaeological testing to determine eligibility under Criterion D.
24ME1110	Lithic Scatter	Disturbance is likely as Access Road occurs eight meters (26.3 ft.) (South of 24ME1110.	Archaeological testing to determine eligibility under Criterion D.
24ME1111	Sheep Creek Surface Stone District	District area will be disturbed with construction of the Adit, Mill Pad, Temporary Waste Rock Storage, Portal Pad, Vent Raises, Cemented tailings Facility, Contact Water Pond, Process Water Pond, and Access Roads.	Presence of intact, subsurface cultural deposit at 24ME163 suggests NRHP eligibility under Criterion D.

2.10 Socio-economic Resources

2.10.1 Population

Meagher County is sparsely populated by both Montana and US standards. The land area, is 2,391.82 square miles and the population density is 0.8 people per square mile, while the average for Montana in 2010 was 7.0 people per square mile. Table 2-29 shows the 2010, 2014, and 2010 – 2014 trends in population, along with the population density (people per square mile) for Meagher County, the state of Montana, and the US. The population in Meagher County has decreased slightly since 2010. The US Census Bureau reports that migration out of the county is greater than migration into the county, and the number of births has also decreased. These are the causes of the decline in population in the county.

Table 2-29. Meagher County, Montana, and US Population and Trend

Year	Meagher County	Montana	US
2014	1,853	1,023,579	318,857,056
2010	1,891	989,415	308,745,538
2010 to 2014	-2.0%	3.5%	13.3%

Source: US Census 2015a, 2015b

Table 2-30 lists the population of White Sulphur Springs and other nearby towns and their distance from the Project site. Figure 2.22 shows locations of towns. More than 142,000 people live less than 100 miles from the Project site.

Table 2-30. Population of Towns and Distance from Project Site

Town or City	Population	Distance from White Sulphur Springs
White Sulphur Springs	925	0
Billings	108,869	164
Great Falls	56,690	64
Bozeman	41,660	95
Helena	29,943	91
Livingston	7,245	87
Lewistown	5,867	130
Townsend	1942	57
Three Forks	1903	92
Harlowton	974	82
Belt	604	35
Martinsdale	530	51
Ringling	45	36

2.10.2 Demographics

Demographics is a characterization of the population. Table 2-31 shows the populations of Meagher County, Montana, and the US by age group in 2009. Meagher County has a significantly higher proportion of its population over the age of 65 compared to Montana and the US average.

Table 2-31. Age Groups in Meagher County, Montana, and US Population

Age Group	Meagher County	Montana	US
Under 5 years old, percent, 2013	5.9%	6.0%	6.3%
Under 18 years old, percent, 2009	18.7%	22.1%	23.3%
65 years old and over, percent, 2009	25.0%	16.2%	14.1%

Data from US Census 2015a, 2015b

2.10.3 Employment by Industry

Meagher County is rural and the main industry is farming and ranching. Table 2-32 shows the industries in the county and trends in employment between 2001 and 2011. In the census, this information is provided by the proprietor. The total number of people employed in Meagher County in 2011 was 697.

Table 2-32. Meagher County Employment by Industry, 2001-2011

Total Employment (Number of Jobs)	2001	2011	Change 2001-2011
Farm	227	179	-48
Retail trade	76	107	31
Real estate and rental and leasing	8	37	29
Administrative and waste services	24	na	na
Educational services	5	11	6
Arts, entertainment, and recreation	52	78	23
Accommodation and food services	109	84	-13
Other services, except public admin.	68	59	-9
Government	180	145	-35
Total Employment (%)			
Farm	19.5%	13.5%	-21.1%
Retail trade	6.5%	9.5%	34.2%
Real estate and rental and leasing	0.7%	8.1%	40.8%
Administrative and waste services	2.1%	na	na
Educational services	0.4%	0.8%	373.2%
Arts, entertainment, and recreation	4.4%	5.9%	42.9%
Accommodation and food services	9.4%	6.4%	-13.7%
Other services, except public admin.	5.8%	4.5%	-13.2%
Government	15.5%	14.1%	-16.1%

Data from: US Department of Commerce. 2014.

2.10.4 Employment Rate

The unemployment rate is an indication of the potential available employees. Both Meagher County and Montana reported lower than average unemployment rates for June 2015, compared to the US unemployment rate of 5.3 percent. Table 2-33 indicates the unemployment rates for Meagher County and the state of Montana.

Table 2-33. June 2015 Labor Force Non-Seasonally Adjusted Preliminary

Area	Labor Force	Employed	Unemployed	Unemployment Rate
Meagher County	944	911	33	3.5%
Montana	531,429	510,347	21,082	4.0%

Data from Montana Department of Labor & Industry 2015

2.10.5 Income

Income is reported by the US Census as "per capita" and household. The per capita takes the total income for the county, state, or country and divides it by the total population for an indication of the income per person. The household income is reported as the median household income, which is where half the households earn more and half the households earn less. Table 2-34 reports these numbers for Meagher County, Montana, and the US, along with the percent of the population that is considered below the poverty level. The US Census definition of poverty (http://www.census.gov/hhes/www/poverty/about/overview/measure.html) is complex. For example, one person living alone over the age of 65 is considered in poverty if their income was less than $10,458 in 2010, as is a family of 4 (two children under 18) who earned less than $22,113 in 2010.

Table 2-34. Per Capita and Household Income

Income Level	Meagher County	Montana	US
5-year (2009-2013) average per capita income in past 12 months (2013 dollars)	$20,288	$25,373	$28,155
Median household income, 2009-2013	$38,182	$46,230	$53,046
Persons below poverty level, percent, 2009 - 2013	13.6%	15.2%	15.4%

US Census 2015a, 2015b

2.11 Noise

Baseline ambient noise monitoring was conducted on September 10 and 11, 2013 in general accordance with the American National Standards Institute (ANSI) S12.18-1994, *Procedures for Outdoor Measurement of Sound Pressure Level* (ANSI 1994). Details of the test apparatus, methods, and quantification of noise data are provided in Appendix J (Big Sky Acoustics, 2013).

Noise measurements were taken at four locations ranging from 0.5 to 2 miles from the proposed mine portal location (Figure 2.21) A 24-hour noise level measurement was completed at Location 1, the most proximal monitoring site (i.e. the Bar Z Ranch). One 1-hour "daytime" (7 a.m. to 7 p.m.) noise level measurement and one 15-minute "nighttime" (7 p.m. to 7 a.m.) noise level measurement were completed at the remaining three locations (i.e. Castle Mountain Ranch, Strawberry Butte, and a location along Butte Creek Road).

Noise levels at each of the four locations were typical for sparsely-populated rural areas (Harris 1998). Dominant noise sources during the daytime consisted of vehicles, haul trucks from the Black Butte Iron Mine, ATVs, and occasional air traffic. Dominant nighttime noise sources included flowing water in Sheep Creek, breezes, and traffic along U.S. 89. Average noise levels ranged from 22 to 48 dBA.

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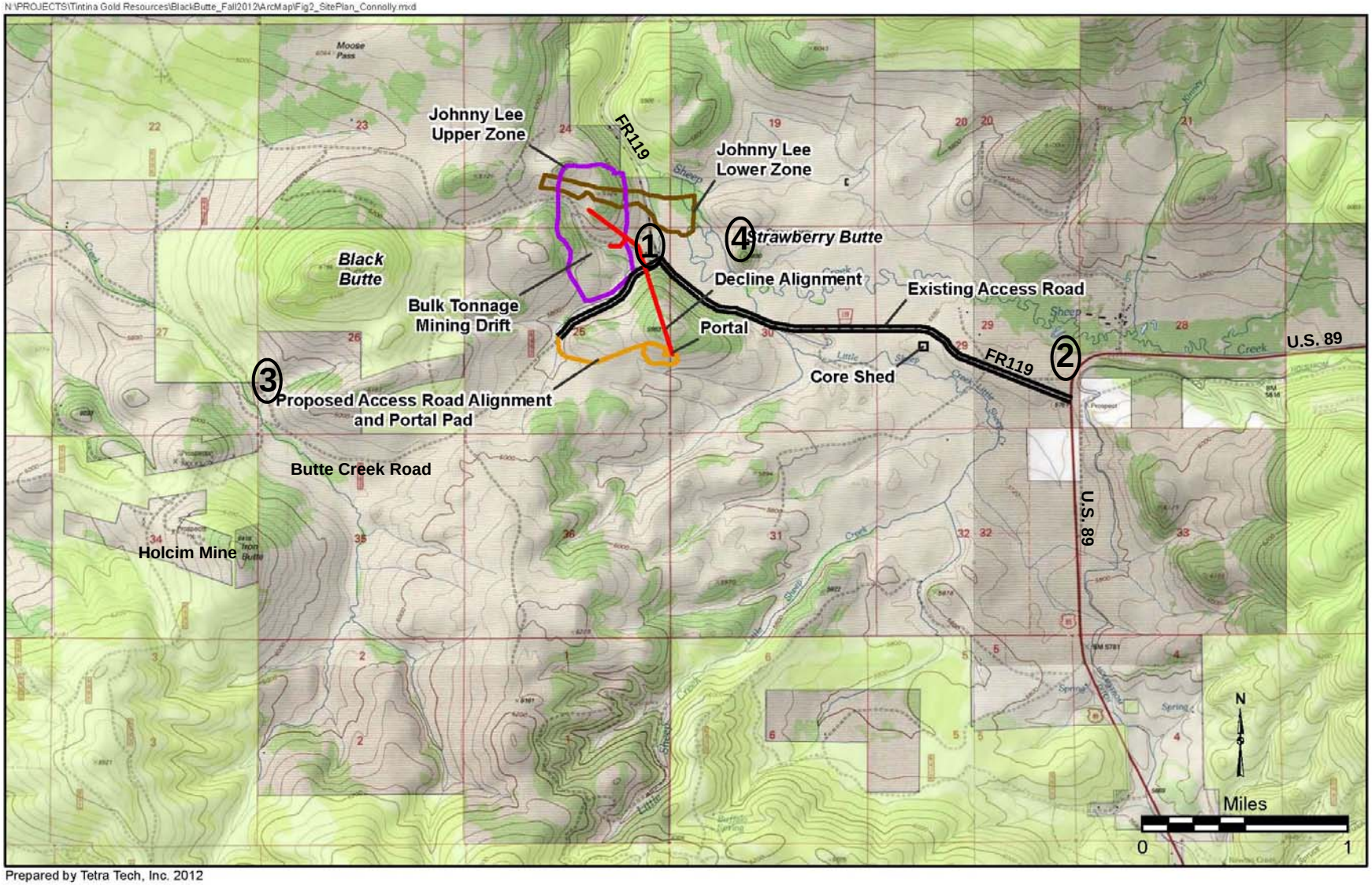


Prepared by Tetra Tech, Inc. 2012

TINTINA RESOURCES

Decline Alignment
Existing Access Road
Proposed Access Road Alignment and Portal Pad
Noise Monitoring Site
Core Shed
Johnny Lee Lower Zone
Johnny Lee Upper Zone
US Forest Service

Figure 2.21
Baseline Ambient Noise Measurement Locations
Black Butte Copper Project
Meagher County, Montana

2.12 Transportation Resources

2.12.1 Transportation Study Area and Methods

This section provides information on the means of transportation in the vicinity of the Project area, as well as the city of White Sulphur Springs and major routes within Meagher County (Figure 2.22). The following information sources were consulted for the baseline transportation study:

- Montana Department of Transportation (MDT) traffic maps and count data
- Montana State Rail Plan
- Montana Rail Link (MRL) and MDT railroad route maps
- Federal Aviation Administration (FAA) airport information
- Montana State Library (MSL) transportation framework
- Aerial photography
- U.S. Geological Survey (USGS) topographic maps

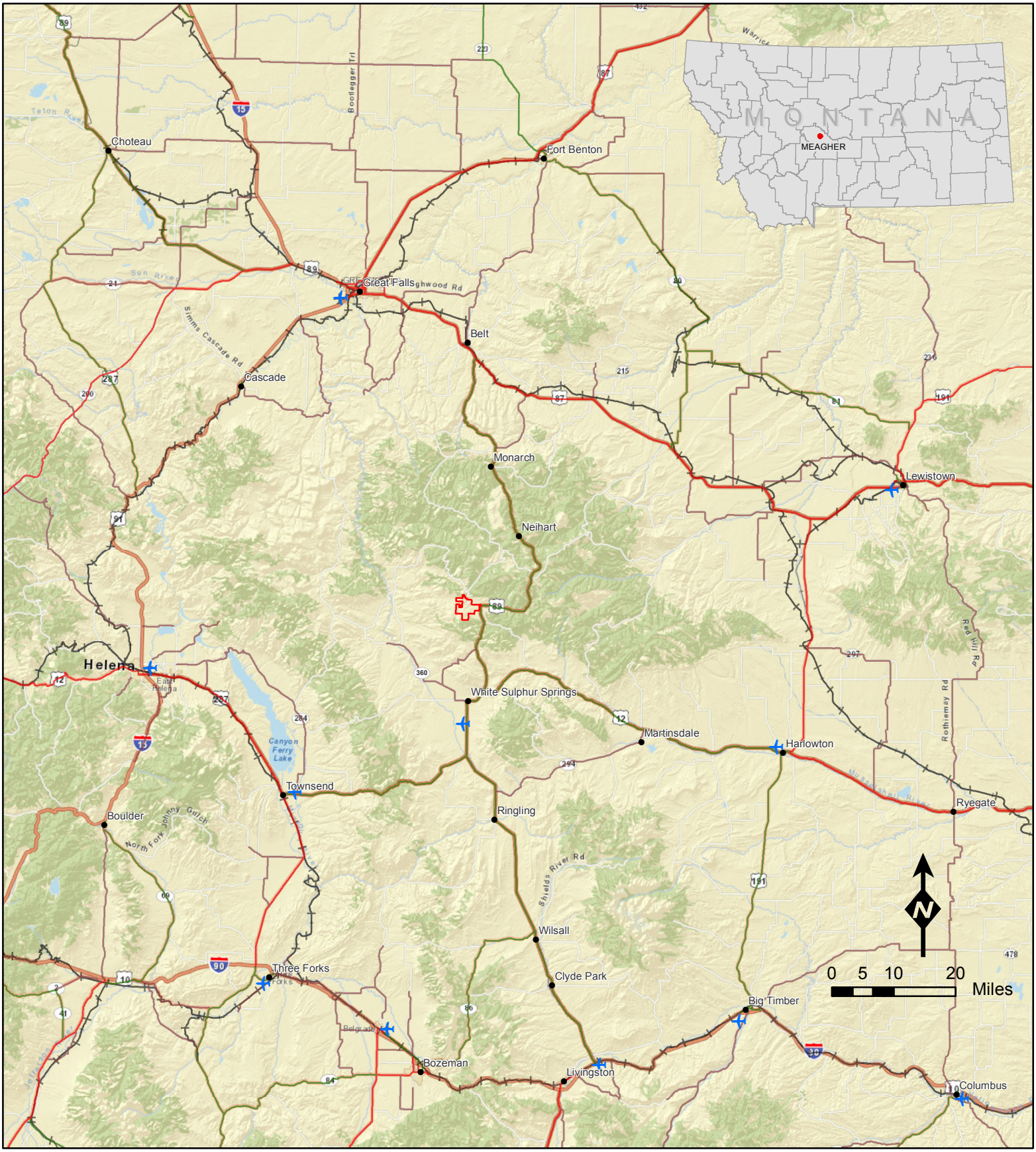
2.12.2 Roads

For the purposes of allocating government funds, Montana categorizes public highways and streets in according to a highway functional classification system (Table 2-35). Montana has both federal- and state-designated classification systems. Federally designated highway systems are the National Highway System (NHS), which includes Interstates, and the Non-Interstate NHS, which are principal arterial roadways other than Interstate highways. State-designated highway systems in Montana include the Primary Highway System (roads that have been functionally classified as principal or minor arterials), the Secondary Highway System (minor arterials or major collectors), the Urban Highway System (arterials or collectors in cities with a population greater than 5,000 selected by MDT and the municipality to be placed within the Urban Highway System), and the State Highway System (roads maintained by MDT that are not part of the Primary, Secondary, or Urban systems (MDT 2010).

Table 2-35. Highway Functional Classification System

Functional Class	Definition and Characteristics	Example
Arterials	Highest level of mobility at the greatest speed, with longest uninterrupted travel. Arterials are additionally categorized as either principal or minor depending on the nature of the area they serve (rural versus urban).	Interstate, US Highways
Collectors	Lower degree of mobility at lower speeds for shorter distances. Collectors are typically two-lane roads that gather and distribute traffic from the arterial routes. In rural areas, collectors are defined as major or minor.	State highway, County road
Local	Lowest degree of mobility at slower speeds with highest degree of access. Local roads connect residential and commercial properties and funnel traffic to higher order roadways.	City streets

Source: MDT 2010



Date: November 4 2015 Source: Westech (2015)

Legend

- Project boundary
- Airport
- Railroad
- Town

Highway system

- NHS NON-INTERSTATE
- PRIMARY
- SECONDARY

TINTINA RESOURCES

Figure 2.22
Project Location and Transportation Network
Black Butte Copper Project
Meagher County, Montana

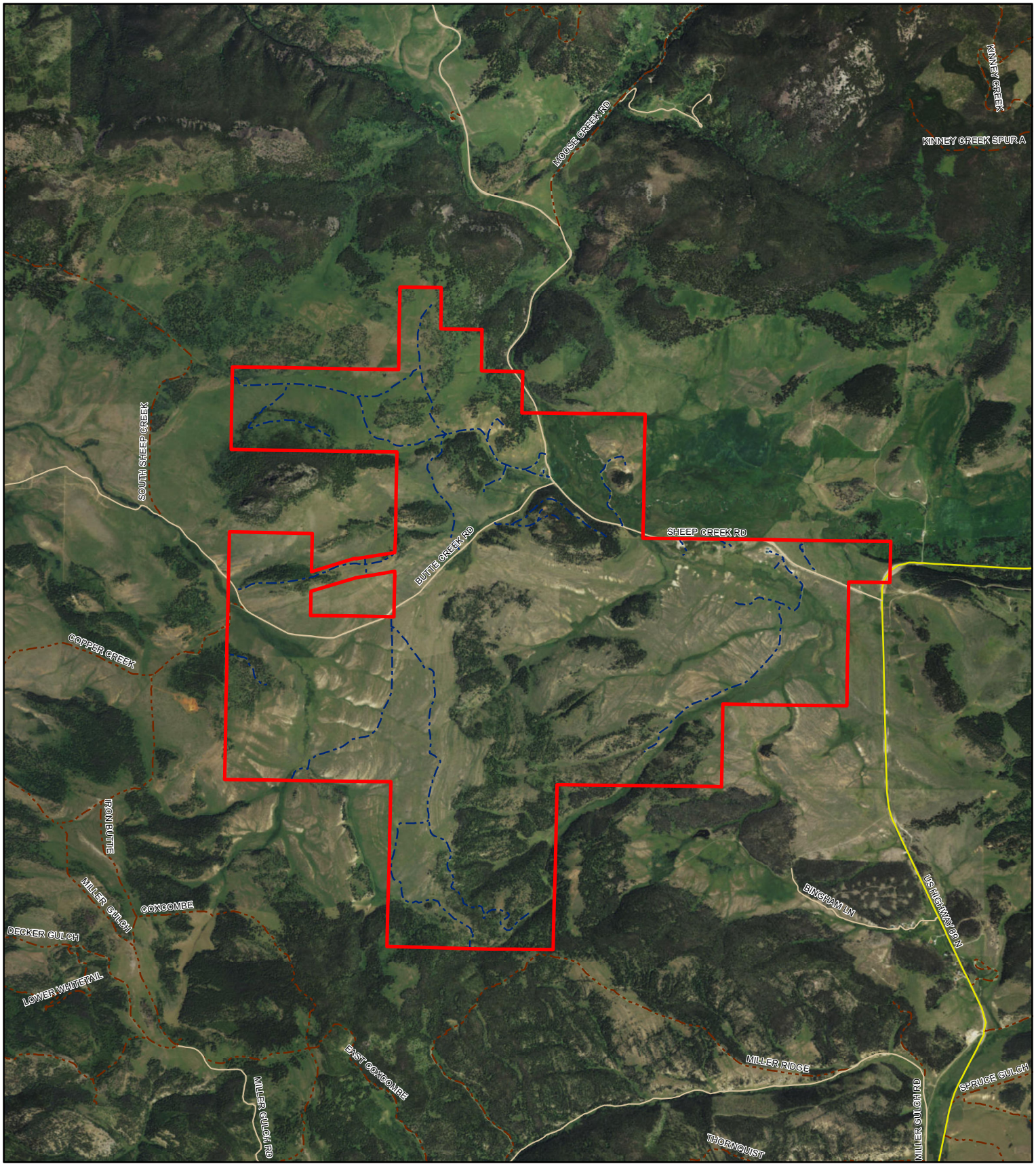
US-89 and county roads provide access to the Project area approximately 15 miles (24 km) north of White Sulphur Springs (Figure 2.23). US-89 lies east of the Project area and is the only paved road in the vicinity and county or U.S. Forest Service roads bound and traverse the Project area. A small number of private roads, primarily in the form of two-track ranch access roads, are present within the Project area (Figure 2.24). A more detailed description of these road networks is provided below.

Within the Project area, approximately 22 miles (35 km) of unpaved roads traversing traverse the property (Figure 2.24; as determined and digitized from aerial photography). The roads are a mix of established gravel roads and less-frequented dirt or grass two-track roads. The established county gravel roads are located in the north half of the Project area and include Sheep Creek Road, a northwest-southeast route, and Butte Creek Road, which splits off of Sheep Creek Road to the southwest. Two unnamed gravel roads that provide access to residential buildings in the northern portion of the Project site. The dirt and grass two-track roads are fairly well distributed across the Project property; the central portion of the Project area has fewer two-tracks than other areas.

U.S. Highway 12 (US-12) and US-89, both of which are classified as primary state highways (MSL 2013) serve White Sulphur Springs (Figure 2.22). A secondary highway, Montana Highway 360 (MT-360), heads west-northwest from White Sulphur Springs to Fort Logan. The town of White Sulphur Springs (MSL 2015) has approximately 24 miles (39 km) of local (city-county) roads.

Highways US-89, US-12, and MT-360, along with secondary Montana highway 294 (MT-294) comprise the main highways in Meagher County (Figure 2.22). MT-294, a two-lane paved highway, connects US-89 with US-12 and passes through the towns of Lennup and Martinsdale, MT. US-12, an east-west two lane paved highway, connects from east to west the towns of Roundup, Harlowton, White Sulphur Springs, and Townsend, MT. Within Meagher County, US-12 has one east bound lane and one west bound lane, and has occasional passing lanes on steep grades. Highway US-89, a paved two-lane highway (one lane for each direction of travel), connects from north to south the towns of Great Falls, Belt, Neihart, White Sulphur Springs, Ringling, Wilsall, Clyde Park, and Livingston, MT. From Great Falls, MT Highway US-89 enters Meagher County 30 miles (48 km) northeast of White Sulphur Springs and exits approximately seven miles (11 km) south of Ringling, Montana before continuing on to Livingston, MT. Highways US-89 and US-12 overlap for approximately 12 miles (19 km) in the vicinity of White Sulphur Springs.

The study used route maps and traffic count data from the MDT (MDT 2015). The MDT collects traffic data through short-term and permanent traffic count stations, which consist of automatic traffic recorder (ATR) and weigh-in-motion (WIM) sites. Proportionally, the short-term traffic count stations provide the bulk of traffic counts. The ATR and WIM stations mainly provide traffic volume data, but several also provide information on vehicle length, classification, weight, and speed. The short-term stations provide data on traffic volume only, and are deployed for a 36- to 48-hour period between April and September. As a result, a seasonal adjustment factor is applied to the short-term counts to better represent traffic conditions on an average day (MDT 2015). Annual Average Daily Traffic (AADT) counts attained from MDT's interactive web map service and referenced below have received application of the adjustment factor.



Date: November 4 2015 Source: Westech (2015)

Legend

Project boundary

0 0.25 0.5 Miles

N W E S

Highway system

PRIMARY

BLM

CITY-COUNTY

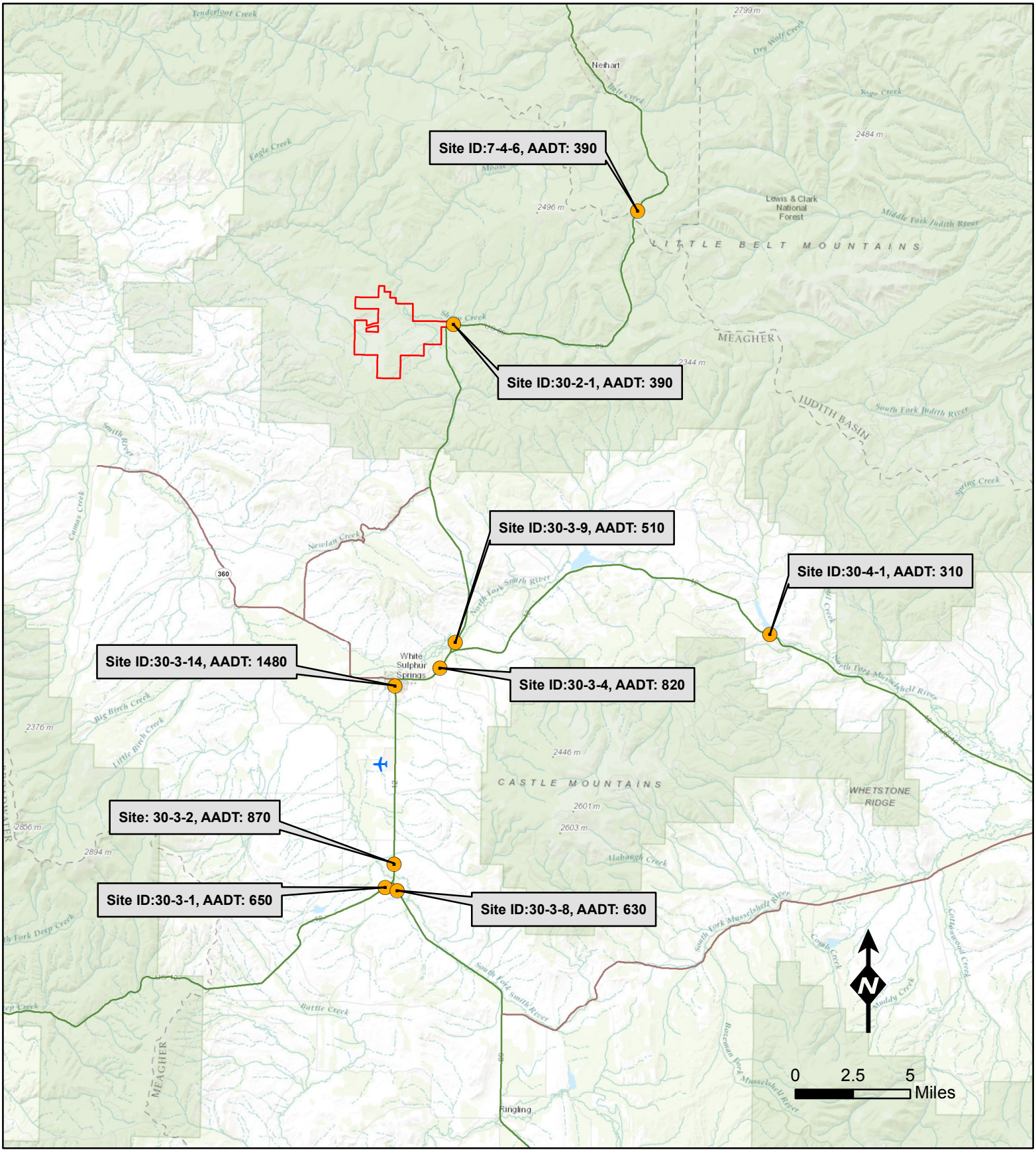
PRIVATE

USFS

TINTINA RESOURCES

Figure 2.23
Project Area Road Detail

Black Butte Copper Project
Meagher County, Montana



Date: November 4 2015 Source: Westech (2015)

Legend

- Project boundary
- Airport
- MDT Traffic Station*

Highway system

- NHS NON-INTERSTATE
- PRIMARY
- SECONDARY

Figure 2.24
MDT Transportation Count Stations

TINTINA RESOURCES

Black Butte Copper Project
Meagher County, Montana

* All stations are short term traffic counting stations.

There are no permanent ATR or WIM traffic monitoring sites in Meagher County. An ATR site is proposed for installation east of White Sulphur Springs on US-12 near Checkerboard, MT and a WIM station is proposed for US-12/US-89 approximately seven miles south of White Sulphur Springs (MDT 2015). Traffic data for the county is provided by several short-term traffic counting sites. Table 2-36 and Figure 2.25 provide the reported AADT value for select short-term traffic count stations in Meagher County in the vicinity of the Project (MDT 2015).

Table 2-36. Average Annual Daily Traffic (AADT) Counts in the Vicinity of the Project

MDT Traffic Site ID	AADT	Highway	Year	Distance, Direction from Project	Comment
30-2-1	390	US-89	2014	<1 mile, East	Located at sharp bend east on US-89
30-3-9	510	US-89	2014	14.5 miles, South	At split from US-12
30-3-4	820	US-12/US-89	2014	16 miles, South	East edge of town
30-3-14	1480	US-12/US-89	2014	18 miles, South	South edge of town
30-3-2	870	US-12/US-89	2014	27 miles, South	North of junction between US-12 & US-89
30-3-1	650	US-12	2014	30 miles, South	Before junction with US-89
30-3-8	630	US-89	2014	30 miles, South	Before junction with US-12
30-4-1	310	US-12	2014	32 miles, Southeast	East of White Sulphur Springs
7-4-6	390	US-89	2014	13.5 miles, Northeast	Near county line

2.12.4 Railroads

This study reviewed various sources for railroad routes and carrier information, including the Montana State Rail Plan (Cambridge Systematics 2010), the Montana Rail Link (MRL) and Burlington Northern Santa Fe (BNSF) websites and route maps, and Montana Department of Transportation railroad route maps. Meagher County (MDT 2015a) has lost the Milwaukee line and the WSS & YP line, and no longer has any currently operating railroad lines. The nearest active railroad line to the Project area is a MRL line 40 miles (64 km) west-southwest of White Sulphur Springs (via US-12) at Townsend, MT; locally this north-south line connects the towns of Three Forks with Helena, MT (Figure 2.22). This segment of MRL line is part of a longer southeast-northwest line that connects Huntley, MT and Sandpoint, Idaho (MRL 2015) and also passes through the town of Livingston approximately 87 miles (140 km) south (along US-89) of the Project area. In addition, a BNSF line lays 57 miles (92 km) (east of White Sulphur Springs near Harlowton, MT. This BNSF line runs north-northwest from east of Laurel to Great Falls, MT (BNSF 2014). Great Falls is approximately 83 miles (134 km) north of the Project area along US-89. The town of Armington Junction (Just south of Belt) also lies along this route and is approximately 57 miles north of the Project site along US 89. BNSF is a Class I railroad, that as of 2006, operated 1,942 miles (3,125 km) of track in Montana. MRL is a Class II regional railroad that operates 875 miles (1,408 km) of track within Montana (Cambridge Systematics 2010). .

2.12.5 Airports

This study acquired airport information from FAA records (FAA 2015) from AirNav, LLC (2015), a private enterprise which provides airport and navigation information to pilots via the internet, and from aerial photography. One public airport is located three miles south of White Sulphur Springs on the west side of MT Hwy 12/89, approximately 19 miles (31 km) due south of the Project area (Figure 2.22). The City of White Sulphur Springs and Meagher County (FAA 2015) jointly own the airport. Facilities at the airport consist of one asphalt runway and one turf runway, measuring 6,100 feet (1860 m) and 3,200 feet (975 m) (respectively) and a single hangar. Transient general aviation contributes sixty-two percent of operations at the White Sulphur Springs airport between August 2013 and August 2014 and local air

traffic contributes 38% to (AirNav 2015). Great Falls, Helena, Bozeman, and Billings, MT all have regional airports with scheduled passenger services suitable for travel to the Project area.

2.13 Land Use

Private citizens own all the property in the Project area which contains the Johnny Lee copper resource and which Tintina needs to use for mine development (Figure 1.4 and Section 1.3). Land uses are predominantly agricultural and include primarily livestock grazing and hay production. In addition, fishing and big game outfitters use the Sheep Creek drainage for hunting and fishing.

The Bar Z Ranch and Short Ranch own 100% of the surface and mineral rights of the lands containing the proposed mine and related facilities. Tintina has lease agreements with each of these owners (Figure 1.4) (Section 1.3) (Resource Modelling, Inc. 2010). The lease agreements allow only underground mining, interfere with current uses as little as possible, and stipulate that after mining the owners can resume, as much as possible, any interrupted land uses such as cattle grazing and hay production.

Vegetation resource investigations in the study area identified seven Conifer Forest and Woodland habitat types (Table 2-28; Section 2.8.1). They are Douglas-fir, with less frequent occurrences of common juniper and infrequent Engelmann spruce. Mature conifer stands occupy 502 acres (200 ha) or 15% of the vegetation study area. Areas with previous logging activities or areas with encroachment by conifers into grassland or shrub land, exhibit stands of immature conifers comprise 235 acres (95 ha) or 7% of the study area.

Rangeland productivity varies considerably among vegetation types in the study area, depending on current conditions and the ecological sites involved. Hypothetical grazing capacity estimates calculated for historic rangeland is 4,350 animal unit months (annually) for the entire baseline study area.

Hay, the only crop grown in the study area, covers 69 acres (28 ha) (2 % of the study area) and hay cropland in the study area can produce approximately 3 to 5 AUM's per acre, depending on the soil. Based on long term production data compiled by the NRCS (2015) the predicted yield of grass hay in the study area can produce 3 to 5 AUMs per acre. In recent practice, ranchers cut grass hay and grass-legume hay on the Sheep Creek floodplain once a year within the study area, and produce approximately 3 tons per acre annually on average (ranch manager, personal communication, 2015).

3.0 OPERATING PLAN

3.1 Introduction

Section 3.0 describes the components, facilities and processes comprising the mine operations in detail. Table 3-1 lists sections of this report that have supporting technical reports as appendices.

Table 3-1. Reference Sections for Operating Plan

Document Section	Section This Report	Detailed Technical Report as Appendix
Engineering Evaluation	3.5	K
Waste and Water Management Facilities	3.6	K
Water Balance	3.72	L

3.1.1 Mine Permit Boundary

The proposed mine permit boundary for the Project (Figure 1.2) encloses a total area of 1,690 acres (683 ha) of private property, all within three tributaries of the upper Sheep Creek drainage. It encompasses all proposed facilities (Figure 1.3) and surface disturbances associated with the Project. The permit boundary specifically excludes the existing county road and follows topographic divides between tributary drainages of Sheep Creek on the south, and the divide between Sheep Creek and Butte Creek to the west. The south and west portions of the permit boundary include drainage sub-basins for surface water run-on and run-off control, while remaining as close as possible to major facilities.

A county road (Sheep Creek Road) accesses the permit area approximately 1.5 miles (2.4 km) west of its intersection with US Highway 89 (Figure 1.2). The permit boundary area consists of two separate subareas (Figure 1.3). The main Project area to the south and west of the county road contains almost all of the proposed major facilities and surface disturbances. A smaller area north of the county road and Coon Creek encloses the collar areas of the four underground ventilation raises, the potable water supply well, and their respective largely existing access roads. A 4-strand barbed-wire fence will surround a small portion of the mine permit boundary area south of the county roadways and enclose most of the facilities. An additional barbed wire fence will enclose both sides of the main access road to avoid conflicts between mine traffic and cattle. Other smaller fenced areas include the individual vent raises, water well, and pumping station. However, these will allow unencumbered existing ranch road access. Eight-foot-tall wildlife chain-link fencing will surround all water-bearing lined ponds.

3.1.2 List of Facilities with Surface Disturbance Acres

Table 3-2 lists the Project's facilities, features, and access roads (which are discussed below) and presents the measured acres of disturbance associated with each facility. An additional 10% of the total acres (26 acres) has been added to the final total acres of disturbance to account for miscellaneous construction disturbances. The total amount of proposed surface disturbance for the project is approximately 285 acres. A more detailed accounting of surface disturbance acres is presented in Table 3-11.

Table 3-2. Acres of Surface Disturbance Consolidated by Major Facility

Facility or Activity	Surface Disturbance (Acres)
New Access Roads	62.62
Direct Underground Mine Support	10.29
Temporary Waste Rock Storage (WRS)	13.12
Contact Water pond (CWP)	10.39
Mill/Plant Site	14.83
Process Water Pond (PWP)	24.92
Cemented tailings Facility (CTF)	78.32
Water Supply	4.30
Underground Infiltration Galleries	5.20
Material Stockpiles	26.83
Other/ Miscellaneous	0.63
Subtotal	**259.05**
Construction buffer zone / Misc. (10%)	25.91
Total Disturbance Acres	**284.96**

3.2 Underground Mine Operations and Mining Methods

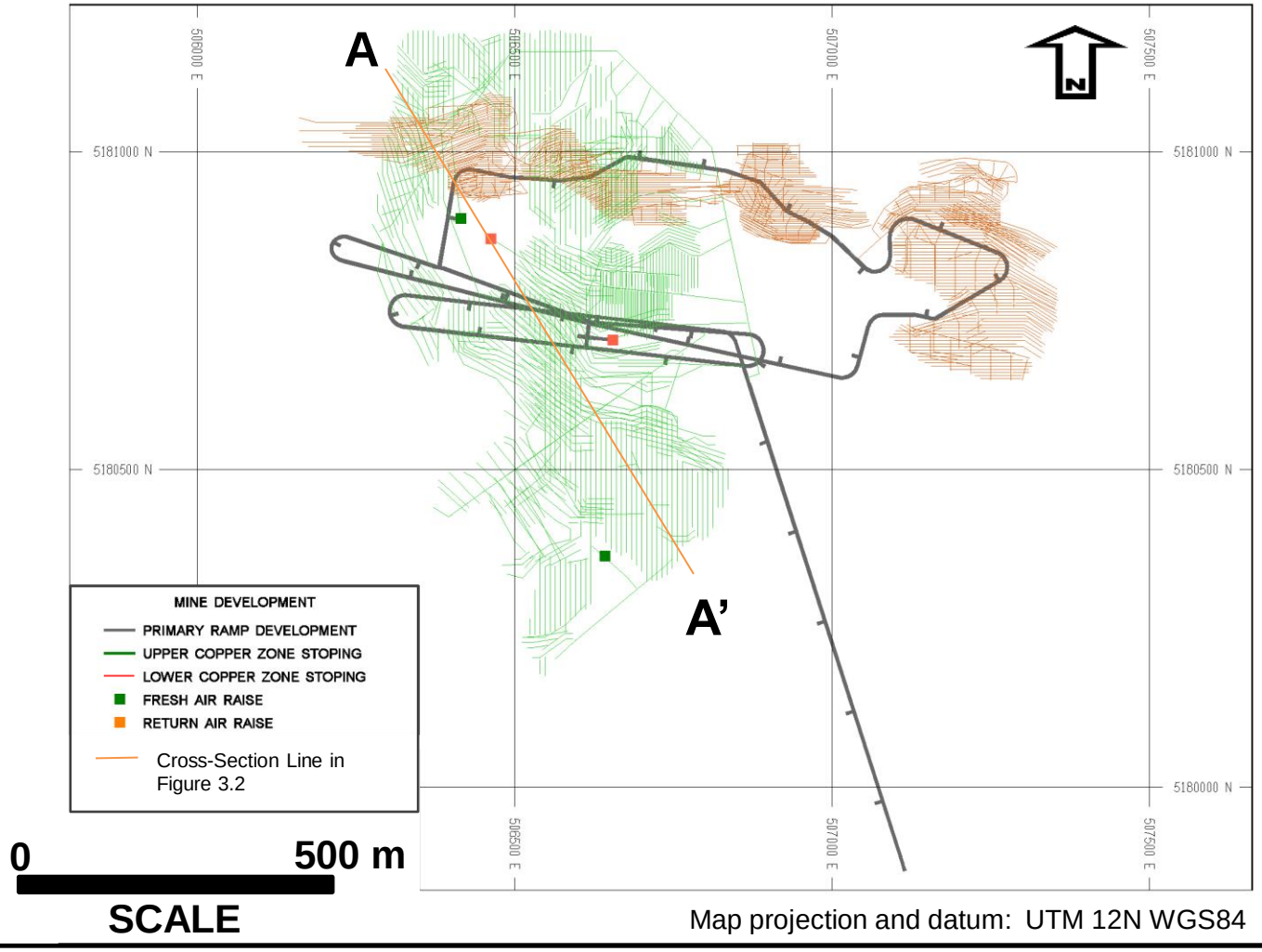
3.2.1 Introduction

Underground mining requires the removal of both the metal resource (valuable metal-bearing rock) and waste (non-mineralized and sub-economic mineralized rock). The two basic stages of underground mining required for access to and/or mining of an underground copper deposit are development mining and production mining. *Development mining* typically involves excavation of uneconomic waste rock in order to gain access to the valuable mineral deposit. Production Mining involves mining of the actual copper-bearing stopes or drifts to remove the profitable rock for subsequent mineral processing.

3.2.2 Tintina's Underground Mine Plan

3.2.2.1 Johnny Lee Development Workings

Tintina plans to access the upper and lower Johnny Lee deposit zones through a single 17-foot wide by 17-foot (5m x 5m) tall mine portal (opening) at the surface. Approximately 18,800-feet (5,730 m) of declines (downward sloping access tunnels) and ramps (upward sloping tunnels) (Figure 3.1 and Figure 3.2 will be developed beyond the surface portal for mining. A 5,398 foot long (1645 m) 17-feet wide by 17-feet tall decline with a slope of -15% will provide the access from surface to the upper copper zone (Figure 3.2). The intersection of the bottom of the decline and the bottom of the upper copper zone lies at a depth from surface of approximately 460 feet (140 m). From there the decline extends an additional 4,954 feet (1,510 m) (to reach the top of the lower Johnny Lee deposit zone, at a depth of 985 feet (300 m) below the surface. The 8,448 long (2,575 m) lower copper zone access loop will provide access for resource extraction, and drop in depth from approximately 985 feet (300 m) feet below surface to approximately 1,640 feet (500 m) below the surface (the depth of the base of the lower copper zone).



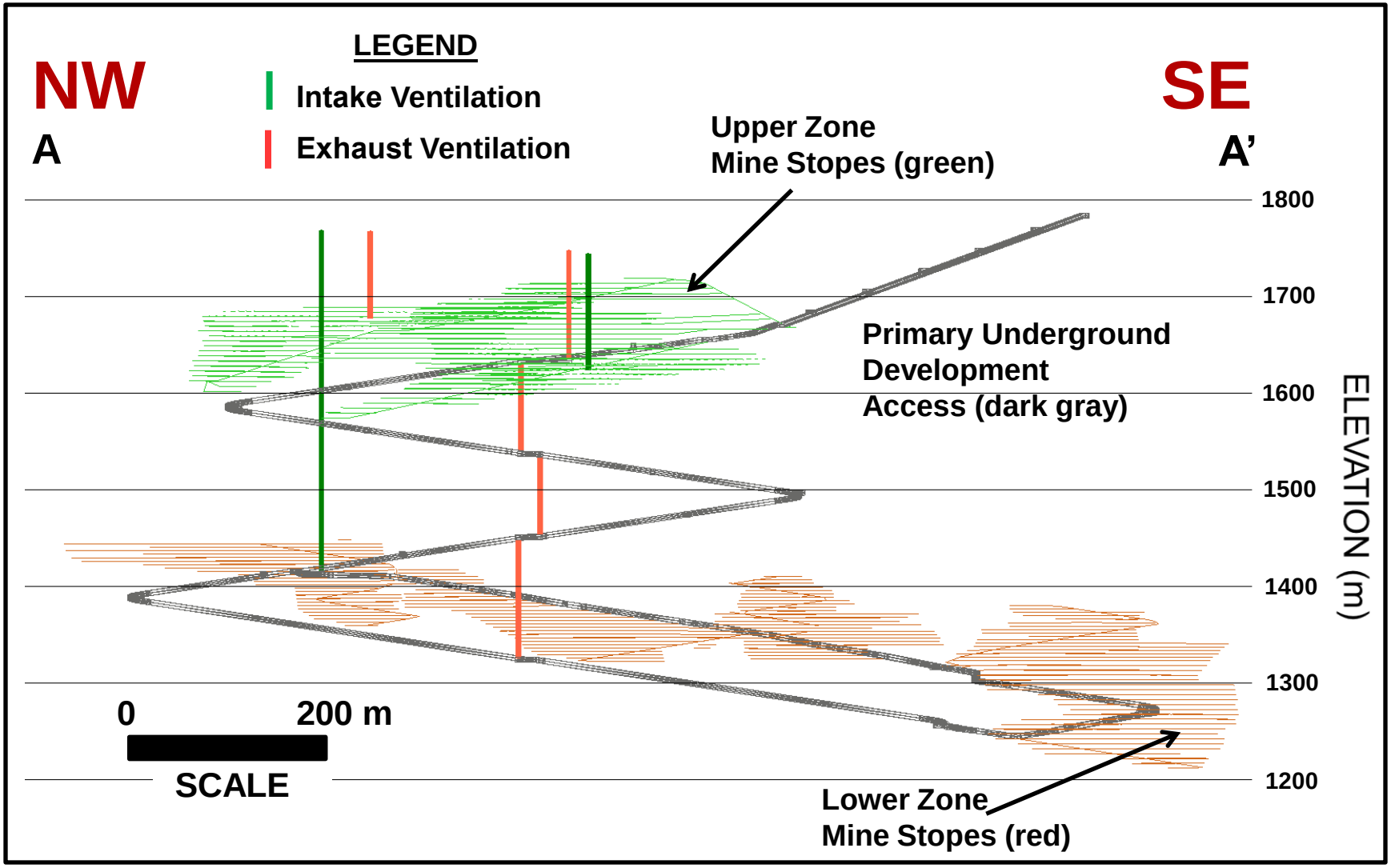
Map projection and datum: UTM 12N WGS84

TINTINA RESOURCES

Date: October 28, 2015

Source: AMEC (2015)

Figure 3.1
Plan Map of Underground Workings and Mining Stopes
Black Butte Copper
Meagher County, Montana



TINTINA RESOURCES

Date: November 9, 2015
Source: AMEC (2015)

Figure 3.2
Cross-Section of Underground Workings and Mining Stopes
Black Butte Copper
Meagher County, Montana

The decline and ramps provide access for all personnel and materials to the working areas. Underground trucks will carry all waste rock and mill feed up the decline to a storage pad immediately west of the portal pad (Figure 1.3) for temporary (approximately 2 year) storage. The temporary waste rock storage pad could hold as much as 453,000 tons (410,000 tonnes) of waste rock while awaiting completion of the CTF. The completed CTF will receive all the waste rock from the temporary waste rock storage pad as well as any new waste rock for co-disposal with the cemented tailings. After reclamation of the temporary WRS pad, a newly constructed 2.0 acre (0.8 ha) lined mill feed storage pad will be constructed in the same area off the northwest corner of the portal pad. It will have storage capacity for as much as 82,600 tons (75,000 tonnes) of mill feed. Any seepage from the temporary waste and resource storage pads, and contact water from the portal pad and mill facility will report via pipeline and HDPE-lined ditch to the CWP for subsequent treatment and discharge (Figure 1.3) (described in Section 3.6.6) or alternatively used as make-up water in the mill. Approximately 14,500,000 tons (13,151,590 tonnes) of copper enriched rock and 706,000 tons (778,810 tonnes) of waste will be mined from development workings. Underground drill stations may be cut if infill development targeting is warranted.

3.2.2.2 Johnny Lee Production Workings

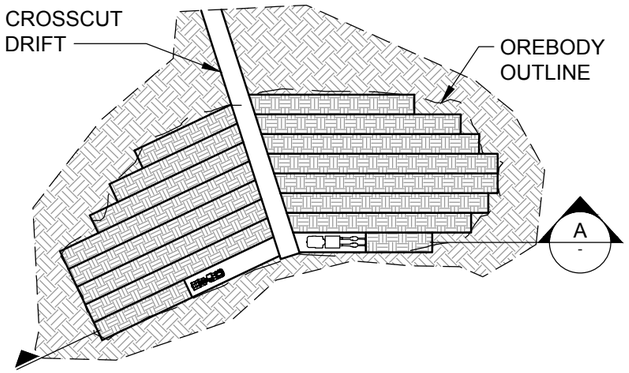
Tintina will use a “drift and fill” mining method. Drift and fill mining has many advantages:

1. Drift and fill operations are an expensive yet very selective method in which the copper-enriched rock can be mined with minimal loss and dilution (mixing of the copper-rich rock with adjacent low-grade or barren rock, thereby lowering the overall grade mined).
2. The entire deposit can be mined (i.e., does not require leaving copper-rich ground supporting pillars).
3. The mined out opening is completely backfilled and supported with cemented tailings, therefore there is no risk of future ground subsidence at the surface.
4. Incremental backfilling of the workings incrementally replace the mined out voids with a very fine-grained cemented tailings that has very low porosity and permeability, and therefore low hydraulic conductivity (approximately 10^{-9} feet/day - about a billionth of a foot per day). Groundwater will move only very slowly through the cemented backfill material which is a factor of 100 less permeable than the in-place and surrounding host bedrock with a hydraulic conductivity of 10^{-7} feet/day).
5. The open space created by active working headings (where sulfide rock is exposed along the walls) are of a limited volume, estimated at a few percent of the total mineral deposit at any one time, before being backfilled with cemented paste tailings. Therefore only a small amount of surface area is available to atmospheric oxygen at any time, and the location of these areas are constantly changing.
6. Backfilling of the drifts and stopes also provides a safe underground working environment for the miners.

Figure 3.2 illustrates individual stopes (i.e., drifts in the resource) which are tunnels driven into the mineral deposit. The resource stopes are typically inclined (maximum 1 to 2% grade), narrow but long slices. The stopes in the upper copper zone will measure either 17 feet (5 m) wide by 17 feet (5 m) high or 26 feet (8 m) wide by 17 feet (5 m) high, depending upon ground conditions and mineralization. The 3,000 foot (920 m) by 1,500 foot (460 m) resource area will accommodate multiple active mining stopes during mining of the entire deposit. The production drifts in the lower zone will generally measure 11.5 feet (3.5

m) wide by 11.5 feet (3.5 m) high. However, production drifts in the lowest portion of the lower copper zone will again reach dimensions of 17 feet (5 m) wide by 17 feet (5 m) high.

The drift and fill mining proceeds as illustrated in Figure 3.3. A drift driven from the ramp to the opposite side of the mineralized zone allows access. Miners can then drive the stope along the length of the mineralized zone. Cemented tailings fed to the underground mine via pipeline from a paste plant on the surface (see Section 3.6.10; Figure 3.32) will subsequently backfill this drift. Miners simultaneously drive several other drifts parallel to the first drift (but spaced out some distance away), and all sequentially receive cemented paste backfill. Once mining in an individual drift is complete and the cement backfill has cured and reached its full strength (usually about a month), a new drift immediately adjacent to the cemented paste backfilled drift is mined. Mining proceeds in this fashion until the copper deposit at this drift level is completely mined out laterally. Miners subsequently develop a second cut series of drifts on top of the underlying mined out backfilled area if the resource is thicker than the 17-foot (5m) tall mining drift. This process of mining drifts above previous backfilled drifts is called overhand mining. This pattern of drifting and backfilling continues both laterally and vertically until the entire resource is mined out.



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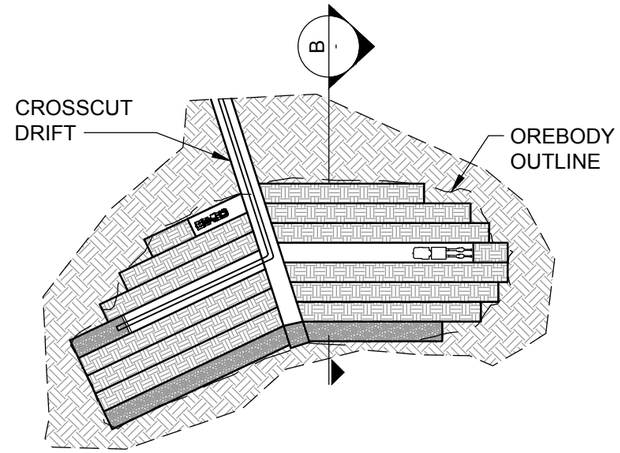

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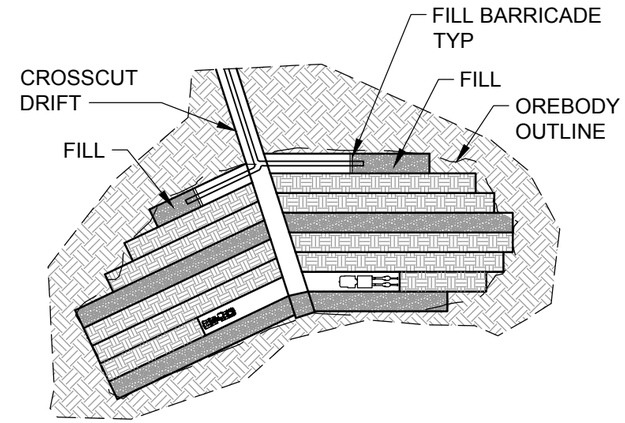

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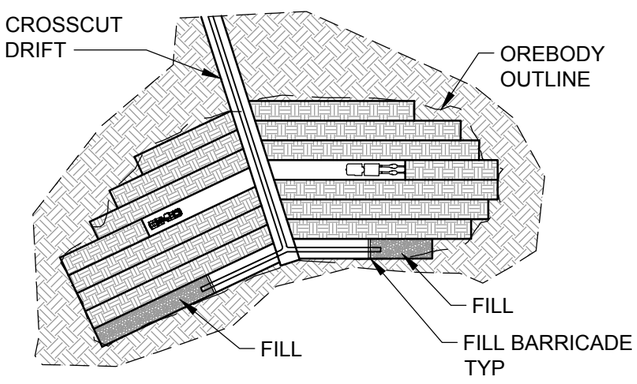

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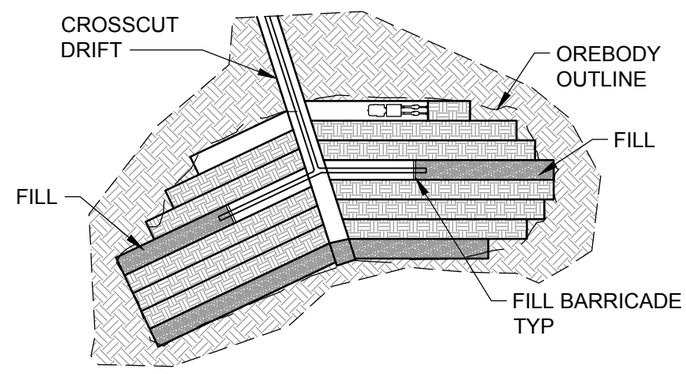

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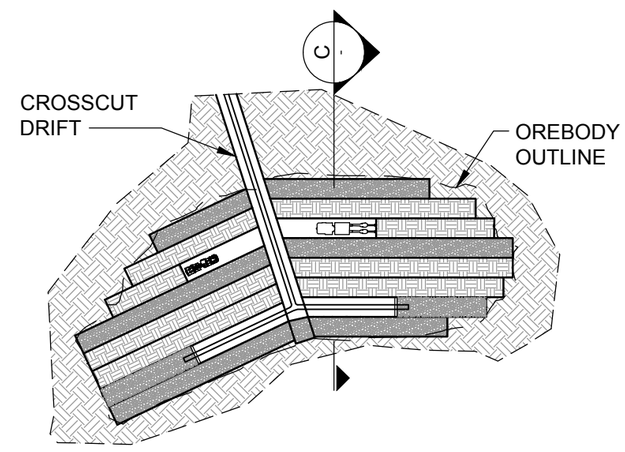

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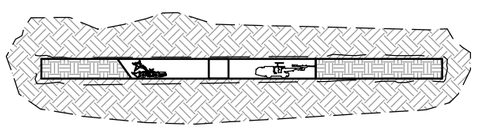

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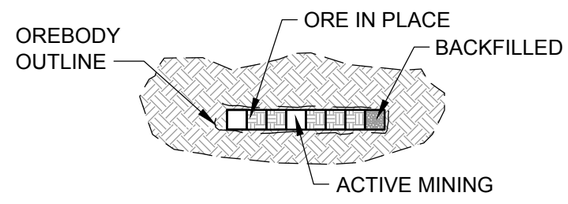

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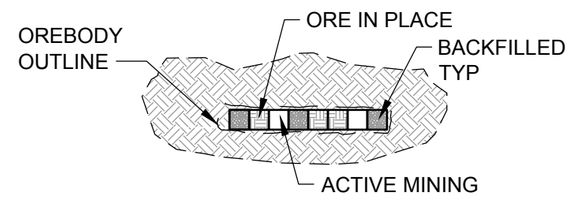

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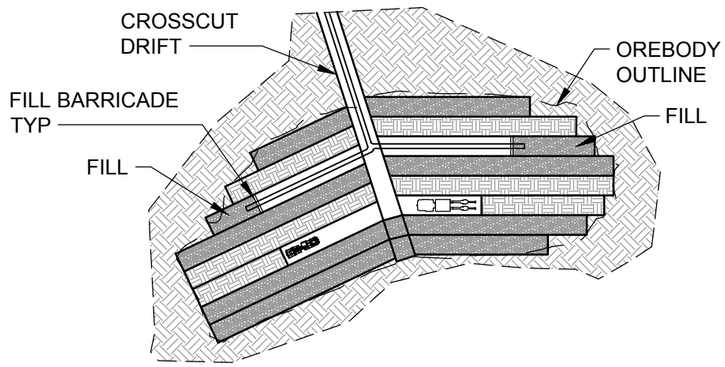
TINTINA RESOURCES

Figure 3.3a
Typical Drift and Fill Mining Method
Sequence 1 Through 6
Black Butte Copper Project
Meagher County, Montana



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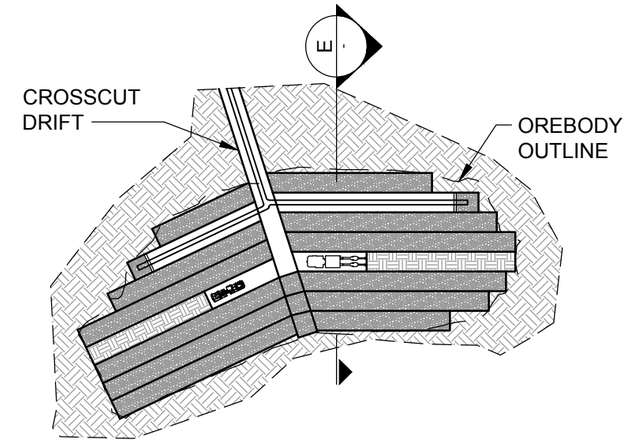

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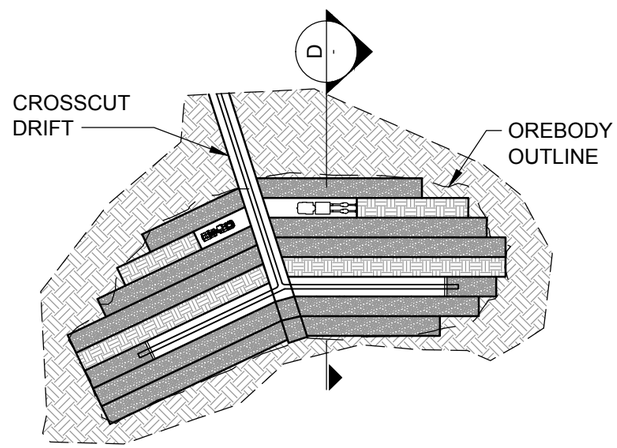

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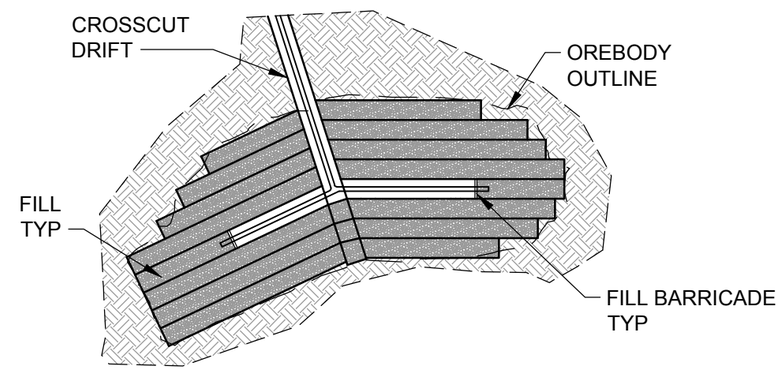

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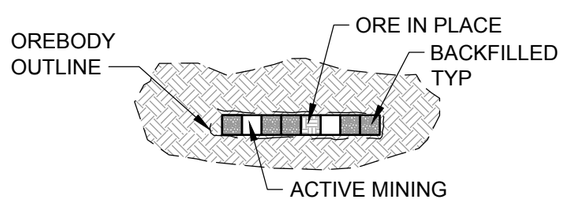

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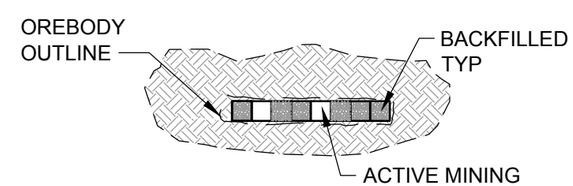

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TINTINA RESOURCES

Figure 3.3b
Typical Drift and Fill Mining Method
Sequence 7 Through 10
Black Butte Copper Project
Meagher County, Montana

3.2.2.3 Mine Dewatering

Based on hydrologic data, the first 1,700 feet (518 m) of decline will encounter very little or no water. A shallow surface pond near the portal and near surface underground sumps will provide storage for this small amount of water. After the decline encounters sustained flows greater than 50 gpm (190 Lpm), pumping will send groundwater from the underground mine to the construction phase Reverse Osmosis WTP (Section 3.7.3) for treatment and discharge to underground infiltration galleries. As a safeguard, the underground infiltration galleries and the WTP will be available for use when underground activities commence.

When mining encounters the regional groundwater table (approximately 1,700 feet [518 m] in from the portal), pumping will move excess water from the underground workings and working faces to underground settling ponds. Reclamation of the small pond located on the surface portal pad described above will commence when these underground ponds are available. Flocculants added to the ponds and/or the sumps will assist in settling sediment. If needed, hydrocarbon booms or oil skimming capability will remove any hydrocarbon contamination from the underground settling ponds. Pumping will push water from the settling ponds through a buried 6-inch (15.2 cm) HDPE pipeline either to the PWP as make-up water or to the WTP located during construction on the mill pad for treatment to compliance with non-degradation criteria and discharged to shallow permeable bedrock via the underground infiltration gallery system.

Early modeling efforts predicted groundwater flows into the mine in the range of 530 to 680 gallons per minute, assuming lack of any inflow controls. Occasional short-term higher flows generated by rapid dewatering of fracture systems encountered by mining could be as high as 1,000 gallons per minute. When mining encounters significant inflows of water from water-bearing faults and/or fractured zones, pressure grouting techniques may be used to control the inflow of water into the mine. Pressure grouting is a widely accepted standard practice in the mining industry. It involves injecting a grout material into fractured rock to seal of waterways, and divert the water around the underground mine openings.

Dewatering of the underground mine workings will produce all water needed for consumptive use by mining operations (about 210 gallons (790 L/min) per minute or 0.47 cubic feet per second). This water will be pumped from the mine to the PWP for use as make-up water. Water pumped from the mine in excess of the PWP maximum design operating capacity (approximately 287,800 cubic yards, 220,000 m^3) will receive treatment to non-degradation standards in the water treatment system and be discharged to the underground infiltration gallery system. Tintina plans to control the flow of water from the mine to a maximum of about 500 gallons per minute (1,893 Lpm). The water treatment system design is optimized in the range of 500 gallons per minute (1,893 Lpm) of continuous flow, with maximum inflow rates of about 510 gallons (1,930 Lpm) per minute. It is estimated that a small quantity of water, approximately 15 to 30 gpm (57 to 114 Lpm) will be required for the actual mine operations, which includes mobile equipment fleet water usage and delineation drilling needs.

3.2.2.4 Mining Rates and Schedules

The underground mine will be developed after four to six months of basic site preparation and construction of an access road, portal pad, underground mine utilities, surface (contractor) support facilities, temporary WRS area, and the CWP. These activities will run concurrently with major surface facilities construction activities. It is anticipated that major site preparation and support facility construction for overall operations will require 24 to 36 months to complete. These facilities are discussed in the surface support facility section (Section 3.6).

During the first four years of mining (including the first 2.5 years of preproduction mining), a mining contractor will drive primary development ramps and development cross-cuts (tunnels not driven in copper-rich rock) to access the mining stopes. After 2.5 years of development mining, Tintina mining crews will start mining copper-enriched rock from upper Johnny Lee deposit production drifts. In all, the total main access ramp length will be approximately 18,800 feet (3.6 miles) (5,730 m), the access cross-cuts total approximately 47,900 feet (9 miles) (14,600 m) and the mining drift length in copper-enriched rock would be approximately 366,400 feet (69 miles) (43 km).

The mine will produce a total of approximately 14.6 million tons (13.2 Mt) of copper-enriched rock and 0.77 million tons (0.7 Mt) of waste over its life. The overall mine production rate will approximate 1.3 million tons (1.2 million tonnes per year) during the peak years of active mining, with about three quarters of that yield from the upper copper zone (2,700 tons per day; (2,500 t/d) and about one quarter (880 tons per day; 800 t/d) from the lower copper zone. The design production rate of 3,600 tons per day (3,300 tonnes per day) requires approximately 18 active mining stopes (headings) (Table 3-3).

The overall mine production rate will be approximately 1.3 million tons (1.2 million tonnes per year) during the peak years of active mining, with approximately 912,500 t/a (tonnes per year, 2,500 t/d (tons per day) yield from the upper Johnny Lee Zone and approximately 292,000 t/a (800 t/d) from the lower zone. Approximately 18 active mining stopes (headings) (Table 3-3) will be required to insure that the design production rate of 3,300 tons per day can be achieved.

Drift lengths in the Johnny Lee upper copper zone average approximately 230 feet (70 m), and in the lower copper zone average approximately 165 feet (50 m). Four crews will mine two headings each to maintain production and minimize the quantity of sulfide-bearing rock exposed to atmospheric oxygen at any one time. A maximum of 1.5M cubic feet of production headings will be open at any given time. The entire mine plan for the two copper zones calls for a total of approximately 118M cubic feet of production drifts in ore. Therefore, only about a few percent of the mining stopes will be exposed to atmospheric oxygen and underground weathering conditions for about 60 to 90 days each at any given time in the entire mine life.

Table 3-3. Number of Open Active Mining Headings by Type, at Any One Time.

Heading Type	Upper Copper Zone Number of Headings	Lower Copper Zone Number of Headings
Development	2	2
Production	6	3
Paste Backfill	3	2
Sub-total	11	7
TOTAL	**18**	

Pre-production mining will produce approximately 453,600 tons (411,500 tonnes) of waste rock during the first two years of production. This material will be placed upon the temporary WRS pad. The development plan schedules completion of the Phase 1 tailings impoundment (CTF) by the end of the second year of construction. At that time a portion of the mine waste rock from the temporary stockpile will be transferred to the CTF. Some waste rock stored on the temporary WRS pad will be crushed and placed on top of the upper HDPE liner of the CTF to form a cushion. Reclamation of the WRS pad will commence after transfer of all remaining waste rock to the CTF. A smaller 82,600-ton (75,000-tonne) pad will then be constructed off of the northwest corner of the portal pad and will serve as a mill feed resource stockpile pad for the remaining life of the mine. The CTF will receive any future mined waste

rock, and this will be covered by and co-deposited with cemented paste backfill. The volume of all waste rock comprises approximately 10% of the total material (waste and tailings) that will be deposited in the tailings impoundment, and almost 70% of material that will be placed in the tailings impoundment during the first year of its operation. Table 3-4 presents the projected production schedule for the life of the mine.

Table 3-4. Copper-rich Rock and Waste Rock Mine Production Schedule

Year	Copper-enriched Rock Tonnes	Waste Tonnes	Total Tonnes
1	0	94,035	94,035
2	10,368	317,502	327,870
3	393,303	194,646	587,948
4	924,065	85,044	1,009,109
95	1,174,212		1,174,212
6	1,158,358		1,158,358
7	1,186,572		1,186,572
8	1,158,911		1,158,911
9	1,210,500	15,298	1,225,799
10	1,249,774		1,249,774
11	1,223,800		1,223,800
12	1,195,805		1,995,805
13	1,176,705		1,176,705
14	942,537		942,537
15	237,997		237,997
Total (tonnes)	**13,151,590**	**706,525**	**13,857,114**
Tons	**14,497,146**	**778,810**	**15,274,853**

3.2.2.5 Mining Equipment

Rubber tired, diesel-powered equipment (including three 7 cubic yard Load-Haul-Dumps [LHD's] and two 5 cubic yard LHD's) will haul all rock mined from the Johnny Lee copper zones to the main underground haulage ways. From there, six, 44 to 66-ton (40 to 60-tonne) diesel trucks will haul all rock to the surface. This equipment will be fueled and serviced at the shop/maintenance facility on surface. This facility will also house offices for engineering, geology, and supervisory personnel. Diesel-powered mobile underground equipment will use low-emission engines that comply with MSHA underground air quality regulations. Dedicated maintenance and fuel/lube trucks will provide maintenance and fueling underground for all drills, bolters, scissors trucks, an ANFO-loader, a grader, fork-lifts, LHD's, and other underground-only equipment. Section 3.6.2 discuss the requirements and design of all surface shops, their associated equipment, and their utilization by equipment operators. Section 3.6.4 and 3.3.2 discuss re-handling of rock from the temporary waste rock storage facility and shipping from the concentrator respectively.

Table 3-5 lists the equipment anticipated for use in mine development and production during year 6 of mining (the largest fleet size year) and the utilities required to advance underground mining. Table 3-6 lists mobile equipment to be used on surface in support of underground mining and for activities at other surface facilities.

Table 3-5. Under Ground Equipment Fleet

Equipment Upper Zone	
2 Boom Jumbo	2
Mechanized Bolter	3

7 yd^3 LHD	2
Scissor Truck	3
44-ton Haul Truck	4
ANFO Loader	1
Total Upper Zone	**15**
Equipment Lower Zone	
2 Boom Jumbo	1
Mechanized Bolter	2
7 yd^3 LHD	1
5 yd^3 LHD	2
Scissor Truck	2
40t Haul Truck	2
ANFO Loader	1
Total Lower Zone	**11**
Shared Upper/Lower Zone Equipment	
Forklift	1
Boom Truck	2
Grader	1
Transmixer	2
Shotcrete Sprayer	2
Fuel/Lube Truck	1
Underground Light Truck	4
Maintenance/Elec Trucks	4
Supervisor Vehicles	4
Engineering/Geology	3
Total Shared	**24**
Total Mine Equipment Fleet	**50**

Mining operations will require various types of surface construction equipment. Table 3-6 lists the types and numbers of this equipment. The year-round operational schedule requires snow plowing during the winter. A snowplow/sanding truck assisted by a road grader, dozer, and rotary plow (if necessary) will be used.

Table 3-6. Surface Equipment in Support of Underground Mining.

Equipment	Number
Excavator	1
Dozer	1
.Haul/Service Trucks	3
Dust Suppression Truck	1
Forklifts	4
Boom Truck -20T	1
Loader	2
Passenger/Crew Van	1

Equipment	Number
Pickup Trucks	15
Vac Truck	1
HDPE Fusion Machines	1
Fuel & Lube Truck	1
Maintenance Trucks	3
Grader	1
Snowplow/Sander	1
Cranes	2
Ambulance	1
Fire Truck	1

3.2.2.6 Operational Underground / Surface Support Mine Workforce and Work Schedule

Underground mining will follow a schedule of two 12-hour shifts per day, seven days per week, and 365 days per year. The personnel required to support and conduct the underground mine operation include a total of 240 Tintina hourly employees and salaried staff. These employees will conduct underground production mining tasks and day-to-day operations. A limited staff will be needed beginning in year 2 of the 13 year construction and production schedule of the proposed mine life. Table 3-7 presents the various positions and number of employees from various internal company support groups, as well as mining and milling personnel. Note that while Table 3-7 includes a total Tintina work force of 243, there will normally be 104 people on-site during day shifts, 41 onsite during night shifts, and the remaining 98 employees will be on days off during the normal operations schedule in years 4 through 13.

Table 3-7. Total Number of Tintina Employees

Total Employees		On-site per Shift		Off-site
Department	**Employees**	**Dayshift**	**Nightshift**	**On Days Off**
General and Administration	22	18	2	2
Maintenance and Surface	48	20	6	22
Mill	51	20	10	21
Mine	122	46	23	53
Total	**243**	**104**	**41**	**98**

3.2.2.7 Other Major Components of Underground Mining

Other major components or elements of underground mining include the following.

Ground Control: The underground workings will be rock bolted to provide basic ground support and shotcrete, steel mats and wire screen mesh will be used as necessary to assist with support in areas with more intense fracturing or poor ground conditions.

Underground Mine Power Supply: The maximum estimated operating electrical load for the Johnny Lee deposit is approximately 5.4 MVA (Mega Volt Ampere, a measure of the amount of power estimated for project needs). Site substations located on the mill pad will carry power to an underground sub-station located in an excavation off the lower extent of the decline (approximately 3,250 feet (1 km) from the portal). Back-up generators will provide power to essential equipment during power outages. These diesel generators will rest near the mill building, and consist of two one-megawatt generators.

Grouting and Groundwater Inflow Control: Pilot holes drilled ahead of the advancing face will test for likely water inflow rates in the vicinity of anticipated water-bearing geologic structures. Pressure grouting will be the primary means of minimizing and controlling the amount of water flowing from water-bearing faults and/or fractures into the mine workings. It involves injecting a grout material into fractured rock. The grout is a cement-based or a solution-based chemical mixture. It could extend under pressure into the wall rock as much as 100 feet (30.4 m) depending on fracturing. Grouting can both strengthen rock and reduce water flow through rock, and is a widely accepted standard practice in the mining industry. Large amounts of water encountered in a pilot hole will require installation of a packer to seal the hole followed by directional grouting prior to advancing the decline.

The initial mine access decline will pass approximately 90 feet (27.4 m) below the Coon Creek tributary of Sheep Creek, approximately 1,700 feet (518 m) in from the portal (Figure 1.3). This is the closest proximity of the decline to the surface once beyond the portal. Shallow bedrock at test well PW-3 (located along the decline trend adjacent to Coon Creek (Figure 2.2), encountered minimal groundwater in its upper 75 feet (23 m), suggesting that dewatering of the deeper decline will have minimal impact on Coon Creek flow. Pumping tests of PW-3 and PW-4 showed no impacts to Coon Creek, nor in piezometers installed in associated wetlands (Figure 2.2). Grouting of any water producing fracture zones encountered at the decline level in the area underlying the creek will minimize the potential for inflow into the underground workings and reduce or eliminate the potential for any reduction of surface water flow in Coon Creek.

Blasting Agents: If mining encounters no substantial groundwater inflow to the workings (as indicated by inflow modeling), Ammonium Nitrate/Fuel Oil (ANFO) will be the primary blasting agent. Miners will load blast holes with ANFO from an explosives truck. To minimize the effects of nitrate and ammonia explosive residues on water quality, blasters will make a concerted effort to limit the use of blasting agents to only those necessary for rock breakage, and to minimize spillage. Exceptional “good housekeeping” efforts can significantly reduce on-going water treatment costs. If wet conditions are encountered, miners will use an emulsion-based powder of other less water-soluble explosives. Emulsion-based powder is available in both stick form and pumpable forms, and many mines use this to control the release of nitrogen by-products produced by explosive residues. In addition to minimizing nitrogen input at the source, Tintina will remove nitrogen to below non-degradation standard with the water treatment system.

Powder Magazines: A temporary powder magazine will initially be located on surface (Figure 1.3). It will subsequently be moved underground (Figure 1.3) to a safe working distance from the portal after the decline advances a sufficient distance. Development mining will establish appropriate sites for powder magazines further underground as the decline and development workings advance towards the resource areas. Explosive storage magazines and practices will comply with all MSHA rules and regulations. A forklift will deliver explosive filled totes from surface to underground storage areas. Tintina will educate and train employees on nitrate issues, proper housekeeping, spill cleanup, and explosives management practices to minimize the potential release of nitrates to waste rock and mine water.

Underground Sumps: An underground settling pond (sump) constructed approximately 500 feet (152 m) from the portal will service the mine prior to intersection of the regional groundwater table. Pumping will lift accumulated water from deeper mine sumps to these pond(s) where booms will skim any oil and fuel residue from the water. In addition, sufficient retention time in these sumps, with or without the use of flocculants, will allow partial removal of suspended sediment from underground mine waters prior to pumping to the WTP clarifiers located in the mill.

Additional underground settling ponds (sumps) locations include one at the bottom of the upper copper zone, one midway through the lower copper zone, and one at the bottom of the lower copper zone. All will be connected in series. Smaller sumps and pumps will transfer water from any additional low areas in the mine to the main dewatering piping. Accumulated mine water will gravity feed from one sump to another before final pumping from the lowest elevation sumps to the near-surface sumps.

3.3 Mineral Production

3.3.1 Processing Method

The mill design is based upon industry standard processing methods that will separate and concentrate the copper minerals. Both a copper concentrate and a tailings or waste stream will be produced from the milling process. The tailings will be managed on site by storing a portion underground as cemented backfill to provide ground stability, and the remainder as cemented paste tailings in a tailings facility.

The approximate copper production tonnages contained in the Project's Johnny Lee mineral deposit come from both an Upper Copper Zone and a Lower Copper Zone. These tonnages are summarized in Table 3-8**.**

Table 3-8. Summary of Proposed Production Tonnage

Metric tonnes	US Customary Tons	Copper Content Cu - %
13,151,000	14,499,000	3.04

A "flotation" process will liberate fine-grained copper minerals from the bulk of the mined rock to form the copper concentrate. The water-based flotation processes rely upon the chemical interaction between fine-grained mineral particles and hydrocarbon-based reagents to separate specific minerals into concentrates. Copper minerals adhere to bubbles formed during agitation of the slurry of water and finely ground rock in a flotation cell, and the bubbles carry the copper minerals to the fluid surface, forming a copper mineral-rich surface froth. Skimming the froth effectively separates all the copper minerals away from the slurry, and the skimmed froth routes to a thickening and filtering circuit to remove the water.

Figure 3.4 is a photograph of copper flotation concentrate produced in a laboratory-scale flotation cell using Black Butte Copper Project materials. The copper minerals concentrate in the froth formed on the fluid surface of the flotation cell. This separation forms the basis of the flotation process. This fine-grained high-grade concentrate is suitable for sale in the world market.

Figure 3.4. Photograph of Copper Concentrate Bench Scale Flotation Cell

The flotation process uses suspension of finely ground rock in water, typically at water to solids weight ratios of about 2:1. Mixing and agitating this slurry in flotation cells maintains suspension of the solids in the mixture. During flotation the slurried solids pass through a number of cleaning stages that are required to optimize recovery of copper minerals into a final saleable concentrate. Multiple stages of flotation require sizing of flotation cells depending upon their role in the various stages of cleaning. The Project process plant flotation cells will range from 65 cubic yards (50 cubic meters) in size to approximately 6.5 cubic yards (5 cubic meters), depending upon which stage of the process the cell is employed.

The flotation process requires addition of trace amounts of reagents (measured in ounces per ton (grams per tonne) to alter the surface chemistry of copper minerals, and allow the copper minerals to ‘float’ to the surface froth of the flotation cell. The ability to attach a mineral particle to an air bubble forms the basis of the mineral separation used to produce a copper concentrate. Oils or hydrocarbons form the basis of copper flotation reagents, and typically work best if added to the water and rock slurry at rates of 0.7 to 3.5 ounces per ton (20 to 100 grams per tonne) of solids being processed. A typical copper flotation process uses lime to maintain a high pH which significantly improves the effectiveness of the separation of copper minerals from the slurry.

The operation will dispose of solids that do not report to the copper concentrate (tailings) back to the underground mine workings as cemented backfill in mined out stopes, or as cemented paste tailings to the CTF.

Copper concentrates produced from the Project will contain approximately 20 to 28 percent copper, depending upon the mineralized zone producing the concentrate, and these concentrates. These concentrates will represent 10 to 15 percent of the total mass of the mined material. Table 3-9 shows a

typical metallurgical balance for the lower copper zone resource based upon recent metallurgical test work.

Table 3-9. Metallurgical Balance for Lower Zone Copper Concentrate Production

Process Stream	Percentage of Mass %	Copper Content %
Flotation Feed	100	4.59
Flotation Concentrate	13.9	30.8
Flotation tailings	86.1	0.36

The flotation milling facility is designed to process up to 3,640 tons of ore per day (3,300 tonnes/day) during two 12-hour shifts. It will operate 365 days per year. This results in a calculated annual ore process rate of 1,327,734 tons/year (1,204,500 tonnes year).

Figure 3.5 is a flow sheet showing the major components of the mineral processing required to produce the copper concentrate from the Project resource. The following sections provide more comprehensive descriptions of the mill facility, milling and flotation process, and the equipment, ancillary facilities, and reagents required.

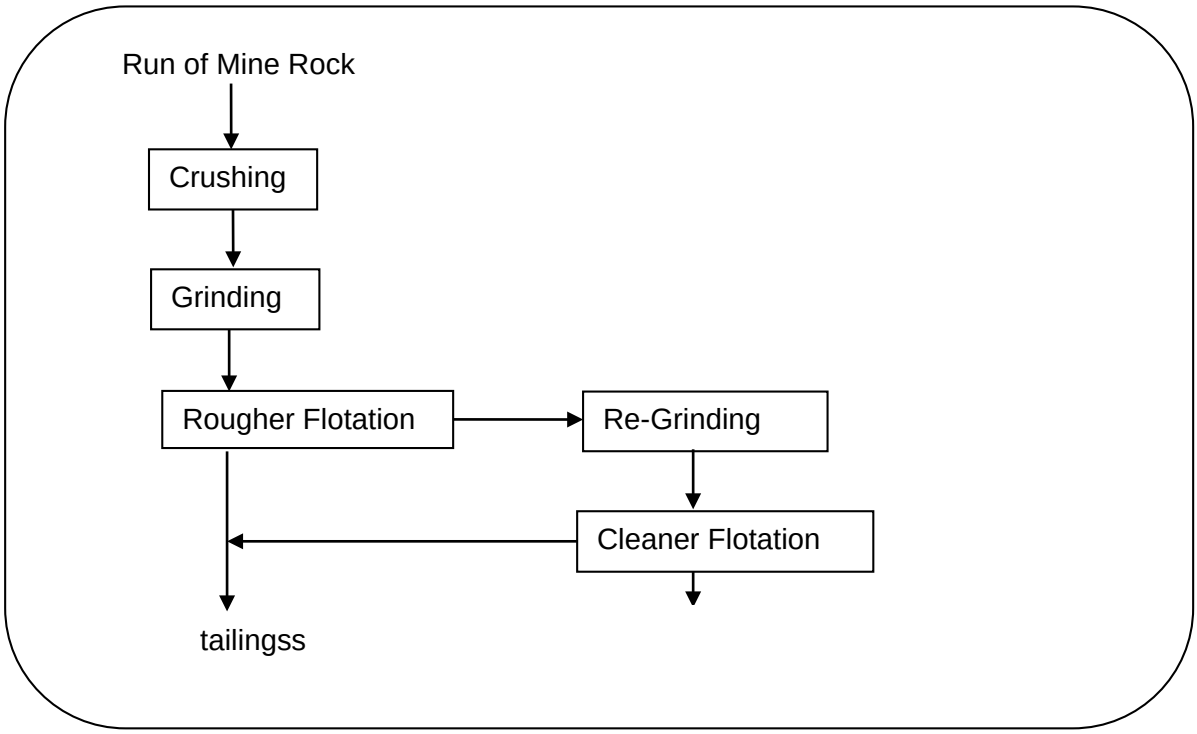


Figure 3.5. Simplified Process Flowsheet Showing Key Unit Operations

3.3.2 Processing Facility

3.3.2.1 Mill Facility Footprint

Figure 3.6 illustrates the major structural features and components of the mill facility. The facility will require a footprint of approximately 14.8 acres (60,000 m^2) which will include about 1.7 acres (6,700 m^2) for a mill laydown area east of the mill facility, and an additional 3.9 acres (15,850 m^2) for a construction laydown area (Figure 3.6) at the west end of the mill facility area. The ground at this higher elevation provides a sound bedrock foundation upon which to build.

Facility preparation will include removing topsoil and subsoil where necessary and transporting it to storage areas. The facility area will have sheet-flow drainage to its outside edges, where storm water will drain into perimeter ditches. During the construction stage and prior to any milling, any storm water that falls on this area will be treated as non-contact water. Ditches and piping will redirect storm water to infiltration basins associated with natural drainage systems. Surface water management will use BMPs to mitigate sediment and run-off controls. As construction on the mill area facilities advances, and when the CWP and water treatment system reach completion, and during the entire mining operations period, operations will treat any water from the mill pad as contact water. This water will be routed in perimeter ditches which convey it to the CWP for pumping to a temporary (construction) water treatment system. The contact water ditches and culverts will convey the 200 year 24-hour rain event on top of the 200 year snow melt peak flow event without overtopping. A 0.1 inch thick (2.5 mm) 100 mil smooth HDPE geomembrane will line the contact water ditches. It will lay on a 1-foot (300 mm) thick layer of 1-inch (30 mm) bedding material.

The mill pad will contain an internal network of roads and a surface parking area sized for approximately 100 vehicles. The areas within the mill facility footprint adjacent to concrete foundations of buildings and other structures will have a gravel surface. During operations the mill pad, surface area drainage will collect in drain ditches and perimeter ditches which direct it into the CWP.

The parking area on the southeast side of the pad and the access road to the east of the pad will see street and highway traffic only (no mine haul traffic). The CTF road to the north, west, and south of the mill facility area and the mill pad adjacent to and north of the truck shop complex will see only haul and mine equipment traffic. Concentrate trucks will remain on the road on the south side of the mill pad on their way to the access road. Drainage from the access road will route this non-contact water to nearby sediment traps and infiltration basins.

3.3.2.2 Mill Building

The one-story, pre-engineered steel sided process plant (or mill building) will measure approximately 275 feet (84 m) long by 120 feet (36 m) wide by 66 feet (20 m) high. It will be taller and larger than any other building in the mill area (Figure 3.6). A dust collection system will capture fugitive dust from various areas inside the process plant, but for the most part the treatment system is a wet process and requires little dust collection. The building will have insulation for heat retention and noise dampening. The mill and mill area will contain areas for the following processes, described in greater detail in Sections 3.3.2.3 through 3.3.2.8:

- Grinding
- Flotation
- Regrinding
- Concentrate dewatering and handling
- Reagent handling

- Paste backfill (separate build to east of mill building)
- tailings thickening (adjacent to the paste plant and mill building)

The mill building will contain the assay and metallurgical laboratories which will have all the laboratory equipment necessary for metallurgical grade testing and control. The laboratories will have all appropriate heating, ventilation, and chemical disposal equipment as needed. Reinforcement of the facility floor will accommodate specialized equipment.

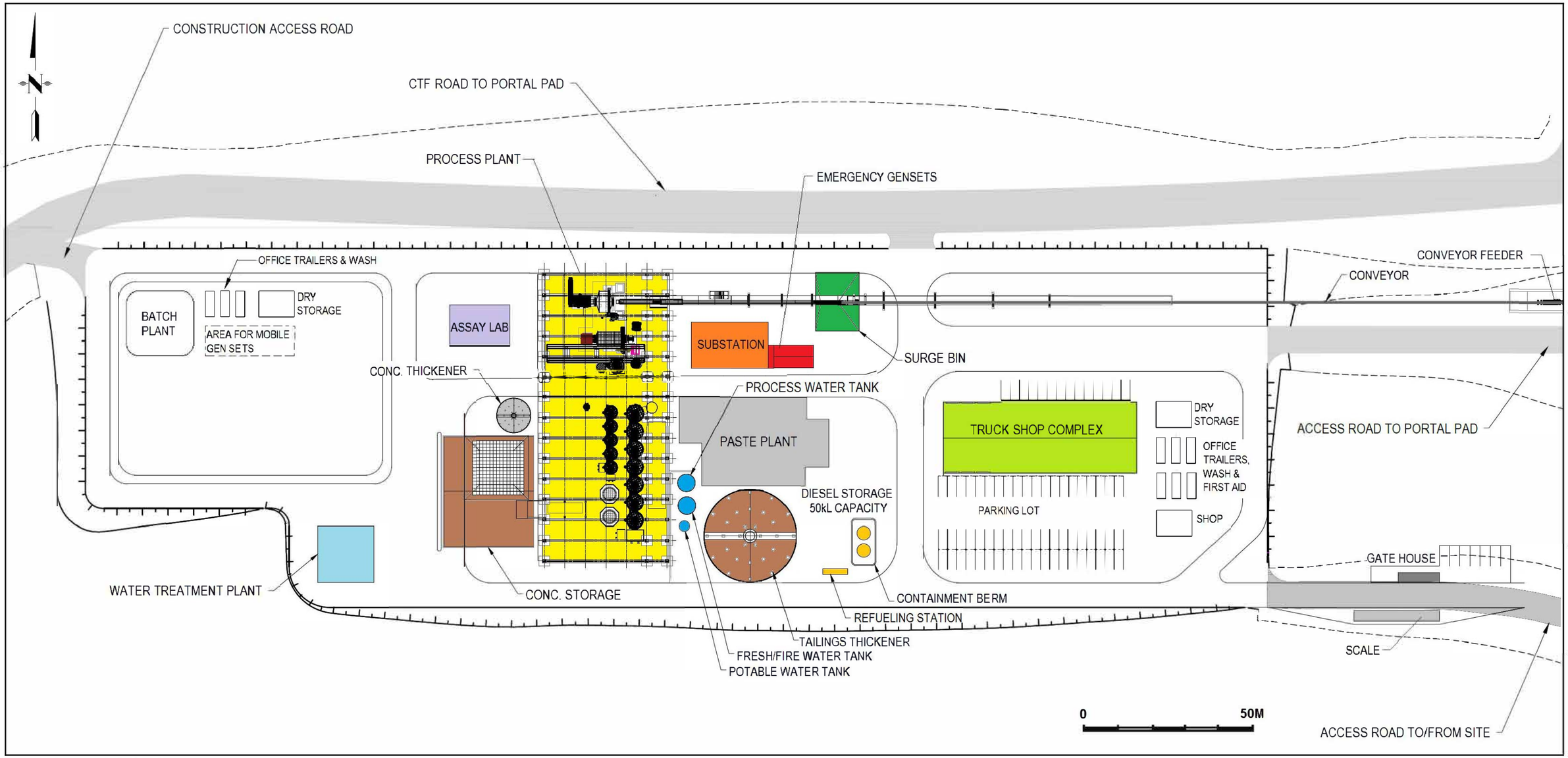
3.3.2.3 Crushing and Grinding

The crushing and grinding stages of the milling process liberates copper minerals to allow for their effective separation during the flotation process, which forms the copper concentrates. Typically a number of stages of size reduction optimize the energy inputs to efficiently liberate the copper minerals.

Resource material trucked from the underground mining operations will be dumped directly onto stationary and vibrating grizzlies with steel gratings that allow the smaller material to bypass the jaw crusher. Rock captured by the grizzlies proceeds into the jaw crusher which will reduce the largest size of rock contained in the discharge from the jaw crusher to approximately 5 inches (12.7 cm) (Figure 3.6 and Figure 3.7). Alternatively, rock can be placed onto the 82,600 ton (75,000 tonne) surface stockpile for later crushing and milling. From the jaw crusher, a conveyor will move the crushed material to a storage bin (Figure 3.6 and Figure 3.7) in preparation for further size reduction in the grinding mills. The crushed material storage bin will have a capacity of approximately 2,755 tons (2,500 tonnes). A dust control system (including a dust collector) will control fugitive dust emissions from the crushing operation. Sound-insulating material and baffles, as well as enclosing the crushing and grinding facilities inside of a largely closed building, will control noise.

Crushed material will be conveyed to the grinding circuit from the storage bin (Figure 3.6 and Figure 3.7). Effective liberation of copper minerals from the host rock requires grinding to the point where 80% measures smaller than 30 microns in diameter (<0.001 inches). The grinding plant will employ three stages of grinding, which crush and grind ore sequentially to complete the grinding process (Figure 3.7). The first stage of grinding is Semi-Autogenous Grinding (SAG), followed by ball mill grinding, and finally stirred milling in a Tower Mill. Each of the mills will operate with a cyclone classification circuit to manage particle sizes of the ground material between mills, and ultimately to control the particle size sent to the flotation process.

Process water added at the SAG mill and at other points within the processing plant will maintain slurry densities of approximately 65% to 75% solids, consistent with the requirements of the grinding and flotation processes. Steel balls will be added as necessary to the SAG and ball mills to maintain optimum grinding efficiency, and will serve as the grinding media in the grinding circuit. The equipment location inside a sound and temperature insulated steel (mill) building will reduce noise from the grinding circuit.



Prepared by Tetra Tech Inc., 2015

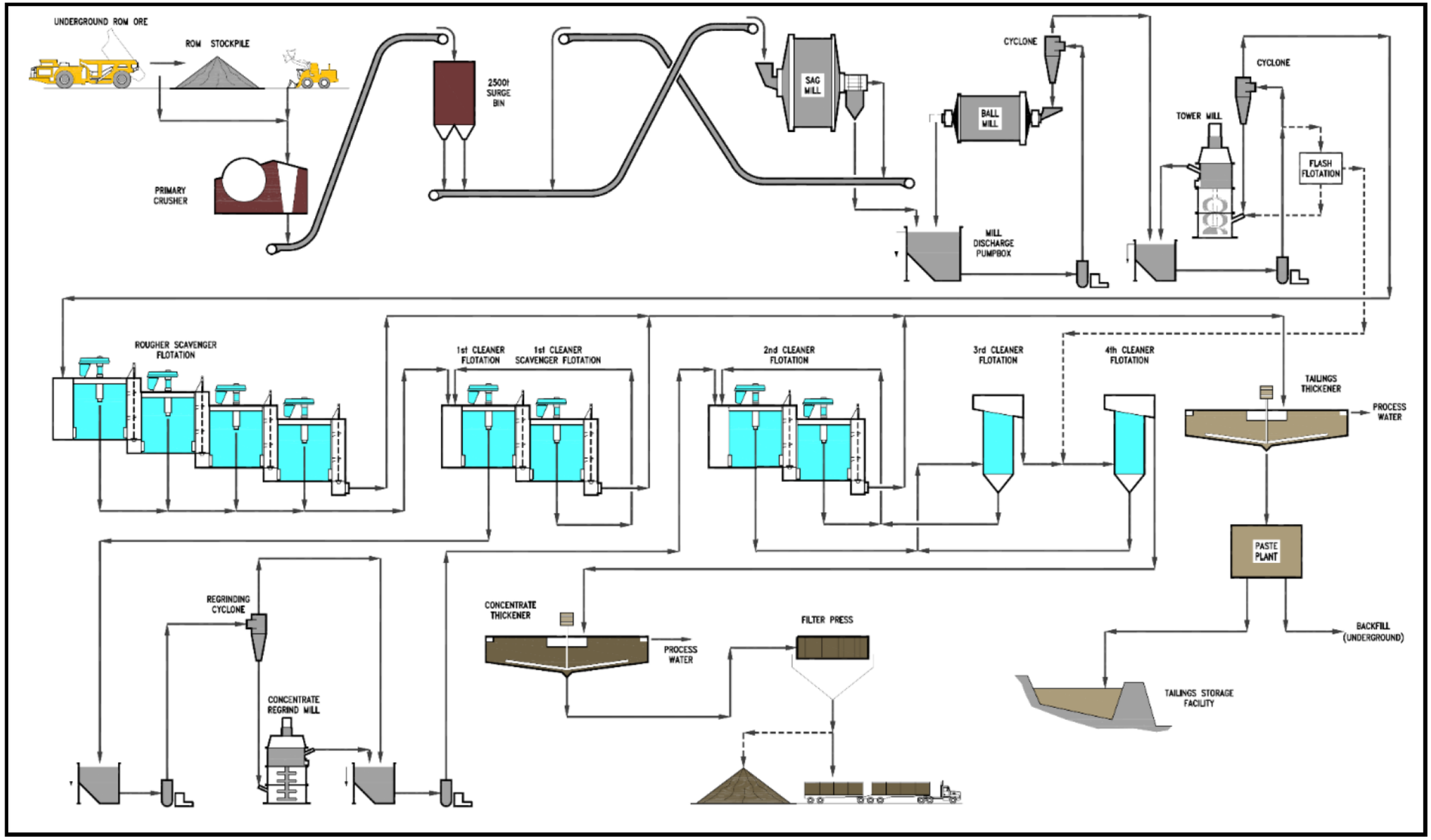
Figure 3.6

Plan Map Showing Mill Facilities

Black Butte Copper Project

Meagher County, Montana

TINTINA RESOURCES



Date: November 4 2015 Source: Tetra Tech (2015)

TINTINA RESOURCES

Figure 3.7
Detailed Process Flow Sheet
Black Butte Copper Project
Meagher County, Montana

3.3.2.4 Flotation Circuits

The Project will use a flotation process (Figure 3.7) to recover and upgrade copper values in order to produce a saleable copper concentrate. Material from the grinding circuit will be very fine (less than 0.001 inches, <30 microns).

Ground material from the crushing and grinding circuit will flow by gravity into the rougher flotation circuit comprised of 65 cubic yard (50 cubic meter) flotation cells. Copper will be recovered in a froth, and transferred to subsequent upgrading stages within the processing plant. The un-recovered tailings will be sent to a paste plant thickener where it will be dewatered and cement will be added, and then to either the CTF, or underground, as cemented backfill.

Concentrate from the first cleaner flotation circuit will be routed to two stirred mills to be reground such that 80% of the material is smaller than 0.0003 inches (<10 microns) before being sent to the second cleaner flotation stage. The final cleaner concentrate produced by the fourth cleaner circuit will be sent to a thickener for dewatering.

The reagents proposed for use in this process are common for copper flotation. They include sodium isopropyl xanthate (SIPX) and Aerophine 3418A as copper mineral collectors and methyl isobutyl carbinol (MIBC) as a frothing agent. The pH will be managed by the use of lime, added at various points in the process, with the flotation pH typically in the range of 10 to 11.5 s.u. This reagent list may be modified operationally to optimize copper recovery.

Tailings from the rougher circuit and the first and second cleaner circuits will be sent directly to a tailings thickener (Figure 3.7). Tailings from the third and fourth cleaner circuits will be recycled through the preceding cleaner circuit, before being routed to the tailings thickener.

3.3.2.5 Copper Concentrate Dewatering and Handling

The final copper cleaner flotation concentrate will be thickened in a high-rate thickener (Figure 3.7) where a flocculent will be added to improve the settling rate of the copper concentrate. Additional dewatering by a pressure filter will reduce the moisture content to approximately 10%. The dewatered copper concentrate will be loaded into concentrate shipping containers at the concentrate storage facility (Figure 3.6). The containers will be sealed and mechanically locked. The sealed containers will be transported by truck to a nearby railhead in Montana, and then by rail and/or ship to a smelter. The sealed containers eliminate dust issues during concentrate transport and also eliminate multiple stages of handling normally associated with concentrate shipping. In addition, the containers are strong and rugged enough that they are unlikely to release concentrate during shipping accidents or mishandling. The concentrate will be packaged and transported in full compliance with all applicable federal and state regulations. The concentrate handling area will be equipped with a dust collection and control system. Appropriate ventilation, fire protection and fire and mixing safety protection, and Material Safety Data Sheet (MSDS) stations will be provided in the area.

3.3.2.6 Tailings Dewatering and Paste Handling Methods

Tailings from the milling process will be dewatered using a separate high-rate thickener and flocculent (a chemical that causes colloids to form, and other suspended particles in liquids to aggregate, forming a floc) to initially achieve a solid density of 60%. The tailings will be further dewatered to 70-85% solids using a vacuum filter. Thickened tailings will be sent to a paste plant (Figure 3.6 and Figure 3.7) where cement, fly ash, and slag will be added as binders. Then they will be used for structural backfill in underground workings or placed as cemented paste tailings in the CTF.

Experimental laboratory testing of Black Butte Copper tailings material evaluated a range of percent solids in the tailings (approximately 79 to 80% works best for the Project tailings), and varying ratios of cement, fly ash and slag. A pumpable tailings mix, with optimum flow conditions and the best setting properties for both the underground and surface tailings mixes was developed. Paste tailings deposited in the CTF will have a total binder content of 0.5 to 2%, whereas cemented paste used as structural backfill underground will have a binder content of approximately 4% in order to provide the necessary additional strength to stand up as walls in the underground workings. Binder of fly ash and slag are available that meet the chemical requirements of ASTM standards for use in cement (i.e., ASTM C618 for a fly ash for use in concrete). Figures 3.8a and 3.8b show the effects of the addition of binder and cement on the slump testing of tailings (flow/strength characteristics), conducted immediately after mixing and pouring into molds) using 79.5% solids in cylinder with no binder in example in Figure 3.8a, and 2% binder in example Figure 3.8b.

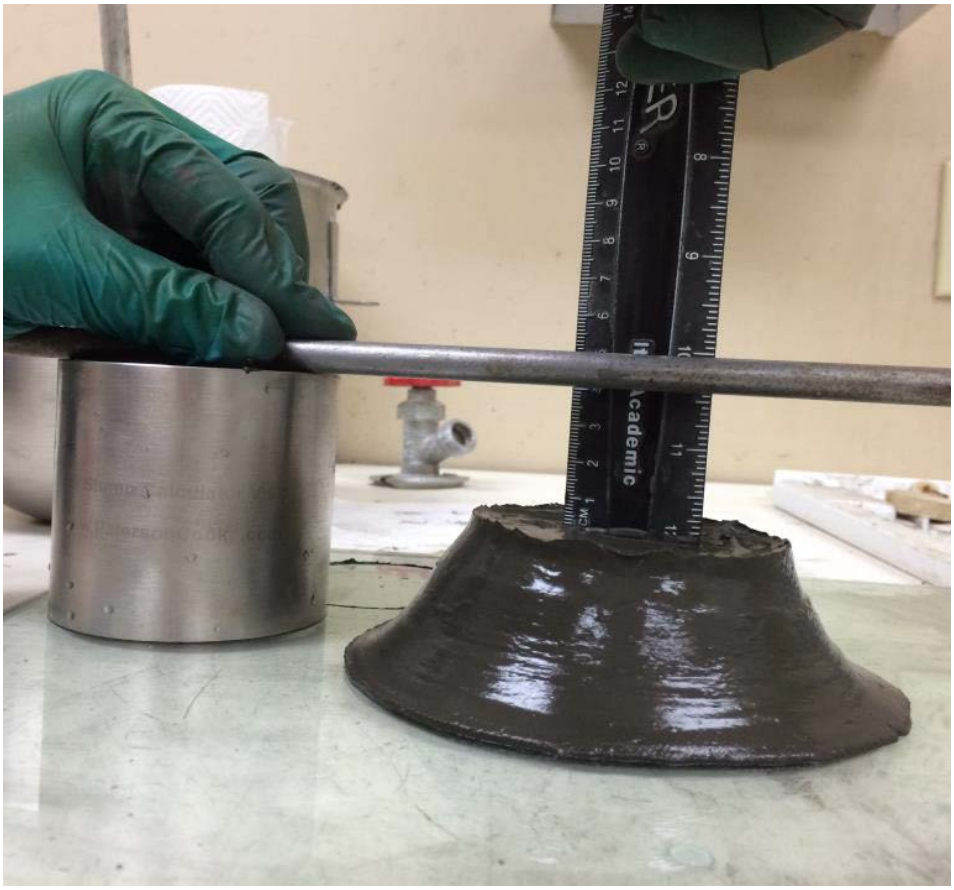


Figure 3.8a. Tailings with 79.5% Solids and No Binder

Note how the cylinder of wet tailings has collapsed and flattened. This cylinder slumped 1.4 inches (38 mm).

Figure 3.8b. Actual Tailings with 79.5% Solids and 2% Binder

Note how the cylinder of wet tailings remains largely intact (little slumping). This cylinder slumped 0.55 inches (14 mm).

The cement and fly ash will be shipped to the Project by self-unloading bulk truck trailers, and uploaded into silos separately by the truck's pneumatic unload system. The silos will be equipped with a dust collecting system to control dust emission.

3.3.2.7 Reagent Handling and Storage

Reagents used for the copper-enriched rock milling process will include hydrated lime ($Ca(OH)_2$) as a pH modifier, sodium isopropyl xanthate (SIPX) and Areophane 3418A as copper collectors, and methyl isobutyl carbinol (MIBC) as a frothing agent. Chemicals used may be varied during the optimization process. The collectors will be added to the flotation process slurry streams to modify the chemical and physical characteristics of mineral particle surfaces, and to enhance the floatability of copper minerals. Flocculent will be used as a settling aid during concentrate and tailings thickening. Anti-scalant will be added as required to protect pipelines and process equipment from caking and mineral precipitates. Estimated annual reagent consumption is shown in Table 3-10.

Table 3-10. Estimated Milling Reagent Consumption

Reagent	Daily Consumption, ton / day	Annual Consumption, tons / year
Hydrated Lime	11.1	3,758
Sodium Isopropyl Xanthate (SIPX)	0.61	209
Aerophine 3418A	0.13	44
Methyl Isobutyl Carbinol (MIBC)	0.19	66
Flocculent	0.22	77
Anti-Scalant	0.06	22

Quick lime (CaO) is expected to be shipped to the mine site by self-unloading bulk truck trailers. The lime will be also be uploaded into a silo by a pneumatic unloading system. The silo will be equipped with a dust collecting system to control dust emission. The quick lime will be slaked (mixed with water) to generate a 15% hydrated lime slurry by weight. The lime slurry will be stored in a holding tank and distributed to various addition points through a closed pressure loop.

SIPX is expected to be shipped to the mine site in solid form in steel drums. A 20% by weight solution will be prepared by dissolving the SIPX with fresh water in a mixing tank prior to storage in a 5-foot (1.50 m) diameter by 5-foot (1.50 m) high holding tank. The solution will be added to the various addition points by metering pumps.

Aerophine 3418A and MIBC is expected to be shipped to the plant as liquids in reusable approximately 500 gallon (2000 liter) containers. These reagents will be pumped to selected points of addition in the process circuit in undiluted form using metering pumps.

Flocculent will be prepared in a mixing system to a dilute solution of approximately 0.2%. The solution will be stored in a holding tank prior to being pumped by metering pumps to the thickener feed points.

Anti-scalant will be delivered in liquid form and added to the process water tank. This is required to minimize scale build-up in the water pipelines and process equipment. This reagent will be added in undiluted form.

A mixing, holding, and dosing system will be provided to occasionally test any new reagents that may improve the metallurgical performance and enhance metal recovery.

The reagent preparation and storage facility will be located within a containment area designed to accommodate 110 % of the volume of all tanks. This will ensure containment in the event of an accidental spill. The storage tanks will be equipped with level indicators and instrumentation to ensure that spills do not occur during normal operation. Appropriate ventilation, fire protection, fire and mixing safety protection and MSDS stations will be provided in the area. These reagents will be handled in accordance with MSDS requirements and any unused test reagents will be returned to the suppliers for disposal.

3.3.2.8 Air Supply System

Two separate air supply systems will service the process plant. Low-pressure air for the flotation cells will be supplied by air blowers. High-pressure air for the overall process plant will be supplied by plant air compressors.

Instrumentation service air will be provided by plant air compressors. Compressed air will be dried and stored in air receivers for distribution to various instruments. Filtration air will also be provided from plant air compressors.

3.3.3 Mill Support Facilities

3.3.3.1 Truck Shop and Administration Building

The mill area will accommodate a number of support facilities within its footprint. These include: a truck shop/administration building; process, potable and fresh/firewater tanks; a concentrate building; a WTP; a bermed fuel storage and fuelling station area; a substation with emergency back-up generators; a staff parking area and a construction laydown area. A gate house and scale will be constructed on the access road at the south east corner of the mill pad. A second scale will be constructed for the concentrate building.

The truck shop complex will consist of a 130 feet (40 m) by 65 feet (20 m) pre-engineered steel frame and steel sided building. It is designed to accommodate facilities for repair and maintenance of heavy surface and underground mine equipment and other light vehicles. The facility will also contain warehouse storage space for spare parts and consumables; an emergency vehicle storage area with first aid station; designated training areas, and offices for the site supervisors, mine engineers, and General and Administrative (G&A) staff. A mine dry (change) facilities will also be provided in this complex.

The truck shop/administration complex will be located east of the process facilities. The service bays inside the truck shop area will consist of:

- Four heavy vehicle repair bays
- One light vehicle service and welding bay
- Emergency vehicle bay

The heavy vehicle repair bays will be designated for service and repair of major equipment. These will include automatic hose reels for dispensing engine oil, transmission fluid, hydraulic oil, air, solvent, diluted coolant, and grease. Hose reels will be supplied by delivery pumps located in the lubrication storage tanks. Waste lubricant recovery systems will pump used oil and coolant to holding tanks located at the lubrication storage building for recycling.

One bay will be used for servicing and maintaining light vehicles. All small equipment required for wheel alignment, balancing and tire repair, automotive testing, and diagnostic purposes will be available in this bay. The light vehicle bay will also be used for welding work. Ventilation fans and flash shields will be provided for personal protection.

A medical/first aid station, ambulance, fire truck and spill response truck/equipment will be located in a dedicated bay area in the truck shop. Patients requiring evacuation will be transferred to the hospital in White Sulphur Springs, MT.

3.3.3.2 Fuel Storage and Dispensing

The fuel storage and fueling area will be 100 feet (30 m) long by 50 feet (15 m) wide and located immediately southwest of the staff parking lot in the mill area. A one-week supply of diesel fuel will be kept on site. Freight trucks will transport diesel fuel to the mine. Fuel will be pumped from the trucks into fuel storage tanks. Two 13,000 gallon (approximately 50,000 L) double-walled fuel tanks will be erected during the construction stage. The fuel tank farm spill containment area will be lined with HDPE liners and protected by safety berms placed along the perimeter. The spill containment capacity will be no less than 110% of the total tank storage. Fueling areas will be on pads adjacent to the fuel storage areas, and a fueling station will be housed in a modular container with automatic shut-off mechanisms to prevent over-fueling and spillage. Manual fire suppressant equipment will be installed at the fueling station.

3.3.3.3 Lube and Oil Storage and Dispensing

The storage area will consist of refurbished cargo containers with a gross floor area of 120 square yards (100 m^2). It will be located approximately 40 feet (12 m) from the truck shop. This distance allows fire safety separation between the truck shop and the lube and oil storage area. The lubricant storage facility will house tanks with a two-week supply of lubricants, and coolants. Waste oil from the mining and plant support equipment fleet will also be stored in this area. A separate HDPE-lined and bermed exterior storage facility will be provided for waste oil and spent coolants prior to being picked up by an third party contractor for recycling or disposal. The lubricant storage building will be furnished with loading/unloading

arms and pumps. This storage facility will also contain air-operated transfer pumps for supplying lubricants to the dispensing reels located in the truck shop service bays.

3.3.3.4 Construction Laydown Area and Container Storage

A 3.9 acre construction laydown area will be provided on the west end of the mill facility. A temporary construction concrete batch plan will be located on the northwest corner of this pad. Sealed concentrate containers may be stored on this pad while awaiting shipment during operations. Spare parts and materials that do not require protection from the elements will also be stored in the laydown area.

3.3.3.5 Water Supply, Storage and Treatment Locations

Three separate water supply systems consisting of a process water supply, fresh water supply, and potable water supply will be used to meet the water supply needs of the Project. Supply tanks containing these different types of water are located on the east side of the mill building as illustrated on Figure 3.6. Recycled water from the PWP to the process water tank will be the primary water source for the milling operation. Make-up water will be provided directly by dewatering of the mine, or from the WTP. Fresh water (for the fresh/fire water tank) will be obtained from the WTP, and will be used for other milling purposes. Potable water (from the potable water tank) will be derived from a public water supply well at or adjacent to Pumping Well 6 (PW-6, Figure 1.3).It will be treated as necessary and supplied for human consumption at various locations throughout the mine site. It will also be used for pump gland lubrication.

The WTP will be located on the southwest corner of the mill pad. The treatment process will have various components including an oil and grease skimmer, clarifier, and Reverse Osmosis system (RO) to remove contaminants. Brine from the reverse osmosis system will be disposed of in the PWP, or added to the mill thickener with cement and binders for disposal in the CTF or underground. The Water Management Section (Section 3.7) provides details on the water supply and treatment system.

3.3.3.6 Staff and Equipment Parking

Approximately 100 staff parking spaces will be located after entry through the security gate south and east of the truck shop complex. It is assumed that many staff will car pool. The parking area will be graded to positively drain to the contact water ditch system surrounding the mill pad. The surface will be gravel and designed for the anticipated traffic loads which will generally be passenger vehicles, vendor suppliers, and concentrate trucks. Equipment parking for mine and surface support vehicles will be located north of the truck/shop complex.

3.4 Mine Site - General Construction, Erosion Control and Engineering Studies

3.4.1 Overview and Disturbance Acres

The location of on-site facilities and infrastructure were carefully designed to avoid or minimize impacts to wetland, riparian, and forested areas, to the extent possible. They were then engineered to reduce the horizontal distances between individual facilities. This reduces the disturbance footprint and the length of haulage roads, and pipelines between facility sites.

A map of surface mine support facilities and a more detailed table of surface disturbance acres for individual facilities are presented in Figure 1.3 and Table 3-11. All surface facilities are located on privately owned land. The total amount of proposed surface disturbances associated with the Project is 285 acres (115 ha).

Table 3-11. Complete List of Surface Disturbance Acres

Facility or Activity	Linear Feature	Construction Disturbance Width	Surface Disturbance
	Lineal feet	**Feet**	**Acres**
New Access Roads			**62.62**
Main Access road to Mill Site	7986	84	15.14
Contractor Access road Butte Creek Road to CTF Road	1,148	98	2.59
CTF Road – portal to CTF	3,937	164	14.83
Power-line corridor	7,564	20	3.46
Truck road to waste rock storage pad	328	98	0.74
Service roads to CTF and PWP foundation drain ponds	656	98	1.48
Service road - Truck road to soil stockpiles (includes road to PWP)	3,609	98	8.15
Service road – Main access to CWP	Already disturbed	---	—
Service Road - CTF to NCWR	6,594	98	14.90
Ventilation raises new access roads	1,181	49	1.33
Direct Underground Mine Support			**10.29**
Portal Pad, Including Support Facilities	984	410	9.27
Ventilation Raise Collar areas (4) (100 x 100', 0.3 acres each) 6-foot chain link fence	100	100 *4	0.91
Pumping lines to portal to PWP	992 undisturbed	5	0.11
Pumping lines to portal to WTP	2300	5	Already disturbed 2.64
Temporary Waste Rock Storage (WRS)			**13.12**
Temporary Waste Rock Storage	820	591	11.12
Copper-enrich rock storage pad (incl. with WRS) (10% of WRS)	295	295	2.00
Drainage Piping WRS to CWP	1,131	20	Already disturbed 1.57
Contact Water pond (CWP)			**10.39**
Contact Water pond (CWP)	656	656	9.88
CWP pump-back piping to WTP	2,328	5	Already disturbed 0.27
CWP pump-back piping to PWP	992 undisturbed	5	0.11
Foundation drain pond			0.40
CWP 8-foot wildlife fence	2600	5	included
Mill/Plant Site			**14.83**
Plant Site (includes mill, laydown area, substation, truck shop /admin, paste backfill plant, and water	1313	492	14.83

Facility or Activity	Linear Feature	Construction Disturbance Width	Surface Disturbance
	Lineal feet	**Feet**	**Acres**
treatment facilities, etc.)			
Primary crusher and conveyor			included
Process Water Pond (PWP)			**24.92**
Process Water Pond (PWP)			23.80
PWP foundation drain pond			0.40
Pump back piping to PWP*	50	20	0.02
Piping PWP to mill	1548	20	0.70
PWP 8-foot wildlife fence			included
Cemented tailings Facility (CTF)			**78.32**
Cemented tailings Facility (CTF)			71.90
CTF foundation drain pond			0.7
Pump-back piping to CTF*	50	20	0.02
CTF Pump-back piping to PWP*	1548	20	1.2
tailings pumping supply Mill to CTF*	4,423	20	2.0
CTF diversion channel			2.50
1.2+10.2 CTF 8-foot wildlife fence			included
Non-Contact Water Reservoir (NCWR)			**7.60**
Noncontact Water Reservoir (NCWR**)**			4.70
NCWR diversion channel			2.10
NCWR Spillway channel			0.50
NCWP piping to spillway channel	738	20	0.30
8-foot wildlife fence			included
Water Supply			**4.3**
Public water supply well and pipeline (100 x 100' pad , 0.3 acres includes water tank)			0.30
Pipeline well to WTP	7380	20	3.4
Water tanks (Mill) distribution lines	1320	20	0.6
LAD areas			**5.2**
Surface LAD	existing		
Sub-surface infiltration gallery	8,340	20	5.2
Stockpiles			**26.83**
Top Soil	492	525	5.93
Subsoil	1,083	558	13.86
Excess excavation stockpile	623	492	7.04
Other/ Miscellaneous			**0.63**
Septic System			0.23
Temp. Powder Magazine			0.40
8-foot chain link fence			included
Barbed wire fencing of Active Mine			included
Subtotal			259.05

Facility or Activity	Linear Feature	Construction Disturbance Width	Surface Disturbance
	Lineal feet	**Feet**	**Acres**
Construction buffer zone / Misc. (5%)			25.91
Disturbance Acres Total			**284.96**

- Much of this pipeline is constructed on ground disturbed by a facility the amount shown is additional disturbance

3.4.2 Construction of Surface Facilities

A number of activities and components are required for all facility construction. These are presented the General Construction Section (Section 3.4.2.1). A discussion of construction BMPs can be found in Section 3.7.6.

3.4.2.1 General Construction

Earthworks construction will include access roads, borrow area preparation, borrow excavation, foundation preparation, subgrade preparation, embankment fill placement, liner bedding, transition filter material processing and placement, installation of the geotextiles and HDPE geomembranes throughout the basin footprints of the waste or water storage facilities, and installation of instrumentation. Additional construction activities will include installation of pumps and pipelines, surface water diversions and storm water management structures.

Embankments will be constructed with fill material excavated from the facility basins as part of the cut-fill construction and impoundment shaping. The majority of this fill will be shale, with minor amounts of granodiorite (intrusive) rock fill and overburden. Heavy truck roads connecting the facilities will be built early in the construction phase to provide access for the construction fleet. The cemented tailings facility (CTF) basin has been designed such that its cut will provide excess construction material for subsequent supplementary use in the other facility embankments as needed. A site-wide cut/fill balance for major facilities is provided in Section 3.4.2.7 and Table 3-12.

During construction it is anticipated that a contractor will be responsible for foundation preparation, basin shaping, liner bedding placement, geomembrane installation, and the installation of instrumentation, sumps, pumps and pipelines. Weathered bedrock excavated from the CTF and PWP basins will be used for liner bedding material. Sand and gravel used for construction of the CTF and PWP drainage sumps will need to be sourced from local borrow areas, or otherwise generated by selective crushing of unweathered bedrock.

Construction of the waste and water management facilities will likely begin at the start of site construction. The temporary WRS pad and the CWP will be constructed first to store waste rock produced during excavation of the mine adit and brine generated from the WTP, respectively. The PWP construction will be completed within 12 to 16 months after start of construction in order to store water pumped out of the underground mine workings and the CWP brine beginning in year 2. Completion of the basin floor of the CTF will be prioritized so that waste rock from the temporary (WRS) pad can be used to construct the basin underdrain concurrently with construction of the remainder of the CTF.

A complete set of engineering drawings (layout plans and cross-sections) and material specifications are contained in an engineering report on mine support facilities by Knight-Piésold (2015d) (Appendix K). Select drawing are presented in the main text of this document.

As-built drawings of the mine's surface facilities and workings will be provided to DEQ in electronic format as part of the annual report for the Project. A copy of the as-built drawings will be maintained in an up-to-date condition and be available at the Project site.

3.4.2.2 Topsoil and Subsoils Handling (Stockpiles)

Clearing and grubbing of shrubs and other vegetation will be completed prior to construction activities in all proposed disturbance areas. Harvested shrubs will be used to provide coarse woody debris to cover early construction reclamation sites, used for sediment erosion control, stored in slash piles or harvested and stockpiled with topsoil. Coarser vegetative and deleterious materials will be removed from the embankment and basin footprint areas. These materials will be placed in stockpiles outside of the final limits of the waste and water management facilities for near- and long–term reclamation and slope stabilization. Until such time, the outer surface will be graded and/or contoured to ensure adequate runoff characteristics and to minimize erosion potential. Valuable timber will be harvested for use by the landowner.

On average approximately 7.5 inches (19 cm) of topsoil and 15 inches (38 cm) of subsoil will be removed from proposed disturbance areas prior to construction. This material will be stored in separate stockpiles requiring areas of 5.9 and 13.9 acres, respectively, located south of the PWP (Figure 1.3). The amount of subsoil removed will be limited to that required by excavations for the specific facility. These stockpiles will be surrounded by silt fences at their bases, and will be graded and re-vegetated using an approved seed mixture (Section 7.2.5). This will reduce soil and moisture loss, minimize erosion from water and wind, and minimize weed invasion. Diversion ditches will be installed uphill from each of the facilities to intercept non-contact water surface drainage, and convey it to existing drainage outlets. Additional silt fences will be installed downstream as required to prevent release of sediment to the environment.

An excess excavation material stockpile will be constructed to the west of the temporary WRS facility (Figure 1.3). This material will largely come from the WRS basin excavation and will be used in year two or three to reclaim this WRS facility (see Section 3.6.4), after waste rock is removed to the CTF.

Contemporaneous reclamation of disturbances will be a priority during the construction period. Maintaining reclaimed areas will be an ongoing Project focus. Surface disturbances related to cut and fill slopes associated with roads, ditches, embankment faces, and the disturbed perimeter of facility footprints will be reclaimed immediately where possible after final grades have been established. Reclamation includes: grading, slope stabilization, drainage control, soil and subsoil placement, and seeding. It is expected that these reclaimed areas will be fully re-vegetated within two to four years following construction.

BMPs will be used to minimize erosion, sedimentation and to control surface and storm water run-off during the construction phase. BMPs and the site-wide water management plan are described further in Section 3.7.6. Removal of vegetation and soil layers will require the use of dozers, excavators, loaders, scrapers and trucks.

3.4.2.3 Foundation Characteristics

Site investigations have been conducted to characterize the subsurface conditions and estimate foundation preparation requirements. Twenty geotechnical holes drilled to evaluate foundation and hydrologic conditions. Thirty nine test pits were also dug to determine the types of overburden present,

characterize its physical properties, determine depth to bedrock, and measure overburden and shallow bedrock infiltration rates. The Property contains a thin veneer of topsoil overlying subsoil and weathered, rippable bedrock to depths ranging from 6 to 62 feet (2 to 20 m). The topsoil and subsoil layers typically have 1.5 to 3 feet (0.5 to 1 m) combined thickness, with topsoil typically being no more than approximately 8 inches (0.2 m) thick. These units will be stripped and stockpiled separately as described above prior to foundation excavation and grading.

The basins to be excavated for facilities with the excavated material used for embankment construction are underlain by *Ynl-A* and interlayered granodioritic intrusive sills (tabular intrusive bodies interleaved with rock and injected along bedding planes). The *Ynl-A* portion of the fresh bedrock has been tested in humidity cells for acid generation and metal mobility and is considered suitable for use as general fill material in embankments. This is true even though the average sulfide content of *Ynl-A* was 2.67%, as it is well buffered by calcareous shales and dolomites.

Geotechnical drilling evidence indicates that the upper 30 m of the Ynl is highly fractured, oxidized and deeply weathered. As a result, this material has been leached. Near surface *Ynl* has average sulfide contents less than 0.28% and is unlikely to generate acid. The granodiorite intrusive sills interlayered with *Ynl-A* is currently undergoing geochemical testing. However, this unit contains less than 0.06% sulfides and is expected to have very little potential to generate acid or release metals. This weathered bedrock and overburden will be excavated, separated, and selectively used for liner bedding or embankment fill.

3.4.2.4 Basin Excavation, Shaping, and Subgrade Preparation

The CWP, PWP and CTF facility basins will be graded and shaped in preparation for the installation of the geomembrane. This includes ripping, drilling and blasting of bedrock (if required), and placement of fill (i.e., crushed weathered bedrock) in areas within the basin. This will achieve the grades and surfaces required for the installation of the geomembrane.

It is anticipated that the CTF cut will extend below the groundwater table and care will need to be taken during design, layout and construction of the foundation drain system to control site drainage. Erosion control including surface water diversions and dewatering measures will be implemented on an as needed basis to manage groundwater seepage into the construction site. The foundation drain systems that underlie the embankments need to be constructed first because the embankments will require material sourced from inside the impoundment.

At the NCWR construction site, only the footprint of the NCWR embankment will be stripped of topsoil/subsoil in preparation for construction of the lined embankment. No basin preparation is required as the basin itself will not be lined. The topsoil/subsoil from the embankment footprints will be stockpiled separately in the soil/subsoil stockpile area (Figure 1.3). Grading plans for each of the facilities are included in individual facility discussions.

3.4.2.5 Geomembrane and Geonet Installation

Two 100 mil HDPE geomembranes will be placed over the entire footprint of the basin and on the upstream embankment and side slopes of the CWP, CTF and the PWP. The HDPE geomembrane panels will be welded together by thermal methods. Non-woven geotextile will be placed below and above the geomembrane to protect it.

A high drainage capacity geonet liner will be placed between the two HDPE geomembrane layers at the PWP, CTF and CWP. The geonet liner will collect any seepage through the upper liner and deliver this to a sump for removal. Quality Assurance and Quality Control (QA/QC) procedures implemented during construction will minimize the potential for construction defects.

3.4.2.6 Basin Underdrains

A basin underdrain will be constructed above the HDPE geomembrane within the CTF basin. Non-woven geotextile will be placed over the floor of the CTF basin to provide abrasion protection of the geomembrane. Approximately 165,300 tons (150,000 tonnes) of waste rock from pre-production will be removed from the temporary waste rock storage pad near the mine adit and crushed so that it meets the material specifications for the basin underdrain. The processed waste rock will be hauled to the CTF basin and placed in layers to facilitate movement of mine fleet traffic within the basin. The remaining approximately 288,000 tons (261,000 t) of waste rock will be placed on top of the basin underdrain.

3.4.2.7 Cut/Fill Material Quantities

The cut volume for the CTF will generate more fill than required for the construction of the PWP, NCWR, and CTF embankments. This surplus material will be placed in the excess material stockpile west of the waste rock storage pad and be used to reclaim that pad in year three. Any remaining material will be reserved for use in other closure/reclamation activities. The excess material stockpile will be reclaimed when it is no longer needed to store suitable fill material.

The PWP will be constructed to an approximate cut-fill balance, and will only require minimal fill from the CTF cut. The NCWR embankment foundation preparation will involve stripping of topsoil/subsoil, but because the NCWR will be unlined, no impoundment shaping will be required. Fill material for the NCWR will be sourced from the CTF cut. Material used to construct the bedding layers and drainage sumps will be processed by the contractor using local borrow/quarry areas or suitable processed fill provided by the mine. A breakdown of the fill material required for the construction of the major facilities, ditches and roads are summarized in Table 3-12. A bulking factor of 20% (after excavation) has been applied to both the cut and fill volumes.

Table 3-12. Project Cut and Fill Quantities

Facility	Bulked Volume Available (m3)	Bulked Fill Required after bulking (m3)	Net (m3)
Mill Pad	49,000	31,000	18,000
Portal Pad	40,000	70,000	-30,000
Contact Water Pond	88,000	65,000	23,000
Roads and Ditches	321,000	321,000	0
Cemented Tails Facility	1,971,000	1,591,000	380,000
Process Water Pond	447,000	470,000	-23,000
Non-Contact Water Reservoir	-23,000	140,000	-163,000
Diversion Ditches	28,000	28,000	0
Temporary Waste Rock Pad	148,000	45,000	103,000
Total	**3,069,000**	**2,761,000**	**308,000**

3.4.2.8 Instrumentation

Instrumentation will be installed in the CWP, CTF, PWP and NCWR embankment fill zones and underlying foundations. The instruments will be monitored during construction and ongoing operations to assess performance. The following types of instrumentation will be installed:

- Vibrating Wire Piezometers –Little water is expected to accumulate on the basin underdrain liner. However, as a precaution, the CTF basin underdrain, basin drain, and wet well sump and pump system will be designed to minimize head on the impoundment liner. This will reduce the potential for seepage from the facility. Vibrating wire piezometers will be installed above the liner at select locations to measure the pore water pressures within the tailings, and monitor the performance of the drainage management systems.
- Survey Monuments and Vibrating Wire Settlement Cells - Regular surveying will aid evaluation of the performance of the embankment slopes and crest with respect to movement, and settling. Periodic surveying of the monument locations will provide early warning of movements.
- Inclinometers - Inclinometers installed at the embankments for the CTF, PWP and NCWR will provide additional tracking of movement.
- The instrumentation plans and details are shown on construction drawings in Appendix K (Knight-Piésold, 2015d).

3.5 Engineering Evaluations

3.5.1 Geotechnical Foundation Evaluations

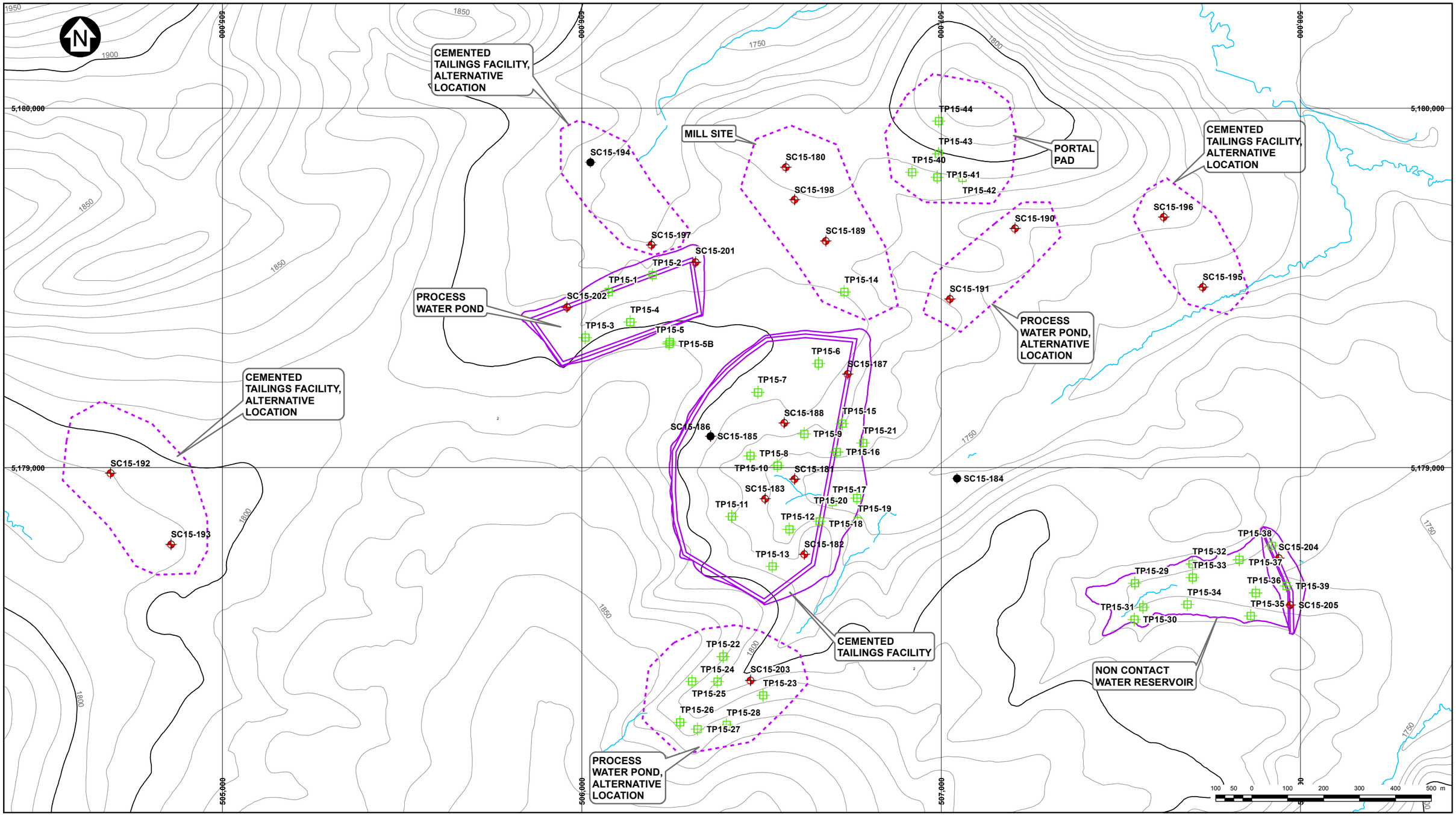
Knight Piésold Ltd. (KP) completed geotechnical and hydrogeological site investigations for the Black Butte Copper Project in the spring of 2015. The key objectives of the site investigation were to:

- Collect geotechnical and hydrogeological information to support a feasibility level design for the construction of the CTF, Process Water Pond, and Non-Contact Water Reservoir.
- Collect geotechnical and hydrogeological information to characterize the conditions at the proposed plant site, portal pad, and contact water pond.
- Complete test pit excavations over the Project area to characterize soil depth to bedrock and suitability as potential for construction material borrow sources.

The site investigation program included the following work (Figure 3.9):

- Drilling with standard penetration testing (SPT) in overburden, packer testing in bedrock, and detailed geotechnical logging of core or characterization of drill-cuttings.
- Installation of standpipe piezometers for long term monitoring of water quality and groundwater elevations.
- Excavation of test pits through overburden until contact with (weathered) bedrock; and,
- Sample collection of soil for particle size analysis and sample collection of bedrock for strength testing.

The site investigation was conducted between March and May 2015, and was split into two phases. The first phase was carried out in March, 2015, during which 19 geotechnical holes were drilled. Four of those 19 holes, were selected to have standpipe piezometers installed for the purposes of long term water quality testing and groundwater elevation monitoring. The second phase was carried out in May, 2015 and consisted of 5 geotechnical drill holes and 44 test pits.



Date: November 3, 2015 Source: Knight Piesolde (2015)

LEGEND:

- MINE LAYOUT
- TEST PIT
- DRILLHOLE
- DRILLHOLE WITH MONITORING WELL
- CONTOUR (10 m)
- CONTOUR (100 m)
- STREAM

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Figure 3.9
2015 Geotechnical Site Investigation Drill Hole and Test Locations
Black Butte Copper Project
Meagher County, Montana

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Rock core was logged using the Rock Mass Rating classification system, developed by Bieniawski in 1989. The Rock Mass Rating system characterizes a rock mass based on the intact rock strength, the degree of fracturing, discontinuity spacing, and discontinuity conditions. Falling head response tests were conducted in bedrock throughout both drilling phases in order to determine the hydraulic conductivity of the bedrock throughout the Project area. Soil samples were collected throughout both phases of the program and sent to Knight-Piesold's soil testing facility in Denver, CO for index testing (particle size distribution, moisture content, and Atterberg limits). Rock core samples were collected during the first phase drilling program and sent to Mine Design Engineering in Kingston, Ontario for unconfined compressive strength testing. Information obtained from the site investigation informed the feasibility design of the tailings and water management facilities.

3.5.2 Design Standards

The design criteria for the waste and water management facilities have been developed to satisfy both US and international standards. Design standards are based on the relevant state and federal guidelines for the construction and operation of a dam in Montana. A detailed Project design basis summary is included in Knight-Piésold (2015d) report Appendix A. The following regulations and guidelines were used to develop the design standards for the Project:

- Administrative Rules of Montana (ARM)
- Federal Emergency Management Agency (FEMA)
- International Commission on Large Dams (ICOLD)

The dam hazard determination described in the ARM is based on the consequences of dam failure (not the condition, probability, or risk of failure). According to ARM Chapter 16.14, a dam must be classified as a high hazard if the impoundment capacity is 50 acre-feet (approx. 60,000 m^3) or larger and it is determined that a loss of human life is likely to occur within the breach flooded area as a result of failure of the dam. The CTF and PWP both have capacities exceeding 60,000 m^3 (78,400 cu yds.) and local landowners have semi-permanent settlements downstream of the facilities that could be impacted by a dam failure.

The US Department of Homeland Security published federal guidelines for dam safety (FEMA, 2004). The guidelines also include a hazard potential classification system which categorizes dams based on the probable loss of human life and the impacts on economic, environmental, and lifeline interests. The FEMA hazard potential classification system is summarized in Table 3-13.

Table 3-13. FEMA Dam Hazzard Potential Classification

Hazard Potential Classification	Loss of Human Life	Economic, Environmental, Lifeline Losses
Low	None Expected	Low and generally limited to owner
Significant	None Expected	Yes
High	Probable. One or more expected.	Yes (but not necessary for this classification)

ICOLD recommends that for major tailings dams, (where failure could result in loss of life and extensive property damage), seismic analysis should be based on the Maximum Credible Earthquake (MCE) (ICOLD, 1989). Damage of the dam is acceptable as long as the integrity and stability to the dam is maintained, and the release of the impounded water and/or tailings is prevented. In addition, for closed

circuit dams where no discharge is permitted (i.e., CTF and PWP as opposed to the NCWP), the tailings dam must provide sufficient freeboard to allow storage of the probable maximum flood (PMF) in addition to normal operational tailings pond containment volumes.

3.5.2.1 Hazard Potential Classifications

The CTF should not be considered a dam by most standards; it will store little to no water in the facility (all water reports to sumps that are pumped back to the PWP) except during periods following exceptional storm events (greater than the 1 in 500 year event). In addition, the CTF is filled with a non-flowable mass of cemented tailings. Although the CTF is not a traditional tailings impoundment, as the material contained in it is non-flowable, the CTF will be designed and constructed in compliance with all applicable requirement for construction of tailings impoundments, including the newly enacted tailings additions to the mine reclamation laws (Senate Bill 409). For compliance with that Act, Tintina has designated their preferred “Qualified Engineer of Record”.

According to the classification scheme, the CTF and PWP are considered to have a high hazard potential classification based on the volume of water stored, expected loss of life and extensive property damage in the event of embankment failure.

The guidelines for high hazard dams specify further that the design must be such that the most severe earthquake that can be reasonably anticipated will not cause catastrophic failure, such as uncontrolled release of a reservoir, although severe damage or economic loss may occur. Under SB 409, for high hazard potential classification dams this is equated with the 1 in 10,000 year event as the Maximum Design Earthquake (MDE). The hazard potential classification and relevant Inflow Design Flood (IDF) and Maximum Design Earthquake (MDE) for each facility are summarized in Table 3-14.

Table 3-14. Dam Hazzard Classification Design Criteria

Facility	Hazard Classification	Inflow Design Flood	Maximum Design Earthquake
CTF	HIGH	Probable Maximum Flood Event	1 in 10,000 year event
PWP	HIGH	Probable Maximum Flood Event	1 in 10,000 year event
CWP	LOW	1/200 year event	1 in 10,000 year event
NCWR	LOW	1/200 year event	1 in 10,000 year event

3.5.3 Seismicity

The Operating Base Earthquake (OBE) for the Project area is defined by the US Army Corps of Engineers (USACE) to be “…an earthquake that can reasonably be expected to occur within the service life of the Project, that is, with a 50-percent probability of exceedance during the service life” (USACE, 1995). The OBE for the Project has been identified as the 1 in 22 year event, which corresponds to a Peak Ground Acceleration (PGA) of 0.021 g.

However, because recent Montana tailings legislation (SB 409; MCA 82-4-301, 82-4-303, 82-4-305, 82-4-335, 82-4-336, 82-4-337, and 82-4-342) requires that new tailings dams in Montana be able to withstand the greater of either the 1 in 10,000 year earthquake event, or the MCE, the Maximum Design Earthquake and Earthquake Design Ground Motion (EDGM) has been defined as the 1 in 10,000 year earthquake event which corresponds to a PGA of 0.35 g.

3.5.4 Tailings Characteristics

Physical testing was conducted on samples of tailings obtained from metallurgical testing. Index and consolidation testing was conducted to characterize the physical properties, and estimate the settled dry density of the cemented tailings deposited into the CTF. Rheology and strength testing was also completed on tailings samples. Based on the test work, the following tailings properties have been adopted for the design:

- Solids content by weight: 79%
- Specific gravity of the tailings solids: 3.77
- Average settled dry density: 2.0 t/m3
- Approximate grain size of the tailings: 94% of the tailings pass the 75 micron (No. 200 sieve)

Binding agents (a mix of 0.5-2% cement, fly ash, or slag by weight for surface deposition) will be added to the tailings during thickening that will create a non-flowable mass once the tailings are deposited and have set up.

The results of the tailings characterization test work are presented in Appendix K of this document (Knight Piésold 2015d document Appendix C).

3.5.5 Stability Analyses

Stability analyses of the CTF, PWP and NCWR embankments were completed to investigate the slope stability under static and seismic loading conditions. A brief discussion of the methodology and design criteria is presented below, with typical cross-sections and results. A detailed discussion on the methodology, assumptions and results of the stability analyses is presented in Knight-Piésold 2015.

3.5.5.1 Modelling Approach

The stability analyses were carried out using the limit equilibrium computer program SLOPE/W (Geostudio, 2012). This program uses a systematic search to obtain the minimum factor of safety from a number of potential slip surfaces. The factor of safety is the ratio of the strength of the designed structure over the loads acting on the structure. Factors of safety were calculated using the Morgenstern-Price Method.

3.5.5.2 Design Criteria

Knight-Piesold utilized a target minimum factor of safety of 1.5 as the design criteria for the stability analyses, in accordance with standard industry practices for dam design. The US Army Corps of Engineers (USACE, 2003) defines the minimum acceptable factor of safety under static loading conditions as 1.3 for end of construction, 1.5 for long-term operations closure, and 1.2 for post seismic scenarios. A factor of safety of 1.2 is acceptable for post-earthquake (seismic) loading conditions provided that the resulting embankment deformations or crest settlements are not large enough to cause a release of stored water or tailings, and that the overall stability and integrity of the embankment is maintained. The target factor of safety used by Knight-Piesold for the design of the Project facilities exceeds SB 409 guidelines and is a conservative design criteria.

3.5.5.3 Material Strength Parameters

The material unit weights and effective strength parameters for soil and rock types used in the analyses are provided in Table 3-15 and Table 3-16, respectively. These parameters are based on information collected during the 2015 site investigation completed by Knight-Piésold 2015.

Table 3-15. Soil Strength Parameters

Material Type	Model	Unit Weight	Effective Friction
		(kN/m^3)	(Degrees)
Fresh Shale Rockfill (Embankment Fill)	Shear/Normal Function (Lower Leps)	21	-
tailings + 0.5-2% Additives[1]	Mohr-Coulomb	22	45

NOTES: 1. Additives to include cement, fly ash and/or slag.

Table 3-16. Rock Strength Parameters

Rock Type	Model	Unit Weight	GSI	UCS	m_i	D
		(kN/m^3)	-	(MPa)	-	-
Shale (Highly Weathered)	Generalized Hoek-Brown Criteria	22	30	10	6	0
Shale (Moderately Weathered)	Generalized Hoek-Brown Criteria	23	40	40	6	0
Shale (Fresh)	Generalized Hoek-Brown Criteria	24	50	50	6	0

3.5.5.4 CTF Stability Analyses

The factors of safety were evaluated for the following cases during steady-state conditions:

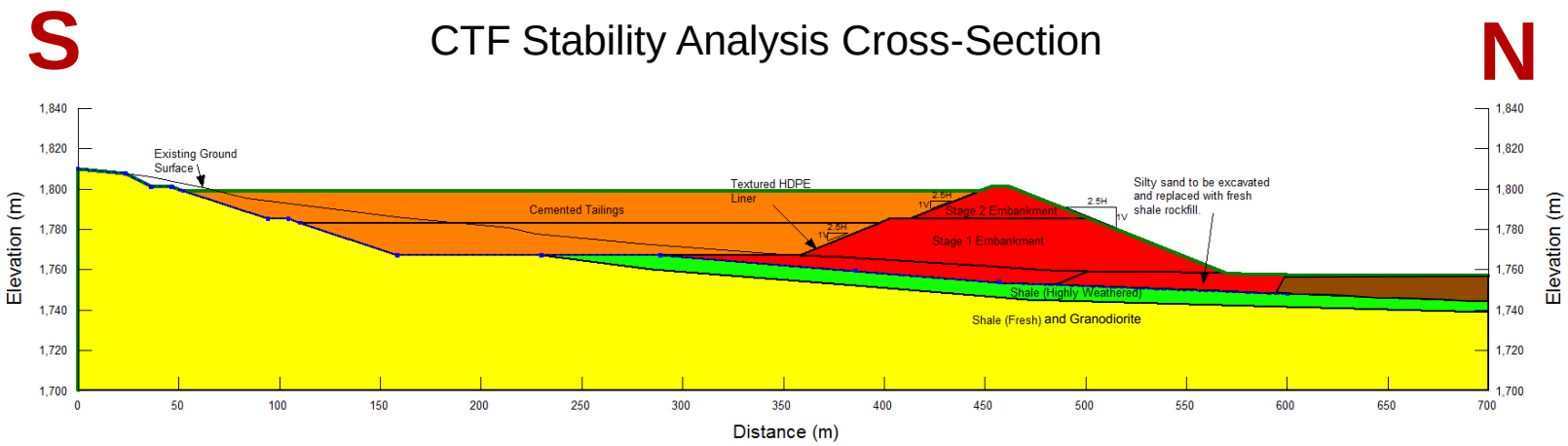
- End of Construction (static only)
- During Operations (static and seismic), and
- Post-Closure (static and seismic).

The CTF stability analysis is based on the maximum cross section through the main (eastern) CTF embankment. Analyses were carried out for the following CTF embankment configurations:

- Final embankment (Crest El. 1,799 m, approximately 46 m high) with no tailings deposition and no retained water (upstream and downstream failure mode).
- Final embankment (Crest El. 1,799 m) with tailings deposition and storm storage up to El. 1,781 m (upstream and downstream failure mode).
- Final embankment (Crest El. 1,799 m) with full tailings and storm storage up to El. 1,797 m (downstream failure mode only)

The cross-section used in the CTF stability analyses is shown on Figure 3.10. The factors of safety for the CTF are shown on Table 3-16. The CTF embankment exceeds the factor of safety requirement for all cases modelled. The critical failure surface and factors of safety for each configuration analyzed are presented in Knight-Piésold 2015).

CTF Stability Analysis Cross-Section



Results of CTF Stability Analysis

Slip Surface Direction	End of Construction			Post-Closure	
	Short-term Stage 1 End of Construction	**Final (Stage 1)** Tailings to El. 1781 m		**Final (Stage 2)** Tailings to El. 1797 m	
	Static	**Static**	**Seismic**	**Static**	**Seismic**
Required Minimum Factor of Safety	**1.3**	**1.5**	**1.2**	**1.5**	**1.2**
Upstream	**2.5**	**2.5**	**1.6**	**n/a**	**n/a**
Downstream	**2.3**	**2.3**	**1.5**	**2.3**	**1.5**

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Figure 3.10
CTF Stability Analysis Cross-Section Black Butte Copper
Meagher County, Montana

Table 3-16. Results of CTF Stability Analysis

Slip Surface Direction	End of Construction			Post-Closure	
	Short-term Stage 1 End of Construction	**Final (Stage 1)** tailings to El. 1781 m		**Final (Stage 2)** tailings to El. 1797 m	
	Static	**Static**	**Seismic**	**Static**	**Seismic**
Required Minimum Factor of Safety	**1.3**	**1.5**	**1.2**	**1.5**	**1.2**
Upstream	2.5	2.5	1.6	n/a	n/a
Downstream	2.3	2.3	1.5	2.3	1.5

3.5.5.5 PWP Stability Analyses

The calculated factors of safety for the PWP embankment exceed the minimum requirements for short term and long term stability during steady-state conditions.

The following cases were evaluated for the PWP embankment:

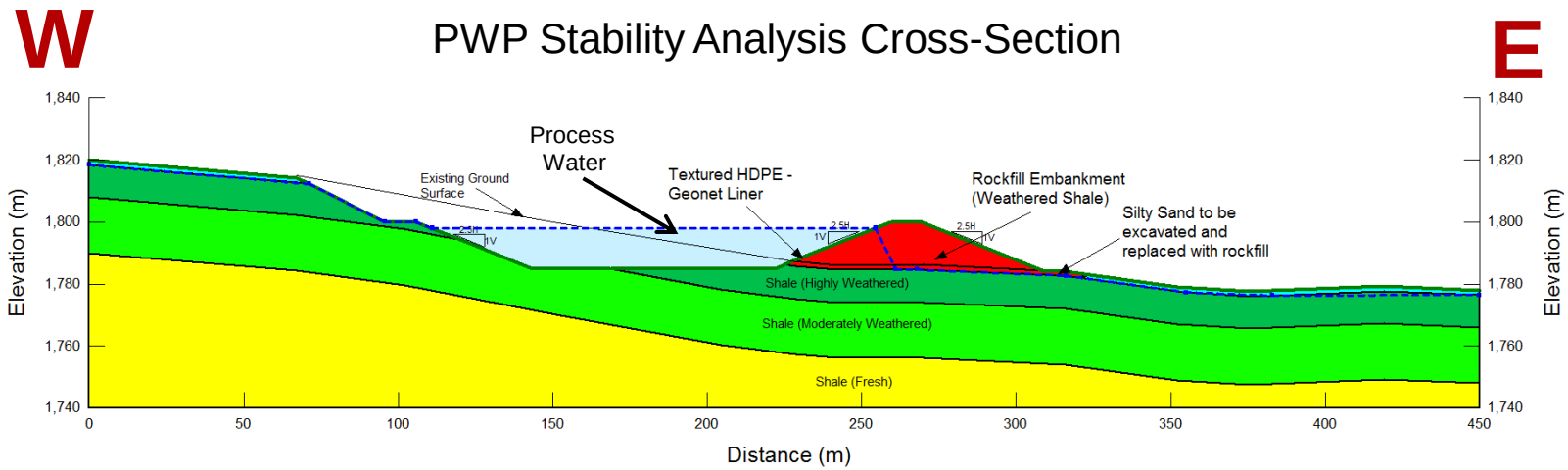
- End of Construction (static and seismic)
- During Operations (static and seismic)

The stability analysis for the PWP was based on the maximum cross section through the northern PWP embankment. The analyses were carried out for the following configurations:

- Final embankment (Crest El. 1800 m) with no retained water (upstream and downstream failure mode)
- Final embankment (Crest El. 1800 m) with retained water up to El. 1798 m (downstream failure mode only)

The cross-sections used in the stability analyses of the PWP are shown on Figure 3.11. The factors of safety for the PWP section are shown on Table 3-17. The PWP embankment exceeds the factor of safety requirement for all cases modelled. The critical failure surface and factors of safety for each configuration analyzed are presented in Knight-Piésold 2015.

PWP Stability Analysis Cross-Section



Results of PWP Stability Analysis

Slip Surface Direction	End of Construction		Operating Conditions	
	Static	Seismic	Static	Seismic
Required Minimum Factor of Safety	**1.3**	**1.2**	**1.5**	**1.2**
Upstream	**2.5**	**1.6**	**n/a**	**n/a**
Downstream	**2.5**	**1.6**	**2.5**	**1.6**

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Figure 3.11
PWP Stability Analysis Cross-Section Black Butte Copper
Meagher County, Montana

Table 3-17. Results of PWP Stability Analysis

Slip Surface Direction	End of Construction		Operating Conditions	
	Static	Seismic	Static	Seismic
Required Minimum Factor of Safety	**1.3**	**1.2**	**1.5**	**1.2**
Upstream	2.5	1.6	n/a	n/a
Downstream	2.5	1.6	2.5	1.6

3.5.5.6 NCWR Stability Analysis

The calculated factors of safety values for the NCWR embankment exceed the minimum requirements for short term and long term stability during steady-state conditions.

The following cases were evaluated for the NCWR embankment:

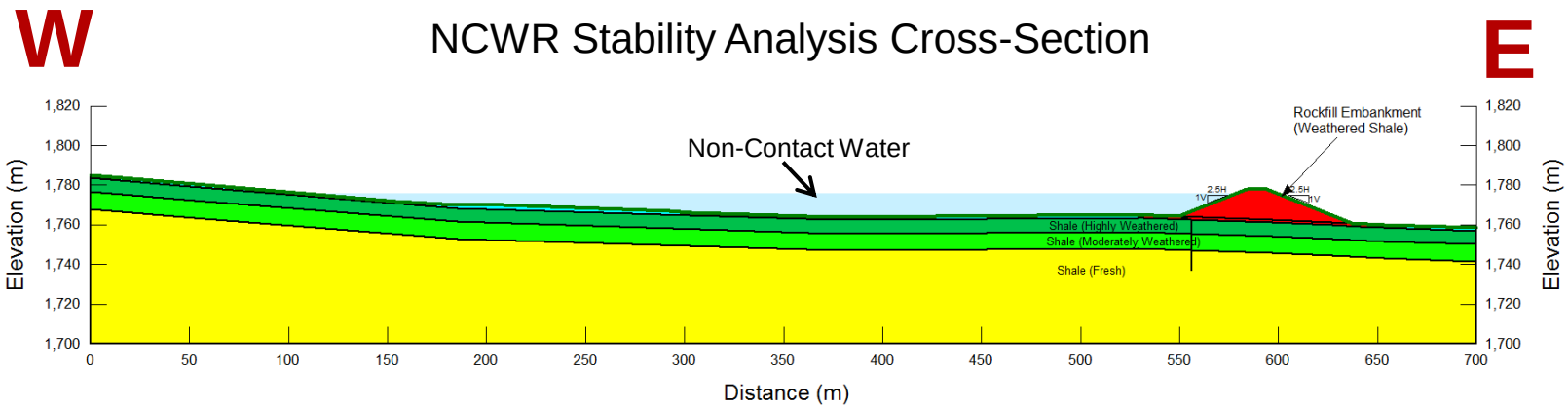
- End of Construction (static and seismic)
- During Operations (static and seismic)
- Rapid drawdown during Operations (static only)

The stability analysis for the NCWR was based on the maximum cross section through the NCWR embankment. The analyses were carried out for the following configurations:

- Final embankment (Crest El. 1,776.5 m) with no retained water to simulate end of construction conditions (upstream and downstream failure mode)
- Final embankment (Crest El. 1,776.5 m) with retained water up to El. 1776 m to simulate operating conditions (upstream and downstream failure mode)
- Final embankment (Crest El. 1,776.5 m) with rapid drawdown of retained water to El. 1764 m (over 24 hours) with buildup of excess pore pressures within NCWR embankment (upstream failure mode only)

The cross-sections used in the stability analyses of the NCWR are shown on Figure 3.12. The factors of safety for the NCWR section are shown on Table 3-18. The NCWR embankment exceeds the factor of safety requirement for all cases modelled. The critical failure surface and factors of safety for each configuration analyzed are presented in Appendix K (Knight-Piésold 2015d).

NCWR Stability Analysis Cross-Section



Results of NCWR Stability Analysis

Slip Surface Direction	End of Construction		Operating Conditions		Rapid Drawdown
	Static	Seismic	Static	Seismic	Static
Required Minimum Factor of Safety	**1.3**	**1.2**	**1.5**	**1.2**	**1.1**
Upstream	**2.5**	**1.6**	**n/a**	**n/a**	**1.5**
Downstream	**2.5**	**1.6**	**2.0**	**1.3**	**n/a**

TINTINA RESOURCES

Date: October 28, 2015

Figure 3.12
NCWR Stability Analysis Cross-Section Black Butte Copper
Meagher County, Montana

Table 3-18. Results of NCWR Stability Analysis

Slip Surface Direction	End of Construction		Operating Conditions		Rapid Drawdown
	Static	Seismic	Static	Seismic	Static
Required Minimum Factor of Safety	**1.3**	**1.2**	**1.5**	**1.2**	**1.1**
Upstream	2.5	1.6	n/a	n/a	1.5
Downstream	2.5	1.6	2.0	1.3	n/a

3.5.6 Seepage Analysis

3.5.6.1 Modelling Approach

This section provides a brief discussion on potential seepage rates during operations of the CTF, PWP and NCWR. Detailed discussions on the modelling approach, assumptions, and results are presented in Appendix K (Knight-Piésold 2015d).

As previously discussed in Section 3.5.2 above, the CWP, CTF and PWP facilities will be double lined impoundments that have two layers of HDPE geomembrane with a layer of high-flow geonet sandwiched in between the 100 mil HDPE membrane. The geomembrane is intended to be impermeable with seepage only possible through defects that may occur during fabrication and/or installation. Seepage through the geomembrane liner systems of the CTF and PWP was modelled using both empirical seepage rate equations and numerical modelling. Empirical methods were based on Giroud and Boneparte (1988) and numerical modelling was completed using the 2D finite element computer program SEEP/W (Geostudio, 2012).

The lining systems in the CWP, CTF and the PWP will significantly limit the potential seepage from the facility to flow through potential defects in the geomembrane. Leakage through the lining systems was modelled using empirical leakage rate equations, which assume a number of defects per hectare (acre) for various geomembrane installation methods. This assessment was carried out to determine potential leakage flow rates through the lined facilities during operations of the CTF and the PWP.

3.5.6.2 CTF and PWP Seepage Analysis

Regulatory agencies frequently require a facility seepage analysis, however, most of the calculations involve fixed manufacture tested defect spacing. The double-lined system of the CTF was modelled for seepage in two separate analyses. The first analysis modelled seepage from the cemented tailings through the upper liner into the geonet. This seepage rate was estimated by modelling a vertical column that represents a unit area of the geomembrane with a single defect, tailings and ponded water. This scenario conservatively represents the CTF in a post storm event condition, where water will be temporarily stored within the CTF until it is pumped to the PWP. The seepage rate through the liner was calculated by multiplying the results of the model by the surface area of the CTF assuming a single 2 mm defect is present for every hectare of geomembrane (Giroud & Bonaparte, 1989a & 1989b, and Giroud, 1997). The estimated potential seepage rate from the CTF to the geonet under the fully saturated condition modelled is approximately 2x10-7 m^3/s or 4.2 gallons/day (16 L/day). However the CTF will be operated with a small volume of stored water (little or no surface pond and often with small volumes of water stored only in the footprint of the sloping sump 130 x 160 feet; 40 x 50m) so the actual rates of seepage is anticipated to be far less.

The second seepage analysis of the lower CTF geomembrane modelled the head pressures present between the upper and lower geomembrane (the thickness of the geonet) with defect density of two 2 mm defects per hectare of the geomembrane (US EPA, 1992). Knight-Piesold estimated the potential maximum seepage through the bottom geomembrane layer to the foundation drain system to be on the order of $3x10^{-6}$ m^3/s, which exceeds the estimated seepage from the upper liner by an order of magnitude. Therefore, total potential seepage from the facility will be limited by the upper liner at a rate of 4.2 gallons per day (16 L/day), and even then only under conditions where the CTF is inundated with water for a prolonged period of time. Seepage through the CTF Liner System will be collected in the CTF Foundation Drain System (discussed in more detail in Section 3.6.7).

The double-lined system of the PWP was also modelled for seepage in two separate analyses. The first analysis modeled seepage through the upper geomembrane to the geonet layer, influenced by head pressure from the full column of pond water and assuming a defect density of one 2 mm defect per hectare (Giroud & Bonaparte, 1989a & 1989b, and Giroud, 1997). The analysis of the lower geomembrane modelled the head pressures present between the upper and lower geomembrane (the thickness of the geonet) with defect density of two 2 mm defects per hectare of the geomembrane (US EPA, 1992). Knight-Piesold estimated the potential seepage rate from the PWP to the geonet layer at approximately $6x10^{-4}$ m^3/s, and the resultant seepage through the bottom geomembrane layer to the foundation drain system to be on the order of $3x10^{-7}$ m^3/s to $1x10^{-6}$ m^3/s, which equates to approximately 26 to 86 L/day. This foundation drain seepage reports to a seepage collection pond which is pumped back to the PWP.

3.5.6.3 NCWR Seepage Analysis

A seepage analysis was done to determine the approximate rate of water leakage from the NCWR through the topsoil/subsoil and weathered bedrock that comprise the impoundment foundation, and to assess the need for alternative seepage control measures.

Two seepage analyses were completed on the NCWR under the following different conditions:

- The embankment overlies weathered bedrock with no seepage control measures in place aside from the HDPE liner on the upstream face of the embankment, which is anchored into dense ground.
- A grout curtain is included in the weathered bedrock at the upstream toe of the embankment.

It was determined that the rate of water loss to seepage and evaporation from the NCWR when at full capacity is approximately 47,000 cubic yards (36,000 m^3) annually, or 130 cubic yards or 26,000 gallons (100 m^3) per day, of which approximately 117 cubic yards or 26,600 gallons (90 m^3) per day is attributed to seepage. The installation of a grout curtain does not significantly impact seepage rates out of the NCWR as head pressures from the overlying pond forces water flow beneath the distal extent of the grout curtain.

The actual discharge rates and periods of active (vs. seepage) discharge from the pond will be controlled by water right requirements for surface water mitigation that is overseen and regulated through permitting by the Montana Department of Natural Resources and Conservation.

3.6 Infrastructure Support and Waste and Water Management Facilities

Below is a list of major surface mine support facilities. Each is described in detail in the subsections that follow:

- Roads
- Portal Pad
- Waste Rock and Copper-enriched Rock Storage Facility (WRS)
- Process Water Pond (PWP)
- Contact Water Pond (CWP)
- Cemented tailings Facility (CTF)
- Non-Contact Water Reservoir (NCWR)
- Material Stockpiles
- Pipelines
- Equipment and Contract Manpower Required for Site Facility Construction

Many more detailed construction drawings of facilities are presented in Knight Piésold (2015d) (Appendix K).

3.6.1 Roads

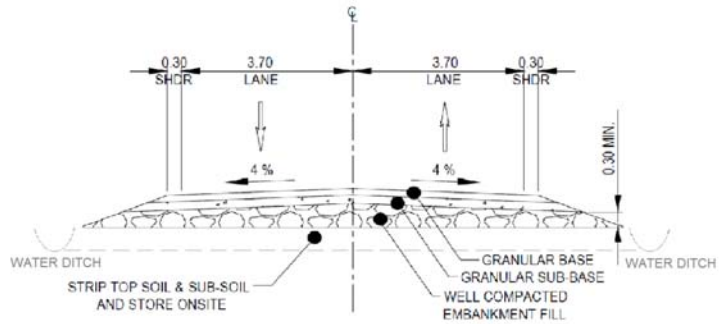
3.6.1.1 Existing Highways and County Roads

A traffic impact study will be completed in conjunction with Meagher County Roads Department, the State of Montana Department of Transportation, and the Federal Highway Administration. This will assess any traffic controls and necessary safety improvements required for the junction of the Project's main access road and the Sheep Creek road, as well as the intersection of the Sheep Creek road with US Highway 89. The intersection of the county road and US 89 is located just south of a blind near right-angle turn along US 89 (Figure 1.3 and Figure 2.22).

Tintina expects to support Meagher County's Roads Department maintenance along the Sheep Creek and Butte Creek roads as necessary, with the level of commitment likely to be determined by interaction between the Company and the County.

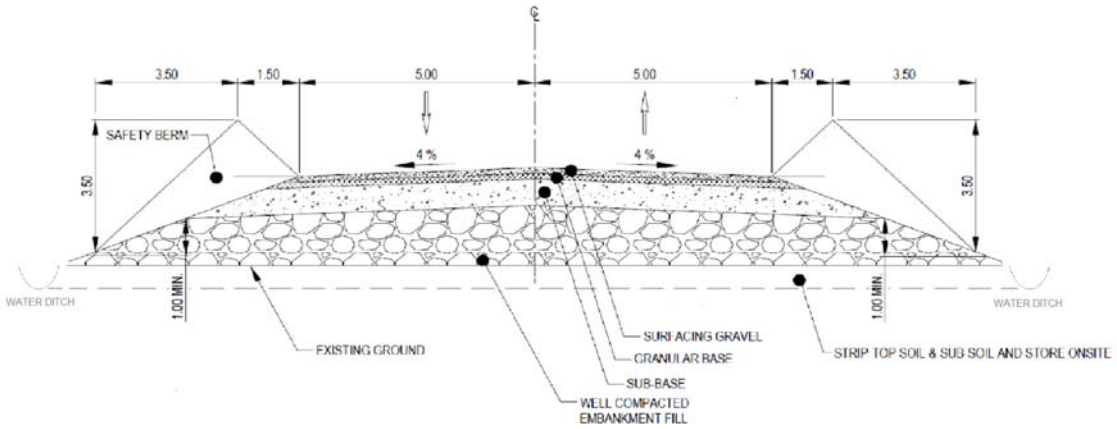
3.6.1.2 Main Access Road, Stream Crossings and Powerline

The access road route alignment was designed to minimize impacts to local ranchers, creek crossing widths, impacts to wetlands, and overall travel distances. Maximum grades will be less than 7%, and cut and fill balances will be optimized. The permanent access road (Figure 1.3) will be a private gravel road designed and constructed to Meagher County and Montana Department of Transportation specifications and standards. Meagher County construction guidelines use typical road cross-sections and plans from Montana's Local Technical Assistance Program (LTAP) (Figure 3.13a). The access road will be designed for a maximum speed of 35 mph, crowned, and have maximum grades of 7%. The roadway will be two lanes, each 12-feet (3.7 m) wide, with minimum 1-foot (0.3 m) wide shoulders developed with side slopes of 2.5H:1V. All mine roads will require berms of one-half axel height or greater for the largest truck using the road as per MSHA safety requirements. The access road will support truck loads delivering supplies to the site, and transporting concentrate from the site.



TYPICAL ACCESS ROAD & INTERNAL SERVICE ROAD CROSS SECTION

Metres
0 2 4 6



TYPICAL CTF ROAD CROSS SECTION
SCALE 1:100

Metres
0 2 4 6

PRELIMINARY DRAWING
NOT TO BE USED FOR CONSTRUCTION

Prepared by Tetra Tech Inc.

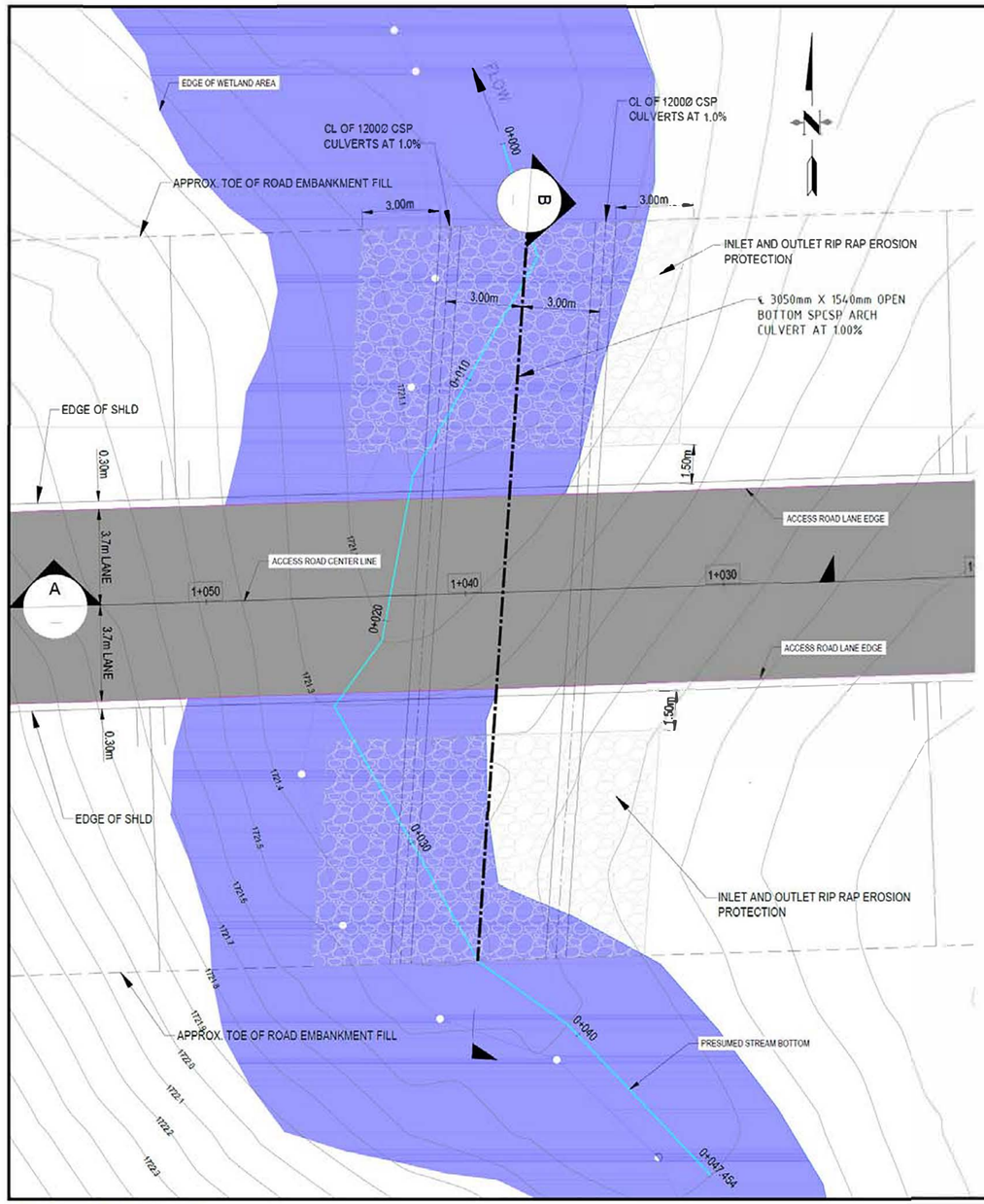
Figure 3.13
Typical Road Cross Sections
Black Butte Copper Project
Mine Operating Permit Application
Meagher County, Montana

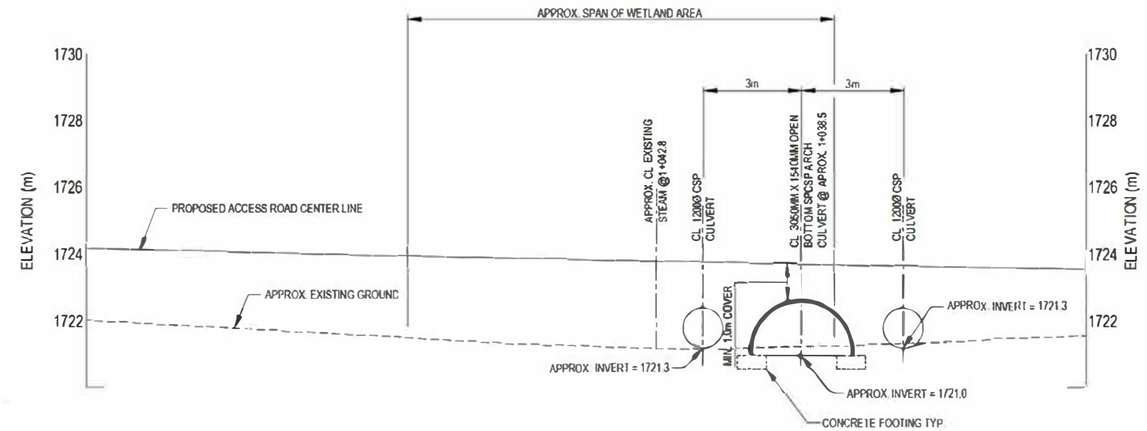
TINTINA RESOURCES

The access road will be gravel surfaced over a compacted sub-grade and crushed gravel top-grade. It will have drainage control, culverts and sediment control basins. The road will be routinely watered to reduce airborne dust. Other controls for dust may include, speed and traffic controls and treatment with magnesium/calcium chloride. Periodic grading will be conducted as necessary.

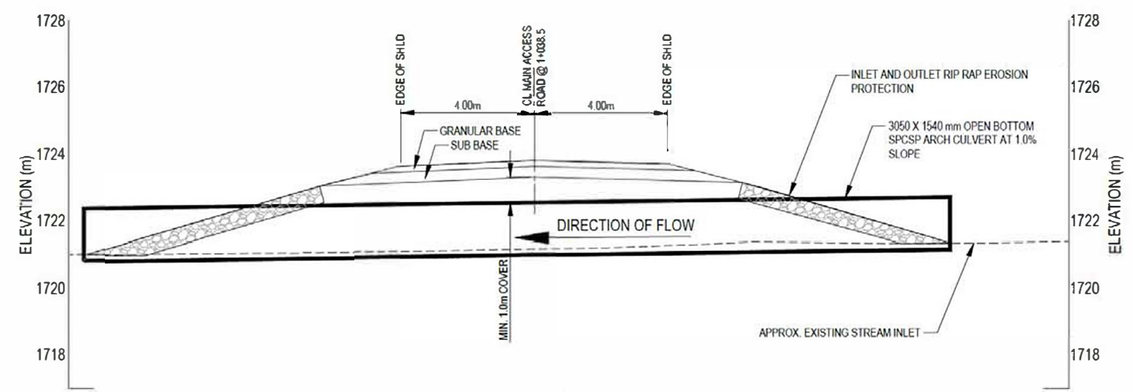
Topsoil and subsoil from access road construction will be salvaged separately and transported to stockpiles or used for near-term construction roadside revegetation support. Road subgrades will be constructed of clean compacted sub-grade gravel road-base materials and topped with crushed and durable gravel purchased from local off-site quarrying operations. Drainage from the road is deemed to be non-contact water and will be collected in roadside ditches designed to accommodate the 10-year return storm event. Drainage control, culverts and sediment control basins will be established as necessary along the roadways. The ditches will be hydroseeded with native species or riprapped for erosion protection depending upon the anticipated velocities and volumes in the ditch section. Water will be diverted to natural drainage areas. Crossing culverts will be installed as needed along the route.

There are two planned creek crossings on the private access road. The sites for stream crossings were selected specifically to minimize impact to wetlands. Impacts are only anticipated to Waters of the US for these two crossings involve 0.11 acres (0.04 ha) of wetlands and 154 linear feet (47 m) of streams (see Section 3.8.3). At each creek crossing, a 9.8 foot (3 m) diameter bottomless pipe arch, and two 6 foot (1.8 m) diameter round culverts will be installed,, one on each side of the half pipe arch (Figure 3.13b). Any storm flow not accommodated is expected to potentially overtop or damage the road requiring occasional repairs. The two creek crossings will permanently impact two wetlands and two streams. These include the following areas which are shown on the wetlands delineation map in Appendix C-1 (Westech, 2014). The eastern crossing will impact 0.05 acres (0.02 ha) of wetlands (W-LS-05) and 86 feet of Little Sheep Creek (S-LS-O4). The western crossing will impact 0.06 acres (0.02 ha) of wetlands (W-LST1-02) and 68 feet (21 m) of the Bush Creek tributary to Little Sheep Creek (S-LST-001).





SECTION A - A



SECTION B - B

Scale: 1: 100 (metres)

PRELIMINARY DRAWING NOT TO BE USED FOR CONSTRUCTION

Prepared by Tetra Tech Inc., 2015

Figure 3.13b

Stream Crossing Culvert Plan

Black Butte Copper Project

Meagher County, Montana

TINTINA RESOURCES

Drainage control will be established along the roadway and the cut and fill slopes to control erosion, and culverts will be installed as necessary. Cut and fill slopes will be re-vegetated as soon as practicable. Vendor use and deliveries along Project roads will be restricted to daylight hours and week days whenever possible.

There will be a gate and guard house at the western end of the main access road to restrict public access to the mine site Figure 3.6. There will also be a number of guest parking slots (8) and a set of truck scales in the gate/guard house area.

3.6.1.3 Construction Access Road

An access road will be required during construction of the main access road and during operations Tintina plans on using the existing road entering the site from the west off of the Butte Creek County road (Figure 2.23). A gate will be installed at the west end of this construction access road to prevent the travelling public from entering the site. The existing road will be upgraded to the standard described above for the permanent access road. The road will be constructed to the same gravel thickness as the permanent access road because the construction truck loads are anticipated to be heavy.

3.6.1.4 CTF Road

The proposed CTF road runs from the portal pad, west then south around the mill pad, and then southeast to the CTF (Figure 1.3 and Figure 3.6). There will be a short branch off the CTF road to access the Temporary WRS and copper-enriched rock Stockpile pads. Another short CTF road segment will connect the mill pad to the main CTF road. This will be used by trucks and other mine and surface equipment to access the truck shop, and by service vehicles to access the portal pad. The proposed CTF road will be constructed for use by 44 ton (40-tonne) trucks hauling copper-enriched rock from the underground mine to the crusher or copper-enrich rock stockpile, and waste rock from underground to the Temporary WRS. After the CTF is constructed, a subcontractor will crush and screen waste rock for use as a cushion layer on the uppermost HDPE of the CTF. Articulated 40-ton rock trucks will then be used to haul this crushed waste rock into the CTF for placement.

Roadway design criteria for surface facility roads are similar to access roads with the exception of 30 mph (50 kph) maximum speeds and approximately 8% maximum grades. Topsoil and subsoil from CTF road construction will be brought to the topsoil and subsoil storage areas west of the CTF. Drainage from the CTF road will be deemed contact water and collected in lined roadside ditches. The liner will be an 80 mil (2 mm) HDPE geomembrane. It will be installed over a 12 inches (300 mm) thick layer of 1.2 inch (30 mm) minus bedding material. In areas of fill, a “false-ditch” will be designed and constructed in order to capture the contact water. Crossing culverts will be installed as needed along the route.

3.6.1.5 Service Roads

Service roads will access the PWP, NCWR, CWP, and topsoil and subsoil storage areas. These internal roads will be designed using applicable low volume road design criteria that include a 16-foot wide roadbed, maximum 8% grade, and 2.5H:1V side slopes and design speeds of approximately 25 mph (40 kph). There will be other minor one lane tracks for maintenance purposes such as beside the mill conveyor. Road-side ditches for the internal service roads will discharge to their existing drainage catchment outlets. The ditches will be hydroseeded with native species or riprapped for erosion protection depending upon the expected velocities in the ditch section. Crossing culverts will be installed as needed along the route. Impacts are only anticipated to Waters of the US for two service road stream crossings include 0.02 acres (0.01 ha) of wetlands and 25 linear feet (7.6 m) of streams (Section 3.8.3).

Internal roads are intended to only be used by single haul units and light vehicles.

3.6.1.6 Traffic Controls

A traffic impact study will be completed to assess any traffic control and intersection improvements where the main Project access road ties into the county roads and where the county roads tie into US Highway 89. The posted maximum speed limit for Project roads will be 35 mph (55 kph).

3.6.1.7 Power and Powerline

The primary source of electricity to the site during operations will be provided by above ground power lines. Tintina estimates that its total power requirements for the Project will be approximately 9 to 12 megawatts (MW). Upgraded power lines will be permitted and installed by the power provider, which has not been determined. In order to assess the Permit Area, power distribution lines will parallel the county road and then the new access road (Figure 1.3) to a substation located on the north side of the Mill facility. The substation will reduce the voltage such that it is suitable for the underground and surface uses at the site. Power poles will be single pole and designed to be avian safe with insulated conductors at cross arms. Impacts to waters of the US for the powerline and water supply line to the public water supply well (PW-6, Figure 1.3) are estimated at 0.01 acres of wetlands and 7 linear feet (2.1 m) of streams (Section 3.8.3) where they cross Coon Creek.

Back-up power will be provided by two 1 MW diesel generators located near the substation on the north side of the mill facility pad. Back-up generators may be stored in 20 foot shipping containers. The most critical power loads are for fire/equipment and pumps, thickener rakes, reagent agitators/pumps, emergency lighting, ventilation exhaust fans, and electrical heaters.

3.6.2 Portal Pad

3.6.2.1 General

The portal pad will have a total disturbance area of 9.27 acres (3.8 ha), and is designed to have a finished surface area of approximately 4.9 acres (2.0 ha) (Figure 1.3 and Figure 3.14). The portal pad will be constructed after topsoil and subsoil are removed and transported to storage areas, and run-off diversion ditches are excavated uphill of the site. The diversion ditches will discharge to natural channels through infiltration basins, or through dissipater structures that allow water to infiltrate into shallow colluvial or bedrock materials.

The portal collar will be constructed with an inside dimension of 17 foot wide by 17 foot (5m x 5m) high with an arched top. The area around the portal will be excavated to allow easy access, and ventilation, air and water pipelines and other necessary utilities required for the operation of the mine. Construction scheduling calls for excavation of the underground mine to begin as soon as access to the site is available and the portal pad is constructed. The proposed portal location lies 170 feet (52 m) above the regional ground water table. The first approximately 1,700 linear feet (518 m) of mining along the initial decline will be above the water table. Because the collars of the ventilation raises are also located well above the water table, none of the mine openings will be capable of discharging groundwater either operationally or in closure. Underground mining will proceed as other surface support facilities are constructed. Surface disturbances associated with the construction of a flat portal pad (Figure 3.15) are discussed under surface facilities (Section 3.6.2.2).

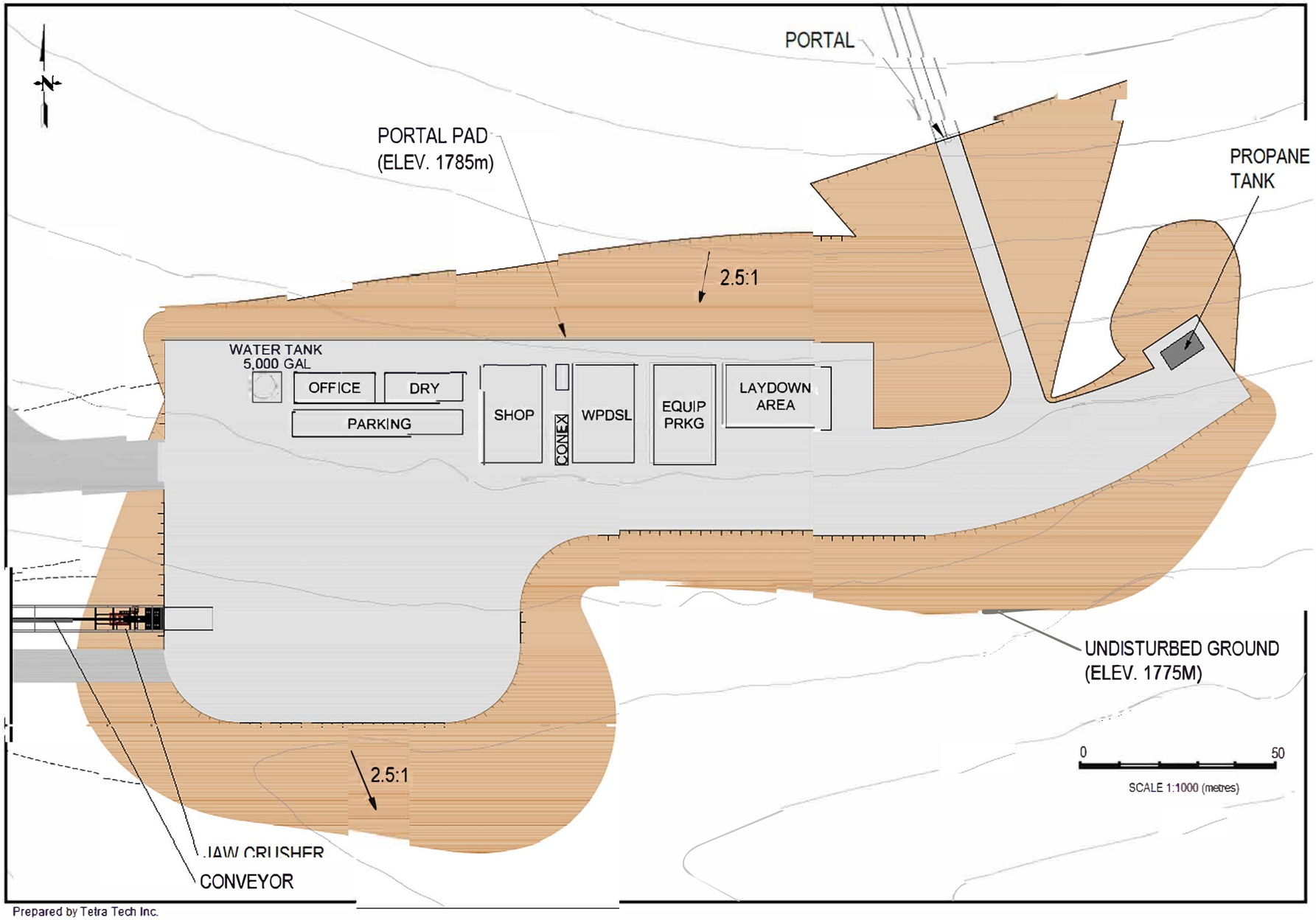


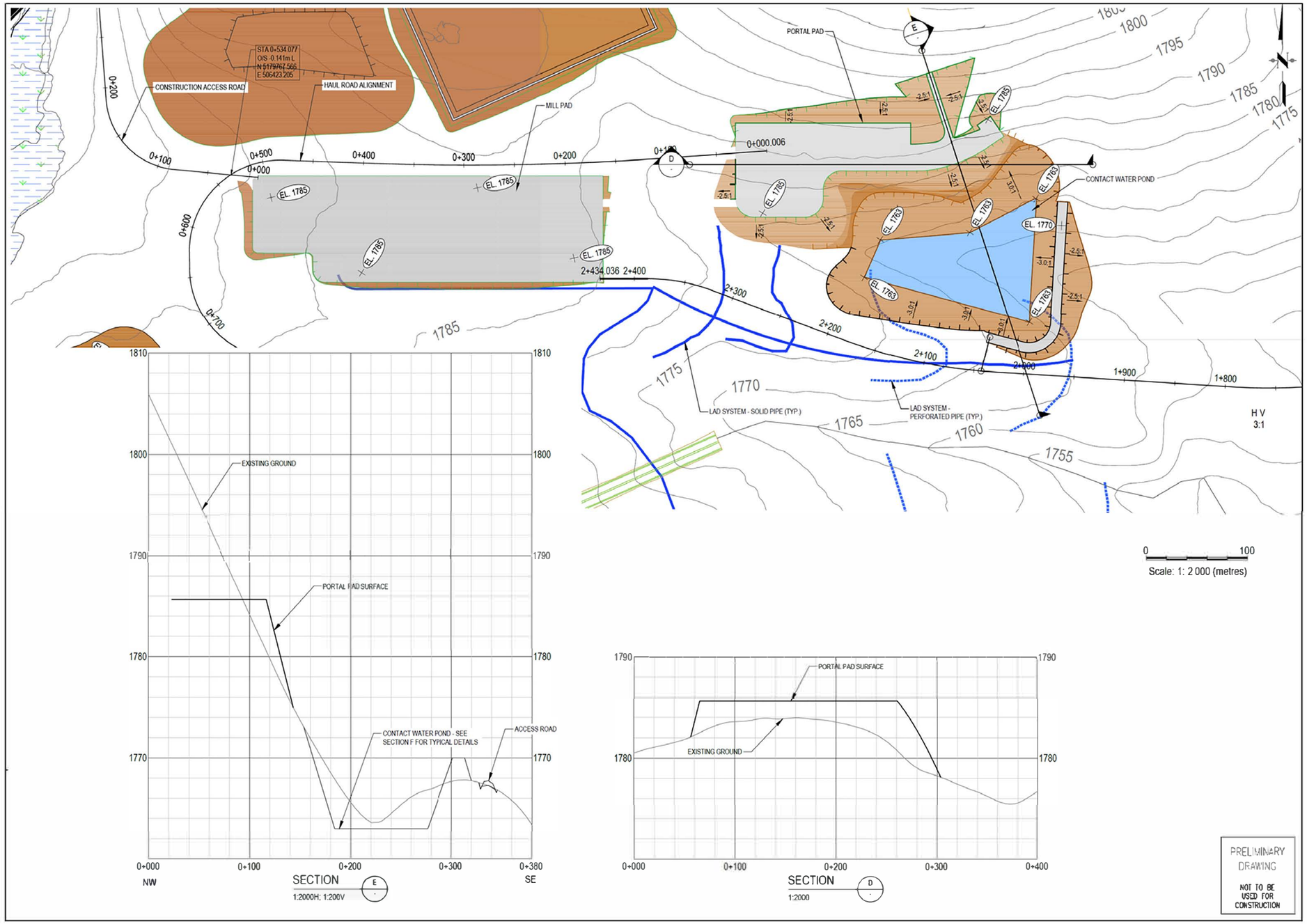
FIGURE 3.14

Plan Map of Portal Pad Showing Contractor Support Facilities

Black Butte Copper Project

Meagher County, Montana

TINTINA RESOURCES



Prepared by Tetra Tech Inc., 2015

Figure 3.15

Portal Pad Plan and Cross Sections

Black Butte Copper Project

Meagher County, Montana

TINTINA RESOURCES

The top of the pad will be constructed with a gently dipping upper surface to the south that allows for gravity sheet-flow drainage to perimeter ditches. These ditches will transport water to the CWP, just south of the portal pad. A safety berm will be constructed at the edge of the pad. The perimeter ditches and culverts are designed to convey the 200 year 24-hour precipitation event (Figure 3.15), along with the 200 year snow melt peak flow. These ditches will have an 80 mil (2 mm) smooth HDPE geomembrane liner installed over a 12 inch (300 mm) thick layer of 1.2-inch (30 mm) minus bedding material.

The flanks of the portal pad will consist of compacted, angle of repose fill slopes. The pad will require cuts and fills to create a nominal level working surface area. Construction of the pad will require approximately 70,000 cubic yards (53,518 m^3) of fill. This initial fill will be obtained by excavation of 31,000 cubic yards (23,700 m^3) from the hillside upon which the pad will be constructed. Additional material will be obtained from excavations associated with other surface facilities. Road base and durable gravel surfacing material will be purchased from local off-site quarrying operations.

3.6.2.2 Portal Pad Use during Initial Construction

Underground mining will commence as major mine support facilities are constructed. The portal pad will be used for the initial 2-3 years. Temporary ancillary support facilities needed for mining contractor support will consist of: an office/dry/change house; a maintenance garage/shop/ /wash-pad/fuel storage and distribution building; warehouse with a power supply area (with back-up generators and air compressor), storage facilities (conex's); a water tank; a sanitary holding tank; a propane tank; laydown/equipment parking; and subcontractor parking areas. The lay-out envisioned for these facilities on the portal pad is depicted on (Figure 3.14). Each of these facilities is described below. Note that the dimensions and precise locations of these facilities may be somewhat modified during actual construction.

Office: A 24 x 66 foot modular office trailer (such as that typically used on construction sites for use by engineering, safety and other mine support personnel) will be placed on concrete piers and tied down as per building code requirements.

Dry/Change House: A 24 x 66 foot modular office trailer (as typically used on construction sites for employees to use to change and shower) will be placed on concrete piers and tied down as per building codes requirements. This building will serve as a gathering point for workers waiting to go underground.

Fuel/Oil Storage, Power Supply Wash/Lube Pad and Shop Building: A 50 x 80 foot fabric covered, insulated, steel truss arch building will be constructed on a concrete slab with built in containment for fuel storage, lubricants and shop fluids (WPDSL on Figure 3.14). This facility will serve as a fuel and oil storage facility, contain a fueling station and lubrication bays, and will also house a wash pad for equipment, and back-up generators. The entire concrete pad for the building will slope to a perimeter foundation curb on the outside and toward one end of the pad. The wash pad will slope into a sediment sump that can be cleaned with a piece of mobile equipment. The sediment sump overflows into a hydrocarbon skimming and sediment settling sump. The underflow from this sump will report to a "grey" water sump that will be pumped into a wash pad water recycle system for further cleaning prior to reuse. Wash pad sediments and oil-skimming residues will be collected and hauled off-site by a licensed hazardous waste disposal company. The fuel/lube storage area will report to a hydrocarbon containment sump which will be sized for 110% containment of the largest tank capacities located in the facility.

Fuels Storage and Fueling Stations: The Project will use both diesel and bio-diesel products as well as a smaller volume of gasoline. Two large diesel storage tanks are planned for the Project along with

several day tanks that will be placed on appropriately design concrete pads. The planned fuel-storage tanks for the Project startup phase include:

- 8,000 gallon double walled tank (diesel)
- 6,000 gallon double walled tank (bio-diesel)
- 1-500 gallon double walled tank (gasoline)
- 1-500 gallon day tank (diesel generator)
- 1-250 gallon day tank (diesel generator)

A fuel and lubricant truck will be used to dispense fuel to mobile equipment and fueling stations will be constructed at the fuel storage tanks and in the generator fueling area. The fuel stations will be located on concrete pads with spill containment to capture potential spills.

Various oils and anti-freeze necessary for mine operations will also be stored on the same concrete pad as the fuel tanks. A semi-van trailer or conex unit will store lubricants, oils, antifreeze, and other similar material, and will be placed near the fuel tanks to complete the fuel/lube station. It is estimated that there will be approximately 2,000 gallons of various oils, including storage for used oil. No fuel is expected to be stored in the underground workings.

Used oil will either be used on site as a fuel source for a shop heater, or will be collected and hauled off-site by a licensed hazardous waste disposal company.

Propane Storage: Propane tanks will be used to store propane on the construction portal pad and at the ventilation raises to seasonally supply heaters for underground air intakes.

Laydown/Equipment Parking: An open 50 x 80-foot storage laydown area will be reserved for various parts and materials required in the mining process. The area will be large enough to be also used as an equipment parking area. Smaller parts and equipment will likely be stored in temporary material storage units (conex boxes) in the laydown area.

Employee Parking: A graded and graveled parking area located near the office and wash/dry building will be reserved for employee parking. As stated above in Section 3.6.2, road base and gravel surfacing will be purchased from local commercial quarrying operations.

Shop/Warehouse and Power Supply Building: A 50 x 80 foot fabric covered, insulated, steel truss arch building will be constructed on a concrete slab to house a mine shop, warehouse, and on-site power supply generators. This facility will primarily serve as a garage/shop maintenance and equipment repair area. It will contain equipment and bays to maintain the mobile equipment fleet. The concrete floor in the shop area will provide containment for fuel, lubricants, and other shop fluids. The building will also provide warehouse space to store supplies, parts, small quantities of lubricants and other items.

Line power is available near the site. However, this line does not have sufficient power to support the anticipated first year or two of mining and support activities. Therefore, three on-site generators are planned for the Project start-up and until adequate line power is provided to the site. These generators will then be used as a back-up power sources in the case of line power failure. The generators will be housed in or adjacent to the Shop/Warehouse building. One generator (a 545 kW unit) will be the primary source of power until line power is provided to the site, and then will be used as a back-up generator in the case of line power failure. This generator will be housed in a van-trailer with a “day-use” diesel fuel tank of approximately 500 gallons. A 320 kW backup generator will provide emergency backup power for the underground pumps, vent fans, and shop in the event the main generator power supply is disrupted. The 320 kW generator will be skid mounted and has a “day” fuel tank with approximately 250 gallons of

fuel on board. Containment will be provided for 500 and 250 gallon day-use fuel tanks on the generators. Fuel will be transferred from the fuel storage area to the generator's day-use tanks as needed. Most of the underground equipment will be electric or diesel powered. Electricity for the ventilation fans and pumps will be supplied by on-site generators in the event of a line-power failure. Power will be distributed throughout the portal and CWP area, and distribution lines will be buried between the generators housed in or adjacent to this building and the portal and other facilities.

Temporary Surface Explosive Storage: Explosives will be temporarily stored on the surface in two separate explosives magazines. One magazine will be for initiation devices and one will be for explosives. The surface powder magazine locations have been carefully determined based on safety and security (Figure 1.3). The surface magazines will be constructed with large berms on three sides in accordance with applicable Mine Health and Safety Administration (MSHA) regulations. ANFO (ammonium nitrate/fuel oil) will be the primary explosive used for underground mining. Depending on the rock hardness and amount of water encountered, stick powder, slurries, or emulsion based explosives products may be used with or instead of ANFO. The temporary surface magazine storage will remain in use until the underground workings advance to a safe distance from the portal when they can be relocated underground. Underground magazines will be relocated as necessary to areas in support of active underground mining.

Septic and Drain Field: Portable toilets will be provided and maintained by a local subcontractor during initial mobilization/construction phases. An on-site wastewater (septic/ drain field) system (see Section 3.8.1) will ultimately be constructed to manage office trailer and mine dry/change house wastewater. This system will be designed to accommodate all on-site staff. The location (Figures 1.3 and Section 3.8.1) may change slightly based on field leach tests and the final design approved by the county. The system will need to be approved by the Meagher County sanitarian.

Core Shed: Two steel sided and roofed pole barns with concrete slab floors have been installed and are in use as a core storage sheds (Figure 1.2 and Figure 1.3). Their construction was permitted under Tintina's existing exploration license.

3.6.2.3 Portal Pad Use during Mine Operation

All of the temporary contract miner support facilities constructed on the portal pad will be removed after permanent replacement support facilities are completed on the mill pad. During the remainder of the mine operation, the portal pad will be an open surface upon which mine trucks and other vehicle circulate, with designated drive, parking, and equipment laydown areas. At that time, the entire surface area of the portal pad will be gravel or concrete slabs. All portal pad surface area drainage will be collected as contact water and directed to the contact water collection pond. Water collected in the CWP will be treated in the WTP before being discharged to groundwater in the subsurface infiltration gallery system.

3.6.2.4 Portal Location and Alternative Locations Evaluated

Two other portal/decline locations were evaluated prior to selecting the proposed site. One was located in the NE/4, NE/4 of section 24 and the other was in the center of the N/2 of Section 25. Although these proposed declines would have been shorter (i.e., closer to the Johnny Lee deposit), they would have intercepted higher amounts of sulfide-bearing rock and caused surface support facilities to be spread out over a greater geographic area, resulting in more disturbance acres. In summary, the proposed portal location and decline alignment were selected because they allow for consolidation of facilities into a smaller geographic area, result in mining of a lower volume amount of sulfide-bearing waste to access the copper-rich deposits, and eliminate the risk of discharge from the portal operationally and in closure.

Appendix Q presents an analysis of alternatives examined, and the selection process for facility locations and tailings disposal options.

3.6.3 Ventilation Raises

Ventilation is required in underground mining to clear fumes from blasting and diesel equipment, as well as to remove excess heat from the underground workings. In the Johnny Lee deposit, this will be accomplished with four (4) ventilation raises (Figure 1.3 and Figure 3.2). These are vertical tunnels that will be mined as “raises” (shafts constructed from the bottom-up). They typically are bored (drilled) from the bottom-up with raise-boring machines. The Johnny Lee ventilation raises will be approximately 16 feet (4.9 m) in diameter and will range in height from 295 feet (90 m) to 1160 feet (354 m) feet in order to reach the surface from the working levels. Two of the proposed ventilation raises will be fresh air intakes and the other two will be exhaust air (as will the mine portal) (Figure 3.2). Air will be moved through the mine by pairs of high volume fans located underground at the base of the two exhaust raises. These push air up the exhaust raise and suck air into the intake raises thereby driving circulation through the mine. This fan location minimizes noise at the surface. When mining is initiated, the portal acts as the main ventilation source and temporary fans are advanced with mining along the main development workings. During winter months intake air must be heated with propane fired heaters before entering the mine. The heaters and propane tanks will be located on the surface at the collars of the intake ventilation raises.

One exhaust ventilation raise (Figure 3.2) will be developed as a secondary escape way for underground mine personnel as is required by MSHA. It will be equipped with a mechanized escape hoist installed at the raise collar. Because the exhaust fans will be located underground, the top of the mechanized egress raise will have a concrete collar foundation and a tripod style headframe that will support the secondary egress conveyance. This secondary egress raise will incorporate a 60 horse-power hoist mounted in a shipping container and will provide hoisting speeds of up to 30 feet/sec (0.9 m/s). The bullet-shaped conveyance will be capable of evacuating two men per trip. Surface disturbances associated with ventilation raises and other surface disturbances are discussed below in Section 3.4.1.

3.6.4 Temporary Waste Rock and Operational Copper-enriched Rock Storage Facilities

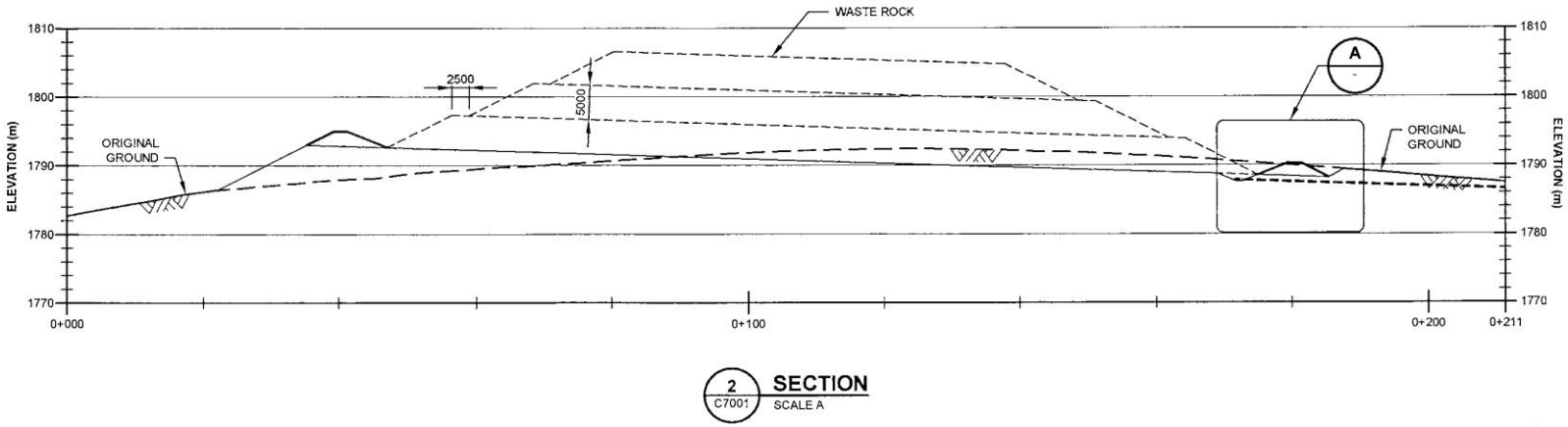
3.6.4.1 Design Characteristics

Approximately 551,155 tons (500,000 t) of waste rock will be generated prior to the start-up of production copper mining and milling operations, and 771,617 tons (0.7 Mt) of waste rock will be generated over the life of the mine. The waste rock has potential for acid generation and metal leaching (see Section 2.4.2), and operationally will be co-disposed with the tailings in the CTF during mining operations. This material will be placed on the temporary WRS facility prior to construction of the CTF, and will require a disturbance footprint of 11.12 acres (4.46 ha) for construction.

3.6.4.2 Liner and Seepage Reclaim Water Systems

The waste rock generated during the first two years of mining will be temporarily stockpiled on an HDPE lined WRS pad, located west of the mine adit portal pad and north of the mill pad (Figure 1.3 and Figure 3.15). The temporary WRS pad is designed to contain 551,155 tons (500,000 tonnes) of waste rock. Waste rock will be stacked over an 11.12 acre area to a maximum height of 50 feet (15 meters) in 16-foot (5 m) lifts with 8-foot (2.5 m) benches (Figure 3.16 and Figure 3.17). The WRS pad will have a 100 mil (2.5 mm, 0.1 inch) HDPE geomembrane with a minimum 12-inch (300 mm) thick layer of bedding material above and below it for protection from the mine fleet traffic during waste rock placement.

Waste Rock Storage Facility Cross Section

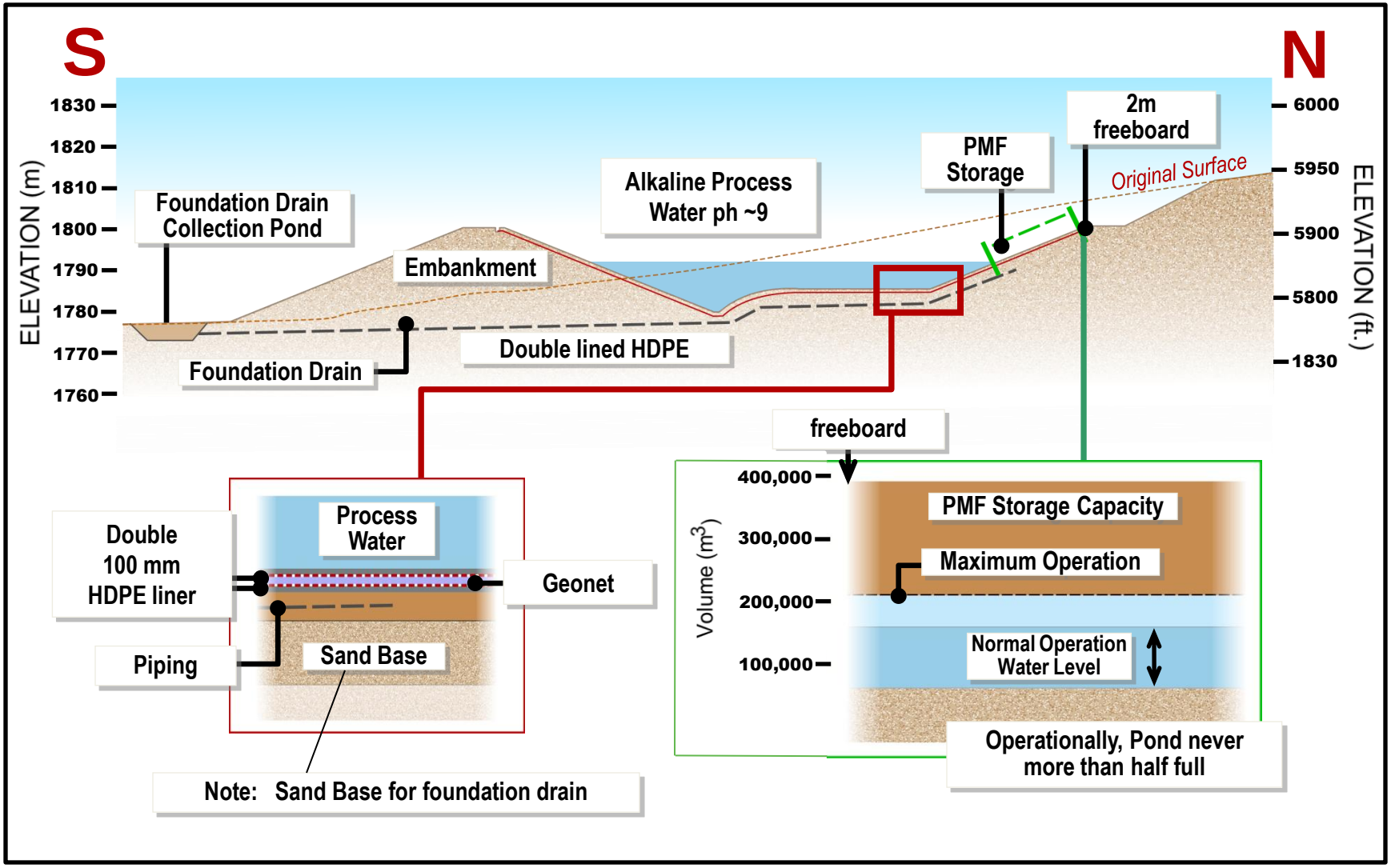


TINTINA RESOURCES

Date: October 28, 2015

From: Knight Piesold (#C7003)

Figure 3.16
Cross-Section of Waste Rock Storage Facility
Black Butte Copper
Meagher County, Montana



TINTINA RESOURCES

Date: October 28, 2015

Figure 3.17
Process Water Pond Schematic Cross-Section
Black Butte Copper
Meagher County, Montana

Additional waste rock material will be placed on top of the upper liner in areas where mine trucks will establish routinely traveled access ramps onto the pad. The remaining 220,462 tons of waste rock generated during production mining will be placed in the CTF and comingled with tailings, and both of these materials will be cemented together.

The WRS pad and liner will be sloped to the south towards an outlet pipe along the south edge of the pad (Figure 3.17). This outlet pipe will transfer collected precipitation and seepage through the waste rock pile from the top of the liner to the double lined CWP (see Section 3.6.6 and Figure 3.22) adjacent and to the south of the mine portal pad (Figure 1.3). Water will be temporarily stored within the CWP during the period of use of the temporary WRS pad, prior to its automatic pump transfer to the WTP.

3.6.4.3 Foundation Drain System

The WRS foundation drain system comprises an interconnected grid of pipes of various diameters and surrounding drainage gravel lenses used to manage the predicted excavation area groundwater flows. The drain system will collect groundwater flows from the WRS basin (below the geomembrane) and embankments, and will report to an outlet drain. The drain then conveys the collected flows to the CWP.

3.6.4.4 Year 2 to 3 Reclamation of the WSP

The waste rock stored on the WRS facility will be mined from several different lithologies, which contain variable amounts of sulfide minerals, all of which will be stored in the same facility. Therefore, all waste rock will be considered Potentially Acid Generating (PAG). All waste rock from the pre-production period will be transferred into the CTF once installation of the geomembrane across the basin floor of the CTF has been completed (approximately 2 years). Some of the waste rock will then be crushed and spread over a portion of the HDPE-lined basin floor of the CTF to create a basin drain system prior to beginning tailings deposition, as described in Section 3.6.7. Additional waste rock will be placed in the basin underdrain and sump areas as needed.

Reclamation of the WRS facility will occur at the end of the first two years of mining (after waste rock has been transferred to the CTF). Reclamation will include removal of the HDPE liner under the facility, backfilling the excavation in the WRS facility area with material from the excess excavation material stockpile (immediately to the west of the WRS facility) (Figure 1.3), reshaping, soil/subsoil placement, and reseeding.

3.6.4.5 Operational Copper-enriched Rock Storage Facility

During the period of time that pre-production waste is removed to the CTF, and before production mining begins, a new copper-enriched rock stockpile facility will be constructed off of the northwest corner of the portal pad (Figure 1.3). The copper-rich stockpile will provide mill feed when the mine is unable to provide copper enriched rock directly to the mill. The copper-enriched rock stockpile pad will have the capacity for approximately 82,600 tons (75,000 tonnes) of rock and cover an area of 2.00 acres (8,090 m^2), to a maximum height of 60 feet (18 m) in 20-foot (6 m) lifts with 17-foot (5 meter) benches (Figure 3.16). The copper-enriched rock storage pad will be used throughout the remainder of the operating mine life.

3.6.5 Process Water Pond (PWP)

3.6.5.1 PWP Design Concepts

The PWP (Figure 3.18) will be a double-lined facility that stores all contact water from the PWP and CTF, including contact water from precipitation and run-off, and collected water from the foundation drain collection ponds. The PWP has a disturbance footprint of 23.80 acres (9.9 ha) and a maximum

embankment height of approximately 50 feet (16 m). The PWP has a capacity of 549,339 cubic yards (420,000 m^3) to provide storage for mill water recycle and storm storage.

The PWP is designed with an operational capacity of as much as 261,600 cubic yards (200,000 m^3). This maintains a sufficient volume of water to offset evaporation, while providing a minimum of four months process water supply. Normal operational storage level requirements for the pond will be between 104,600 to 209,300 cubic yards (80,000 to 160,000 m^3). Under average climatic conditions, the PWP will have as much as 104,600 cubic yards (80,000 m^3) of capacity to allow for temporary water storage caused by variances in operations. The operational volumes have been optimized such that wetter than average year conditions will still not encroach on the storm storage above 200,000 m^3 (261,600 cu yds.) in the PWP. The additional 261,600 cu yds. (220,000 m^3) of capacity will allow for storage of water from a PMF storm event. Because of these excess storage volumes, the PWP operationally should never be more than half full (Figure 3.18) unless a major storm event has occurred.

3.6.5.2 PWP Liner and Seepage Reclaim Water System

The PWP will be a double-lined impoundment that has two layers of 100 mil (2.5 mm, 0.1 inch) geomembrane with a 0.3 inch (7.6 mm) high flow geonet layer sandwiched between the geomembrane layers. The geonet will act as a conduit for potential leakage through the upper geomembrane. Any seepage into the geonet will be directed via gravity to a sump and pump reclaim system at a low point in the PWP basin. Water collected in the sump will be pumped through a riser pipe to the embankment crest, and back into the PWP. An underlying subgrade layer will be installed to protect the lining system.

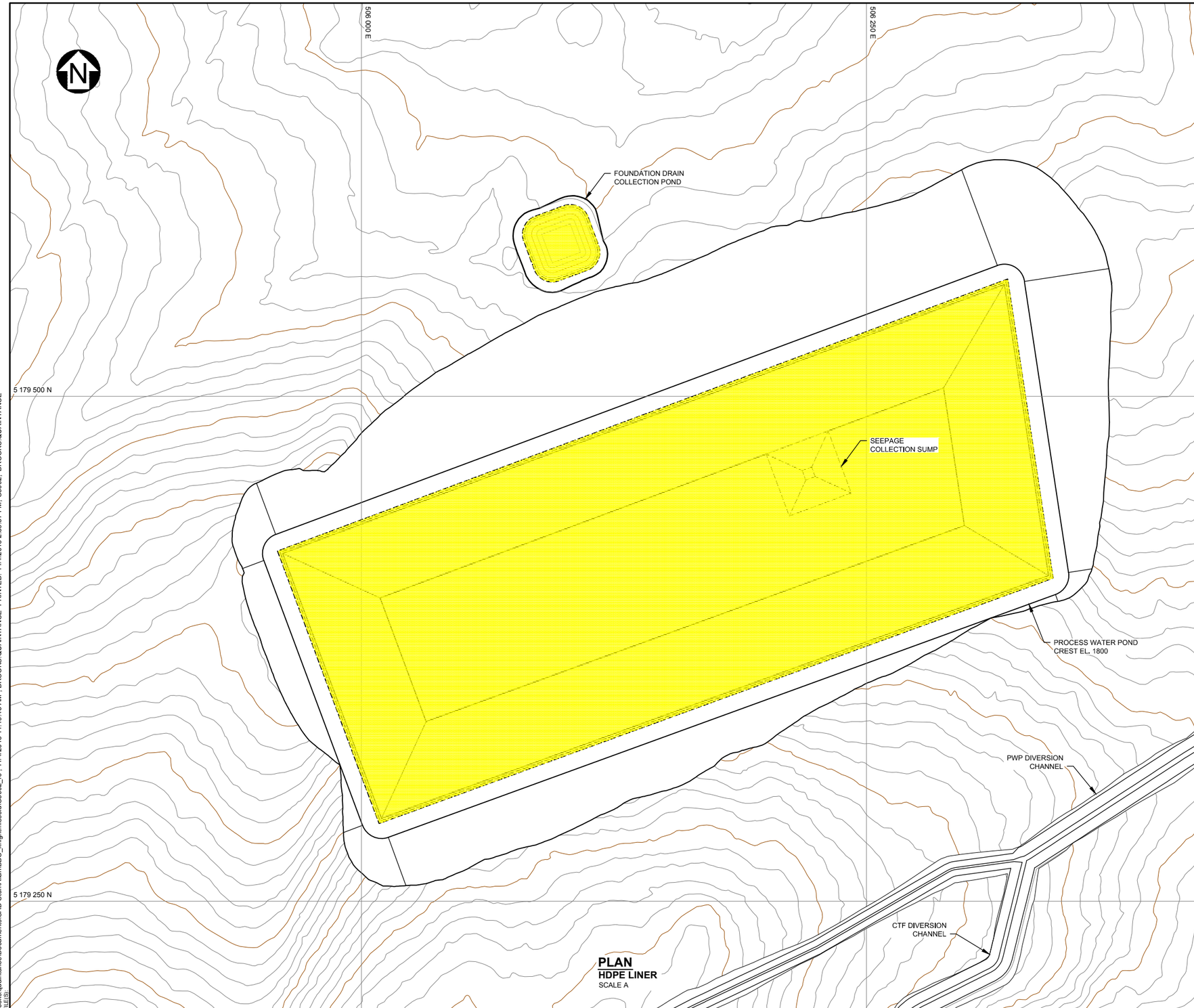
The seepage reclaim system between the HDPE geomembrane layers will consist of a sump filled with drainage gravel that will be deep enough to allow the effective operation of a submersible pump that can be raised and lowered through a protective pipe. The bottom of the pipe will be perforated (in the sump) for pump operation. An additional drain pipe will be included for redundancy. The pump will have a high/low water level primer to control pumping (it will switch on when the water level reaches a high water mark and switch off when the water level reaches the low water mark). Potential seepage through the lower geomembrane will be intercepted by the PWP Foundation Drain System, as discussed in Section 3.6.5.

Details of the PWP Liner System, including pipeline lengths, sizes, design and minimum required thicknesses of drainage gravel are shown on Figure 3.19.

3.6.5.3 PWP Foundation Drain System

The PWP foundation drain will collect groundwater flows below the PWP geomembrane, and convey all collected flows to a collection and recycle pond downstream of the PWP. Its construction will be started early, and will become operational shortly after initiating construction of the PWP. The foundation drain comprises an interconnected dendritic system of pipes, embedded in drainage gravel that is designed to collect and funnel the predicted groundwater flows to a downgradient foundation drain collection pond. The PWP foundation drain system has the following components:

- Drains on the PWP basin floor, installed prior to the installation of the geomembrane,
- Drains beneath PWP embankments
- Outlet drain to the foundation drain collection pond.



PLAN
HDPE LINER
SCALE A

LEGEND:

HDPE LINER

LINER SYSTEM ANCHOR TRENCH

NOTES:

1. COORDINATE GRID IS UTM NAD83 ONE 12.
2. PLAN BASED ON INFORMATION PROVIDED BY TINTINA RESOURCES INC., DATED FEB 03, 2011.
3. CONTOUR INTERVAL IS 1 METER.
4. DIMENSIONS AND ELEVATIONS ARE IN METERS, UNLESS NOTED OTHERWISE.
5. HDPE LINER CONFIGURATION SHOWN ON DRG. C3005.

SCALE A 20 10 0 20 40 60 80 100 m

TINTINA RESOURCES

BLACK BUTTE COPPER PROJECT
MINE OPERATING PERMIT APPLICATION

MEAGHER COUNTY, MT

FIGURE 3.18
PROCESS WATER POND
HDPE LINER AND SEEPAGE COLLECTION
LAYOUT PLAN

REV	DATE	DESCRIPTION	DESIGNED	DRAWN	REVIEWED	APPROVED
0	15OCT'15	ISSUED FOR MOP APPLICATION	GIM	PP	KDE	KDE

REVISIONS

DRAWING BY KNIGHT PIESOLD: VA101-460/3

SOURCE FIGURE NUMBERS: C3002

REVISED DATE: OCTOBER 15, 2015

REVISION 0

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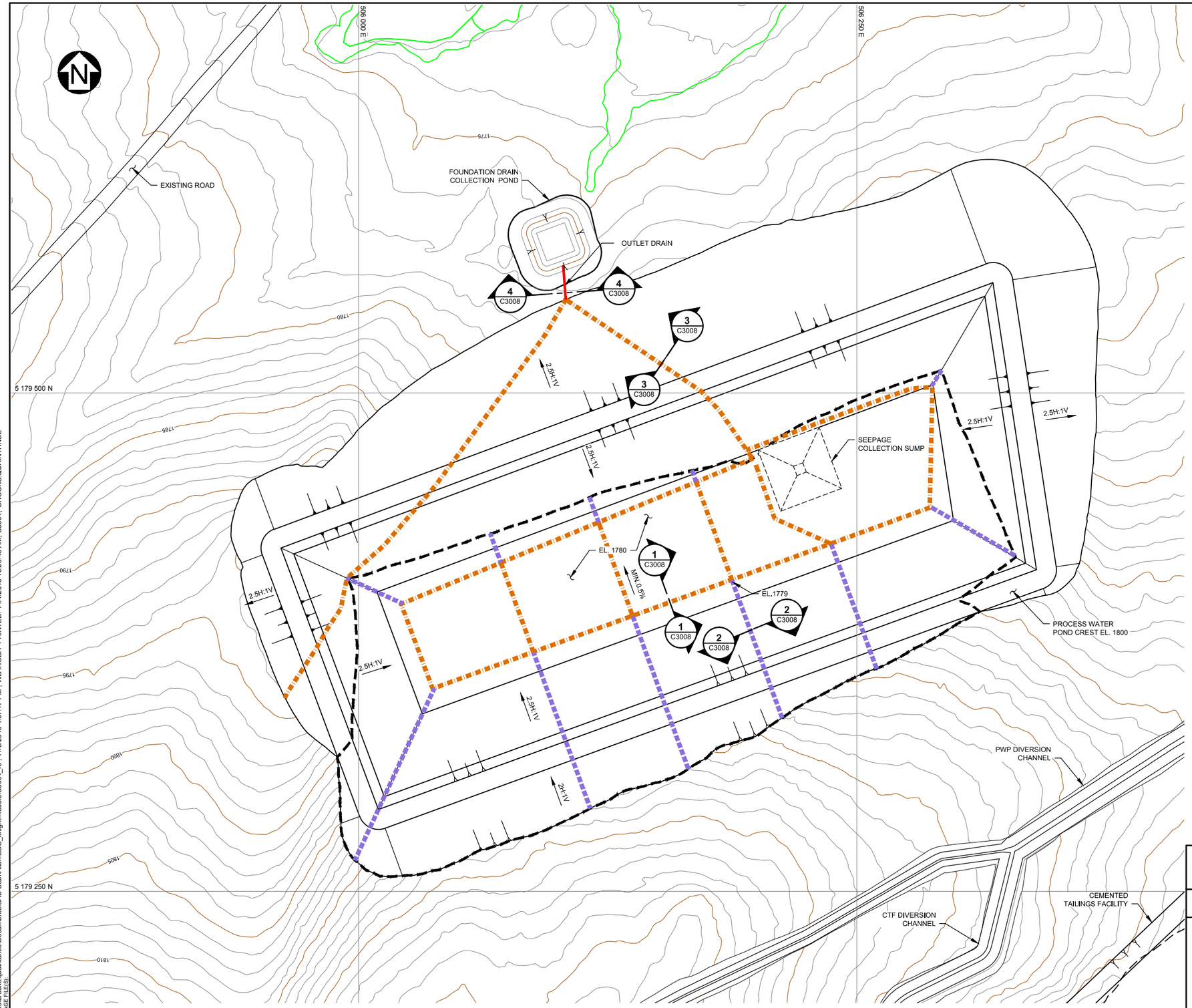

LEGEND:

- 6" N12 WT PE OUTLET PIPE
- 6" N12 ST PE DRAIN PIPE (BASIN FLOOR)
- 4" N12 ST PE DRAIN PIPE (SLOPE)
- CUT/FILL TRANSITION

NOTES:

1. COORDINATE GRID IS UTM NAD83 ZONE 12.
2. CONTOUR INTERVAL IS 1 METER.
3. DIMENSIONS AND ELEVATIONS ARE IN METERS, UNLESS NOTED OTHERWISE.
4. FILL CONTOURS NOT SHOWN FOR CLARITY.
5. DRAIN TRENCHES WILL BE SLOPED TOWARDS OUTLET PIPE CONNECTION AT A MINIMUM GRADE OF 0.5%.
6. LAST 10m OF OUTLET PIPE WILL BE SOLID PIPE BACKFILLED WITH IMPERMEABLE MATERIAL.
7. OUTLET PIPE WILL EMPTY INTO A WEIR TO MEASURE PIPE FLOW.

SCALE A 20 10 0 20 40 60 80 100 m

TINTINA RESOURCES

BLACK BUTTE COPPER PROJECT

MEAGHER COUNTY, MT

FIGURE 3.19
PROCESS WATER POND
BASIN FOUNDATION DRAIN SYSTEM PLAN

REV	DATE	DESCRIPTION	DESIGNED	DRAWN	REVIEWED	APPROVED
0	15OCT'15	ISSUED FOR MOP APPLICATION	GIM	NSD	KDE	KDE

REVISIONS

REVISED DATE: OCTOBER 15, 2015

REVISION 0

DRAWING BY KNIGHT PIESOLD: VA101-460/3

SOURCE FIGURE NUMBERS: C3004

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

Operationally, groundwater, meteoric water, and seepage (if any) infiltrating the foundations of the facility will be collected by the foundation drain system and directed into the foundation drain collection pond. The foundation drain collection pond is a very small facility requiring only a 0.4 acre (0.16 ha) construction footprint and is located downstream (north) of the PWP embankment (Figure 3.19). The foundation drain pond will contain only small volumes of water and may often be dry. Collected water will be pumped back to the PWP. The foundation drain pond will be a 100 mil HDPE geomembrane lined pond with a submersible turbine pump. An HDPE pipeline will convey the flows back to the PWP. Details of the PWP Foundation Drain System are shown on Figure 3.19.

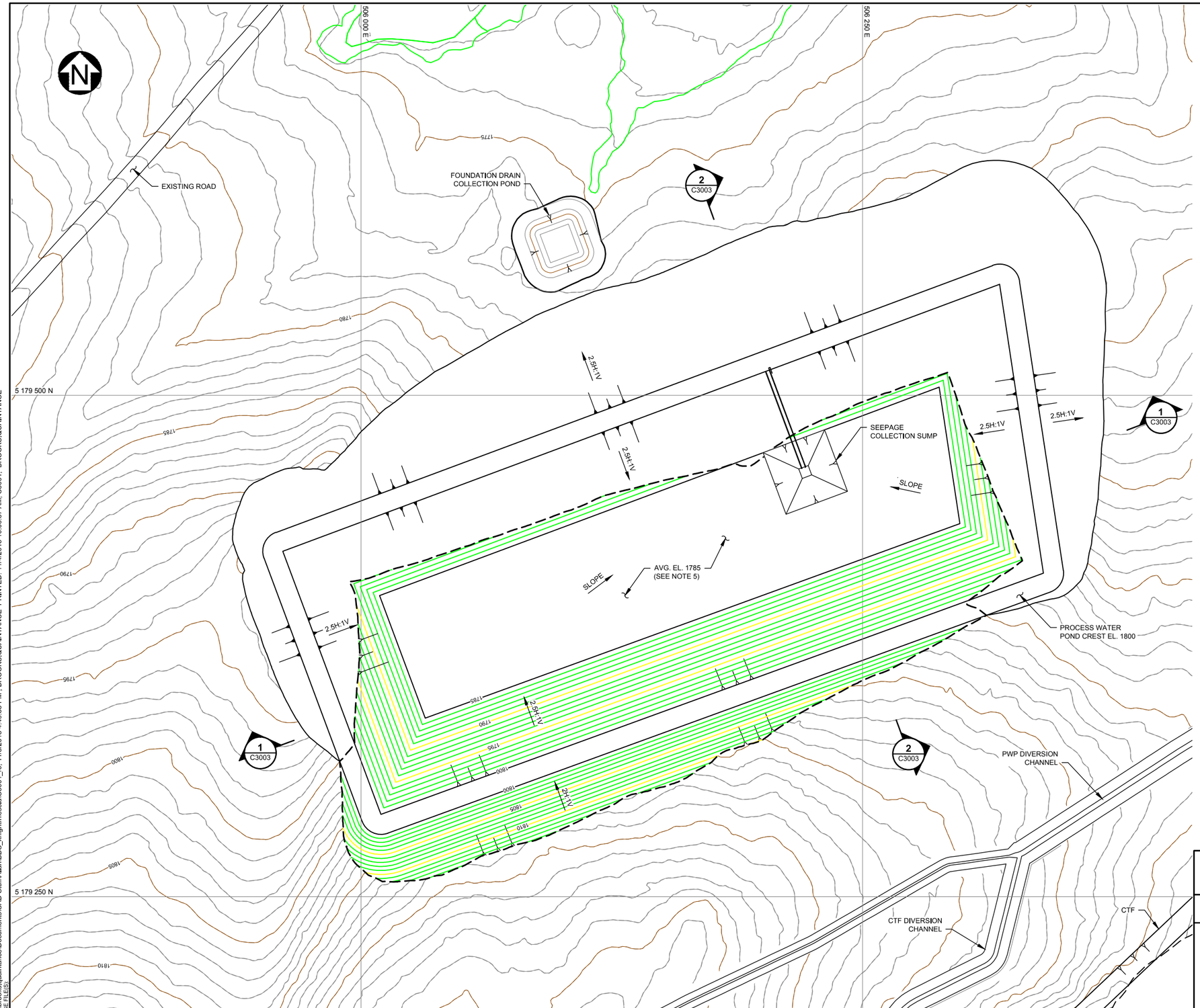
3.6.5.4 PWP Embankment Cross-Section

The Process Water Pond will be constructed prior to the start of mining operations. The embankment will be a homogeneous rock fill embankment. The internal (upstream) slope of the impoundment will be constructed at a 2.5H:1V slope to facilitate geomembrane placement. The external slope (downstream) will be constructed at a 2.5H:1V slope to facilitate reclamation of the downstream slopes, which can be completed shortly after construction. The crest width will be 33 feet (10 m) to allow working space for pipelines and traffic. The maximum embankment height will be approximately 75 feet (23 m).

The majority of embankment fill will be general fill sourced from excavation as part of the cut-fill balance for the PWP impoundment shaping. The material will consist of fresh to moderately weathered rock fill with organics and loamy material removed.

The geomembrane will be placed on prepared subgrade fill material that will provide a protective layer between the geomembrane and natural ground or other fill materials. The fill will be primarily sourced from weathered bedrock and select fresh rock that meets the required material specifications. General rock fill will be processed as necessary to meet the material specifications. Non-woven geotextile fabric will be placed between the geomembrane and subgrade bedding.

The PWP plan is shown on Figure 3.20. Sections and details are shown on Figure 3.21.



LEGEND:

EXCAVATION CONTOURS

CUT/FILL TRANSITION

NOTES:

1. COORDINATE GRID IS UTM NAD83 ZONE 12.
2. CONTOUR INTERVAL IS 1 METER.
3. DIMENSIONS AND ELEVATIONS ARE IN METERS, UNLESS NOTED OTHERWISE.
4. FILL CONTOURS NOT SHOWN FOR CLARITY.
5. BASIN TO BE GRADED AT A MINIMUM 0.5% TOWARDS SEEPAGE COLLECTION SUMP.

SCALE A 20 10 0 20 40 60 80 100 m

TINTINA RESOURCES

BLACK BUTTE COPPER PROJECT

MEAGHER COUNTY, MT

FIGURE 3.20
PROCESS WATER POND
GRADING PLAN

REV	DATE	DESCRIPTION	DESIGNED	DRAWN	REVIEWED	APPROVED
0	15OCT'15	ISSUED FOR MOP APPLICATION	GIM	NSD	KDE	KDE

REVISIONS

REVISED DATE: OCTOBER 15, 2015

REVISION 0

DRAWING BY KNIGHT PIESOLD: VA101-460/3

SOURCE FIGURE NUMBERS: C3001

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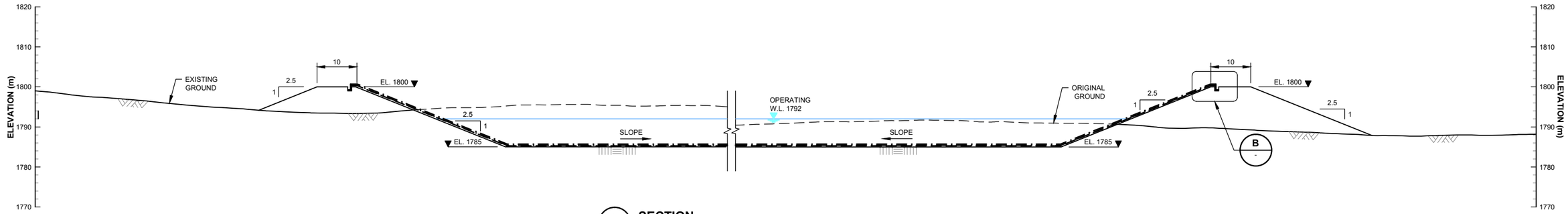
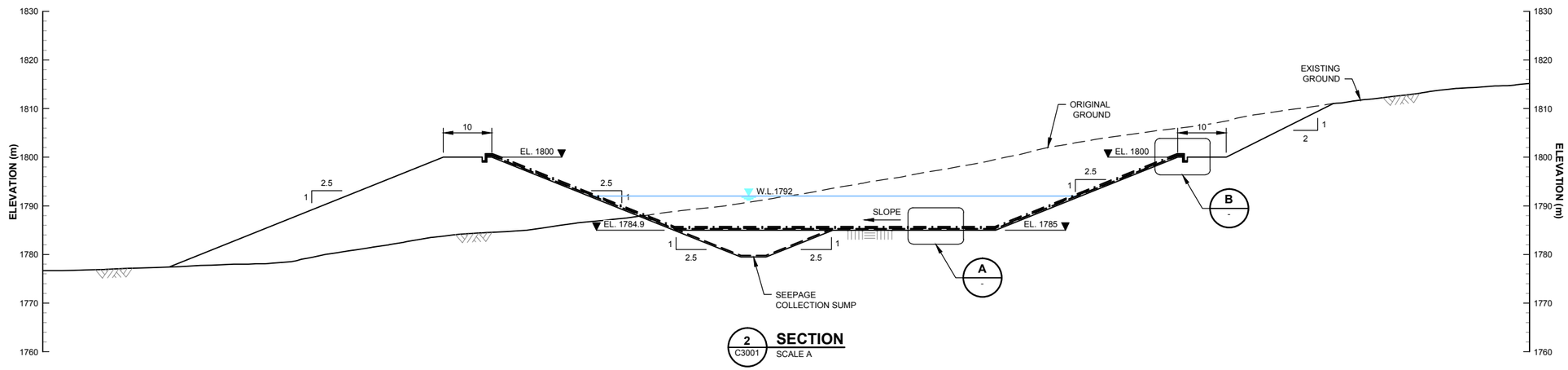


1 C3001 **SECTION**
SCALE A



2 C3001 **SECTION**
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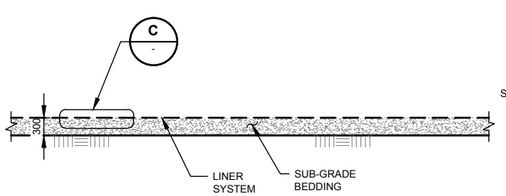
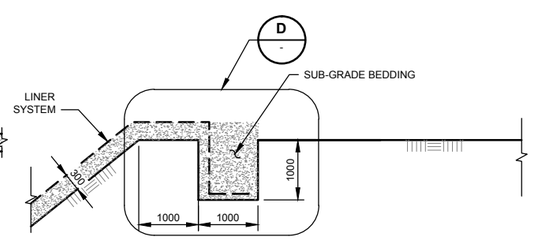
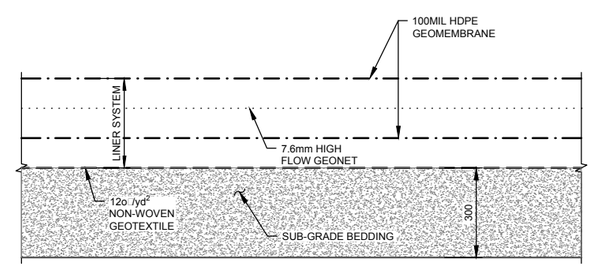


A - **DETAIL**
LINER SYSTEM PLACEMENT DETAILS
SCALE B



B - **DETAIL**
LINER SYSTEM ANCHOR DETAILS
SCALE B



C - **DETAIL**
LINER SYSTEM DETAILS
SCALE A

NOTES:

1. DIMENSIONS AND ELEVATIONS ARE IN METERS, UNLESS NOTED OTHERWISE.

SCALE A 4 2 0 4 8 12 16 20 m

TINTINA RESOURCES

BLACK BUTTE COPPER PROJECT

MEAGHER COUNTY, MT

FIGURE 3.21
PROCESS WATER POND
EMBANKMENT AND SECTIONS

REV	DATE	DESCRIPTION	DESIGNED	DRAWN	REVIEWED	APPROVED
0	15OCT'15	ISSUED FOR MOP APPLICATION	GIM	NSD	KDE	KDE

REVISIONS

REVISED DATE: OCTOBER 15, 2015

REVISION 0

DRAWING BY KNIGHT PIESOLD: VA101-460/3

SOURCE FIGURE NUMBERS: C3003

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3.6.5.5 Process Water Pond Embankment Freeboard

The PWP has been designed to maintain a minimum of 6.6 feet (2 m) of freeboard at all times (Figure 3.17 and Figure 3.18). The purpose of the minimum 6.6 feet (2 m) freeboard is to provide an allowance for wave run-up generated from wind. The 6.6 feet (2 m) freeboard is not intended as an allowance for storing excess process water. Therefore the PWP includes sufficient capacity to contain the required amount of process water, run-off, precipitation, and the design storm event (PMF) reporting directly to the PWP. Additionally, run-off and precipitation reporting to the CTF for storm events up to and including the 1 in 500 year 24 hour storm event will be pumped into the PWP for storage and recycle.

3.6.5.6 Process Water Pond Water Reclaim System

The PWP supplies process water to the reclaim tank located at the mill. The reclaim system has been sized to provide the annual requirement of 5,401,836 cubic yards (4,130,000 m^3) of process water during full production. A 20% design factor has been included in the design flow rate to allow for operational flexibility.

The intake for the reclaim system includes a 30 HP centrifugal pump located on a pad on the crest of the PWP embankment, at the northeast corner. A stand-by pump will be provided as back-up. The pump intake line will be installed down the side of the pond.

An 18-inch (45.7 cm) DR21 HDPE pipeline conveys the flows from the PWP to the reclaim tank. The pipeline alignment follows the access road, and will be installed on the left side of the road and anchored with earthen berms as required. The pipeline will discharge into the top of the reclaim tank at the mill site.

3.6.5.7 PWP Alternative Locations Evaluated

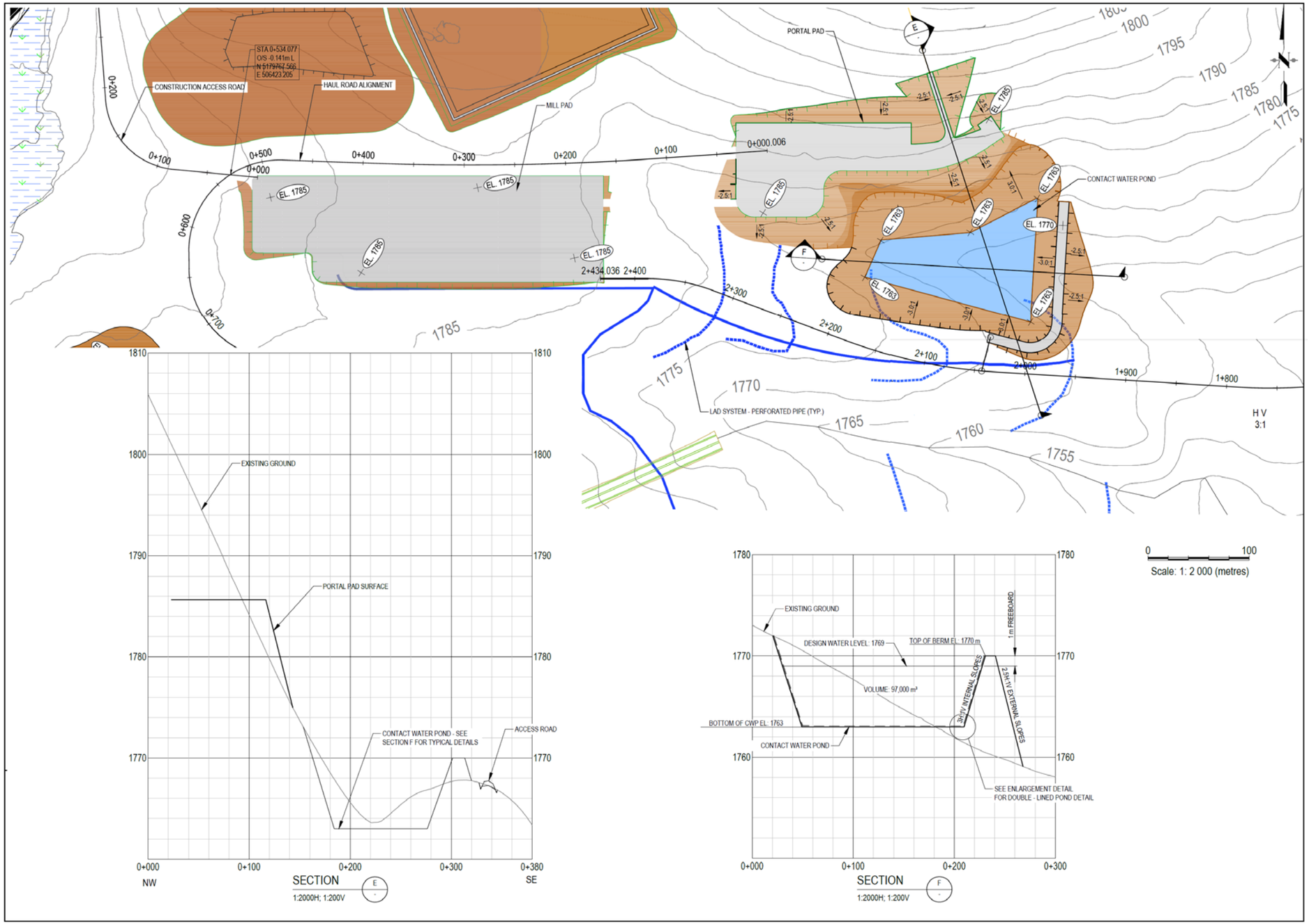
Six alternative locations were evaluated for the PWP prior to selection of the final facilities locations. The final selection process was influenced primarily by impacts to wetlands. Appendix Q presents an analysis of alternatives examined and the selection process for facility locations and tailings disposal options.

3.6.6 Contact Water Pond (CWP)

3.6.6.1 CWP Design Concept

The CWP is designed to collect surface run-off from the mill area, portal pad, WRS pad, copper-enriched rock storage pad (during operations), CTF road north of the mill, and from the CWP itself (Figure 1.3 and Figure 3.22). This water is called contact water because it could come in contact with potentially contaminated source material from the facilities. Best management practices for preventing the co-mingling of unaffected surface and groundwater (non-contact water) with contact water will be implemented.

The CWP will be a double-lined facility with an underlying foundation drain (similar to that described for the PWP and CTF) (Figure 3.22) that covers a disturbance area of about 9.88 acres (4 ha) and has a capacity to store a total of 126,800 cubic yards (97,000 m^3) of water. The construction phase storage capacity required includes runoff from the above mentioned facilities and WTP brine and solids storage. Contact water run-off will be separated from brine during this period by a central berm constructed beneath the liner system during basin shaping. The eastern end downstream embankment height is about 32 feet (10 m).



Prepared by Tetra Tech Inc.

Figure 3.22

CWP Plan & Sections
Black Butte Copper Project
Mine Operating Permit Application
Meagher County, Montana

TINTINA RESOURCES

3.6.6.2 Management during Routine Operations

Contact water will be delivered to the CWP during operations along an 80 mil HDPE lined drainage channel surrounding the facilities. Water in the CWP will be pumped to the WTP prior to disposal, or alternatively will be pumped back to the PWP. The pump will have a high/low water level primer to control pumping (switched on when the water level reaches a high pre-set water level water and switched off when the water level reaches a low water mark). As a result of this pump-back capability, the CWP will operationally contain little or no water, and at many times of the year may be dry.

3.6.6.3 Management during Mine Start-up

During initial development mining, and prior to the construction of the PWP, the mine workings will encounter groundwater flow that will require treatment before it can be sent to underground infiltration areas. Water pumped from underground during this period of time will be sent directly to the construction stage WTP located on the portal pad. The construction stage WTP includes a sophisticated two stage reverse osmosis treatment system capable of treating water to non-degradation standards for groundwater (see Section 3.7.3). Treated water will be sent to the underground infiltration galleries, and the remaining brine fraction resulting from the water treatment process will be temporarily stored in the CWP. The estimated volume of brine to be stored on the CWP over the two year period while major facility construction completes the PWP is 2.2 million gallons (8,300 m^3, 10850 cu yds.), about 8% of the ponds total storage capacity (see Section 3.7.3). The remaining 92% of the storage capacity exceeds the requirements for the 1:200 year storm event.

Once the PWP is completed, brine generated by the RO treatment system will be transferred directly to the PWP, or to the paste plant in the mill facility for mixing with cemented tailings.

3.6.6.4 CWP Liner and Seepage Reclaim

Like the PWP, the CWP will be a double-lined impoundment with two layers of 100 mil (2.5 mm, 0.1 inch) geomembrane with a 0.3 inch (7.6 mm) high flow geonet layer sandwiched between the geomembrane layers. The geonet will act as a conduit for potential leakage through the upper geomembrane. Any seepage into the geonet will be directed via gravity to a sump and pump reclaim system at a low point in the CWP basin. Water collected in the sump will be pumped through a riser pipe to the embankment crest, and back into the CWP. An underlying subgrade layer will be installed to protect the lining system.

The seepage reclaim system between the HDPE geomembrane layers will consist of a sump filled with drainage gravel that is deep enough to allow the effective operation of a submersible pump that can be raised and lowered through a protective pipe. The bottom of the pipe will be perforated (in the sump) for pump operation. An additional drain pipe will be included for redundancy. The pump will have a high/low water level primer to control pumping (switched on when the water level reaches a high water mark and switched off when the water level reaches the low water mark). Potential seepage through the lower geomembrane will be intercepted by the PWP Foundation Drain System, as discussed in Section 3.6.5.

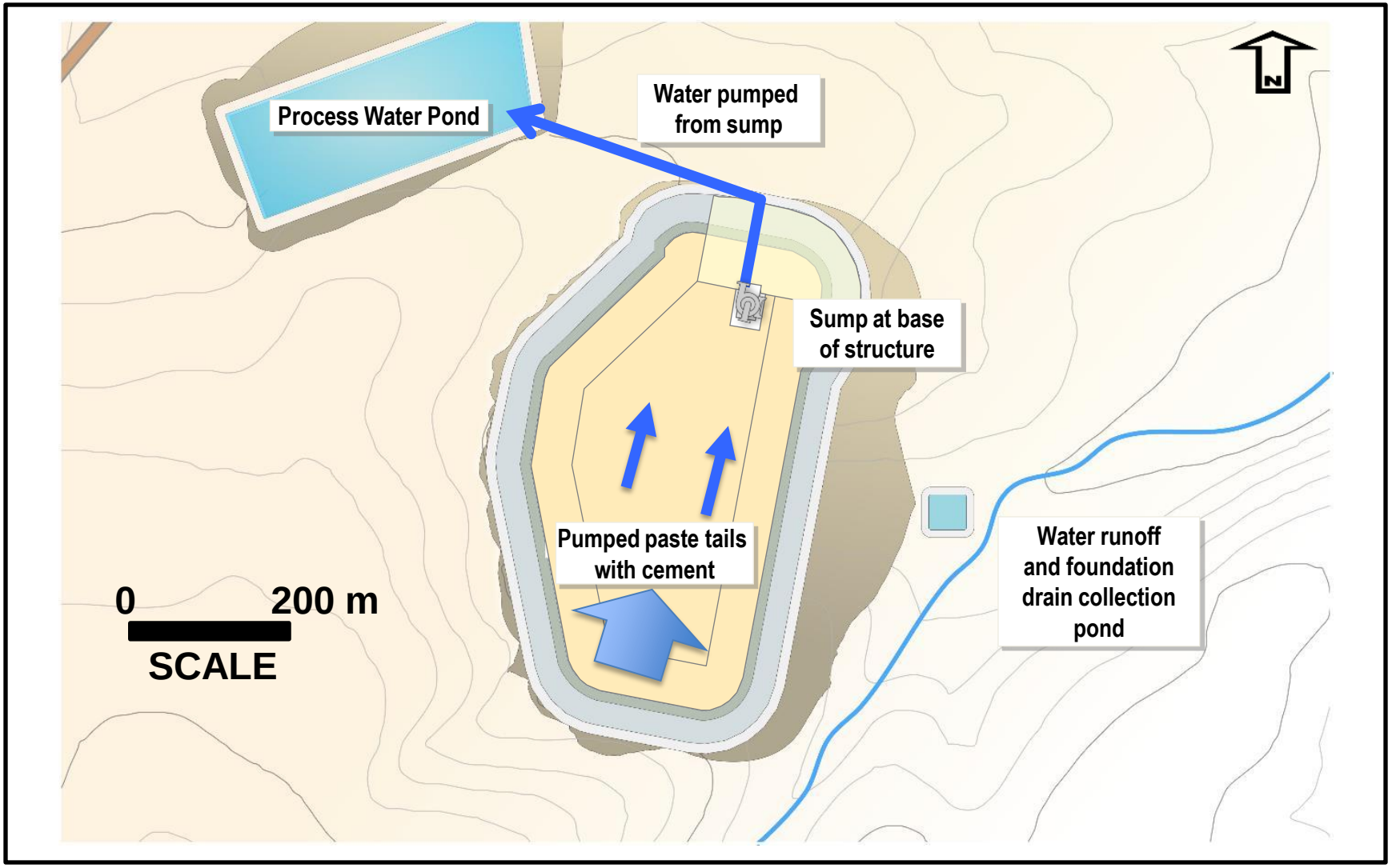
Details of the CWP Liner System including pipeline lengths, sizes, design and minimum required thicknesses of drainage gravel are shown on Drawings C3003 and C3005 (Appendix K) (Knight-Piésold, 2015d). Details of the Seepage Collection System are shown on Drawings C6500 to C6520 (Appendix K) (Knight-Piésold, 2015d).

3.6.7 Cemented tailings Facility (CTF)

3.6.7.1 CTF Design Concepts

The CTF is designed to store 55% of all tailings generated in the mill over the 13 year active mine life and 100% of waste rock brought to surface. The CTF (Figure 1.3) has a storage capacity of 5.6 million cubic yards (4.3 Mm^3). This includes 4.1 million cubic yards (3.15 Mm^3) of cemented tailings (6.9 million tons, 6.29 Mt at a settled density of 2 t/m^3), and 1.1 million cubic yards (0.85 Mm^3) of waste rock (1.9 million tons, 1.7 Mt at a density of 2.0 t/m^3). Capacity for an additional temporary storage of storm water up to and including the PMF flood event of 0.4 million cubic yards (0.3 Mm^3) has been included. The volume of tailings stored also accounts for the removal of 1.52 million tons (1.38 Mt) of concentrate from the 14.6 million tons (13.2 Mt) of copper-enriched rock. Figure 3.24 and Figure 3.25 are schematic Plan and Sections views of the CTF, respectively. The cemented tailings facility has a disturbance footprint of 71.90 acres (29.0 ha)

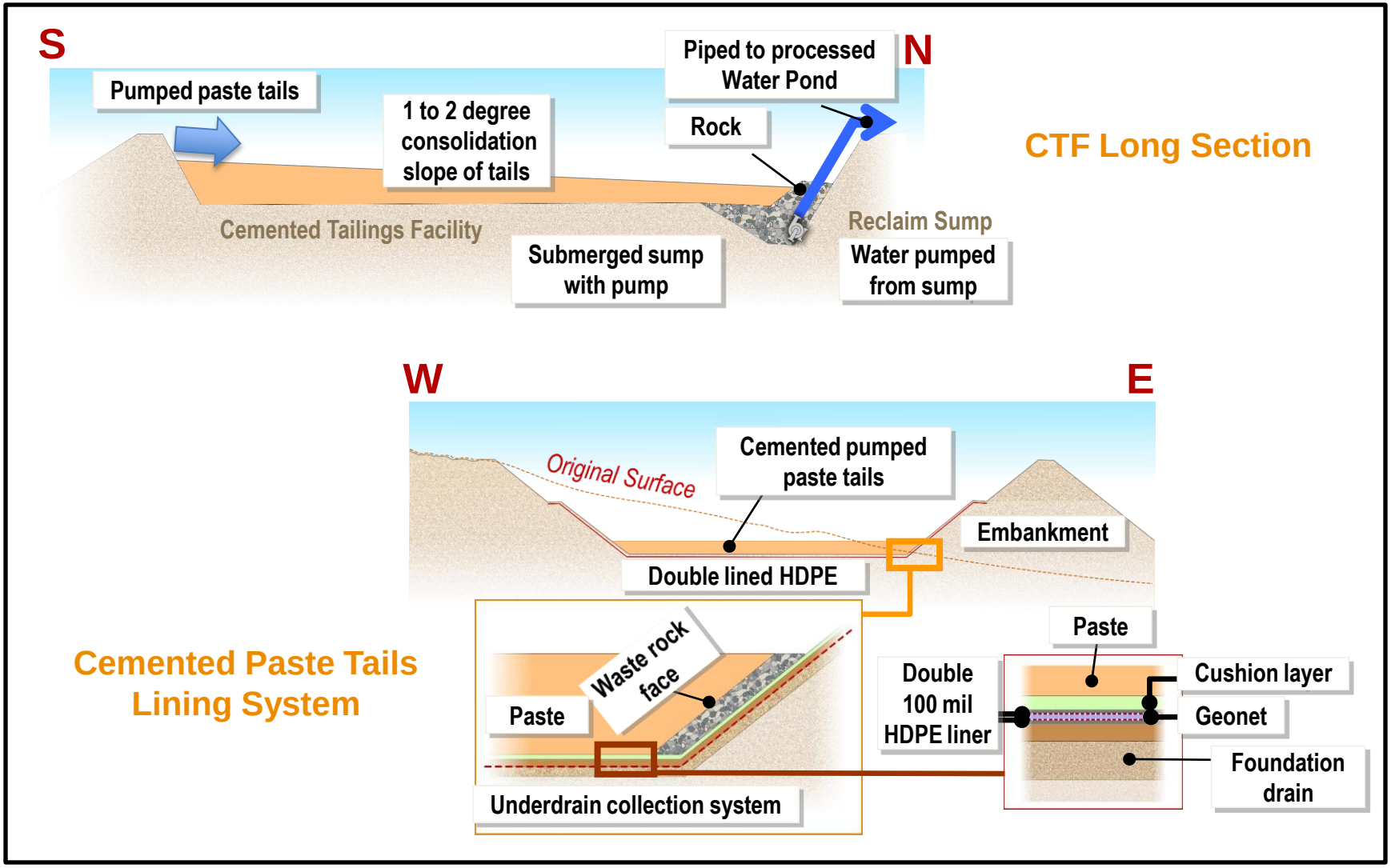
The PWP is designed to store additional water from the CTF for a 24 hour storm up to and including the 1 in 500 year event. A wet well sump and pump system within the CTF will be used to transfer water from the CTF to the PWP, and will be designed to pump out water from the 1 in 100 year 24 hour storm event over a 10-day period. The CTF will have capacity to store runoff and direct precipitation from the PMF event until there is capacity in the PWP to pump the water from the CTF.



TINTINA RESOURCES

Date: October 28, 2015

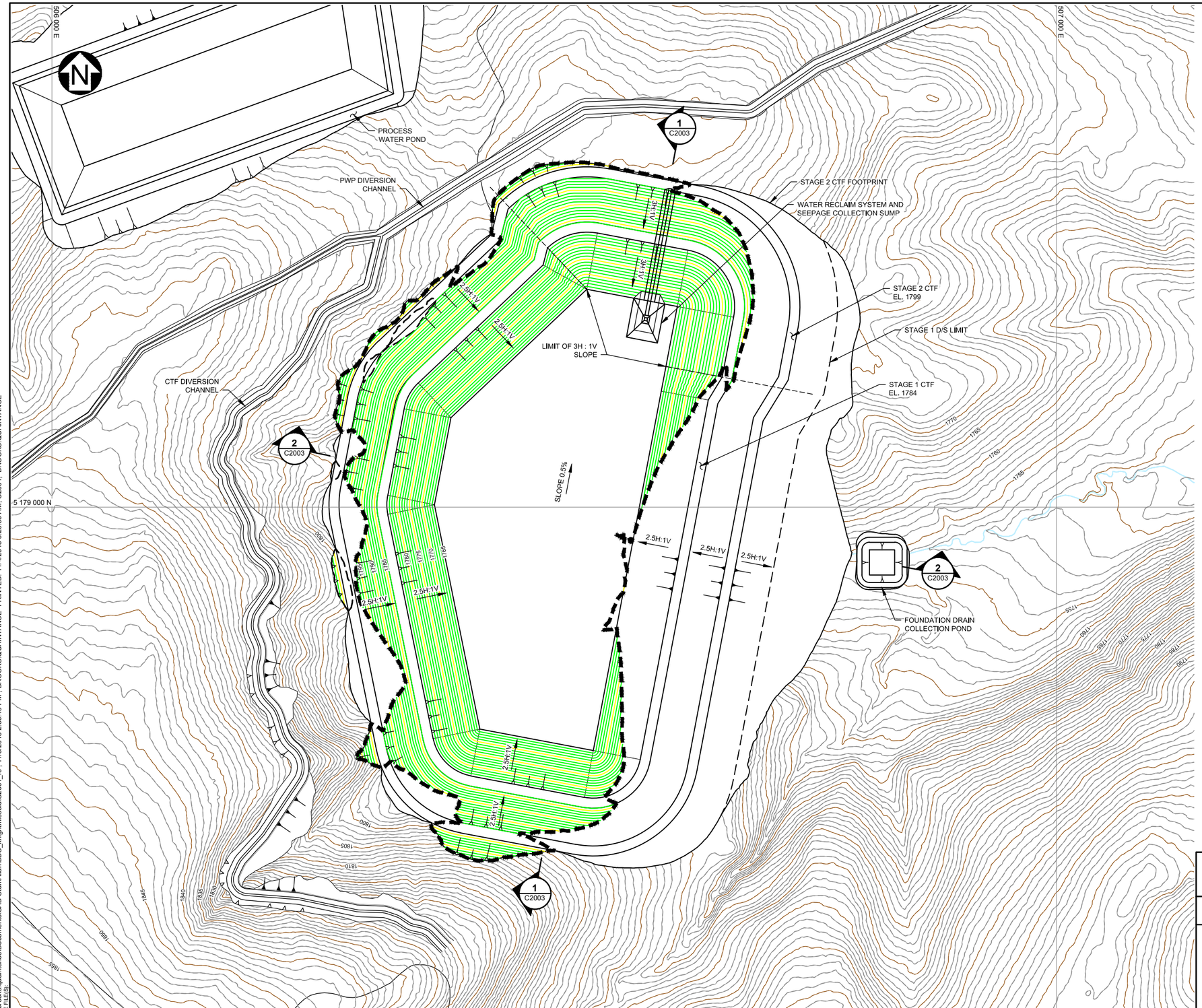
Figure 3.23
CTF Schematic Plan View
Black Butte Copper
Meagher County, Montana



TINTINA RESOURCES

Date: October 28, 2015

Figure 3.24
Schematic CTF Sections with Reclaim and Lining Systems
Black Butte Copper
Meagher County, Montana



LEGEND:

- EXCAVATION CONTOURS
- ORIGINAL STRIPPED GROUND CONTOURS TO BE REGRADED
- CUT/FILL TRANSITION

NOTES:

1. COORDINATE GRID IS UTM NAD83 ZONE 12.
2. PLAN BASED ON INFORMATION PROVIDED BY TINTINA RESOURCES, DATED (FEB 03, 2011).
3. CONTOUR INTERVAL IS 1 METER.
4. DIMENSIONS AND ELEVATIONS ARE IN METERS, UNLESS NOTED OTHERWISE.
5. FILL CONTOURS NOT SHOWN FOR CLARITY.

SCALE A 40 20 0 40 80 120 160 200 m

TINTINA RESOURCES

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MEAGHER COUNTY, MT

FIGURE 3.25
CEMENTED TAILINGS FACILITY
GRADING PLAN

REV	DATE	DESCRIPTION	DESIGNED	DRAWN	REVIEWED	APPROVED
0	15OCT'15	ISSUED FOR MOP APPLICATION	GIM	NSD	KDE	KDE

REVISIONS

REVISED DATE: OCTOBER 15, 2015

REVISION 0

DRAWING BY KNIGHT PIESOLD: VA101-460/3

SOURCE FIGURE NUMBERS: C2001

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

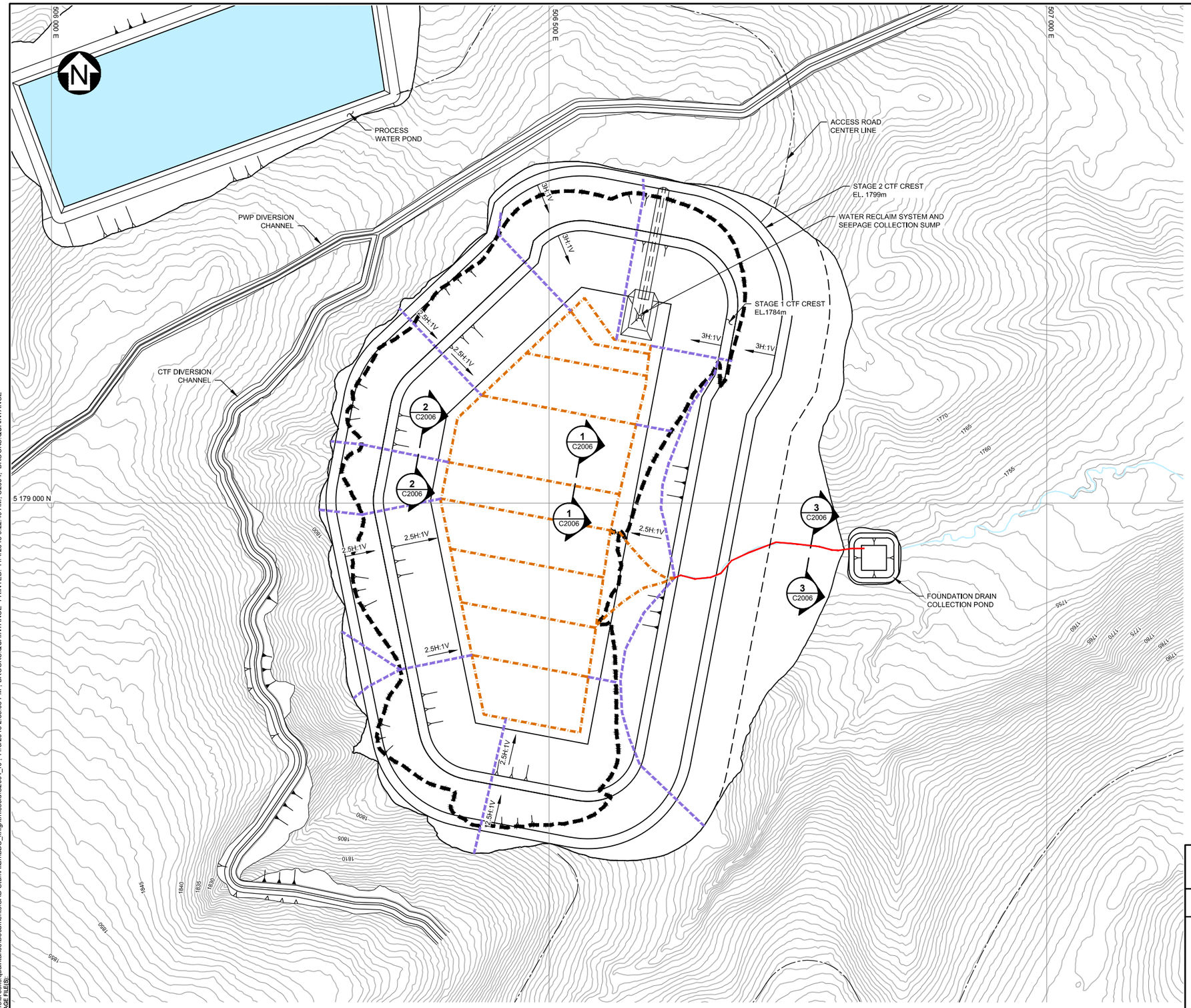
3.6.7.2 CTF Foundation Drain System

The foundation drain system will be constructed early and will become operational shortly after commencing construction of the CTF. Groundwater, meteoric water, and seepage (if any) infiltrating the foundation of the facility will be collected by the foundation drain system and directed into the foundation drain collection pond. Water will be pumped back from the ponds to the CTF. The foundation drain comprises an interconnected dendritic system of pipes, embedded in drainage gravel that is designed to collect and funnel the predicted groundwater flows to a downgradient foundation drain collection pond.

The CTF foundation drain system has the following components:

- Drains on the CTF Basin Floor
- Drains beneath CTF Embankments (areas of fill)
- Outlet drain to the foundation drain collection pond.

The foundation drain collection pond is a very small facility requiring only a 0.7 acre (0.28 ha) construction footprint and is located at the downstream toe of the CTF embankment (Figure 3.26). Collected water will be pumped into to the CTF and subsequently transferred to the PWP. The collection pond will be a 100 mil (2.5 mm, 0.1 inch) HDPE geomembrane lined pond with a submersible turbine pump. An HDPE pipeline will convey the flows from the pond to the CTF. Details of the CTF foundation drain system, including pipeline lengths, sizes, and minimum required thicknesses of drainage gravel are shown on Figure 3.26.



LEGEND:

- 250mm (10") N12 WT PE OUTLET PIPE
- 200mm (8") N12 ST PE DRAIN PIPE (BASIN FLOOR)
- 100mm (4") N12 ST PE DRAIN PIPE (CUT SLOPES)
- CUT/FILL TRANSITION

NOTES:

1. COORDINATE GRID IS UTM NAD83 ONE 12.
2. CONTOUR INTERVAL IS 1 METER.
3. DIMENSIONS AND ELEVATIONS ARE IN METERS, UNLESS NOTED OTHERWISE.
4. DRAIN TRENCHES WILL BE SLOPED TOWARDS OUTLET PIPE CONNECTION AT A MINIMUM GRADE OF 0.5 .
5. LAST 10m OF OUTLET PIPE WILL BE SOLID PIPE BACKFILLED WITH IMPERMEABLE MATERIAL.
6. OUTLET PIPE WILL EMPTY INTO A WEIR TO MEASURE PIPE FLOW.

SCALE A 40 20 0 40 80 120 160 200 m

TINTINA RESOURCES

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MEAGHER COUNTY, MT

FIGURE 3.26
CEMENTED TAILINGS FACILITY
FOUNDATION DRAIN SYSTEM

REV	DATE	DESCRIPTION	DESIGNED	DRAWN	REVIEWED	APPROVED
0	15OCT'15	ISSUED FOR MOP APPLICATION	GIM	NSD	KDE	KDE

REVISIONS

DRAWING BY KNIGHT PIESOLD: VA101-460/3

SOURCE FIGURE NUMBERS: C2004

REVISED DATE: OCTOBER 15,2015

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3.6.7.3 Embankment Cross-Sections

The CTF will have a single embankment to close off the east end of the impoundment, allowing for natural topographic containment to the west. The CTF will be constructed using a cut-fill balance, where excavated materials from impoundment shaping will provide the required storage capacity and fill material for the confining embankment.

The embankment will be a homogeneous rock fill embankment. The internal (upstream) slope of the embankment will be constructed at a 2.5H:1V slope to facilitate geomembrane placement. The external (downstream) slope will also be constructed at a 2.5H:1V slope to facilitate concurrent reclamation of the embankment during operations (Figure 3.28). The embankment crest width will be 33 feet (10 m) to allow working space for tailings and reclaim water pipelines and traffic. The maximum embankment height will be approximately 150 feet (46 m) for the Stage 2 crest at El. 5,900 feet (1799 m), while the height of Stage 1 bench will be approximately 100 feet (31 m) with the crest at El. 5,853 feet (1784 m).

The majority of the embankment fill will be general fill sourced from excavation as part of the CTF impoundment shaping. The material is expected to consist of fresh to moderately weathered rock fill with organics and loamy overburden material removed.

The geomembrane will be placed on a subgrade bedding material that will provide a protective layer between the geomembrane and natural ground or embankment fill materials. The subgrade bedding material will be primarily sourced from weathered bedrock and select fresh rock that meets the required material specifications. General rock fill will be processed as necessary to meet the material specifications. Non-woven geotextile fabric will be placed between the geomembrane and subgrade bedding. The CTF sections and details are shown on Figure 3.27.

3.6.7.4 CTF Embankment Freeboard

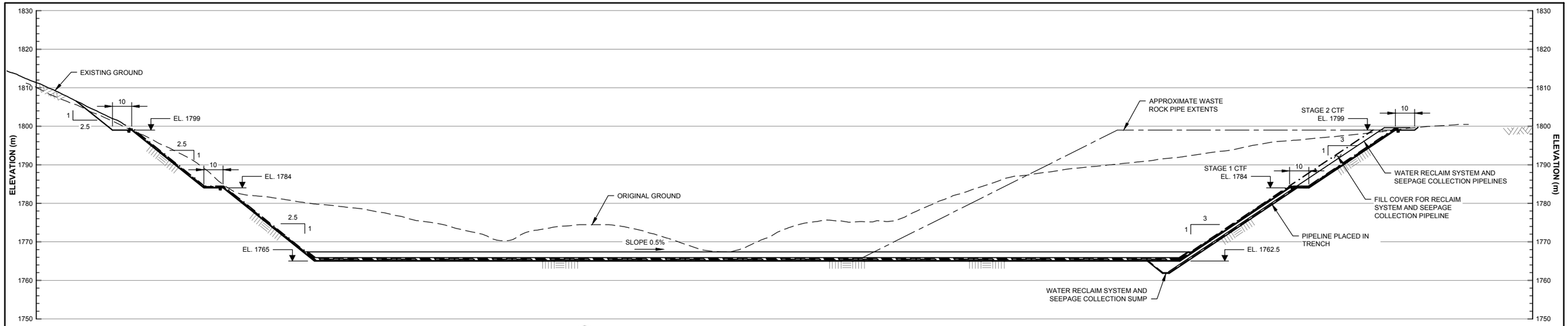
Tailings will be deposited strategically from the embankment and southern basin perimeter (Figure 3.23). The CTF will be maintained with a little or no pond (often with small volumes of water stored only in the footprint [130 x 160 feet; 40 x 50 m] of the sloping sump). The tailings surface will be developed to direct surface water towards the wet well sump and pump system (Figure 3.24).

Under these conditions, sufficient storage capacity will be available to contain all surface tailings, waste rock, runoff, and precipitation (up to and including the design storm event) while maintaining a minimum freeboard of 6.6 feet (2 m). Construction will be staged such that the minimum freeboard requirement is maintained, even during the design storm event.

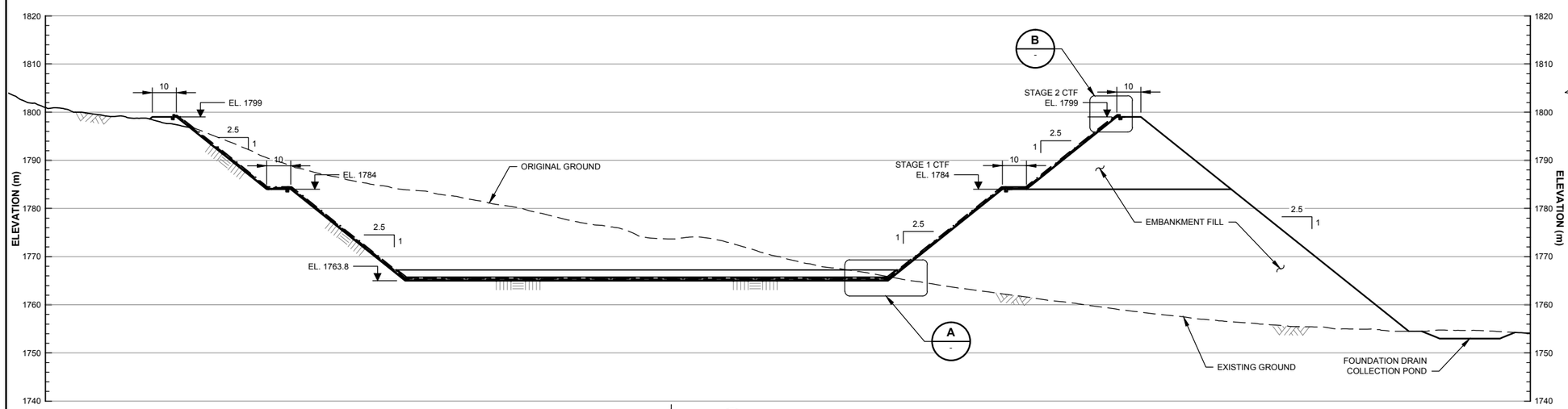
3.6.7.5 CTF Basin Drain System

An internal basin drain (Figure 3.29) will be installed in the CTF (above the geomembrane) using waste rock generated from the mine during the pre-production phase. It will be connected to the wet well sump and pump system located in the CTF. The basin drain system will collect tailings bleed water and any water that percolates through the tailings mass, and convey it to the water reclaim system to be pumped to the PWP (Figure 3.23). This will facilitate a low phreatic level within the tailings mass and will reduce the head on the geomembrane. This is an effective measure to minimize potential seepage through defects that may be present in the geomembrane.

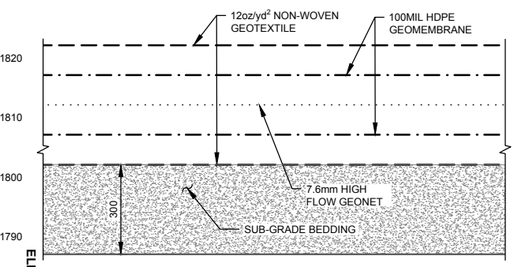
The basin drain system will be constructed using processed waste rock, which will be crushed to meet the material specifications necessary to promote free drainage. The CTF basin floor will be graded at a minimum of 0.5% towards the wet well sump. The processed waste rock will be placed over the HDPE geomembrane across the entire basin floor to create a full underdrain.



1 C2001 **SECTION**
HORIZONTAL: SCALE A
VERTICAL: SCALE B



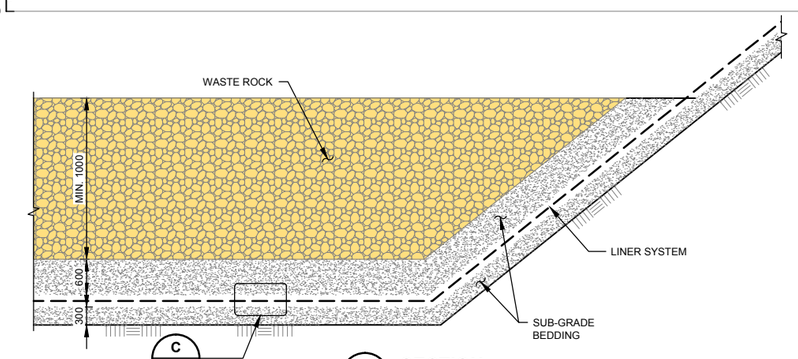
2 C2001 **SECTION**
HORIZONTAL: SCALE A
VERTICAL: SCALE B



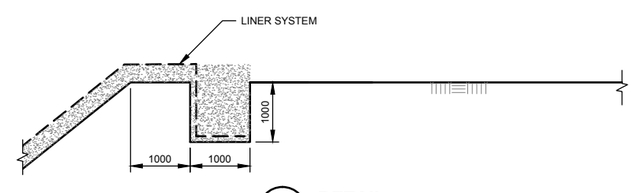
C - **DETAIL**
LINER SYSTEM DETAILS
SCALE D

NOTES:

1. DIMENSIONS AND ELEVATIONS ARE IN METERS, UNLESS NOTED OTHERWISE.
2. BASIN UNDERDRAIN THICKNESS BASED ON AVAILABLE FILL MATERIAL



A - **SECTION**
BASIN UNDER DRAIN
SCALE C



B - **DETAIL**
ANCHOR TRENCH DETAIL
SCALE C

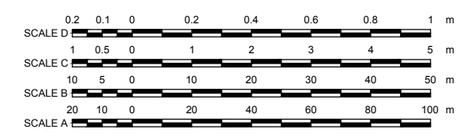


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FIGURE 3.27
CEMENTED TAILINGS FACILITY SECTIONS AND DETAILS

REV	DATE	DESCRIPTION	DESIGNED	DRAWN	REVIEWED	APPROVED
0	15OCT'15	ISSUED FOR MOP APPLICATION	GIM	NSD	KDE	KDE

REVISIONS

REVISED DATE: OCTOBER 15, 2015

REVISION 0

DRAWING BY KNIGHT PIESOLD: VA101-460/3

SOURCE FIGURE NUMBERS: C2003

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

3.6.7.6 Embankment Staging

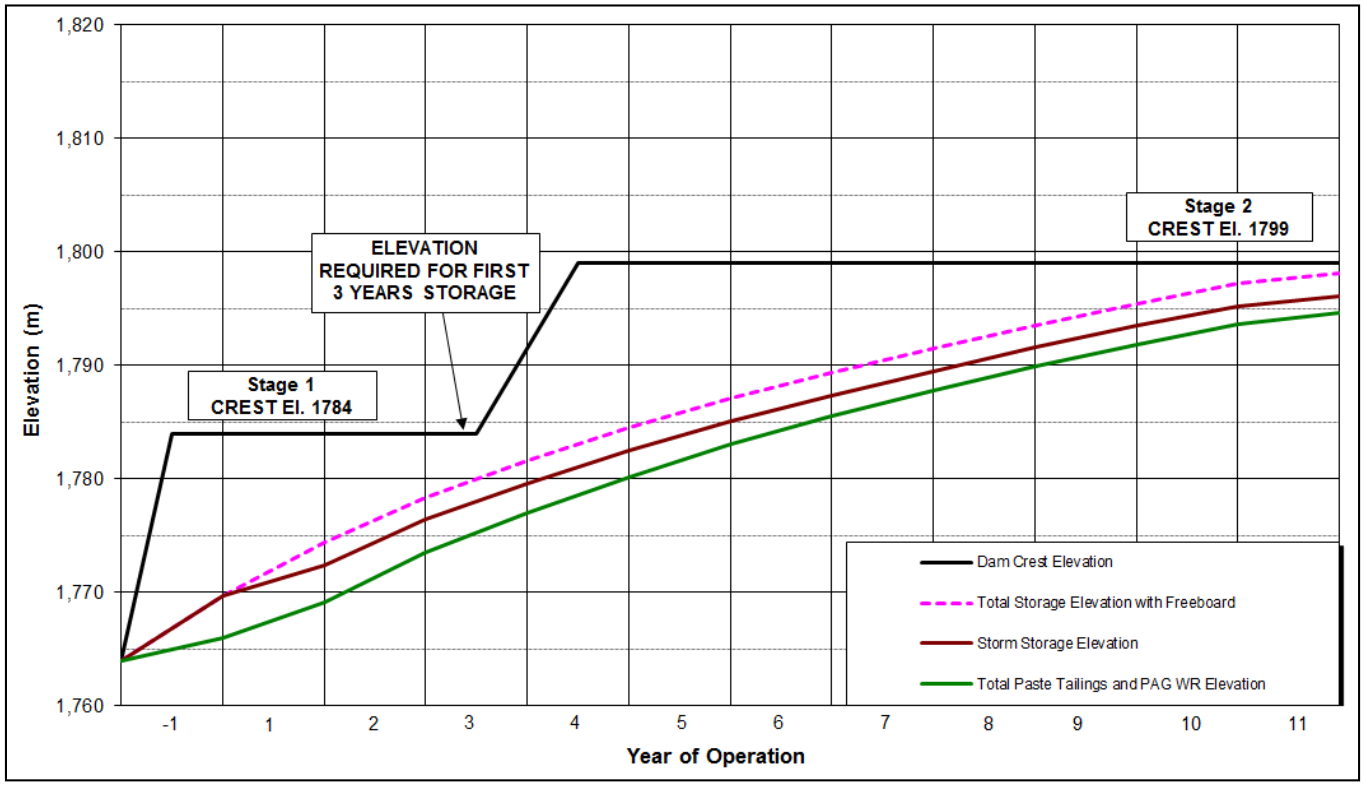
The CTF will be developed in two stages throughout the life of the mine (Figure 3.28). Stage 1 will be constructed to El. 1784 m prior to commencement of milling operations. This will provide storage for 3 years of surface tailings deposition and waste rock placement. It is anticipated that a surplus of fill material will be available at the completion of the Stage 1 construction phase. This excess material will be placed and compacted on the CTF embankment in preparation for the Stage 2 construction to El. 1799 m.

Construction of Stage 2 will occur during years 3 to 4. All remaining stripping and grubbing, excavation, and fill placement will occur during this time, as well as the installation of the liner system to the ultimate crest elevation of El. 1799 m.

The preliminary filling schedule and embankment stages are shown on cross-section Figure 3.28. The filling schedule and timing for staged expansions will be reviewed on an on-going basis during operations. The actual rate of filling may vary, depending upon a variety of operating factors including:

- Mill throughput
- Settled tailings density
- tailings surface slopes

Figure 3.28. CTF Filling Schedule and Embankment Construction Stages



NOTES:

1. Filling schedule based on PEA production schedule from AMEC and includes storage of 55% total tailings and 1.7 Mt of waste rock.
2. Storm storage volume is estimated on the basis of containing a PMF event.
3. Freeboard considerations are assumed to be 2 m.

3.6.7.7 CTF Lining System and Seepage Control

The CTF will be fully lined with a double liner system that consists of a layer of 0.3 inch (7.6 mm) high-flow geonet sandwiched between layers of 0.1 inch (100 mil) HDPE geomembrane (Figure 3.27). The HDPE liner system will be placed upon the upstream embankment face. The entire CTF basin will be covered with an underlying prepared subgrade comprising processed material obtained from impoundment shaping.

The seepage control measures incorporated into the CTF are as follows:

- Two layers of 0.1 inch (100 mil) HDPE geomembrane encompassing a layer of high-flow geonet will cover the entire CTF basin and upstream face of the embankment. The geomembrane is intended to be impermeable, with seepage only possible through defects that may occur during fabrication and/or installation. Any seepage through the upper geomembrane will be collected and transferred to a seepage collection sump and pump system at the north end of the embankment.
- The cemented tailings will be comprised of very fine-grained clay sized particles (100 % less than 0.001 inches or 30 microns, and 80% smaller than 0.0003 inches or 10 microns) with very low permeability. The hydraulic conductivity will be on the order of $3x10^{-9}$ m/sec (flow rate of about 3 billionths of a foot per second based on laboratory testing (AMEC, 2015). The tailings are highly thickened prior to deposition, and it is expected that most of the remaining interstitial water will remain trapped in the tailings, with limited bleed water.
- A basin underdrain will be constructed above the geomembrane (Figure 3.29) to maintain low head on the geomembrane, thereby minimizing the potential for seepage.
- Little water will collect in the facility. There will be a small or more likely no surface pond and the facility will often have only small volumes of water stored in the footprint (130 x 160 feet; 40 x 50m) of the sloping sump. Runoff, precipitation and limited bleed water from the tailings will be directed to a water reclaim system within the impoundment. Water from the reclaim system will be pumped to the PWP for storage and mill use.
- As described above, a foundation drain system will be constructed to collect groundwater and potential seepage flow beneath the geomembrane.

3.6.7.8 CTF Seepage Reclaim Sump

The purpose of the seepage reclaim system is to collect any seepage through the upper HDPE geomembrane and direct it through the geonet, via gravity, to a sump and pump system at a low point in the CTF basin. Water collected in the sump (Figure 3.29) will be pumped through a riser pipe to the embankment crest and to the PWP. An underlying subgrade layer will be installed to protect the lining system.

The seepage reclaim system between the HDPE geomembrane layers (Figure 3.27) will consist of a sump filled with drainage gravel deep enough to allow the effective operation of a submersible pump that can be raised and lowered through a protective pipe. The bottom of the pipe will be perforated (in the sump) for pump operation. An additional drain pipe will be included for redundancy. The pump will have a high/low water level primer to control pumping (switched on when the water level reaches a high water mark and switch off when the water level reaches the low water mark).

Potential seepage through the lower geomembrane will be intercepted by the CTF Foundation Drain System (Figure 3.26).

3.6.7.9 CTF Water Reclaim System

The CTF will be operated with a small or more often no pond. Water will be temporarily ponded following only major storm events. The basin underdrain will convey what little water percolates through the tailings mass to the wet well sump and reclaim system, while surface water run-off from precipitation events will report directly to the sump system. The reclaim pumps will be operated on an as-needed basis to transfer all collected water from the CTF to the PWP for mill use. Minor amounts of sediment may be transferred from the CTF to the PWP. Process water stored in the PWP will be monitored on a regular basis to ensure that adequate clarification of water is taking place prior to recycling for mill use.

The water reclaim system consists of a basin drain connected to a wet well sump that extends to surface. The CTF basin underdrain system will be integrated with the basin drain and wet well sump to promote flow to the sump.

The water reclaim system serves two purposes:

- To allow the removal of water that may be released from the cemented tailings (only small amounts of bleed water is expected) and conveyed to the reclaim system by the basin underdrain.
- To allow the collection and removal of precipitation and runoff (surface water) in the CTF.

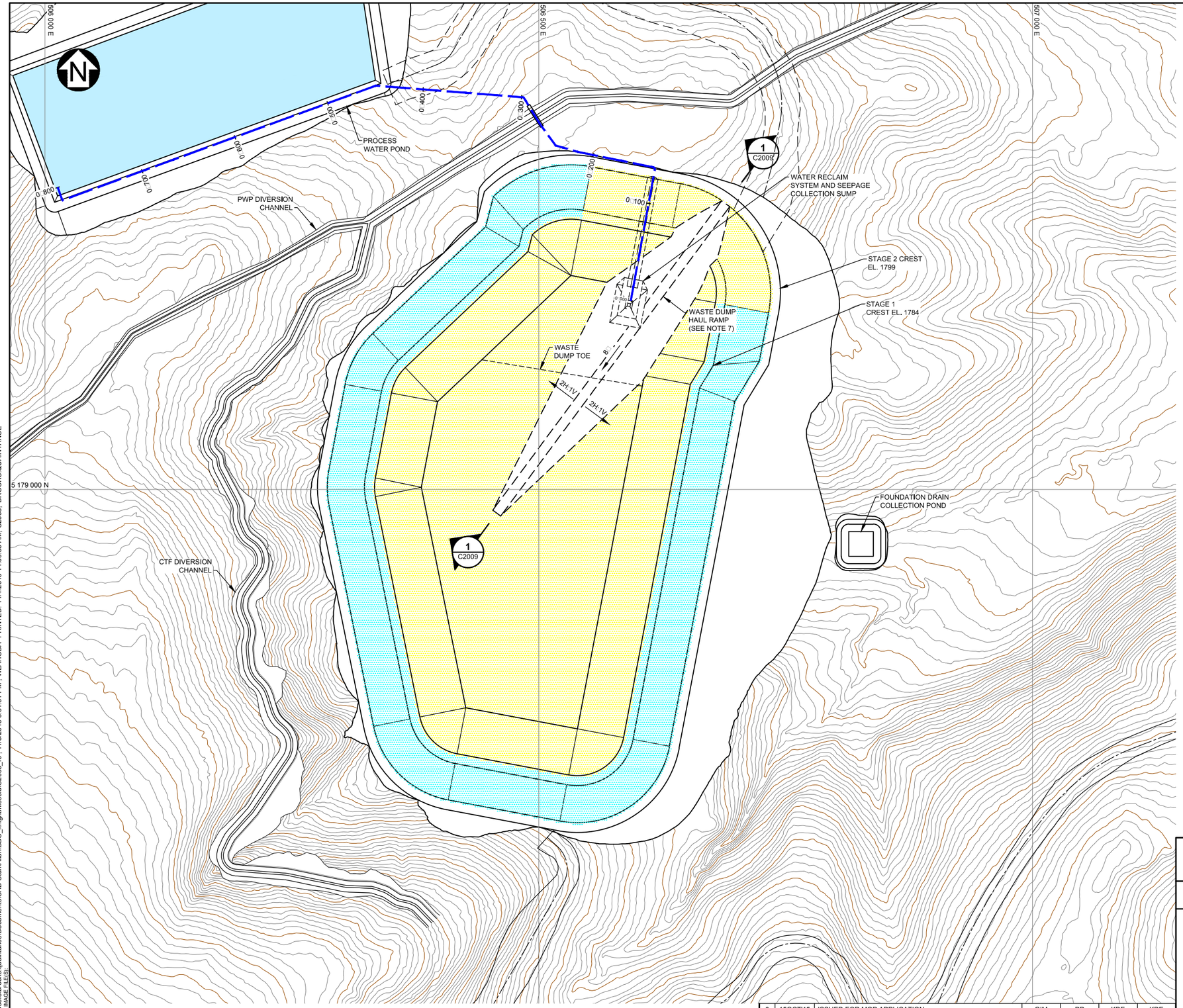
The basin drain comprises a lined trench filled with drainage gravel and a drain pipe that will be connected to the wet well sump in the low point of the CTF (Figure 3.29). The sump will be filled with drainage gravel and will be deep enough to allow the effective operation of a submersible pump that can be raised and lowered through a protective pipe. The drainage gravel will be covered with a layer of filter sand that will prevent migration of tailings fines into the drainage gravel.

The bottom of the pipe will be perforated (in the sump) for pump operation. The pipe will extend in a channel on the embankment face to the embankment crest, and will be surrounded by a layer of drainage gravel to allow water infiltration into the system. An additional drain pipe will be included for redundancy. The drainage gravel will be surrounded by suitable fill material sourced from excavation of the impoundment. Bedding layer material will be placed to protect the geomembrane. The internal slope of the CTF will be reduced to 3H:1V at the sump location to facilitate the placement of drainage gravel and bedding fill material.

Crushed waste rock will be used to construct the wet well sump and basin drain such that they will be free draining. The wet well pump will have a high/low water level primer to switch on when the water level in the sump reaches the high water level mark, and switch off when the water level reaches the low water level mark. The system has been designed to pump out a 1 in 100 year 24-hr rainfall event over a period of 10 days (approximately 5.3 gallons per second (300 gpm; 20 L/s) through a HDPE pipeline to the southeast corner of the PWP (a pipeline length of approximately 2,400 feet [730 m]).

3.6.7.1 CTF tailings Delivery System

Tailings will be delivered at approximately 79% solids content (by weight) via pump and pipeline from the mill to the south end of the CTF (Figure 3.33) via an 8-inch (20.3 cm) PN150 steel pipeline. The pipeline will run along the west crest of the impoundment, and discharge tailings at the southernmost point of the CTF. The pipeline will be double-walled between the mill site and the CTF to capture and contain tailings in the event of the pipeline leak. Double walled pipe will not be required on the CTF crest as tailings will flow into the CTF in the event of a leak. The pipeline will have an internal HDPE liner to prevent corrosion.



LEGEND:

- STAGE 1 LINER SYSTEM
- STAGE 2 LINER SYSTEM

NOTES:

1. COORDINATE GRID IS UTM NAD83 ZONE 12.
2. PLAN BASED ON INFORMATION PROVIDED BY TINTINA RESOURCES INC., DATED (FEB 03, 2011).
3. CONTOUR INTERVAL IS 1 METER.
4. DIMENSIONS AND ELEVATIONS ARE IN METERS, UNLESS NOTED OTHERWISE.
5. WASTE ROCK WILL BE PLACED AROUND WATER RECLAIM SYSTEM AND SEEPAGE COLLECTION SUMP IN SUCH A MANNER AS TO PREVENT INUNDATION OF THE RECLAIM SYSTEM BY TAILINGS
6. WASTE ROCK WILL BE PLACED OR SIDE CAST OFF HAUL RAMP AS NEEDED.
7. HAUL RAMP WILL BE CONSTRUCTED USING SURPLUS FILL FROM CTF EXCAVATION DETAILS TO BE FINALIZED WITH MINE OPERATOR.

SCALE A: 40 20 0 40 80 120 160 200 m

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MINE OPERATING PERMIT APPLICATION

MEAGHER COUNTY, MT

FIGURE 3.29
CEMENTED TAILINGS FACILITY
BASIN DRAIN AND SUMP

REV	DATE	DESCRIPTION	DESIGNED	DRAWN	REVIEWED	APPROVED
0	15OCT'15	ISSUED FOR MOP APPLICATION	GIM	PP	KDE	KDE

REVISIONS

REVISED DATE: OCTOBER 15, 2015

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DRAWING BY KNIGHT PIESOLD: VA101-460/3

SOURCE FIGURE NUMBERS: C2008

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Tailings will be deposited using spigot offtakes positioned at the southern end of the CTF. Northward sloping beaches will be developed through selective spigot placement over the life of the mine that will direct surface water following precipitation events towards the wet well sump at the north end of the facility. The formation of permanent ponds on the surface of the CTF facility are not anticipated.

Details of the tailings delivery system are shown on Drawings C6100 to C6120 in Appendix K (Knight-Piésold, 2015d).

The Project will be operating in freezing temperatures for a significant portion of each year. The pipeline will be insulated or het traced to protect against freezing. Additionally, the pipeline will be flushed with water and drained when not in use so that no standing water or tailings are left in the pipeline to freeze or set up.

3.6.7.2 CTF Waste Rock Co-disposal during Operations

Waste rock will be delivered to and stored within the CTF during operations and integrated with the basin drain and reclaim system. Waste rock generated throughout the life of the mine will be placed in the CTF around the water reclaim system, which will promote drainage into the reclaim sump. A ramp will be constructed into the basin of the CTF, so that waste rock can be hauled into the impoundment by haul trucks and spread with a dozer.

Waste rock will be generated throughout the life of the mine. The truck ramp into the CTF basin will be maintained to facilitate waste rock placement. The waste rock will extend up the slopes of the CTF basin. Subgrade material made from processed waste rock will be placed on the geomembrane prior to waste rock deposition to protect the liner system. The waste rock placement will be staged such that the working surface and water reclaim system will not become inundated by tailings deposition.

3.6.7.3 Tailings Management Alternative Selection

A total of four different alternative locations were reviewed for the location of the CTF. One was eliminated because of its location in the Butte Creek drainage, and its inability to contain the entire volume of tailings in one facility. Two others were eliminated principally because of their impacts to wetlands (5 and 11 acres each, 2.0 and 4.5 HA, respectively). Appendix Q presents an analysis of alternatives examined and the selection process for facility locations and tailings disposal options.

3.6.8 Non-Contact Water Reservoir (NCWR)

3.6.8.1 NCWR and Water Rights

To obtain an appropriation permit, Tintina is required to develop a mitigation plan to address depletion to surface water flows associated with the consumptive use of groundwater in its operations and submit that plan to DNRC for approval. For planning purposes, Tintina has included a Non-Contact Water Reservoir (NCWR) (Figure 1.3) as part of the Project facilities as a potential option for storing water for mitigation purposes. This reservoir could be filled using water rights during the irrigation period of the year, to off-set consumptive use during the non-irrigation months of the year. However, the consumptive use value reported above is an estimate. In addition, Tintina has yet to submit a draft mitigation plan to DNRC for their approval and it is not known how much depletion the DNRC will determine needs to be mitigated. The resolution of these issues will determine whether the final mitigation plan (and therefore the final construction plan) will include the NCWR.

The NCWR as illustrated on Figure 3.30 has a disturbance footprint of 7.6 acres (3.0 ha). However, a mitigation plan has not been developed or submitted to DNRC for their approval. It is unknown if the NCWR will be included in the final mitigation plan and therefore the final construction plan.

3.6.8.2 NCWR Overview

The NCWR (Figure 3.31) has a design capacity of 470,862 cubic yards (360,000 m^3) of water. At full capacity, the reservoir will flood approximately 17 acres (6.9 ha) which includes approximately 0.95 acres (0.38 ha) of wetlands. It is anticipated that water stored in this reservoir will be allowed to seep from the reservoir floor to the downstream catchment as required. Existing surface flows will be diverted around the NCWR. If water is diverted to the reservoir for storage, it will be delivered by a pipeline discharging into the NCWR from the embankment crest onto a geomembrane liner on the upstream embankment face. A protective layer of HDPE geomembrane (rub sheet) will be placed at the discharge point to protect the geomembrane.

3.6.8.3 NCWR Embankment Fill Zones

The NCWR embankment will be constructed with general fill material sourced from the impoundment shaping of the CTF. The embankment (Figure 3.32) will be a homogeneous rock fill embankment. Aside from topsoil/subsoil removal within the embankment footprint, no impoundment shaping will be completed for the NCWR because the basin will remain an unlined facility. The total area of surface disturbance required by the embankment will be 4.7 acres (1.9 ha). The upstream face of the embankment will be lined with an HDPE geomembrane to reduce seepage. The upstream and downstream faces of the embankment will be constructed to a 2.5H:1V slope to facilitate geomembrane placement and reclamation. The height of the embankment will be 47.6 feet (14.5 m) at an elevation of 5,858 feet (1776.5 m), and the crest of the embankment will be 32-feet (10 m) wide to accommodate traffic and pipelines. The toe of the geomembrane will be tied into dense natural ground by an anchor trench.

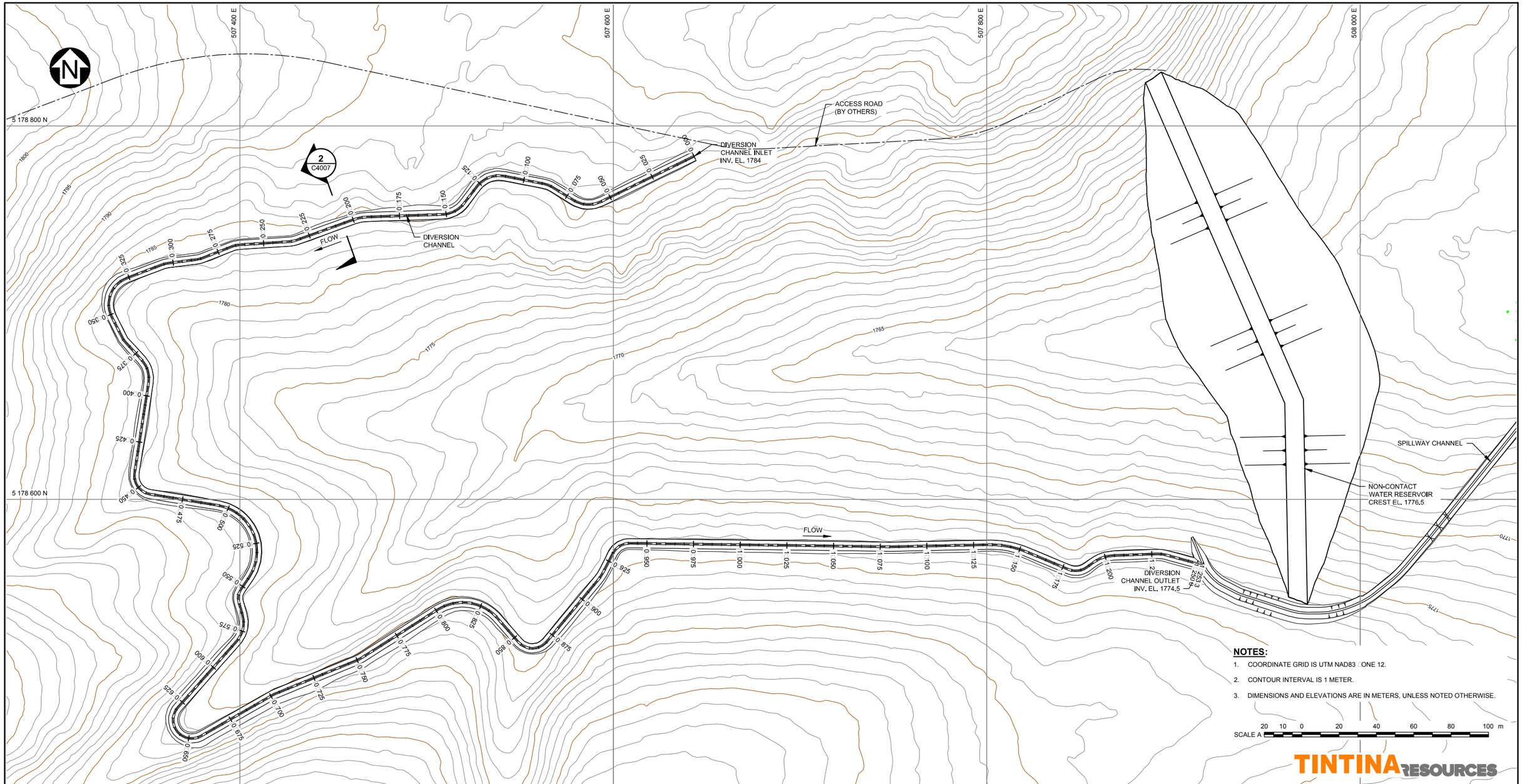
3.6.8.4 NCWR Spillway Configuration

The consequence of NCWR failure is less than the other mine dam facilities at the Project site. A spillway is included to prevent overtopping of the embankment and safely route the design storm event through the NCWR, and discharge it to the wetlands downstream (as it will were the NCWR not there) (Figure 3.33). The spillway is sized for the 1 in 200 year 24 hour storm. HydroCAD, (a storm water modeling platform), was used to model the contributing area in order to estimate the peak instantaneous discharge associated with the 1 in 200 year storm event that will report to the spillway. The facility was conservatively modeled as full to the invert elevation of the spillway at the start of the storm.

The spillway will be constructed on the south side of the facility in the natural topography of the abutment, as shown on (Figure 3.33). The invert elevation will be 5,826 feet (1776 m), which will be 6.6 feet (2 m) below the embankment crest elevation of 5828 feet (1776.5 m). The maximum water level during the design storm event will be 5,822 feet (1774.7 m), allowing 6 feet (1.8 m) of freeboard in the spillway. The outlet geometry will be a trapezoidal weir with a base width of 6.5 feet (2 m), maximum depth of 6.5 feet (2 m), and side slopes of 2H:1V, as shown on (Figure 3.33). The weir transitions into a trapezoidal channel with a base width of 3.2 feet (1 m) and depth of 3.2 feet (1 m). The trapezoidal channel discharges into the natural channel downstream of the NCWR embankment. The spillway will be predominantly cut in rock and will be lined with riprap to prevent erosion of the channel bed during high flows.

3.6.8.1 NCWR Seepage and Discharge Management

Seepage rates from the NCWR are anticipated to be approximately 26 to 68 gpm (1.7 to 4.3 L/s) (approx. 81,820 gallons per day; 372,000 L/day; 372 m^3/day) when the NCWR is at full capacity. The average seepage rate will be lower as the NCWR drains and the head on the ground decreases.



NOTES:

1. COORDINATE GRID IS UTM NAD83 ZONE 12.
2. CONTOUR INTERVAL IS 1 METER.
3. DIMENSIONS AND ELEVATIONS ARE IN METERS, UNLESS NOTED OTHERWISE.

SCALE A 20 10 0 20 40 60 80 100 m

TINTINA RESOURCES

BLACK BUTTE COPPER PROJECT

MEAGHER COUNTY, MT

FIGURE 3.30
NON-CONTACT WATER RESERVOIR PLAN MAP WITH DIVERSION CHANNEL

REV	DATE	DESCRIPTION	DESIGNED	DRAWN	REVIEWED	APPROVED
0	15OCT'15	ISSUED FOR MOP APPLICATION	MH	NSD		

REVISIONS

REVISED DATE: OCTOBER 15, 2015

REVISION 0

DRAWING BY KNIGHT PIESOLD: VA101-460/3

SOURCE FIGURE NUMBERS: C4006

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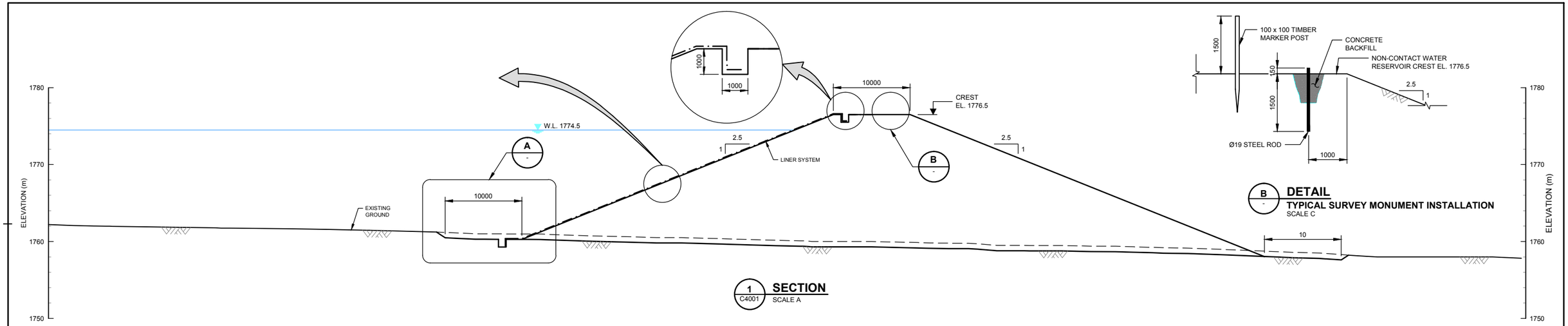

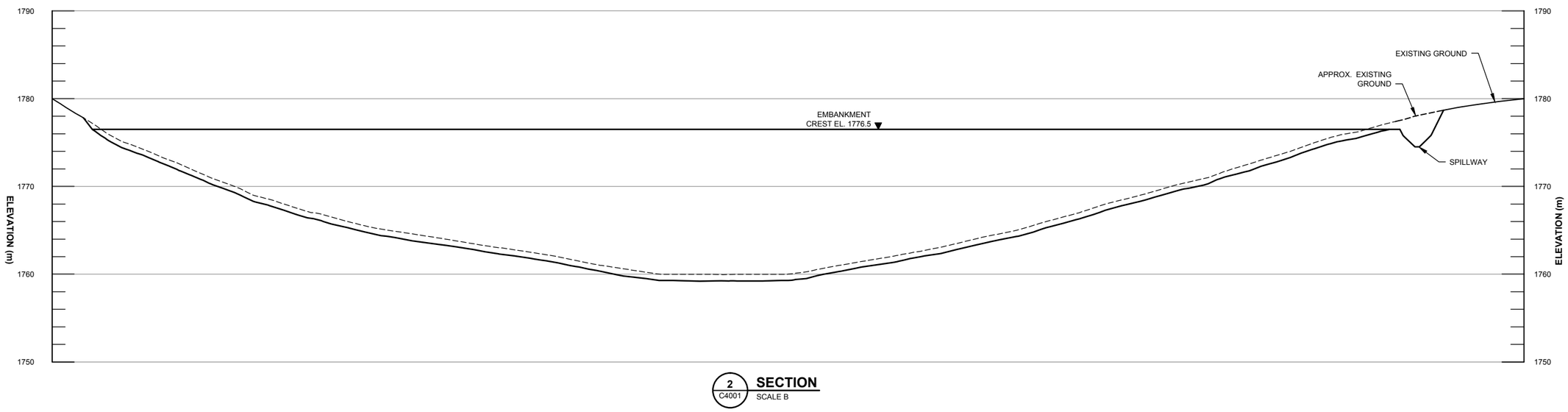

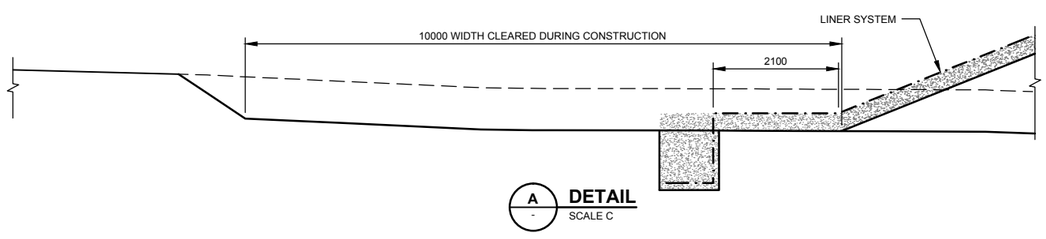

NOTES:

1. DIMENSIONS AND ELEVATIONS ARE IN METERS, UNLESS NOTED OTHERWISE.
2. TOPSOIL AND SUB-SOIL TO BE STRIPPED FROM EMBANKMENT FOOTPRINT.

SCALE C: 1 0.5 0 1 2 3 4 5 m
SCALE B: 10 5 0 10 20 30 40 50 m
SCALE A: 5 2.5 0 5 10 15 20 25 m

TINTINA RESOURCES

BLACK BUTTE COPPER PROJECT M

MEAGHER COUNTY, MT

FIGURE 3.31
NON-CONTACT WATER RESERVOIR
CROSS-SECTIONS

REV	DATE	DESCRIPTION	DESIGNED	DRAWN	REVIEWED	APPROVED
0	15OCT'15	ISSUED FOR MOP APPLICATION	GIM	NSD	KDE	KDE

REVISIONS

REVISED DATE: OCTOBER 15, 2015

REVISION 0

DRAWING BY KNIGHT PIESOLD: VA101-460/3

SOURCE FIGURE NUMBERS: C4003

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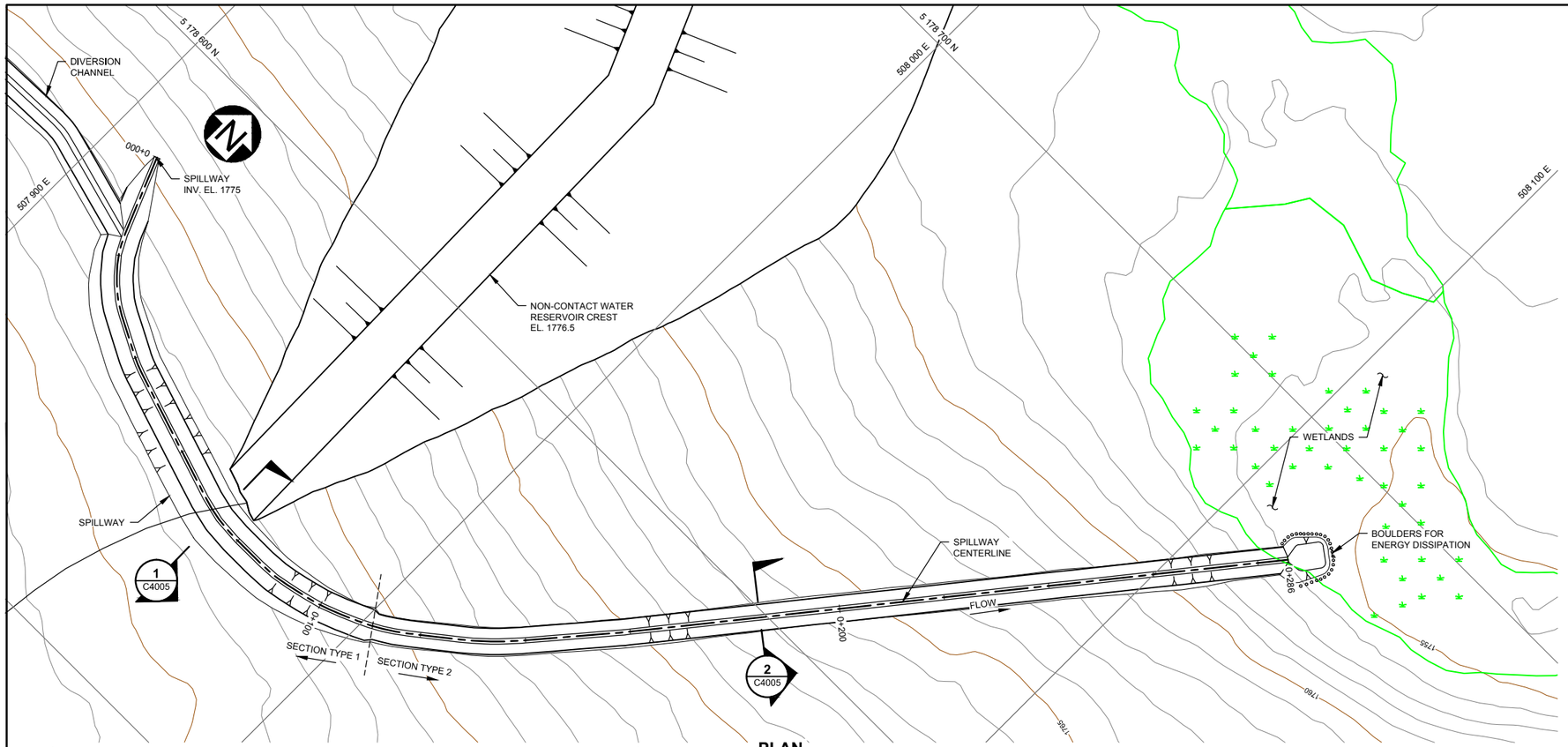
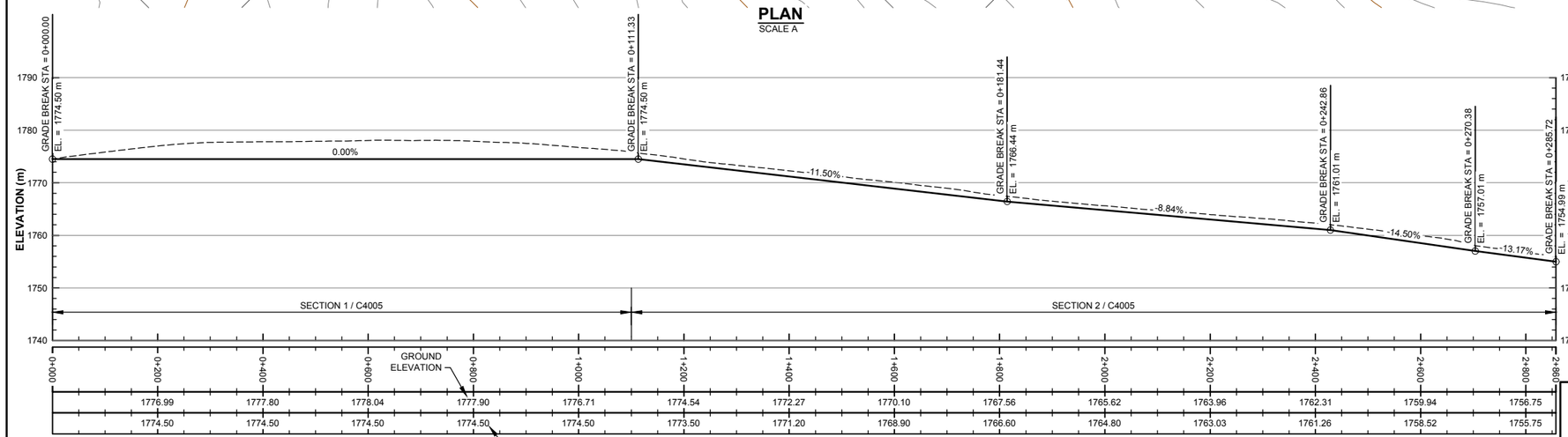


PLAN
SCALE A



1 PROFILE ALONG SPILLWAY
SCALE A

NOTES:

1. COORDINATE GRID IS UTM NAD83 ZONE 12.
2. CONTOUR INTERVAL IS 1 METER.
3. DIMENSIONS AND ELEVATIONS ARE IN METERS, UNLESS NOTED OTHERWISE.

SCALE A 10 5 0 10 20 30 40 50 m

TINTINA RESOURCES

BLACK BUTTE COPPER PROJECT

MEAGHER COUNTY, MT

FIGURE 3.32
NON-CONTACT WATER RESERVOIR
SPILLWAY CHANNEL
PLAN MAP AND SECTION

REV	DATE	DESCRIPTION	DESIGNED	DRAWN	REVIEWED	APPROVED
0	15OCT'15	ISSUED FOR MOP APPLICATION	MH	NSD	KDE	KDE

REVISIONS

REVISED DATE: OCTOBER 15, 2015

REVISION 0

DRAWING BY KNIGHT PIESOLD: VA101-460/3

SOURCE FIGURE NUMBERS: C4004

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If the NCWR were to be used for storing water for mitigation purposes water could be allowed to leak or be pumped from the facility on an annual basis, as required to offset mine site consumptive water use during periods of lower-precipitation. A pump will be located on a pad on the crest of the NCWR (adjacent to the spillway) and will draw water from the base of the reservoir and discharge into the spillway. Under these circumstances, the rate of seepage from the NCWR will be monitored based on pond elevation, and pumping rates will be adjusted as needed to ensure that the required volume of water discharged from the NCWR on a monthly basis.

3.6.8.2 Basin Run-off Diversion

Runoff into the NCWR basin will be diverted around the facility and discharged. A diversion ditch (Figure 3.31) will be constructed to direct surface flows around the south side of the NCWR. The diversion channel will connect to the NCWR spillway, and water flow will discharge directly upstream of and be allowed to infiltrate prior to entering the downstream wetlands.

3.6.8.3 NCWR Alternative Locations Evaluated

Six alternative locations were evaluated for the NCWR prior to selection of the final facility location. Largely the final selection process was influenced by impacts to wetlands. Appendix Q presents an analysis of alternatives examined and the selection process for facility locations and tailings disposal options.

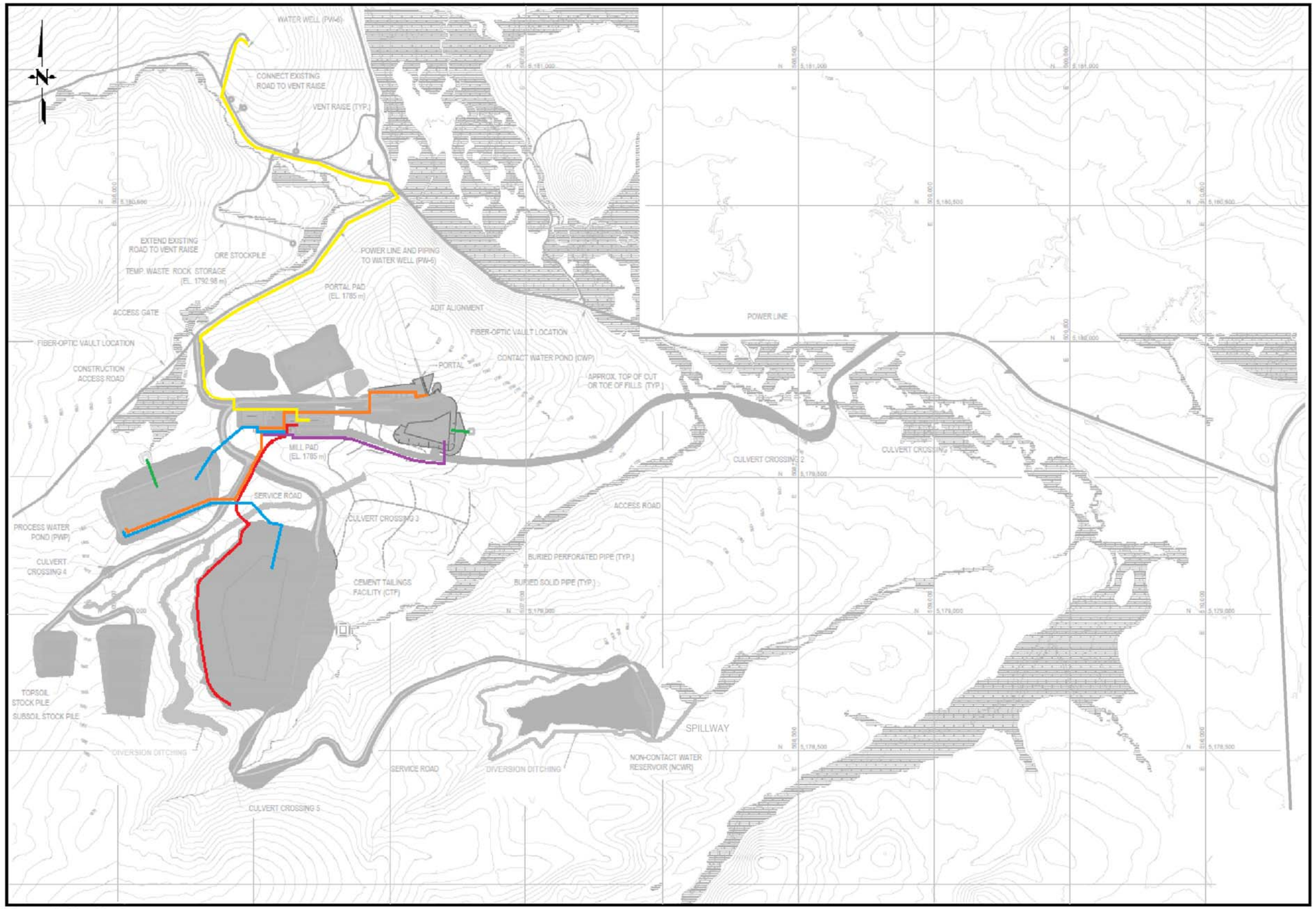
3.6.9 Stockpiles

The total amount of soil to be harvested from all construction facility disturbance areas will be approximately 696,000 cubic yards (532,148 m^3). Approximately, a third 194,700 cubic yards (141,231m^3) will be topsoil, and the remaining 501,300 cubic yards (390,900 m^3) will be subsoil. A swell factor of 12% was used for stockpiled soils. This material will be removed from proposed disturbance areas prior to construction and will be stored in separate topsoil and subsoil stockpiles of 5.9 and 13.9 acres respectively. Soil stockpiles will be located south of the PWP and west of the CTF (Figure 1.3). The amount of subsoil removed will be limited to that required by excavations for the specific facility. These stockpiles will be surrounded by silt fences at their bases. They will be graded and re-vegetated using an approved seed mixture (Section 7.2.5) to reduce soil and moisture loss, minimize erosion from water and wind, and minimize weed invasion. Additional downstream silt fences will be installed if necessary to prevent release of sediment to the environment.

A 7.04 acre (2.85 ha) excess excavation material stockpile will be constructed to the west of the temporary WRS facility (Figure 1.3). This material (approximately 170,000 cubic yards, 130,000 m^3) will largely come from the WRS basin excavation and will be used in year two or three to reclaim the WRS facility (see Section 3.6.4), after all waste rock is removed to the CTF.

3.6.10 Pipelines

A number of pipelines will be constructed as described in the individual facilities sections. A map of pipelines excluding the underground infiltration gallery lines (which are shown on Figure 1.3) is shown on Figure 3.34. Lengths of surface disturbances associated with pipelines are tabulated on the acreage table (Table 3-12). Widths of surface disturbance for buried pipelines are generally estimated at 20 feet (6 m). The pipelines will be re-contoured and reseeded shortly after burial.



Prepared by Tetra Tech Inc.

LEGEND

- CTF SYSTEM
- RECLAIM SYSTEM
- FOUNDATION DRAIN SYSTEM
- FRESH WATER SYSTEM
- MINE DEWATERING SYSTEM

TINTINA RESOURCES

Figure 3.33
Pipeline Plan Map
Black Butte Copper Project
Mine Operating Permit Application
Meagher County, Montana

3.6.11 Equipment and Contract Manpower Required for Support Facility Construction

Surface support facility construction by a subcontractor will take place in years 1 through 3. It will require the following types and amount of equipment (Table 3-19).

Table 3-19. Surface Facility Construction Equipment List

Surface Facility Construction Equipment	Total
Trucks, Vans	**32**
Bus, 35 Passenger	**4**
Air Compressor c/w Air Receiver	**5**
Bobcat c/w sanding unit T750	**1**
Concrete Trucks	**2**
Crane, 90 Ton RT, man basket	**2**
Haul Trucks	**9**
Excavators	**5**
Dozers	**4**
Fuel Tank (Double Wall) Ltr's TBD	**6**
Drill	**4**
Grader Cat 14G	**4**
Power Generators, small	**4**
Power Generators (diesel) 500 kw	**4**
Heater, Frost Fighter 350,000 BTU	**7**
Light Plant 8 KW	**11**
Loader c/w Bucket & Forks Cat 950	**7**
Man lift, Articulating 85'	**7**
Packer, Drum	**3**
Rectifier, Welder c/w 250' Cable, S & G	**4**
Scissor Lift, Man lift	**12**
Temporary power skids	**9**
Tool Crib, Architectural, Elec, Mech.	**6**
Water Truck	**2**
Welder, Diesel c/w Trailer, 250' Cable, S & G	**6**
Zoom-Booms	**6**
Office Trailers	**8**
Wash Cars	**5**
Cold Storage/Shop (Sprung Structures) 50' x 100'	**1**
Ambulance	**1**
Spill Response Vehicle	**1**
Security (SUV)	**1**

The number of subcontracted personnel required on-site for surface support facility construction is estimated to reach a maximum of about 144 during the second year of the three-year construction period.

Note that on Table 3-20 although the total number of subcontractor employees averages about 144 for the three year facility construction period, that only an average of 74 (maximum 107) will be on-site at any given time (as others are on their day's off). This total number of contact employees includes 24 mining subcontractor employees that will work on site underground for the first four years (including the first two years of preproduction mining), principally mining primary and secondary development workings to access the copper-enriched rock.

Table 3-20. Facility Construction Manpower

Activities		Construction Manpower											
	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12
SURFACE EARTHWORKS												
Onsite	23	28	29	29	39	34	24	14	10			
Offsite	5	9	9	9	13	13	8	5	3			
Sub Total	**28**	**37**	**38**	**38**	**52**	**47**	**32**	**19**	**13**			
Mining												
Onsite	16	16	16	24	30	30	30	30	30	24	20	20
Offsite	5	5	5	8	10	10	10	10	10	8	6	6
Sub Total	**21**	**21**	**21**	**32**	**40**	**40**	**40**	**40**	**40**	**32**	**26**	**26**
Surface Construction												
Onsite						20	29	42	57	57	43	29
Offsite						7	9	14	19	19	14	10
Sub Total						**27**	**38**	**56**	**76**	**76**	**57**	**39**
Tintina Personel												
Owner/Mgmt	5	5	5	5	5	10	10	10	10	10	10	10
Aux. (first aid, security etc.)	5	5	5	5	5	5	5	5	5	5	5	5
Sub Total	**10**	**10**	**10**	**10**	**10**	**15**	**15**	**15**	**15**	**15**	**15**	**15**
Construction Total Onsite	**44**	**49**	**50**	**58**	**74**	**94**	**93**	**96**	**107**	**91**	**73**	**59**
Construction Total Roll	**59**	**68**	**69**	**80**	**102**	**129**	**125**	**130**	**144**	**123**	**98**	**80**

3.7 Water Management

3.7.1 Water Supply

Three separate water supply systems consisting of a process water supply, fresh water supply, and potable water supply will required for the Project. Supply tanks will be located on the east side of the mill building as illustrated on Figure 3.6. Recycled water from the PWP to the process water tank will be the primary mill water source. Additional water will be provided by dewatering the mine, and from the WTP. Fresh water (from the fresh/fire water tank) will be obtained from the WTP and will be used for other milling purposes. Potable water (from the potable water tank) will be sourced from a public water supply well (PW-6; Figure 1.3), and will be treated as necessary for human consumption. Potable water will also be used for pump gland lubrication.

3.7.1.1 Potable Water Supply

Tintina will supply potable water to the Project for drinking water, showers, and restroom facilities. The average potable water needs for the Project are 3,750 gallons (14,200 L/day) per day (2.6 gpm, 10 L/min) (see Section 3.8.10). Tintina is proposing to either use the PW-6N test well (Figure 1.3) for their Public Water Supply (PWS) well, or to instead use it as a test well for permitting and to drill a new well in the vicinity. Initial water quality samples were collected from PW-6N during well development using air-lifting. Analysis showed that all of the constituents were below the human health standard. It should be noted that samples collected during air-lifting are not collected using standard procedures. Tintina will collect a water quality sample using standard operating procedures as part of the testing for permitting the well for the PWS. Tintina is in the process of developing an application for a PWS well with the DEQ's Public Water Supply Bureau. The system will be completed in accordance with Circular DEQ-1. In addition, the point of diversion will be included in the groundwater right application to DNRC for the Project.

Potable water will be pumped along a 7,380 foot (2,249 m) long buried pipeline (Figure 3.34) that follows a ranch road, then a segment of the Butte Creek county road, and then the construction access road to the potable water treatment system located in the WTP (Figure 3.6). This water will be chlorinated and filtered if necessary. The 3.4 acre (1.38 ha) surface disturbance associated with this pipeline assumes a 20 foot (6 m) wide construction zone, which will be reclaimed immediately following construction of the pipeline. Treated water will be pumped to a covered potable water storage tank (on the east side of the mill facility) and to a potable water pump house at the truck shop complex. It will be distributed to various facilities, including the mill. Potable water will also be used for mill gland water.

3.7.1.2 Fresh Water and Fire Water Supply

Fresh water will be derived from the WTP and piped to the fresh/fire water tank located on the east side of the mill building (Figure 3.6). Fresh water will be used in the mill (for cooling, lubrication, tailings paste, etc.), reagent preparation, and fire suppression and fire protection water.

The fresh water / fire water tank will have a reserve in the lower portion of the tank that will be drawn from below the primary water nozzles. The fire-fighting reserve in the tank will meet a two-hour demand at 1,000 gpm (3,785 Lpm). Fire water pump skids with diesel-driven fire pumps, a jockey pump, and controls will be installed. Dedicated fire mains with hydrants will be provided at the process plant, ancillary buildings, truck shop complex, and primary crushing area. Fire extinguishers will also be provided throughout the facilities. Fire hose reels and cabinets will be installed throughout the process plant building and truck shop. Sprinkler systems will be installed in the warehouse, the main office, and the

truck shop complex. Fire alarm systems will report to the plant control room, which will be manned 24 hours a day.

3.7.1.3 Process Water Supply

Process water will be comprised of recycled water from the PWP and the milling process (i.e., overflows of the copper concentrate thickeners), water from the sump of the CTF, water from the underground mine, and as needed treated water from WTP. These water streams will be directed to a 40-foot (12.5 m) diameter by 45-foot (14.0 m) high process water tank (Figure 3.6), from which the water will be distributed to the process plant and other service locations.

3.7.2 Water Balance

3.7.2.1 Model Methodology

An operational water balance model for the Project was developed using the GoldSim modeling platform to assess mean hydrologic characteristics and variability of flows Appendix L (Knight-Piésold, 2015c). The volume of water in the CTF, PWP and NCWR were estimated on a monthly basis over 15 years (including 3 years for pre-production and 13 years of operations). The three year reclamation period will only require water from the potable Public Water Supply well. Meteorological parameters for the model were developed using site specific data in conjunction with regional data Appendix A-1 (Bison Engineering, 2015 on CD). The water balance model uses the determined mean monthly precipitation and evaporation values as inputs for each year. These account for rain and snow accumulation, snowmelt, evapotranspiration, and resulting runoff. The surface area was calculated for each time-step using the Depth-Area-Capacity (DAC) data for the facility. Deterministic and stochastic approaches were used in the model and are summarized below.

3.7.2.2 Model Assumptions and Scenarios

The mill requirements and outputs, along with miscellaneous freshwater requirements (truck wash, dust control, etc.) were provided as annual rates occurring when the mill will be in full production. The inputs to the water balance model are shown in Table 3-21.

Table 3-21. Water Balance Inputs

Component	Units	Value	Source
Hydrometeorology			
Mean Annual Precipitation	mm	416	KP
Mean Annual Pond Evaporation	mm	514	KP
Runoff Coefficient (Undisturbed Ground)	mm	0.2	KP
Runoff Coefficient (Disturbed Ground /Facility Footprints)	mm	1.0	KP (Assumes no seepage from facilities)
Copper-enriched Rock ***Production***			
Copper-stockpile Water to Mill	m^3/yr.	12,000 to 52,000	John Huang, TT[1]
tailings Production			
Nominal Mill Process rate	tonne/day	3,300	Tintina
tailings Dry Density	tonne/m^3	2.0	Tintina
tailings Specific Gravity	-	3.77	Tintina
tailings Solids Content	-	74%	Tintina
tailings Water to CTF	m^3/yr.	51,000 to 221,000	John Huang, TT[1]
tailings Water to Underground	m^3/yr.	42,000 to 186,000	John Huang, TT[1]

Component	Units	Value	Source
Water Lost to Voids	%	100%	Assumption
Mill Process			
Freshwater Requirements	m^3/yr.	44,000 to 192,000	John Huang, TT[1]
Water lost to Concentrate	m^3/yr.	4,000 to 16,000	John Huang, TT[1]
Thickener Overflow	m^3/yr.	938,000 to 4,107,000	John Huang, TT[1]
Required Water from the PWP	m^3/yr.	979,000 to 4,286,000	John Huang, TT[1]
Other Freshwater Use	m^3/yr.	49,000	John Huang, TT
Underground Dewatering	gpm	500	Hydrometrics

NOTES:

1. Range of values for the life of mine, based on the production schedule.

The water balance results were calculated on a mean monthly basis as well as on an annual basis for each year. The scenario modelled includes a PWP start-up volume of 120,000 m^3 (156,950 cu yds.), with mean monthly precipitation conditions for the life of mine.

Three separate scenarios were modeled using the life-of-mine water balance in order to obtain an understanding of the water requirements of the mill facility on the PWP volumes during operations. The model was run deterministically for the mean case, and stochastically for the wet (95th percentile) and dry (5th percentile) cases. The estimated monthly volumes reporting to the proposed mine site, and the resulting effects on the volumes in the PWP are presented in terms of probabilities of occurrence for the three different climatic scenarios:

- **Scenario 1 – Mean**: The model was run deterministically and the results correspond to mean monthly climatic conditions.
- **Scenario 2 – 95th Percentile (Wet)**: The results correspond to abnormally wet conditions, and represent the climatic conditions to be exceeded once every 20 years, on average.
- **Scenario 3 – 5th Percentile (Dry)**: The results correspond to abnormally dry conditions, and represent the climatic conditions expected to be exceeded 19 years out of 20, on average (i.e. volumes will not exceed these values once every 20 years, on average).

The objective of the water management plan is to maintain a minimum monthly pond volume of approximately 120,000 m^3 (156,950 cu yds.) in the PWP, while not encroaching on the storm storage that exists above a volume of 200,000 m^3 (261,590 cu yds.).

3.7.2.3 Model Results

The results for all 3 climatic scenarios during the 13 year mine operating life are outlined in detail in Appendix K (Knight-Piésold, 2015d). Table 3-22 below shows the pond operating volume ranges and average annual surface water volume transferred from the PWP to the WTP for the three climatic scenarios. The main conclusion from this analysis is that the average annual groundwater make-up required to sustain the minimum pond volume will be 213,200 cubic yards (163,000 m^3).

Table 3-22. Water Transferred from the PWP to the WTP for the Three Climatic Scenarios

Climatic Scenario	PWP Operating Volume Range (m^3)	Average Annual Water Volume Transferred from the PWP to the WTP (m3)
Scenario 1: Mean Conditions	120,000 – 170,000	110,000
Scenario 2: 95th Percentile (wet)	120,000 – 170,000	232,000[a]
Scenario 3: 5th Percentile (dry)	120,000 – 170,000	34,000

Notes:

(a) Even though this value is larger than the maximum pond operating range value in the table and the maximum allowable value described below in (b), the excess volume will be treated in the WTP and discharged to the underground infiltration galleries in compliance with non-degradation criteria.

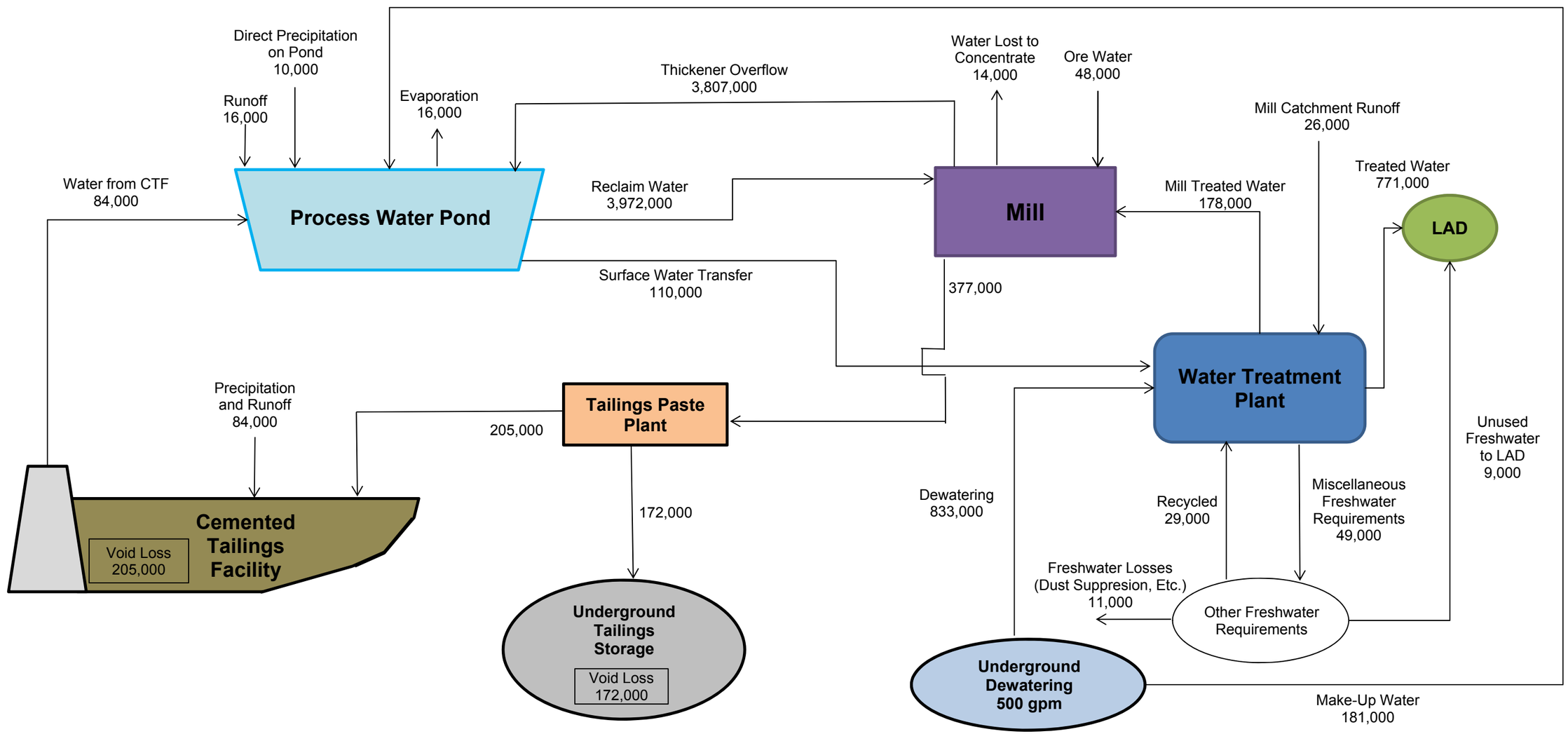
(b) This analysis assumes a minimum allowable PWP design volume of 120,000 m^3 (156,950 cu yds.) and a maximum allowable design volume of 200,000 m^3 (261,590 cu yds.) that defines the operating range.

Direct precipitation on the PWP facility will not contribute sufficient water to offset the mill water requirements while maintaining the minimum PWP pond volume of 120,000 m^3 (156,950 cu yds.). Therefore, it will be necessary to supplement the PWP with water from the underground mine workings. No make-up water will be required in year 1 or 2 as no production facilities will be in operation.

The estimated PWP pond volume **prior to** the water transfer to the WTP and groundwater transfer to the PWP was modeled in all three climatic conditions. The volume trends in this analysis indicate that there is sufficient storage capacity in the PWP during abnormally wet year scenarios (95th percentile), and in a dry year (5th percentile). The groundwater source will be used as make-up water in the later dry year scenario.

The PWP pond volume **after** surface water transfer to the WTP and groundwater transfer to the PWP in this analysis indicates that the pond volume for each scenario is similar after the water transfer is included in the model. The amount of water transferred to the WTP and released to the environment by discharging is greater than the amount required to keep the pond volume within the mean scenario operating range under dry and abnormally wet conditions.

A detailed summary of the water balance is provided in the Knight Piésold report Appendix L (Knight-Piésold, 2015c) of this document. The water balance schematic shown on Figure 3.34 was used as the basis for model development and shows in some detail the annual inflows and outflows to and from the facilities during the sixth year of production (year 6) under mean climatic conditions. The deterministic results of the detailed site water balance broken down by facility component as it relates to Figure 3.35 (Mean Case Year 6) are described below.

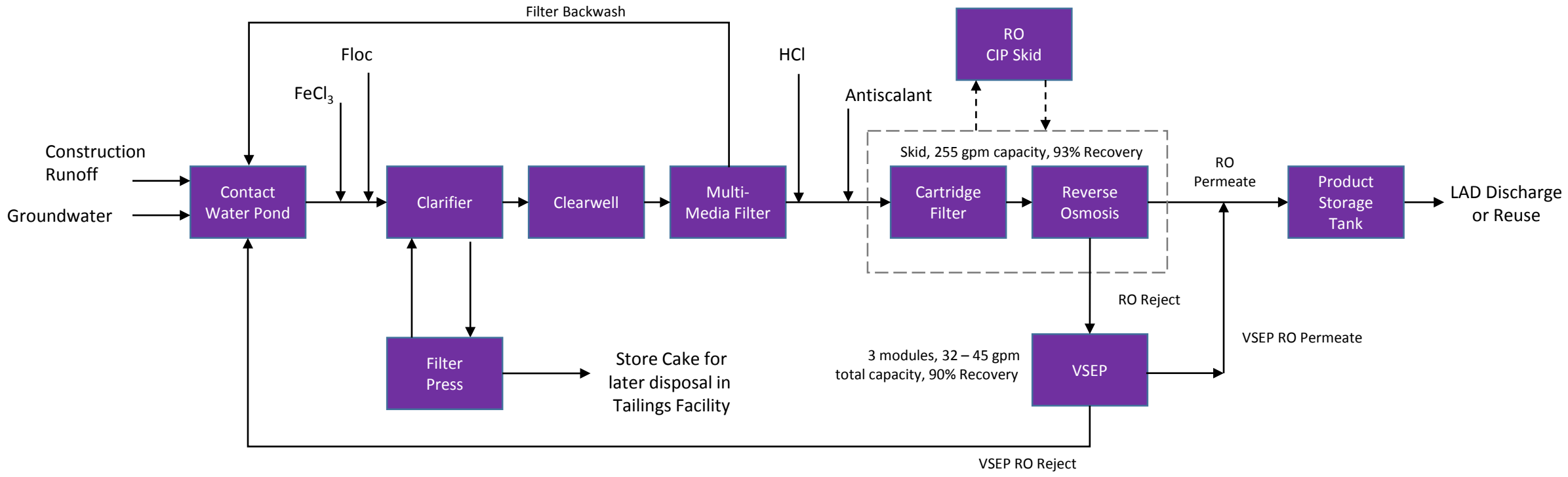


NOTES:
1. ALL WATER VOLUMES ARE EXPRESSED IN UNITS OF CUBIC METRES PER YEAR.
2. WATER IN TAILINGS PASTE IS ASSUMED TO BE UNRECOVERABLE.
3. SEEPAGE IS ASSUMED TO BE ZERO AS THE FACILITIES ARE LINED.
4. LAD = LAND APPLICATION AND DISPOSAL.

Date: November 4 2015 Source: Knight Piesold (2015)

TINTINA RESOURCES

Figure 3.34
Annual Water Balance Schematic for Mean Case - Year 6
Black Butte Copper Project
Meagher County, Montana



TINTINA RESOURCES

Figure 3.35
Water Treatment Construction Phase Process Flow Diagram
Black Butte Copper Project
Meagher County, Montana

A much more generalized schematic of water movement through the system is presented in Figure 4.10 (Section 4.2)

The generalized site water management plan is described below:

- The sources of water for the mining and milling operation comes from dewatering of the underground mine.
- The primary source of reclaim water for the mill is the PWP.
- Surface water and precipitation reporting to the CTF will be transferred to the PWP.
- Surface water and precipitation reporting to the PWP, including that transferred from the CTF, will be transferred to the WTP where it will be treated prior to discharge to the underground infiltration galleries.

Additional make-up water required by the mill is assumed to be supplied from underground dewatering and stored in the PWP. Make-up water required by the PWP is assumed to be untreated. Fresh water required by the mill is assumed to be treated by the WTP.

3.7.3 Water Treatment

Tintina evaluated the need and the potential methods for water treatment at the Project. The following sections describe the basis of design, the screening process used for assembling and evaluating water treatment alternatives, and the proposed water treatment processes for various stages of the life cycle of the mine.

3.7.3.1 Basis of Design

The basis of design for water treatment was based upon the planned development of the Project, the water budget for the Project, the characteristics of the water that requires management, and the effluent treatment goals. Figure 4.10 provides a schematic of critical portions of the water flow path at the project site.

3.7.3.2 Operating Phases and Design Flows

Water will require management during three phases of the mine life cycle. Each phase will have different design flows and raw water quality. They include:

Construction Phase: Groundwater from mine dewatering and water collected in the CWP will require treatment at an estimated maximum average combined flow rate of approximately 221 to 326 gallons per minute (gpm) (836 to 893 L/min) during the first two years of construction (Section 4.1.6.2; Table 4-6). The estimated volume of water to be treated during the Construction Phase is 313.8 million gallons (1,187 million L) (Section 4.1.6.2; Table 4-6). Based on analytical data from *UCZ* groundwater samples, groundwater will have several parameters of concern that must be addressed before discharge (Section 3.7.4.3). Treated water will be discharged to underground infiltration galleries, which will be constructed early in the Project. Liquid and solid residuals from water treatment will be stored in a segmented portion of the CWP for later on-site disposal in the PWP.

Operational Phase: The combined flow of groundwater and process water that will require treatment during this phase is expected to be 510 gpm (1,930 liters) (see Section 4.1.6.2). Treated water will be discharged to the underground infiltration galleries, and liquid and solid treatment residuals will be disposed on-site using the PWP, or directly to the Paste Plant.

Closure Phase: Prior to decommissioning, water from the PWP will be treated using similar processes as the previous phases. The design flowrate for the treatment of process water during closure (Section 4.1.6.2) will remain at 510 gpm (1,930 liters). Assuming continuous treatment at the design flow rate of 510 gpm (1,930 liters), treatment of 52.8 million gallons (200,000 m^3 (261,590 cu yds.) Normal maximum operational water level) of PWP water will require a minimum of 2.5 months. If the PWP also held the PMF event volume, treatment will take approximately 5 months. Treated water will be discharged to the underground infiltration gallery system. Solid and liquid water treatment residuals will be disposed on-site if suitable facilities are available. Otherwise, these residuals will be disposed of off-site.

These three phases of mine life will have the same effluent goals. However, the water sources, flow rates, influent water quality, and facilities available for disposal of treatment residuals will vary.

3.7.3.3 Raw Water Quality, Treatment Goals, and Treatment Parameters

Groundwater from *UCZ* monitoring wells was assumed to represent the water quality of groundwater that will be produced during mine dewatering. Water quality data from three locked cycle metallurgical tests completed by SGS (2015) are expected to represent process water quality during the Operational and Closure Phases. These data, along with prior experience at similar sites, were used to determine the anticipated raw water quality during each phase of the Project.

To facilitate an evaluation of water treatment options, Tintina estimated the water quality of the discharge water to be equal to the maximum concentration measured from wells completed in the *UCZ* (Table3-25), and adjusted a few constituents (e.g., Nitrate + Nitrite) based on prior experience at similar sites. It is understood that a few constituents may have elevated water quality from the *UCZ* during mining. However, the total estimated discharge from the mine working comes from multiple hydrostratigraphic units. The *UCZ* has the poorest water quality, and the upper unit (*Ynl-A*) has relatively good water quality. The *Ynl-A* is estimated to contribute approximately 25% of the flow that will be discharged from the mine workings. With the *Ynl-A* contributing approximately 25% of the flow from the mine working and being much higher quality water with respect to constituent concentrations, using the maximum concentrations for each constituent from the *UCZ* provides a conservative estimate for the water quality of water discharged from the mine.

For each phase, treated water will be discharged to the underground infiltration gallery disposal areas for infiltration to groundwater or to the LAD. To allow for non-degradation discharge of treated water to groundwater, the effluent limits will be the Estimated Non-Degradation Maximum Treatment Levels (ENDMTLs) which are presented in Table 3-24. These are the non-degradation maximum treatment levels for each constituent. Parameters of concern (POC) for each phase were established by comparing the expected raw water quality to the ENDMTLs. The POC that need to be addressed by water treatment systems during the Construction, Operations, and Closure Phases are similar, but differ slightly due to the different mixtures of raw water sources. The ENDMTLs values (Table 3-24) are provided as estimates of non-degradation criteria only; actual values will be calculated and reported by DEQ as part of the formal permitting process for mine discharges.

Construction Phase**:** Water that must be managed during the Construction Phase will be a mixture of groundwater and construction runoff. Analytical data from *UCZ* groundwater samples are expected to be representative of groundwater produced by dewatering. Based on a comparison of raw water quality to ENDMTLs, the parameters of concerns for the Construction Phase are arsenic, lead, strontium, and thallium in produced groundwater. Total suspended solids

(TSS) and nitrogen species (nitrate, nitrite, and precursors [i.e. ammonium]) will also be parameters of concern. All of these parameters of concerns will require treatment before discharge of water.

Operational Phase: Water that must be managed during the Operational Phase will be primarily a mixture of groundwater and process water. Parameters of concerns were established by comparing the maximum concentrations of each constituent in *UCZ* groundwater and the locked cycle tests to ENDMTLs. If a constituent had a maximum concentration that exceeded its ENDMTL, it is considered a parameters of concern. Based on this analysis, the parameters of concern for water treatment of the Operational Phase are pH, dissolved metals (antimony, arsenic, copper, lead, nickel, strontium, and thallium), nitrogen species (nitrate, nitrite, and precursors), and TSS.

Closure Phase: With the exceptions of TSS and nitrogen species, water quality data from three locked cycle tests completed by SGS (2015) were used to estimate the expected raw water quality for the treatment of process water during mine closure. For each parameter, the design raw water quality of process water requiring treatment during mine closure was calculated as the greater of the maximum detected concentration and the highest limit of detection of all non-detects. For TSS and nitrogen species, prior experience was used to arrive at raw water quality levels for these parameters. A typical value of 20 mg/L was assumed for TSS, and concentrations of nitrogen species were assumed to be similar to those estimated for the treatment of mine water during operations.

Based on this analysis, the Closure Phase parameters of concern are pH, antimony, arsenic, copper, lead, nickel, nitrogen species (nitrate, nitrite and precursors), strontium, thallium, and TSS.

Table 3-23. Statistical results of Upper Copper Zone water quality (MW-3, PW-8, AND PW-9)

PARAMETER	UNIT	FRACTION	MIN	MAX	MEAN	MEDIAN	25TH %	75th %	Detects	Non-Detects	Count
OXYGEN (O) (FLD)	mg/L	DIS	-121.7	5.7	-3.9	1.46	0.19	2.4975	22	0	22
PH - FLD	s.u.	NO MEAS	6.11	7.88	6.92	6.98	6.78	7.08	22	0	22
SC (UMHOS/CM AT 25 C) (FLD)	umhos/cm	NO MEAS	496	883	758	818	745.75	852.75	22	0	22
WATER TEMPERATURE (FLD)	C	NO MEAS	8.38	10.93	9.63	9.7	9.095	10.0975	22	0	22
TDS (MEASURED AT 180 C)	mg/L	NO MEAS	318	607	521	559	525.25	592.5	22	0	22
TOTAL SUSPENDED SOLIDS	mg/L	NO MEAS	10	10	10	10	10	10	0	16	16
CALCIUM (CA)	mg/L	DIS	61	124	81	82	77	84	22	0	22
MAGNESIUM (MG)	mg/L	DIS	30	58	48	51.5	46.25	55	22	0	22
SODIUM (NA)	mg/L	DIS	3	17	12	14	11.25	16	22	0	22
POTASSIUM (K)	mg/L	DIS	2	4	3	3	3	3	22	0	22
TOTAL ALKALINITY AS CACO3	mg/L	NO MEAS	180	230	208	210	200	220	22	0	22
BICARBONATE ALK AS HCO3	mg/L	NO MEAS	260	290	272	270	270	270	5	0	5
CARBONATE AS CO3	mg/L	NO MEAS	1	1	1	1	1	1	0	5	5
CHLORIDE (CL)	mg/L	NO MEAS	1	2	1	1	1	2	17	5	22
SULFATE (SO4)	mg/L	NO MEAS	91	280	227	260	230	278	22	0	22
FLUORIDE (F)	mg/L	NO MEAS	0.4	0.8	0.6	0.65	0.6	0.7	22	0	22
TOTAL KJELDAHL NITROGEN AS N	mg/L	NO MEAS	0.5	0.5	0.5	0.5	0.5	0.5	0	1	1
NITROGEN, TOTAL (NO3 + NO2 + TKN)	mg/L	NO MEAS	0.5	0.5	0.5	0.5	0.5	0.5	0	1	1
NITRATE + NITRITE AS N	mg/L	NO MEAS	0.01	0.02	0.01	0.01	0.01	0.01	4	18	22
PHOSPHORUS (P)	mg/L	TOT	0.01	0.01	0.01	0.01	0.01	0.01	1	0	1
ALUMINUM (AL)	mg/L	DIS	0.009	0.03	0.013	0.009	0.009	0.009	0	22	22
ANTIMONY (SB)	mg/L	DIS	0.0005	0.003	0.0011	0.0005	0.0005	0.001	6	16	22
ARSENIC (AS)	mg/L	DIS	0.013	0.09	0.059	0.066	0.062	0.0715	22	0	22
ARSENIC (AS) +3	mg/L	TOT	0.064	0.064	0.064	0.064	0.064	0.064	1	0	1
ARSENIC (AS) +5	mg/L	TOT	0.005	0.005	0.005	0.005	0.005	0.005	1	0	1
BARIUM (BA)	mg/L	DIS	0.01	0.04	0.02	0.0125	0.011	0.015	22	0	22
BERYLLIUM (BE)	mg/L	DIS	0.0008	0.001	0.0008	0.0008	0.0008	0.0008	0	22	22
CADMIUM (CD)	mg/L	DIS	0.00003	0.00008	0.000039	0.00003	0.00003	0.00003	0	22	22
CHROMIUM (CR)	mg/L	DIS	0.001	0.01	0.005	0.005	0.002	0.00875	0	22	22
COBALT (CO)	mg/L	DIS	0.005	0.01	0.008	0.01	0.005	0.01	0	22	22
COPPER (CU)	mg/L	DIS	0.001	0.002	0.002	0.002	0.002	0.002	0	22	22
IRON (FE)	mg/L	DIS	0.77	2.35	1.32	1.19	1.03	1.23	22	0	22
LEAD (PB)	mg/L	DIS	0.0003	0.0202	0.0043	0.0003	0.0003	0.000725	6	16	22
MANGANESE (MN)	mg/L	DIS	0.0173	0.086	0.0381	0.0345	0.024	0.04325	22	0	22
MERCURY (HG)	mg/L	DIS	0.000005	0.00001	0.000006	0.000005	0.000005	0.000005	1	21	22
MOLYBDENUM (MO)	mg/L	DIS	0.001	0.005	0.002	0.002	0.001	0.002	5	17	22
NICKEL (NI)	mg/L	DIS	0.001	0.01	0.003	0.001	0.001	0.00175	6	16	22
SELENIUM (SE)	mg/L	DIS	0.0002	0.001	0.0004	0.0002	0.0002	0.0002	0	22	22
SILVER (AG)	mg/L	DIS	0.0002	0.02	0.0061	0.001	0.001	0.01525	0	22	22
STRONTIUM (SR)	mg/L	DIS	0.755	16.2	10.253	13.75	8.215	14.9	22	0	22
THALLIUM (TL)	mg/L	DIS	0.0003	0.0035	0.0011	0.00055	0.0004	0.0009	22	0	22
URANIUM	mg/L	DIS	0.0003	0.008	0.0032	0.0011	0.001025	0.008	13	9	22
ZINC (ZN)	mg/L	DIS	0.002	0.108	0.0175	0.008	0.00275	0.01	11	11	22

Table 3-24. Estimated Water Treatment Standards Based on Groundwater Non-Degradation Criteria

SITE CODE	Groundwater Wells (MW-6B, MW-7, AND MW-8) (mg/L)					Groundwater Human Health Standard	Category	Non Deg. Trigger Level	Ambient + Trigger	Applicable Non-significance Factor ARM 17.30.715	Non Deg. Threshold	Required Reporting Limit (RRL)	TBEL Limit	Estimated Non Deg. Maximum Treatment Level
	Count	BD	25%ile	75%ile	Average									
ANTIMONY (SB)	18	10	<0.0005	0.0010	<0.0022	0.006	Toxic	0.0004	0.0014	0.15	0.0009	0.0005	--	0.0019
ARSENIC (AS)	18	6	<0.001	0.003	0.002	0.010	Carcinogen	NAI	0.003	NAI	NAI	0.001	--	0.003
BARIUM (BA)	18	0	0.06525	0.106	0.079	2.0	Toxic	0.002	0.108	0.15	0.3000	0.0	--	0.4055
BERYLLIUM (BE)	18	18	<0.0008	<0.0008	<0.0008	0.004	Carcinogen	NAI	<0.0008	NAI	NAI	0.001	--	<0.0008
CADMIUM (CD)	18	18	<0.00003	<0.00003	<0.00003	0.005	Toxic	0.0001	0.0001	0.15	0.0008	0.00008	0.05000	0.0008
CHROMIUM (CR)	18	18	< 0.01	< 0.01	< 0.01	0.1	Toxic	0.001	< 0.01	0.15	0.0150	0.001	--	0.0150
COPPER (CU)	18	18	< 0.002	< 0.002	< 0.002	1.3	Toxic	0.0005	0.0025	0.15	0.1950	0.001	0.150	0.150
LEAD (PB)	18	13	<0.0003	0.0003	<0.0004	0.015	Toxic	0.0001	0.0004	0.15	0.00225	0.00050	0.30000	0.00225
MERCURY (HG)	18	17	<0.000005	<0.000005	<0.000005	0.002	Toxic w/ BCF >300	NAI	<0.000005	NAI	NAI	0.00001	0.001	0.000005
NICKEL (NI)	18	16	< 0.001	< 0.001	< 0.001	0.1	Toxic	0.0005	0.0015	0.15	0.0150	0.010	--	0.0150
SELENIUM (SE)	18	13	< 0.0002	0.0002	0.0021	0.05	Toxic	0.0006	0.0008	0.15	0.0075	0.0010	--	0.0075
SILVER (AG)	18	18	< 0.02	< 0.02	< 0.02	0.1	Toxic	0.0002	< 0.02	0.15	0.0150	0.001	--	0.0150
STRONTIUM (SR)	18	0	0.093	0.200	0.157	4.0	Toxic	0.1	0.3003	0.15	0.6000	--	--	0.8003
THALLIUM (TL)	18	18	< 0.0002	< 0.0002	< 0.0002	0.002	Toxic	0.0003	0.0005	0.15	0.0003	0.0002	--	0.0003
URANIUM (U)	18	15	< 0.008	< 0.008	< 0.007	0.03	Carcinogen	0.00003	< 0.008	NAI	NAI	--	--	0.008
ZINC (ZN)	18	17	< 0.002	< 0.002	< 0.002	2.0	Toxic	0.005	0.007	0.15	0.3000	0.01	0.5	0.3000
PH FLD (S.U.)	18	0	7.465	7.82	7.62	6.5-8.5	Harmful	--	--	--	--	--	6.0-9.0	6.0-9.0
NITRATE + NITRITE AS N	18	9	< 0.01	0.1	0.05	10	Toxic	7.5	7.5	0.15	7.5	0.01	--	7.5
TOTAL SUSPENDED SOLIDS (TSS)	--	--	--	--	--	--	--	--	--	--	--	--	20	20
TOTAL KJELDAHL NITROGEN AS N	3	3	< 0.5	< 0.5	< 0.5	--	--	--	--	--	--	--	--	--
NITROGEN (N) TOT	3	3	< 0.5	< 0.5	< 0.5	--	--	--	--	--	--	0.01	--	--
PHOSPHORUS (P) TOT	3	0	0.025	0.04	0.03	--	--	--	--	--	--	0.001	--	--
SPECIFIC CONDUCTIVITY (UMHOS/CM)	18	0	319.25	528.25	436	<1000	--	--	--	--	--	--	--	<1000
TOTAL ALKALINITY AS CACO3	18	0	170	240	212	--	--	--	--	--	--	--	--	--
ALUMINUM (AL)	18	8	<0.009	0.031	0.038	--	--	--	--	--	--	--	--	--
COBALT (CO)	18	18	< 0.01	< 0.01	< 0.01	--	--	--	--	--	--		--	--
IRON (FE)	18	5	0.02	0.08	0.06	--	--	--	--	--	--	0.05	--	--
MANGANESE (MN)	18	0	0.041	0.105	0.092	--	--	--	--	--	--	0.005	--	--
MOLYBDENUM (MO)	18	5	0.002	0.004	0.004	--	--	--	--	--	--		--	--
TOTAL HARDNESS AS CACO3	18	0	166	286	225	--	--	--	--	--	--	--	--	--

NAI = No Allowable Increase (applies to all Carcinogen and Toxics with BCF >300)

-- = Not Applicable

Statistics calculated using the value of detection limit when less that detection results. Average value assigned < when 50% or more of samples below detect.

3.7.3.4 Water Treatment Selection Process

Water treatment processes were evaluated for their ability to effectively reduce the concentrations of the parameters of concern for each phase to below their respective ENDMTLs. Because few treatment methods alone are capable of effectively reducing the concentrations of all identified parameters of concern, several treatment trains were evaluated and compared. The treatment trains that were evaluated combined several treatment technologies in series, and were capable of reducing concentrations of identified parameters of concern to below ENDMTLs.

Technology screening considered the following factors:

- Potential to treat parameters of concern to required levels
- Reliability of treatment
- Degree of application for the treatment of mining waste waters
- Technical characteristics of the technology
- Ease of operation
- Ease of construction
- Ease of implementation
- Cost
- Residuals/waste stream management

Several treatment processes were evaluated but eliminated from consideration due to high costs or potential ineffectiveness. Biological treatment processes could be used for reducing nitrogen species, but will have limited effectiveness for dissolved metals and would potentially be inhibited at low temperatures. Media-based treatment methods that utilize synthetic or natural (e.g. zeolite) ion exchange media are capable of effectively removing most of the dissolved constituents of concern. However, due to the wide range of contaminants, multiple reactors in series would be required for complete treatment, and regeneration processes would produce large volumes of brine that must be treated or disposed.

The treatment trains that are described below for each phase are similar and will meet effluent goals, given the specific constraints of each phase. Each treatment train relies on clarification and filtration to reduce TSS concentrations, and reverse osmosis (RO) with pre-treatment to remove dissolved parameters of concern.

3.7.3.5 Water Treatment for the Construction Phase

As described in Section 3.4.2, the mine will be constructed over approximately two years. The Construction Phase will include development of surface facilities, as well as development and advancement of the underground mine. Groundwater produced during dewatering will be pumped to the CWP (capacity of 25 million gallons, 97,000 m^3; 126,870 cu yds.), along with construction runoff. Water from the CWP will be treated to maintain low pond level and meet discharge goals. Treated water will be disposed in the underground infiltration gallery system or beneficially reused at the site, while treatment residuals will be stored on-site for further treatment and/or disposal during the Operational Phase.

The main components of the Construction Phase water treatment train (Figure 3.35) are as follows:

- **Contact Water Pond:** This pond will receive pumped groundwater and construction runoff, and will provide equalization of flows and concentrations prior to treatment.
- **Clarifier:** Water will be pumped from the CWP at a steady rate to a clarifier to remove the majority of the TSS. Ferric chloride ($FeCl_3$) and an anionic flocculent will be added ahead of the clarifier to improve solids removal in the clarifier; these chemicals may also partially remove some dissolved

metals and arsenic by co-precipitation. The clarifier overflow will have an estimated average concentration of 15 mg/L TSS. Overflow will be collected in a Clearwell Tank and pumped through a series of multi-media pressure filters to polish suspended solids further. The clarifier underflow will be dewatered using a plate and frame filter press, and the resultant sludge hauled to the tailings facility for on-site disposal.

- **Multi-Media Filter:** A series of multi-media pressure filters will remove the remaining suspended solids from the clarifier overflow. The media filters will contain two media: fine sand and anthracite. The filters will be designed with a relatively low filtration rate to ensure removal of TSS below 1 mg/L on an average basis. Solids that accumulate in the media filters will be periodically backwashed with filtered effluent or final RO product water. The backwash water will be routed back to the CWP.
- **RO system:** RO systems apply water under pressure to semi-permeable membranes. Clean water permeates through the membrane, whereas dissolved constituents are retained by the membrane in a reject stream (RO reject is also referred to as brine because it has salts concentrated from treated water). Two skid-mounted RO systems, each with a maximum treatment capacity of 255 gpm (965 Lpm) and an estimated recovery of 93%, have been selected for this application. Each RO skid will have a cartridge filter to remove additional suspended solids and membranes specifically selected to eliminate the dissolved parameters of concern that are expected in groundwater. At a recovery of 93%, the average RO influent flows of 221 to 376 gpm (836 to 893 L/min) will result in permeate flows ranging from approximately 206 to 350 gpm (780 to 1325 L) and reject flows ranging from approximately 15 to 26 gpm (57 to 98 L/min). The reject stream will be managed as described below, using a Vibratory Shear Enhanced Processing (VSEP) RO system designed by New Logic Research in Emeryville, California (***www.vsep.com)***. To mitigate potential fouling of the RO membranes, hydrochloric acid (HCl) and antiscalant will be added to the RO feed water after the granular media filter. A Clean-In-Place (CIP) system will also be available to clean RO membranes should they become fouled over time.
- **Product storage tank:** Treated water will be stored in a product storage tank before discharge or reuse. The treated water will be nearly pure water, containing less than 50 mg/L total dissolved solids (TDS), and will meet all of the ENDMTLs (Table 3-24).

This treatment train will produce four streams: 1) filter backwash, 2) dewatered solids from the filter press, 3) permeate from the RO system, and 4) RO reject. The filter backwash will be routed back to the CWP. Dewatered solids will be stored on-site for ultimate disposal in the tailings facility after construction is complete. The RO permeate will meet discharge requirements and can be discharged or reused. The concentrated RO reject will require further management. The skid-mounted RO system will produce reject at an average flow rate ranging from 15 to 26 gpm (57 to 98 L/min), or approximately 22 million gallons (82 million L) of RO reject over the initial two-year Mine Construction Phase. Mechanical evaporation, ambient evaporation, and on-site storage of the entire reject volume using temporary tanks was considered but rejected due to uncertain effectiveness and/or prohibitive costs. On-site storage of concentrated brine in the CWP and/or off-site hauling to a disposal well is feasible if the volume of brine can be reduced to low enough levels.

To reduce the volume of brine that must be managed during the Construction Phase (as well as the Closure Phase), a VSEP system will be used. VSEP is an RO system that incorporates vibrational shear forces to prevent membrane fouling and maintain high recoveries, thereby effectively treating RO reject streams and reducing the volume of brine that must be managed. The proposed VSEP system will consist

of three modules with a total treatment capacity of 32 to 45 gpm (121 to 170 L) at a water temperature ranging from 5 – 25°C and an estimated recovery of approximately 90%. VSEP permeate will meet ENDMTLs, and the reject flow rate will be reduced from a maximum of approximately 26 gpm (98 L/min) to a maximum of about 2.6 gpm (9.8 L/min). The VSEP system will reduce the volume of brine that requires further management from approximately 22 million gallons (82 million L) (produced by the RO system) to approximately 2.2 million gallons (8.3 million L). The concentrated reject from the VSEP system will be routed back to the CWP for storage until the Operational Phase. Alternatively, if the dissolved salt concentration in the CWP becomes too high, the VSEP concentrate brine will be hauled off for disposal in a permitted injection well. The nearest injection well is located in Utah.

Water management during the Construction Phase will rely on the availability of two components of the overall mine development: the underground infiltration galleries for discharge of treated water, and the CWP for storage of brine produced by the VSEP system. The underground infiltration galleries and the CWP will be constructed early in the overall mine development process such that these facilities are available before dewatering and water treatment begins. During the Construction Phase, the treatment train (including RO and VSEP) will produce approximately 311.6 million gallons (1.8 million m3) of permeate that meets discharge requirements, and 2.2 million gallons (8.3 million L) of brine that requires further management. Permeate will be discharged in the infiltration galleries, and the brine produced by the VSEP system will be stored in the CWP. Because the RO system will be capable of treating up to 510 gpm (1930 L) of feed water generated from underground, the RO system has excess capacity to handle additional volume that may be produced by precipitation and other inflows into the CWP.

Although not specifically identified as parameters of concern, oil and grease (O&G) may be present in groundwater pumped from the underground mine, or may be present in construction runoff. Best Management Practices for O&G management will be implemented at the Project during the Construction, Operation, and Closure Phases to minimize the potential of O&G entering the treatment system. Mine construction and operations personnel will be trained to prevent and respond to O&G spills and leaks, and spill response equipment will be strategically placed. The primary approach will be prevention of leaks and spills during blasting operations (fuel oil) and from heavy equipment (fuels, lubricating oils, and hydraulic oil). If spills or leaks do occur, the initial response will be capture and containment of O&G to prevent contact with underground water. If O&G does come into contact with underground water, absorbent booms will be used to isolate and remove O&G from water in the underground sumps. O&G that reports to the surface with pumped water will be removed using absorbent booms or socks deployed in the Capture Pond, clarifier, or other pre-treatment water systems. The clarifier will have a skimmer that will be used primarily for removal of surface scum, but which can also be used for skimming O&G from the water surface in the clarifier. Absorbent booms can also be temporarily affixed to the clarifier skimmer to improve O&G removal. Any residual O&G that remains in the clarifier overflow will be effectively removed in the media filter before entering the RO system.

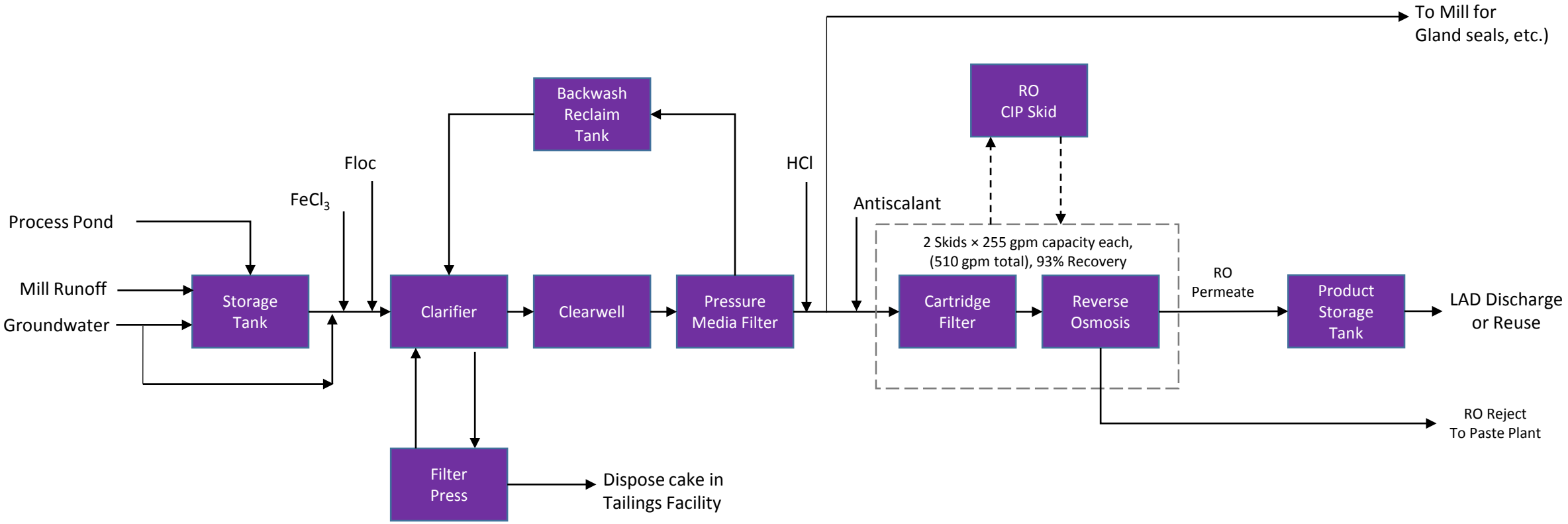
Nitrogen species from blasting operations (nitrate, nitrite, and ammonium) may be present in groundwater that reports to the surface. To minimize or eliminate these parameters in water that must be treated, TRI will develop and implement an Explosives Management Plan which will emphasize best management practices for use of ammonium nitrate/fuel oil (ANFO) explosives compositions. Additionally, the use of explosives emulsions will be considered to eliminate use of ANFO and minimize concentrations of nitrogen species in water to be treated.

Due to the temporary nature of this treatment system, most of these components will be temporary (two year) rental units. However, the two 255 gpm (820 Lpm) skid-mounted RO system and the VSEP system will be purchased and repurposed for water treatment during later phases of this Project.

3.7.3.6 Water Treatment for the Operational Phase

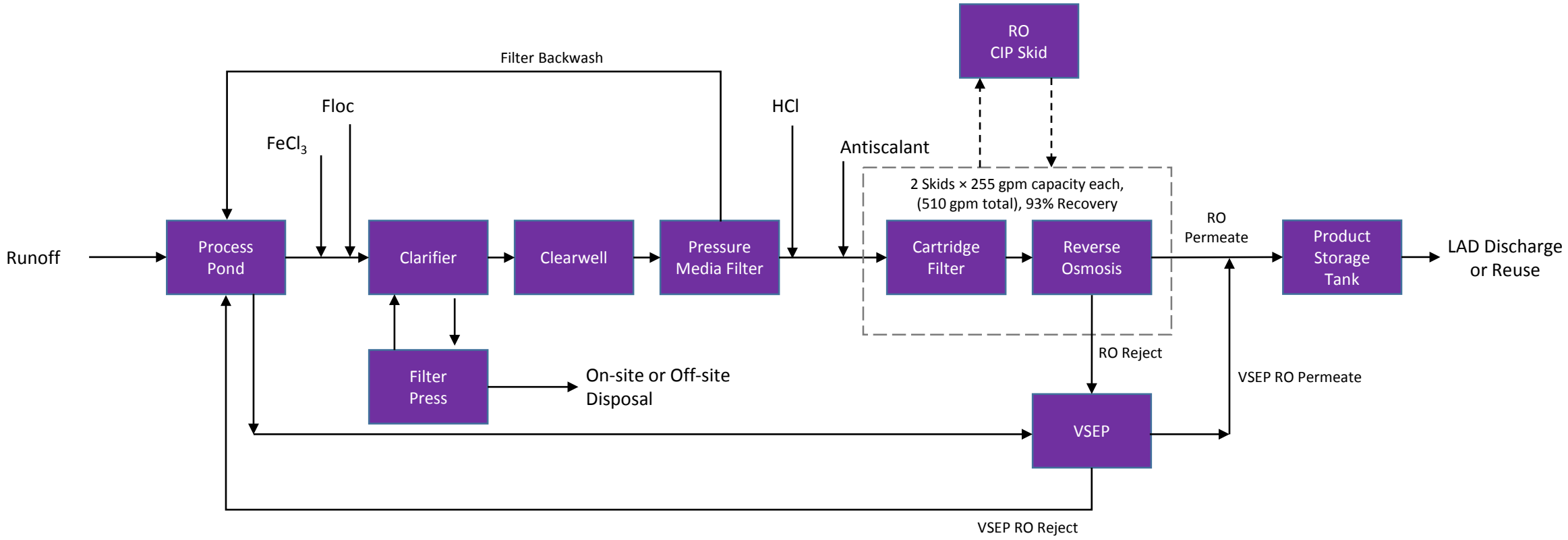
The water treatment processes proposed for the Operational Phase are similar to those for the Construction Phase (Figure 3.36). Figure 4.10 provides a schematic of the operational flow path of water on the site. A mixture of groundwater, mill runoff, and PWP water will be treated during the Operational Phase, and the parameters of concern will include TSS, dissolved metals, and nitrogen species. A clarifier will be used to reduce TSS concentrations, and an RO system will remove dissolved contaminants. O&G will be removed before the RO system. A more permanent WTP (WTP) will be constructed to treat the higher anticipated flows. Rather than using the CWP, influent will be collected in an influent tank that will provide storage and equalization. The WTP will utilize two 255 gpm (837 Lpm) RO skids from the Construction Phase, maintaining the RO treatment capacity of 510 gpm (1,673 Lpm). Rental units (such as the clarifier, filter press, and pressure filters) used during the Construction Phase will be replaced with permanent water treatment processes with higher capacity. Additionally, multiple on-site disposal options (the paste plant and PWP) for RO reject will be available, eliminating the need for volume reduction with the VSEP system. The VSEP system will be maintained as a back-up in case it is needed during the Operational Phase. Otherwise it will be used later in the Closure Phase.

As shown in Figure 3.37, mill runoff and water from the PWP will be combined with groundwater in the influent storage tank. To prevent excessive accumulation of solids in the influent tank, the tank will have an agitator. Part of the influent groundwater will be routed directly to the clarifier inlet to reduce TSS loading to the influent tank. Water from the influent storage tank will be pumped to the WTP. After coagulation, flocculation, clarification, and pressure filtration, part of the flow will be diverted to the mill for use as gland water and other ancillary processes. Acid and anti-scalant will be added to the RO system feed, which will have a flow rate of approximately 510 gpm (1930 L/min). At the anticipated RO system recovery of 93%, 36 gpm (136 L/min) of RO reject and 474 gpm (1692 L/min) of permeate will be produced. Treated effluent will meet discharge standards for all parameters of concern, and will be discharged at the underground infiltration gallery system or reused at the site (Table 3-25).



TINTINA RESOURCES

Figure 3.36
Water Treatment Operational Phase Flow Diagram
Black Butte Copper Project
Meagher County, Montana



TINTINA RESOURCES

Figure 3.37
Water Treatment Closure Phase Flow Diagram
Black Butte Copper Project
Meagher County, Montana

Table 3-25. Operational Phase Parameters of Concern

PARAMETER	Units	Influent[(a)]	Treated Effluent[(b)]	ENDMTL[(c)]
pH	s.u.	10.4	8.6	6.0-9.0
Antimony (dissolved)	mg/L	0.0523	<0.0004	0.0019
Arsenic (dissolved)	mg/L	0.090	<0.0014	0.003
Copper (dissolved)	mg/L	2.80	<0.0005	0.15
Lead (dissolved)	mg/L	0.391	<0.0006	0.00225
Nickel (dissolved)	mg/L	0.016	<0.0005	0.015
Nitrate + Nitrite as Nitrogen	mg/L	11.3[(d)]	1.9	7.5
Strontium (dissolved)	mg/L	16	0.10	0.8
Thallium (dissolved)	mg/L	0.0097	<0.0002	0.0003
Total Suspended Solids	mg/L	150[(e)]	< 1	20

Notes:

(a) Results are based on water quality data from upper copper zone monitoring wells (MW-3, PW-8, and PW-9) reported by Hydrometrics (2015a).

(b) Treated effluent concentrations are estimates based on modeling of water treatment process performance under expected operating conditions.

(c) Estimated non-degradation maximum treatment levels (ENDMTLs) are water quality goals that need to be met to allow for non-degradation discharge of treated water to groundwater (Hydrometrics, 2015b).

(d) Estimated nitrogen equivalent of 50 mg/L of nitrate, which is the maximum concentration observed at other underground mines in Montana.

(e) Typical value from experience.

As during the Construction Phase, the WTP will produce filter backwash, dewatered solids from the filter press, permeate from the RO system, and RO reject. The filter backwash will be directed to a new storage tank and metered back into the clarifier for re-treatment. Dewatered solids will be stored on-site for ultimate disposal in the tailings facility. The RO permeate will meet discharge requirements and can be discharged at the underground infiltration gallery system or reused. After the mine facilities are in place, there will be multiple options for disposal of RO reject. The preferred brine disposal option is pumping of brine to the paste plant and incorporation of the brine into the cemented tailings for permanent disposal. Under the expected operating conditions (i.e., RO recovery of 93%), about 36 gpm (136 Lpm) of RO reject will be sent to the Paste Plant. If RO recovery is lower than anticipated, a higher volume of RO reject brine will be produced. If the paste plant does not have sufficient capacity to accept the higher volume, a fraction of the brine produced could be sent to the PWP. Disposal of RO reject brine to the PWP is also a contingency when the Paste Plant is not operating due to maintenance or unscheduled shutdowns.

3.7.3.1 Water Treatment for the Closure Phase

Water from the PWP will be treated during the closure phase to allow decommissioning of the pond and site restoration. The water treatment processes during the closure phase will be similar to those for previous phases, and will utilize the same treatment equipment to treat process pond water at a flow rate up to the plant capacity of 510 gpm (1930 L/min) (Figure 3.38). Parameters of concern will include pH, TSS, dissolved metals (antimony, arsenic, copper, lead, nickel, strontium, and thallium), and nitrogen species (nitrate, nitrite and ammonium). Water from the Process Pond will be treated in the clarifier to reduce TSS concentrations, and the RO system will remove dissolved contaminants. These processes will produce filter backwash, dewatered solids from the filter press, permeate from the RO system, and RO reject. Filter backwash will be routed to the PWP.

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Date: November 4, 2015 Source: Hydrometrics (2015)

TINTINA RESOURCES

Figure 3.38
Schematic of Surface LAD Area
Black Butte Copper Project
Meagher County, Montana

Dewatered solids will be disposed on-site if facilities are available, or off-site in a landfill. RO permeate will meet discharge requirements and can be discharged at the underground infiltration gallery system or reused.

Initially, the RO reject will be directed back to the PWP because the paste plant will be decommissioned and unavailable for brine disposal. Alternatively, the VSEP could be operated to concentrate the RO reject further prior to discharging to the PWP. With discharge of RO permeate to the underground infiltration gallery system and return of RO reject to the PWP, over time, the PWP volume will be reduced and the dissolved salt concentration in the pond will increase to the point where the RO system will be no longer effective. At this point, the VSEP system will be recommissioned for reducing the Process Pond volume further. VSEP permeate will meet ENDMTLs and be discharged to the underground infiltration gallery system The concentrated VSEP reject will be recirculated to the Process Pond for temporary storage until the VSEP system is no longer effective. At this point, the VSEP brine will be characterized and trucked off-site for disposal at a permitted disposal facility.

3.7.4 Treated Water Disposition

With the exception of the Public Water Supply well, Tintina's only source of water for use in mining will be from groundwater inflow into the newly opened mine workings. This water will be pumped to surface in order to dewater the mine. Approximately 60% of the water produced from underground will not be put to any beneficial use, and will be treated to meet non-degradation standards and discharged back to groundwater. The other approximately 40% of the water produced will be used in the mining process. Treated water will either be returned to the local shallow bedrock hosted groundwater system using underground infiltration galleries or be applied to the land surface by using surface irrigation system (LAD). In addition, contact water from the mining operations (precipitation and surface water run-on to the various facilities) will need to be treated and disposed of in either a surface LAD system or to underground infiltration galleries. Figure 4.10 provides a schematic of critical portions of the water flow path at the project site.

Tintina plans to dispose of treated water to a surface LAD area during summer months as necessary using traditional Rainbird-type irrigation systems. This type of system was used successfully in 2014 to discharge water generated from 30-day pumping tests. Major components of this method of water disposal will be through evaporation and vegetative uptake. Therefore, the Rainbird-type systems work best during the spring-summer-early fall seasons when vegetation growth and evaporation rates are high. Use of this surface LAD system will be most effective during the second year of mine dewatering when slightly larger volumes of water need to be disposed of with a limited amount of available storage capacity. Monitoring of a surface LAD system used to dispose of water from aquifer pump testing in 2014 showed that the system could be operated without impacting surface water or groundwater. Because of the short application season at the Project site, Tintina plans to use the surface LAD system as a seasonal back-up for the underground infiltration gallery.

Because water needs to be disposed of continually throughout the year, Tintina plans to use two large areas of underground infiltration galleries constructed to dispose of water below the frost level. This will return treated underground water to the shallow fractured bedrock system. Water will be treated to levels meeting non-degradation standards for discharge to local groundwater. Tintina has conducted shallow and deep percolation testing to identify areas suitable for these types of disposal scenarios as is described in the soil section (Section 2.5.2) above. Therefore, Tintina has developed the capability of discharging to one surface and one underground system that have considerable excess capacity for handling anticipated mine water. Tintina has discussed the need for an Underground Injection Control

Permit (UIC) with the appropriate staff at EPA Region 8 in Denver and has agreed to submit an application, to facilitate a determination from EPA regarding whether a UIC permit is necessary.

3.7.4.1 Surface LAD Area

Tintina plans to use a surface irrigation system for seasonal disposal of water treated by the Projects water treatment system to non-degradations criteria for groundwater. This section provides a summary of the LAD system design, operation and monitoring program for water disposal. The LAD design is based upon groundwater well pumping tests designed to measure the sustained water flows from various geologic formations. Pumped water was discharged using the surface LAD system in late July through mid-October 2014. The LAD system was designed to apply water to the LAD area at rates below the normal evapotranspiration (ET) rate throughout the discharge period to ensure zero discharge to groundwater or surface water (Hydrometrics, 2014a). Because water discharge from the Project will be treated to non-degradation criteria for groundwater, discharges to groundwater should be acceptable throughout the proposed mine life

The LAD supply tests consisted of pumping water from the pumping well through two inch (5 cm) polyethylene pipe to two 21,000-gallon (79,500 L) storage tanks for short-term water storage (Figure 3.39). Five additional tanks were located on site to provide supplementary storage for water generated from 30-day pump tests when weather conditions did not allow for discharge to the LAD system. The LAD discharge area was located approximately 3,000 feet (915 m) northwest of the water storage tanks (Figure 3.39) and approximately 3,000 feet (915 m) west of Pumping Well PW-6 (Figure 1.3). Water was discharged from the tanks to the LAD area using a high capacity pump. Within the LAD area, ten 1½-inch (3.8 cm) spur lines diverted water from the mainline to 90 impact sprinklers. The spur lines were placed in parallel 85 to 90 feet (27.4 m) apart from each other. Each sprinkler head was placed 90 feet (24.7 m) apart along the spur lines to ensure there is no overlap of application areas. The pressure to the sprinkler heads was adjusted daily to 35 psi to meet the required discharge rate and application area of each sprinkler.

The LAD area used in 2014, occupied approximately 17 acres (6.9 ha). This area could be expanded to at least 40 acres (16 ha) with no additional surface disturbance. The daily discharge to the LAD system did not exceed the average daily ET rate for each month of operation. The total volume of water discharged to the LAD for each long-term pumping test is summarized in Table 3-26.

Table 3-26. Total Discharge to Surface LAD

Test Well	Discharge Days	Total Volume Pumped to Tanks (gallons)	Total Volume Pumped to LAD (gallons)*	Total Volume Applied to LAD surface (gallons)**
PW-8	20	410,682	401,250	280,875
PW-9	15	141,609	158,650	110,775
Total	35	552,291	559,500	391,650

*Total Volume Pumped to tanks does not include step tests or PW-6 test.
**Based on 70% sprinkler efficiency.

Water resource monitoring was conducted on a weekly basis while the LAD system was in operation. The monitoring program included monitoring of seven lysimeters in the LAD area and three adjacent springs. The water quality and quantity monitoring data collected from the springs and lysimeters showed

that water discharge to the LAD system did not impact surface or groundwater water resources. The installation of the surface LAD system requires no surface disturbances other than for overland access by pick-up trucks with trailers to move men and material onto the site for initial assembly of the systems. Sampling and system flow adjustments are accomplished on-foot.

3.7.4.2 Underground Infiltration Galleries

Underground infiltration galleries are used to minimize issues related to freezing surface conditions by disposing of water below the frost level. This allows year-round water disposal. Tintina's designed galleries return treated pumped underground water to the shallow fractured uppermost part of the lower Newland Formation (*Ynl-A*) bedrock system in the same general area as it was extracted.

The underground infiltration gallery will be constructed with supply lines running down two broad topographic ridges, one oriented east-west and the other north-south (Figure 1.3). The first ridge lies approximately 985 feet (300 m) south of the portal pad. The second ridge is approximately 2,953 feet (900 m) south of the portal pad, 985 feet (300 m) west of the CTF and immediately south of the soil stockpiles. (Figure 1.3). The potentiometric surface map (Figure 4.6) indicates that groundwater beneath the first ridge is approximately 40 to 100 feet (12 to 30.5 m) below the ground surface. Discharges to the underground infiltration gallery will be introduced from 4 to 6 feet (1.2 to 1.8 m) below the surface in highly fractured bedrock with high infiltration rates (32 feet/day (10 m/day) average).

Water will be pumped directly from the WTP at a monitored quality that meets non-degradation standards for groundwater (see Section 3.7.3.4). It will be discharged through approximately 10,000 linear feet (3,050 m) of perforated HDPE pipe laid out in a grid-like pattern in the two disposal areas (Figure 1.3). Perforated pipes will be buried below the frost line in deep (as much as 100 feet, 30 m) of highly fractured near surface bedrock. The flow of water in individual arms of perforated pipe within the grid will be controlled by valves. This will allow water to be switched to different areas to avoid saturation of near surface soils or the formation of downgradient seeps and springs. It also allows control of periods of rest between infiltration cycles. Saturated depths will be monitored by piezometers within the drain field, and downgradient groundwater monitoring wells will measure downgradient water quality.

As discussed in Soil Section 2.5.2 above, soils and shallow bedrock underlying map units Ch-b and Wg-b are able to transmit or infiltrate large volumes of water, and are therefore, well suited for construction of subsurface infiltration systems. Hydraulic conductivities measurements of the deep paralithic material underlying these soils were conservatively calculated at an average rate of 32 ft./day (10 m/day) which equates to an overall water disposal capacity of 6,000 gpm (22.7 m^3 per minute) per acre of underground infiltration gallery trenching.

Using these infiltration rates it would take 14,520 linear feet (4425 m) of three-foot (0.9 m) wide trench to comprise an acre of trenching that was capable of disposing of 6,000 gallons (27,225 L) of water per minute. Maximum flow rates from the decline have been predicted to be approximately 500 gpm (2273 L). This could be disposed of in approximately 1,210 linear feet (369 m) of perforated piping within trenches. As a contingency (based upon possible discontinuities in the paralithic zones and to minimize the risk of saturating specific bedrock areas), the estimated linear feet of perforated trenching will be increased to approximately 10,000 linear feet (3050 m). This is a factor of more than eight times the minimum amount required. Figure 1.3 shows the underground infiltration gallery system as a blue line that is dashed in the perforated sections. This length of perforated piping should be capable of disposing of as much as 4,132 gpm (15,600 L).

The local (Hydrometrics 2013-2014) and regional (Hydrometrics 2015 GW Assessment) potentiometric surface maps indicate flows to the east north-east in these areas, away from the decline collar. The decline collar lies some 170 feet (51.8 m) above the water table, and does not rise to intersect the existing workings until approximately 1,700 feet (518 m) north of the portal. Therefore, there is little chance for water from the infiltration gallery to reenter the active mine workings. The infiltrated treated water will mix with the regional groundwater and improve its overall water quality.

Construction of the underground infiltration gallery will require a tracked excavator, loaders, and trucks with trailers to move men and materials to the excavation sites. The tracked excavator will dig a 3-foot (0.9 m) wide trench approximately 4 to 6 feet deep (1.2 to 1.8 m) (below the frost line). Discharge water will be distributed from the WTP at below groundwater non-degradation standards using a 6-inch (15.24 cm) HDPE pipe that will be perforated in areas where subsurface irrigation is desired (dashed blue lines on Figure 1.3). The pipe will not be perforated in areas that serve only to transmit water (the solid blue lines on Figure 1.3). The bottom 8-12 inches (20.3 to 30.4 cm) of the trench in the segments to be used for irrigation will be filled with washed gravel. The pipe will be welded together and perforated in the appropriate sections before laying it in the trench. The perforated sections of the pipe will have 3 inches (7.6 cm) of gravel placed over the top of the pipe. The lower portion of the trench will be protected from fine soil infiltration using a filter fabric or plastic screen sections developed for that purpose. The trench will be backfilled with excavated material, soil placed and re-vegetated.

Surface disturbances required for access will consist of pioneered roads of approximately 15 feet (4.6 m) in width. Trenches will be excavated in the roadway. Total trench lengths will be approximately 15,100 feet (4,602 m), making the total disturbance area for the subsurface drain system approximately 5.20 acres (1.7 ha). Trenches will be backfilled, roads scarified, topsoil/subsoil replaced and the area re-vegetated upon completion of construction of the system. The underground infiltration galleries are not expected to require significant maintenance. Any maintenance and monitoring of system performance will occur during routine inspections conducted by an inspector on an ATV along two-track trails.

Twelve new piezometers will be installed within the various cells of gallery. Infiltration areas will be rotated based upon piezometer results. This will eliminate development of bedrock saturation zones and surface seeps and springs downgradient. Baseline conditions will be measured before initial use of the system. The frequency of measurements will be adjusted pending the results of the initial monitoring.

Tintina will construct the underground infiltration galleries no closer than 400 feet (122 m) to any wetland or surface water. The locations of the underground infiltration gallery lines shown on Figure 1.3 are conceptual. Prior to their installation, Tintina will use data from monitoring wells and piezometers near the wetlands and infiltration galley sites to finalize the drain field design. Tintina will notify DEQ prior to beginning installation of the underground infiltration gallery system so that DEQ staff can be on-site to observe installation and construction.

3.7.5 Storm Water

3.7.5.1 Design Events

The 24 hour design storm events for the Project (at El. 5,698 feet [1737 m]) are presented on Table 3-27.

Table 3-27. Storm Event Summary

Return Period (years)	24 Hour Storm Event (mm)	24 Hour Storm Event (In)
2	35	1.37
5	49	1.92
10	58	2.28
15	64	2.52
20	67	2.64
25	70	2.76
50	79	3.11
100	88	3.47
200	96	3.78
500	108	4.25

The probable maximum precipitation (PMP) for the Project area is defined as the greatest depth of precipitation for a given duration that is physically possible. The PMP event for the Project is estimated to be 22 inches (560 mm). This is equivalent to the average annual precipitation (21.7 inches 550 mm) at the Project site.

The probable maximum flood (PMF) is defined as the largest flood that could conceivably occur at a particular location. The PMF is usually estimated from probable maximum precipitation (Appendix A-1) (Knight-Piésold, 2015a), and where applicable, snow melt, coupled with the worst flood producing catchment conditions. The PMF for the Project area is therefore calculated by adding together the PMP (22 inches or 560 mm) and the 1 in 100 year snow accumulation (11.4 inches or 290 mm) which results in a PMF of 33.46 inches (850 mm) or 1.5 times the total annual precipitation in the Project area.

The Project facilities including the CWP, PWP, and CTF were designed to store the PMF volume in addition to their normal operations volume as required by FEMA, ICOLD and DEQ based on the high potential hazard facility classification. The NCWR spillway will be a low risk facility which is designed to safely pass a peak instantaneous discharge associated with the 1 in 200 year 24 hour storm event. The spillway is included to prevent overtopping of the embankment and safely route the design storm event through the NCWR, and discharge it to the wetlands downstream. The NCWR facility was conservatively modeled as full to the invert elevation of the spillway at the start of the storm.

3.7.5.2 Surface Water Diversion Ditches

The primary objective of the diversion ditches is to maximize the collection of non-contact runoff from the catchments upstream of the WRS, CWP, CTF, PWP, and NCWR and convey it around these facilities for downstream discharge. The diversion ditches reduce the amount of runoff contributing to the mine facilities by diverting their respective upstream catchments. This reduces the capacity required in the facilities to meet storm water PMP and PMF storage requirements, and reduces overall consumptive water use. Diversion of non-contact water also reduces flow impacts downstream of the Project.

All sections of the diversion ditch system for the CTF and PWP are designed to carry the predicted peak flow generated during a PMF event. The diversion channels for the WRS, CWP, and NCWR are designed to carry predicted peak flow for a 1 in 200 year storm event. HydroCAD was used to model the contributing

areas in order to estimate the peak instantaneous discharge associated with the storm event that will report to the ditches.

The ditches will be constructed with a side slope of 2H:1V. Excavated fill material will be used as construction fill for other Project facilities as needed. It is currently assumed that the channels will be predominantly cut in rock and will need little erosion protection. Where erosion protection is required (e.g. sections of deep overburden or filled downslopes) engineered soil stabilization (i.e., concrete filled or vegetated geocell products) or riprap will be used to prevent erosion of the channel bed during high flows. The base width of the various ditch sections ranges from 6.5 to 8.2 feet (2.0 m to 2.5 m), while the ditch depth ranges from 4 to 8.2 feet (1.2 m to 2.5 m). Entire channel widths are as wide as 40 feet (12m). The ditches were designed to maintain a 0.3 m freeboard during the storm event. Steel pipe bridges will be constructed to allow tailings delivery and reclaim water pipelines to pass over the diversion channel.

An energy dissipater is included to reduce the runoff velocities and energy at the outlet of the diversion ditch system. A spreading transition still basin will serve as an energy dissipater, and includes the following components:

- spreading transition
- chute blocks at the entrance to the stilling basin
- basin blocks
- end sill

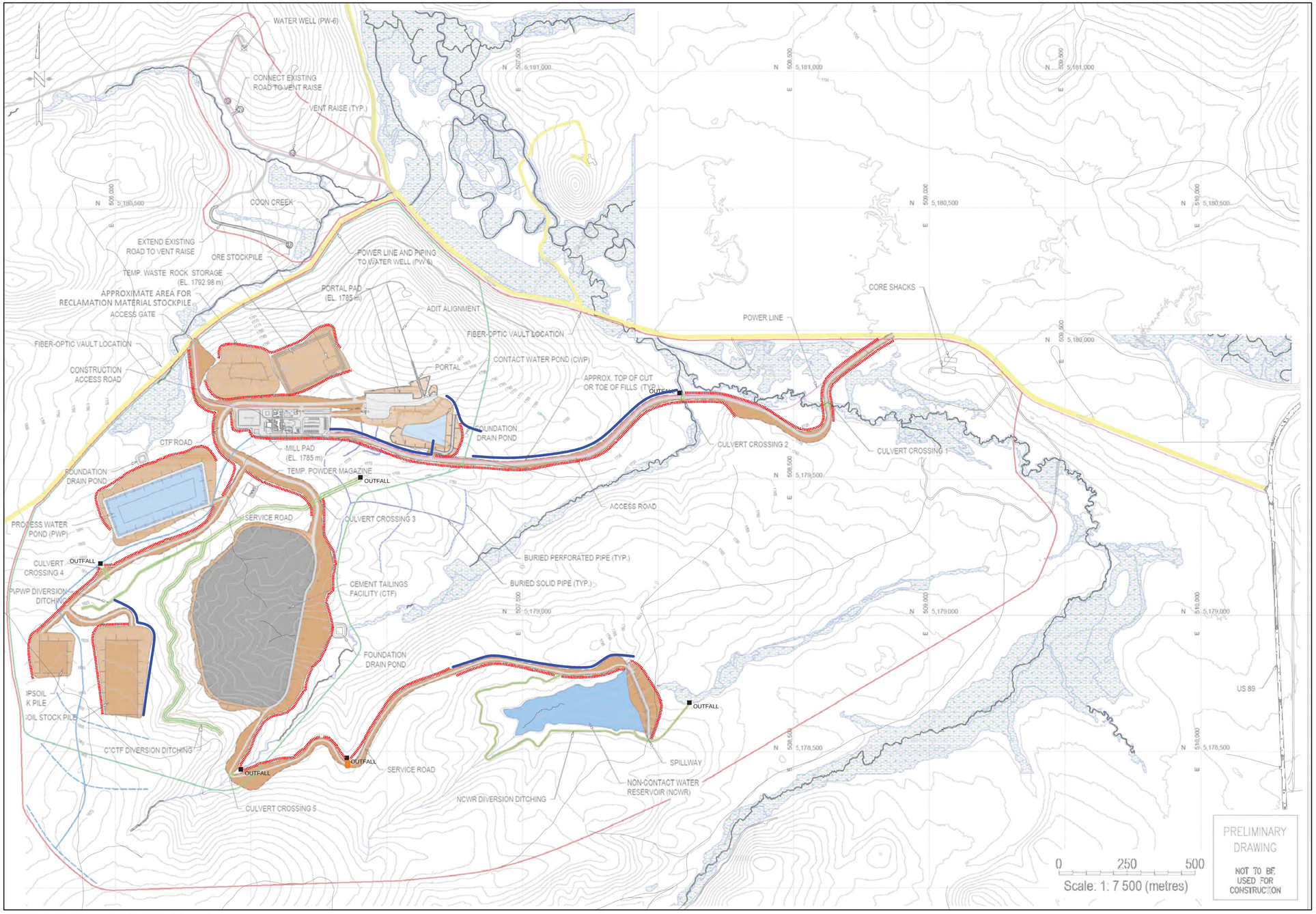
Surface water diversion channel construction details are illustrated on Drawings C5001 to C5004 in Appendix K (Knight-Piésold, 2015d).

3.7.5.3 Storm Water Control and Management

Prior to any surface disturbing activities, Tintina is required to apply for a permit for authorization for storm water discharges associated with construction activities from the DEQ's Water Protection Bureau. The applicant must prepare a Storm Water Pollution Prevention Plan (SWPPP) which is designed to protect the state waters from pollutants, which during construction are principally sediment. There are three major components to the Storm Water Pollution Prevention Plan:

- Assessing the characteristics of the site such as nearby surface waters, topography, and storm water runoff patterns
- Identifying potential sources of pollutants such as sediment from disturbed areas, and stored wastes or fuels; and
- Identifying BMPs which will be used to minimize or eliminate the potential for pollutants to reach surface waters through storm water runoff.

BMPs at construction sites typically develop various erosion and sediment control measures and implement a plan of regular maintenance and inspections to ensure that they operate correctly over time.



PREPARED BY: HYDROMETRICS, INC.

LEGEND:

- STREAMS
- WETLANDS
- POWER LINE ROUTE
- APPROX. TOES / TOP OF CUT
- PROPOSED CULVERT
- MINE PERMIT BOUNDARY (APPROX.)
- FENCE
- EXTENSION OF UNDERGROUND DRAIN FIELD
- TOE OF DISTURBANCE EROSION CONTROL
- RUN ON DIVERSION DITCH
- OUTFALL STORMWATER OUTFALL

TINTINA RESOURCES

Figure 3.39
Site Drainage Control
Black Butte Copper Project
Mine Operating Permit Application
Meagher County, Montana

After Tintina has completed construction activities at the site and prior to going into production, they will be required to apply for a second permit for authorization for storm water discharges associated with industrial activity from the DEQ's Water Protection Bureau.

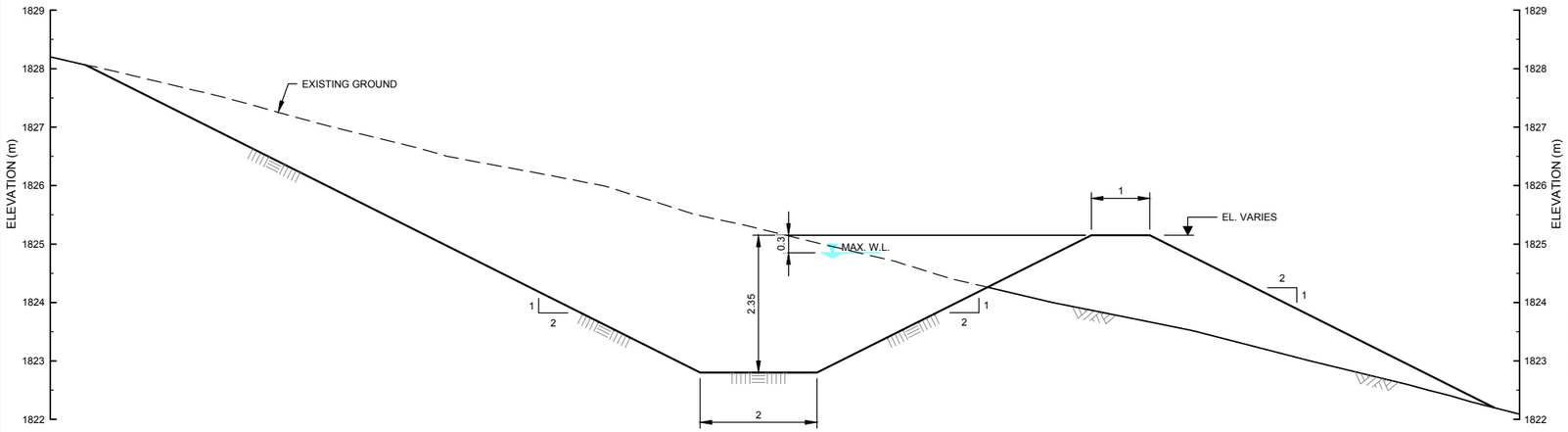
Best Management Practices for construction activities are described below in Section 3.7.6. During Tintina' s preparation of a SWPPP a water control and a storm-water management plan will be prepared and implemented at the site to prevent co-mingling of unaffected water with water affected by construction activities and later by mining and milling. This plan will also develop controls for run-off from the site and adjacent areas. Storm water management is typically implemented by diverting storm water runoff around disturbed areas, or by collecting runoff for sediment removal prior to discharge. The majority of storm water runoff at the site will be controlled by diversion around disturbed soils. Diversion structures will consist of drainage ditches or swales, spreaders, sediment traps, rock berms, straw wattles, and slash windrows. Drainage structures will be sized to safely convey the 24-hour, 100-year storm event.

All storm water controls will be constructed prior to, or in conjunction with, soil removal and stockpiling. Storm water controls are passive systems that require regular inspection for eroded areas and build-up of sediment in the slash windrow or sediment traps. With proper maintenance and inspection, each storm water control will remain in place until completion of the construction phase, and where required throughout the operational stages of the Project. Many BMPs will remain in place through mine closure and until subsequent stabilization and revegetation of disturbed areas is complete.

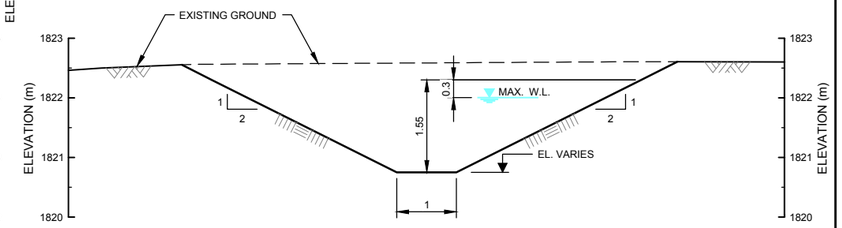
A surface water diversion ditch around the upper sides and side slopes of disturbed areas will be used to divert clean storm water from the disturbed facility areas within the site. Energy dissipation features or spreaders will be constructed where the surface water diversion outlets meet undisturbed ground. The spreaders will convert the flow concentrated in the diversion ditch to sheet flow and discharge it over an erosion blanketed lip to an undisturbed area at non-erosive velocities. The spreaders will be located such that the discharge water will not be collected by the down-slope berms or concentrated in down-slope channels. If site conditions determine that the spreaders are not appropriate for the site, down-slope drainage channels and energy dissipating outlets or infiltration basins will be specified. Sediment carried from diversions around facilities by storm water runoff will be periodically removed from the ditches and sump(s) collection drains or infiltration basins.

Water captured in the toe ditches surrounding the waste rock pads and seepage collection ponds will be diverted to the seepage ponds.

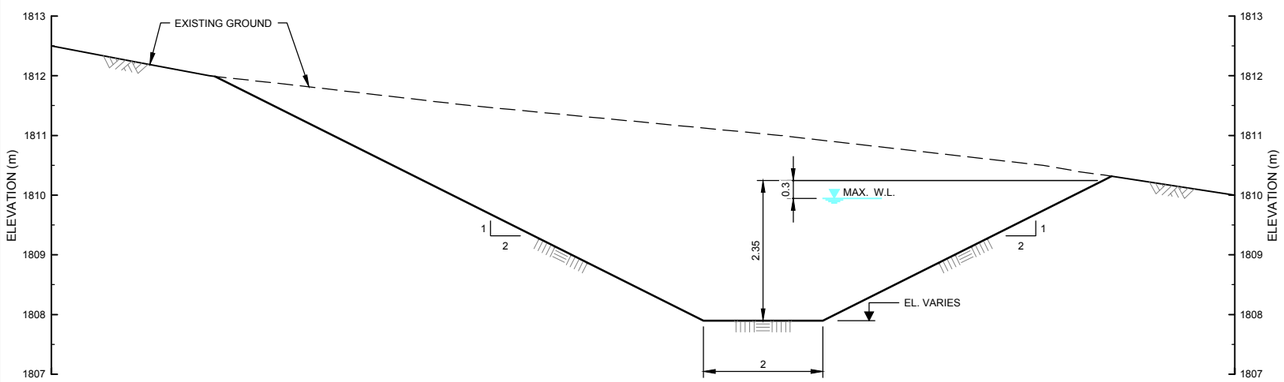
Figure 1.3 shows the general location of surface water run-on and run-off diversion ditches developed for the Project's construction areas, mine site and its supporting facilities. Typical cross-sections of diversion ditches are illustrated on Figure 3.40 from the CTF and PWP areas. A SWPPP will be developed for the Project site illustrating the final layout with respect to storm-water management. The SWPPP will be updated as needed to accurately reflect actual site BMPs conditions.



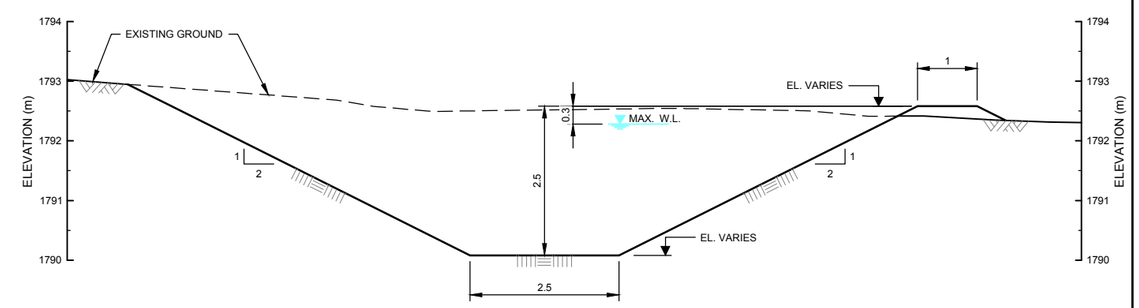
1 C5001 SECTION TYPE 1
CTF DIVERSION CHANNEL (CUT AND FILL)
SCALE A



3 C5002 SECTION TYPE 3
PWP DIVERSION CHANNEL
SCALE A



2 C5001 SECTION TYPE 2
CTF DIVERSION CHANNEL (ALL CUT)
SCALE A



4 C5002 SECTION TYPE 4
CTF AND PWP DIVERSION CHANNEL
SCALE A

SCALE A 1 0.5 0 1 2 3 4 5 m

TINTINA RESOURCES

NOTES:

1. DIMENSIONS AND ELEVATIONS ARE IN METERS, UNLESS NOTED OTHERWISE.
2. MAXIMUM WATER LEVEL (MAX. W.L.) BASED ON ANTICIPATED WATER DEPTH DURING THE PROBABLE MAXIMUM FLOOD (PMF).

BLACK BUTTE COPPER PROJECT M

MEAGHER COUNTY, MT

FIGURE 3.40
TYPICAL CROSS-SECTIONS OF DIVERSION CHANNELS FOR PROCESS WATER POND AND CEMENTED TAILINGS FACILITY

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0	15OCT'15	ISSUED FOR MOP APPLICATION	MH	NSD		

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REVISED DATE: OCTOBER 15, 2015

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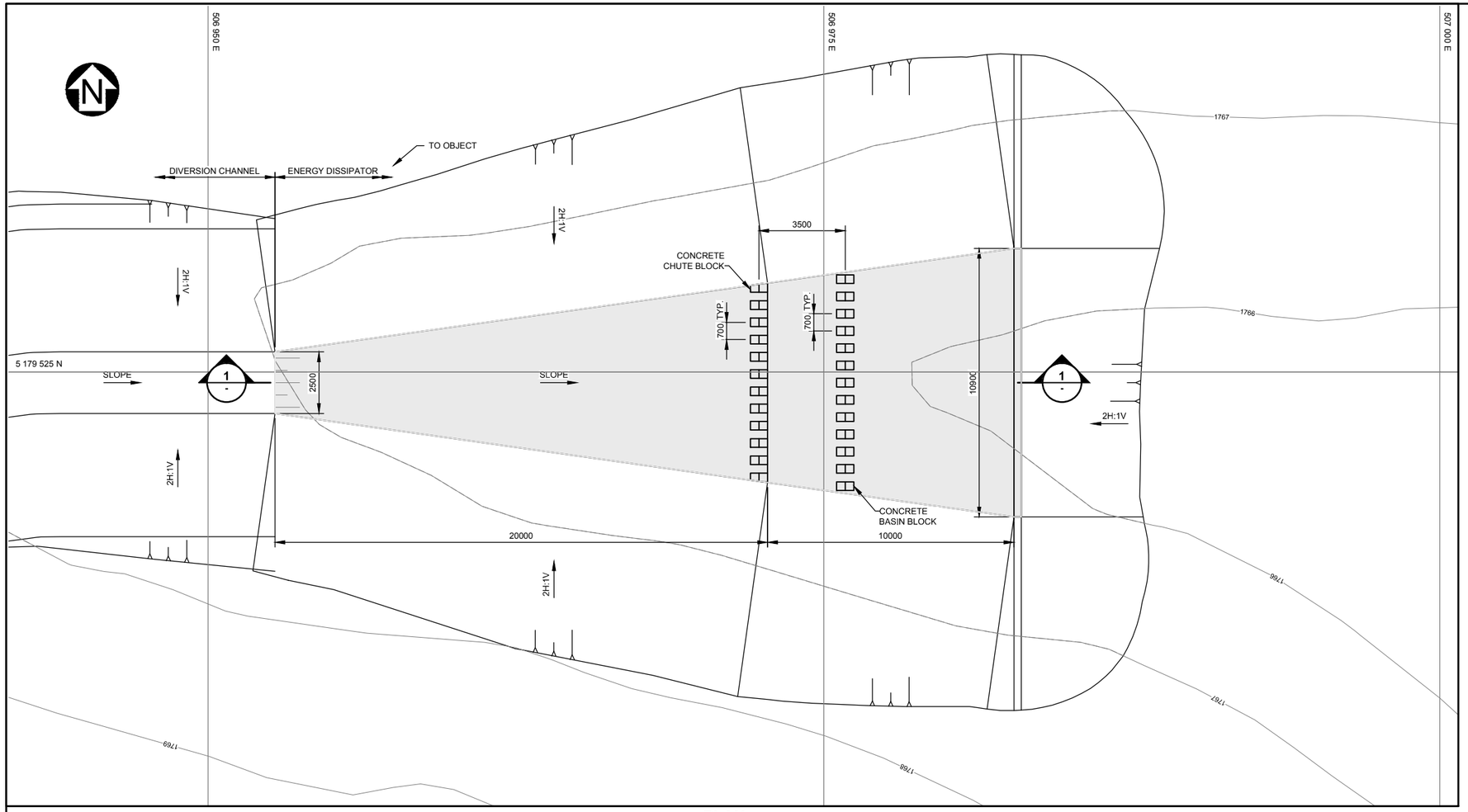
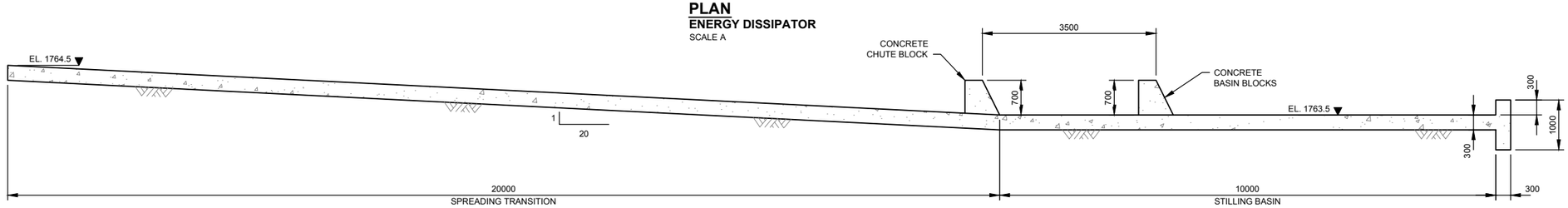


PLAN
ENERGY DISSIPATOR
SCALE A



1 - **SECTION**
SCALE B

LEGEND:

CONCRETE

NOTES:

1. DIMENSIONS ARE IN MILLIMETERS AND ELEVATIONS ARE IN METERS, UNLESS NOTED OTHERWISE.

SCALE B: 1000 500 0 1000 2000 3000 4000 5000 mm

SCALE A: 2 1 0 2 4 6 8 10 m

TINTINA RESOURCES

BLACK BUTTE COPPER PROJECT

MEAGHER COUNTY, MT

FIGURE 3.41
TYPICAL DIVERSION CHANNEL
ENERGY DISSIPATION PLAN MAP

REV	DATE	DESCRIPTION	DESIGNED	DRAWN	REVIEWED	APPROVED
0	15OCT'15	ISSUED FOR MOP APPLICATION	MH	NSD		

REVISIONS

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DRAWING BY KNIGHT PIESOLD: VA101-460/3

SOURCE FIGURE NUMBERS: C5004

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3.7.6 Erosion Control Methods and Best Management Practices (BMPs)

During the construction phase, a number erosion control techniques, methods or features will be used. The bulleted list that follows identifies and defines them.

- **Vegetation Management and Re-vegetation:** Natural vegetation is one of the best and most cost effective methods of reducing the potential for erosion and sedimentation by keeping soil secure and providing ground cover to reduce raindrop velocities.
- **Mulching:** This is the application of a uniform protective layer of straw, wood fiber, wood chips, or other acceptable material on the soil surface of a seeded area to allow for the immediate protection of the seed bed during re-vegetation. Mulching can be used in areas that require temporary or permanent covers.
- **Rolled Erosion Control Products:** These products consist of geosynthetic or organic materials composed of two layers of coarse mesh with a central layer of permeable fibres. These are used to cover un-vegetated cut or fill slopes when vegetation or mulching alone may be unsuccessful.
- **Slope Roughening:** Cut and fill slopes can be roughened with tracked machinery or other means to reduce run-off velocities, increase water infiltration rates, and helps facilitate future re-vegetation. It is simple, inexpensive, and provides immediate short-term erosion control for bare soil where vegetative cover is not yet established.
- **Re-contouring:** This method can reduce the effect of erosion by shortening the length of the accumulation and movement of water as well as decreasing the angle of the erosional slope. Re-contouring is easily planned and constructed on site.
- **Silt Fencing:** This is a perimeter control type BMP used to intercept sheet flow runoff in conjunction with other BMPs. Typical silt fencing comprises a geotextile fabric anchored to posts driven into the ground. It promotes sediment control by filtering water that passes through the fabric and increases short term retention time, allowing suspended sediments to settle. Silt fences will be placed parallel to slope contours in order to maximize ponding efficiency.
- **Temporary Sediment Traps and Sediment Basins:** A sediment trap/basin is a temporary structure used to detain runoff from small drainage areas (generally < 2 hectares) to allow sediment to settle out. A sediment trap/basin can be created by excavating a basin, utilizing an existing depression, or constructing a small dam on a slight slope downward from the work area.
- **Filter Bags:** Filter bags are generally constructed from a sturdy non-woven geotextile capable of filtering particles larger than 150 microns. Filter bags are typically installed at the discharge end of pumped diversions, via fabric flange fittings, and remove fine grained materials before discharging to the environment.
- **Flocculants:** Flocculation systems are installed in sediment control ponds and use chemical or natural additives (e.g., corn starch, chitosan, guar gum, etc.) to accelerate the natural settling process as sediment-laden water flows through the pond. These systems reduce the required pond retention time.
- **Collection Ditches:** A collection ditch intercepts contact water runoff from disturbed areas and diverts it to a stabilized area where it can be effectively managed. Coarse non-acid generating rock and equipment to build ditches and dams will be easily obtained on site, and require little further maintenance, making them effective improvements.

- **Diversion Ditches:** Diversion ditches are constructed up-gradient of disturbed areas to intercept clean surface water runoff and discharge it through a stabilized outlet designed to handle the expected runoff velocities and flows from the ditch without scouring.
- **Culverts:** Culverts are used in tandem with collection or diversion ditches to pass water flow beneath disturbed areas, typically roadways, to prevent the erosion of these constructed structures.
- **Water bars:** Water bars serve to reduce sheet flow and surface erosion of areas of exposed soil and/or roads by diverting runoff towards a stable vegetated area or collection ditch. Water bars may require regular maintenance when subjected to frequent traffic crossings.

3.7.6.1 Specific Construction BMPs

Erosion control BMPs will be implemented prior to and during construction at the Project. Erosion control BMPs reduce erosion by stabilizing exposed soil, or by reducing surface runoff flow velocities. There are generally two types of erosion control BMPs:

- Source control BMPs for protection of exposed surfaces
- Conveyance BMPs for control of runoff

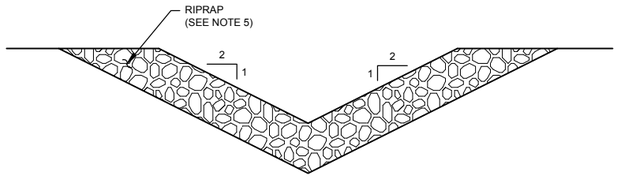
Examples of BMP's that will be implemented are included in "Water Quality BMPs for Montana Forests" (MSU Extension Service, 2001). The following BMPs will likely be used to minimize erosion, sedimentation, and to control surface and storm water run-off at the Project site:

1. Staged development to allow "green-up" or re-establishment of vegetation and minimize erosive areas.
2. Suspension of construction dirt work during periods of heaviest precipitation and runoff to minimize soil disturbance and erosion.
3. Restrict vehicular and equipment access to construction areas, or provide working surfaces/pads.
4. Minimize clearing of rights-of-way and stripping of building sites.
5. Physically mark clearing boundaries on the construction site.
6. Hydro-seed or re-vegetate cut and fill slopes and disturbed natural slopes as early as possible.
7. Use mulches and other organic stabilizers to minimize erosion until vegetation is established on sensitive areas or soils.
8. Plan seeding and planting to allow establishment before end of growing season.
9. Isolate cleared areas and building sites with diversion channels, ditches, and swales to re-direct runoff.
10. Retain natural drainage patterns wherever possible.
11. Install run-off diversions that are primarily located at surface facilities and separate contact storm water and non-contact storm water.
12. Line unavoidably steep interceptor or conveyance ditches with filter fabric, rock, polyethylene lining, or armoring to prevent channel erosion.
13. Construct stable, non-erodible ditches, and inlet and outlet structures.

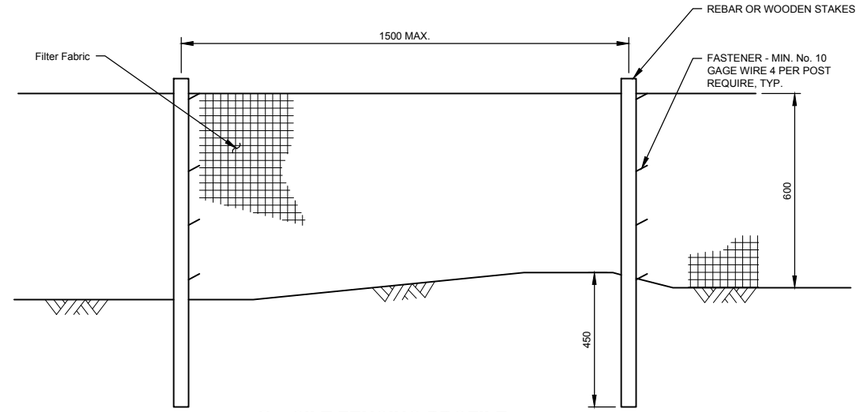
14. Sediment/silt fencing or other similar methods such as straw bales, sediment traps, and berms will be used to control sediment from disturbed areas.
15. Provide bed load clean-outs at culverts and ditches.
16. Construct, operate, and maintain sediment control ponds.
17. Develop and follow a maintenance and inspection schedule as part of the development plan. Regular inspections will occur after major precipitation or other run-off events, and also on a routinely scheduled basis to ensure that BMPs are functioning properly
18. Stockpile the required erosion/sediment control materials including: filter cloth, rock, seeding, drain rock, culverts, staking, matting, polyethylene, used tires, etc.
19. Plow snow off of the Project access roads as required. Good drainage will be established along all access roads and travel surfaces before each winter. Particular attention will be paid during the spring snowmelt/run-off season to ensure that water is controlled along access roads and in disturbed area of the site. This will minimize erosion and the transport of sediment.

Topsoil and subsoil will be removed from the sites and stockpiled. Interceptor or major diversion ditches will be installed uphill from the WRS, portal pad, mill facility, PWP, and CTF (Figure 1.3) to intercept non-contact water drainage, and convey it to existing drainage outlets. Figure 3.40 shows cross-sections of typical diversion structures around major facilities such as the PWP and CTF that are designed to carry the PMF event.

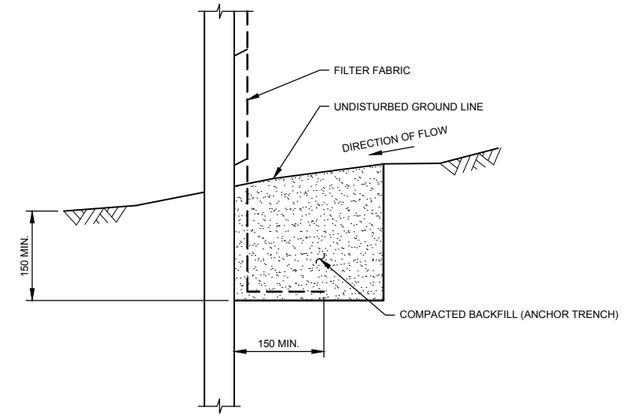
Figure 3.43 and Figure 3.44 illustrate a variety of typical erosional control BMPs that will be implemented at the Project site.



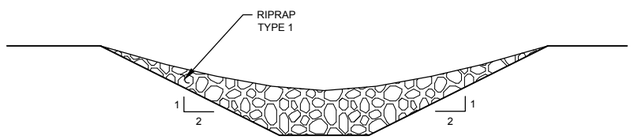
CD DD **COLLECTION AND DIVERSION DITCH**
NTS



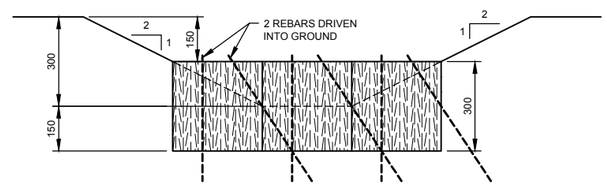
SF **SILT FENCING PROFILE**
SCALE A



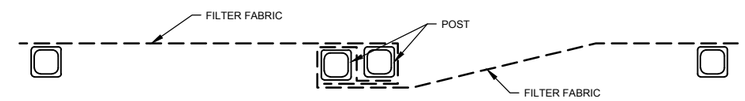
SF **SILT FENCING CROSSING SECTION**
SCALE B



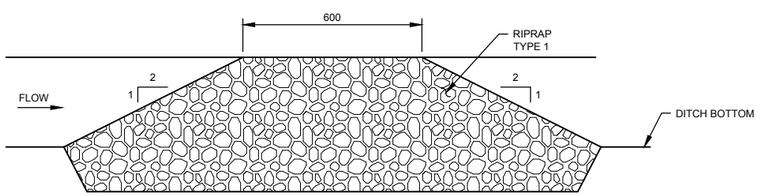
RD **ROCK DAM CROSSING SECTION**
SCALE A



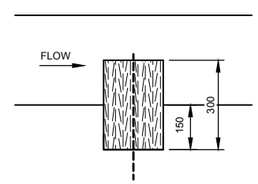
ST **STRAW BALE CROSSING SECTION**
SCALE A



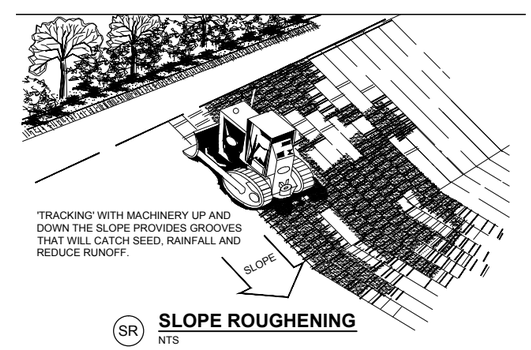
SF **ATTACHING TWO SILT FENCES**
SCALE B



RD **ROCK DAM PROFILE**
SCALE A



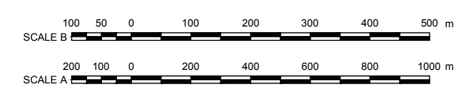
ST **STRAW BALE PROFILE**
SCALE A



SR **SLOPE ROUGHENING**
NTS

NOTES:

1. ALL SEDIMENT AND EROSION CONTROL MEASURES MUST BE CONSTRUCTED, STABILIZED AND FUNCTIONAL BEFORE SITE DISTURBANCE BEGINS.
2. SITE GRADING SURFACE WATER RUNOFF TO BE DIRECTED TO THE SEDIMENT TRAPS AT ALL TIMES DURING SITE DISTURBANCE ACTIVITIES UNTIL FINAL STABILIZATION IS ACHIEVED.
3. THE CONTRACTOR SHALL INSPECT ALL EROSION CONTROL MEASURES PERIODICALLY AND AFTER EACH RUNOFF-PRODUCING RAINFALL EVENT. ANY NECESSARY REPAIRS OR CLEANUP TO MAINTAIN THE EFFECTIVENESS OF THE EROSION CONTROL DEVICES SHALL BE MADE IMMEDIATELY.
4. AN AREA IS CONSIDERED TO HAVE ACHIEVED FINAL STABILIZATION WHEN IT HAS A MINIMUM UNIFORM 70% VEGETATIVE COVER OR OTHER PERMANENT NON-VEGETATIVE COVER TO RESIST ACCELERATED SURFACE EROSION.
5. ONLY REQUIRED WHEN ERODIBLE SOILS HAVE BEEN EXPOSED.



TINTINA RESOURCES

BLACK BUTTE COPPER PROJECT

MEAGHER COUNTY, MT

FIGURE 3.42
TYPICAL BMPS
SHEET 1 OF 2

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0	15OCT'15	ISSUED FOR MOP APPLICATION	MH	PP		

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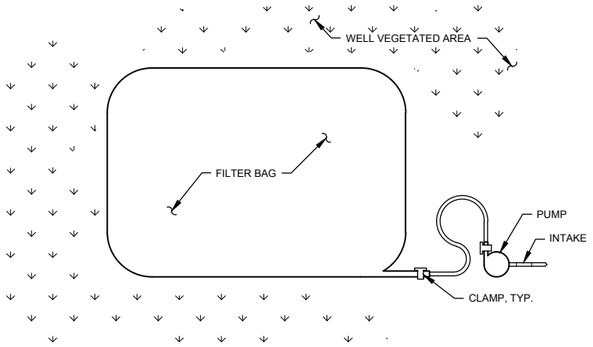
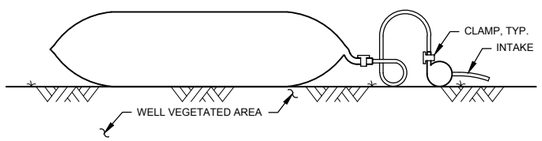
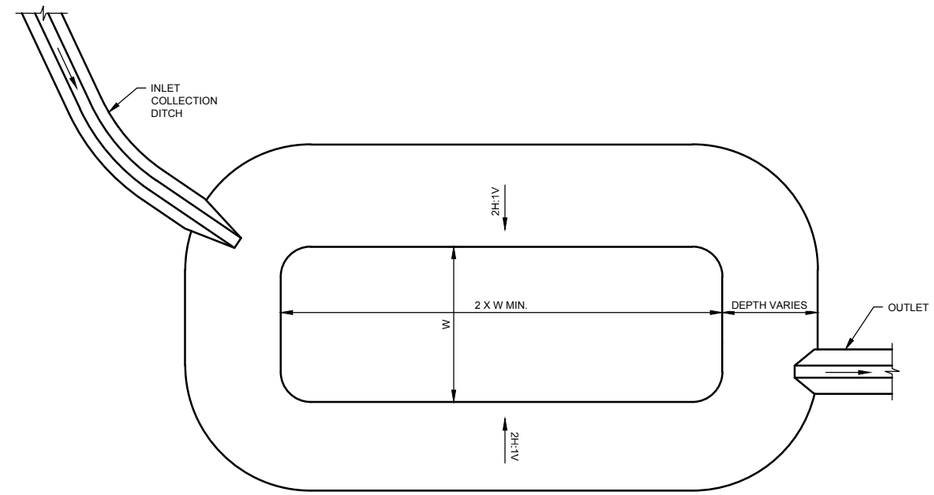


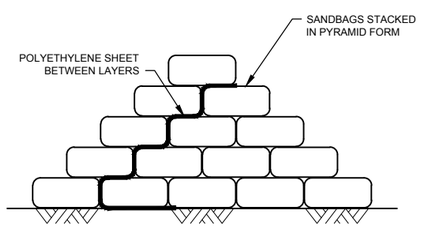
FB **FILTER BAG PLAN**
SCALE A



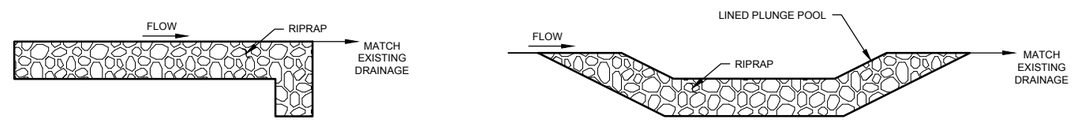
FB **FILTER BAG ELEVATION**
SCALE A



SB **SEDIMENT BASIN PLAN**
SCALE B



DS **TEMPORARY STREAM DIVERSION STRUCTURE**
NTS



TYPE 1
SMALL DRAINAGES

TYPE 2
LARGER DRAINAGES

ED **ROCK ENERGY DISSIPATOR**
NTS

SEDIMENT BASIN GENERAL NOTES:

1. SEDIMENT BASINS DETAIN STORMWATER RUNOFF FROM A DISTURBED AREA FOR AN EXTENDED TIME, ALLOWING SEDIMENT TO SETTLE.
2. SEDIMENT BASINS MAY REMAIN IN PLACE DURING OPERATIONS, AS INDICATED IN THE PLANS OR AS DIRECTED BY THE ENGINEER, OR SITE EMT.
3. SEDIMENT BASINS MAY HAVE PUMP OR OUTLET CHANNEL TO COLLECTION DITCH.
4. RELEASES FROM SEDIMENT BASINS REQUIRE FURTHER WATER MANAGEMENT/BMPS (EX. PUMPBACK, DISCHARGE TO COLLECTION DITCHES, FILTER BAGS, AND VEGETATED BUFFER STRIPS.)
5. SEDIMENT BASINS TO BE FIELD FIT TO OPTIMIZE CUT AND FILL QUANTITIES TO ACHIEVE MINIMUM SPECIFIED DIMENSIONS.

SEDIMENT FILTER BAG GENERAL NOTES:

1. NON-WOVEN GEOTEXTILE FILTER BAG WHICH RETAINS ALL SEDIMENT PARTICLES LARGER THAN 150 MICRONS.
2. PLACE FILTER BAGS ON STABLE OR WELL VEGETATED AREAS WHICH ARE FLATTER THAN 5% AND WILL NOT ERODE WHEN SUBJECTED TO BAG DISCHARGE
3. CLAMP PUMP DISCHARGE HOSE SECURELY INTO FILTER BAGS.
4. THE PUMPING RATE SHALL BE NO GREATER THAN 750 gpm OR ½ THE MAXIMUM SPECIFIED BY THE MANUFACTURER, WHICHEVER IS LESS. PUMP INTAKES SHOULD BE FLOATING AND SCREENED.
5. WHEN SEDIMENTS FILL ½ THE VOLUME OF A FILTER BAG. IMMEDIATELY REMOVE THAT BAG FROM SERVICE. PROPERLY DISPOSE OF SPENT BAGS WITH THEIR SEDIMENTS. SPARE BAGS SHALL BE KEPT AVAILABLE FOR REPLACEMENT OF THOSE THAT HAVE FILLED.
6. THE DISCHARGE FROM THE FILTER BAG SHOULD NOT PASS THROUGH A DISTURBED AREA OR CAUSE AN EROSION PROBLEM DOWN SLOPE.
7. VEGETATED BUFFER STRIP WILL BE LEFT DOWNSTREAM OF THE FILTER BAG.
8. FILTER BAGS SHALL BE INSPECTED DAILY. IF ANY PROBLEM IS DETECTED PUMPING SHALL CEASE AND NOT RESUME UNTIL THE PROBLEM IS CORRECTED.

SCALE B: 5 2.5 0 5 10 15 20 25 m

SCALE A: 2 1 0 2 4 6 8 10 m

TINTINA RESOURCES

BLACK BUTTE COPPER PROJECT

MEAGHER COUNTY, MT

FIGURE 3.43
TYPICAL BMPS
SHEET 2 OF 2

REV	DATE	DESCRIPTION	DESIGNED	DRAWN	REVIEWED	APPROVED
0	15OCT'15	ISSUED FOR MOP APPLICATION	MH	PP		

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3.8 Other Operational Management Components

3.8.1 Employees, Contractors and Housing

3.8.1.1 Total Project Employment with Subcontractors

During operations, work will follow a schedule of two 12-hour shifts per day, seven days per week, and 365 days per year. The personnel required to support and conduct the complete operation includes a total of 243 hourly employees and salaried Tintina staff, and 24 contract employees from a mining subcontractor. Out of the total Tintina work force of 243 normally only104 people will be on-site during day shifts, 41 during night shifts, and the remaining 98 on days off.

During the initial 3 years of surface support and mine construction the total number of subcontractor employees will range between 59 and 144. Due to shift work and days off, the number of actual subcontractors on-site will average approximately 74 on day shift. Construction will follow a 7 days a week, 12 hours per day schedule with a skeleton workforce on nightshift.

3.8.1.2 Positive Effects of the Project on Local Communities

Positive effects of the proposed Project development include:

- reduction of unemployment in the region;
- job opportunities for younger people, and encouragement to retain younger people in the adjacent communities;
- increased tax base for local, state, and federal government;
- economic stimulus for existing local businesses;
- long-term, meaningful employment for residents in mining operations and related positions (i.e., environmental monitoring, service and supply sectors);
- economic development and contract opportunities for existing and new businesses; and
- community infrastructure improvements.

3.8.1.3 Accommodations for Employees and Subcontractors

Tintina will require 243 employees for the operation over the 13 years and will focus on hiring from local communities within 110 miles of the operation. Tintina currently estimates it will have the opportunity to hire at least 30% of our employees within the 111 miles of the operation. The remainder will come from further away and will relocate to the area or commute to the mine. The mine will offer a 7 day on, 7 day off schedule which will allow some employees the opportunity to commute. Table 3-28 lists the names of towns, their, populations, and the distance from White Sulphur Springs. In order to enhance employment opportunities, Tintina is committed to providing training positions for various jobs throughout the operations.

Tintina has inventoried as many as 35 vacant apartments and houses for sale in the White Sulphur Springs community (August 2013). Table 3-29 also lists available motel room and recreational vehicle spots within a distance of about 75 miles of the Project. Note that this table does not include many motel room and RV sites available in the communities of Livingston, Bozeman, Helena and Great Falls.

Tintina does not intend to provide housing for its permanent employees or construction camp lodging for the temporary construction work force. Tintina will work with the local community to help develop suitable housing options for all of its permanent / subcontractor employees needing assistance.

Table 3-28. Towns and their Populations within 111 Miles of White Sulphur Springs

Town	Distance from White Sulphur Springs (miles)	Population*
White Sulphur Springs	0	943
Newhart	40	51
Great Falls	111	59,152
Helena	76	29,943
Townsend	42	1,942
Three Forks	77	1,903
Whitehall	99	1,079
Belgrade	87	7,798
Bozeman	80	41,660
Livingston	71	7,245
Harlowton	57	974
Belt	79	597
	Total	**153,269**

Data from 2013 US census.

Table 3-29. Temporary Construction Housing Availability

Units Available		Motel Facility	Location	Distance From Project Site (miles)
32		All Seasons Motel	White Sulphur Springs	18
32		Spa Motel	White Sulphur Springs	18
12		Tenderfoot	White Sulphur Springs	18
8		Gordons Highland	White Sulphur Springs	18
36		Mustang Motel	Townsend	61
15		Bob's Bar / Motel	Neihart	22
19		Countryside	Harlowton	74
18		Corral Motel	Harlowton	74
99 total rooms within 50 miles; 172 total rooms within 74 miles*				
Hook-ups	**Condition**	**Recreational Vehicle Facility**	**Location**	
16	Frost Free	Conestoga	White Sulphur Springs	18
31	Warm Weather	Conestoga	White Sulphur Springs	18
13	Frost Free	Springs	White Sulphur Springs	18
56	Few Frost Free	Lake KOA	Townsend	68
6	Frost Free	Tahoe Acres	Livingston	61
20	Few Frost Free	Chief Joseph Park	Harlowton	74
60 RV spaces available within 18 miles; 142 RV spaces within 74 miles				

*Does not include motel rooms nor all RV sites available in in Livingston MT (71 miles)

Numerous other motel and RV Sites are also available in Livingston, MT (71 miles), Bozeman, MT (80 miles), and Great Falls MT (110 miles).

3.8.2 Projected Construction and Operational Traffic

Projected average daily construction (over a 3 year period) and operational (over a 13 year period) traffic numbers are 62.6 and 100.6 per day, respectively (Table 3-30). Highway transportation study numbers indicate that some 850 vehicle per day travel US Highway 89 and 12 (both south and east of White Sulphur Springs), and as many as 1,480 vehicles per day pass through White Sulphur Springs proper (Table 2-36, Section 2.12).

Table 3-30. Construction and Operational Project Traffic Estimates

Traffic Estimates - Construction Phase	
Materials Incoming	**Average Trucks per Day**
Construction Material	3.6
Diesel /Propane	0.5
Equipment/Mining Supplies	1
Misc.; WTP, Sewage, etc.	1
Total	**6.1**
Worker Transportation	**Daily Average**
Bus	2
Personal Cars	33
Suppliers/Visitors/Management	20
Total	**55**
Materials Outgoing	Daily Average
Wastes (trash, recycle, oil wastes, sewage)	1.5
Total	**1.5**
Grand Total Daily Construction	**62.6**
Traffic Estimates - Operations Phase	
Materials Incoming	**Average Trucks per Day**
Mill Materials, cement, binder	6.3
Fuel, propane	0.3
Site & Mining Supplies	1
Misc., WTP, Sewage	1
Concentrate	18
Total	**26.6**
Worker Transportation	**Daily Average**
Cars	70
Misc., suppliers	3
Total	**73**
Materials Outgoing	Daily Average
Wastes (trash, recycle, oil wastes, sewage)	1
Total	**1**
Grand Total Daily Operations	**100.6**

3.8.3 Waters of the US (WOTUS)

Baseline wetland delineation and functional assessment (Figure 2.9) mapping and reports were completed during 2014 and 2015 by Westech Environmental Services. Summary results are presented in Section 2.3 and detailed technical reports in Appendices C-1 and C-2 of this report. Based on Westech's inventory/assessment, Tintina initiated a formal request for jurisdictional determinations from the U.S. Army Corps of Engineers (USACE) to identify Waters of the United States (WOTUS). Field investigations over the course of two days (July 27 and August 18, 2015) included personnel from the USACE, US EPA, Westech Environmental Services, and Tintina.

Proposed facility locations as presented in this mine operating permit application (Figure 1.3, which also shows wetland delineation mapping) were overlaid with mapped wetlands and streams to identify areas of overlap that might indicate potential impacts to WOTUS by mine facilities construction. Tintina examined a variety of alternatives in order to identify the alternative for with the least impacts to wetland and streams. Original mine facility designs might have impacted as much as 11.68 acres (4.7 ha) of wetlands. However, careful planning has led to a proposal that could impact as little as 1.82 acres (0.7 ha) of wetlands (Table 3-32). These potentially include: 0.11 acres (0.04 ha) along the main access road, 0.72 acres (0.29 ha) beneath the proposed CTF, 0.02 acres in culvert crossings near the CTF, and 0.02 acres (0.01 ha) stream crossing along service roads and powerline alignments associate with the proposed public water supply line, and 0.94 acres (0.38 ha) of wetlands for a total of 1.82 acres (0.74 ha) of potential impacts.

In addition to wetlands the USACE also regulates placing of dredged or fill materials into active stream segments. Table 3-31 identifies stream segments that might be impacted by proposed facility construction. These potentially include 154 linear feet (47 m) of streams along the access road, 696 linear feet (212 m) of streams beneath the proposed CTF, 25 feet (7.6 m) of streams along service road stream crossings, 7 feet of stream along the powerline/pipeline corridor from the proposed public water supply line, and 669 linear feet (204 m) in the footprint of the NCWR for a total of 1.550 linear feet (472 m).

Tintina's facility construction will impact some 1.82 acres (0.73 ha) of wetlands and 1,550 linear feet (472 m) of stream and therefore will not likely qualify for a nationwide exclusion allotted for mining activities (0.5 acres (0.02 ha) of wetlands and 300 linear feet (91.4 m) of stream) and will be required to file for an individual permit under Clean Water Act Section 404. This permit is required to be approved before construction of facilities. An application for this permit will be submitted during the mine operation permit application process period with the USACE.

Table 3-31. Estimated wetland disturbance acreage by Project facility

	Wetland Class	Project Facility	Disturbance Footprint (acres)
W-LS-02	PSS1E	Access Road	0.06
W-LS-05	PEM1E	Access Road	0.05
		Access Road Total	**0.11**
W-LST1-13	PEM1B	Cement tailings Facility (CTF)	0.27
W-LST1-12	PEM1B	Cement tailings Facility (CTF)	0.16
W-LST1-09	PEM1B	Cement tailings Facility (CTF)	0.29
		Cement tailings Facility (CTF) Total	**0.72**
W-LS-05	PEM1E	Culvert Crossing 1	0.01
W-LS-02	PSS1E	Culvert Crossing 2	0.01

	Wetland Class	Project Facility	Disturbance Footprint (acres)
		Culvert Crossings Total	**0.02**
W-LST2-13	PEM1B	Non-Contact Water Reservoir (NCWR) - Water	0.30
W-LST2-15	PEM1B	Non-Contact Water Reservoir (NCWR) - Water	0.18
W-LST2-14	PSS1B	Non-Contact Water Reservoir (NCWR) - Water	0.47
		Non-Contact Water Reservoir (NCWR) - Water Total	**0.95**
W-SCT5-01	PEM1B	Power Line and Piping to Water Well (PW-6)	0.01
		Power Line and Piping to Water Well (PW-6) Total	**0.01**
W-LST1-16	PEM1A	Service Road	0.01
		Service Road Total	**0.01**
		Grand Total	**1.82**

Note 1: PSS wetland class is a shrub wetland, PEM wetland class is an herbaceous wetland.

Table 3-32. Estimated Linear Feet of Stream Disturbance by Project facility

Stream Segment ID	Stream Class	Name	Project Facility	Disturbance Length (feet)
S-LST1-01	R3UB3	Trib. to Little Sheep Ck.	Access Road	68
S-LS-04	R3UB3	Little Sheep Ck.	Access Road	86
			Access Road Total	**154**
S-LST1-07	R4SB5		Cement tailings Facility (CTF)	339
S-LST1-06	R4SB5		Cement tailings Facility (CTF)	357
			Cement tailings Facility (CTF) Total	**696**
S-LS-04	R3UB3	Little Sheep Ck.	Culver Crossing 1	9
S-LS-04	R3UB3	Little Sheep Ck.	Culvert Crossing 1	8
			Culvert Crossing 1 Total	**18**
S-LST1-01	R3UB3	Trib. to Little Sheep Ck.	Culvert Crossing 2	3
S-LST1-01	R3UB3	Trib. to Little Sheep Ck.	Culvert Crossing 2	4
			Culvert Crossing 2 Total	**7**
S-LST2-02	R3UB3		Non-Contact Water Reservoir - Water	669
			Non-Contact Water Reservoir - Water Total	**669**
S-SCT5-06	R3UB3	Trib. to Sheep Ck.	Power/Piping to Water Well (PW-6)	7
			Power/Piping to Water Well (PW-6) Total	**7**
			Grand Total	**1550**

Note 1: R3 stream class is a perennial stream. R4 stream class is an ephemeral stream.

3.8.4 Air Quality and Dust Control

Air quality monitoring plans are designed to ensure that fugitive dust generated from cut and fills, tailings surfaces, and other construction, storage and disposal areas do not become a public nuisance, or detriment to flora or fauna. In addition, air quality rules require reasonable precautions to be taken to prevent emission of airborne particulate matter. Tintina will be required to obtain a Montana Air Quality

Permit under the Montana Clean Air Act that specifies requirements for applicable State and Federal air quality standards. The permits issued will specify dust control, monitoring, and reporting requirements in detail. The air quality permit application requires that the applicant demonstrate compliance with all applicable state and federal regulations and ambient air quality standards.

Tintina will apply for and acquire an Air Quality Permit from DEQ's Air Quality Bureau prior to construction and mining activities at the site. A list of equipment and specifications for all other stationary emissions sources will be compiled for submittal for review and final determination of permitting needs once specific pieces of equipment have been selected for the mining operation. Detailed information will be provided for the eight diesel generators proposed for construction and two for operations, the air compressor used temporarily during initial underground construction (prior to line-power being connected), and the two main back-up generators and other small emergency generators used for hoists for emergency underground mine evacuation operationally, as well as propane heat sources for mine air during winter months. The conditions of the Air Quality Permit will specify monitoring and reporting requirements in detail, and may specifically require air quality monitoring for particulates.

The ambient air monitoring station just west of the core shed (Figure 1.2) will remain operational to accurately characterize the local meteorology, to collect additional baseline data during mine permitting, and then monitor air quality during mining and in closure.

The Administrative Rules of Montana (ARM) 17.24.115(h) requires that a reclamation plan ensure that precautions are taken to ensure that airborne fugitive dust generated from cuts, tailings or disposal areas do not become a public nuisance or detriment to flora or fauna. Further, air quality rules under ARM 17.8.308 require that reasonable precautions are taken to prevent emissions of airborne particulate matter.

Tintina will implement additional dust control measures by watering along access and CTF roads and/ or the use of chemicals on high traffic areas near private ranch buildings. This will reduce the impacts of fugitive dust to insure that it is not further exacerbated by blowing wind. Temporary waste rock and life of mine copper-enriched rock storage areas will also be watered as necessary to minimize dust while loading or unloading material. Monitoring by site personnel during each shift will ensure watering is done to the level required to minimize the effects of dust at the site. Construction related disturbances that may generate dust and are not needed operationally will be re-contoured, soil placed, and revegetated as quickly as possible following construction. This will include road cut-and-fill slopes, facility berms (WRS Stockpile, and mill facility), embankments and berms of the CTF, CWP, PWP, WRS and NCWR, buried pipelines, water diversion ditches, and soil/subsoil stockpiles. Dust control from the CTF is not expected to be problematic because the material will be moist (20%) and will be stabilized with cement additions to provide a non-flowable mass. Dust control features for the interior and exterior environments for the mill site and primary crusher are detailed in the Mill facility section (Section 3.3.2).

Other components of the dust control plan Include:

- Minimizing exposed soil areas to the extent possible by prompt revegetation of reclaimed areas
- Establishing temporary vegetation on inactive soil and spoil stockpiles that will be in place for one year or more
- Use of chemical dust control products to stabilize access and trucking road surfaces
- Application of water to access roads and active haul roads during dry periods
- Enclosure of screens, crushers, and copper-enriched rock and waste transfer points

- Covering of conveyor belts
- Use of fabric filter dust collectors at crushing, screening, transfer, and loading points

3.8.5 Visual Resource Assessment

Plan maps of the surrounding area and proposed facility locations were used to determine viewing angles of the Project in order to generate visual resource projections. This information was then used to determine where the public would have the least obscured view of proposed facilities. Section map worksheets were then prepared to determine sight lines from the viewpoints to the proposed facilities. Land and structure elevations and the relationship to the viewpoint elevations were used as measurements for the simulations. The projection of the sight lines revealed if and how much of the proposed facilities were visible from the viewpoints, and was used to aid in selection of the final viewpoints. A wireframe of the proposed facilities was constructed on the landscape using the information from the worksheets. Once the visibility of the subject was determined, color, shading and texture were then added to the wireframe.

Three viewpoints (VP) from which the public was likely to view the Project site were selected for visual resources assessment of the Project site. Viewpoint 2 (Figure 3.44) is located on US Highway 89 about 0.5 miles (800 m) south of the junction with the Sheep Creep county road looking west-northwest (see Figure 1.3). VP-6 (Figure 3.45) is located on the Sheep Creek county road about 0.5 miles (800 m) west of the core sheds looking southwest. VP-7 (Figure 3.46) is located on the Butte Creek Road about 300 feet (100 m) northeast and downhill of the divide between Sheep and Butte Creek looking northeast. In the figures the existing condition is shown in the upper photograph and the year 3 view (shortly after construction) is simulated in the lower photograph.

As a means of providing a site-wide oblique aerial photographic view, Figure 3.47 illustrates a graphic representation of the Project site looking to the northwest.

VP-US Highway 89 Existing

VP-US Highway 89 Proposed

Date: November 19, 2015 Source: Tetra Tech (2015)

TINTINA RESOURCES

Figure 3.44
VP US Highway 89
Black Butte Copper Project
Meagher County, Montana

VP-Sheep Creek Road Existing

VP-Sheep Creek Road Proposed

Date: November 19, 2015 Source: Tetra Tech (2015)

TINTINA RESOURCES

Figure 3.45
VP Sheep Creek Road
Black Butte Copper Project
Meagher County, Montana

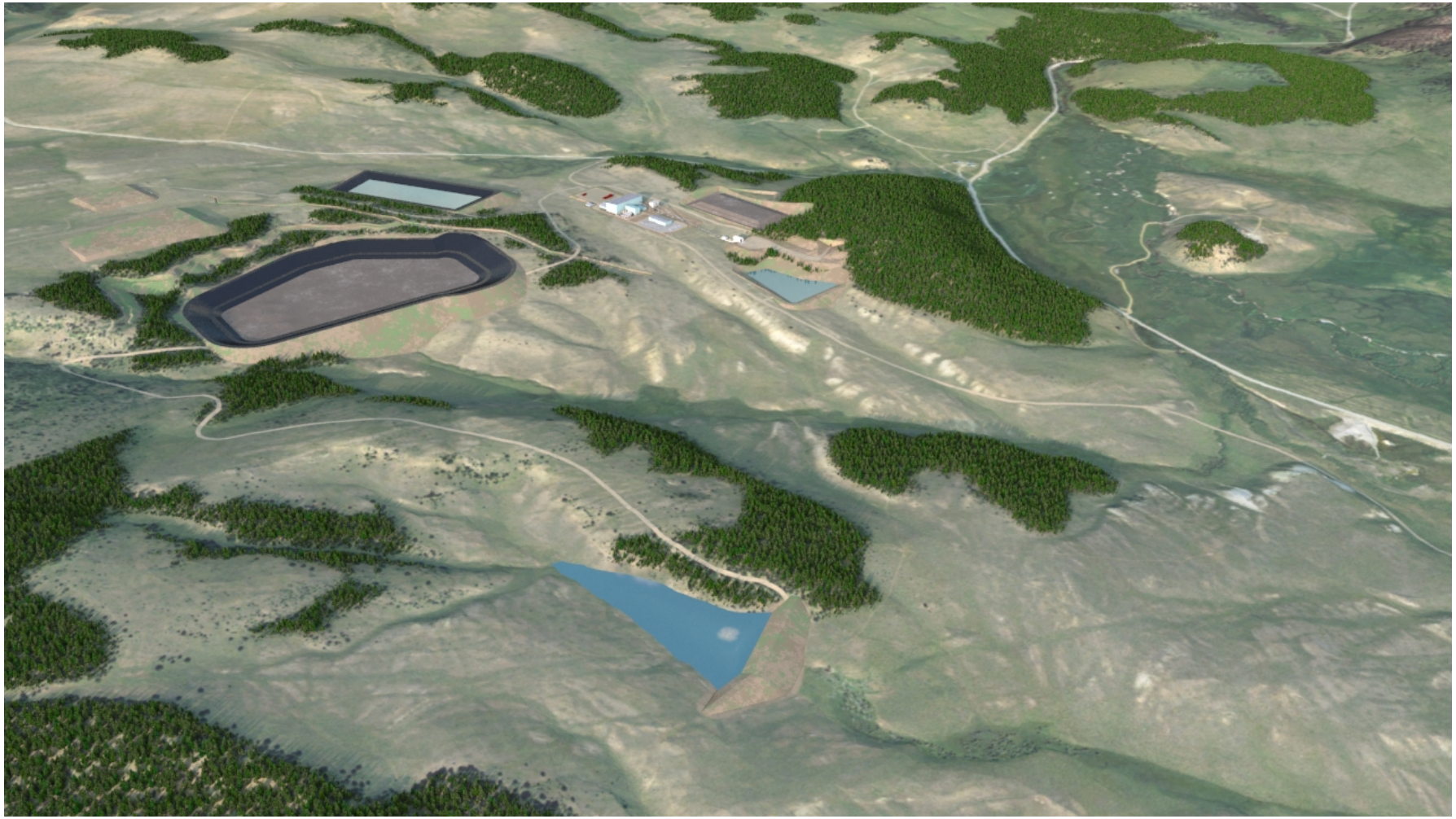
VP-Butte Creek Road Existing

VP-Butte Creek Road Proposed

Date: November 19, 2015 Source: Tetra Tech (2015)

TINTINA RESOURCES

Figure 3.46
VP Butte Creek Road
Black Butte Copper Project
Meagher County, Montana



Date: November 19, 2015 Source: Tetra Tech (2015)

TINTINA RESOURCES

Figure 3.47
Oblique Aerial Simulation Looking Northwest
Black Butte Copper Project
Meagher County, Montana

3.8.6 Operational Noise

An Operational Noise Assessment was completed for the Black Butte Copper Project by Big Sky Acoustics. Methods of quantifying and describing noise levels are discussed in greater detail in Appendix J (Big Sky Acoustics, 2015).

It is important to note that the EPA has determined that a day-night average noise level (L_{dn}) of 55 dBA or less is sufficient to protect public health and welfare in residential areas. Instantaneous peak noise levels (L_{pk}), such as those produced by blasting, are considered an annoyance if they exceed 115 dBP.

Assumptions used for noise predictions are summarized in Table 3-33 and are based upon a conservative assumption that all equipment and operations will operate simultaneously during a given phase. Noise contours for the construction and production phases show the influence of the local topography on the propagation of noise relative to the four baseline monitoring sites (Figure 2.22, Figure 3.48 and Figure 3.49).

Table 3-33. Summary of Assumptions Used for Noise Predictions

Action / Phase	Assumptions
Construction	• Two pieces of diesel-powered earth-moving equipment operating at the Cemented tailings Facility (CTF) for 20 hours per day. • Two pieces of diesel-powered earth-moving equipment operating at the Process Water Pond (PWP) for 20 hours per day. • Two pieces of diesel-powered earth-moving equipment operating at the portal pad for 20 hours per day. • Two pieces of diesel-powered earth-moving equipment operating at the mill pad for 20 hours per day. • Trucks moving material from the portal pad area to the CTF and PWP. 80 round trips per day for 20 hours per day at 25 mph.
Production	• Mill operates 24 hours per day. • Crusher at west end of portal pad operates 20 hours per day. • Underground mine truck bringing material from portal to crusher. 82 round trips per day for 24 hours per day at 15 mph. • Loader operating at crusher 20 hours per day. • Vent raises with ventilation fan at bottom of two 120 foot long, 7-foot diameter shafts. Fan is attenuated to meet 85 dBA at 3 feet (0.9 m).
Blasting	• Charge is 632 pounds (286.6 Kg) of explosive per delay. • Initial blasting at or near the surface.

Table 3-34**,** Table 3-35, and Table 3-36 summarize the predicted noise levels due to construction, production, and blasting activities, respectively. An audibility determination of construction and production noise at the four baseline measurement locations is also provided. The predicted construction and production noise Ldn levels are less than the EPA guideline of 55 dBA at each location. Construction and production noise levels are predicted to be “faint”, but audible, due to the low ambient noise levels in the area.

Blasting will be audible for several miles around the Project site when it occurs at or near the surface. As the Project progresses underground, blasting noise will decrease. The blast noise is predicted to be less than the 115 dBP annoyance threshold at each location, except Location 1, the Bar Z Ranch, which is predicted to be 116 dBP.

Table 3-34. Summary of Predicted Construction Noise Levels (dBA)

Baseline Monitoring Location	Measured Baseline Noise Level (L_{dn})	Predicted Project Noise Level (L_{dn})	Perception of Project Noise at Locations
1	42	40	Clearly audible
2	48	29	Rarely audible
3	33	32	Occasionally audible
4	31	29	Occasionally audible

Table 3-35. Summary of Predicted Production Noise Levels (dBA)

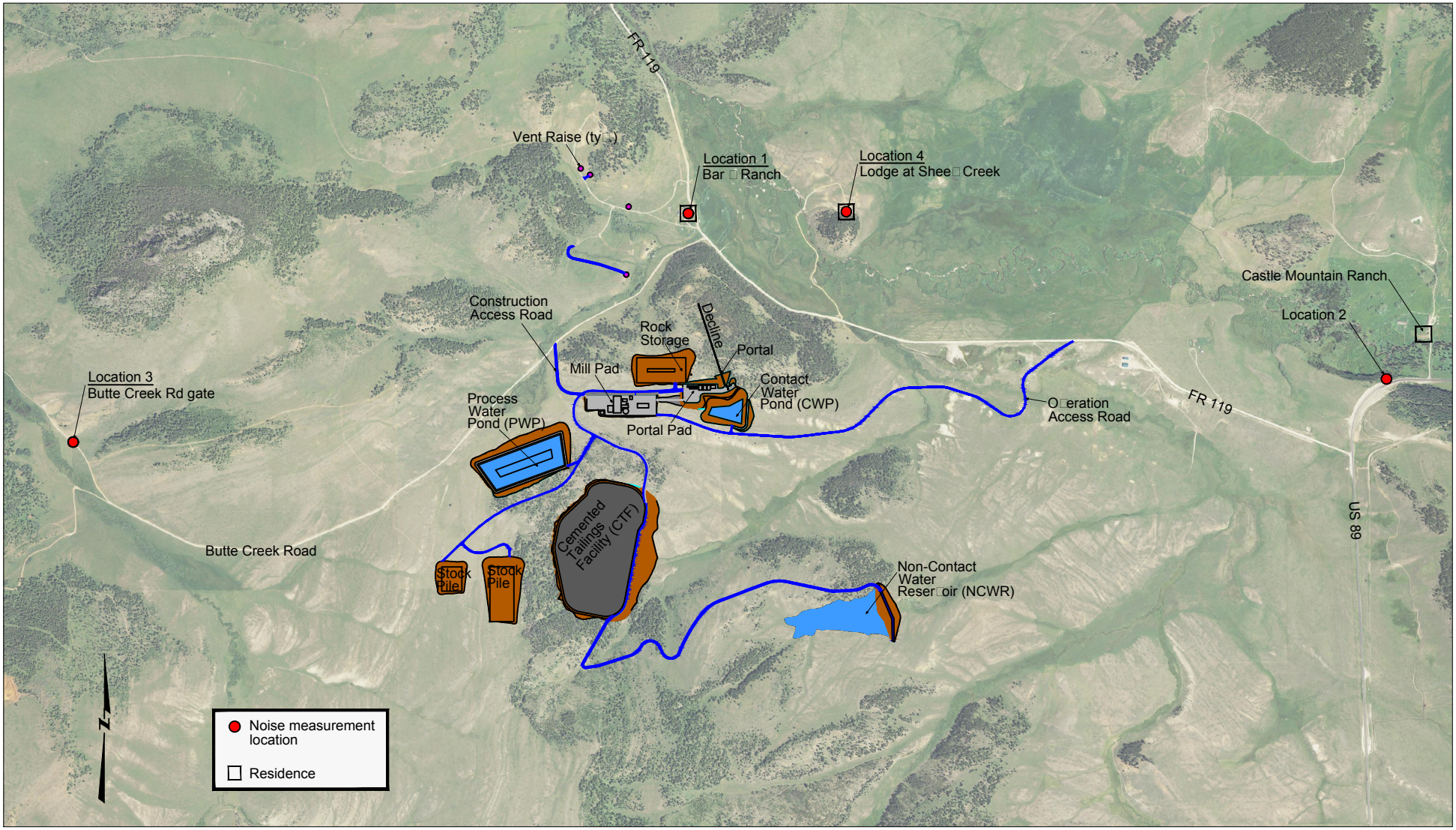
Baseline Monitoring Location	Measured Baseline Noise Level (L_{dn})	Predicted Project Noise Level (L_{dn})	Perception of Project Noise at Locations
1	42	35	Clearly audible
2	48	30	Occasionally audible
3	33	31	Clearly audible
4	31	27	Occasionally audible

Table 3-36. Summary of Predicted Blasting Noise Levels (dBP)

Baseline Monitoring Location	Predicted Blast Noise Level (L_{pk})
1	116
2	106
3	106
4	114

All surface vehicles will use discriminating backup alarms that comply with MSHA requirements where backup alarms are required. Noise levels will be maintained at less 82 dBA from ventilation fans. The portal will function as both the intake and exhaust of mine air.

Representative noise levels cannot be measured at the site until equipment and facilities are in place.

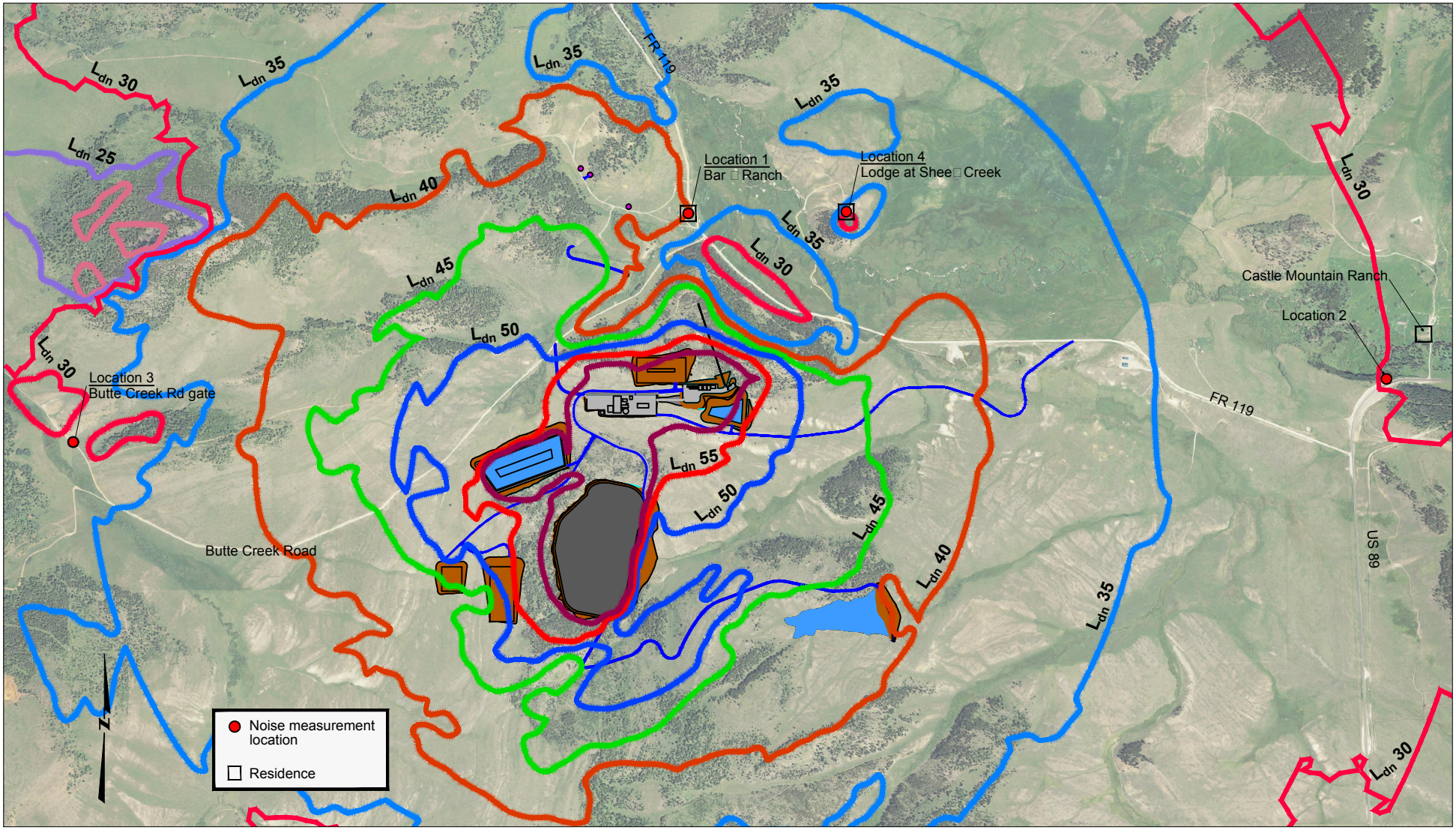


Date: November 30, 2015 Source: Big Sky Acoustics LLC (2015)

Scale: 1 mm = 250 m (8.5"x11")

TINTINA RESOURCES

Figure 3.48
Project Facilities and Noise Monitoring Locations
Black Butte Copper Project
Meagher County, Montana



Scale: 1 mm = 250 m (8.5"x11")

Date: November 30, 2015 Source: Big Sky Acoustics LLC (2015)

TINTINA RESOURCES

Figure 3.49
Noise Contours (dBA): Construction Phase Black Butte Copper Project
Meagher County, Montana

3.8.7 Fire Protection

Fire protection is a typical component of both construction and mining operations. Fire hazards at the Project are very low for most of the year, and moderate in the late summer through the fall. The principle potential zones of fire include:

- Brush fires in the shrub-covered terrain surrounding the Project site
- Fire at the mill processing facility.
- Douglas fir forested ridgetops in the vicinity of the Project area

All mobile equipment will have installed fire extinguishers for Class A, B, and C fires. During the summer forest fire season, Department of Natural Resources and Conservation (DNRC) guidelines will be followed. Tintina will require employees, contractors, and subcontractors to comply with all applicable Federal and State fire laws and regulations, and insure that they take all reasonable measures to prevent and suppress fires in the area of operations. Fire and ambulance equipment are described in the mill facility section (Section 3.3.3). The mill facility, shop and administrative areas will be protected to NFPA requirements with sprinkler systems and will be MSHA-compliant.

In the event of a brush fire, fire protection will be with water from the fire storage tank and the water and fire trucks, augmented by the White Sulphur Springs and Meagher County fire services. Support for fires involving Forest lands could include the U.S. Forest Service. Tintina will cooperate with Meagher County and other stakeholders on fire reduction mitigation activities.

3.8.8 Solid Waste Disposal

The predominant solid wastes from the Project will be tailings and waste rock, and the facilities for storage, and the handling of these materials are discussed in Sections 3.6.7 and 3.6.4 respectively. Other waste generated at the site will include general wastes (paper, bottles, cans, and food), maintenance shop wastes, and sewage wastes. All solid waste will be disposed of in accordance with rules and regulations of the Waste and Underground Tank Management Bureau, of the DEQ. No landfill will be constructed on site. Containers for various types of refuse will be provided at appropriate locations at the site. For refuse that contains food or other items that could be an attractant to wildlife, appropriate containers will be properly located to minimize wildlife access and will be emptied frequently.

General waste will be collected daily in plastic bags and placed in dumpsters at various locations at the site for collection by a contract service. This service will pick-up wastes on a weekly basis and transport them to a licensed county solid waste facility.

Maintenance shop waste consisting of rags, paper, metal, cardboard, and wood boxes (in which spare parts are received) will be sorted and disposed of in a specific dumpsters identified for this purpose. Once a week (or more often if required), a contract service will pick up this waste and dispose of it in various types of facilities including a metal recycling facility, a wood waste disposal facility, and/or a licensed county solid waste facility. Recycling will be implemented wherever appropriate and applicable.

3.8.1 Sewage Treatment

Domestic wastewater (from sinks, toilets, and showers) at the mine site will be treated and disposed using a conventional septic system. The septic system will consist of a septic tank to settle solids and a subsurface drain field to dispose of settled wastewater. The system will require periodic maintenance that includes cleaning the septic tank effluent filter and pumping out the septic tank to remove accumulated solids. Septic tank pumping frequency is assumed to occur annually but may not be required

more than every 3 to 5 years. Solids will be pumped from the septic tank by DEQ licensed septic haulers and disposed at an approved facility according to applicable regulations.

The volume of wastewater generated at the site was determined based on the predicted workforce size and wastewater flow values taken from the Montana Department of Environmental Quality Circular DEQ-4. For aboveground workers, wastewater values for Industrial Buildings were used. For underground miners, wastewater values for Dormitory/Bunkhouses were used as these workers are likely to generate more wastewater due to their use of onsite shower facilities. The resulting average daily wastewater flow from the site is 3,800 gallons per day (Table 3-37).

Table 3-37. Estimated Wastewater Flow

Typical Wastewater Flows (DEQ 4)	Range of Wastewater Flow (gpd)		Wastewater Flow Typical (gpd) /employee	Number of Employees	Total Flow (gpd)
Industrial Building (Aboveground Workers)	10	16	13	76	**988**
Dormitory, Bunkhouse (Underground Workers)	20	50	40	69	**2,760**
				Total	**3,748**

Based on the expected rate of effluent flow from the septic tank and online soil infiltration data (which are consistent with data collected during siting studies for mine dewatering underground infiltration galleries systems), approximately 4,750 square feet (440 m^3) of drain field will be required. The Project intends to construct a drain field measuring approximately 100 foot by 100 foot (930m^3) in order to provide about 50% excess capacity.

3.8.2 Hazardous Materials Disposal

All hazardous materials (fuels, waste lubricating oil, hydraulic fluid, antifreeze, and other similar waste) will be stored in DOT approved containers with secondary containment, labeled by specific fluid type. A licensed commercial hazardous waste disposal contract service, that specializes in handling and recycling or other licensed means of disposal of these types of waste will pick up these fluids and transport them to a recycling facility. A combined Storm Water Pollution Prevention Plan (SWPPP) / Spill Prevention Containment and Clean-Up (SPCC) plan for the Project will be prepared as required for the final operating permit. These plans will address the potential for accidental spills of fuel or other hazardous materials such as hydraulic fluid, grease, or coolant. Appendix P (Tintina Resources, 2013b) is a preliminary Emergency Response Plan developed for the Project, which is currently being revised.

3.8.3 Site Security

A four-strand barbed-wire fence will surround the core Project facility area as shown on Figure 1.3. The purpose of this fence is to keep cattle out of the active mine areas while allowing property owners maximum use of their land for cattle grazing. The fence will be placed on either side of the main access and construction access roads to lane them off for worker, vehicle and cattle safety (Figure 1.3). The main access road to the Project will have a lockable gate at the Sheep Creek county road. This gate will remain open during all active periods of operation. The main access road will have another gate on the

southeast end of the mill facility pad (Figure 3.6). A guardhouse will be located along the barbed-wire perimeter fence described above. This gate will be either monitored or manned 24-hours per day during operations to control entry onto the site. Because the operating schedule is anticipated to be 7 days per week, 365 days per year, mine staff will provide security, in the event of a longer term closure the company may elect to hire a watchman.

The guardhouse area will also have a small parking area and a truck scale for weighing trucks carrying materials onto and off the site. In the vicinity of the mine, signs will be posted between the public access roads and adjacent private property to discourage trespassing.

The contractor access road will have a lockable gate at the Butte Creek county road, this gate will be open and monitored during active construction periods or alternatively during less active periods locked and opened as necessary.

The CWP, PWP and CTF will have eight-foot high wildlife fences constructed around them. The NCWP will have a barbed wire fence surrounding the reservoir to prevent cattle from damaging the shoreline and diversion ditches. Eight foot high chain-link fences will also surround the four ventilation raise collar areas and the potable water well location (Figure 1.3). The temporary powder magazine will be fenced and protected as required by MSHA regulations until it is relocated underground during the first year of development mining.

3.8.4 Lighting

All operational and construction exterior lighting will be shielded to reduce visual impacts from viewpoints in the Sheep Creek valley to the extent that it can be safely accomplished.

3.8.5 Cultural Resource Protection

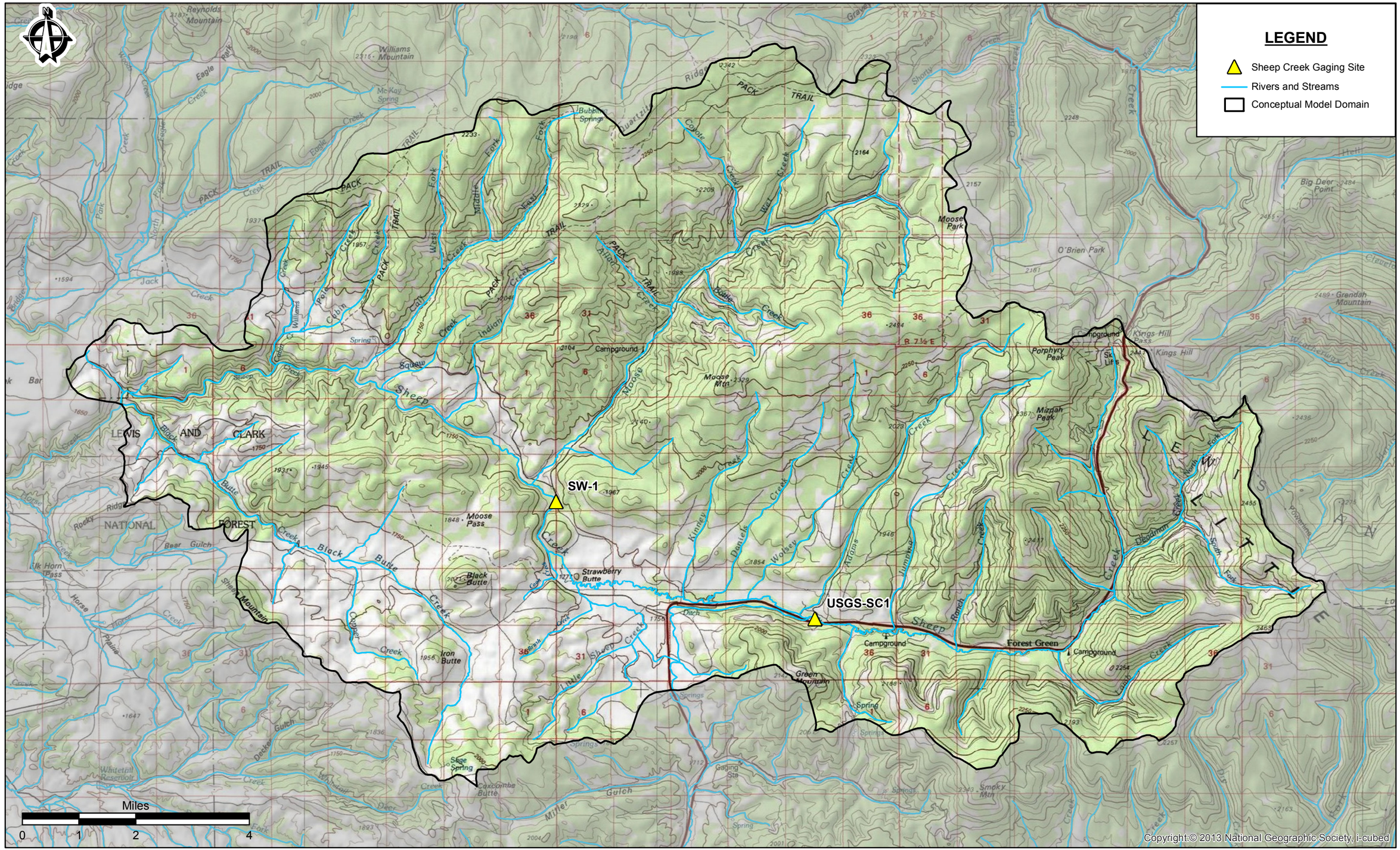
Cultural resources were surveyed in areas likely to be within the area of influence of surface disturbances. Although several lithic scatter sites have been identified as occurring in proposed construction areas (Section 2.9), Tintina has agreed to mitigate these sites by excavation and/or study where necessary as determined by SHIPO. DEQ has recommended an archaeologist be present during construction in the vicinity of any of the prehistoric sites identified. Any future discoveries in the Project area will be professionally recorded and evaluated and any sites found to be eligible for the National Register will be protected or mitigated in accordance with state SHIPO requirements.

4.0 MODELING STUDIES

4.1 Hydrologic Conceptual Model

4.1.1 Regional Setting

Sheep Creek, originates in the Little Belt Mountains at an elevation of approximately 7,400 feet (2,256 m). It discharges to the Smith River approximately 36.6 river miles (59 km) to the west at an elevation of 4,380 feet (1,335 m). This conceptual model focuses upon the upper two thirds of the Sheep Creek watershed, which extends from the headwaters of Sheep Creek downstream to the confluence of Black Butte Creek. The model area shown in Figure 4.1 includes a number of small unnamed tributaries in addition to larger tributary streams which support perennial flow over most of their reach. Little Sheep Creek and Black Butte Creek are two of the larger named tributaries to Sheep Creek in the immediate Project area that support perennial flow over most of their length. Black Butte Creek lies immediately west of the Project area and joins Sheep Creek approximately 7 miles (11.3 km) downstream of the Project site.



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Date: November 9, 2015 Source: Hydrometrics (2015)

TINTINA RESOURCES

Figure 4.1
Conceptual Model Area
Black Butte Copper Project
Meagher County, Montana

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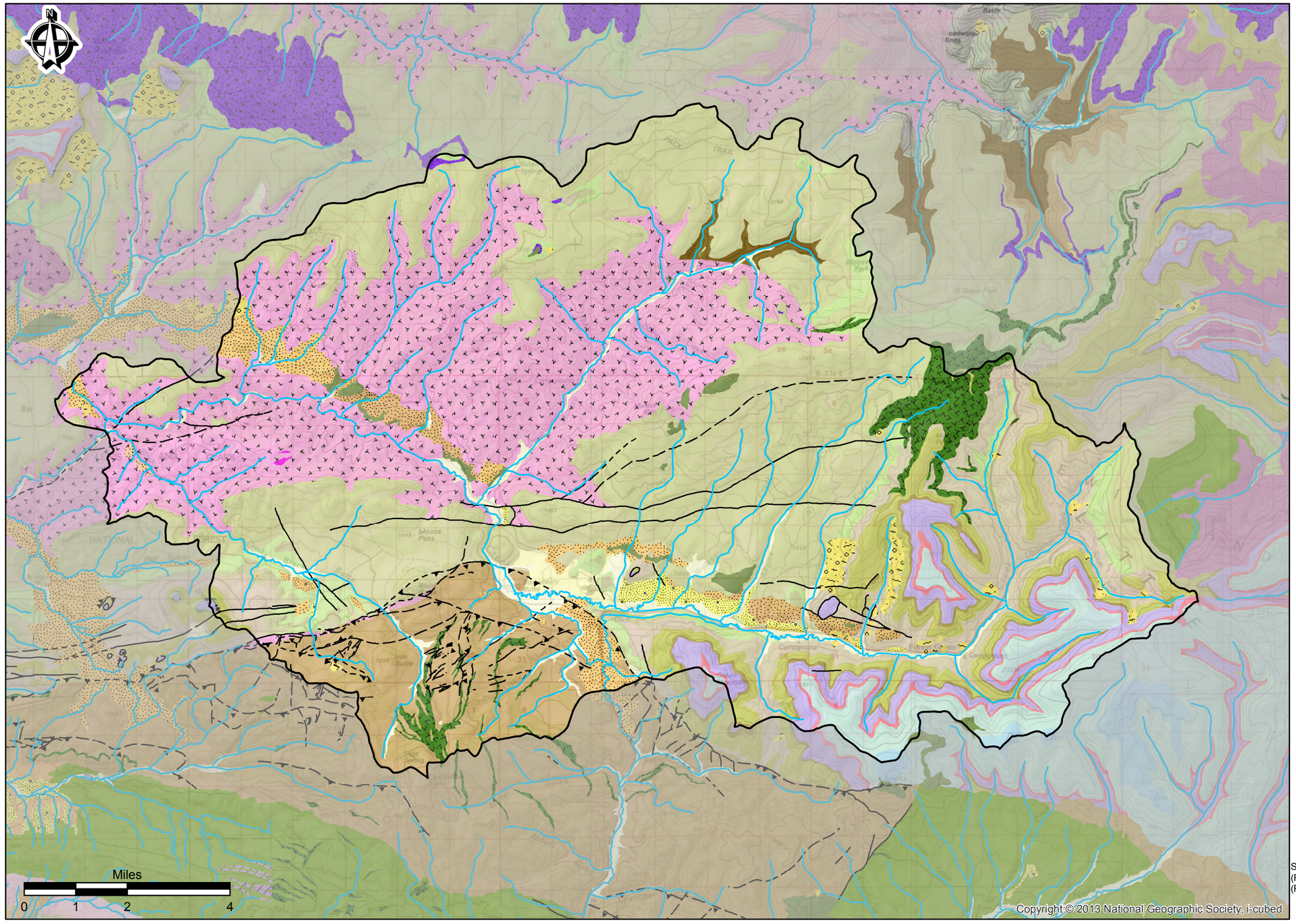


LEGEND

Quaternary

- Qt Terrace gravel (Holocene and Pleistocene)
- Qp Pediment gravel (Holocene? and Pleistocene)
- QTg Older gravel (Pleistocene and Pliocene)
- Qoa Old alluvium (Holocene or Pleistocene)
- Ql Landslide deposit (Holocene and Pleistocene)
- Qc Colluvium (Holocene)
- Qac Alluvium and colluvium, undivided (Holocene)
- Qa Alluvium (Holocene)

Tertiary

- MIOGs Sedimentary rocks, undivided (Miocene and Oligocene)
- OGs Sedimentary rocks older than basalt flow (Oligocene and Eocene?)
- EOqm Quartz monzonite (Eocene)
- Eobhqm Biotite hornblende quartz monzonite (Eocene)
- Eobgd Biotite hornblende dacite (Eocene)
- Oib Basalt (Oligocene)

Paleozoic

- Mm Mission Canyon Limestone (Upper and Lower Mississippian)
- Ml Lodgepole Limestone (Lower Mississippian)
- MDt Three Forks Formation (Lower Mississippian and Upper Devonian)
- Du Upper and Middle Devonian rocks, undivided
- Dj Jefferson Formation (Upper Devonian)
- DCm Maywood Formation (Upper and Middle Devonian) and locally Upper Cambrian beds
- Cpi Pilgrim Formation (Upper Cambrian)
- Cp Park Shale (Upper and Middle Cambrian)
- Cm Meagher Limestone (Middle Cambrian)
- Cf Flathead Sandstone (Middle Cambrian)
- Cw Wolsey Formation (Middle Cambrian)

Belt Supergroup

- Yg Greyson Formation (Mesoproterozoic)
- Yn Newland Formation (Mesoproterozoic)
- Yc Chamberlain Formation (Mesoproterozoic)
- Xag Augen gneiss (Paleoproterozoic)
- Xgg Granite gneiss (Paleoproterozoic)
- Xbg Biotite gneiss (Paleoproterozoic)
- Xgda Gneissic granodiorite and amphibolite, undivided (Paleoproterozoic)
- Xd Diorite (Paleoproterozoic)
- Xa Amphibolite (Paleoproterozoic)
- Xpd Pinto Diorite (Paleoproterozoic)
- Wd Metadiorite (Neoarchean)

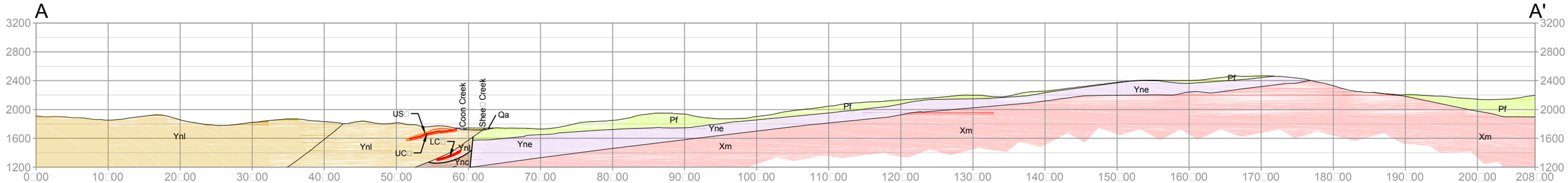
- Fault_defined
- Fault_approximate
- Fault_inferred
- Thrust_defined
- Thrust_approximate
- Thrust_inferred

Souce: Geologic data from White Sulphur Springs Quadrangle (Reynolds and Brandt, 2006) and Canyon Ferry Dam Quadrangle (Reynolds and Brand,2005)

Date: November 9, 2015 Source: Hydrometrics (2015)

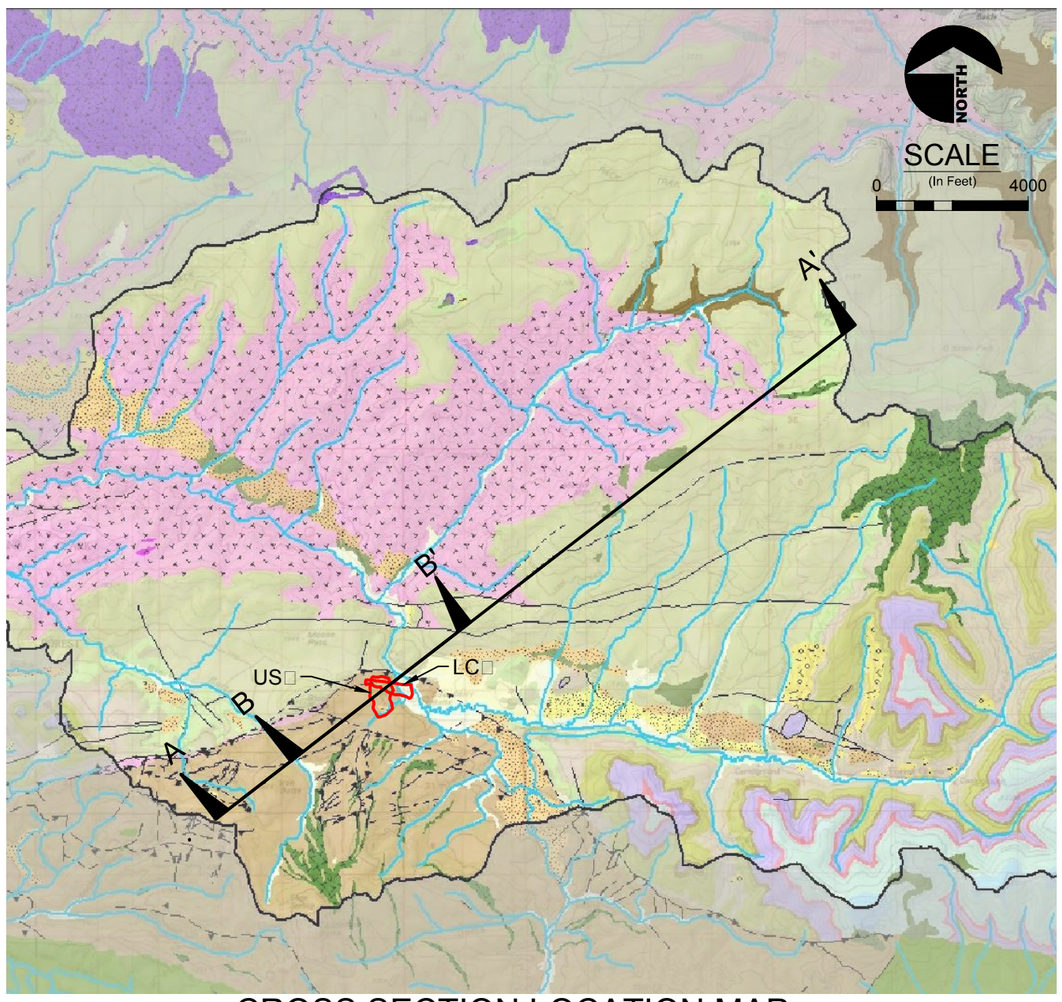
TINTINA RESOURCES

Figure 4.2
Regional Geologic Map
Black Butte Copper Project
Meagher County, Montana

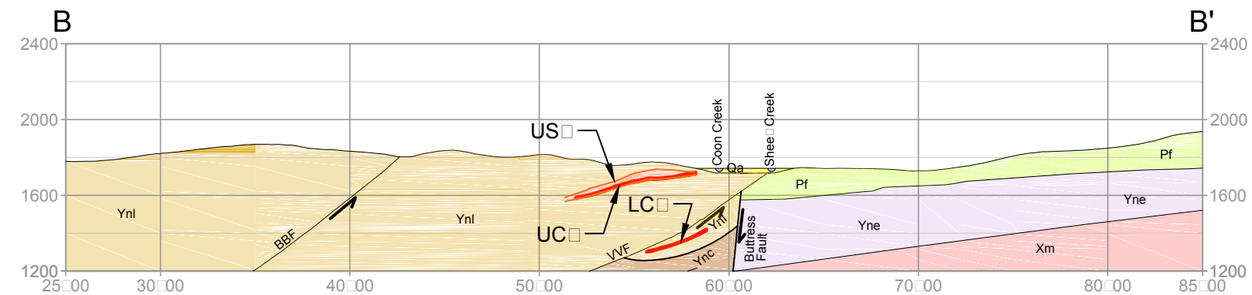


CROSS SECTION A - A'

1" 1400'



CROSS SECTION LOCATION MAP



CROSS SECTION B - B'

1" 800'

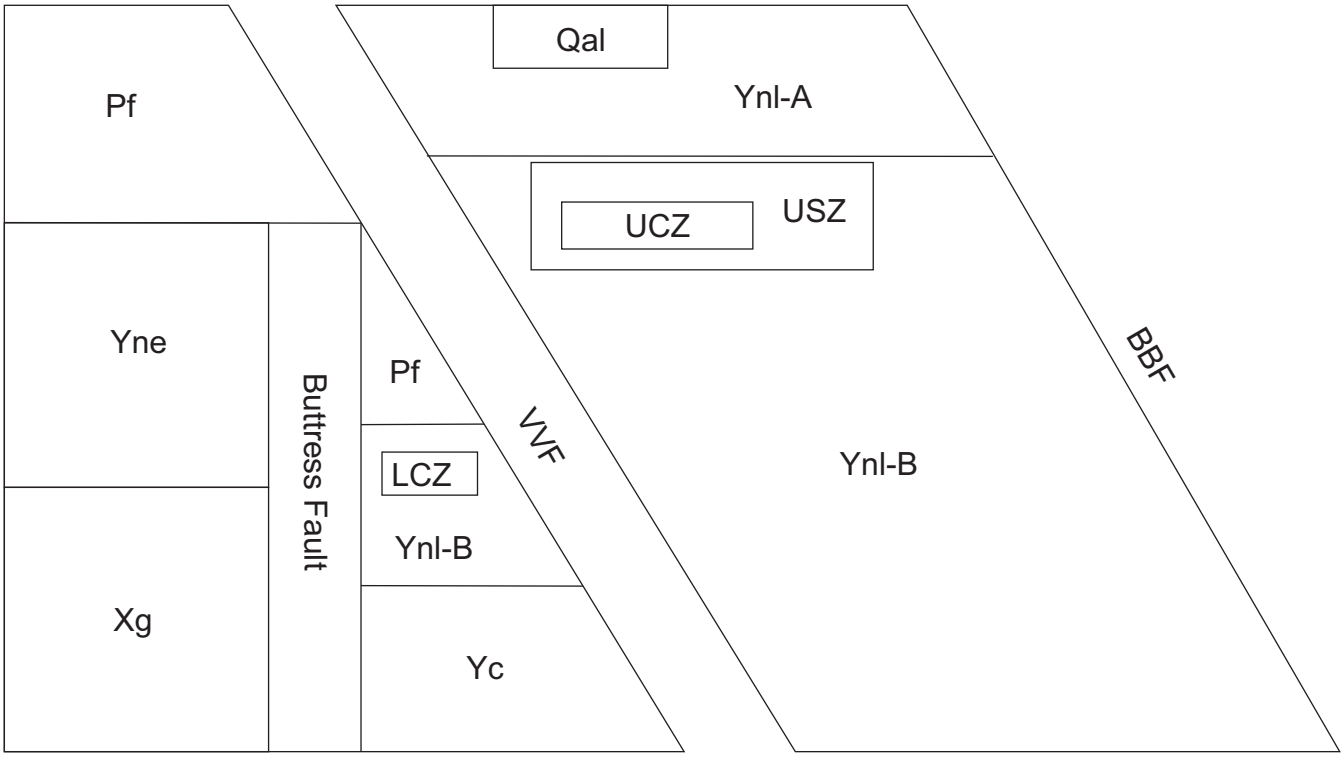
LEGEND

Qal	Quaternary Allu ial De osits
Pf	Flathead Sandstone
Ynl	Lo er Ne land Shales
US	U er Sulfide one
UC	U er Co er one
LC	Lo er Co er one
Yc	Chamberlain Shale
Yne	Neihart Quart ite
Xm	Crystalline Bedrock
VVF	Volcano Valley Fault
BBF	Black Butte Fault

Date: November 9, 2015 Source: Hydrometrics (2015)

TINTINA RESOURCES

Figure 4.3
Schematic Cross-Section
Black Butte Copper Project
Meagher County, Montana



LEGEND

Qal	Quaternary Alluvial Deposits
Pf	Flathead Sandstone
Ynl-A	Lower Newland Shales/Shallow
Ynl-B	Lower Newland Shales/Deep
USZ	Upper Sulfide Zone
UCZ	Upper Copper Zone
LCZ	Lower Copper Zone
Yc	Chamberlain Shale
Yne	Neihart Quartzite
Xg	Crystalline Bedrock
VVF	Volcano Valley Fault
BBF	Black Butte Fault

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Date: November 9, 2015 Source: Hydrometrics (2015)

TINTINA RESOURCES

Figure 4.4
Hydro-Stratigraphic Units
Black Butte Copper Project
Meagher County, Montana

4.1.2 Hydro-Stratigraphic Units

The regional and local geologic setting of the Project, including stratigraphic units, is presented in Section 1.4. A hydro-stratigraphic unit is a body of rock or structure that acts as a reasonably distinct hydrogeologic system. For the purposes of this model, the major hydro-stratigraphic units (HSUs) generally coincide with parts of the principal geologic units in the area, but also include structural fault zones. The principal HSUs are briefly described below and are shown in the schematic diagram (Figure 4.2). Hydraulic properties of the major units within the Project area are listed in Table 4-1, and are based on the results of aquifer testing described in the Baseline Water Resources Monitoring and Hydrologic Investigations Report (Hydrometrics, 2015b). Hydrologic characteristics of units outside of the Project area have been estimated based upon literature values for similar formations.

Table 4-1. Hydraulic Properties of Hydro-Stratigraphic Units

Unit	Description	Thickness (ft.)	Hydraulic Conductivity (ft./day)	Storage Coefficient	Source of Hydraulic Properties
Geologically-Based Hydrostratigraphic Units					
Sheep Creek Alluvium (AL)	coarse-grained sand and gravel alluvium	17	200	0.2 to 0.35	slug test; literature
Flathead Sandstone (*Pf*)	sandstone bedrock	100	10^{-5} to 1.5	NA	literature
Lower Newland Formation shallow (*Ynl-A*)	calcareous and non-calcareous shale and siltstone bedrock	30-50	1 to 2.3 GM 1.5	$1x10^{-4}$ to $8x10^{-6}$	pumping test
Upper Sulfide Zone [*USZ*]	highly mineralized zone	30-150	0.01 to 0.7 GM 0.08	6×10^{-5} to 9×10^{-5}	pumping test
Upper Copper Zone [*UCZ*]	copper zone within USZ				
Lower Copper Zone [*LCZ*]	copper mineralized zone	30-50	1.9×10^{-4}	NA	pumping test
Lower Newland Formation deep (*Ynl-B*)	dolomitic and non-dolomitic shale and siltstone bedrock	150 in FW; to 2,000	0.001 to 0.007	NA	pumping test
Chamberlain Shale (*Yc*)	siliceous, locally arenaceous shale	500	0.001 to 0.007	NA	assumed
Niehart Quartzite (*Yne*)	recrystallized sandstone	800	low; N.A.	NA	assumed
Crystalline Bedrock (*Xg*)	metamorphic crystalline rock	to depth	10^{-3} to 10^{-1}	NA	literature
Structurally Defined Hydro-stratigraphic Units					
Volcano Valley Fault	fault; clay gouge core; variable associated fracturing	150	7.1×10^{-4} to 1.5×10^{-5} avg. 2.8×10^{-5}	NA	permeameter testing
Black Butte Fault		10 - 14			assumed
Buttress Fault		5			
Brush Creek Fault		44			

GM=geometric mean value; used when properties ranged several orders of magnitude FW=footwall
N.A.=not available; avg. = arithmetic average value; used when properties were within the same order of magnitude

4.1.2.1 HSUs Established Based in Geologic Units

Quaternary Deposits – this HSU corresponds to the alluvial sand and gravel deposits of the Sheep Creek Alluvium that lie along the axes of the major drainages.

Newland Formation – this HSU consists of calcareous and non-calcareous shale and siltstone with discrete weathered intervals. For the purpose of this model, the Newland Formation is divided into shallow (*Ynl-A*) and deep (*Ynl-B*) bedrock units. The highly mineralized Upper Sulfide Zone (*USZ*) separates *Ynl-A* and *Ynl-B*. The deeper bedrock (*Ynl-B*) typically produces lower yields than wells completed in the shallower bedrock unit (*Ynl-A*).

Upper Sulfide Zone (*USZ*) – the HSU divides the shallow and deep *Ynl-A* from *Ynl-B* and is a thick zone of mineralization that includes the upper copper zone (*UCZ*). The *USZ* is a lower permeability unit within *Ynl-A* and *Ynl-B*.

Flathead Sandstone - this HSU is composed of fine- to medium-grained sand that is generally well cemented. It was encountered in exploration boreholes adjacent to the Volcano Valley Fault. There are no test wells within the Flathead sandstone in the Project area to establish site-specific hydraulic parameters for this unit. Hydraulic conductivity is assumed to exhibit a general decrease with depth due to decreased weathering and greater overburden pressures (Snow, 1968).

Chamberlain Shale – this HSU underlies the *Ynl-B* and has only been encountered in exploration boreholes on the north side of the *VVF*. There are no test wells that penetrate the Chamberlain shale to determine hydrologic characteristics of this unit. For the purposes of this model it is assumed to have properties similar to the shale of the lower Newland Formation (*Ynl-B*).

Neihart Quartzite – this HSU is a recrystallized sandstone that underlies the Chamberlain shale on the north side of the *VVF*. Quartzites have low permeability and typically form confining units except where they are fractured. No quantitative hydrologic data exist in this area. However, core hole data indicate this unit generally exhibits low permeability characteristics except in localized zones of fracturing associated with the Buttress Fault. While the Neihart quartzite is considered to be a low permeability HSU in the model. It has the potential to produce high yields if highly fractured intervals are directly encountered in association with permeable fault zones (see the discussion of the Structural HSUs). It should be noted that the mine workings under the current mine plan do not intercept the Neihart quartzite.

Crystalline Bedrock – this HSU forms the core of the Little Belt Mountains and is present north of the *VVF*. Because crystalline rocks have negligible primary porosity, groundwater is only present within joints and fractures. The permeability of the joints and fractures typically decreases rapidly with depth due to the combined effect of the weight of the overlying rock and the tendency of weathering to penetrate only a short distance into the bedrock. The model incorporates this general relationship between permeability and depth (Snow, 1968) and assumes that the permeability of crystalline basement rocks decreases by three orders of magnitude in its upper 300 feet (91.4 m).

Tertiary Intrusive rocks – this HSU consists of igneous granodiorite intruded into the lower Newland Formation in the area south of the *BBF*. There are no test wells completed in the intrusive rocks. However, granodiorite is a low permeability crystalline rock that for the purpose of this model is assumed to have hydrologic characteristics similar to the crystalline bedrock.

4.1.2.2 Structurally Defined HSUs

The Johnny Lee deposit is bounded by four fault zones that have the potential to significantly influence groundwater flow through this area. These include the Volcano Valley Fault, Black Butte Fault, Buttress Fault, and Brush Creek Fault. The influence of these faults over groundwater flow is a function of the permeability characteristics within the faults. In general, fault zones are considered to have two structural zones: a core where most of the movement takes place and a surrounding damage zone where brittle fracturing may extend out into the surrounding rock. The fault core can have very low permeability due to clay-rich fault gouge that restricts groundwater flow across the fault plane. Damage zones contain fractures that can enhance the permeability of the rock immediately bounding the fault core and thus enhance flow parallel to the fault plane. The permeability of these features can be altered by later mineralization or alteration that fill the fractures and reduce permeability within the damage zone. The permeability characteristics of a given fault depend upon the presence and thickness of a gouge zone, the degree of supplementary fracturing in the damage zone, and the presence of cementation that fills fractures.

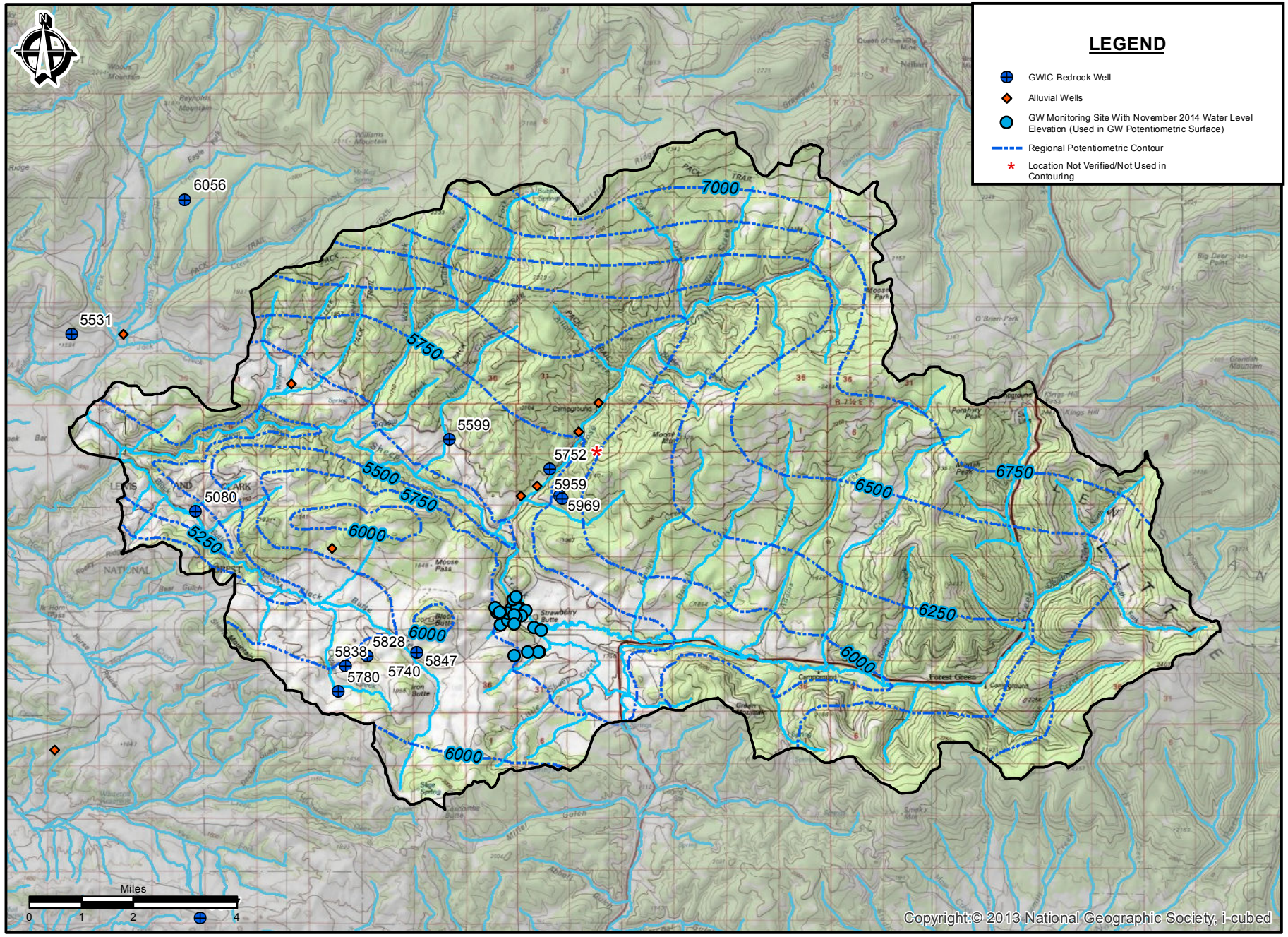
Exploration boreholes show fault gouge present within the cores of each of the faults. Therefore, these fault zones are considered separate hydro-stratigraphic units for the purposes of this model. The presence and extent of fault gouge versus open fracture/damage zones was evaluated for each of the fault units. It should be noted that below the Buttress Fault, test well PW-6 did encounter a fractured interval in the Neihart Quartzite approximately 175 feet (53.4 m) beneath the Buttress fault that produced high yields during air testing. The fracturing and associated permeability at this location does not appear to extend vertically upward based upon exploration drilling. Exploration boreholes showed variable degrees of fault-associated fracturing that range from competent quartzite with minor fracturing to high angle fractures in Niehart Quartzite adjacent to the fault. Significant groundwater flow with artesian pressures was only noted at one of the exploration sites.

For this model all of these faults are considered to contain low permeability gouge zones that limit flow across these units. There does not appear to be a well-developed damage zone in the more ductile Newland shales. Fault-related fracturing is locally more notable within the more brittle geologic units (i.e., quartzite and crystalline intrusive rocks).

4.1.3 Groundwater Flow Conditions

Both a watershed scale and a local scale potentiometric maps of the Project area were developed to define the principal directions of groundwater flow within the watershed, and provide a more detailed understanding of groundwater flow. The watershed scale potentiometric map is shown in Figure 4.5. The groundwater flow directions inferred from the potentiometric contours are generally coincident with the larger scale topographic trends. Potentiometric contours indicate that groundwater flow converges on the major drainages which include Sheep Creek, Moose Creek, Little Sheep Creek and Black Butte Creek.

A more detailed potentiometric map of the Project area was developed based on Tintina's network of monitoring wells and piezometers and is shown in Figure 4.6. The underground mine lies beneath the tight group of bedrock wells just west of Strawberry Butte. This map depicts the potentiometric surface in the lower Newland wells, as well as the water table elevation in the shallow alluvial system. The alluvial groundwater system has a hydraulic gradient of approximately 0.008. The hydraulic gradient across the Project area in the shallow bedrock wells is approximately 0.065, but flattens out in Sheep Creek Meadows suggesting there is discharge of groundwater from the shallow bedrock system to the overlying alluvial aquifer in this area. Hydraulic gradients are unit less numbers with gradients measured in feet/foot.



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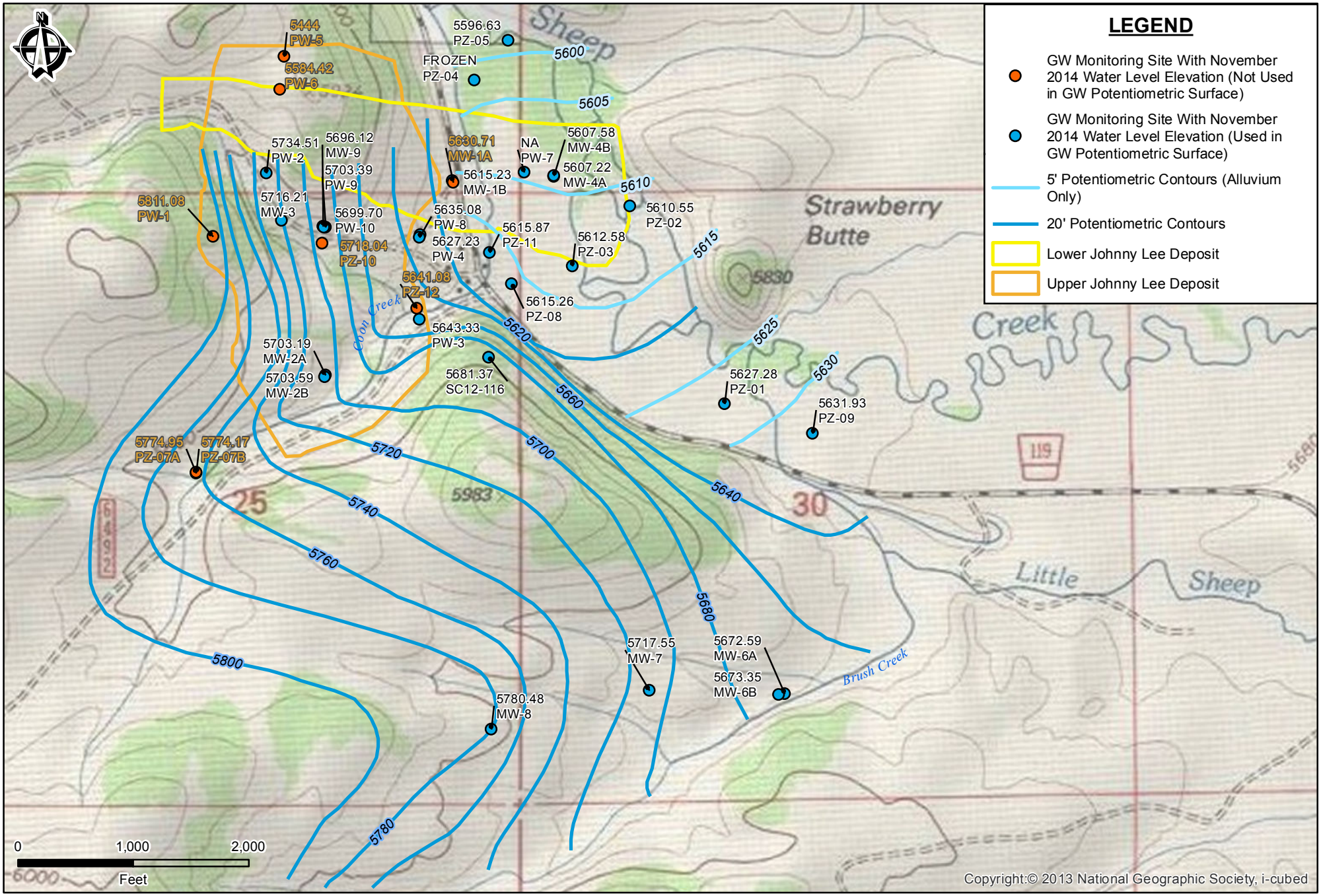
Date: November 9, 2015 Source: Hydrometrics (2015)

TINTINA RESOURCES

Figure 4.5
Regional Potentiometric Map
Black Butte Copper Project
Meagher County, Montana



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Date: November 23, 2015 Source: Hydrometrics (2015)

TINTINA RESOURCES

Figure 4.6
Project Scale Potentiometric Map
Black Butte Copper Project
Meagher County, Montana

Most paired wells show upward hydraulic gradients with the exception of what appears to be shallow perched groundwater over shale bedrock (MW-1A/1B), and springs that feed the headwaters of Coon Creek (PZ-7A/7B) (Figure 2.3). In the lower elevation areas the wells show a progressive upward gradient between the deeper bedrock units and shallow units. Artesian conditions are evidenced at the depth of the lower sulfide zone (PW-7), and in an exploration core hole in the Neihart Quartzite (see the discussion on the Buttress Fault) (Section 4.1.2.2). The upward gradients suggest that recharge occurs from higher elevation exposures upslope, and that more competent overlying layers are producing high confining pressures in the fractured bedrock system. Wells MW-9, PW-9, and PW-10 are clustered within 10 feet (3 m) of each other, and show a large vertical gradient from the *UCZ* to both the *Ynl-A* (7.27 feet; 2.2 m) and the *Ynl-B* (3.69 feet; 1.1 m).

Groundwater levels typically show seasonal fluctuations in the bedrock wells of 1 to 3 feet (0.3 to 0.91 m), peaking in early June and declining through the summer months (Hydrometrics, 2015b). Groundwater levels continue to decrease at a slower rate through the winter months and reach seasonal lows in February and March. The shallow alluvial system fluctuates 1 to 1.5 feet (0.3 to 0.46 m) seasonally with similar seasonal trends as those observed in the bedrock system. The seasonal early June spike in water levels occurs more rapidly in the alluvial system than in the bedrock system and also tails off more rapidly, stabilizing at a lower level by late August or September through April.

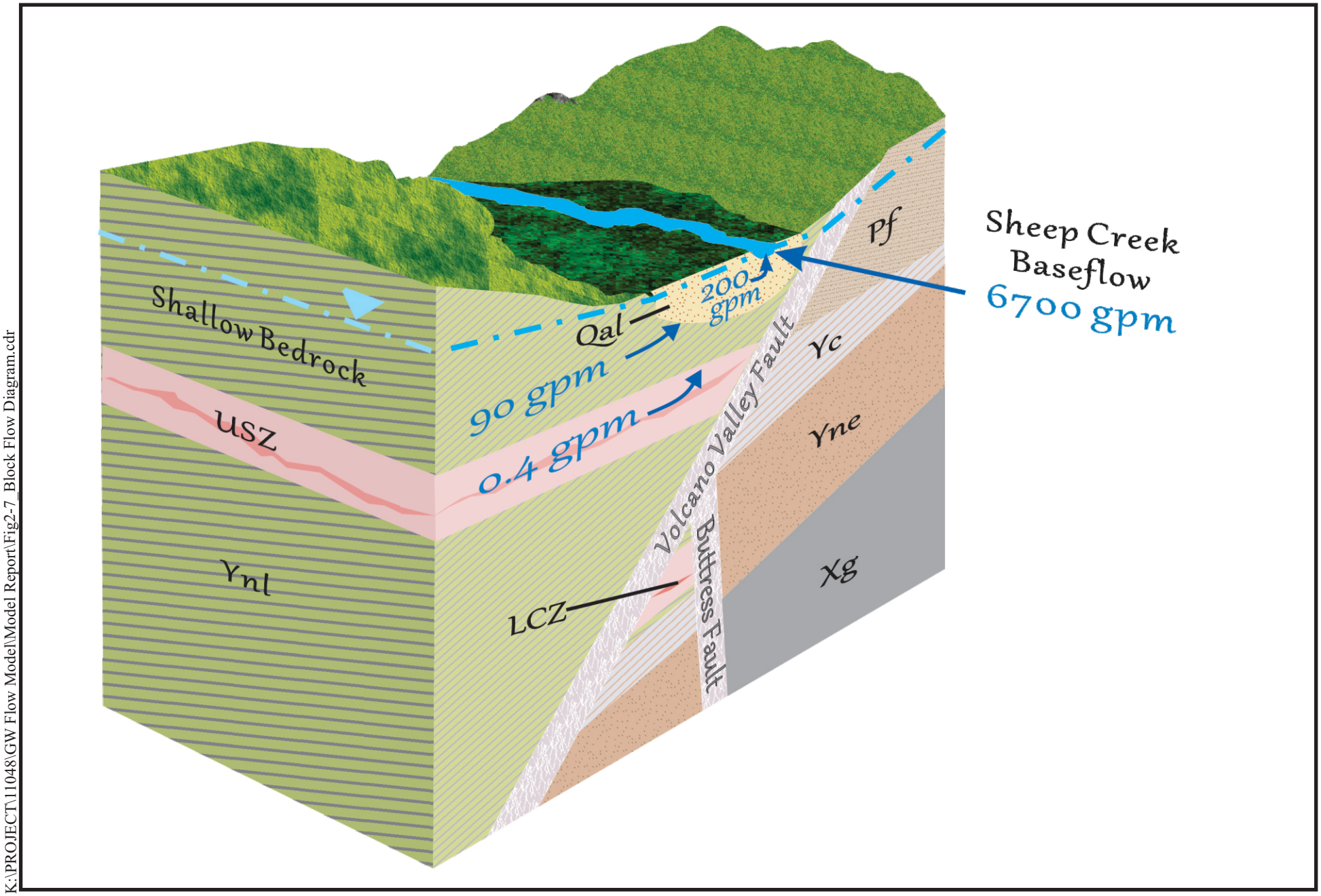
Water levels generally indicate confined or leaky confined conditions in the bedrock aquifers and unconfined conditions in the shallow alluvial system. With a few exceptions water was first encountered in the bedrock wells a substantial distance below the stabilized water level elevations in the completed wells. Low permeability shale layers appear to produce confined pressure conditions in these areas. Leaky confined systems may be present in shallow bedrock wells at MW-4 and MW-6, where saturated conditions were encountered above the primary producing zones in the wells.

Groundwater flux through the Sheep Creek alluvium, the shallow bedrock system (*Ynl-A*), and the upper sulfide zone (*USZ*) can be estimated from potentiometric data and hydraulic conductivity data using a simple Darcy's Law calculation. Because this applies a simplified porous media solution to bedrock formations with variable properties, it should only be considered a generalized assessment of the relative flux of groundwater in each of these units. The calculations focus on flow through the bedrock within the footprint area of the upper deposit, and flow through the downgradient alluvial system towards Sheep Creek. Input assumptions and estimated fluxes are shown in Table 4-2.

Table 4-2. Darcy's Law Groundwater Flow Estimates

	Hydraulic Conductivity (ft./d)	Aquifer Width (ft.)	Aquifer Thickness (ft.)	Hydraulic Gradient	Groundwater Flux(gpm)
Sheep Creek Alluvium	200	1500	16	0.008	199
Ynl-A	1.5	3400	50	0.065	86
Upper Sulfide Zone	0.01	3400	30	0.0675	0.36

These estimates show the relative groundwater flux through each unit (shown graphically in Figure 4.7) which represents the relative contributions from these units to base flow in Sheep Creek. Flow in the shallow bedrock system may account for up to 45% of the groundwater flow in the sand and gravel alluvial aquifer at this location, while flow in the Upper Sulfide Zone in the deeper *Ynl-B* bedrock account for less than 0.2% of that in the alluvial system. The total discharge from the alluvial aquifer in the Sheep Creek Meadows area is approximately 3% of typical late season in-stream base flow conditions in Sheep Creek (6,700 gpm; 25,400 Lpm) within this reach.



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Date: November 23, 2015 Source: Hydrometrics (2015)

TINTINA RESOURCES

Figure 4.7
Block Flow Diagram Black Butte Copper Project
Meagher County, Montana

4.1.4 Groundwater – Surface Water Interaction

Exchange of groundwater and surface water is controlled by the relative elevation difference between the water table and the streams, and the permeability of the streambed. With the exception of periods of peak stream flow levels during spring runoff, Sheep Creek is typically lower than groundwater levels in the alluvium and bedrock groundwater systems, and acts as a sink for collection of groundwater discharge. In contrast, some of the tributary drainages such as Coon Creek issue from smaller spring fed perched groundwater systems. These streams become perennial in their lower reaches, where they intercept the regional water table.

Groundwater within the Sheep Creek alluvium is directly connected to Sheep Creek. The alluvial gravels are recharged from the stream during high flow periods. They receive groundwater recharge from adjacent and underlying bedrock systems and alluvial systems in tributary drainages during the remainder of the year. Alluvial groundwater enters the stream where the Sheep Creek channel enters narrow bedrock canyons immediately north of the Project area, and alluvial deposits are extremely minor or absent. The amount of recharge to Sheep Creek from the alluvial aquifer in the narrow bedrock canyon immediately downstream of the Project was estimated at approximately 200 gpm (760 Lpm). This represents a relatively small increase in the total base flow of Sheep Creek (approximately 3%). We presume a similar increase in stream flow at a second location approximately 3 miles (4.8 km) downstream of the Project area where Sheep Creek again enters a narrow bedrock canyon for which there is no well data. There is a gradual increase in base flow on Sheep Creek from upstream to downstream that represents progressive groundwater discharge to the stream on the order of 300 to 340 gpm (1,136 to 1,287 Lpm) per river mile (0.66 to 0.75 cfs/mile). This increase excludes surface inflow from the major tributaries.

4.1.5 Water Balance

4.1.5.1 Groundwater Recharge

Infiltration of precipitation and snow melt are the primary sources of recharge to the groundwater system. Infiltration rates of 10 to 15% of annual precipitation are commonly assumed as a reasonable approximation of groundwater recharge rates in modeling analyses of intermontane basins in western Montana (Briar and Madison, 1992). It is assumed that virtually all of the infiltration recharge to the shallow and deeper groundwater flow systems within the drainage reports back to Sheep Creek and its major tributaries. Therefore, generalized flow estimates during base flow periods should approximately correlate with the percentage of annual infiltration rate. A 10% infiltration rate appears to closely match observed base flows. The calculated results are shown in Table 4-3.

Table 4-3. Comparison of Infiltration Recharge Baseflow Estimates to Observed Baseflow

Sheep Creek Gaging Stations	USGS-SC1	SW1
Watershed Area (acres)	27,676	50,162
Watershed Area (m^2)	1.12E+08	2.03E+08
Average Annual Precipitation (in)	28.3	26.4
Average Annual Precipitation (m)	0.72	0.671
Volume (acre-ft.)	6.53E+04	1.10E+05
Volume (m^3)	8.06E+07	1.36E+08
Assumed Infiltration rate	**10%**	**10%**
Baseflow Estimate (cfs)	9.0	15.2
Baseflow observed (cfs)	9.1	15.0

Note: These average values were calculated from a 30-year average PRISM model.

While widespread irrigation can be a significant source of recharge to shallow groundwater systems, the irrigated acreage adjacent to Sheep Creek is a very small fraction of the watershed area (<2%). Hydrographs do not indicate that return flows contribute significantly to base flow conditions in the late winter/early spring. Given the limited acreage in this watershed that is under irrigation and the timing of irrigation returns, irrigation is unlikely to be a significant factor in simulating groundwater flow conditions during base flow periods.

4.1.5.2 Groundwater Discharge

Groundwater flow within the shallow and deeper groundwater systems in the Sheep Creek drainage appears to coincide with general topographic trends and likely reports back to Sheep Creek within the confines of the basin. Stream flow monitoring has been conducted at baseline monitoring sites in the vicinity of the Project site (Hydrometrics, 2015b). There is also a historical USGS gaging site on Sheep Creek below the confluence of Adams Creek (Figure 4.1). Late season stream flow data is not available for many of the tributaries, or for Sheep Creek at the confluence of Black Butte Creek (which represents the lower boundary of the study area). Stream flow estimates for these ungauged sites were assessed using a similar method to that used to establish recharge rates. The calculated watershed areas, average annual precipitation rates, annual flow volumes and resultant base flow estimates are summarized in Table 4-4.

Table 4-4. Baseflow Estimates for Selected Sheep Creek Watershed Areas

Watershed	Watershed Area (acres)	Average Annual Precipitation (ft.)	Precipitation Volume (ac-ft.)	Baseflow Estimate* (cfs)
Sheep Ck at USGS - SC1	2.77E+04	2.36	6.54E+04	9.0
Sheep Ck at SW-1	5.02E+04	2.20	1.10E+05	15.3
Sheep Ck at confluence of Black Butte Ck	1.12E+05	2.10	2.34E+05	32.3
Moose Creek	2.32E+04	2.41	5.61E+04	7.7
Black Butte	1.47E+04	1.57	2.31E+04	3.2
Calf Creek	6.47E+03	2.30	1.49E+04	2.1
Adams Creek	4.73E+03	2.55	1.21E+04	1.7

*Calculated based on 10% of annual precipitation volume

Streamflow measurements were taken on Sheep Creek at the confluence with Black Butte Creek, on Black Butte Creek at the confluence with Sheep Creek, on Moose Creek and at Sheep Creek gaging station SW-1 in September of 2015. These were compared to precipitation-based flow estimates. These base flow estimates are shown in Table 4-5.

The results from Sheep Creek compare favorably to the previous precipitation based flow estimates for base flow at the downstream limits of the model. Sheep Creek and Moose Creek show greater variability. This may reflect the applicability of seasonal Sheep Creek flow adjustments to these other drainages due to seasonal irrigation diversions, and seasonality of base flow characteristics. However, both are within the assumed accuracy of the estimate (± 20%).

Table 4-5. September 2015 Flow Measurements with Seasonally Adjusted Baseflow Estimates

Site	Sept 2015 Flow (cfs)	Adjusted to Late Season Norm (cfs)	Precipitation Based Estimate (cfs)
Sheep Ck at SW-1	9.0	15.3	15.3
Sheep Ck at Black Butte Ck	17.7	30.0	32.2
Moose Ck at mouth	6.0	10.1	7.7
Black Butte Ck at mouth	1.5	2.6	3.2

4.1.6 Summary of Groundwater Modeling Assessment

4.1.6.1 Introduction

The groundwater modeling analysis was conducted to assist Tintina with mine design and planning, and to assess the potential for impacts to groundwater and surface water from dewatering throughout the mine life and after closure. The hydrogeology has been well characterized in the shallow HSUs in the Project area, and therefore the model has a smaller degree of uncertainty associated with them. There is increasing uncertainty in the properties of the lower HSUs (e.g. *LCZ*). However, flow volumes and hydraulic conductivity from these lower units is very small. Uncertainty associated with the properties of the outlying HSUs also increases.

The model uses conservative assumptions (i.e., higher storage in HSUs where data was not available) to assess impacts to water resources. In addition, it simulated the headwaters of both Coon Creek and Brush Creek, despite the fact that hydrological investigations indicate the headwaters of these two drainages are not connected to the deeper groundwater system. This provides additional conservatism to the assessment of effects on surface water.

The model domain is divided into 16 layers and discretized with an unstructured grid into 320,972 cells. The unstructured grid is more tightly discretized around key features (surface water, mine structures and faults) within each layer. The layers within the model vary in thickness and are designed to provide sufficient discretization to simulate specific hydrologic relationships. Layer 1 is about 16 feet (4.88 m) thick which represents the thickness of the alluvial systems and highly weathered shallow bedrock. Layers 2 and 3 are used to define the shallow bedrock flow conditions within the *Ynl-A* which is more permeable and fractured than the deeper *Ynl-B* bedrock. Throughout most of the model, layers 4 through 6 represent a transitions zone from the more permeable fractured bedrock conditions near the surface to the base bulk permeability of the more competent bedrock at depth. In the Project area layers 4 through 6 correlate with the *USZ* and *UCZ;* Layer 4 and 6 consist of the *USZ* overlying and underlying the *UCZ* in Layer 5. Layers 7 through 16 represent the deeper bedrock system with layer 11 representing the *LCZ* in the Project area.

The model uses equivalent porous media (EPM) assumptions as the most reasonable method to characterize the hydrogeological system. However, the regional bedrock in the model domain is a fracture controlled system. Using the equivalent porous media approach presumes that each cell in the model represents a combination of fractures and rock matrix. Where fractures are sparse the hydraulic conductivity is very low, and where fracturing is more prevalent the hydraulic conductivity is higher.

The results of the groundwater modeling analysis are discussed below. Details of the model are described in the Groundwater Modeling Report included in Appendix M (Hydrometrics, 2015c).

4.1.6.2 Summary of Model Results

Simulated mine inflows range from 220 to 500 gpm (833 to 1,893 Lpm). The lowest inflows occurring upon completion of the surface decline at the end of year 1 (Table 4-6). The highest simulated inflows are in year 4 (following construction of all access ramps and declines to the full depth of the mine, and at the commencement of full scale mining). The calibrated model indicates that the inflow rates decrease in subsequent years (as more cemented paste is backfilled into the mined out stopes). Sensitivity analyses show that the estimated flow could increase between 10-15% if there is higher storage capacity or elevated hydraulic conductivities in the lower layers relative to what was modeled in the steady state model.

The model simulations show that the effects on surrounding groundwater levels (drawdown) are relatively localized, with most of the drawdown occurring within the Project area. The largest magnitude of drawdown is seen in the *LCZ* where drawdown exceeds 1500 feet (457.2 m). The drawdown cone is very steep and narrow in the lower zone, and does not extend into the upper layers. A similar trend is seen by comparing the magnitude of drawdown in the *UCZ* (maximum drawdown approximately 500 feet [152 m]) and the upper most layer of the model (maximum drawdown approximately 290 feet; 88.4 m). Similar to the mine inflow estimates, the largest extent of drawdown is seen in year 4 (Figure 4.8), with the drawdown extents receding as stopes are backfilled with cement paste and mine inflows are reduced.

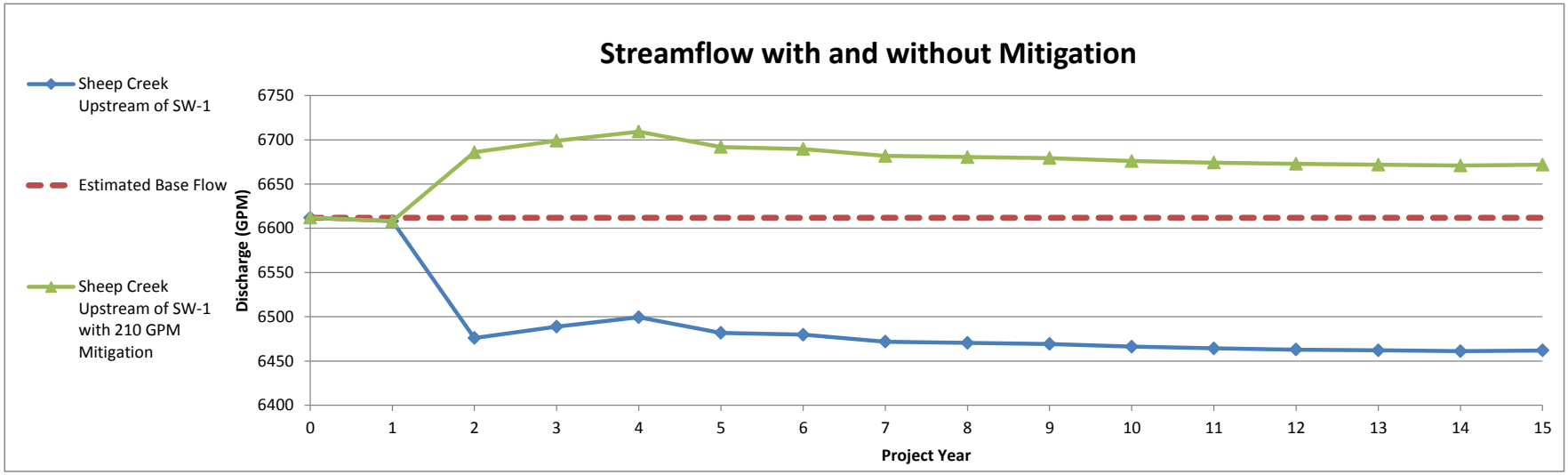
The simulated drawdown in the groundwater of the sand and gravel alluvial system of sheep Creek is approximately 10 feet (3.0 m) near the western edge of the alluvium where Coon Creek flows to the north. Coon Creek appears to limit the drawdown in this area as the drawdown is reduced below 5 feet (1.5 m) just east of Coon Creek. Drawdown in groundwater of the alluvial system beneath Sheep Creek is approximately 1 foot (0.3 m).

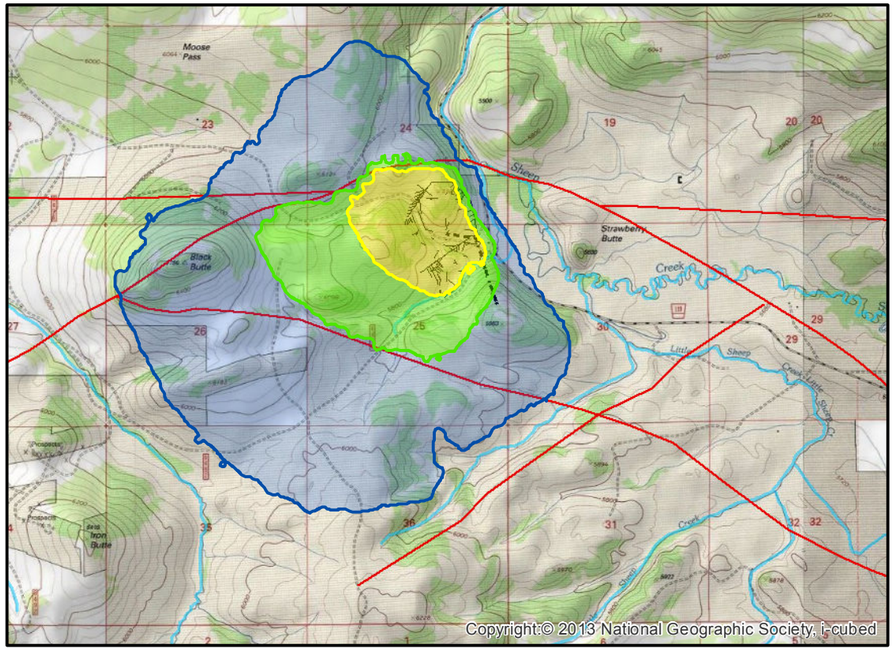
Table 4-3 shows the simulated base flow for streams in the primary watershed areas addressed by the model throughout the mine life. The model simulations indicate that surface water depletion from mine dewatering within the Project area are primarily in Sheep Creek upstream of SW-1 with a maximum depletion of 0.35 cfs, which is approximately 2% of the base flow in Sheep Creek at this location. Streamflow reductions in Sheep Creek at its confluence of Black Butte Creek (model domain) were simulated to be approximately 0.45 cfs or 1.4% of base flow at this location. The stream depletion at the model domain is a combination of the depletions in Sheep Creek above SW-1 and a minor simulated depletion in Black Butte Creek of 0.1 cfs (approximately 3-4% of the flow in Black Butte Creek). The simulated depletions in Black Butte Creek are a result of capturing groundwater near the groundwater divide between Sheep Creek and Black Butte Creek, which would typically discharge to Black Butte Creek. As noted above and in the groundwater modeling report (Hydrometrics, 2015c), the model uses conservative assumptions with the use of EPM model, and simulation of headwater drainages in the model. The bedrock aquifer likely has less connectivity than the EPM model simulates which would limit the extents of the drawdown and stream depletion. However, the total stream depletion in Sheep Creek would likely not change as it is assumed to be near the predicted consumptive use of the project.

All of the simulated stream depletions are within the measurement error for surface water discharge measurements (generally +/- 10%). The total simulated depletion is near the consumptive use rate of the project (210 gpm; 800 Lpm; 0.47 cfs). The water rights mitigation plan will offset all of the stream depletion in Sheep Creek (and Black Butte if necessary) by mitigating flows at a rate equal to the consumptive use of the project (210 gpm; 800 Lpm) as required in closed basins by the Montana Department of Natural Resources and Conservation.

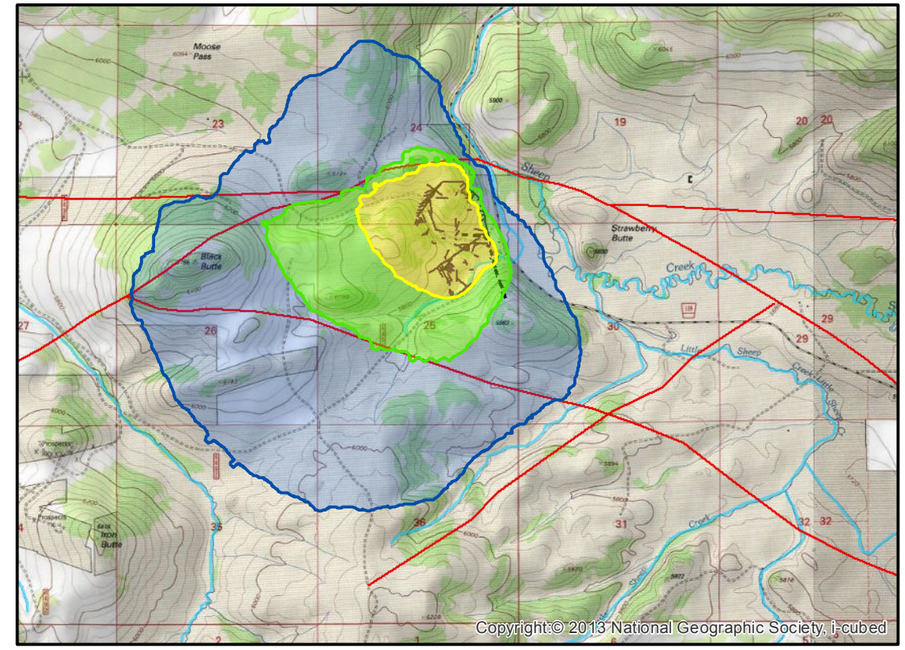
Table 4-6. Simulated Average Annual Inflow to Mine Workings

Mining Progress	Pre-Mining/ Steady State	Declines and Accesss		Declines/Access Ramps/Mining		Mining										
Project Year	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Basin	Simulated Groundwater Discharge to Surface Water (gpm)															
Sheep Creek Upstream of SW-1	**6612**	6608	6476	6489	6499	6482	6480	6472	6470	6469	6466	6464	6463	6462	6461	6462
Sheep Creek Upstream of SW-1 with 210 GPM Mitigation	**6612**	6608	6686	6699	6709	6692	6690	6682	6680	6679	6676	6674	6673	6672	6671	6672





Layer 1



Layer 3

Feet

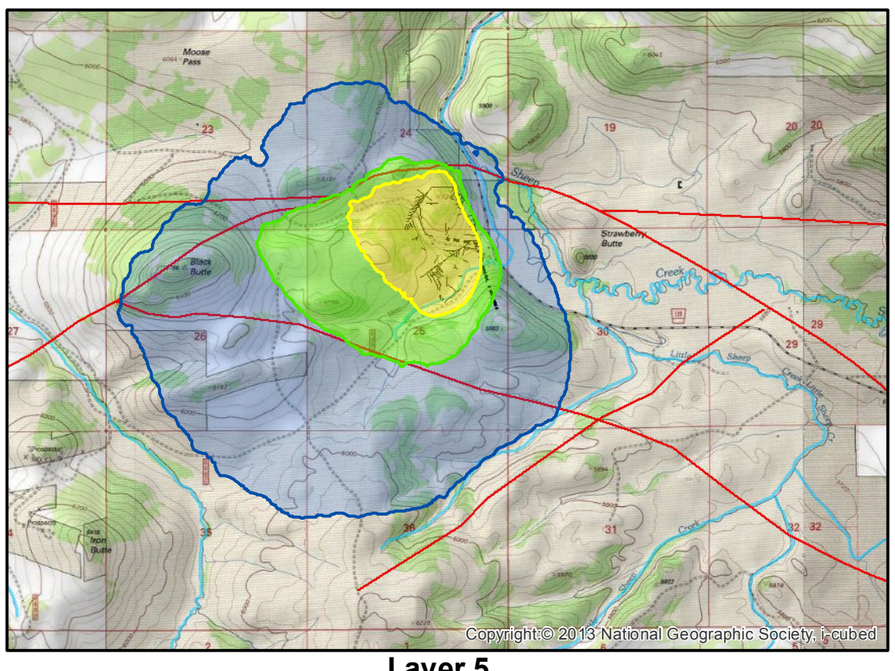
0 2,000 4,000 8,000

LEGEND

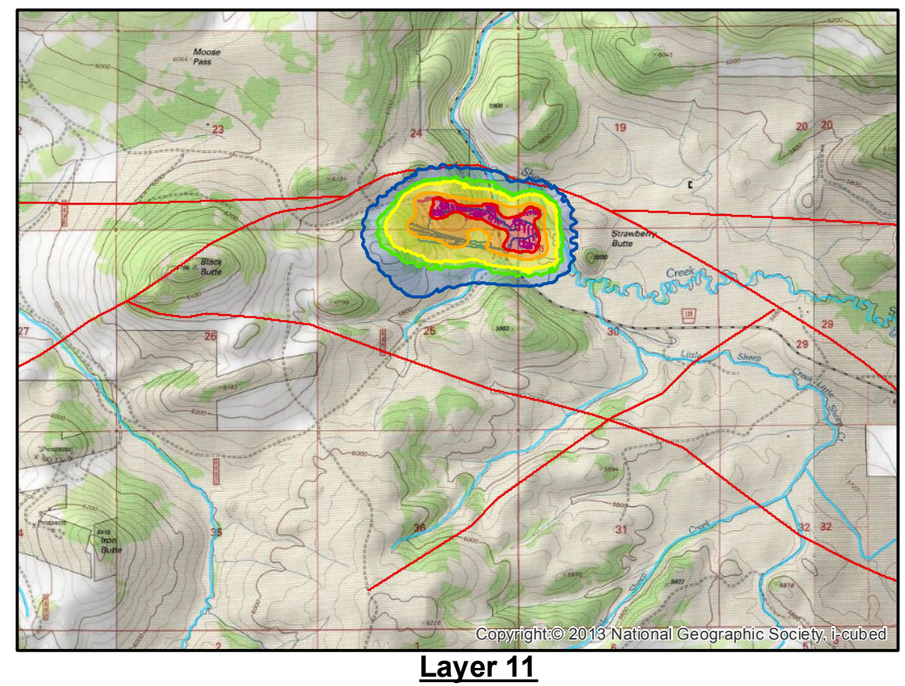
- Upper Decline
- UpperAccess
- Lower Decline
- LCZ Access
- Faults (surface expression)
- Rivers and Streams

Drawdown Interval (feet)

- 10
- 50
- 100
- 500
- 1000



Layer 5



Layer 11

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Date: November 30, 2015 Source: Hydrometrics (2015)

TINTINA RESOURCES

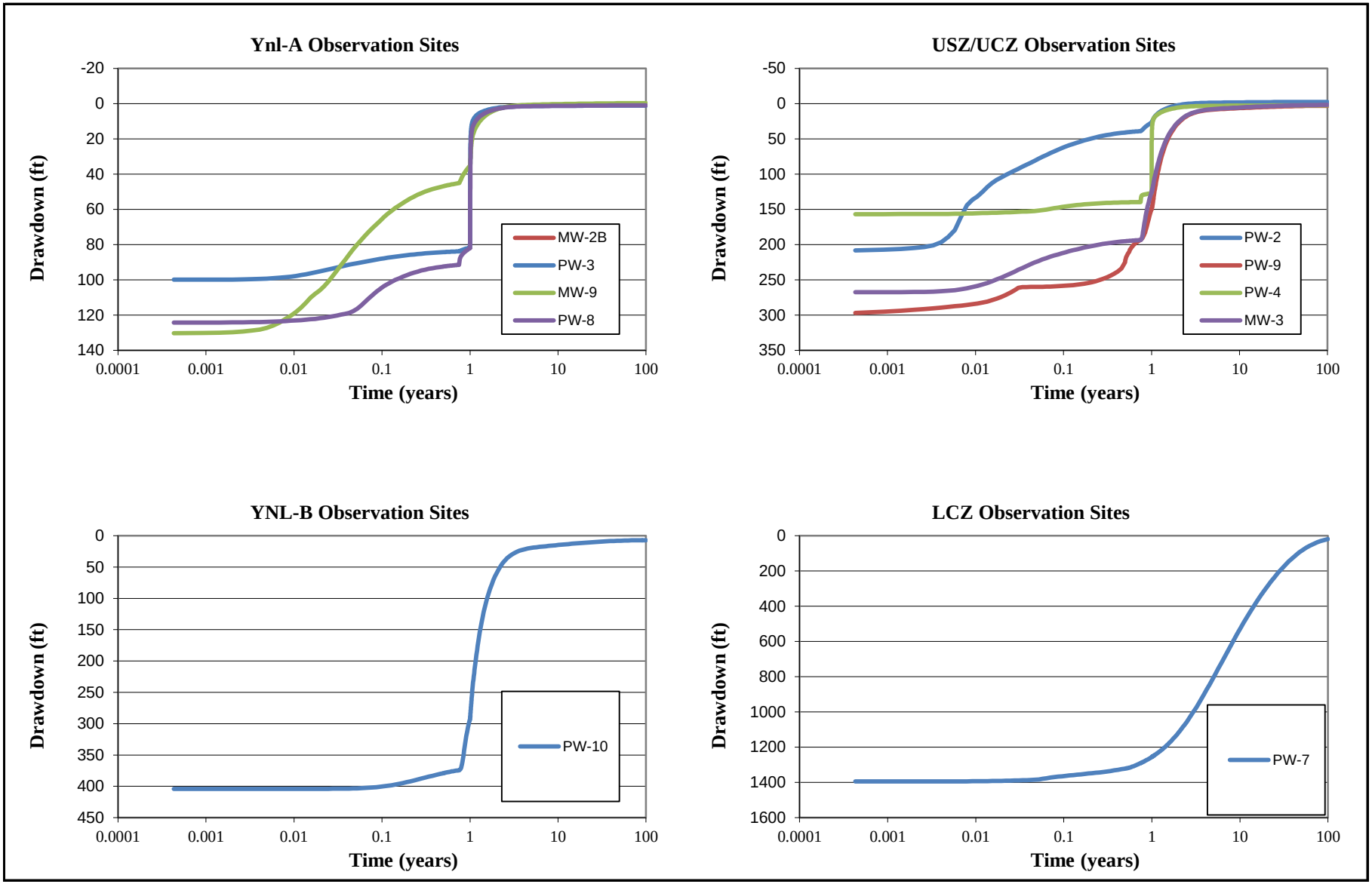
Figure 4.8
Simulated Drawdown - Year 4
Black Butte Copper Project
Meagher County, Montana

The largest relative impacts to streamflow are seen in Coon Creek, which is part of the SW-1 watershed and runs over the southern edge of the *UCZ* and above the surface decline. The model simulates a 70% reduction in base flow at the end of mining; the majority of the reduction is in the lower reach of Coon Creek where it is in connection with the alluvial system. Coon Creek is a small tributary stream to Sheep Creek, and is often fully diverted during the irrigation season and frozen during the winter months. Tintina has an agreement with the water right holder for Coon Creek to utilize the water right if necessary. Based upon these factors, the reduction in flow to Coon Creek itself will not have a substantive effect on water resources in the area. The primary effect on downstream water resources is addressed in the evaluation of the SW-1 watershed and at the model domain.

Post mining simulations indicate that the effects from dewatering will decrease slightly in the groundwater system and surface water resources through the first year of closure. Figure 4.9 shows the recovery over time for wells completed in the *Ynl-A, USZ/UCZ, Ynl-B*, and *LCZ.* Effects on water resources decrease quickly after the first year. The shallow water table is within 1-2 feet (0.3 to 0.6 m) of pre-mining levels within 3 to 4 years of closure and the reduction in stream flows are limited to the SW-1 watershed ($\leq$0.1 cfs). There are no measureable effects to stream base flow resulting from mine dewatering either operationally or during closure. There are no model predicted effect to stream base flow 20 years after mining has stopped.

The modeling analysis includes an evaluation of effectiveness of grouting the near surface portion of the decline as a mitigation alternative to reduce mine inflow and corresponding effects on nearby surface water streams and groundwater. The grouting mitigation simulations show a large decrease in mine inflows to the surface decline; with the first year having a 10 fold reduction. However once additional mine workings are developed the flow draining to the mine workings is only reduced by 15% to 25% (66 to 84 gpm) from the simulation without grouting. This reduction has no effect on the simulated depletion to the streams as the mine dewatering rate is still larger than the consumptive use rate of 210 gpm (800 Lpm).

The Black Butte Copper Project is located in the Upper Missouri River Basin, which is closed to new surface water appropriations. Tintina is in the process of developing an application for a groundwater right for water produced from underground (< 500 gpm; 1,800 Lpm) and put to beneficial use in the mill, tailings paste plant and other water needs, of which an estimated 210 gpm (800 Lpm) is consumptive. A mitigation plan is being developed with the assumption that all of the consumptive use will result in depletion in surface water, which is similar to what the model shows. The mitigation plan will recommend providing water indirectly to the surface water system at the consumptive use rate (210 gpm, 800 Lpm) to offset any depletion in the streams. This is shown by adding the water right mitigation rate of 210 gpm (800 Lpm) to the simulated base flow in the streams during mining resulting in the net flow in the streams being equal or greater than the pre-mining base flows. Table 5-5 shows the base flow in Sheep Creek in the watershed upstream of SW-1 throughout the mine life, and the resultant base flow with water rights mitigation.



Date: November 9, 2015 Source: Hydrometrics (2015)

TINTINA RESOURCES

Figure 4.9
Water Level Recovery
Black Butte Copper Project
Meagher County, Montana

4.2 Geochemical Modeling

4.2.1 Hydrogeochemical Predictions of Water Quality

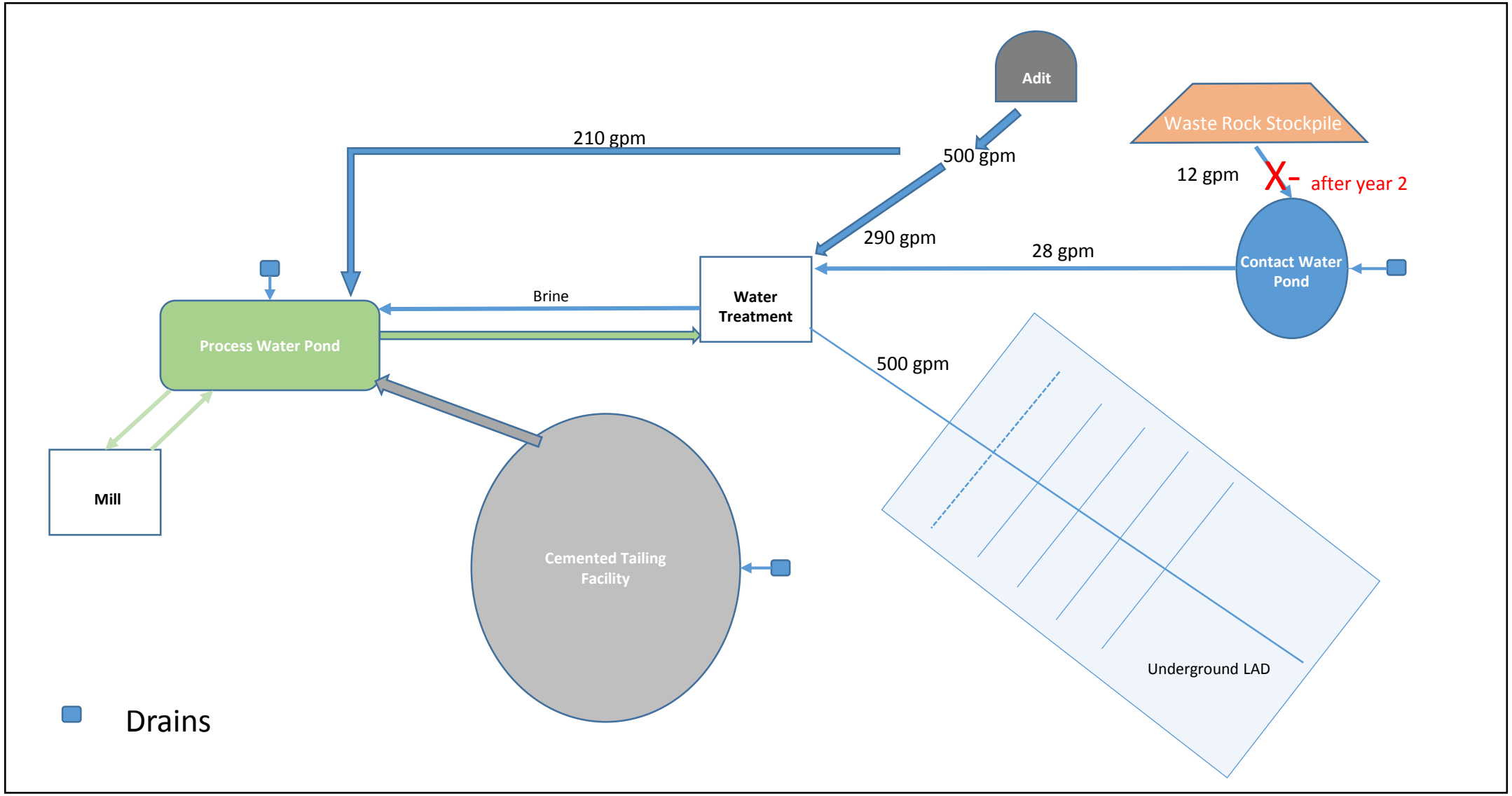
The design of the Project has been directly informed by the environmental geochemistry data detailed in the Baseline Geochemistry Report, presented in Appendix D (Enviromin, 2015) of this mine permit application. Mine facilities where water will potentially be influenced by geochemistry include the subsurface workings, temporary waste rock storage pad, cemented tailings facility, process water pond, contact water pond, water treatment plant, and the underground infiltration gallery system. These facilities are described in detail in Section 3.0 above. As shown in Figure 4.10 and described in detail in Section 3.0, groundwater pumped from the underground sumps will be distributed between the PWP and the WTP. Water from the WRS will report directly to the CWP until year 3, when waste rock stockpile will be removed altogether.

In recognition of the sulfide content of the tailings to be produced from the Project, Tintina has proposed an innovative cemented tailings storage design. By incorporating binders into the tailings as they are placed in the lined CTF, Tintina will encapsulate sulfidic tailings and limit their exposure to oxygen and water, as well as reduce the potential for these materials to be transported in the unlikely event of dam failure. Furthermore, Tintina proposes to encapsulate all mined waste rock within the CTF, thereby limiting acid and metal release potential for the waste rock. The majority of this rock will be produced from the decline early in operations, and will therefore be placed into the lowermost part of the lined CTF. Waste rock produced subsequently will be placed into PAG cells within the cemented paste backfill. Water seeping from tailings as they consolidate and harden will mix with runoff from direct precipitation onto the CTF; this water will be collected in a waste rock-lined sump prior to being pumped back to the PWP.

At closure, the water balance will change significantly (Figure 4.11). Mining will cease and all underground mining stopes will have been backfilled. Dewatering will cease and groundwater will rebound, filling the decline and any air-gaps in backfilled stopes. Water from underground will no longer report to the PWP or the WTP. Contributions from the WRS will have been eliminated in year 3, reducing the solute load from the CWP. Following the placement of final tailings lifts, a HDPE geomembrane will be used to cap the CTF, eliminating incident precipitation and greatly reducing the availability of oxygen. Progressively less water will report to the CTF sump following closure from the cemented tailing mass, and solute load is expected to decline, so that the chemistry of water requiring treatment will change (Figure 4.11).

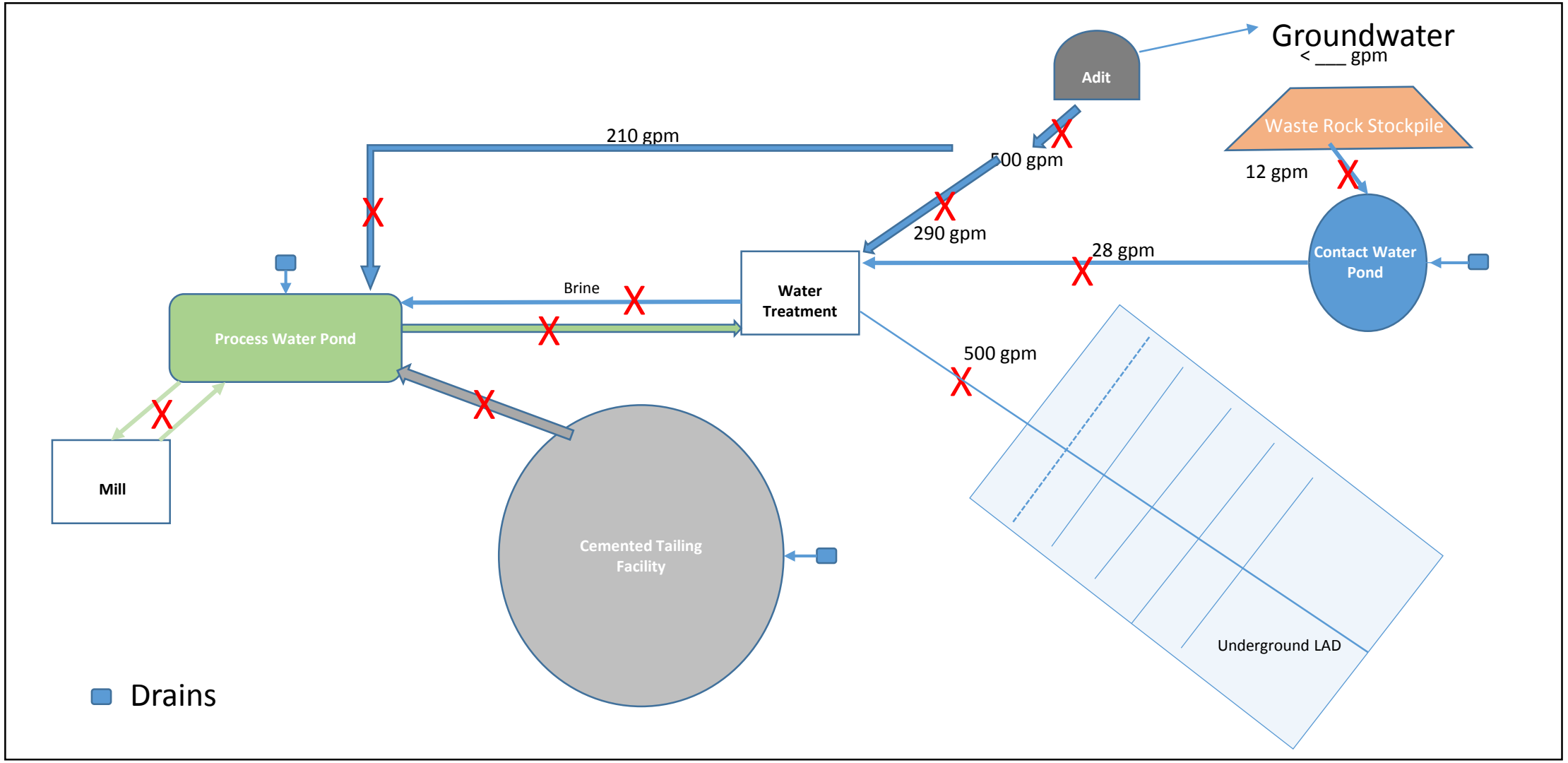
Models of facility hydrogeochemical performance are currently being developed; we anticipate completing them during first or early second quarter 2016, following consultation with MT DEQ and when ongoing geochemical test work is complete. These models will integrate proposed designs with hydrological, geochemical, and water balance data to predict water quality for the Project facilities during operations (year 6) and at closure. There are four models under development:

- Groundwater quality prediction in the underground workings;
- Seepage prediction for temporary waste rock storage, which will be collected in the CWP and treated or used as make-up water in the PWP;
- CTF seepage/runoff water quality, which will ultimately return to the PWP and WTP for release following treatment and discharge to an underground infiltration gallery; and
- Updated and refined water quality data predictions for water reporting to the WTP based on UG, CWP, and CTF predictions.



TINTINA RESOURCES

Figure 4.10
Operational Site Water Balance - Year 6
Black Butte Copper Project
Meagher County, Montana



TINTINA RESOURCES

Figure 4.11
Closure SIte Water Balance - Year 20
Black Butte Copper Project
Meagher County, Montana

Each model will apply groundwater flow predictions (Appendix M) (Hydrometrics, 2015c) and geochemistry data being collected (Appendix D; Enviromin 2015) to facility-specific conceptual models describing conditions during operations and at closure. The analytical approach will recognize changes in the operational water balance and extent of oxidation throughout mine life, as well as solubility and sorption constraints on the quality of water in each setting. Uncertainty will be addressed using sensitivity analyses. The conceptual models and implementation approach for each facility will be discussed with DEQ prior to implementation, and the results will be reported thereafter.

4.2.2 Prediction of Groundwater Quality in the Underground Workings

Most rock that will be exposed underground lies below the water table, and will interact with influent groundwater during dewatering operations. An estimated 500 gpm (1,893 Lpm) of groundwater will flow through exposed rock into the mine along faults, joints, and fracture surfaces encountered during mining and to some limited extent enhanced during blasting. Waste rock within the undifferentiated *Ynl* (4%), the *USZ (28%)*, the *Ynl B (32%)*, and the *LZ-FW* (35%) will be exposed along the 5 m (16.5 ft.) wide by 5 m (16.5 ft.) high decline, and will experience variable fluxes of groundwater based on predictions of hydraulic conductivity between hydrostratigraphic units defined in the groundwater model (Appendix M; Hydrometrics, 2015c). Release of sulfate, acidity, and metal will be proportional to the mineralogy, exposed surface area, and flux of water for each lithotype, as well as the length of time rock is exposed to oxidation.

Rock will likewise be exposed to groundwater in the mined stopes. However, while the decline will remain open throughout mine life, rock in the active stopes representing 1% of the ore zone will be exposed for only 90 days per stope prior to backfilling with 4% cement-amended paste tailings. Previously mined and backfilled stopes will contribute significantly lower solute load, driven primarily by limited diffusion of oxygen into the low-permeability backfill, and by interaction of groundwater along small air pockets in gaps that develop between the backfill and the stope back. At any given time, the chemistry of water in the underground sump will therefore represent the sum of contributions from waste rock lithotypes exposed in the decline, together with solute loading from the active mining stope and any previously backfilled stopes. This water will be collected and pumped to surface, where it will be divided between the process water pond as make-up water (210 gpm; 800 Lpm) and the water treatment plant (290 gpm: 1097 Lpm) prior to discharge.

Geochemical models will predict the impacts of oxidation for year 6 and at mine closure. Oxidation is expected to occur along the exposed back and rib, with the ultimate limit of oxidation being controlled by the diffusion of oxygen into the rock surrounding the decline over time (Davis et al., 1986; Kempton and Atkins, 2009). Oxidation will be greatest along the exposed back and rib within the decline itself, and will diminish with distance into the bedrock. The resulting “oxidized rind” of the decline will be exposed to influent groundwater along fracture surfaces (Siskind and Fumanti, 1974) at predicted rates of inflow (Appendix M; Hydrometrics, 2015c), resulting in the dissolution and desorption of sulfate and metals, as well as nitrate from the surfaces of the rock. Each of the exposed lithotypes will contribute a unique suite of solutes based on lithotype mineralogy and reactivity, which will be represented by kinetic humidity cell test results (Appendix D; Enviromin, 2015) appropriately scaled to address reactive mass and water flux. Solutes contributed by the “oxidized rind” will be added to those known to be present in influent groundwater. Water flowing from each of the waste rock lithologies will then be mixed, in relative proportions, to groundwater flow into the decline, equilibrated with atmospheric conditions, and allowed to precipitate minerals that have potential to sorb metals. The net solution chemistry for contributions from the decline will thus be calculated.

At closure, mining and dewatering will cease. The groundwater table will rebound, fully submerging the backfilled stopes and eliminating the exposure of rock to oxygen. This will essentially eliminate contributions from the decline, so that mass loading in closure will be reduced to contributions from the extremely low permeability, saturated cemented paste backfill.

4.2.3 Seepage Prediction for Temporary Waste Rock Storage

Mixed waste rock will be stockpiled on a 100 mil HDPE liner during the first two years of mine life (while the decline is driven and construction of the CTF is completed). Precipitation onto the pile has potential to infiltrate along preferential flow paths, but it is unlikely that the entire pile will accumulate sufficient water for flow under unsaturated conditions (the wetting requirement) in a two year time frame. Any seepage will be collected and directed to the CWP prior to treatment. The relative ratio of rock types on the stockpile will be directly proportional to the tonnage of rock to be mined as workings advance (Table 2-20). The relative surface area is unknown, but is expected to be significantly smaller than that of the humidity cell tests. Solute loading from the material will recognize that a relatively limited amount of oxidation will take place during the two years of exposure, and the fact that the wetting requirement of the stockpile will likely not be met during the relatively short storage period. Oxidation of this material, as represented by the humidity cell data, will be appropriately scaled in predicting water quality using the facility water balance developed by Knight-Piesold (2015c)(Appendix L). Predictions of seepage will be made for years 1 and 2. Uncertainty related to unsaturated hydrology and surface area of waste rock will be addressed in sensitivity analyses.

4.2.4 CTF Seepage/Run-off Water Quality

To predict seepage quality for the CTF, a small volume of dewatering seepage will be expected to mix with runoff from precipitation that will contact the waste rock-lined sump of the CTF. Together with the CTF water balance developed by Knight Piesold (2015c), solute loading from cement-amended paste tailings will be calculated. The resulting water quality prediction will be reacted with waste rock to be used in construction of the CTF sump.

All stockpiled waste rock will be placed into the lined CTF in years 2 and 3; this represents 65% of waste rock to be placed in the facility over mine life. These basal waste rock deposits will then be covered by 2% cemented paste in routine sequential wedge-shaped flows that are expected to be up to one foot (0.305 m) in thickness. Deposition of cemented paste tailings will occur daily. Subsequent coverage will not be immediate in any given location, as the spigoting location will vary. It is therefore assumed that cemented paste tailings may be left exposed to air and water operationally for up to 30 days, and that reactions proportional to those observed in the 4% paste-amended tailings humidity cell test (Appendix D)(Enviromin, 2015) may occur along the exposed surface of each lift. Although Tintina proposes to place tailings in a 0.5 to 2% cemented paste, each lift will behave as a massive block, and is unlikely to disintegrate as was observed for the laterally unsupported 2-inch diameter, 6-inch tall 2% cemented core during kinetic testing. The sensitivity of the predicted water quality to this assumption will be tested in sensitivity analyses. Waste rock produced following year 3 will be placed into localized cells within the cemented paste deposits; seepage from these zones will be represented using 4% cemented paste HCT data and compared with the 4% cemented paste plus ROM HCT data in sensitivity analyses. This is because the inclusion of relatively coarse, 3/8 inch ROM in the fine grained cement paste resulted in textural disruption of the low permeability, relatively more massive cement; this was reflected in the results of kinetic tests

4.2.5 Updated Water Quality Data Predictions (WTP and PWP, based on UG, WRS, and CTF)

In the absence of final geochemical test results, the quality of water reporting to the WTP has been estimated based on worst-case groundwater quality and process water measured during metallurgical testing (AMEC, 2015). Following completion of the predictions for UG, WRS, and CTF, the chemistry of the PWP water will be re-evaluated. The chemistry of water reporting to the WTP will also be re-assessed and updated if needed.

5.0 MITIGATIONS

5.1 Summary

Tintina has aggressively sought out and implemented a number of innovative process variations and modified the ways in which facilities are sited and constructed. These will reduce risks to human health and the environment. The mitigations and their justifications include:

- Process variations
  - Use of cemented paste tailings backfill underground
    - Provides structural strength for ground support and prevents surface subsidence
    - Results in extremely low hydraulic conductivity of backfill (water flows through at a rate of about 10^{-9} (one billionth of a foot per day)
    - Helps neutralize acid-generation because paste fluid properties are highly alkaline (high pH of 9 to 10)
    - Significantly reduces or eliminate sulfide oxidation (and acid production) because paste tailings will reside below groundwater table after closure in a chemically anoxic (non-oxidizing) environment
    - Reducing conditions also inhibit the solubility of many metals
    - Allows drift and fill mining which provides for 100% extraction of copper-enriched rock
  - Use of cemented paste tailings in surface tailings facility
    - Cemented paste tailings are a stable non-flowable low strength solid
    - Cemented paste tailings establish a 1-2° slope towards sump, allowing for drainage to CTF sump
    - Cemented paste properties provide extremely low hydraulic conductivity to tailings (water flows through at a rate of about 10^{-9} (one billionth) foot per day) on the facility
  - Use of sealed containers for shipping
    - Concentrate loaded in enclosed concentrate shed
    - No loss of material during transport
    - Eliminates off-site contamination because no intermediate load-out, transfer or storage areas are required
    - Reduced risk of spillage in event of accident
  - Contact water containment
    - Contact water transported in lined ditches or HDPE pipelines to lined storage facility prior to pump-back to PWP or WTP
- Facility siting
  - Mine openings (portal and ventilation raises) all located well above the water table therefore no risk of any discharge to surface water in closure
  - Locations sited off of all main streams (> 0.4 miles from Sheep Creek , and 19 river miles from Smith River)
  - All facilities confined to one sub-basin drainage (Sheep Creek)
  - All facilities locations selected to minimize impacts to wetlands (less than 1.82 acres (0.73 ha) of wetlands impacted by all Project disturbances and activities).

    - Portal and decline location selected over alternatives sites to minimize amount of sulfide-bearing rock brought to surface for storage on the temporary waste rock facility
- Facility construction
    - Water-bearing mine waste facilities
        - All water-bearing facilities have foundation drains (beneath the facilities) with foundation drain collection ponds that pump back to treatable storage
        - All water-bearing facilities have double HDPE-lined basins with geonet sandwiched between liners for drainage; drainage from geonet layer reports to sump in CTF
        - The CTF facility has an internal basin drain with water collected off of the top of liners and directed to PWP storage facilities or treatment
        - The high hazard dams (CTF and PWP) are designed to store the Probable Maximum Flood Event (equivalent of 33 inches (830 mm) of precipitation in a single storm event, about 1.5 times larger than total annual precipitation),
        - Additional minimum of 6.6 feet (2 m) of freeboard storage in excess of PMF event (CTF and PWP)
        - One smaller facility (CWP) and one fresh water facility NCWR can store the 1:200 year storm event
        - PWP designed to operate less than ½ full
        - CTF, PWP, NCWR and CWP facilities are designed to withstand the Maximum Credible Earthquake event, and the 1 in 10,000 year event (as required by recent Montana Legislation SB 409)
        - Have foundation factors of safety for stability well in excess of what is needed to avoid risk of failure (see Section 3.5.5).
        - Have third-party engineer of record and panel of 3 independent tailings engineers that oversee the design, construction, operation and closure of the CTF
        - Water can be continuously removed from CTF and CWP; little water will be stored on either of these facilities as ponds or in sump
            - Low water storage reduces or eliminates hydrostatic head of water on facility liners
            - With almost no head on the CTF and CWP liners, seepage through the liners will be negligible
- Underground grouting of fractures under Coon Creek
    - Minimizes risk of surface subsidence from mining
    - Minimizes loss of surface and groundwater into mine workings, thereby reducing potential for impacts to creek and associated wetlands (however, no impacts to either detected in pump testing)
- Tailings release from pipelines and storm water control
    - Double walled tailings transport pipe system (high pressure steel line within an outer HDPE pipe)
- Use of BMPs to route storm water in diversion ditches around facilities and deliver water and sediments to discharge points with sediment collection.

5.1.1 Failure Modes Effects Analysis (FMEA)

Tintina developed a number of these mitigations by searching for ways to reduce risks to human health and the environment, through an examination of the effectiveness of proposed operational processes

and examination of facility designs and their modes of failure using a methodology called Failure Mode and Effects Analysis. Failure Modes and Effects Analysis (FMEA) is a systematic method for examining processes or facility designs to identify where and how they might go wrong or fail; and to assess the relative impact of different types of failures.

Once this is accomplished, the parts of the process that are most in need of change are identified. A FMEA is often used to structure mitigation for risk reduction based on either failure (mode) severity reduction, or based on lowering the probability of failure's occurrence or both. FMEA is used to evaluate processes and facilities for possible failures and to prevent them, by correcting the processes or design proactively, rather than reacting to adverse events after failures have occurred. This emphasis on prevention can significantly reduce risk of harm to human health and the environment.

An example of one of the graphic outputs from this process is presented in Figure 5.1. This figure evaluates the change in risk associated with project facilities that results from having ample vs. marginal water storage capacity and the ability to pump-back water from a facility in order to prevent a discharge. As can be seen from this figure facilities with the properties of ample storage and pump-back capabilities greatly reduces the risk of failure from facilities that lack those attributes, such as many of the historically constructed facilities. A portion of the FMEA evaluated during planning for process selection and facility design for the Black Butte Project is included in this report as Appendix R.

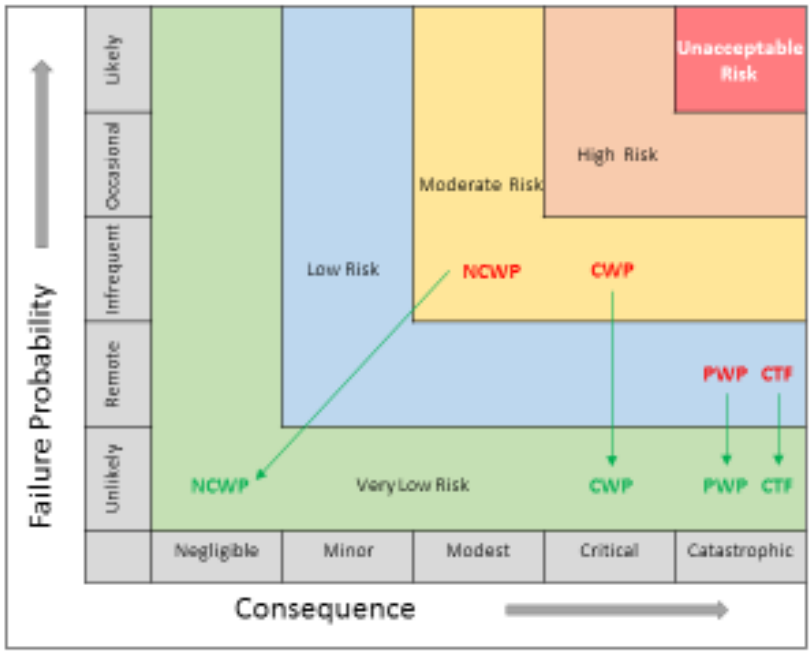


Figure 5.1. Overfilling of Facility and Discharge Resulting from Inadequate Water Storage Capacity or Lack of Pump-back Capability

6.0 MONITORING

6.1 Monitoring Introduction

Baseline monitoring has been conducted and will continue throughout the mine permitting period to assess environmental conditions prior to surface disturbing activities. This monitoring characterizes existing conditions at the site, and provides a baseline against which to identify potential impacts to resources. Baseline resource study results are described under the resource evaluations in the Existing Conditions portion of this report (Section 2.0).

Operational monitoring is designed to identify potential environmental impacts to resources. The frequency of monitoring for resources is stipulated by DEQ, and intended to detect potential impacts in a timely manner and trigger the implementation of operational changes and/or mitigation measures. Various means of protecting specific resources are discuss below and in the Mitigations section (Section 5.0).

Post-mining monitoring continues after closure to monitor potential impacts. This monitoring will continue until such time that DEQ determines that frequency and number of sampling sites for each resource can be reduced or that closure objectives have been met and monitoring can be eliminated.

6.2 Ongoing Baseline Monitoring

Expected ongoing monitoring programs during the permitting period include weather, water quality and quantity, aquatic resources, and ongoing environmental geochemistry.

The existing water quality and quantity monitoring program currently evaluates 11 surface water sites. Flow, stage and field parameters (temperature, pH and SC) are monitored quarterly at all of these sites. Water quality samples are collected at six of the sites during quarterly (or more frequent) monitoring. In addition, 12 groundwater monitoring wells and 10 seeps and springs are monitored for water quantity (or water levels) and quality on at least a quarterly basis. Nine aquifer test wells, and 12 piezometers are monitored for water levels only, on a quarterly or more frequent basis (Section 2.2). These monitoring sites are depicted on Figure 2.2 and Figure 2.3. Soil, wildlife, vegetation, cultural, socio-economic, and visual and transportation resources are unlikely to change as a result of, or during the permitting process. Any significant changes to these resources, should they occur, will be assessed and reported to DEQ.

6.3 Operational Monitoring

6.3.1 Water Quality and Quantity Monitoring

6.3.1.1 Proposed New Operational Monitoring of Facility Sites

As permitting proceeds and construction of new mine support facilities are anticipated, additional water resource monitoring of these facilities will be warranted. Tintina proposes the following for new facility monitoring sites, to provide a technically sound and regulatory sufficient monitoring program. These sites will be monitored on a quarterly basis for the same surface and groundwater parameters as for the current baseline study programs (Section 2.0). Table 6-1 lists and Figure 6.1 shows proposed new sampling site locations for surface water, groundwater monitoring wells, and piezometers. Monitor wells and wetland piezometers are strategically located downgradient of proposed water-bearing facilities and infiltration galleries. Infiltration gallery piezometers (not shown on Figure 6.1) will measure depth of saturation in near surface materials. It is intended that all three newly proposed surface water sites, seven of the paired downgradient monitor wells for major facilities, and all five new wetland piezometers (Figure 6.1) be

installed prior to or early in the EIS process. This will allow at least one year of new baseline facility monitoring data collection before construction. An additional six operational downgradient facility monitoring wells, and 15 new piezometers for the underground infiltration galleries are proposed to be installed during the facility construction period. Baseline data from this latter set of wells and piezometers is not required as their locations are paired with the initial set of wells installed.

Table 6-1. Additional Operational Facility Monitoring Sites

Site	New Surface Water Station	Downgradient Monitoring Well (initial/construction)*	Downgradient Wetlands Piezometers	Inlying Infiltration Gallery Piezometers
Upper Coon Ck.	1			
Upper Brush Ck.	1			
Lower Brush Ck.	1			
WRS		1 / 2	0	0
CWP		1 / 2	1	0
PWP		1 / 2	1	0
CTF		1 / 3	1	0
NCWR		1	1	0
Infiltration Gallery central		1	1	8
Infiltration Gallery southwest		1 / 2	0	7
Total	**3**	**13**	**5**	**15**

Initial wells to be installed prior to or early in the EIS period whereas, construction wells will be installed prior to facility construction.

The proposed increased monitoring is likely sufficient, as a minimum of two downgradient surface and groundwater monitoring well locations monitor water resources of each of the new facilities. Both downgradient groundwater monitoring wells and internal and external piezometers will monitor the underground infiltration galleries. Changes in groundwater quality near the infiltration galleries are not expected because the discharges will be treated to non-degradation criteria for groundwater.

LAD and underground infiltration gallery sites will be visually inspected to ensure that surface ponding, seep, and spring development and surface water runoff is not occurring. The piezometers will also be used to track groundwater mounding and to avoid soil saturation. It is expected that monthly adjustments will be required to the amount/time water is applied to each cell(s), or distributed along lines in the gallery system. Because the mine discharge rate is expected to be low during the initial development, there will be an opportunity to better understand and calibrate application rates and cell rotation using piezometer water level measurements of soil saturation.

NOTES:

MINE FACILITY LOCATIONS ARE PRELIMINARY AND APPROXIMATE, AND ARE SUBJECT TO CHANGE WITH FURTHER DESIGN.

LEGEND:

- NEW SW (SW) — MW
- NEW MONITOR WELL (MW) — P
- NEW PIEZOMETER (P) — SW
- DEVELOPED SPRING
- SW_SITES - FLOW
- SPRING
- SW_SITES - FLOW_WQ
- TEST WELL
- MONITORING WELLS
- PIEZOMETER

WATER WELL (PW-8)
CONNECT EXISTING ROAD TO VENT RAISE
VENT RAISE (TYP.)
MINE PERMIT BOUNDARY (APPROXIMATE)
COON CREEK
EXTEND EXISTING ROAD TO VENT RAISE
TEMP. WASTE ROCK STORAGE (EL. 1792.98 m)
APPROXIMATE AREA FOR RECLAMATION MATERIAL STOCKPILE
ACCESS GATE
POWER LINE AND PIPING TO WATER WELL (PW-8)
PORTAL PAD (EL. 1788 m)
STOCKPILE
ADIT ALIGNMENT
FIBER OPTIC VAULT LOCATION
CONSTRUCTION ACCESS ROAD
PORTAL
CONTACT WATER POND (CWP)
APPROX. TOP OF CUT OR TOE OF FILLS. (TYP.)
FOUNDATION DRAIN POND
PAD (EL. 1785 m)
TEMP. POWDER MAGAZINE
CULVERT CROSSING 2
CULVERT CROSSING 1
CORE SHACKS
POWER LINE
ACCESS ROAD
SERVICE ROAD
CULVERT CROSSING 3
PROCESS WATER POND (PWP)
CULVERT CROSSING 4
PWP DIVERSION DITCHING
BURIED PERFORATED PIPE (TYP.)
BURIED SOLID PIPE (TYP.)
CEMENT TAILINGS FACILITY (CTF)
FOUNDATION DRAIN POND
TOPSOIL STOCK PILE
SUBSOIL STOCK PILE
CTF DIVERSION DITCHING
CULVERT CROSSING 5
SERVICE ROAD
NCWR DIVERSION DITCHING
NON-CONTACT WATER RESERVOIR (NCWR)
SPILLWAY

0 250 500
Scale: 1: 7 500 (metres)

FIGURE 6.1
PROPOSED NEW MONITORING SITES

TINTINA RESOURCES

PRELIMINARY DRAWING

NOT TO BE USED FOR CONSTRUCTION

6.3.1.2 Water Quality and Compliance Monitoring of Facilities

The facilities will require water quality sampling and monitoring during operations. Tintina recommends that the following be sampled for water quality and flow or water levels:

- Water treatment facility discharge point (non-degradation compliance)
- Foundation drain (CWP, PWP and CTF) water quality sampling to monitor effectiveness of the liners and foundation drains

It is recommended that water treatment facility discharge be measured weekly, and that facility down-gradient foundation drain ponds be sampled monthly, until longer sampling frequency periods are deemed acceptable by DEQ. Piezometer down-gradient wetland water levels should be measured monthly.

Other sites are recommended for monitoring for flow for operational water balance and water right's needs. These include:

- Underground dewatering discharge to mill and WTP
- Process water pond discharge to the WTP

6.3.1.3 Trigger Level Values for Implementation of Mitigations

If a preliminary laboratory report showing that a contaminant has exceeded local background non-degradation criteria for groundwater at any of the groundwater monitoring sites is received, Tintina is required to notify DEQ within 3 working days and submit a corrective action plan for addressing the exceedance.

If contaminants from facilities, underground infiltration galleries, or the surface LAD are identified in a preliminary laboratory report from surface water, Tintina is required to notify DEQ within 3 working days, and modify the system to prevent discharge to surface water. Tintina recognizes that no discharge to surface water will be authorized under the mine's operation permit.

6.3.2 Facility Operational Monitoring

Proper operation, monitoring, and record keeping are critical to the operation of all waste and water management mine facilities. A Tailings Operations, Monitoring and Surveillance (TOMS) Manual will be prepared for all of the waste and water management systems (WRS, CWP, PWP and CTF). This document will be reviewed and updated on an ongoing basis (i.e. during the initial construction program and during operations). The TOMS Manual will outline regular monitoring, inspection, and reporting requirements as well as emergency response measures in the event of an upset of operating conditions. The TOMS Manual should be referenced for all operations and monitoring activities relating to the WRS, CWP, PWP, CTF and NCWR and ancillary waste and supply lines and water control structures.

Activities or inspections to be carried out during construction and operation of the, CWP, PWP, CTF and NCWR will include:

- monitoring of construction and commissioning of the foundation drain,
- seepage collection and sump and pump-back systems,
- construction/extension and management of tailings discharge pipe works,
- basin underdrains,
- water reclaim systems, and
- pipe works and seepage recycle systems.

Concurrent reclamation of the downstream embankment slopes will be undertaken for all facilities following the completion of first and/or second phases of embankment construction.

Extensive monitoring will be undertaken as part of the ongoing operation of these facilities, and will provide important input for performance evaluation and refinement of operating practices. Monitoring will be conducted throughout the life of the facility including construction, operation, decommissioning, and post-closure.

The proposed monitoring falls into three basic types as follows:

- **General Monitoring** - This includes items such as:
    - tailings deposition locations
    - checks on pipe joints and pipe integrity
    - performance of pumps and valves
    - embankment freeboard
    - water levels in sumps and ponds

Regular inspections will help identify any areas of concern that may require maintenance or more detailed evaluation. General monitoring will largely be undertaken through visual inspections carried out by designated personnel. Detailed inspection checklists, action sheets, and recording and reporting procedures will be developed for daily, weekly, and monthly inspections.

- **Performance Monitoring -** This includes items such as:
    - tailings solids content
    - Volume of tailings deposited
    - Groundwater monitoring well sampling and testing
    - Analyzing piezometer levels within the tailings mass
    - Analyzing settlement gauge data
    - Analyzing inclinometer data
    - Reviewing tailings level and density surveys
    - Surveying of the cemented tailings surface slopes
    - Monitoring movement detection monuments
    - Completing embankment surveys
    - Water flow measurements

The monitoring program will be used to verify the performance of the facility, to refine future embankment raise levels, and to ensure that the Project is operating safe and secure facilities. Monitoring of the waste and water management facilities will also provide performance evaluation information that will help refine operating practices.

During operations, a surface and groundwater quality monitoring program will be conducted in order to determine seasonal and temporal changes in the foundation drain flows and receiving water quality from the CWP, CTF, and PWP. This program will be carried out to confirm compliance with downstream receiving water quality requirements and to protect groundwater quality from changes over time. The program will consist of sampling and analyses of:

- Foundation drain flows from the CTF collection sump
- Monitoring wells located throughout the mine site, especially those down gradient from the CWP, PWP, and CTF

6.3.2.1 Facility Geotechnical Monitoring

Geotechnical monitoring will include survey monuments on the crest and downstream slopes of all embankments. These monuments will require initial quarterly surveying and then at regular intervals in order to indicate any settlement or movement of the embankments. Inclinometer measurements will also be recorded simultaneously as part of the geotechnical monitoring program. Additional monitoring will include the ongoing monitoring of the pore pressures within the basin underdrain, basin drain, and wet well sump and pump system in the CWP, PWP and CTF. This will include monitoring of the vibrating wire piezometers installed during operations. The piezometers will be monitored regularly during operations.

6.3.3 Waste Rock Geochemistry Monitoring

Geochemical monitoring of waste rock will not be required. Temporary storage of waste on the WRS pad will only be necessary for rock produced during the first 1.5 to 2 years of development mining. All waste rock produced during this time will be assumed to be PAG. The temporary WRS pad will have a foundation underdrain collection system and a 0.1 inch (100 mil) HDPE liner. A basin drain to collect seepage from precipitation or snowmelt will be constructed on the upper surface of the liner. Seepage will be transferred by a pipeline and/or geotextile lined drainage channel either directly to the CWP or more likely piped directly to the reverse osmosis water treatment system. Water will be treated to non-degradation groundwater criteria prior to discharge to the underground infiltration drain system or surface LAD. Some waste rock stored on the temporary WRS pad will be crushed and used as a cushion layer for the upper liner of the CTF once it is operational. Excess waste rock stored on the temporary WRS pad, and waste rock produced operationally over the life-of–mine will be co-disposed of with the cemented tailings in the CTF.

6.3.4 Air Quality Monitoring

Air quality monitoring is designed to ensure that fugitive dust generated from cut and fills, tailings surfaces, and other construction, storage, and disposal areas does not become a public nuisance, or detriment to flora or fauna of the area. Air quality rules require reasonable precautions to be taken to prevent emission of airborne particulate matter. Tintina will be required to obtain a Montana Air Quality Permit under the Montana Clean Air Act that specifies requirements for applicable State and Federal air quality standards. The permit will specify dust control, monitoring and reporting requirements in detail. The air quality permit application requires that the applicant demonstrate compliance with all applicable state and federal regulations and ambient air quality standards. Tintina plans to monitor air quality at its weather station location, and additionally monitor for particulates and fugitive dust as specified in an air quality permit. Monitoring of ambient air quality will be conducted to the extent required under the terms of the air quality permit.

Dust control associated with the internal and external atmosphere of the mill, and in the vicinity of the crusher are described in the operation plan (Section 3.3). Fugitive dust management is discussed in Section 3.6.1 for construction areas and roads and Section 3.3.2.2 for facilities.

6.3.5 Wetlands Monitoring

Wetlands will be monitored quarterly using previously and newly installed piezometers for changes in water levels that could be attributed to mining. Measurable water level changes in tributary and main stream wetlands are not expected based on the results of aquifer pump testing and hydrologic modeling. As a potential mitigation, Tintina plans to grout fractures in bedrock in the area where the development decline ramp passes some 90 feet (27.5 m) under Coon Creek and its associated wetlands. In addition, Tintina also plans to augment flows to wetland using treated water should impacts to wetlands developed

over the relatively short period of the mining (13 years). The risk of surface disturbance to wetlands (other than those anticipated under the mine plan (Section 3.0) will be will be avoided by marking wetland locations proximal to proposed construction areas prior to commencement of construction activities.

6.3.6 Aquatic Resource Monitoring

A second and final year of seasonal baseline surveys for the assessment of fish, mussels, macroinvertebrates, periphyton and habitat evaluation at sites in the Project area and Sheep Creek drainage basin will be completed during 2016 using Tenderfoot Creek as a reference reach. Project goals will continue to be:

1. To conduct standardized surveys and collect baseline information on the aquatic communities present at stream sites associated with established surface water-quality monitoring sites prior to mine development, and
2. To assess aquatic community integrity with key indicators comparing these against biotic thresholds of reference condition standards.

A final compilation report of both years of aquatic baseline studies will be submitted to DEQ.

6.3.7 Noise Monitoring

Noise levels will be monitored as required by EPA, OSHA and MSHA in surface and underground areas during all construction and operational phases of the Project.

6.3.8 Reclamation Monitoring

Reclamation monitoring including visual (ocular) pedestrian surveys will be conducted to evaluate the effectiveness of reclamation. Maintenance and/or supplemental reclamation will be prescribed, if needed, to correct any observed problems. Reclamation monitoring will include observations of soil erosion and re-vegetation success. Reclamation surveys will be designed to compare the stability and utility of the reclaimed landscape to pre-mining conditions.

6.3.8.1 Soil Erosion and Construction Monitoring

Soil erosion and construction monitoring includes monitoring during active construction as well as long-term maintenance monitoring during closure. Monitoring will be conducted at all Project facility sites and along access roads to identify areas where slumps, rills, gullies, and sheet-wash might occur. Any identified erosion problems will be immediately corrected. Routine long-term maintenance monitoring will be conducted annually in the fall and continue for a period of three years following the completion of reclamation activities.

6.3.8.2 Re-vegetation Monitoring and Management

Revegetation will be monitored annually during the growing season to identify areas where vegetation may be failing, to determine the cause, and to document successful revegetation efforts. Revegetation monitoring will be conducted in conjunction with routine soil maintenance monitoring. Systematic pedestrian inspections will be conducted to identify areas that have inadequate cover, poor seedling growth, damage (winter die off), obvious nutritional deficiencies, or weed infestation.

Data recorded in early years will include observations of seedling success and vigor. Later observations will include plant vigor, composition, relative density, and vegetative diversity. Annual reports will be provided to DEQ in order to determine when the revegetation program will be deemed successful. Once sites have achieved reclamation success by meeting pre-closure reclamation goals with concurrence from DEQ, they will be removed from the annual survey.

Post-operation land use management will provide for reestablishment of pre-mine land uses of livestock grazing and hay production as discussed in the vegetation section (Section 2.8) and in the Land Use section (Section 2.13). Upon cessation of mining operations, cattle will be excluded from grazing on revegetated areas (through appropriate fencing) until vegetation is well-established and hardy enough to withstand moderate grazing. Noxious weeds will be monitored and treated with herbicide on reclaimed and adjacent areas.

6.3.8.3 Weed Control

Noxious weeds observed in the Project area include Canada thistle, musk thistle, and hound's tongue. Their distribution is described in greater detail in the vegetation baseline studies summarized in Section 2.8 and discussed in detail in Appendix H (Westech, 2015d).

Tintina has a weed management program in place (Appendix O), whose effectiveness has been significantly improved as a result of site visits by DEQ personnel. The program will be expanded to include new areas of proposed construction activities and surface disturbances. The focus of Tintina's weed management program is to protect weed-free vegetation communities by monitoring and treating new or expanding weed populations within the Project area. Weeds are spread by a variety of means that may include construction and mining equipment, construction and reclamation materials, livestock, wildlife, and wind. The risk of weed establishment clearly increases with ground-disturbing activities.

The weed management plan outlines strategies to prevent and or control the spread of noxious weeds during operation and closure. It focuses on preventative measures, management methods and education. Noxious weeds will be controlled using appropriate mechanical, biological and chemical treatments which meet the requirements of Meagher County, Montana and Federal laws. The weed control plan is designed to prevent the establishment and spread of weeds along mine access roads, areas disturbed by construction, mining, and processing activities, and in the vicinity of soil stockpiles. This scope of the plan will be developed between the landowners, Meagher County weed control officials, DEQ and Tintina. Tintina's current weed Plan is presented in Appendix O.

6.4 Post Operational Closure Monitoring

Once mining operations are complete and final reclamation and closure plans have been implemented, post-operational and closure monitoring plans will be developed in consultation with DEQ. These plans will be based on the final mine facilities layout and operational phase monitoring plans and results. Typically these plans will focus on long-term water quality and quantity monitoring, effectiveness of erosion control, and monitoring of vegetative success to document post-closure conditions at the former mine site. Post-operational monitoring will continue until the mine is certified by DEQ as being fully reclaimed by meeting closure goals, and all bonding release milestones have been met.

6.4.1 Facility Closure Monitoring

The goals of the reclamation plan (Section 7.0) for the waste and water management facilities are to achieve long term stability of each facility site or the one remaining embankment, to develop a self-sustaining productive vegetative cover over the tailings and synthetic liners, and to ensure long term protection of the surrounding environment. In order to document the success in achieving these goals, a post-closure monitoring program will be developed including geotechnical monitoring, hydrogeological monitoring, re-vegetation monitoring, erosion control, and the continuation of approved water quality monitoring and water treatment plans.

Geotechnical monitoring will include survey monuments on the crest and downstream slopes of all remaining embankments, as well as on fill material used to cap the CTF at closure. These monuments will require surveying at regular intervals in order to indicate any settlement or movement in the facilities. Inclinometer measurements will also be recorded simultaneously as part of the geotechnical monitoring program. Following closure, all monuments and inclinometers will be monitored until no noticeable additional settlement movement takes place within a 12-month period.

Additional monitoring will include the ongoing monitoring of the pore pressures within the basin underdrain, basin drain, and wet well sump and pump system in the CTF. This will include monitoring of the vibrating wire piezometers installed during operations, as well as any others required at closure. The piezometers will be monitored regularly during operations and for a post-closure period until the reclamation has been deemed complete and the bond released.

6.4.2 Water Quality Monitoring

Monitoring conducted over the life of the mine will indicate whether any adverse impacts to water quality have occurred during operations. Following cessation of mining operations, the approved post-operational water monitoring program will be implemented. This program will be used in conjunction with other reclamation and revegetation monitoring to document post-reclamation conditions at the former mine site and in surrounding water resources.

Both short- and long-term water quality monitoring closure programs will be established with DEQ. These programs will be based upon baseline studies and data collected during mining that prescribes surface and groundwater sampling sites, analytes, and frequency of sampling. The selected sites will likely be a subset of the operational water monitoring sites, and will be phased out as closure criteria were met and verified over time.

Results of the water quality monitoring will be provided to DEQ, who will determine whether down-sizing or cessation of the monitoring program is permissible. Provided that additional water quality monitoring is not warranted, the monitoring wells will be decommission by sealing the full length of the well with an inert cement grout. The casing will be cut off below ground level as per Montana well abandonment protocols and regulations.

Post-operational monitoring will occur until such time as the mine is certified as fully reclaimed and all bonding release milestones are met, or as determined in the post-operational monitoring program to be developed in conjunction with DEQ.

6.4.3 Reporting

A report will be submitted annually to DEQ describing post-operational closure water quality monitoring results, discussing reclamation and erosional problems, identifying remedial measures taken, and documenting reclamation/closure success.

7.0 RECLAMATION AND CLOSURE

7.1 Introduction

The reclamation and closure plan is structured to meet the requirements of the Montana Metal Mines Reclamation Act (MCA § 82-4-301 *et seq*). Three categories (periods) of reclamation and closure have been developed for the Project including: temporary closure, near- or short-term construction/operational reclamation, and permanent closure. The overall objectives of these types of reclamation and closures are similar and include:

- Re-contouring and re-vegetation of disturbed areas and landforms that have been modified by the construction of facilities throughout life-of-mine operations,
- Stabilization of disturbed areas using erosion, sediment control, and revegetation measures to prevent air and water pollution, and
- Noxious weed control.

Temporary closure reclamation will occur if the mine enters into a period of temporary inactivity. At that time, evidence of intent not to abandon the Project and to resume operations will be submitted to DEQ (in accord with ARM 17.24.150). Tintina will request that deferred implementation of the permanent closure plan be approved by DEQ. Temporary closure reclamation and site protection will include: stabilizing site-wide drainage facilities, prevention of unnecessary erosion by stabilization and revegetation of any existing disturbances, maintaining site access, provide site security by maintenance of fencing of facilities, protection of equipment, and preparation and implementation of a facility inspection program. All infrastructure required to resume mining will remain in place.

Construction/operational reclamation takes place during operations and stabilizes disturbed areas during and shorty after mine facility construction. Operational reclamation is focused upon construction disturbances associated with facilities that will remain in place throughout life of mine operations (i.e., cut and fill slopes, downstream embankments, pipe-line trenches, access roads and erosion control ditches and berms), or those that occur peripheral to and between constructed mine facilities. Interim reclamation of temporary or construction roads, embankments, soil stockpiles, ditch cuts and fills, trenches, surface water control structures, and other disturbances not inherently stable will occur during the first appropriate seeding season following construction. Reclamation of disturbed areas will be carried on throughout operations to the maximum extent practicable.

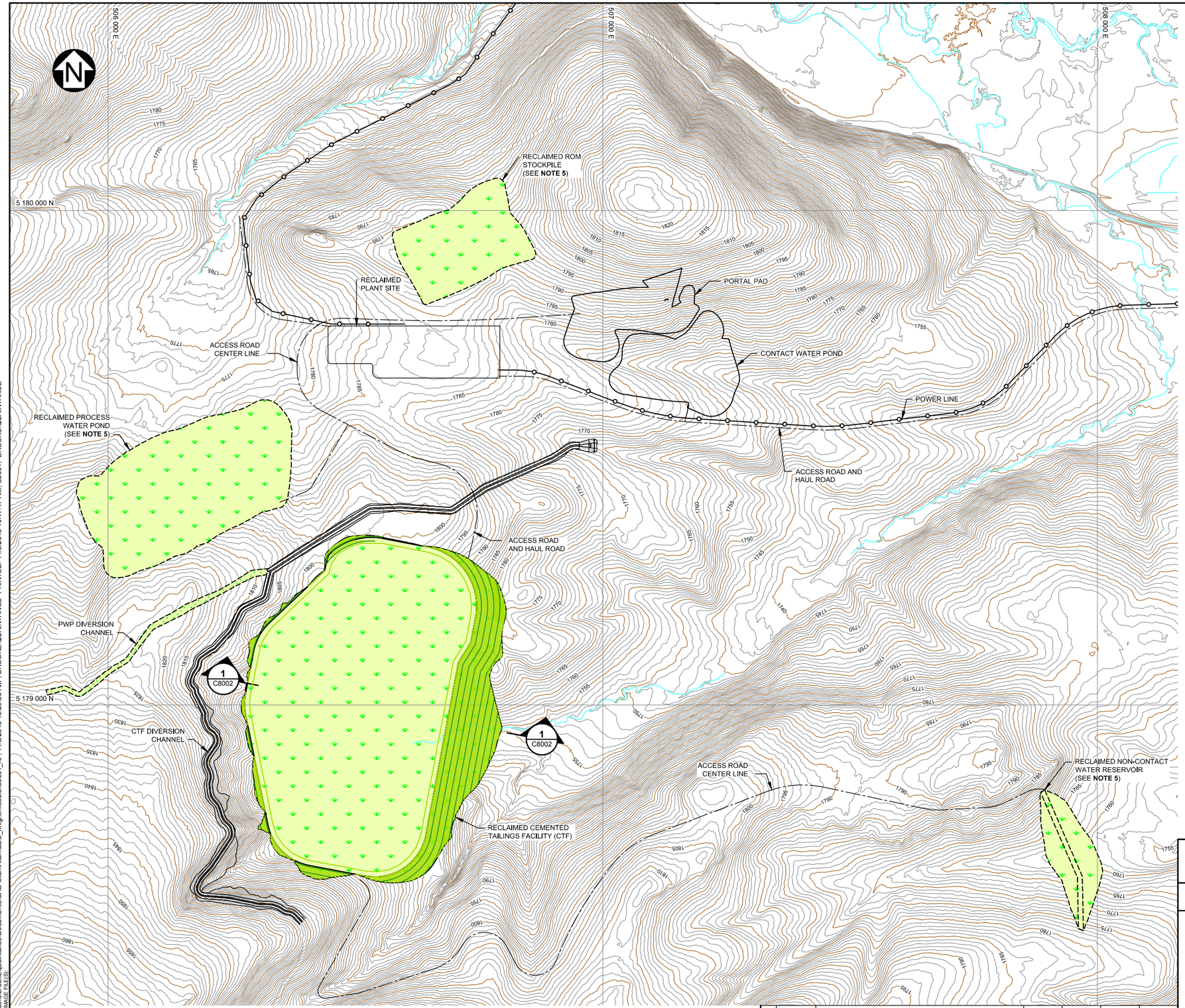
The 11.12 acre (4.5 ha) temporary WRS facility (WRS) and the 7.04 acre (2.8 ha) excess excavation materials stockpile will both be reclaimed near the end of the second year of facility construction. Both of these facilities are located immediately west of the portal pad (Figure 1.3) The WRS pad is designed to hold the first two years of development mining waste until the CTF is completed. The WRS pad liner will be removed and shipped off-site for disposal or recycling, compacted surfaces at the base of the WRS stockpile will be ripped to relieve compaction and allow for future water infiltration, and the excess material stockpile will be used to reclaim the WRS pad to near pre-existing topography.

Permanent reclamation and closure will occur at the end of mine life. It includes reclamation of all disturbances and removal of facilities that will not be retained by the private landowners for post-mining use. Should permanent closure of the mine operations occur before execution of the full mine plan, it is expected that reclamation objectives and plans will remain the same as those presented below. If revised closure plans are required, they will be prepared in cooperation with DEQ.

Permanent mine closure planning is the most comprehensive type of reclamation planning and considers all disturbed ground across the permit area Planning activities anticipate closure of all mine openings, dewatering and treatment of water from all storage facilities, facility and building removal, liner disposal, site-wide re-contouring of disturbance areas to near pre-mining topography for most facilities, drainage stabilization and erosion control, redistribution of soils, establishment of long-term vegetative cover, and site-wide reestablishment of conditions that support pre-mining beneficial land uses.

The long-term closure plan is discussed in greater detail below. The specific closure plan for each facility is described in Section 7.2.3. Prior to initiating permanent closure, Tintina will meet and review the previously approved final long-term closure plan with DEQ. Any proposed revisions to the plan will be submitted to DEQ in writing for their approval.

A site plan map showing the post closure topographic map for the site including portal pad, mill facility, WRS, CWP, CTF, PWP, NCWR, and soil and excess material stockpiles facilities is shown in Figure 7.1.



LEGEND:

RECLAIMED AREA

NOTES:

1. COORDINATE GRID IS UTM NAD83 ZONE 12.
2. PLAN BASED ON INFORMATION PROVIDED BY TINTINA RESOURCES INC., DATED FEB 03, 2011.
3. CONTOUR INTERVAL IS 1 METER.
4. DIMENSIONS AND ELEVATIONS ARE IN METERS, UNLESS NOTED OTHERWISE.
5. PWP, NCWR, AND ROM STOCKPILE AREAS WILL BE CONTOURED AT RECLAMATION TO APPROXIMATE THE ORIGINAL TOPOGRAPHY.
6. PLAN SITE, PORTAL PAD, CONTACT WATER POND, AND ACCESS ROADS CLOSURE PLAN WILL BE DEVELOPED BY TETRA TECH.

SCALE A: 80 40 0 100 200 300 400 m

TINTINA RESOURCES

BLACK BUTTE COPPER PROJECT

MEAGHER COUNTY, MT

FIGURE 7.1
SITE PLAN MAP OF POST CLOSURE TOPOGRAPHY

REV	DATE	DESCRIPTION	DESIGNED	DRAWN	REVIEWED	APPROVED
0	16OCT'15	ISSUED FOR MOP APPLICATION	GIM	PP		

REVISIONS

REVISED DATE: OCTOBER 16, 2015

REVISION 0

DRAWING BY KNIGHT PIESOLD: VA101-460/3

SOURCE FIGURE NUMBERS: C8001

SAVED: C:\Users\brooks.quaintance\Documents\CAD Stuff\Allan\BBC_knightmiesold\C8001_r0 , 11/5/2015 10:29:53 AM , BROOKS.QUAINTANCE PRINTED: 11/5/2015 10:47:47 AM, C8001, BROOKS.QUAINTANCE
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7.2 Detailed Plan for Permanent Reclamation and Closure

7.2.1 Post Mining General Construction Measures

Following are construction measures that will be applied site-wide during permanent closure. They include facility removal, landform restoration, surface reclamation, and closure activities. The goals of these construction measures are to achieve long term stability of each reclaimed facility site or remaining embankment, to develop a self-sustaining productive vegetative cover, and to ensure long term protection of the environment with respect to water quality and erosion.

Natural drying and evaporation will reduce the moisture content in waste materials, and pond levels in water storage facilities. Cement, fly ash, or slag added to the tailings operationally during thickening will stiffen the tailings after deposition and create a stable, non-flowable mass as part of the on-going process of tailings deposition. At closure all remaining water will be pumped from the facilities and their respective sumps and foundation drain ponds, treated to non-degradation standards for groundwater, and discharged to shallow bedrock infiltration galleries or the LAD. Any sediment present in the PWP after draining, will be mixed with cement to create a hardened, non-flowable mass.

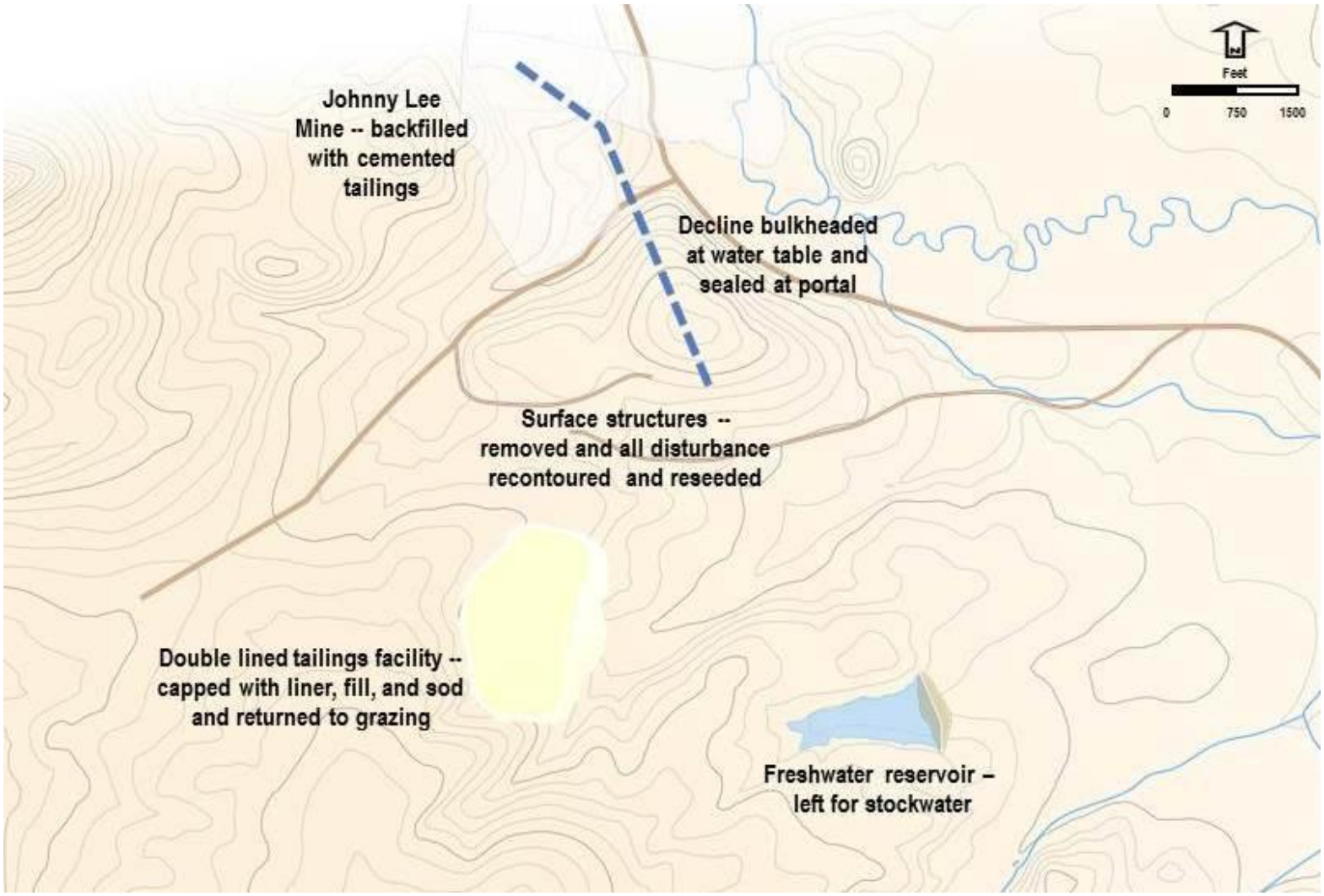
An HDPE cover will be placed on the tailings facility, welded to the bottom liner, and the remaining embankment reshaped as described below in the CTF closure section (Section 2.2.3.6). Final reclamation of the facilities will include decommissioning of the foundation drain outlet pipes and collection ponds for the CWP, CTF, and PWP. Drain pipes will be excavated at their ends, cut short, capped, and reburied. The foundation drain collection ponds will have their liners removed prior to reclamation. The liners will be hauled off-site either to a disposal or recycling center.

Reclamation of facility areas will include removal and off-site disposal or recycling of liners, filling of excavated basins, and reshaping of the ground surface. This will be done by placing embankment or other fill materials to create a self-draining surface approximating the pre-mining topography that will provide long term stability after closure. This surface will be capped with soil and re-vegetated. Subgrade bedding material may need to be placed above the tailings and general fill to provide a protective layer for HDPE geomembrane placement, depending upon the material that forms the final upper surface (this will not be required for a smooth tailings surface). Surface gradient restoration will be suitable for the post-operation use of rangeland. Grading will minimize the amount of precipitation and run-on that infiltrates into disturbed areas.

Revegetation measures include soil replacement using the stockpiled topsoil and subsoil, seedbed preparation and seeding with approved seed mixes (Table 7-2). In most places, a topsoil cover of approximately 7.5 inches (18 cm) thickness and a subsoil of approximately 15 inches (38 cm) will be placed over the regraded topography. Inactive borrow areas and stockpiles will also be re-contoured, covered with topsoil, and revegetated at closure. All disturbed ground will be re-contoured and re-vegetated. A footprint depicting final reclamation of the Project site is illustrated in Figure 7.2.

7.2.2 Post Mining Building and Solid Waste Disposal

In final closure all buildings, related equipment, and surface infrastructure at the mine site will be dismantled and removed, (unless the landowner requests otherwise for select buildings). Salvageable equipment and construction materials will be sold. The buildings will be dismantled and recycled or disposed of at an approved facility, as will all above ground piping and other infrastructure. Concrete foundations will be broken up, exposed rebar cut-off, leveled, and buried on the respective facility sites with a minimum cover of 1.5 feet (0.45 m) of fill material.



TINTINA RESOURCES

Date: October 28, 2015

Figure 7.2
Site Plan Map with Final Reclamation Black Butte Copper
Meagher County, Montana

Following removal and/or salvage of facilities, any remaining solid waste will be disposed of in accordance with laws and regulations of the Montana Waste and Underground Tank Management Bureau, and Meagher County. Valuable inert waste such as steel, concrete, plastic or wood will be sold to scrap dealers for recycling. Some waste may be transported to an approved waste transfer station as authorized by the county solid waste district. Hazardous wastes will be removed from the property by a licensed commercial hazardous waste disposal company.

7.2.3 Site-specific Facility Closure

7.2.3.1 Post Mining Road Use and Closure

Post mining land uses in the general area will remain the same as the pre-mining land uses (grazing and hay production) (Section 2.8). Property lease agreements include commitments to reestablish these land uses. The post-mining topography has been designed to be erosionally stable. It will be graded to minimize the amount of precipitation and run-on that infiltrates into disturbed areas, thereby, accommodating the pre-mining beneficial uses. To the extent possible, features enhancing wildlife habitat will also be incorporated into the final closure plan. Possible examples include: use of shrubs on grazing lands, willows in riparian areas, and creation of slash or rock piles during final revegetation. Recreational use of the land is limited and only occurs with permission of the landowners.

Reclamation activities to meet fundamental Operating Permit requirements of site stability, minimizing erosion, and providing a self-sustaining vegetative plant community. Removal of all buildings and earthwork facility reclamation will insure protection of the property owners, livestock, and the public should they gain access to this private property. Grading of final topography will insure that landforms and slopes are suitable for livestock grazing. During final closure activities, temporary fencing will be required to protect newly seeded areas from livestock grazing. Fencing will be removed as revegetation areas are deemed successful by DEQ. Meeting these objectives will assure that pre-mining land uses are restored.

The Sheep Creek and Black Butte county roads will remain open to public access throughout the mine-life. The main access road to the mine site (including bridges), construction road access, and service roads access to various facilities (Figures 3.13a and 3.13b) on private property will not be open to the public. They will either be completely reclaimed or left open with a reduced footprint at the request of the landowner. Complete closure of roads will consist of obliteration with re-contouring of the road surface disturbance, and blending road construction materials with existing topography. Road disturbance areas will receive sub- and topsoil placement and reseeding with approved mixes to reestablish a long-term vegetative cover.

Road widths will be narrowed to reduce the footprint of mine roads requested for post-mining use by the landowners. Road widths will be reduced to one lane with turn outs, by removal of road base materials over a portion of the roadway surface and re-contouring, soil placement, and reseeding.

7.2.3.2 Underground Mine Closure

The elevation and location of the mine portal and collars for the four ventilation raises above the pre-mining groundwater table precludes any natural direct surface discharge from these openings or the underground workings. Prior to initiating underground mine closure, Tintina plans to install two groundwater monitoring wells, one each that intersects deeper portions of mined-out zones in both the upper and lower sulfide zones. These wells will be used to monitor groundwater quality in closure. However, it is expected that the mined-out areas and the cone of groundwater depression associated

with the mine, will be principally recharged by laterally flowing regional groundwater of background water quality.

As the dewatering pumps are turned off and removed, the mine will flood to pre-mining groundwater levels over time. Post mining hydrologic simulations indicate that the effects from dewatering will show a slight decrease in the groundwater system and surface water resources through the first year of closure. Figure 4.9 shows the recovery over time for wells completed in the *Ynl-A, USZ/UCZ*, *Ynl-B*, and *LCZ*. Effects on water resources decrease quickly after the first year. The shallow water table is within 1-2 feet (0.3 to 0.6 m) of pre-mining levels within 3 to 4 years after closure, and the reduction in stream flows are limited to the SW-1 watershed ($\leq$0.1 cfs). There are no measureable effects to stream base flow resulting from mine dewatering either operationally or during closure. There are no model predicted effects to stream base flow 20 years after mining has stopped.

In preparation for underground mine closure, all mobile equipment and all salvageable fixed equipment (pumps, electrical transformers and wiring, hoists) and all economically salvageable utilities (power, air, water, and backfill lines) will be removed from the underground workings for salvage sale. All underground mined-out stopes will have been backfilled with cemented tailings. Tintina will backfill as much of the development workings as possible with cemented tailings during operations, (for example the access ramps to the lower sulfide zone should it be mined out in advance of the upper sulfide zone) or with other mine facility waste materials (i.e., copper-enriched rock stockpile liner protection materials, potentially contaminated sediments from the process water or seepage collection ponds, and any possible contaminated materials from the surface of the portal pad). These materials will be placed below the ultimate groundwater level in closure.

Tintina plans to place a concrete hydraulic wall in the decline immediately above the upper sulfide zone to reduce the potential for groundwater communication between the upper sulfide zone and the upper *Ynl-A* aquifer in closure. Tintina also plans on using NAG materials to backfill an approximately 200-foot long section of the decline where it passes beneath Coon Creek in order to minimize the long term risk of collapse that could damage the grouted segment of drift installed during initial mine development.

The four ventilation raises will have all surficial superstructures including hoists and power supply lines removed. The raises will be closed by using 10 -20 foot (3 to 6 m) thick cement plugs set far enough down the raise to be in solid bedrock. Rebar will be drilled into the bedrock walls of the raise and a rebar grid will be constructed across the width of the plug interval prior to pouring the cement. Once the cement plug has cured, the raise will be backfilled to surface with excess excavation materials. The access roads will be reclaimed, soil will be placed on the surface and the site seeded.

The portal will be closed with cemented rock backfill for at least the first 25 feet (7.6 m) of underground workings. If there is risk of subsidence based upon the ground conditions at the portal, a longer section of workings will be backfilled with NAG materials until a long-term stable configuration is reached. A concrete wall will be placed at the portal before backfilling and reclamation of the portal pad.

7.2.3.3 Portal Pad Closure

The portal pad will be re-graded and re-vegetated, to further bar the workings from entry. The portal pad fill slope material will be used to backfill the cut on the north side of the pad, and excess material will be tapered out to achieve a final reclamation slope of 3:1 or less. Figure 7.1 shows post-mining reclamation topography in the portal area. Material at the perimeter of the reclaimed site will be graded to blend with surrounding topography. A stabilized drainage will be re-established. Stockpiled soil/subsoil will be placed over the re-graded surfaces, and the area seeded.

7.2.3.4 Copper-enriched Rock Stockpile and Contact Water Pond Closure

The Copper-enriched Rock Stockpile will likely remain in place until late in the mining process. Its associated contact water pond and foundation drain lines will then be drained to either the PWP or to the water treatment system. After treatment to non-degradation criteria for groundwater, it will be discharged into the underground infiltration galleries. Basal cushion layer materials on top of the copper-enriched rock stockpile liner will be placed underground in development workings or in ventilation raises as backfill. The bottom liner for the copper-enriched rock stockpile will be cut up, removed and buried in the CTF prior to reclamation, or hauled off site for disposal or recycling. Compacted surfaces at the base of the copper-enriched rock stockpile will be ripped to relieve compaction and allow future water infiltration. The perimeter of the reclaimed site will be graded to blend with surrounding topography, topsoil placed and the surface reseeded. Figure 7.1 shows post-mining reclamation topography in the copper-enriched rock stockpile area.

Tintina plans to keep the CWP open into closure. During this time, it will be used in conjunction with the WTP to treat water (if any is present) that may accumulate in the sump of the closed CTF. Treated water will discharge to an underground infiltration gallery, and the brine will be stored in the CWP on one side of the central berm (created when it was first constructed). Brine will ultimately be hauled off-site for disposal. It is not expected that any significant amount of water will accumulate in the CTF sump in closure once the welded HDPE cover is placed on the CTF. Treatment, however, will continue until monitoring provides sufficient data with regard to water accumulation rates to evidence that final closure objectives have been met. At that time the water treatment system can be dismantled and the CWP reclaimed. The CWP will then be closed by removing all water stored on the facility. The CWPs double liner will be removed and hauled off-site for disposal or recycling. The footprint of the CWP will be ripped to relieve compaction, the site regraded, soil placed and the site seeded.

7.2.3.5 Process Water Pond Closure

The PWP and its foundation drain pond will remain in place until the milling of all copper-enriched rock is completed. Operationally, the volume of water in the process pond is expected to be maintained at or below 235,400 cubic yards (180,000 m^3) or approximately 45 million gallons. At the operational treatment system rate of approximately 500 gpm (2,275 L/min), it will take approximately 3 months to treat all of the water in this pond at closure. Water will be treated to meet non-degradation standards for groundwater then discharged to the underground infiltration gallery system. At a flow rate of 500 gpm the underground infiltration gallery systems are expected to perform well and dispose of the volume of water without causing a breakthrough to surface water. Down-gradient groundwater and surface water will continue to be monitored.

Once the PWP is dewatered, the accumulated slimes will be mixed with cement and air dried, wrapped in the liner, and buried during final facility re-grading. Embankment fill from the PWP will be used to bury the liner system. Because the PWP was constructed as a cut and fill material balance facility, there will be ample material available to bury the liners during reclamation to a depth of 20 feet (6 m) or more using embankment materials. Remaining slopes will be contoured to resemble pre-mining conditions.

The PWP's foundation drain pond will subsequently be drained, and the water treated and discharged to the underground infiltration gallery system. The liner will be cut and the remnants placed on top of the CTF or alternatively shipped offsite for disposal or recycling. Compacted surfaces at the base of the seepage collection pond will be ripped to relieve compaction and allow for future water infiltration. The perimeter of both the reclaimed PWP and foundation drain pond areas will be graded to blend with surrounding topography, topsoil/subsoil placed, and the site seeded.

7.2.3.6 Cemented tailings Facility Closure

Permanent closure of the CTF will include dewatering (by pumping back any water on the liners or from the foundation drain ponds to the PWP), treatment and disposal of process and foundation drain waters, installation of the HDPE cover, ground shaping to create a new closure topography, redistribution of soils, and establishment of long-term vegetative cover.

At closure, all water will be pumped out of the CTF (including the sump and foundation drain collection pond), and treated in the on-site WTP. Cement, fly ash, or slag added to the tailings during thickening will stiffen the tailings after deposition and create a stable, non-flowable mass. Natural drying and evaporation will reduce the moisture content in the tailings. Prior to final placement of tailings in the CTF, the cement content may be increased to approximately 5% in order to create a hardened surface on which equipment can work, thereby reducing the time required for reclamation and closure of the facility.

Subgrade bedding material may need to be placed above the tailings and general fill to provide a protective layer for HDPE geomembrane placement, depending upon the character of the material that forms the final upper surface (none will be required for a smooth tailings surface). Shaping of the tailings surface may be required for closure. Shaping may be accomplished by selective tailings deposition or placement of general fill material to create a self-draining topographic surface suitable for capping and closure of the CTF.

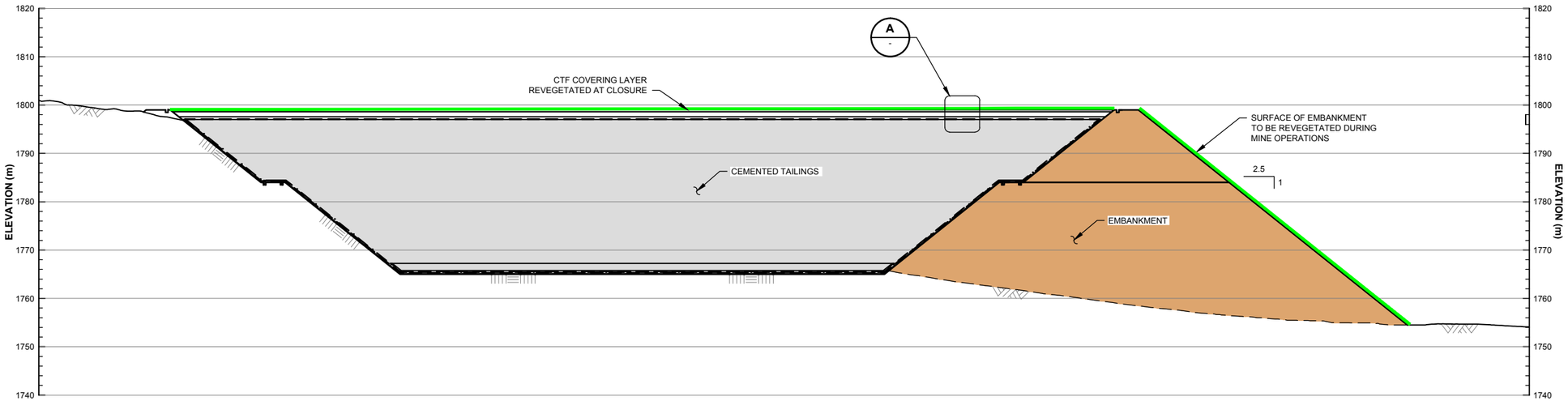
The CTF will be covered with a 0.1 inch (100 mil) HDPE geomembrane which will be welded to the existing liner system. The geomembrane cover will be capped with non-reactive rock fill and overburden, and graded to control runoff. The capping layer will be a minimum of 3 feet (1m) thick to comply with state guidelines for reclamation and closure, and will also serve to provide a stable platform for topsoil/subsoil cover and revegetation. The cover material must be sized so that the geomembrane is not damaged during placement.

Revegetation measures include soil replacement using the stockpiled topsoil and subsoil, seedbed preparation, and seeding with approved seed mixes (Table 7-1). A soil cover will be placed over the regraded surface, as well as rock placed in irregular mosaic patterns on the lateral embankment slopes. The soil cover will be revegetated with approved seed mixes, with revegetated slopes not exceeding 160 feet (50 m) in length before being interrupted by a rocky zone. These rocky zones will be placed asymmetrically across the slopes.

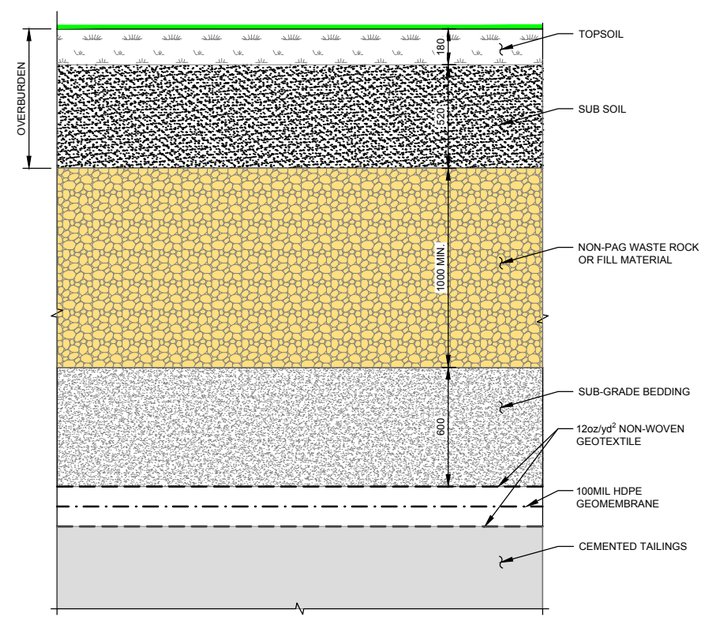
A site plan map showing the post closure topographic map for the CTF is shown in Figure 7.1. Cross-sections of the reclamation topography in the CTF and its seepage collection pond area are shown in Figure 7.3.

7.2.3.7 Non-Contact Water Reservoir Closure

It is expected that the local landowner will prefer to retain the unlined reservoir facility. Because the reservoir will likely no longer be filled annually, the down-stream embankment will be excavated to remove excess material, resized, and re-constructed to contain water from the 200 year event, and an appropriately sized spillway will be re-constructed. The NCWR geomembrane will be removed from the upstream embankment and shipped off site for disposal or recycling. The down-stream embankment will be retained at a 3:1 slope, the margins or the embankment will be graded to blend with surrounding topography, topsoil placed, and the newly disturbed embankment area re-seeded.



1 C8001 **SECTION**
HORIZONTAL: SCALE A
VERTICAL: SCALE B



A - **DETAIL**
CTF CLOSURE COVER DETAILS
SCALE C

NOTES:

1. TAILINGS SURFACE WILL BE LEVELED USING SUB-GRADE BEDDING AS NEEDED.
2. DIMENSIONS ARE IN MILLIMETERS AND ELEVATIONS ARE IN METERS, UNLESS NOTED OTHERWISE.

SCALE C: 0.3 0.15 0 0.5 1.0 1.5 m
SCALE B: 10 5 0 10 20 30 40 50 m
SCALE A: 20 10 0 20 40 60 80 100 m

TINTINA RESOURCES

BLACK BUTTE COPPER PROJECT

MEAGHER COUNTY, MT

FIGURE 7.3
CTF RECLAMATION AND CLOSURE CROSS-SECTION

REV	DATE	DESCRIPTION	DESIGNED	DRAWN	REVIEWED	APPROVED
0	16OCT'15	ISSUED FOR MOP APPLICATION	GIM	PP		

REVISIONS

REVISED DATE: OCTOBER 16, 2015

REVISION 0

DRAWING BY KNIGHT PIESOLD: VA101-460/3

SOURCE FIGURE NUMBERS: C8002

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7.2.3.8 Diversion Ditches and Sediment Collection Basins

Surface water diversion ditches and sediment collection basins not retained in post-mining closure will be reclaimed and reseeded. Where it is necessary to retain these features in closure, ditches and basins may be reduced in size to handle the 200 year flood event.

7.2.3.9 Pipeline, Underground Infiltration Galleries, and Well Closures

Surface disturbances resulting from excavation and trenching of buried water supply/distribution lines, paste backfill lines, and underground infiltration distribution lines will be reclaimed immediately after initial construction by re-contouring, soil replacement, and reseeding. During final closure all surface piping will be removed and compacted, and two track access trails along the lines will be ripped and re-vegetated. Underground piping will not be removed. However, ends of solid sections of piping will be excavated and the pipe ends capped.

Spray-type irrigation systems will be disassembled and removed for reuse by local ranchers.

Monitor wells not scheduled for post closure monitoring will be plugged and abandoned according to applicable laws, and surface casing cut off below the ground surface. Casing for lysimeters and piezometers will be removed. All areas disturbed by abandonment activities will be scarified and reseeded.

7.2.4 Soil Salvage, Handling and Redistribution

Soil and subsoil will be salvaged from most facility construction areas, constructed roads and hydrology infrastructure sites prior to major excavation for facility construction. Sites where soils will be salvaged, but not stockpiled, include small disturbances such as vent raises and water wells, other areas where soils will be immediately replaced (such as pipeline trenches and buried powerlines), and soil and excavation excess stockpile areas. No additional acres for construction buffer zone were added to the soil balance. Estimated soil salvaged depths and soil volumes are provided on Table 7-1. Salvaged soil will be stockpiled for replacement during reclamation activities.

7.2.4.1 Soil Salvage

The suitability of soil and subsoil proposed for reclamation was determined from physical and chemical data collected during the baseline soil survey (see Section 2.5 and Table 2-25). The volume of soil suitable for salvage and reclamation use was limited by slope, shallow depth to bedrock, coarse fragment quantity, and exposed bedrock at the construction site.

It is expected that soil thickness will vary considerably throughout the proposed disturbance area. Adequate soil volume to support reclamation is available as discussed in the soil section (Section 2.5.1) above. However, in the event of a shortage of cover soil, soils containing coarse fragments in excess of 50 percent by volume will be screened and salvaged for use in reclamation so that no offsite topsoil will be required. Coarse material will be used as fill during reclamation and closure.

All suitable topsoil and subsoil within the recommended salvage depths (Table 7-1) will be removed prior to commencing construction activities. To the extent practicable, salvage activities will be timed to avoid periods of wet or saturated soil in order to limit soil compaction. If possible, soil removed from an area will be hauled directly to, and used to reclaim, another previously disturbed area (thus eliminating the need for prolonged storage). Soils removed during road construction will be concurrently used to revegetate adjacent cut and fill slopes.

Table 7-1. Modified Acres of Disturbance and Estimated Soil Salvage Volumes

Soils Map Unit Symbol (MUSYM)	Road Disturbances (ac)					Mine Operations Disturbances (ac)					Pond / Diversion Disturbances (ac)				Soil Salvage Thickness (inches)			Soil Volume (cubic yards)		
	Access Road	Construction Access Road	Road to Vent Raise	Haul Road	Service Road	Cemented Tailings Facility	Mill Pad	Portal Pad	Subsoil Stockpile	Temporary Waste Rock Storage	Diversion Ditching	Non-Contact Water Reservoir Dam	Process Water Pond	Total Disturbance per Map Unit (ac)	1st Lift	2nd Lift	Total Salvage	1st Lift Volume	2nd Lift Volume	Total Soil Volume
Ch-b	6.2	0.8		4.5		7.9	9.1	1.8		1.3	0.1	4.3	5.3	**41.3**	6	0	**6**	21941	0	**21941**
Cp-c				0.1	2.3	3.6		6.3		1.8	1.7			**15.8**	6	0	**6**	12665	0	**12665**
Dc-a	2.8													**2.8**	12	24	**36**	4517	9035	**13552**
Hl-b					2.9	4.5								**7.4**	12	0	**12**	11939	0	**11939**
Kp-c					5.3	19.2			1.6		3.6		16.7	**46.4**	12	0	**12**	47916	0	**47916**
Ml-a	0.3													**0.3**	12	24	**36**	484	968	**1452**
Ml-b	0.2													**0.2**	12	24	**36**	323	645	**968**
Pn-b		1.4		7.2	7.0	36.7	0.2			7.9	4.5	0.4		**65.3**	6	0	**6**	46545	0	**46545**
Ry-b	1.8													**1.8**	12	24	**36**	2904	5808	**8712**
Wa-b		1.2							12.0		0.3		5.2	**18.7**	12	0	**12**	21780	0	**21780**
Wg-b	5.0													**5.0**	12	12	**24**	8067	8067	**16133**
Wu-b			0.7											**0.7**	0	0	**0**	0	0	**0**
Total Acres	**16.3**	**3.4**	**0.7**	**11.8**	**17.5**	**71.9**	**9.3**	**8.1**	**13.6**	**11.0**	**10.2**	**4.7**	**27.2**	**205.7**				**179080**	**24523**	**203603**

Notes:

[1]Soil will not be salvaged in topsoil storage areas and thus are not included in soil volume calculations.

The total volume of salvageable topsoil is about 203,603 cubic yards (155,700 m^3). This volume is about 10,000 cubic yards (7,650 m^3) larger that reported in Section 3.6.9 resulting from a minor variation in acreage assumed available for soil stripping and is considered the more accurate value. The average topsoil re-spread depth over the total disturbance area would be 7.5 inches (19.0 cm). The following sections detail soil salvage and replacement activities.

7.2.4.2 Soil Storage and Protection

Multiple topsoil and subsoil lifts will be stored in two separate stockpiles in a convenient location for reclamation accessibility, and identified with signage. Stockpiles will be constructed with 2.5h:1v side slopes and 3h:1v access ramps that are restricted in area to minimize undue compaction.

The stockpiles will be re-vegetated to prevent water and wind erosion until the soil is needed for use in closure. Broadcast seeding will be conducted during the first appropriate season following stockpiling. The stockpile surface will be scarified to provide a proper seedbed if needed. The estimated life of each stockpile is the life of the mine.

7.2.4.3 Soil Testing and Redistribution

Stockpiled soil will be tested before redistribution to identify what, if any, deficiencies or limitations in soil physical and chemical properties exist that may affect plant growth. The need for fertilizer, liming, organic matter, and other amendment additions will be determined. Prior to soil redistribution, compacted areas (particularly along access roads and beneath facilities) will be ripped to relieve compaction. This will also eliminate potential slippage along layer contacts, and promote a hospitable root zone.

Topsoil and subsoil will be redistributed evenly over the disturbed area, allowing an average redistribution depth of approximately 7.5 inches (18 cm) for topsoil/plant growth media and about 15 inches (38 cm) of subsoil.

7.2.5 Revegetation

Re-vegetation will be conducted to stabilize disturbances and restore watershed characteristics, soil productivity and visual resources to be consistent with post operation land use objectives. Re-vegetation activities will proceed following soil redistribution during interim and/or final closure. Re-vegetation procedures are described in the following sections.

7.2.5.1 Revegetation Mixtures and Rates

Post-mining revegetation is based on an evaluation of baseline vegetation type acreages within the proposed disturbance footprint. Impacted vegetation types primarily include Upland Shrubland (52 percent); Conifer Forest and Woodland (33 percent); Upland Grassland (14 percent); and Riparian and Wetland (<1 percent) (Section 2.8) (Appendix H; Westech 2015d). No Hay Meadow will be disturbed.

Tintina proposes to utilize the three permanent native revegetation mixtures presented in Table 7-2. These mixtures were formulated based on pre-mining species composition and anticipated post-mining site conditions (soils, topography, slope, etc.). The species are self-regenerating, and are compatible with other plant, wildlife, and livestock species in the vicinity. The seed mixtures will provide a diverse and permanent plant cover that will effectively stabilize the post-mining soil surface.

Seed that is genotypically and phenotypically adapted to the project area and primarily from within the Northern Rocky Mountains or Great Plains will be used when commercially available in sufficient quantity and of acceptable quality. Seeding rates have been calculated on a Pure Live Seed (PLS) basis. All seed will be documented noxious weed-free.

Grasses and shrubs will be seeded. In the Upland Shrubland mixture, the grass seeding rates will be reduced by 50 percent; grasses and shrubs may be seeded together using a broadcast drop seeder. Where grasses are drill-seeded, they will be applied separately from shrubs to alleviate herbaceous competition and promote the establishment of shrubs. Shrubs will generally be broadcast seeded.

Table 7-2. Reclamation Seed Mixtures

			DRILL RATE										
			(Pounds PLS/PLS per Sq.Ft.)										
SPECIES		**RECOMMENDED VARIETY**	**UPLAND GRASSLAND**				**UPLAND SHRUBLAND**				**CONIFER FOREST AND WOODLAND**		
GRASSES:													
Agropyron smithii	Western wheatgrass	Rosana	5.00	/	10		2.50	/	5		2.50	/	5
Agropyron spicatum	Bluebunch wheatgrass	Goldar	2.00	/	6		1.00	/	3		1.00	/	3
Agropyron trachycaulum	Slender wheatgrass	Pryor	1.50	/	5		0.75	/	3		0.75	/	3
Festuca idahoensis	Idaho fescue	Nezpurs, Winchester	1.50	/	15		0.75	/	8		0.75	/	8
Festuca campestris	Rough fescue	VNS	2.00	/	9		1.00	/	4		1.00	/	4
Koeleria macrantha	Prairie junegrass	VNS	0.10	/	5		0.05	/	2		0.05	/	2
Oryzopsis hymenoides	Indian ricegrass	Rimrock	3.00	/	10		1.50	/	5		1.50	/	5
Poa secunda	Sandberg's bluegrass	High Plains	0.25	/	6		0.10	/	3		0.10	/	3
Stipa nelsonii	Columbia needlegrass	VNS	3.00	/	10		1.50	/	5		1.50	/	5
	Sub-total Grasses		**18.35**	**/**	**76**		**9.15**	**/**	**38**		**9.15**	**/**	**38**
			BROADCAST RATE										
SHRUBS:			(Pounds PLS/PLS per Sq.Ft.)										
Artemisia tridentata	Big sagebrush						2.00	/	115		1.00	/	57
Rosa woodsii	Wood's rose										1.00	/	1
Ribes spp.	Currant										1.00	/	8
Shepherdia canadensis	Canada buffaloberry										1.00	/	1
Symphoricarpos albus	Common snowberry										2.00	/	3
	Sub-total Shrubs						**2.00**	**/**	**115**		**6.00**	**/**	**70**
	TOTAL		18.35	**/**	**76**		**11.15**	**/**	**153**		**15.15**	**/**	**108**
TREES:													
Juniperus scopulorum	Rocky Mountain juniper										X		
Picea engelmannii	Engelmann spruce										X		
Pinus contorta	Lodgepole pine										X		
Pinus ponderosa	Ponderosa pine										X		
Pseudotsuga menziesii	Douglas-fir										X		
Application rates for grasses are based on drill seeding; rates would be doubled for broadcast seeding.													

7.2.5.2 Seedbed Preparation and Seeding Method

Seedbed preparation will be conducted immediately after grading and soil redistribution. Ripping will be conducted prior to soil application to reduce compaction beneath liner areas, building sites, and the portion of road surface that will be reclaimed. On slopes exceeding 33 percent, on sites too narrow to negotiate with equipment, or on sites where organic debris has been re-spread, the soil surface will be left in a roughened condition. Seeding will be coordinated with other reclamation activities to occur as soon after seedbed preparation as possible. Fall seeding is preferred. However, seeding will be conducted during spring and summer as long as soil moisture, climatic, and accessibility conditions are appropriate. When soil moisture conditions are suitable, late summer/ early fall seeding (mid-August to mid-October) may be employed. Spring seeding (early April through mid-June) will be practiced if areas are ready for revegetation, climatic conditions are acceptable, and access is possible. Interim revegetation will be implemented to stabilize sites prior to permanent revegetation (e.g., sediment control structures or topsoil/subsoil stockpiles) as soon after their construction as possible.

Both broadcast and drill-seeding will be used. Drill-seeding will be used wherever equipment can safely negotiate the terrain, and will be conducted along the contour wherever possible. Seeding depth will generally be ¼ to ½-inch (0.63 to 1.27 cm). A rangeland drill, broadcast drop seeder, or comparable equipment will be used. Broadcast seeding will be conducted for shrubs, for slopes exceeding 33 percent, and on areas with high coarse fragment content. Seed will be broadcast manually or using mechanically-operated cyclone-type bucket spreaders or a drop-seeder. On small or hard-to-access sites, hand raking will be used to cover seed. Hydro-seeding may be utilized on a limited basis. If hydro-seeding is used, seed, mulch and tackifier will be applied using the manufacturer's recommended rates and procedures. Hydro-mulch and tackifier will be applied at a rate to produce a uniform mat on the ground at rates recommended by the manufacturer. Fibers will be dyed to facilitate visual metering.

Cultural treatments that will be practiced to ensure successful re-vegetation include mulching and re-spreading woody debris. Where used, mulch will be certified noxious weed seed-free cereal grain straw. Straw will be crimped on the contour, or will be dozer-tracked with tracked grousers perpendicular to the slope. If the use of fertilizer is indicated, it will be based on cover soil tests. Application rates will be formulated to achieve soil macronutrient levels capable of promoting plant growth and productivity.

If revegetation problem areas are encountered, the cause will be identified. If the cause appears to be related to soil infertility or toxicity, a soil testing program will be implemented. Tests will be conducted to ascertain macro- and micronutrient status, pH, cation exchange capacity, and potential toxicity and heavy metal problems. Appropriate remedial actions will be taken to correct any problem.

7.3 Reclamation Schedule

Tintina will initiate final closure reclamation activities within one year of reaching a decision to permanently discontinue mining in the area. An extension of the one-year time frame could be requested from DEQ if circumstances warranted. If additional mining in the vicinity of the Project area is still under consideration, temporary closure of the site will follow the procedure outlined in Section 7.1 Long-term closure of the site is expected to take approximately 2 to 3 years, excluding successful long-term revegetation establishment and water quality monitoring. All major facilities have reclamation and closure plans associated with them, with the exception of the main Project access road (which will be downsized in closure) and the NCWR (which will likely be retained by the property owner for ranching support purposes and be downsized). The property owners may request that other surface facilities be transferred to the ranch estate by mutual agreement between the ranch, Tintina, and DEQ. Interim reclamation of

soil stockpiles, cut and fill slopes, and other construction related disturbance will occur during the first appropriate seeding season following construction.

7.4 Bond Release

DEQ is responsible for calculating the amount of performance bond for reclamation of the Project. The purpose of the bond is to ensure the fulfillment of obligations under the MMRA and rules implementing MMRA by ensuring the availability of funds sufficient to perform reclamation in the event of default by the operator. The posting of the performance bond payable to the State of Montana is a precondition to issuance of an Operating Permit. The amount of the bond is based upon the estimated cost to the State to ensure compliance with the Clean Air Act of Montana, the Montana Water Quality Act, and the MMRA (including the reclamation plan set forth in this Mine Operating Permit Application).

Once the Project is further along in the Application approval process and the document reviewed by DEQ, (all necessary facilities and surface disturbances identified, and a reclamation plan agreed upon) DEQ Hard Rock Section staff will prepare a bond calculation assuming site-wide reclamation and closure plan will be executed by a 3rd party contractor under DEQ supervision.

Tintina may request incremental bond release in closure and will request a complete bond release from DEQ once all reclamation activities are deemed complete, and sufficient data is available to evidence that final closure objectives have been met.

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