Resolution Copper Mining LLC

Resolution Copper Project

DEIS Design for Alternative 6 – Skunk Camp

Doc. # CCC.03-81600-EX-REP-00006 - Rev. 1

ISO 9001
ISO 14001
OHSAS 18001

M09441A20.738

August 2018

August 8, 2018

Resolution Copper Mining LLC
P.O. Box 1944
Superior, Arizona
85273

Ms. Vicky Peacey
Senior Manager – Permitting and Approvals

Dear Ms. Peacey:

Resolution Copper Project
DEIS Design for Alternative 6 - Skunk Camp
Doc. # CCC.03-81600-EX-REP-00006 – Rev. 1

We are pleased to provide the Environmental Impact Statement (DEIS) Design for the Tailings Storage Facility (TSF) Alternative 6 – Skunk Camp for the Resolution Copper Project.

Yours truly,

KLOHN CRIPPEN BERGER LTD.

Kate Patterson, P.E., P.Eng., M.Eng.
Associate, Project Manager

KP:dl

Klohn Crippen Berger Ltd. • 500 - 2955 Virtual Way • Vancouver BC V5M 4X6 • CANADA
604.669.3800 t • 604.669.3835 f • www.klohn.com

Resolution Copper Mining LLC

Resolution Copper Project

DEIS Design for Alternative 6 – Skunk Camp

Doc. # CCC.03-81600-EX-REP-00006 - Rev. 1

EXECUTIVE SUMMARY

Resolution Copper Mining LLC (RC) is proposing to develop the Resolution Copper project (the Project), an underground copper mine, using the block cave mining method. The mine site is approximately two miles east of the town of Superior in the Pioneer Mining District, Pinal County, Arizona. The project mine plan includes generation of approximately 1.37 billion tons (Bt) of tailings over a 41-year mine life.

The Tonto National Forest (the Forest) is currently in the “alternatives development” portion of the NEPA process which the Forest will use as a component of the Project’s environmental impact statement (EIS). A number of tailings storage facility (TSF) designs are currently being assessed and will be included in the draft EIS (DEIS). This report presents Alternative 6 – Skunk Camp.

Select key elements of Alternative 6 are summarized below:

- Alternative 6 would use a centerline-raised compacted cycloned sand embankment. A portion of the scavenger tailings would be cycloned to create two products: cycloned (underflow) sand used to construct the embankment; and finer overflow tailings would be deposited into the scavenger beach.
- Pyrite tailings would be discharged subaqueously from a floating barge or pipelines directly into the reclaim pond, to maintain pyrite tailings saturation during operations for the benefit of water quality.
- Low-permeability, segregated pyrite tailings cells contained by downstream-raised embankments incorporating engineered low-permeability layers[1] to manage downstream water quantity and quality. The reclaim pond would be maintained within the pyrite tailings cell. Pyrite tailings would be kept saturated to prevent oxidation, in order to control water quality concerns associated with pyrite tailings.
- Tailings will be piped to the Skunk Camp TSF site from West Plant via an approximate 22 mile to 30 mile-long pipeline. The pipeline route has not yet been finalized, however is anticipated to require at least one major valley crossing.
- Tailings would be pumped to the TSF rather than flow by gravity to increase reliability and reduced potential for pipeline upsets (i.e. sanding of the lines) and associated spills.

The main benefits of Alternative 6 are:

- that it is located far from population centers and close to other mining areas, in an area of low-density population, and generally out of public view;
- that the site location may reduce the impact to National Forest System lands;

[1] Low-permeability containment details could comprise of one or more of the following: geomembrane liner, compacted fine tailings, asphalt, slurry bentonite, cemented paste tailings, etc.

- that it utilizes a cross-valley embankment requiring less embankment fill to retain tailings, compared to a ring dyke impoundment, thus reducing operational and construction complexity associated with the required embankment rate of rise;
- that it has topography that is amenable for embankment construction and tailings storage, and potential favorable foundation for seepage control and borrow availability (to be evaluated); and,
- that the Gila River, the downstream receiving water body is located approximately 13 miles from the TSF.

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1 INTRODUCTION

1.1 General

Resolution Copper Mining LLC (RC) is proposing to develop the Resolution Copper project (the Project), an underground copper mine, using the block cave mining method. The mine site is approximately two miles east of the town of Superior in the Pioneer Mining District, Pinal County, Arizona. The project mine plan includes generation of approximately 1.37 billion tons (Bt) of tailings over a 41-year mine life.

RC submitted a General Plan of Operations (GPO) (RC 2016a) for the Project to the Tonto National Forest (the Forest). The subsequent issue of a Notice of Intent by the Forest (GPO 2016) triggered the beginning of the Forest's environmental analysis of the Project, in accordance with the National Environmental Policy Act (NEPA). The analysis will ultimately lead to the issuance of a Record of Decision on the Project by the Forest.

The Forest is currently in the "alternatives development" portion of the NEPA process which the Forest will use as a component of the Project's environmental impact statement (EIS). Klohn Crippen Berger Ltd. (KCB) has been commissioned by RC to prepare select tailings storage facility (TSF) designs to support the alternatives development process and the draft EIS (DEIS). The alternatives being considered are:

- Alternative 1 – No Action;
- Alternative 2 – Near West Modified Proposed Action (Modified Centerline Embankment - "wet");
- Alternative 3 – Near West Modified Centerline Embankment (High-density thickened NPAG[2] Scavenger and Segregated PAG[3] Pyrite Cell);
- Alternative 4 – Silver King Filtered;
- Alternative 5 – Peg Leg;
- Alternative 6 – Skunk Camp;

Alternative 6 is located in the headwaters of Drippings Springs Wash (Figure 1.1 and Figure 1.2) and utilizes a centerline raised cycloned sand embankment constructed from non-potentially acid generating (NPAG) scavenger tailings to contain the scavenger impoundment and separate downstream raised cycloned sand embankments to contain the potentially acid generating (PAG) pyrite tailings, which would be deposited subaqueously and stored in segregated low-permeability cells.

[2] The Forest use the term (Non-Potentially Acid Generating) NPAG tailings to refer to scavenger tailings described in the GPO (RC 2016a).
[3] The Forest uses (Potentially Acid Generating) PAG tailings to refer to cleaner tailings described in the GPO (RC 2016a), also referred to as pyrite tailings.

The scope of the Alternative 6 DEIS design is to use the referenced information to provide a basis for comparing potential impacts of the TSF alternatives.

1.2 Key Elements of Alternative 6

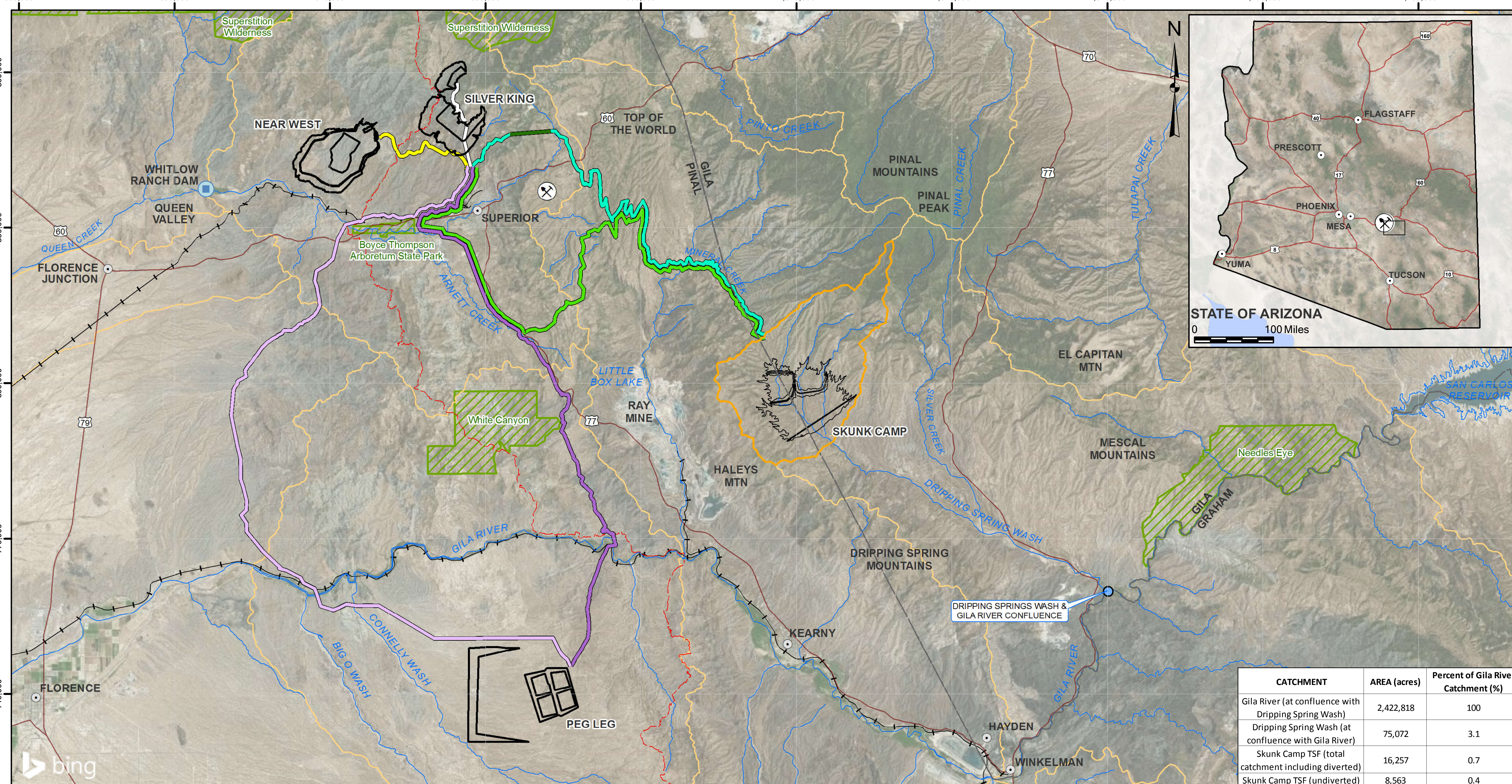
Key elements of Alternative 6 are summarized below:

- Alternative 6 proposes to use a centerline-raised compacted cycloned sand Main Embankment and separate downstream-raised cycloned sand embankments for the pyrite cells. A portion of the scavenger tailings would be cycloned to create two products: cycloned (underflow) sand used to construct the embankments; and finer overflow tailings which would be deposited subaerially onto the scavenger beach.
- Pyrite tailings would be stored within two low-permeability, segregated cells (Pyrite Cell 1 and Pyrite Cell 2), that would be operated sequentially. The reclaim ponds would be maintained within these cells. Pyrite tailings would be discharged subaqueously from floating barges or pipelines directly into the reclaim ponds, to maintain pyrite tailings saturation during operations for the benefit of water quality. The pyrite cells would include engineered low-permeability layers[4] to manage downstream water quantity and quality and maintain a pond.
- Tailings would be piped to the Skunk Camp TSF site from West Plant via an approximate 22 mile to 30 mile-long pipeline.

The main benefits of Alternative 6 are:

- that it is located far from population centers and close to other mining areas, in an area of low-density population, and generally out of public view;
- that it utilizes a cross-valley embankment for the main impoundment and downstream-raised embankments for the pyrite cells, requiring less embankment fill to retain tailings compared to a ring dyke impoundment, thus reducing operational and construction complexity associated with the required embankment rate of rise;
- that it has topography that is amenable for embankment construction and tailings storage, and potentially favorable foundation for seepage control and borrow availability; and
- that the Gila River, the downstream receiving water body is located approximately 13 miles from the TSF.

[4] Low-permeability containment details could comprise of one or more of the following: geomembrane liner, compacted fine tailings, asphalt, slurry bentonite, cemented paste tailings, etc.



CATCHMENT	AREA (acres)	Percent of Gila River Catchment (%)
Gila River (at confluence with Dripping Spring Wash)	2,422,818	100
Dripping Spring Wash (at confluence with Gila River)	75,072	3.1
Skunk Camp TSF (total catchment including diverted)	16,257	0.7
Skunk Camp TSF (undiverted)	8,563	0.4

LEGEND

- TSF ALTERNATIVE
- WATERSHED
- TSF CATCHMENT
- RESOLUTION OREBODY
- NEAR WEST PIPELINE CORRIDOR
- SKUNK CAMP TSF - WEST PLANT PIPELINE CORRIDOR NORTH ROUTE
- SKUNK CAMP TSF - WEST PLANT PIPELINE CORRIDOR TUNNEL NORTH ROUTE
- SKUNK CAMP TSF - WEST PLANT PIPELINE CORRIDOR SOUTH ROUTE
- PEG LEG PIPELINE CORRIDOR: WEST ROUTE
- PEG LEG PIPELINE CORRIDOR: EAST ROUTE
- SILVER KING SLURRY PIPELINE
- WHITLOW RANCH DAM
- TOWN OR CITY
- WILDERNESS AREA AND STATE PARK
- COUNTY LINE
- HIGHWAY
- EXISTING RAILWAY
- ARIZONA NATIONAL SCENIC TRAIL (ARIZONA TRAIL)
- RIVER OR MAJOR DRAINAGE

0 5 Mile

NOTES:
1. NAD83, ARIZONA STATE PLANE CENTRAL
2. IMAGERY PROVIDED BY ESRI/BING AERIAL IMAGERY
3. WATERSHEDS PROVIDED BY NATURAL RESOURCE CONSERVATION SERVICE

\\VCR-FS-V\Projects\M\M09441A20 - RES-Near West PFS-PES\400 Drawings\GIS\Mxd\Reports\SkunkCamp\DEIS\Fig1_1_Regional_Location.mxd 2018-08-07 12:21:55 PM

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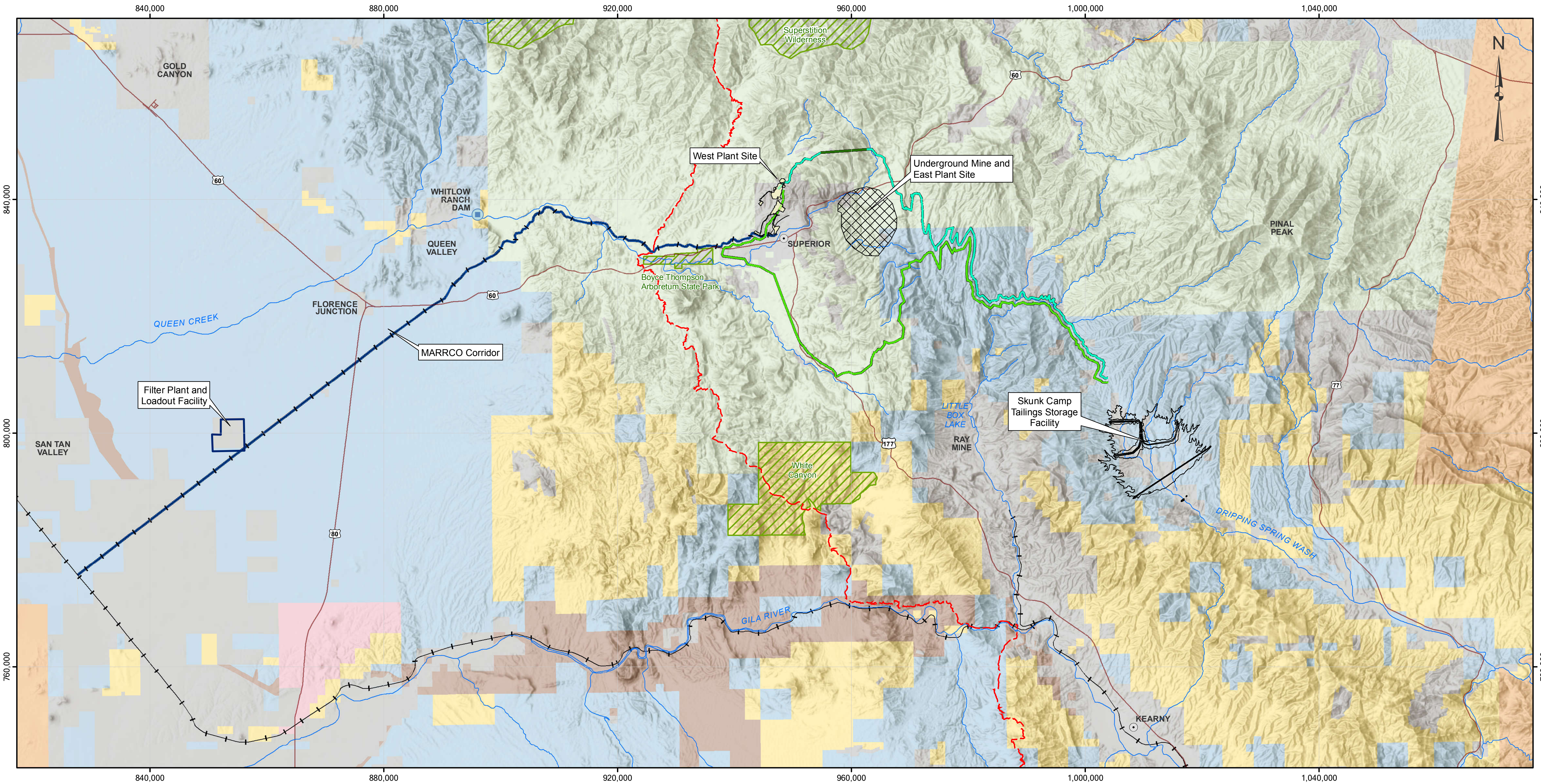
CLIENT: RESOLUTION COPPER

Klohn Crippen Berger

PROJECT: RESOLUTION COPPER PROJECT DEIS DESIGN FOR ALTERNATIVE 6: SKUNK CAMP

TITLE: REGIONAL SETTING

PROJECT No.	FIG No.
M09441A20	1.1



LEGEND

- SKUNK CAMP TAILINGS STORAGE FACILITY
- ZONE OF SUBSIDENCE
- WEST PLANT
- FILTER PLANT AND LOADOUT FACILITY
- MARRCO CORRIDOR
- SKUNK CAMP TSF - WEST PLANT PIPELINE CORRIDOR NORTH ROUTE
- SKUNK CAMP TSF - WEST PLANT PIPELINE CORRIDOR TUNNEL NORTH ROUTE
- SKUNK CAMP TSF - WEST PLANT PIPELINE CORRIDOR SOUTH ROUTE
- WILDERNESS AREA OR STATE PARK
- WHITLOW RANCH DAM
- TOWN OR CITY
- EXISTING ROAD
- ARIZONA NATIONAL SCENIC TRAIL (ARIZONA TRAIL)
- EXISTING RAILWAY
- RIVER OR MAJOR DRAINAGE

LAND OWNERSHIP

- BUREAU OF LAND MANAGEMENT
- BUREAU OF RECLAMATION
- COUNTY
- INDIAN RESERVATION
- LOCAL OR STATE PARKS
- MILITARY
- NATIONAL PARKS
- PRIVATE
- STATE TRUST LAND
- STATE WILDLIFE AREA
- UNITED STATES FOREST SERVICE

0 5 Mile

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NOTES:
1. NAD83, ARIZONA STATE PLANE CENTRAL
2. HILLSHADE PROVIDED BY ESRI
3. LANDUSE FROM THE ARIZONA BUREAU OF LAND MANAGEMENT (1:100,000) CURRENT AS OF DEC 19TH, 2012.

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PROJECT: RESOLUTION COPPER PROJECT
DEIS DESIGN FOR ALTERNATIVE 6: SKUNK CAMP

TITLE: SITE LOCATION AND LAND OWNERSHIP OVERVIEW

PROJECT No.	FIG No.
M09441A20	1.2

Document Path: \\WCR-FS-V\Projects\M\M09441A20 - RES-Near West PFS-PES\400 Drawings\GIS\Mxd\Reports\SkunkCamp\DEIS\Fig1_2_Site_Location_Ownership_Overview.mxd

1.3 Previous Studies

Relevant studies that have been utilized in the design for Alternative 6, many of which have been adopted from the Near West site, include:

- An embankment design alternatives trade-off carried out for the Near West site to identify the preferred embankment design (KCB 2017a).
- Summary reports of the subsurface site investigation (SI) program at the Near West site in 2016/2017 which included drilling and pit trenches have been adopted for this study, specifically the characterization of the Gila Conglomerate:
  - Geotechnical site characterization report (KCB 2017b) including summary of related SI activities and laboratory testing.
  - Hydrogeological site characterization report prepared by Montgomery and Associates (M&A 2017b).
  - Geochemical characterization of bedrock units prepared by Duke Hydrochem (Duke 2017a).
- Geochemical characterization report of scavenger and pyrite tailings (Duke Hydrochem 2016 and 2017b).
- Site-specific seismic hazard assessment of the Near West site prepared by Lettis Consultants International, Inc. (LCI 2017).

In addition, from the public domain:

- Geology maps (Cornwall and Banks 1971, Cornwall and Krieger 1978, Dickinson 1992); and
- Well logs and spring inventory from Arizona Department of Water Resources (ADWR).

Information adopted from these and other reference reports are cited herein as appropriate. Original reports should be referred to for specific information and further discussion.

2 SITE CHARACTERIZATION

2.1 Setting & Topography

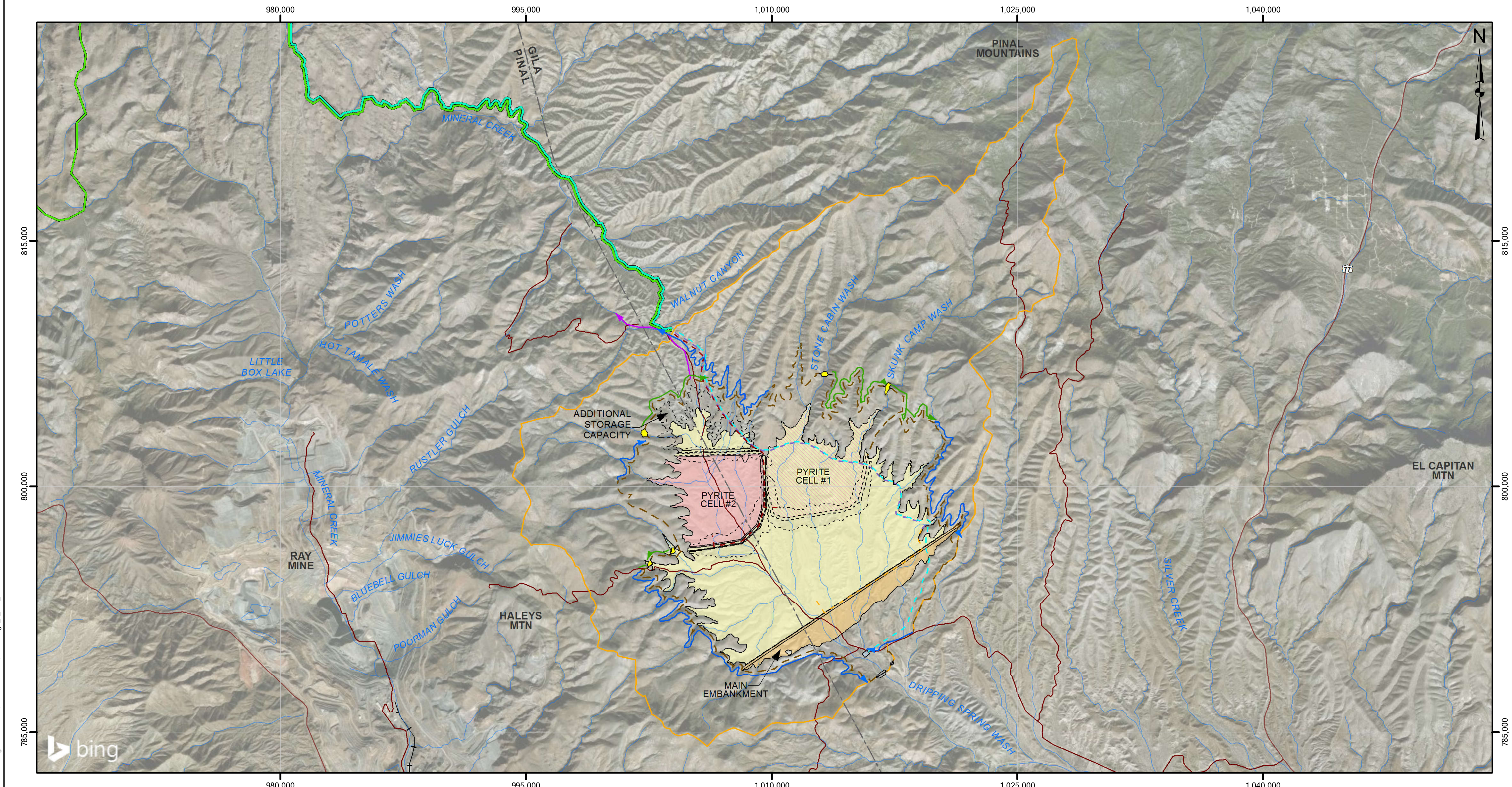
The Skunk Camp TSF site is in the Dripping Springs Wash Basin (refer to Figure 1.1), approximately 13 miles upstream of its confluence with the Gila River. The Dripping Springs Wash Basin is approximately 378 square miles in area and is described by the Arizona Department of Water Resources (2009) as consisting of a mid-elevation mountain range and Arizona uplands Sonoran desert scrub.

The Dripping Spring Mountains define the western boundary of the site, and the Mescal Mountains and Pinal Mountains define the eastern boundary. The base elevation of the TSF is approximately 3,160 ft and the peaks of adjacent mountains are (Figure 1.1): 4,566 fasl at Haley Mountain, 6,568 ft at El Capitan Mountain, and 7,848 fasl at Pinal Peak.

The site is within the Basin and Range physiographic zone of Arizona, near its northern boundary with the Central Highlands Transition physiographic zone, marked by the southern edge of the Superstition Mountains (URS 2013). The site location, relative to West Plant, is shown on Figure 1.1.

The Basin and Range mountain ranges are composed of fault-block mountains formed during extensional faulting and crustal thinning. The Central Highlands Transition zone is a northwest trending escarpment marking the transition from the Colorado Plateau to the north with the Basin and Range province to the south (see Figure 2.2).

Within the proposed TSF area, the base of the valleys are infilled with sand and gravel alluvial deposits and are ephemeral drainages. When present, surface water flows from north to south, discharging to the Gila River, approximately 13 miles downstream of the site. The proposed site is located south of a surface water divide, see Figure 2.1. Surface water south of the divide flows through the site, roughly southeast through Dripping Springs Wash Basin to the Gila River, whereas surface water north of the divide flows into the Mineral Creek basin, which flows into the Gila River approximately 16 miles downstream of the confluence of Dripping Springs Wash and the Gila River.



\\VCR-FS-V\Projects\M\M09441A20 - RES-Near West PFS-PES\400 Drawings\GIS\Mxd\Reports\SkunkCamp\DEIS\Fig2_1_Site_Details.mxd 2018-08-07 12:28:38 PM

LEGEND

- SCAVENGER TAILINGS
- SCAVENGER OVER PYRITE TAILINGS
- PYRITE TAILINGS
- SEEPAGE COLLECTION DAM
- ACCESS/UTILITY CORRIDOR
- TOE COLLECTION POND
- OVERFLOW/UNDERFLOW PIPELINE
- RECLAIM WATER PIPELINE
- PYRITE PIPELINE
- SCAVENGER PIPELINE
- SKUNK CAMP TSF - WEST PLANT PIPELINE CORRIDOR NORTH ROUTE
- SKUNK CAMP TSF - WEST PLANT PIPELINE CORRIDOR SOUTH ROUTE
- PROPOSED ROAD
- TSF CATCHMENT
- SURFACE WATER DIVERSION DAM
- SURFACE WATER DIVERSION DAM DRAWDOWN PIPELINE
- SURFACE WATER DIVERSION CHANNEL
- CLOSURE SURFACE DIVERSION CHANNEL
- COUNTY LINE
- EXISTING ROAD
- EXISTING RAILWAY
- RIVER OR MAJOR DRAINAGE

NOTES:
1. NAD83, ARIZONA STATE PLANE CENTRAL
2. IMAGERY PROVIDED BY ESRI/BING AERIAL IMAGERY.

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0 2 Mile

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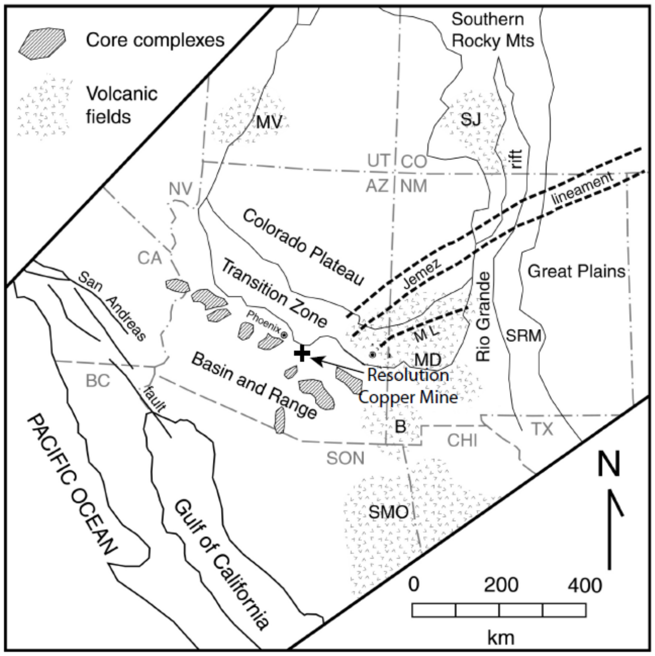
PROJECT: RESOLUTION COPPER PROJECT DEIS DESIGN FOR ALTERNATIVE 6: SKUNK CAMP

TITLE: SITE DETAILS

PROJECT No.	FIG No.
M09441A20	2.1

Figure 2.2 Regional Seismic Zone (URS 2013)



Modified from: Drewes *et al.* (1985)

2.2 Land Use

The site is outside of the Arizona Department of Water Resources Aquifer Management Areas, on a mixture of State Trust and Private Land. Other aspects of the Skunk Camp TSF site, with respect to land-use, include (see Figure 1.2):

- The area is currently used for livestock grazing, ranching and road access to recreational areas. Vegetation comprises mainly desert shrub and cacti.
- Access within the site is by compacted gravel roads, accessed from Highway 77, located southeast of the area.
- Within the proposed footprint, and immediately downstream of the proposed site, there are a few ranch properties which include permanent dwellings. The nearest residential area is located along Highway 77 near Christmas, near the confluence of Dripping Spring Wash with the Gila River approximately 11 miles downstream of the proposed TSF.
- There are no known historic mines within the TSF footprint, but there are known historic and active mining in the region. There is potential for interactions between the sites:
  - **Ray Mine**, 5 miles to the west of the proposed Skunk Camp TSF area (over the Dripping Spring Mountains), is an active open pit copper mine currently owned and operated by ASARCO Grupo Mexico (see Figure 1.1 and Figure 2.1).

  - **Troy Mine,** 5.4 miles to the south of the proposed Skunk Camp area (within the Dripping Spring Mountain Range), is an inactive underground copper / base metals mine currently optioned by Q-Gold Resources, and actively undergoing exploration activities (see Figure 2.4).
  - **Dripping Spring Mine,** 6.0 miles to the south-southeast of the proposed Skunk Camp area (within the Dripping Spring Mountain Range), is a closed polymetallic underground and open pit mine which operated from 1925 to 1995. Workings at the site reached shallow depths of 50 to 75 feet. Adjacent historic workings include C & B Mine and Cowboy Mine, both inactive underground workings.
  - **Christmas Mine**, 14.8 miles to the southeast of the proposed Skunk Camp area, is a closed underground and open pit copper mine, which closed in 1992. The property is currently owned by Freeport McMoRan. A number of historic mine workings are also identified in the area around Christmas Mine.
- In addition to the mines noted above, other unidentified mine workings may be present in the region and would be further investigated. The proposed TSF would be founded on a deep Gila Conglomerate deposit, which is not typically mined.

2.3 Regional Geology

The regional basement in the area of the Skunk Camp TSF site are facies of the Precambrian Pinal Schist. The schist is overlain by the younger Precambrian Apache Group, comprising the silt and sandstones of the Pioneer Formation, Dripping Spring Quartzite, Mescal Limestone and basalt, and the Troy Quartzite. The Precambrian rocks are in turn overlain by Paleozoic sedimentary rocks, including the Bolsa Quartzite and Martin, Escabrosa and Naco limestones. All of the Precambrian rocks are intruded by Precambrian diabase dykes and sills, and the entire sequence is intruded by Late Cretaceous and Tertiary dikes and plutons. Tertiary tuffs and conglomerates were deposited over the older rocks in the region (Cornwall et al. 1971).

The pre-Tertiary rocks in the region have been intricately deformed, mostly by tilting and faulting, with most faults dipping steeply, indicating normal movement. Normal faulting has produced graben features with stratigraphic displacements in excess of 2,000 ft. Dripping Spring Wash runs through one such graben which is infilled with a thick package of Tertiary (Gila) Conglomerate (Cornwall et al. 1971). There is little mapped evidence of faulting within the Tertiary sedimentary rocks.

2.4 Site Geology

Data on the regional geology is available from Dickinson (1992), Cornwall et al. (1971) and Cornwall and Krieger (1978). As discussed in Section 1.3, supplementary data from the Near West site characterization reports have been adopted for this assessment. The bedrock geology of the Near West and Skunk Camp TSF sites generally comprises similar rock units. The site geology is shown on Figure 2.3 and Figure 2.4.

Where available, well log information has also been reviewed, to aid in estimating the thickness of Gila Conglomerate present within the basin, and preliminary site reconnaissance visits have been carried out by RC and KCB staff. A single well log, for a location near to the proposed scavenger embankment toe, notes that the Gila Conglomerate at that location as over 1,500 ft thick.

2.4.1 Foundation Geology

As noted in Section 2.4, the regional basement rock at site is the Precambrian Pinal Schist, unconformably overlain by Younger Precambrian Apache Group rocks (Dripping Spring Quartzite, Mescal Limestone) and diabase. Tertiary age Gila Conglomerate, which overlays the diabase, forms the majority of the foundation for the proposed facility. Quaternary pediment and alluvium has formed erosion surfaces, ridges, and valley infill deposits, within the region.

The proposed TSF would be founded primarily on Tertiary Gila Conglomerate, partially covered by Quaternary deposits, including alluvium in the base of the major valleys, and pediment along local ridges, as well as occasional travertine deposits in various valley walls.

Based on topography and regional geology maps, surface water diversion channels would be excavated into Gila Conglomerate, quartzite and diabase. Based on current knowledge, the main design considerations for this foundation are:

- removal of Quaternary deposits from embankment footprints as part of foundation preparation or borrow activities;
- potential for reduced foundation strength resulting from Gila Conglomerate saturation; and
- groundwater flowpaths.

Preliminary field reconnaissance suggests that the Gila Conglomerate at the Skunk Camp TSF site is coarser grained than the Gila Conglomerate reviewed at Near West. However, in the absence of site specific characterization, the following general characterization of the unit from Near West is included in this report for context:

- Gila Conglomerate at Near West has an average unconfined compressive strength (UCS) of roughly 1800 psi, classifying as a very weak to weak rock. This strength is significantly higher than that of the tailings and does not impact the stability of the TSF.
- Gila Conglomerate at Near West has been observed to lose strength when saturated. Reduced shear strength ($\phi' = 26°$) was assigned to the upper 10 ft of Gila Conglomerate for the Near West DEIS designs to account for this potential. Stability assessments completed for the Near West site are assumed to be applicable for the Skunk Camp TSF site until more information is available.
- Hydraulic conductivity of the Gila Conglomerate at the Near West site varies widely between 1×10^{-2} cm/s to 1×10^{-8} cm/s (based on packer testing) with the higher values being associated with localized discontinuities. Hydraulic conductivities in the middle of this range were assumed for the analyses completed to support the Skunk Camp DEIS: 1×10^{-4} cm/s for weathered Gila at surface; and 1×10^{-5} cm/s for deeper Gila.

The proposed surface water management system will consist of a series of diversion channels, and associated diversion dams and ponds located to route non-contact water around the TSF. Although the alignments of the proposed channels and locations of proposed dams and ponds are not yet finalized, regional geology information indicate that these features will be founded on three major geologic units, namely:

- Gila Conglomerate;
- Diabase; and
- Troy Quartzite.

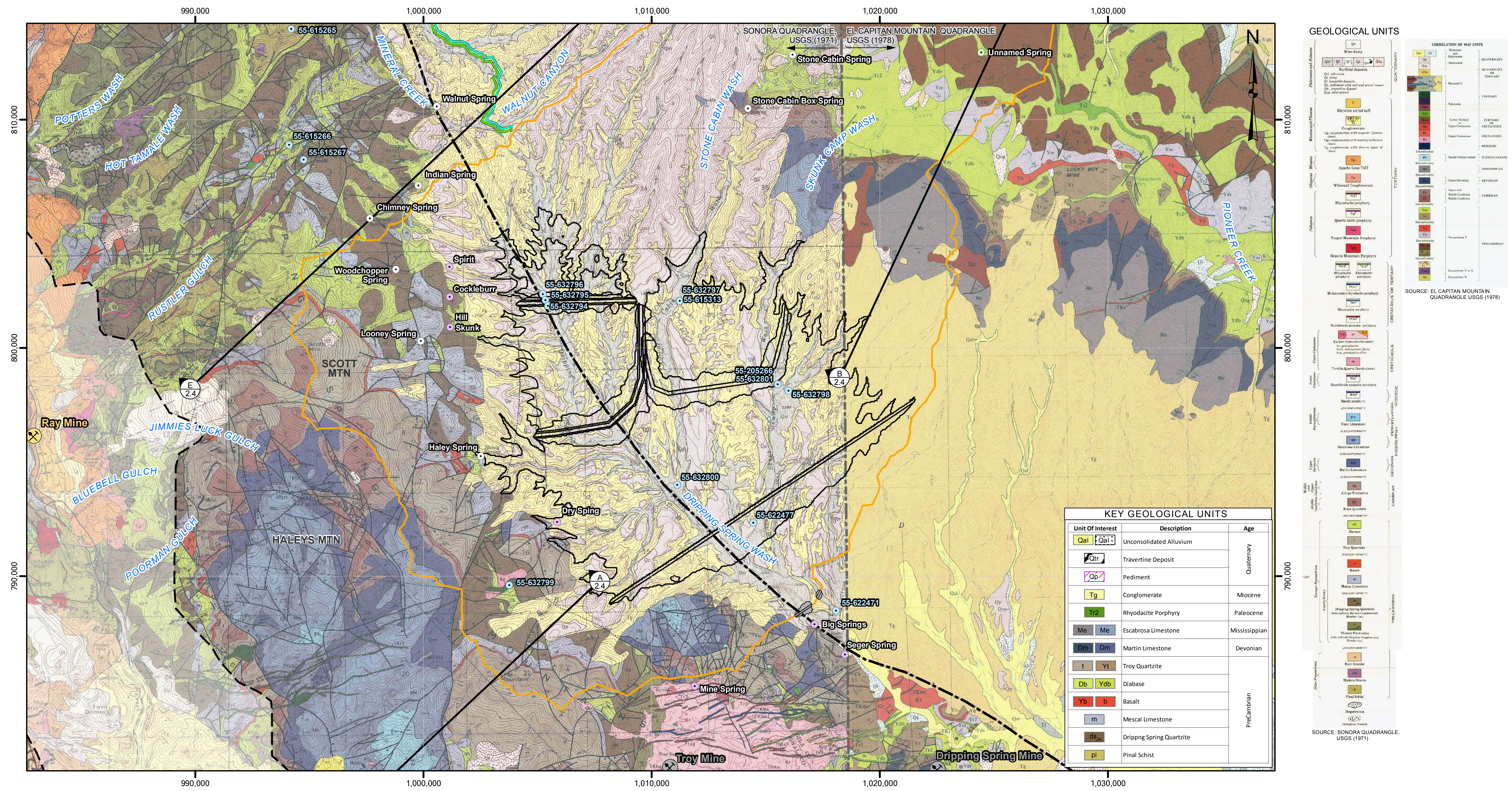
Specific requirements with respect to excavation and foundation preparation for the surface water management system would be investigated further.

2.4.2 Faults

Along the proposed centerline of the impoundment is a north-trending normal fault, aligned roughly along Dripping Spring Wash. The fault is noted in literature as having a stratigraphic displacement of more than 2,900 ft (see Figure 2.4), east side down (Cornwall et al. 1971).

To the west of the proposed impoundment, the Ransome Fault, and associated sub-faults, separate the Tertiary and Quaternary geologic units from the Dripping Spring Quartzite, Mescal Limestone, and Rhyodacite Porphyry.

These faults are not considered to be potential sources of seismicity, as they are not thought to have been active throughout the Quaternary Period (LCI 2017). It is not known at this time whether these faults act as preferential flow paths, or low permeability boundaries, for groundwater flows.



KEY GEOLOGICAL UNITS

Unit Of Interest	Description	Age
Qal Qal	Unconsolidated Alluvium	Quaternary
Qtr	Travertine Deposit	
Qp	Pediment	
Tg	Conglomerate	Miocene
Tr2	Rhyodacite Porphyry	Paleocene
Me Me	Escabrosa Limestone	Mississippian
Dm Dm	Martin Limestone	Devonian
t Yt	Troy Quartzite	PreCambrian
Db Ydb	Diabase	
Yb b	Basalt	
m	Mescal Limestone	
ds	Drippng Spring Quartzite	
pi	Pinal Schist	

LEGEND

- SKUNK CAMP TAILINGS STORAGE FACILITY
- SEEPAGE COLLECTION DAM
- TSF CATCHMENT
- RAY MINE
- ACTIVE MINE
- HISTORICAL MINE
- SKUNK CAMP TSF - WEST PLANT PIPELINE CORRIDOR NORTH ROUTE
- SKUNK CAMP TSF - WEST PLANT PIPELINE CORRIDOR SOUTH ROUTE
- ADWR WELL LOCATION AND IDENTIFIER
- SPRING (ALRIS)
- SPRING (ADWR SURFACE WATER)
- SPRING UNKNOWN
- DRIPPING SPRING FAULT
- GEOLOGY SECTION
- EXISTING ROAD
- EXISTING RAILWAY
- RIVER OR MAJOR DRAINAGE

NOTES:
1. NAD83, ARIZONA STATE PLANE CENTRAL
2. REFER TO REPORT FOR SOURCE OF GEOLOGY

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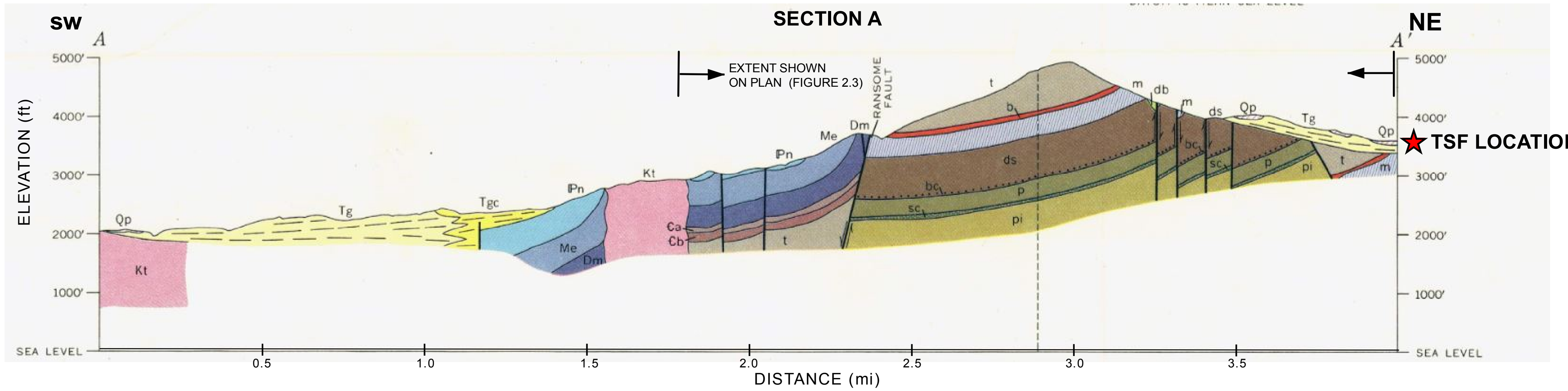
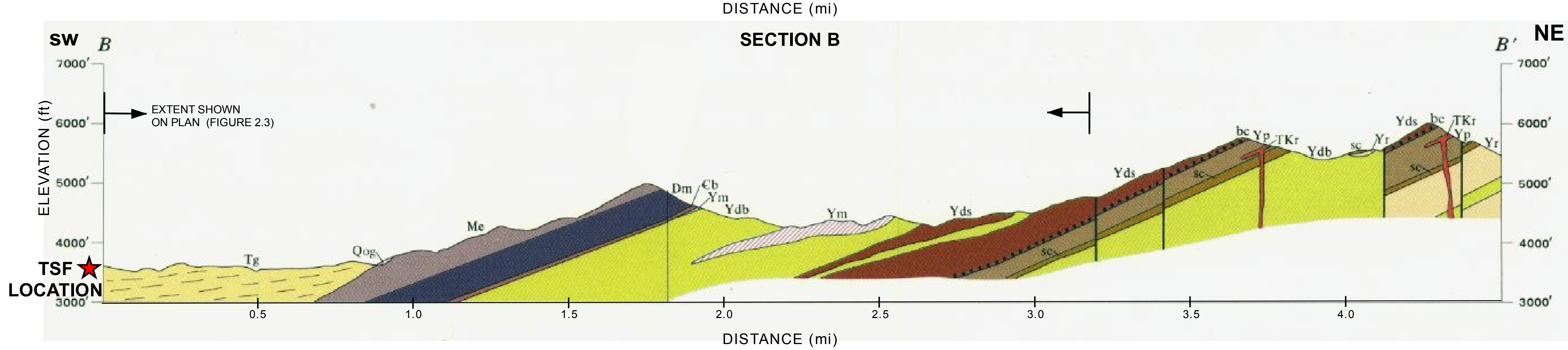
PROJECT: RESOLUTION COPPER PROJECT DEIS DESIGN FOR ALTERNATIVE 6: SKUNK CAMP

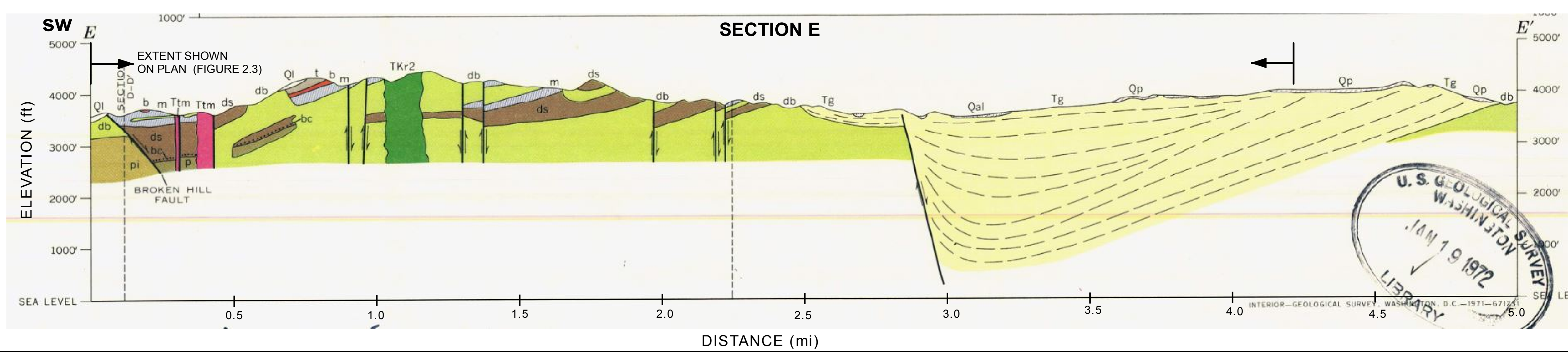
TITLE: SITE GEOLOGY

PROJECT No. M09441A20

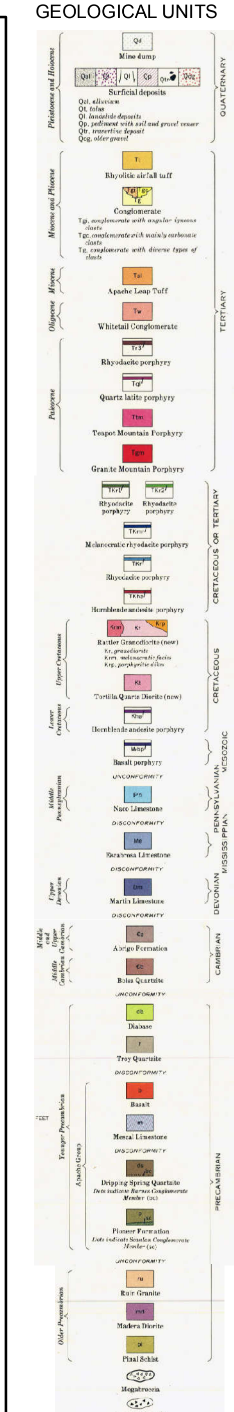
FIG No. 2.3

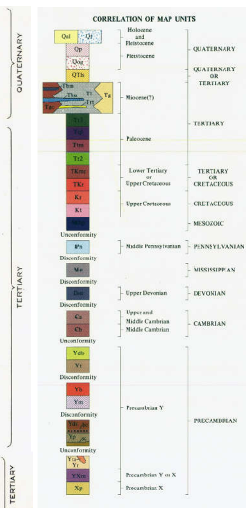






GEOLOGICAL UNITS





KEY GEOLOGIC UNITS

Unit Of Interest	Description	Age
Qal, Qal	Unconsolidated Alluvium	Quaternary
Qtr	Travertine Deposit	
Qp	Pediment	
Tg	Conglomerate	Miocene
Tr2	Rhyodacite Porphyry	Paleocene
Me, Me	Escabrosa Limestone	Mississippian
Dm, Dm	Martin Limestone	Devonian
t, Yt	Troy Quartzite	PreCambrian
Db, Ydb	Diabase	
Yb, b	Basalt	
m	Mescal Limestone	
ds, bc	Drippng Spring Quartzite	
pi	Pinal Schist	

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CLIENT: RESOLUTION COPPER

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PROJECT: RESOLUTION COPPER PROJECT
DEIS DESIGN FOR ALTERNATIVE 6: SKUNK CAMP

TITLE: SITE GEOLOGY SECTIONS

PROJECT No. M09441A20

FIG No. 2.4

NOTES:
1. REFER TO REPORT FOR SOURCE OF GEOLOGY
2. REFER TO FIGURE 2.3 FOR LOCATION OF SECTION
3. SECTION A AND E SOURCE: GEOLOGIC MAP OF THE SONORA QUADRANGLE, PINAL AND GILA COUNTIES, AZ. U.S. GEOLOGICAL SURVEY, 1971.
SECTION B SOURCE: GEOLOGICAL MAP OF THE EL CAPITAN MOUNTAIN QUADRANGLE, GILA AND PINAL COUNTIES, AZ. U.S. GEOLOGICAL SURVEY, 1978.

\\VCR-FS-V\Projects\M\M09441A20 - RES-Near West PFS-PES\400 Drawings\GIS\Mxd\Reports\SkunkCamp\DEIS\Fig2_4_Site_Geology_Sections.mxd 2018-08-07 12:14:40 PM

2.5 Seismicity

The Skunk Camp TSF site is 19 miles away from the Near West site and for the purposes of this assessment is assumed to have a similar seismic hazard to the Near West “Gila Conglomerate” from LCI (2017). The Near West site has low historic seismicity (LCI 2017); 16 earthquakes within 62 mi (100 km) and 51 earthquakes within 124 mi (200 km) are part of the seismic record that dates back to 1830. Only two of the recorded earthquakes have had a moment magnitude greater than 5, both in excess of 62 mi (100 km) of the site. None of the recorded earthquakes have had a moment magnitude greater than 6.

The site-specific seismic hazard assessment completed for Near West calculated the peak ground acceleration (PGA) and spectral acceleration at return periods up to 10,000 years, and provided both uniform hazard spectra (UHS) and conditional mean spectra (CMS). The results indicated that the hazard from short period ground motions is controlled by the background seismicity (seismicity not associated with known faults) close to the site, whereas the distant San Andreas Fault (see Figure 2.2) influences the hazard for longer periods which are typical for most large earthfill structures.

The Skunk Camp TSF site sits across the mapped Dripping Spring and Ransome Faults. These faults are not believed to have been active within the Quaternary period (2.6 Ma to present) (LCI 2017). The Skunk Camp TSF site is closer in proximity to the Quaternary active faults which may result in slight increases to the short period seismic loads at the Near West site.

2.6 Site Hydrogeology

A conceptual understanding of the hydrogeological setting has been developed based on a desktop review of available literature.

Regional groundwater is assumed to flow from northwest to southeast within the proposed TSF area towards the Gila River. The groundwater flow from surface infiltration near the site is expected to be primarily through the surface alluvial channels and upper weather zone of the Gila Conglomerate. Alluvium is the principal aquifer for wells within the region (ADWR 2009), noted in literature as being less than 150 ft thick. Recent measurements of depth to groundwater (at one location) within the alluvium and Gila Conglomerate, undertaken by RC, suggest that groundwater levels are approximately 70 ft below the ground surface, or deeper, along the eastern edge of the site.

Several identified, regional features and local observations that may also affect the regional groundwater flow and potential TSF seepage within the basin, include:

- The Gila Conglomerate, which forms the foundation of the proposed facility, is variable across the site, and has been noted to be less cemented at surface than the Gila Conglomerate observed at the Near West site, particularly in areas towards the north of the site (see Figure 2.3).
- The highland areas of Dripping Springs Wash Basin, including Pinal Peak, which form a large portion of the upstream catchment are anticipated to be areas of high groundwater recharge for the region (see Figure 2.1).

- The surface water divide between Dripping Springs Wash and Mineral Creek is also a potential groundwater divide.
- Downstream of the site, the Gila River, which flows year-round, acts as the regional drainage point. The river and channel deposits are assumed to be a discharge point for surface and groundwater runoff from the surrounding areas, including the Dripping Springs Wash Basin.
- The Ray Mine open pit, located in a western, adjacent surface water catchment, is a potential regional groundwater sink as a result of dewatering activities; however, it is not clear if the groundwater regimes at the proposed site and the open pit are hydraulically connected or not (e.g. faults and associated bedrock units act as a low permeability boundary between the sites).

Based on this understanding of the hydrogeological setting for the proposed TSF, the assumptions for the hydrogeological conceptualization are:

- that the alluvium is the major pathway for groundwater flow, and acts as the primary aquifer in the region;
- that the Gila Conglomerate at depth is relatively low permeability compared to the alluvium and some of the other bedrock units in the area and may also act as a limited regional aquifer;
- the direction of groundwater flow is predominantly northwest to southeast and that no groundwater flows north across the catchment divide to Mineral Creek; and
- groundwater flow from the catchment to the east of the facility, Pinal Peak, does not contribute to near-surface groundwater flow at the proposed TSF location; and, groundwater flow/seepage towards the north of Ray Mine from the proposed TSF does not occur.

2.7 Climate and Hydrology

The Skunk Camp TSF site is within a semi-arid climate zone with low average annual precipitation (19 inches to 20 inches) and high estimated average annual potential evapotranspiration, or PET (estimated to be 72 inches, similar to the Near West site). The average temperature range is between an average minimum of 46°F and an average maximum of 87°F.

The region experiences three seasonable types of precipitation events:

- Winter storms that occur during October through March. These are typically long duration, low intensity events.
- Summer monsoonal storms that occur during June through September. These are typically short duration, high intensity thunderstorms, and are common throughout the monsoon season.
- Tropical storms that occur during August through October. These are rare events but produce the most extreme rainfalls in southern Arizona. They are the dying remnants of oceanic storms and typhoons and are typically moderate duration (~24 hours), high intensity events.

Storm event depths were taken from the National Oceanic and Atmospheric Administration (NOAA) Atlas 14 and Applied Water Associates (AWA) Probable Maximum Precipitation (PMP) estimator. The climate and design storm details are included in the design basis memorandum (DBM) in Appendix I.

In its current state, drainage at the site occurs through a series of valleys (or canyons) that report to Dripping Spring Wash, which reports to the Gila River. The drainage valleys located within the Skunk Camp area are ephemeral streams that are typically dry. A number of springs are located to the west of the proposed site, with limited to no associated typical flows. The surface water catchments, and their relation to the Gila River catchment, is shown on Figure 1.1.

3 TAILINGS CHARACTERIZATION

3.1 Tailings Types

The Resolution project will generate two physically, mineralogically and geochemically discrete tailings streams known as scavenger tailings and pyrite tailings; scavenger tailings will account for approximately 84% of tailings produced by weight and pyrite tailings the remaining 16%.

KCB (2018) has summarized the existing geotechnical laboratory testing data for the tailings and geotechnical characterization for the DEIS design.

Duke HydroChem (2016 and 2017b) summarized the tailings geochemical laboratory data and characterization for the DEIS design (Duke Hydrochem 2016 and 2017b).

3.2 Geochemical

The scavenger tailings contain a low percentage of pyrite (with a mean sulfide content of less than 0.1% by weight) and low neutralization potential. Additionally, the release of acidity, sulfate and metal/metalloids from the scavenger tailings is limited by the very low sulfide and residual metal contents (Duke HydroChem 2016).

The pyrite tailings contain a much higher percentage of pyrite (>20% by weight) and are classified as PAG (Duke HydroChem 2016). The pyrite tailings' specific gravity ranges from 3.23 to 4.33, with an average of 3.87, which reflects the variability in high-density pyrite content of the samples.

3.3 Geotechnical

Geotechnical properties of the tailings for the DEIS were characterized based on laboratory testing, literature review and comparison with similar projects, refer to Table 3.1 and Table 3.2. Key comments regarding the tailings geotechnical characterization are as follows:

- Index properties and behaviors (particle size distributions, plasticity, specific gravity, consolidation behavior, and hydraulic conductivity) of the pyrite tailings and scavenger "total" tailings were measured in the laboratory. The same suite of testing was performed on the scavenger "beach" and scavenger overflow tailings, except for consolidation.
- Properties of the cycloned sand and cyclone overflow were estimated from numerical cyclone simulations, pilot-scale cyclone tests, and comparison of scavenger and pyrite tailings index properties with those at other sites.
- The scavenger beach "composite" is not a discrete tailings type, rather an interlayered deposit of scavenger tailings and cyclone overflow that will form the tailings beach. Properties of the composite beach were guided by the characterization of the other tailings types, with consideration for the method of deposition and experience on other projects.
- Shear strength values were estimated based on similar materials at other mines including Bingham Canyon Mine (Kennecott), Pinto Valley Operations and a literature review.

- Average consolidated tailings densities for slurry tailings were selected based on large-strain consolidation testing and KCB experience on similar projects.
- The compacted density of cycloned sand was estimated using the specific gravity of the tailings and a typical void ratio for compacted sand with a similar gradation.

Further details on tailings characterization and engineering design property selection are reported in KCB (2018).

Ranges or "base case" values for engineering design properties based on laboratory testing and case histories are summarized in Table 3.1. Ranges of values selected for hydrogeological properties are summarized in Table 3.2. Engineering properties have been selected from available characterization data.

Table 3.1 Summary of Tailings Engineering Properties used in Design Assessments

<table>
<tr><th rowspan="2">Material</th><th rowspan="2">Specific Gravity[1]</th><th rowspan="2">Atterberg Limits[1,4]</th><th rowspan="2">USCS Class</th><th colspan="2">Particle Size Distribution[2]</th><th rowspan="2">Deposition Method</th><th rowspan="2">Dry Unit Weight for Tailings Staging (pcf)[3]</th><th rowspan="2">Effective Friction Angle (ϕ')</th><th rowspan="2">Peak Undrained Shear Strength Ratio (Su-p/σ'v)</th><th rowspan="2">Liquefied Undrained Shear Strength Ratio (Su-LIQ/σ'v)</th></tr>
<tr><th>% fines <74 micron</th><th>% clay <2 micron</th></tr>
<tr><td>Pyrite Tailings</td><td>3.87</td><td>LL: 18%
PI: 3%</td><td>ML</td><td>80</td><td><20</td><td>Subaqueous deposition at 50% solids content</td><td>106</td><td>27°</td><td>0.2</td><td>0.05</td></tr>
<tr><td>Scavenger "Total" Tailings</td><td rowspan="6">2.78</td><td rowspan="6">LL: 20%
PI: 1%</td><td>ML</td><td>50</td><td><10</td><td rowspan="3">Subaerial deposition at 60% solids content</td><td rowspan="2">87</td><td rowspan="5">32°</td><td rowspan="5">0.25</td><td rowspan="5">0.1
(base case);
0.05
(sensitivity)</td></tr>
<tr><td>Scavenger "Beach" Tailings</td><td>SM</td><td>25</td><td>2</td></tr>
<tr><td>Scavenger "Fines" Tailings</td><td>ML</td><td>94</td><td>7</td><td rowspan="3">81</td></tr>
<tr><td>Cyclone Overflow</td><td>ML</td><td>90</td><td>15</td><td>Subaerial deposition at 60% solids content</td></tr>
<tr><td>Scavenger Beach "Composite"</td><td>-</td><td>-</td><td>-</td><td>Mixture of spigotted scavenger tailings and cyclone overflow</td></tr>
<tr><td>Cycloned Sand</td><td>SP-SM</td><td><20</td><td>0</td><td>Discharged to hydraulic cells at 60% solids content and compacted</td><td>113</td><td>34°</td><td>N/A</td><td>N/A</td></tr>
</table>

Notes:
1. Represent averages from the tailings tested or cyclone numerical simulations.
2. "Beach" and "Fines" values directly measured from laboratory testing. For rationale behind values selected for other materials refer to the DBM (Appendix I)
3. For long-term, consolidated dry density estimates to be used in other analyses, refer to Appendix II.
4. LL = Liquid Limit; PI = Plasticity Index.
5. Su-p = peak undrained strength; Su-LIQ = liquefied undrained strength; and σ'v = vertical effective stress.

Table 3.2 Summary of Engineering Hydraulic Parameters

Material	Horizontal Saturated Hydraulic Conductivity k_h (cm/s)	Anisotropy Ratio k_h/k_v	Total Porosity n_{total}	Effective Porosity $n_{effective}$	Specific Yield S_y
Pyrite Tailings	1×10^{-6} to 1×10^{-7}	1 to 10	0.40 to 0.50	0.25 to 0.50	0.20 to 0.30
Scavenger "Total" Tailings	5×10^{-5} to 5×10^{-6}	1 to 10	0.30 to 0.40	0.25 to 0.40	0.20 to 0.30
Scavenger "Beach" Tailings	5×10^{-4} to 5×10^{-5}	1 to 10	0.30 to 0.40	0.25 to 0.40	0.25 to 0.35
Scavenger "Fines" Tailings	1×10^{-6} to 1×10^{-7}	1 to 10	0.40 to 0.50	0.25 to 0.50	0.20 to 0.30
Scavenger Beach "Composite"	5×10^{-5} to 5×10^{-6}	10 to 100	0.40 to 0.50	0.25 to 0.50	0.20 to 0.30
Cyclone Overflow	1×10^{-6} to 1×10^{-7}	1 to 10	0.40 to 0.50	0.25 to 0.50	0.20 to 0.30
Cycloned Sand	5×10^{-2} to 1×10^{-3}	1 to 10	0.30	0.30	0.30

3.4 Tailings Deposition Slopes

Tailings deposition slopes are a function of particle size distribution, percent solids of discharged slurry, specific gravity, spigot design/arrangement, distance from deposition point and whether tailings will be deposited subaerially or sub aqueously. Slopes should be monitored regularly during operations and the tailings deposition plan adjusted as required. Deposition slopes for discharged slurry tailings adopted for deposition modeling are summarized in Table 3.3. They were chosen based on review of case history data from operating cycloned sand tailings impoundments and subaqueous pyrite tailings facilities.

Table 3.3 Tailings Slopes

Tailings Type	Tailings Slopes	Justification
Scavenger Beach "Composite"	Above Water: 1% for the first 1,500 ft, 0.5% after 1,500 ft Below Water: not applicable for Alternative 8	Based on topography and bathymetry surveys from two large, cycloned sand impoundment beaches and slopes below water.
Pyrite Tailings	Below Water: 10.0% for the first 100 ft, 0.5% after 100 ft	Based on topography and bathymetry surveys of subaqueous disposal of high-pyrite tailings from floating barges.

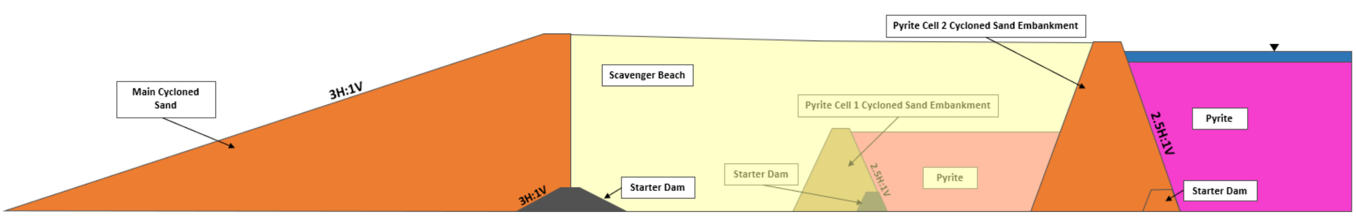
4 DESIGN BASIS

4.1 General

The DBM, refer to Appendix I, was developed with input and agreement from RC. A summary of key design basis and objectives are outlined below; however, the DBM (Appendix I) should be referenced for further details.

- The pyrite tailings are to be deposited subaqueously from a floating barge into a pond with low-permeability layers so they can remain saturated throughout operations. This is done to reduce potential for acid rock drainage (ARD) and metal leaching (ML) that can be triggered by pyrite tailings exposure to water and oxygen (Duke 2017b).
- For stability analysis, all potentially liquefiable contractive tailings are assumed to liquefy regardless of the triggering mechanism.
- The design cross-section for the embankments includes an outer compacted cycloned sand structural zone that is raised using a centerline approach for the Main Embankment and a downstream raised approach for the pyrite cell embankments (Figure 4.1).
- The downstream slope of the cycloned sand embankment was set to 3H:1V based on the results of stability analyses (KCB 2017a). Localized flattening or excavation of potentially weak foundation layers, may be required to meet stability criteria in all areas.

Figure 4.1 Schematic Section of Proposed Facility



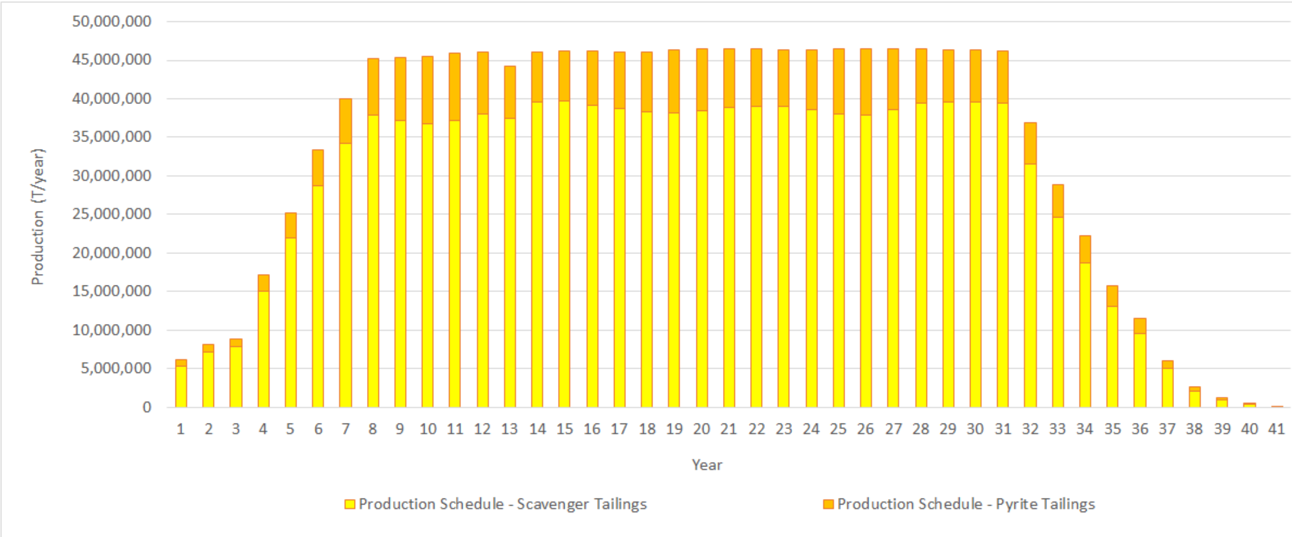
4.2 Tailings Production Rate

The tailings production schedule is summarized in Table 4.1 and illustrated on Figure 4.2.

Table 4.1 Production Schedule Summary

Item	Production Schedule
	DEIS
NPAG Scavenger Tailings	1,151 Mtons
PAG Pyrite Tailings	220 Mtons
Total Tailings (Scavenger and Pyrite)	1,371 Mtons
Percentage of Pyrite Tailings by Mass	16%
Number of Production Years	41

Figure 4.2 Annual Tailings Production Schedule



4.3 BADCT Approach

The TSF would apply for an Aquifer Protection Permit (APP) with an "individual" Best Available Demonstrated Control Technology (BADCT) approach, which is performance based, and allows the applicant to select from all available Demonstrated Control Technologies (DCTs) that constitute BADCT. This process considers site specific characteristics, operational controls, and other DCTs.

Under the individual BADCT approach, the TSF is considered a "tailings impoundment" and will be designed in accordance with Section 3.5 of the BADCT manual (ADEQ 2005). The seepage dams are considered to be "surface ponds" and will be designed in accordance with Section 3.6 of the BADCT manual (ADEQ 2005) and the regulations pertaining to water dams (A.A.C. R12-15).

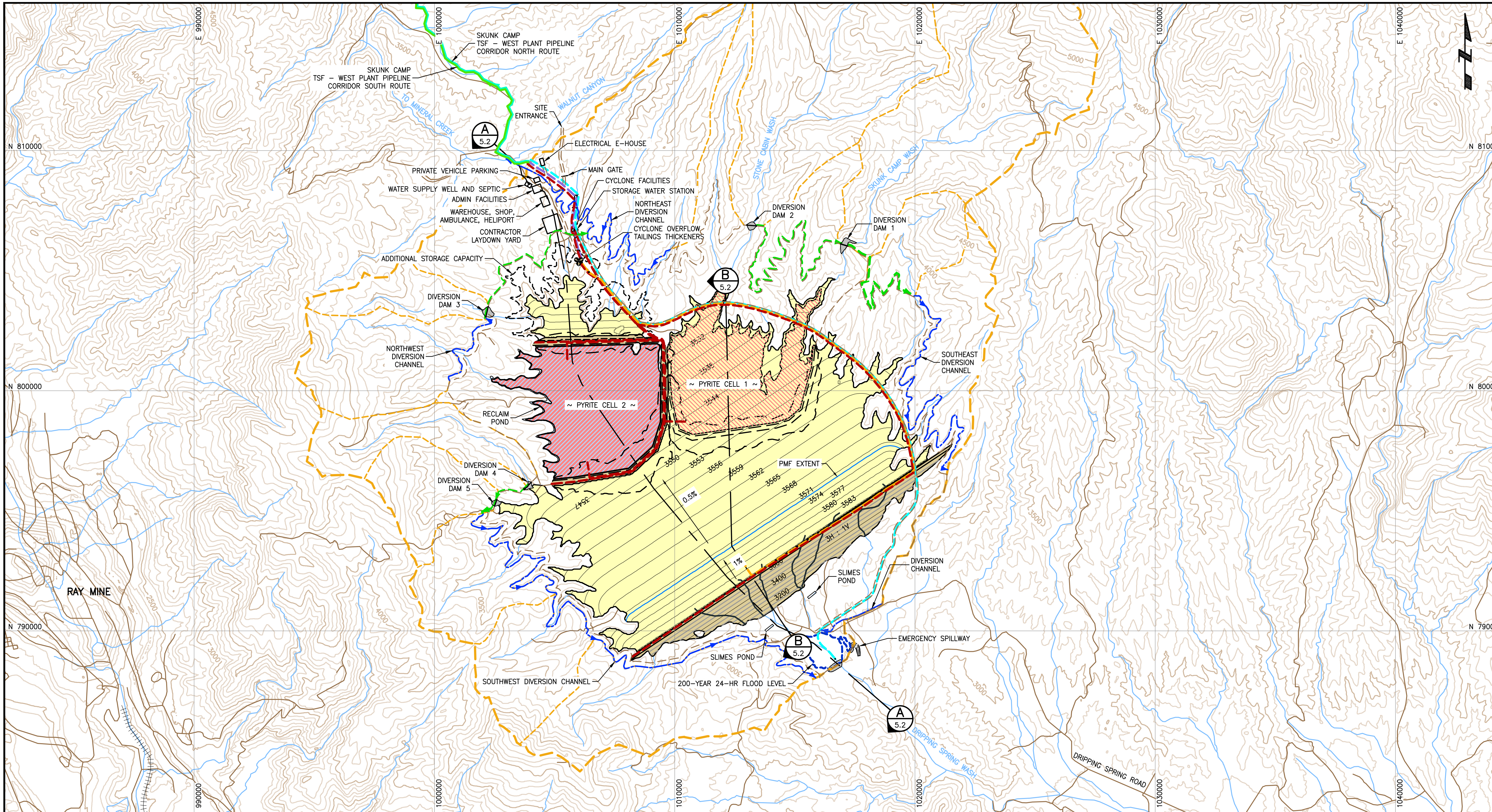
5 TAILINGS MANAGEMENT PLAN

5.1 TSF Features

Key features of the TSF during start-up and operations include the following:

- General fill borrow area within the Gila Conglomerate and rock quarries (quartzite and diabase) developed within and near to the TSF footprint to source fill and erosion protection materials.
- Cross-valley, earthfill starter dams would facilitate tailings placement before the cycloned sand embankments are established.
- Segregated cells to retain pyrite tailings upstream of the scavenger beach.
- Embankment underdrain system comprised of a sand and gravel blanket drain and rockfill finger drains.
- Non-contact surface water management system, comprising upslope diversion channels and dams to divert non-contact water around the facility.
- Tailings delivery system that transports scavenger total tailings and pyrite tailings to the TSF from the West Plant for cycloning and/or deposition.
- A reclaim pond maintained within the pyrite cell to maintain pyrite tailings saturation and allow for excess water to be reclaimed to the West Plant via floating pump barge and pipeline.
- A pyrite tailings deposition barge, associated pipelines and support systems to facilitate subaqueous deposition of pyrite tailings in the segregated cell.
- A cyclone system that processes a portion of scavenger total tailings to produce cyclone underflow (cycloned sand) for embankment construction. A by-product of this operation is cyclone overflow which is thickened before being deposited into the TSF impoundment.
- Tailings thickeners located at the TSF to increase solids content of the scavenger tailings overflow prior to deposition in the TSF.
- All components of the seepage management system comprise the items listed below, refer to discussion on seepage management in Section 8:
  - A primary Seepage Collection Pond constructed in the natural valley downstream of the cycloned sand embankment.
  - A groundwater cut-off installed downstream of the Seepage Collection Pond to improve seepage collection.
  - Associated mechanical and electrical infrastructure required to return collected seepage water to either:
    - the reclaim pond located within the pyrite tailings cell, or;
    - the reclaim water tank.

The general layout and cross section of the TSF is shown on Figure 5.1 and Figure 5.2.



LEGEND

- SURFACE WATER DIVERSION AND SEEPAGE COLLECTION DAM
- STARTER DAMS
- CYCLONED SAND MAIN EMBANKMENT AND PYRITE CELL EMBANKMENT
- SCAVENGER TAILINGS
- PYRITE TAILINGS
- PYRITE TAILINGS COVERED BY SCAVENGER TAILINGS
- RECLAIM POND
- 200 YEAR 24-HR FLOOD EXTENTS
- CATCHMENT BOUNDARY
- SUB-CATCHMENT BOUNDARY
- FINGER DRAIN
- DIVERSION CHANNEL – CENTERLINE
- NON-CONTACT SURFACE WATER MANAGEMENT PIPELINE
- SCAVENGER PIPELINE
- PYRITE PIPELINE
- SEEPAGE WATER RECLAIM PIPELINE
- OVERFLOW/UNDERFLOW PIPELINE
- PROPOSED ROAD
- EXISTING ROAD
- FACILITY BUILDING
- RAILWAY
- NATURAL DRAINAGE

NOTES

1. PROJECTION AND DATUM: ARIZONA STATE PLANE CENTRAL NAD 83 – INTERNATIONAL FOOT.
2. TOPOGRAPHY BASED ON INTERMAP NEXTMAP DSM AND DTM ACQUIRED IN 2004.

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CLIENT: RESOLUTION COPPER	PROJECT: RESOLUTION COPPER PROJECT DEIS DESIGN FOR ALTERNATIVE 6: SKUNK CAMP
Klohn Crippen Berger	TITLE: ULTIMATE LAYOUT PLAN
SCALE: AS SHOWN	PROJECT No.: M09441A20
FIG. No.: 5.1	

KCB-FIG-D-L

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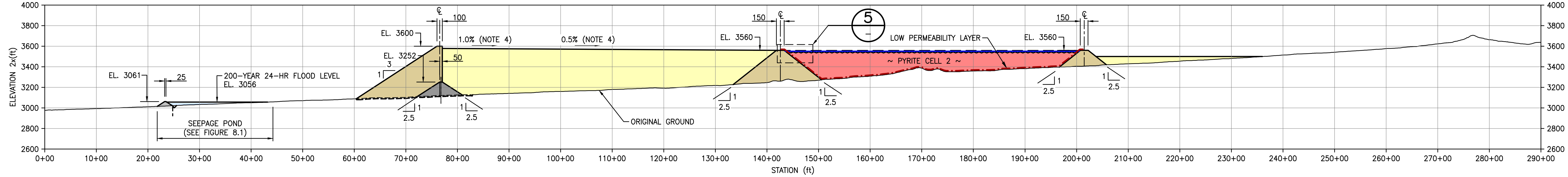

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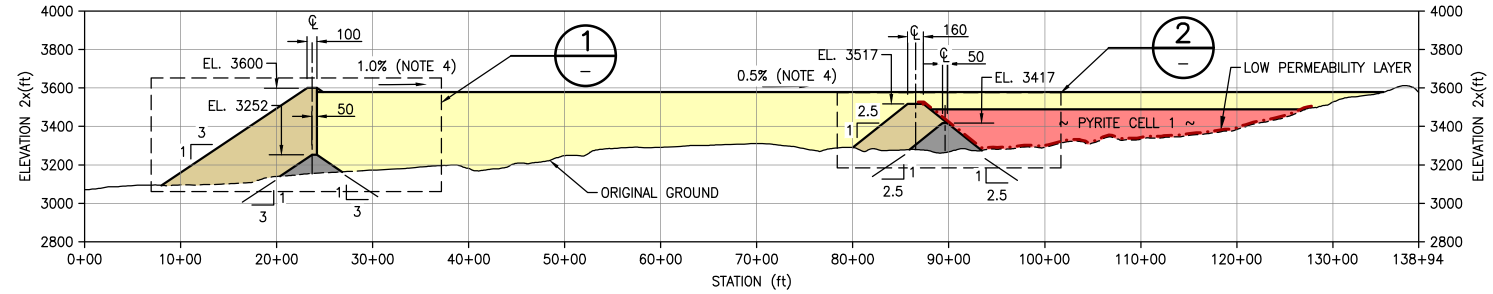
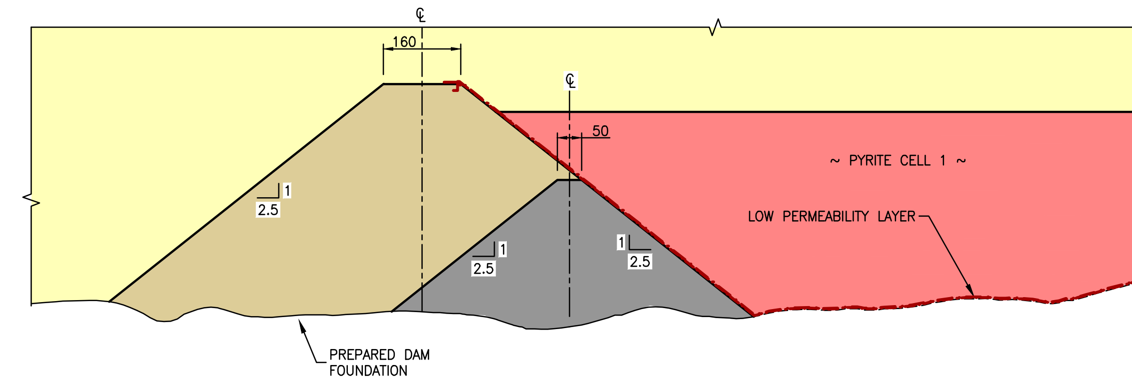
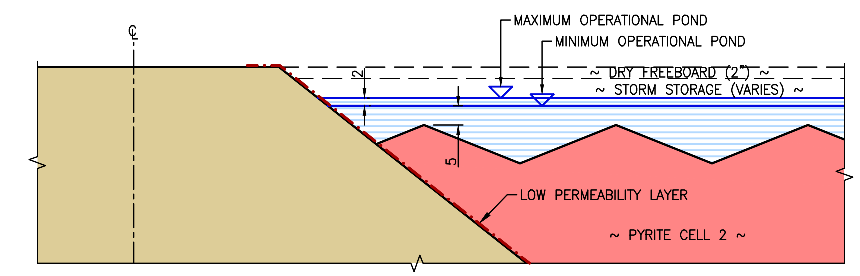


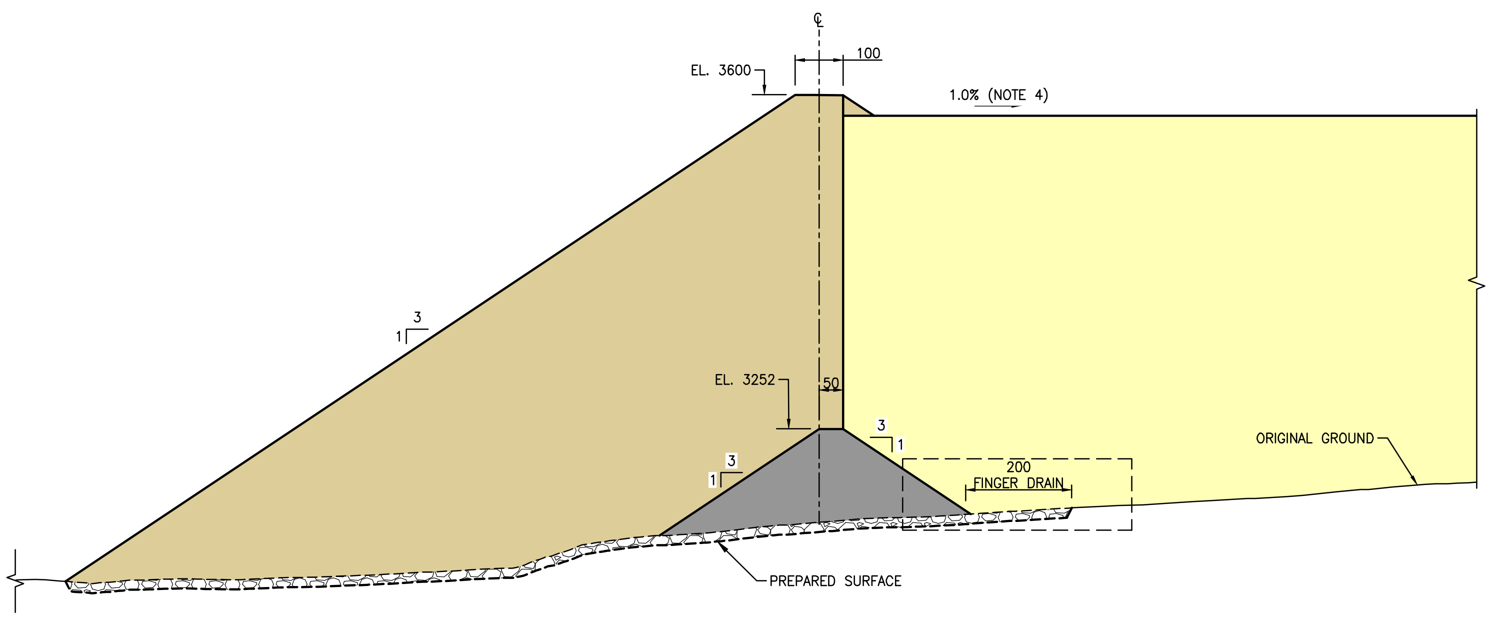
SECTION B
SCALE A 5.1



DETAIL 2
SCALE B



DETAIL 5
SCALE C



DETAIL 1
SCALE B

LEGEND

- SEEPAGE COLLECTION DAM
- STARTER DAMS
- CYCLONED SAND MAIN EMBANKMENT AND PYRITE CELL EMBANKMENT
- SCANVEGER TAILINGS
- PYRITE TAILINGS
- RECLAIM POND

NOTES

1. PROJECTION AND DATUM: ARIZONA STATE PLANE CENTRAL NAD 83 – INTERNATIONAL FOOT.
2. TOPOGRAPHY BASED ON INTERMAP NEXTMAP DSM AND DTM ACQUIRED IN 2004.
3. THE VERTICAL SCALE IS TWICE THE HORIZONTAL SCALE.
4. SEE DBM FOR TAILINGS DEPOSITION SLOPE ASSUMPTIONS.

SCALE D 2 0 2 FT
SCALE C 50 0 50 FT
SCALE B 200 0 200 FT
SCALE A 1000 0 1000 FT

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CLIENT: RESOLUTION COPPER	PROJECT: RESOLUTION COPPER PROJECT DEIS DESIGN FOR ALTERNATIVE 6: SKUNK CAMP
Klohn Crippen Berger	TITLE: ULTIMATE LAYOUT SECTIONS AND DETAILS
SCALE: AS SHOWN	PROJECT No. M09441A20 — FIG. No. 5.2

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KCB-FIG-D-L

5.2 Embankment Design

5.2.1 Overview

The scavenger tailings would be impounded by a cross-valley starter dam constructed of borrow material prior to plant commissioning and then raised during operations with compacted cycloned sand fill using the centerline construction approach.

Key components of the design include the following:

- Cycloned sand shell to provide structural support to tailings, would require fill be placed to a specified density to achieve a dilative behavior during shear.
- Underdrain system comprising a sand and gravel blanket drain with gravel primary drains along main drainages and some extended beneath the scavenger beach to maintain a low phreatic surface in the tailings embankment, intercept and direct seepage from the impoundment and hydraulic placement to the downstream Seepage Collection Pond (SCP).

It should be noted that there is precedent in the industry for compacted cycloned sand embankments to the height predicted (500 ft).

The pyrite tailings would be impounded in two separate cells, operated sequentially. The Pyrite Cell 1 starter dam would be constructed of borrow material prior to plant commissioning and then raised during operations with compacted cycloned sand fill using the downstream construction approach. The Pyrite Cell 2 starter dam would be constructed of compacted cycloned sand fill prior to Year 16 (when pyrite tailings would be deposited within it), also using the downstream raised construction approach.

5.2.2 Downstream Embankment Slope and Stability

A 3H:1V downstream slope for the scavenger beach cycloned sand Main Embankment is assumed to meet slope stability criteria (Appendix I) with typical expected foundation conditions based on the preliminary stability analysis summarized in KCB (2017a). Localized flattening of the slope or excavation of potentially weak foundation layers may be required to meet stability criteria in select areas.

A 2.5H:1V upstream and downstream slope for the pyrite cells cycloned sand embankments is assumed. A steeper slope is assumed for these embankments because they would be buttressed along the toe by the rising scavenger beach and ultimately covered by the scavenger tailings post-closure. This assumption is predicated on the timing of both the scavenger beach rise and the pyrite cell embankment construction, and will need to be confirmed.

5.3 Tailings Management Strategy

Figure 5.1 and Figure 5.2 present the proposed layout of the Skunk Camp TSF at ultimate configuration (end of mine life). The overall tailings management strategy is as follows:

- Scavenger tailings and pyrite tailings earthfill starter dams would be constructed to store tailings at start-up before the cycloned sand embankments are established. The pyrite starter cells would include a low-permeability layer and be flooded for subaqueous deposition of pyrite tailings.
- During operations, a portion of scavenger tailings would be cycloned and the coarser underflow by-product (cycloned sand) would be used as embankment fill which would be placed in hydraulic placement cells.
- Scavenger tailings cyclone overflow would be thickened at the TSF to minimize slurry bleed water and then discharged from the embankment crest. Thickening and thin-lift deposition strategy would be adopted to avoid formation of a continuous pond in the scavenger beach cell.
- Maintain a reclaim pond in the pyrite cells to allow subaqueous deposition and prevent oxidation of the pyrite tailings, refer to Section 5.4.
- Floating barge would be used to recycle excess water from the pyrite cells ponds to the West Plant for ore processing.
- Raise pyrite cell embankments primarily with cycloned sand throughout operations to maintain adequate capacity for tailings and flood storage.
- Transition to a “dry-cover” facility would be made for closure to promote runoff (i.e. avoid ponding) on the tailings surface and reduce infiltration over the long-term.

The overall strategy is discussed further herein, including information regarding the supplementary structures necessary to meet project requirements.

5.4 Tailings Delivery and Process Facilities

Scavenger and pyrite tailings slurry would be thickened at the West Plant to 60% and 50% solids, respectively, and delivered to the cyclone house at the north end of the TSF site (see Figure 5.1). As discussed previously, scavenger tailings would be cycloned to produce embankment fill with the cyclone overflow being thickened at the TSF before discharge into the impoundment.

Pyrite tailings would be sent directly to a floating deposition barge for subaqueous deposition located within the pyrite cells (see Figure 5.1).

The key auxiliary facilities located at the TSF site are summarized below:

- cyclone system which includes a building, slurry dilution tanks, storage tanks, pumps and cyclones;
- scavenger cyclone overflow tailings thickeners;
- electrical substation and distribution lines;
- vehicle maintenance and fueling shop;
- warehouse for spares along with outside storage areas;

- administration and locker room facilities; and
- parking facilities.

Tailings delivery and water reclaim distribution lines include:

- cycloned sand distribution pipelines to hydraulic cells for embankment construction;
- scavenger tailings ("total" tailings and cyclone overflow) distribution pipelines to the embankment crests;
- pyrite distribution pipeline to the deposition barge and/or floating pipelines; and
- return water line from the reclaim pond.

Further details on the tailings delivery and process facilities is provided in Golder (2018).

5.5 Pyrite Tailings Management

Pyrite tailings would be deposited subaqueously from a floating barge throughout operations. As discussed previously, the primary advantage of this management approach is that pyrite tailings would not oxidize which would increase the potential to impact downstream receptors.

5.6 Tailings Staging Plan

Tailings deposition has been sub-divided into four major stages, as described below. The percentage of the tailings volume deposited in each of the stages is provided in brackets. Additional figures showing the TSF at several stages of development, as well as the locations of the catchments, referenced in this section, are provided in Appendix II.

- Stage I – Years 0 to 2 (1% of total tailings volume):
    - construction of the scavenger tailings Main Embankment and Pyrite Cell 1 starter dams (prior to Year 0);
    - impounding of water behind the Pyrite Cell 1 starter dam to establish a minimum water cover for the pyrite tailings and to float the pyrite deposition system and reclaim barge;
    - pyrite tailings deposition into Pyrite Cell 1 from the pyrite deposition barge;
    - scavenger tailings deposition from the crest of the Main Embankment. Slurry bleed water that collects on the scavenger tailings surface is collected in low points and pumped to Pyrite Cell 1; and,
    - cycloning of scavenger tailings to produce cycloned sand for embankment construction at the Main Embankment and Pyrite Cell 1; and
- Stage II – Years 3 to 15 (35% of total tailings volume):
    - continued subaqueous pyrite tailings deposition in Pyrite Cell 1;

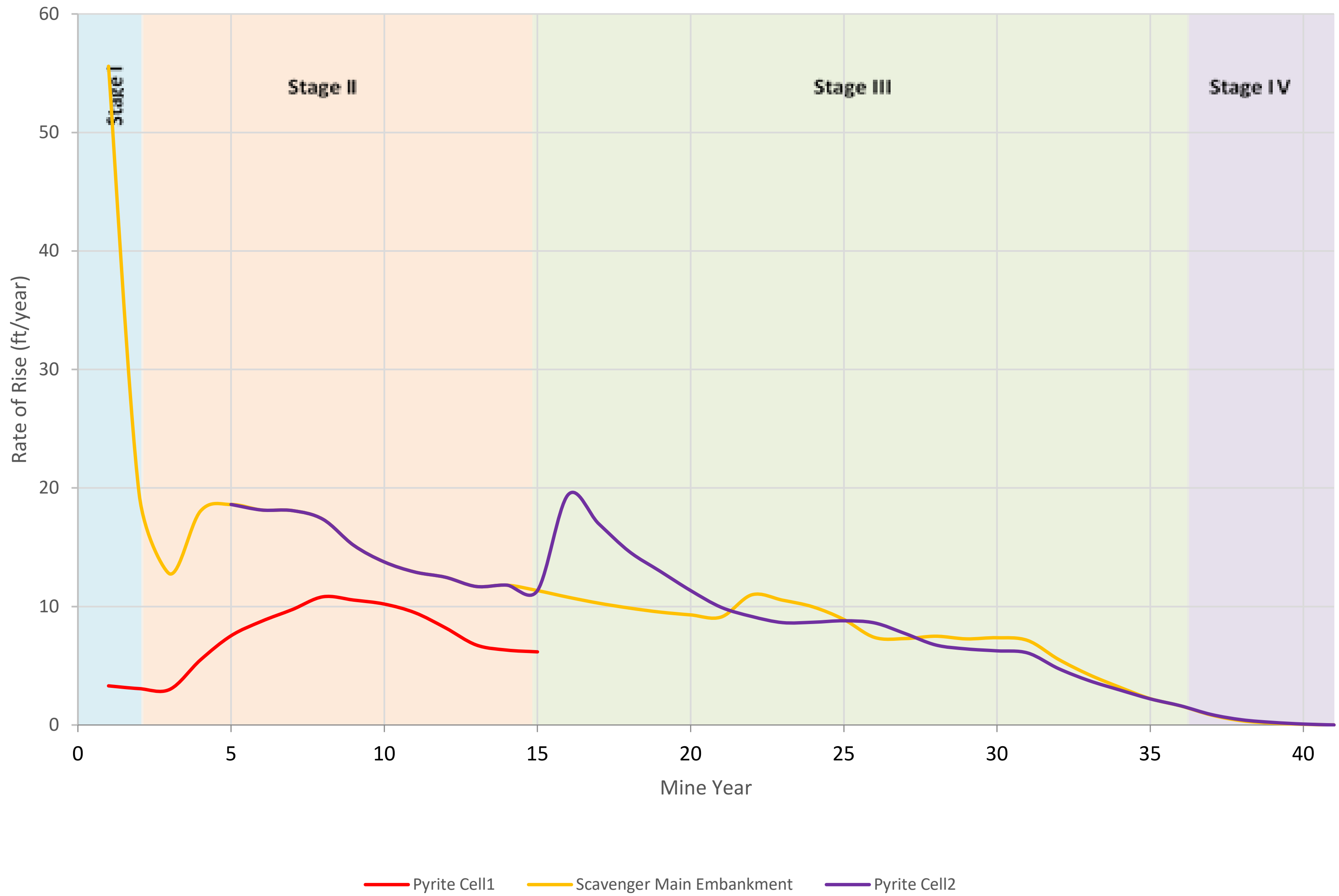
- continued scavenger tailings deposition on the scavenger beach. Slurry bleed water and runoff that collects on the scavenger tailings surface is collected in low points and pumped to Pyrite Cell 1;
- continued cycloning of scavenger tailings to produce cycloned sand for embankment construction of the Main Embankment and Pyrite Cell 1 embankment, as well as for the establishment of the starter embankment for Pyrite Cell 2 (starting in Year 5 to contain scavenger tailings in the scavenger beach area); and,
- impounding of water behind the Pyrite Cell 2 starter dam to establish a minimum water cover for the pyrite tailings and to float the pyrite deposition system and reclaim barge.

- Stage III – Years 16 to 36 (64% of total tailings volume):
  - pyrite tailings deposition into Pyrite Cell 2 from the pyrite deposition barge;
  - scavenger tailings deposition in Pyrite Cell 1, to cover the pyrite tailings and displace the pond. As the pond is displaced it would be either syphoned or channeled to Pyrite Cell 2;
  - continued scavenger tailings deposition within the main impoundment, eventually inundating Pyrite Cell 1 (between Year 15 and 30, depending on operations). Slurry bleed water and runoff that collects on the scavenger tailings surface is collected in low points and pumped to Pyrite Cell 2; and
  - continued cycloning of scavenger tailings to produce cycloned sand for embankment construction at the Main Embankment and Pyrite Cell 2.
- Stage IV – Years 36 to 41 (1% of total tailings volume):
  - pyrite deposition into Pyrite Cell 2 from the pyrite deposition system;
  - continued scavenger tailings deposition within the main impoundment, as well as north of Pyrite Cell 2 to form the ultimate tailings surface that slopes to the north. Slurry bleed water and runoff that collects on the scavenger tailings surface is collected in low points and pumped to Pyrite Cell 2 or the reclaim tank;
  - continued cycloning of scavenger tailings to produce cyclone sand for embankment construction at the Main Embankment and Pyrite Cell 2; and
  - towards the end of Stage IV, scavenger tailings are deposited within Pyrite Cell 2 to cover the pyrite tailings and promote drainage towards the north (where a closure channel would be constructed), reducing the area of pyrite tailings that would need to be covered and reclaim pond to be managed at the end of operations.

The tailings staging plan described above was modeled using the software program MUCK3D (MineBridge Software Inc., version 1.0.5). A detailed discussion on the modeling approach, key assumptions and results are included in Appendix II and summarized below.

- Pyrite tailings are able to be deposited subaqueously at all stages, as required to maintain saturation.
- The impoundment layout is capable of storing the required tailings and flood storage volumes.
- Long beaches (>400 ft) are maintained during the Inflow Design Flood (IDF) for all years except for Years 0 to 5. Mobilization of pumps, modifications to the staging plan, or other methods to remove or store water (including upgrading the design of the upstream diversions, increasing the capacity of the starter dams, or other methods to safely route stored water) may be required during this time to maintain an adequate beach length.
- The forecasted rate of embankment rise, above the initial starter dam crests, is shown on Figure 5.3. Rate of embankment crest rise between 11 ft/yr and 20 ft/yr is expected in the first 15 years before leveling out to less than 10 ft/yr for the remainder of operations. The tailings deposition sequence and embankment layout can be refined during future design stages to attenuate peak rate of rise projections.
- The total cycloned sand volume required for construction (170 Myd^3) is less than the total amount that can be produced (243 Myd^3), based on the assumed density and availability assumptions outlined in the DBM (Appendix I). This provides operational flexibility (i.e. the cyclone plant can have longer periods of downtime and still meet volume requirements) and an opportunity to reduce the period before progressive reclamation of the embankment slopes can begin, if excess cycloned sand is used to build the Main Embankment out towards the ultimate toe.

Figure 5.3 Skunk Camp Rate of Rise



6 WATER MANAGEMENT PLAN

6.1 Surface Water Management System

The objectives of the operational water management plan are to:

- divert non-contact water around the TSF to keep it separate from contact water;
- minimize water losses through tailings thickening of the scavenger tailings cyclone overflow, and maximize contact water reclaimed from the TSF to the West Plant for ore processing;
- intercept embankment toe seepage and contact surface runoff from the TSF and reclaim to either the pyrite cells ponds, or the reclaim water tank;
- maintain a reclaim pond in the pyrite cell to keep pyrite tailings saturated;
- store the IDF within the impoundment with adequate freeboard; and
- protect the TSF and diversion structures from excessive erosion during flood events.

The surface water management system includes the following components:

Non-contact Diversion Structures

The catchments upstream of the TSF (12,500 acres) would be diverted around the TSF as much as practical using diversion channels, dams and pipelines as shown on Figure 2.1 and Figure 5.1.

Four diversion channels have been included along the east and west of the TSF to intercept and route the upstream catchments around the facility. The channels would be cut into the drainage valley slopes and generally follow the topography. To maintain a constant slope, five diversion dams would need to be constructed across smaller side drainages with low-level outlets and pipelines conveying flow to nearby diversion channels. Where possible, the diversion dams and channels would incorporate features to cut-off the flow of groundwater within the alluvium.

The diversion structures are sized to convey the peak flow or volume generated from a 24-hr duration, 100-year return period storm (point-precipitation). During higher storm events, the diversion structures would include emergency spillway structures that would convey flow to the TSF.

Approximately 7,300 acres of the upstream catchment would be diverted south, to Dripping Springs Wash, and 1,700 acres would be diverted north to Walnut Canyon, which feeds into Mineral Creek. Mineral Creek is diverted through Ray Mine. Both drainages discharge to the Gila River, with Drippings Springs Wash discharging to the Gila River approximately 25 miles upstream of the location Mineral Creek discharges to the Gila River.

Embankment Runoff Collection Ditches

Collection ditches would be constructed along the embankment toe and at underdrain discharges to convey water to the SCP.

Seepage Collection Pond (SCP)

The SCP would be constructed to collect seepage water from the tailings embankment underdrain system and surface runoff from the embankment slope. The location of the SCP is shown on Figure 5.1.

Water from the SCP would be pumped to the pyrite cell pond or the cyclone house. The design criteria for the SCP sizing is included in the DBM (Appendix I). The storage capacity would have allowance for the minimum operating volume, maximum seasonal volume (for an average climatic year), allowance for operational upset, flood storage for critical duration storm events including sediment and minimum freeboard above peak flood level.

Additional ponds may be required to manage fines suspended in water decanted from cycloned sand hydraulic placement cells, if the planned ponds are not suitable.

6.2 Water Balance

A preliminary operational and post-closure water balance was completed to provide inputs into the following assessments completed by others:

- site-wide water balance to estimate make-up water requirements; and
- downstream solute transport.

The conceptual operational TSF water balance is represented schematically on Figure 6.1; the inputs, assumptions and results are summarized in Appendix III.

The water balance was simplified to be focused around the water ponds (i.e. seepage collection ponds, the pyrite cell ponds). The West Plant water requirements and TSF reclaim rates are shown on Figure 6.2. A summary of the TSF system losses and surpluses are given in Table 6.1 and Table 6.2.

Table 6.1 Summary of TSF System Water Requirements from Other Sources

Flow Description	Operations (acre-ft)	Post-Closure Phase 1 (acre-ft)	Post-Closure Phase 2 (acre-ft)	Post-Closure Phase 3 (acre-ft)
Additional water required for Pyrite Pond (to maintain saturation)	1,500	0	0	0
TSF system loss (water required for the West Plant from other sources)	476,600	0	0	0

Table 6.2 Summary of TSF Active Water Management Requirements (System Surplus)

Flow Description	Operations (acre-ft)	Post-Closure Phase 1 (acre-ft)	Post-Closure Phase 2 (acre-ft)	Post-Closure Phase 3 (acre-ft)
Surplus from Pyrite Pond	0	12,300	0	0
Surplus from Seepage Collection Pond	0	0	21,000[1]	0

Note 1: surplus means water is not required at the West Plant and the water would be treated and released

Following closure, active water management of the TSF would occur for 5 years, followed by an additional 40 years of active water management at the SCP. Further details of the water balance are included in Appendix III.

Figure 6.1 Water Balance Schematic

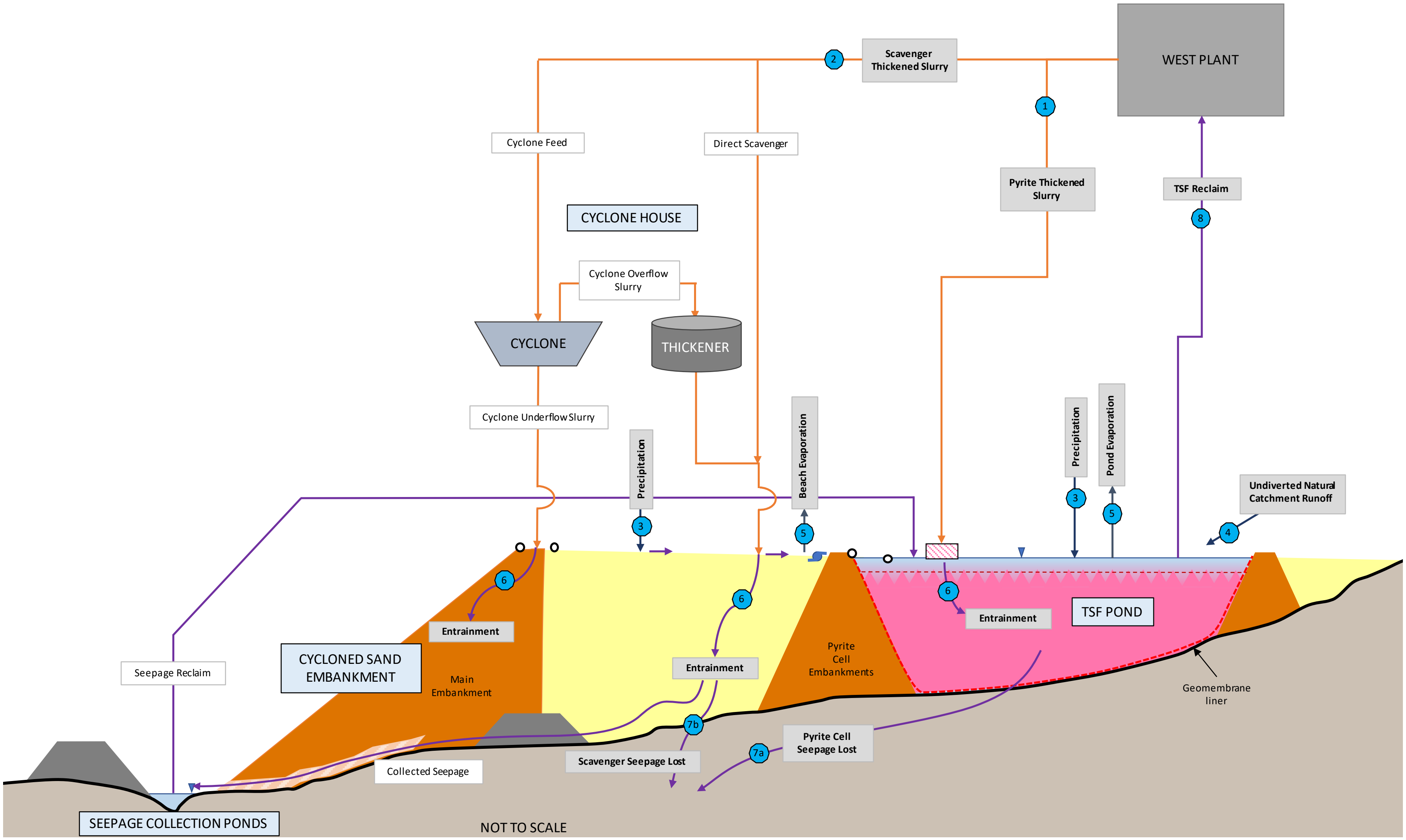
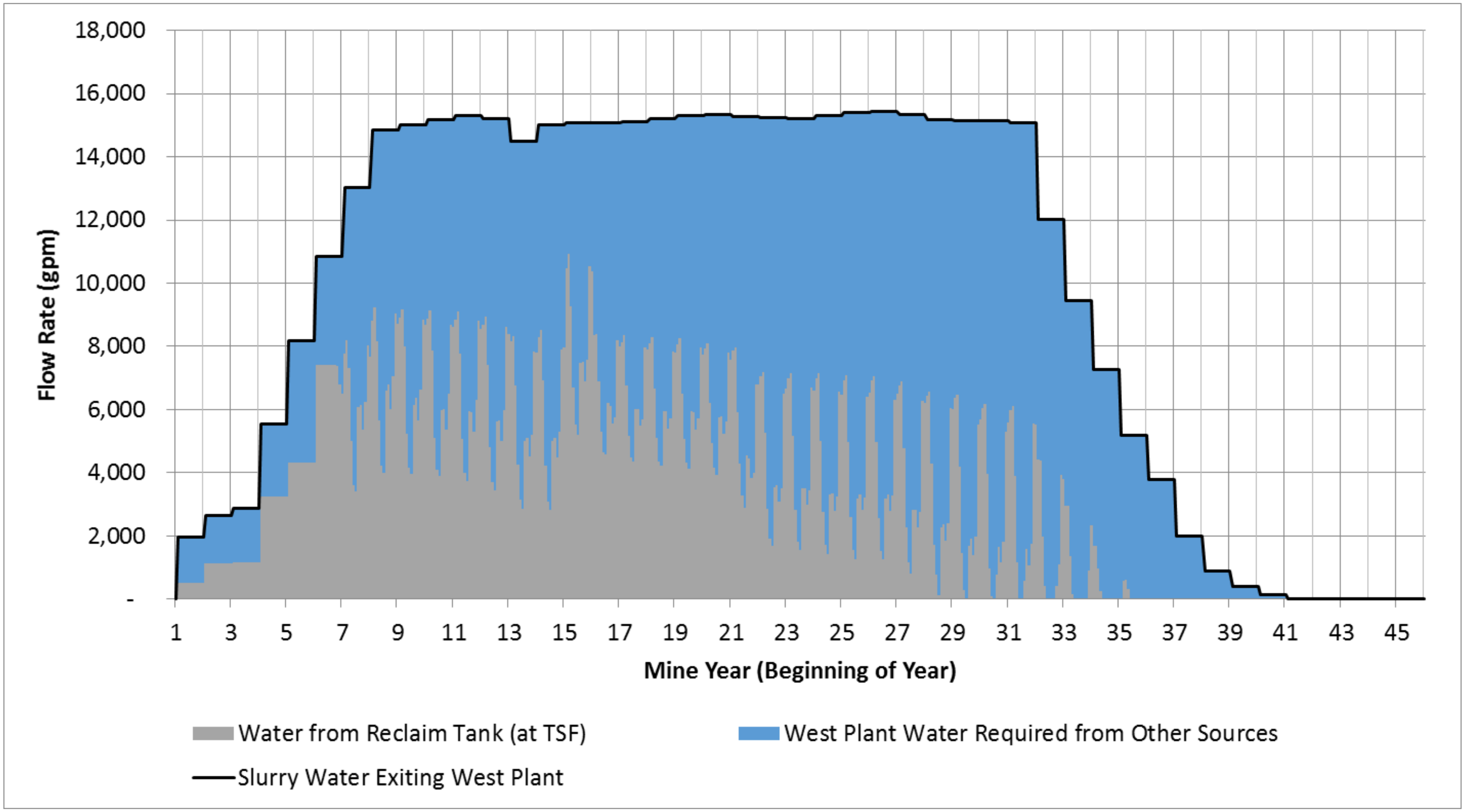


Figure 6.2 West Plant Water Requirements from TSF and Other Sources



7 SEEPAGE MANAGEMENT PLAN

Engineered low-permeability layers for the pyrite cells and managing the scavenger beach as dry as possible would be implemented to reduce seepage from the TSF. Embankment underdrains would be used depress the phreatic surface within the cycloned sand and to direct seepage from the facility to the SCP. Embankment and local catchment runoff would also be collected in the SCP.

Seepage that does enter the foundation is expected to predominantly flow south through the alluvium channels and surficial weathered Gila Conglomerate towards the Gila River. Therefore, the SCP would be located downstream of the TSF with grouting/cut-offs to competent bedrock to restrict groundwater flow through the alluvials.

The embankment underdrainage would include the following:

- The scavenger starter dam would be constructed above the embankment blanket drain. The intention is that the blanket and finger drains would collect water from the tailings and convey it beneath the starter dams to a series of lined channels located within the drainage channels downstream of the TSF. The lined channels would then convey the collected seepage water to the lined SCP.
- Underdrains would be extended 100 ft to 200 ft into the impoundment to intercept seepage from the scavenger beach area.

The SCP includes the following elements:

- Excavation of all alluvial soil beneath the crest of the dam and replacement with compacted granular fill.
- An engineered low-permeability layer on the upstream face.
- A cementitious grout curtain that extends to a depth of approximately 100 ft into the foundation, and into each abutment.
- Pumpback wells installed in a pumpback sump on the upstream side of the grout curtain.

Preliminary lost TSF seepage rates were estimated in the water balance by two-dimensional (2D) numerical seepage analyses, refer to Table 7.1. The inputs, assumptions and results of the seepage assessments are presented in Appendix III and Appendix IV. The values are appropriate for use in the conceptual water balance but are likely conservative and over-estimate seepage as the effect of pit dewatering from the Ray mine has been discounted.

Table 7.1 Lost TSF Seepage Comparison

Mine Years	Water Balance Seepage Estimate			2D Seepage Assessment Lost Seepage (Appendix IV)
	Pyrite Cell Lost Seepage (acre-ft/yr)	Scavenger Tailings Lost Seepage (acre-ft/yr)	Total Lost Seepage (acre-ft/yr)	(acre-ft/yr)
1 to 7	1	95	96	-
8 to 31	7	430	437	-
32 to 41	11	509	520	564 to 660[1]
Post-Closure	4	55	59[2]	202 to 258[1]

Note: 1. For ultimate layout using a 2D cross-section and a representative length of 15,000 ft (see Appendix IV).
2. Assumed to be 3% of precipitation over closure beach surface (3,000 acres).

8 DUST MANAGEMENT PLAN

The key considerations for dust management of the Skunk Camp TSF are:

- the surface area of the impoundment;
- susceptibility of beach tailings to wind erosion, when dry;
- susceptibility of cycloned sand to wind erosion, when dry; and
- TSF embankment slopes which cannot be progressively reclaimed until ultimate downstream slopes are established in the later stages of operations.

The conceptual dust management plan is based on the following approach to manage wind erosion of the TSF surface.

- Cycloned sand embankment slopes:
  - The scavenger Main Embankment construction would be sequenced to establish the ultimate downstream slope as soon as practical to allow progressive reclamation of the slope with an erosion resistant cover.
    - Progressive reclamation for the scavenger embankment downstream slope is forecast to start after Year 10, ramping up to Year 20. Thereafter the downstream slope from each annual raise could be progressively reclaimed within 12 months.
  - The Pyrite Cell 1 embankment would be sequenced to establish the ultimate downstream slope as soon as practical to allow progressive reclamation of the slope with an erosion resistant cover. The Pyrite Cell 2 embankment would be raised in horizontal lifts. The embankments slopes would eventually be covered by the scavenger tailings beach (downstream) or pyrite tailings (upstream). Temporary dust control measures would be implemented, as necessary, to manage dust while they are exposed.
  - Hydraulic placement cells would be wetted during active placement and, if necessary, could be wetted by sprinklers when inactive.
  - Dust from areas that would be exposed for an extended period (inactive areas that have not been progressively reclaimed) could be managed through temporary erosion controls such as: polymers, wind fences, and/or temporary sand and gravel erosion protection layer.
- Scavenger tailings beach:
  - Tailings deposition spigot locations would rotate to keep as much of the beach area wet as practical.
    - Tailings beaches undergoing active tailings deposition are considered wetted with low dust erosion potential.

    - Inactive tailings beaches are considered to be dry and, if left for extended periods, may be wetted by sprinklers or sprayed with polymer, if necessary.
    - Relative to the cycloned sand embankment, tailings beaches are expected to have higher erosion resistance due to desiccation and crusting may form at the surface.
- Reclaim pond:
  - Tailings submerged in the reclaim pond would not be exposed to wind erosion.
  - Service roads would be regularly watered or sprayed with a dust suppressant, as required.

9 BORROW PLAN

Earthfill construction materials are required for the following purposes:

- general fill for starter tailings embankments and water collection dam construction;
- sand and gravel for underdrains, blanket drains and dam zones; and
- riprap for erosion protection.

Based on the regional geology information for the Skunk Camp area (refer to Section 2.4), there are two potential general fill borrow sources within the TSF footprint which may provide suitable fill: the pediment, which forms ridges, and the Gila Conglomerate which forms the foundation for the TSF.

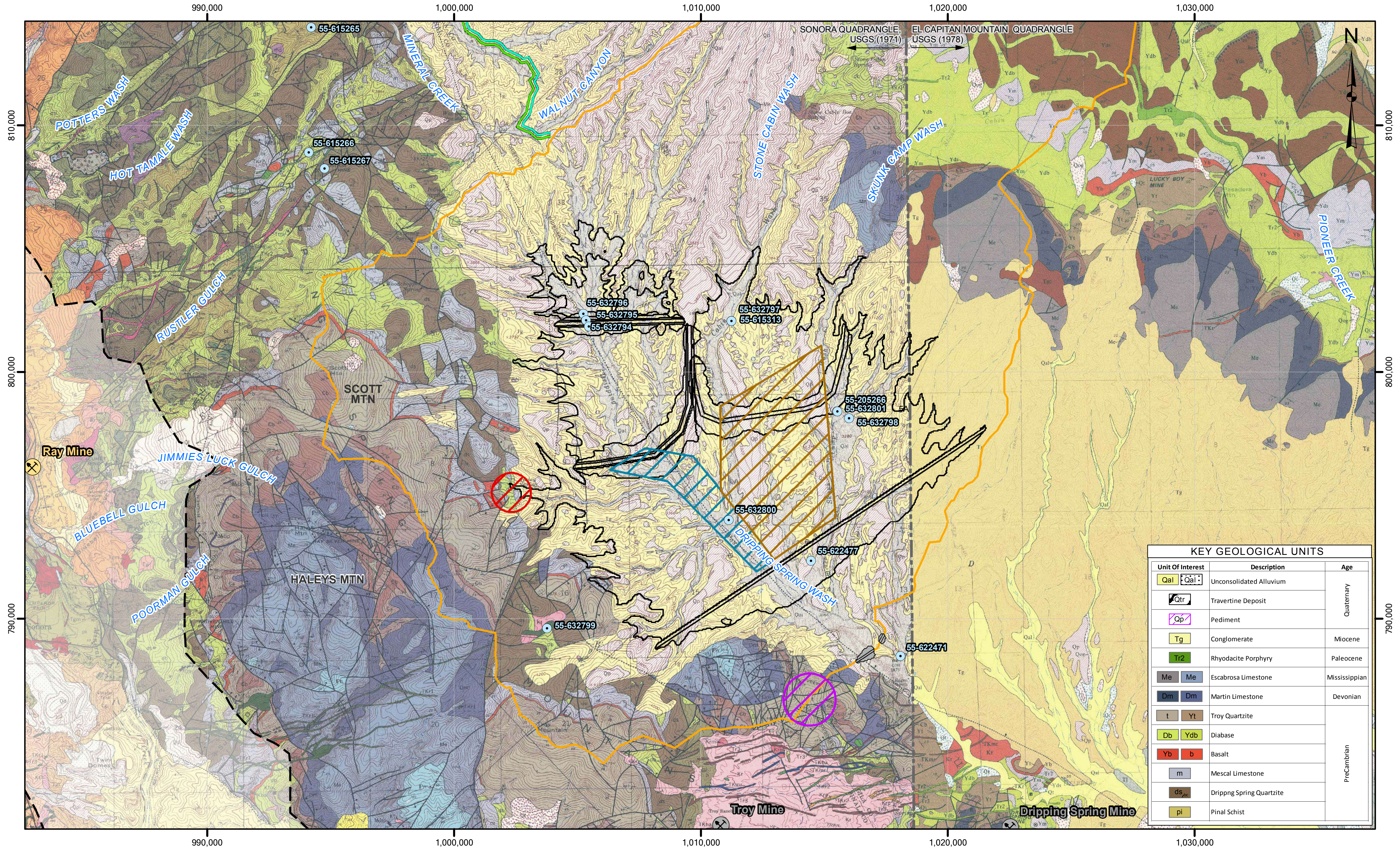
Experience at the West Plant site indicates a surface layer of Gila Conglomerate can be ripped with a dozer, however below approximately 5 ft to 10 ft drilling and blasting is typically required. The pediment material, and alluvium (if appropriate for use) can be easily machine excavated. All of the material must be processed to varying degrees to produce a specified gradation depending on purpose.

A preliminary borrow area has been identified within the scavenger beach area, to provide the added benefit of increased tailings storage (Figure 9.1).

The preferred source of sand and gravel for the blanket drains and underdrains is the alluvial sediments located within the active channels; however, the volume available of suitable material is unknown. If there is a deficit of suitable material, other rock units in the vicinity, such as the diabase, could be quarried and processed as it naturally weathers to sand-sized grains. The suitability of these rock types would be assessed prior to use.

Riprap for erosion protection will be sourced from a Troy Quartz quarry established adjacent to the right abutment of the main dam.

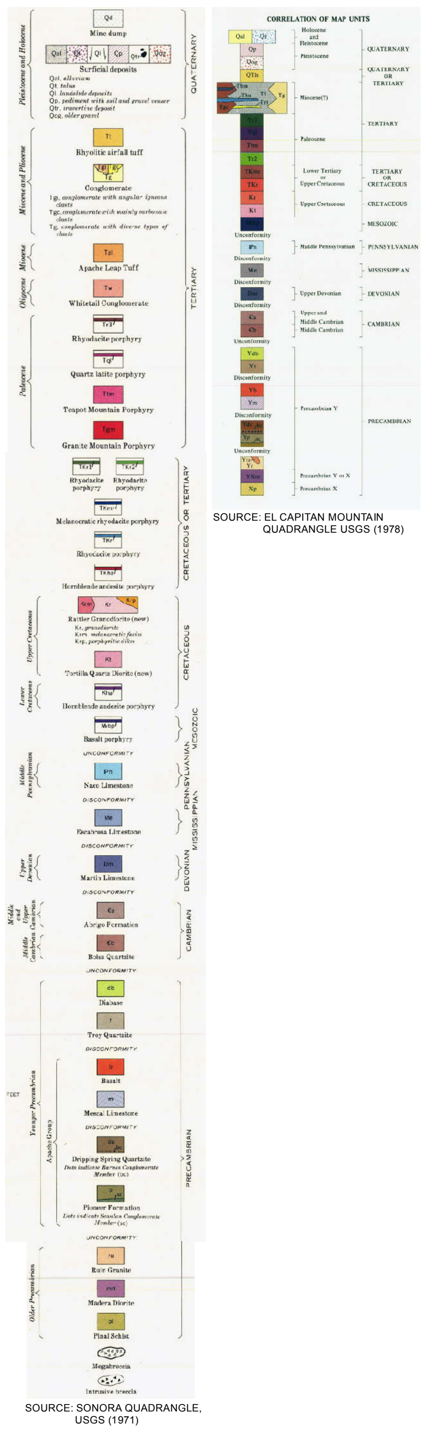
A plan showing preliminary outlines of borrow areas is presented as Figure 9.1.



KEY GEOLOGICAL UNITS

Unit Of Interest		Description	Age
Qal	Qal	Unconsolidated Alluvium	Quaternary
Qtr		Travertine Deposit	Quaternary
Qp		Pediment	Quaternary
Tg		Conglomerate	Miocene
Tr2		Rhyodacite Porphyry	Paleocene
Me	Me	Escabrosa Limestone	Mississippian
Dm	Dm	Martin Limestone	Devonian
t	Yt	Troy Quartzite	PreCambrian
Db	Ydb	Diabase	PreCambrian
Yb	b	Basalt	PreCambrian
m		Mescal Limestone	PreCambrian
ds		Drippng Spring Quartzite	PreCambrian
pi		Pinal Schist	PreCambrian

GEOLOGICAL UNITS



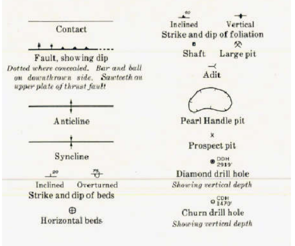
LEGEND

- SKUNK CAMP TAILINGS STORAGE FACILITY
- SEEPAGE COLLECTION DAM
- TSF CATCHMENT
- RAY MINE
- ACTIVE MINE
- HISTORICAL MINE
- SKUNK CAMP TSF - WEST PLANT PIPELINE CORRIDOR NORTH ROUTE
- SKUNK CAMP TSF - WEST PLANT PIPELINE CORRIDOR SOUTH ROUTE

POTENTIAL BORROW AREAS

- POTENTIAL ALLUVIUM BORROW FOR DRAIN MATERIAL
- POTENTIAL DIABASE BORROW FOR DRAIN MATERIAL
- POTENTIAL GILA CONGLOMERATE AND PEDIMENT BORROW FOR GENERAL DAM FILL AND LINER BEDDING MATERIAL
- POTENTIAL TROY QUARTZITE QUARRY FOR RIP RAP

- EXISTING ROAD
- EXISTING RAILWAY
- RIVER OR MAJOR DRAINAGE



NOTES:
1. NAD83, ARIZONA STATE PLANE CENTRAL
2. REFER TO REPORT FOR SOURCE OF GEOLOGY

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0 1 Mile

CLIENT: RESOLUTION COPPER — Klohn Crippen Berger

PROJECT: RESOLUTION COPPER PROJECT DEIS DESIGN FOR ALTERNATIVE 6: SKUNK CAMP

TITLE: BORROW AREAS

PROJECT No. M09441A20

FIG No. 9.1

\\KCB-FS\Projects\M\M09441A20 - RES-Near West PFS-PES\400 Drawings\GIS\Mxd\Reports\SkunkCamp\DEIS\Fig9_1_Borrow_Areas.mxd 2018-08-07 12:17:15 PM

10 PRELIMINARY CLOSURE PLAN

The closure and cover strategy for the facility begins during operations and tailings deposition planning, and continues through to the onset of closure. The primary performance objectives for closure and reclamation of the TSF are to:

- establish a stable landform;
- establish a sustaining vegetated cover system that limits net infiltration and protects surface water runoff quality;
- minimize ponded water on the closed tailings surface;
- promote high levels of saturation of the pyrite tailings to reduce their exposure to atmospheric oxygen during operations (and post-closure by limiting oxygen ingress);
- protect the reclaimed surface against wind and water erosion; and
- provide a growth medium for vegetation establishment and long-term sustainability.

Management during operations of the PAG pyrite tailings and their location within the facility post-closure is important to reducing the risk of Acid Rock Drainage / Metal Leaching (ARD/ML) in tailings seepage. The tailings deposition strategy is to confine the pyrite tailings within the segregated, low-permeability area to minimize contact with water and oxygen.

During operations, the cycloned sand embankments' slopes would be progressively reclaimed as soon as practical. Towards the end of operations, scavenger tailings would be strategically deposited within the southern portion of the pyrite cell to cover the pyrite tailings and promote drainage towards the north (where a closure spillway would be constructed) reducing the area of pyrite tailings that would need to be covered at the end of operations, see Figure 10.1.

At the end of operations, the remainder of Pyrite Cell 2 would be covered with a layer of scavenger tailings while the reclaim pond size is decreased through pumping to the West Plant and active water management. A cover system would be placed over the top of the impoundment surface and be revegetated. The ultimate tailings surface would also be shaped to shed water to a closure spillway (shown on Figure 10.1), so that no permanent ponds would be impounded on the surface.

The downstream slopes of the embankment would be armored and runoff collection channels would be constructed on the slopes to convey surface runoff around the seepage collection pond.

Post closure is separated into three phases for the water balance: active TSF closure, active seepage pond closure, and passive closure.

Phase 1 – Active TSF Closure (Mine Year 42 to 46)

- Remaining unreclaimed embankment slopes are reclaimed (covered and vegetated).
- The tailings beaches are reclaimed (covered and vegetated).

- Pyrite cell is covered with re-slurried hydraulically deposited or mechanically borrowed and placed scavenger tailings. The pond is expected to evaporate within five years. However, if evaporation alone is insufficient, the pond would be pushed to one end of the pyrite cell during cover placement and managed via active water management[5].
- Draindown that collects at the SCP is pumped back to the Pyrite Cell 2 pond while present. The Pyrite Cell 2 and SCP can be managed without discharge through evaporation, except for large storm events (200 yr 24 hr). If evaporation alone is insufficient, the pond would be pushed to one end of the pyrite cell and managed via active water management.
- A closure spillway and diversions are constructed to divert runoff from the natural catchment and reclaimed TSF surfaces around the SCP once practical (assumed to be completed by year five post-closure).

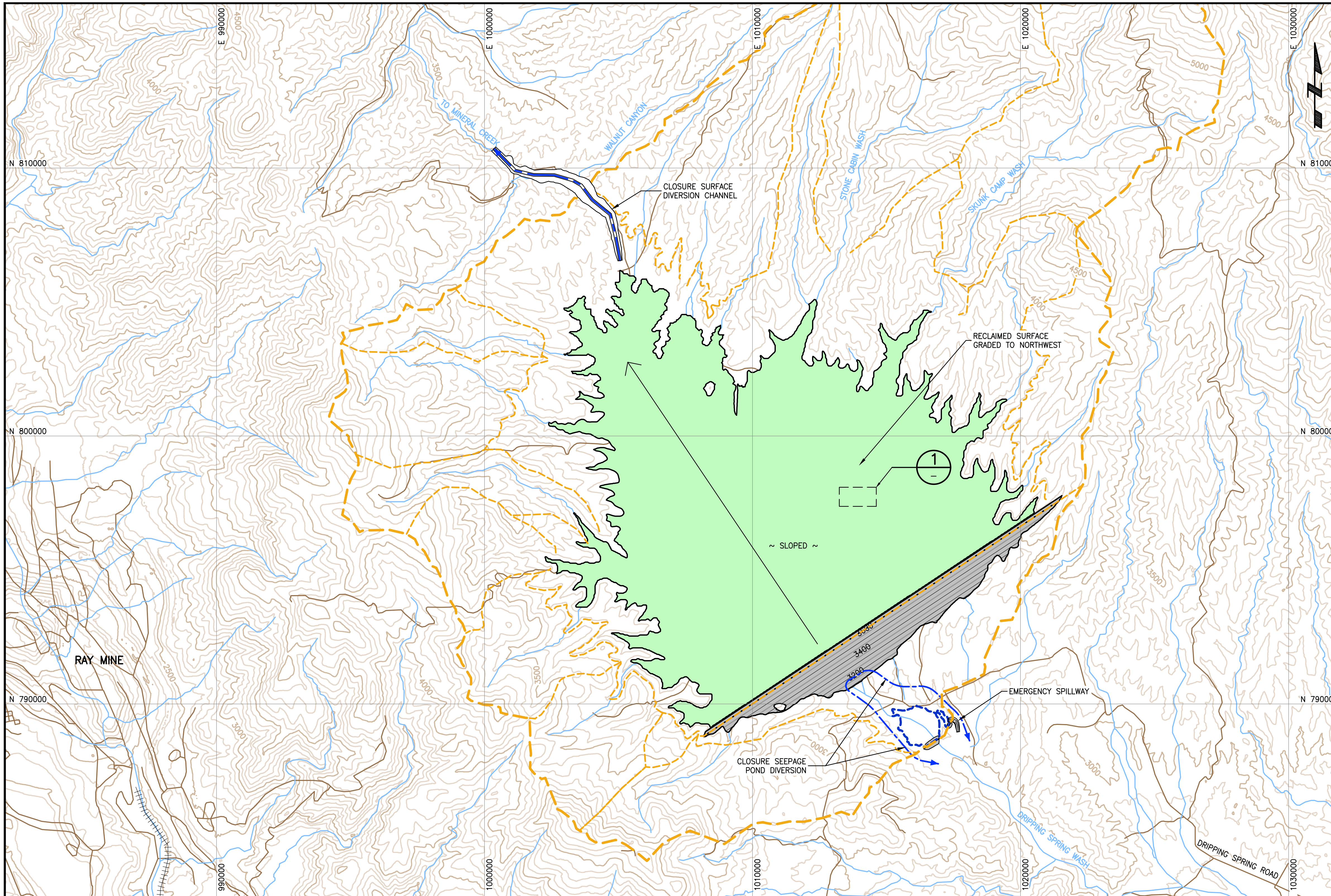
Phase 2 – Active Seepage Pond Closure (Mine Year 47 to 62)

- The closure spillway is commissioned, conveying surface runoff from the tailings surface area north to Mineral Creek.
- Active water management[6] is required to reclaim water from the SCP.

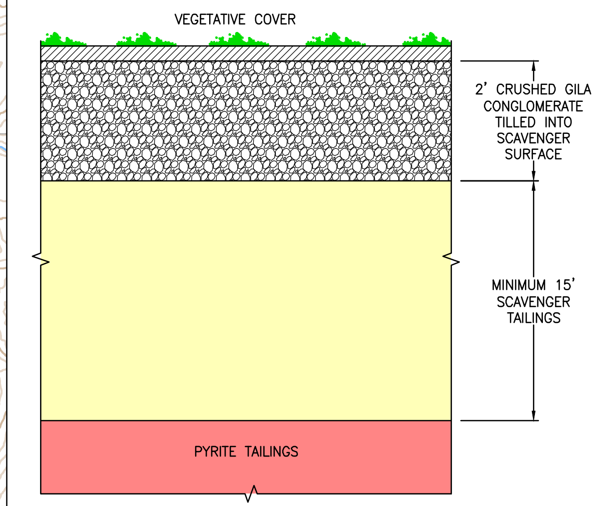
Phase 3 – Passive Closure (Mine Year 62 onwards)

- The SCP is able to passively evaporate all inflows without release, except for large storm events, without the need for active water management after the end of operations.
- If water reporting to the SCP is not suitable for discharge, the collection dams/ponds would remain and passively evaporate the inflows until the seepage quantity is negligible or the seepage quality is suitable for discharge, at which point the SCP would be decommissioned.

[5] Active water management is defined as any required management of water at the seepage collection dams so that the pond does not discharge to the environment below a 200-year 24-hour storm runoff. This can include pumping to another location (e.g. a pond on the tailings surface), treating and releasing to the environment, releasing to the environment directly if the water quality is suitable or using spray evaporators to manage by evaporation.



PLAN
SCALE A



DETAIL 1 TYPICAL PYRITE TAILINGS CLOSURE COVER
N.T.S.

LEGEND

- RECLAIMED EMBANKMENT
- CLOSURE SURAFCE
- CATCHMENT BOUNDARY
- SUB-CATCHMENT BOUNDARY
- DIVERSION CHANNEL – CENTERLINE
- EXISTING ROAD
- PROPOSED ROAD
- NATURAL DRAINAGE

NOTES

1. PROJECTION AND DATUM: ARIZONA STATE PLANE CENTRAL NAD 83 – INTERNATIONAL FOOT.
2. TOPOGRAPHY BASED ON INTERMAP NEXTMAP DSM AND DTM ACQUIRED IN 2004.

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SCALE B: 10 0 10 FT
SCALE A: 2000 0 2000 FT

CLIENT	RESOLUTION COPPER / Klohn Crippen Berger
PROJECT	RESOLUTION COPPER PROJECT DEIS DESIGN FOR ALTERNATIVE 6: SKUNK CAMP
TITLE	CLOSURE PLAN
SCALE	AS SHOWN
PROJECT No.	M09441A20
FIG. No.	10.1

Date: 2018-08-03 Time: 10:51 AM
Drawing File: \\int.klohn.com\ProjData\M\VCR\M09441A20 – RES-Near West PFS-PES\400 Drawings\CAD\Alt 8 Skunk Camp\DEIS\Fig-10.1 – Closure – Plan.dwg – 10.1 (persyem)

KCB-FIG-D-L

11 CLOSING

This report is an instrument of service of Klohn Crippen Berger Ltd. The report has been prepared for the exclusive use of Resolution Copper Mining LLC (Client) for the specific application to the Resolution Copper Project, Skunk Camp Design Study. The report's contents may not be relied upon by any other party without the express written permission of Klohn Crippen Berger. In this report, Klohn Crippen Berger has endeavored to comply with generally-accepted professional practice common to the local area. Klohn Crippen Berger makes no warranty, express or implied.

KLOHN CRIPPEN BERGER LTD.

Joseph Quinn, P.Geo. (AB), Ph.D.
Associate, Senior Engineering Geologist

Robert Cross, P.Eng., P.Geo.
Geotechnical Engineer

Kate Patterson, P.E., M.Eng.
Associate, Project Manager

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APPENDIX I

Design Basis Memorandum

Resolution Copper Project

DEIS Design for Alternative 6 – Skunk Camp

Technical Memorandum

Appendix I – Design Basis Memorandum

DISCLAIMER

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1 INTRODUCTION

1.1 General

This is the design basis memorandum (DBM) for the design of Alternative 6 – Skunk Camp which is one of the tailings storage facility (TSF) design alternatives that Resolution Copper Mining LLC (RC) intends to include in the draft environmental impact statement (DEIS) for the proposed Resolution Copper Project. This TSF is located at the Skunk Camp location on the border of Pinal and Gila Counties, Arizona. The DBM outlines the design objective as well as the design criteria and assumptions. This DBM is considered a “live” document that will be reviewed and updated throughout the design process.

1.2 Design Objective

The objective of the TSF is to store the tailings produced by the proposed Resolution Copper Project. The design incorporates findings from the alternative studies. Limited site specific data has been collected at the site at the time of this study, primarily consisting of regional geological maps, well log information for a small number of wells, and preliminary site reconnaissance visits by RC and KCB staff. This conceptual level design is based on site condition assumptions from similar sites.

The design regulations and guidelines are outlined in Section 1.3, and the design criteria and assumptions are tabulated in Section 2.

The scope of the DEIS design is to provide a basis for comparing impacts from TSF alternatives. The design is tailored to meet United States Forest Service (USFS) requirements for the DEIS.

1.3 Design Regulations and Guidelines

The TSF design is governed and guided by the regulations and guidelines listed below. The general approach adopted in this design is to set the design criteria based on the governing regulations, and then to supplement these regulations with guidelines from international practice where the governing regulations are not specific. Where international guidelines are more stringent than the governing regulations, consideration is also given to the additional measures needed to meet the more stringent guidelines.

Governing

Tailings Storage Facility and Seepage Collection Dams

- Arizona State Legislature. 2016. Arizona Administrative Code (A.A.C.).
  - Title 18. Environmental Quality. Chapter 9: Department of Environmental Quality – Water Pollution Control. Chapter 11: Department of Environmental Quality, Article 1: Water Quality Standards.
  - Arizona State Legislature. 2016. Arizona Revised Statues (A.R.S.).
    - Title 49 – The Environment.

- Regulatory agency: Arizona Department of Environmental Quality (ADEQ).
- Environmental Protection Agency (EPA). Clean Water Act (CWA) - 33 U.S.C. §1251 et seq. (1972).
- Rio Tinto. 2017. D5 – Management of Tailings and Water Storage Facilities.

<u>Seepage Collection Dams (only)</u>

In addition to the above governing regulations, the seepage collection dams are regulated by the Arizona Department of Water Resources (ADWR). The additional application Arizona Administrative Code (A.A.C.) is Title 12. Natural Resources. Chapter 15. Department of Water Resources (A.A.C. R12-15).

Guidance

- Arizona Department of Environmental Quality (ADEQ). 2005. Arizona Mining Guidance Manual BADCT (Best Available Demonstrated Control Technology).
- British Columbia Ministry of Energy and Mines (MEM). 2016. *Health, Safety and Reclamation Code for Mines in British Columbia*.
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- Canadian Dam Association (CDA). 2014. *Technical Bulletin: Application of Dam Safety Guidelines to Mining Dams*.
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- United States Army Corps of Engineers (USACE). 2002. Coastal Engineering Manual. Engineer Manual 1110-2-1100, U.S. Army Corps of Engineers, Washington, D.C. (in 6 volumes).
- United States Army Corp of Engineers (USACE). 2004. *General Design and Construction Considerations for Earth and Rock-Fill Dams. EM 1110-2-2300.*
- United States Army Corp of Engineers (USACE). 2003. *Slope Stability. EM 1110-2-1902.*

1.4 BADCT Approach

The TSF will apply for an Aquifer Protection Permit (APP) with an “individual” Best Available Demonstrated Control Technology (BADCT) approach, which is performance based, and allows the applicant to select from all available Demonstrated Control Technologies (DCTs) that constitute BADCT. This process considers site specific characteristics, operational controls, and other DCTs.

Under the individual BADCT approach, the TSF is considered a “tailings impoundment” and will be designed in accordance with Section 3.5 of the BADCT manual (ADEQ 2005). The seepage pond is considered to be a “surface pond” and will be designed in accordance with Section 3.6 of the BADCT manual (ADEQ 2005) and the regulations pertaining to water dams (A.A.C. R12-15).

2 DESIGN CRITERIA

Table 2.1 Design Criteria

	Item	Design Criteria	Reference
1.0	**Tailings Storage Facility (TSF) Embankment Design**		
1.01a	CDA Consequence Classification	To be confirmed following inundation study, which will be completed in a later design stage.	▪ CDA (2007a)
1.01b	Rio Tinto Risk Category	Class IV (considered Class IV until all necessary mitigations have been included in design)	▪ D5 Standard (Rio Tinto 2017)
1.02	Storage capacity	Capacity to store all NPAG scavenger (scavenger) and PAG pyrite (pyrite) tailings production	▪ RC requirement
1.03	Downstream slope	▪ No steeper than 2H:1V	▪ MEM (2016)
1.04	Minimum Factor of Safety	▪ Static (upstream or downstream) – 1.5 (during operation and long term) ▪ Liquefied/post-cyclic – 1.2 ▪ Rapid drawdown – N/A	▪ BADCT (ADEQ 2005) supplemented with MEM (2016) ▪ D5 Rio Tinto (2017) ▪ CDA (2007a) ▪ N/A
1.05	Deformations (seismic or static, e.g. settlement)	▪ For cases with no liquefiable materials, horizontal seismic coefficient for pseudo-static analysis = 0.6 x Peak ground acceleration (PGA). This seismic coefficient is selected to maintain consistency with the requirements of the seepage collection dams, as per A.A.C R12-15-1216. ▪ For elements of the TSF sensitive to deformation, a simplified deformation analysis is required. ▪ Predicted deformations shall not jeopardize containment integrity (e.g. does not reduce freeboard sufficiently to lead to an uncontrolled release of fluid tailings, does not impact the functionality of the drains, etc.).	▪ BADCT (ADEQ 2005) ▪ D5 Rio Tinto (2017)
1.06	Seismicity	▪ Maximum Credible Earthquake (MCE). Earthquake design ground motions will be selected in future design stages for appropriate return period events.	▪ BADCT (ADEQ 2005) supplemented with MEM (2016), CDA (2014), D5 Rio Tinto (2017) and industry practice
1.07	Pond Storage Capacity	See Figure 2.1 Storage capacity = minimum operating volume + maximum average seasonal volume + volume required for operational upset + volume for critical duration storm event including sediment (Environmental Design Flood and Inflow Design Flood) + volume required for "dry" freeboard (Table 2.1, Item 1.11)	▪ BADCT (ADEQ 2005)

Table 2.1 Design Criteria (cont'd)

	Item	Design Criteria	Reference
1.08	Storage Volume for Operational Upset Conditions	RC to confirm after RC internal risk audit and to be updated in next stage of design.	
1.09	Environmental Design Flood (EDF)	Minimum requirement for BADCT is 100-year 24 hr. Design will assume 200-year 24 hr; EDF will be confirmed through water balance and water quality modeling.	▪ BADCT (ADEQ 2005)
1.10	Inflow Design Flood (IDF) For Dam Safety	<u>Return Period:</u> Probable Maximum Flood (PMF) <u>Duration:</u> For individual BADCT, the facility-specific critical design storm duration is established by considering several durations and determining which results in the maximum required storage capacity to contain the design flood volume. Therefore, the duration will be confirmed during the flood routing and water balance calculations: ▪ with a spillway: spillway sized for the critical duration of 6 hr to 72 hr; and ▪ without a spillway: minimum of 72 hr (to be confirmed based inflows and discharge rates).	▪ BADCT (ADEQ 2005) ▪ FEMA (2013) ▪ MEM (2016) ▪ D5 Rio Tinto (2017)
1.11	"Dry" Freeboard	▪ Wind and wave run-up + 2 ft ▪ Wind event annual exceedance probability = 2-year ▪ Wave height and run-up to be calculated using industry standard methods ▪ Earthquake-induced settlements of the embankment crest to be assessed and included in minimum freeboard determination	▪ BADCT (ADEQ 2005) ▪ CDA (2007b) ▪ USACE (2002)
1.12	Beach length	Will become part of the Quantitative Performance Objectives (QPO) ▪ Sufficient to achieve seepage and hydraulic gradient criteria during normal operations and periods of flood storage. ▪ Sufficient to provide a secondary defense against loss of fluid tailings in the event of downstream slope displacement.	
1.13	Seepage	Water quality requirements at the point of compliance are to be assessed.	▪ BADCT (ADEQ 2005), Clean Water Act (EPA) and Arizona State Legislature (A.A.C. R18-11)
1.14	Drains	▪ Provide drains/filters satisfying USACE (2004) guidelines to mitigate potential for internal erosion. ▪ Drains designed to maintain phreatic surface to acceptable levels within the embankment with adequate safety factor to account from clogging and uncertainty.	▪ USACE (2004)

Table 2.1 Design Criteria (cont'd)

	Item	Design Criteria	Reference
1.15	Construction and Operations	▪ Quantifiable performance objectives to be defined prior to construction. ▪ All construction and borrow materials with contingency to be defined prior to construction.	▪ MEM (2016)
1.16	Closure	Planned closure landscape is to be a physically stable landform without a permanent water pond that meets point of compliance criteria.	▪ D5 Rio Tinto (2017)
1.17	Closure Surface Diversions	The design criteria will be selected based on consequence of failure, e.g. impact on other structures or environment.	▪ BADCT (ADEQ 2005) ▪ D5 Rio Tinto (2017)
1.18	External Erosion Protection	The design criteria will be selected based on consequence of failure, e.g. impact to structural zones, containment, other structures or the environment. BADCT requires, at a minimum, that if the TSF is within the 100-year flood plain, drainage controls must be designed to protect the TSF from damage or flooding for 100-year peak streamflows.	▪ BADCT (ADEQ 2005)
2.0	**Seepage Collection Pond (and associated Dam(s))**		
2.01	Assumed downstream hazard classification for the dam	High (to be confirmed in future design stages)	▪ A.A.C R12-15-1216
2.02	Downstream slope	As per Table 2.1, item 1.03	
2.03	Stability Factor of Safety (FOS)	▪ End of construction – Static (upstream or downstream) – 1.3 (≤ 50 ft high), 1.4 (> 50 ft high) ▪ Steady state seepage – Static – 1.5 ▪ Rapid drawdown – 1.2	▪ A.A.C R12-15-1216 ▪ D5 Rio Tinto (2017)
2.04	Deformations (seismic or static, e.g. settlement)	▪ Pseudo-static – FOS = 1.0 with horizontal seismic coefficient = 0.6 x Peak ground acceleration. ▪ As per Table 2.1, item 1.05, where elements are sensitive to deformations, a simplified deformation analysis will be conducted to identify the potential displacements for comparison with allowable deformations for that element. ▪ Predicted deformations shall not jeopardize containment integrity (e.g. does not impact the integrity of the dam core or the spillway, etc.)	▪ A.A.C R12-15-1216 and BADCT (ADEQ 2005) ▪ D5 Rio Tinto (2017)
2.05	Seismicity	▪ MCE, assumed to be mean 1:10,000 year return period: ♦ Sensitivity to 95th percentile to be considered	▪ A.A.C R12-15-1216 supplemented with MEM (2016) and CDA (2007a) ▪ D5 Rio Tinto (2017)
2.06	Pond Storage Capacity	See Table 2.1, item 1.07	
2.07	Storage Volume for Operational Upset Conditions	One week of average seepage and precipitation to account for a period of pump shut-down	

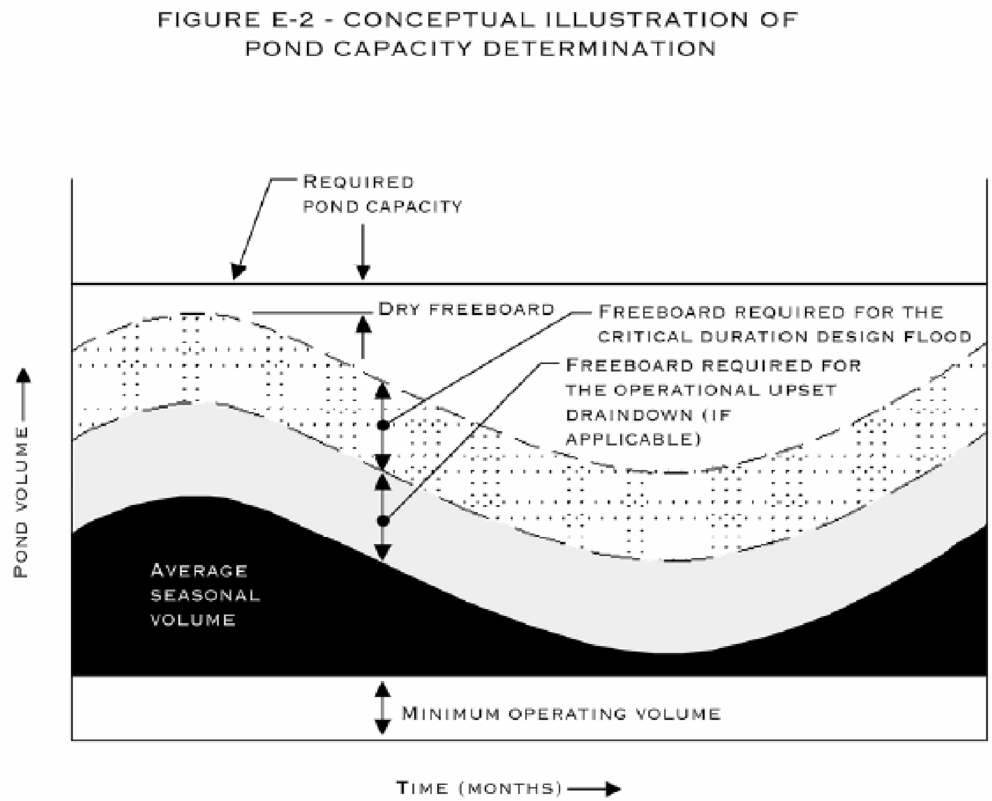
Table 2.1 Design Criteria (cont'd)

	Item	Design Criteria	Reference
2.08	Environmental Design Flood (EDF)	Minimum requirement for BADCT is 100-year 24 hr. TSF design will assume 200-year 24 hr; EDF will be confirmed through water balance and water quality modeling.	▪ BADCT (ADEQ 2005)
2.09	Inflow Design Flood (IDF) For Dam Safety	Storm to be routed through spillway - Probable Maximum Flood (PMF) <u>BADCT:</u> <u>Return Period:</u> if failure of dam would pose an imminent risk to human life and/or high downstream incremental consequences the PMF should be used. <u>Duration:</u> For individual BADCT, the facility-specific critical design storm duration is established by considering several durations and determining which results in the maximum required storage capacity to route the design flood volume. The range of storm duration to be considered are 6 hr to 72 hr. <u>A.A.C R12-15-1216:</u> For a high hazard potential dam, the applicant shall design the dam to withstand an inflow design flood that varies from .5 PMF to the full PMF, with size increasing based on persons at risk and potential for downstream damage. The applicant shall consider foreseeable future conditions. <u>FEMA (2013):</u> PMF for a dam classified as high hazard.	▪ BADCT (ADEQ 2005) ▪ A.A.C R12-15-1216 ▪ D5 Rio Tinto (2017) ▪ FEMA (2013)
2.10	Freeboard	Largest of: ▪ IDF + wave run up with a critical wind annual exceedance probability of the 1 in 2 year event ▪ IDF + 3 ft ▪ 5 ft	▪ A.A.C R12-15-1216 with consideration from CDA (2007b)
2.11	Low level outlet (or discharge - pump)	Can discharge 90% of storage volume within 30 days (minimum capacity).	▪ A.A.C R12-15-1216
2.12	Seepage	See Table 2.1, item 1.13	
2.13	Drains	▪ Provide core and drains/filters satisfying USACE (2004) guidelines to limit potential for internal erosion. ▪ Drains designed to maintain phreatic surface to acceptable levels within the embankment with adequate safety factor to account from clogging and uncertainty.	▪ BADCT (ADEQ 2005), USACE (2004) and A.A.C R12-15-1216
2.14	Crest width	Minimum of dam height (centerline) divided by 5, plus 5 ft. Minimum crest width = 12 ft, maximum crest width = 25 ft.	▪ A.A.C R12-15-1216

Table 2.1 Design Criteria (cont'd)

	Item	Design Criteria	Reference
2.15	Erosion protection	Well graded, durable riprap, sized to withstand wave action, placed on a well graded pervious sand and gravel bedding or geotextile with filtering capacity suitable for the site.	▪ A.A.C R12-15-1216
2.16	External Erosion Protection	The design criteria will be selected based on consequence of failure, e.g. impact on other structures or environment. (BADCT requires, at a minimum, that if the TSF is within the 100-year flood plain, drainage controls must be designed to protect the TSF from damage or flooding for 100-year peak streamflows.)	▪ BADCT (ADEQ 2005)

Figure 2.1 Pond Capacity Determination (ADEQ 2005)



3 DESIGN BASIS

Table 3.1 Design Assumptions, Constraints & Data Sources

	Item	Design Basis	Comments
1.0	**General Design Basis**		
1.01	TSF location	▪ Skunk Camp site, Pinal & Gila Counties, Arizona ▪ State land and private land ▪ Coordinates (Arizona State Plane Central NAD83): 920,000’ E, 880,000’ N	
1.02	Mine Flow Sheet	Selective	
1.03	Mine life	41 years	Received from RC; email dated December 12, 2018
1.04	TSF operating life	41 years	Received from RC; email dated December 12, 2018
1.05	Tailings types	Two types of tailings are produced: ▪ scavenger tailings (84% of total weight); and ▪ pyrite tailings (16% of total weight).	Received from RC; email dated December 12, 2018
1.06	Tailings technology	Thickened slurry (scavenger and pyrite tailings). Cycloning.	
1.07	Tailings delivery	See process schematic (Figure 3.1)	
1.08	Total tailings production	1.37 billion short tons	Received from RC; email dated December 12, 2018
1.09	Ore and tailings production schedule	Table 3.2	
1.10	Units	U.S. Customary	
1.11	Embankment raise methodology	Hydraulically placed cycloned sand using centerline raised methodology for the Main Embankment Hydraulically placed cycloned sand using downstream-raised methodology for the Pyrite Cell Embankments See Figure 3.2	
1.12	Cycloned sand availability	Cycloned Sand Recovery: 45% Cyclone uptime: 50% (Year 1-2); 70% (Year 3-5); 80% (Year 6-41) Cycloned sand retention in hydraulic cells: 90%	Lower bound recovery from Krebs simulations (dated January 10, 2018)
2.0	**Topography**		
2.01	Projection	Arizona State Plane Central	
2.02	Datum	NAD83	
2.03	Unit of measurement	U.S. Customary	

Table 3.1 Design Assumptions, Constraints & Data Sources (cont'd)

<table>
<tr><th></th><th>Item</th><th>Design Basis</th><th>Comments</th></tr>
<tr><td>3.0</td><td>Seismicity</td><td></td><td></td></tr>
<tr><td>3.01</td><td>Ground Motions</td><td>Not considered in analysis at this stage of design (refer to Table 3.1, Item 6.02).</td><td></td></tr>
<tr><td>4.0</td><td>Climate and Hydrology</td><td></td><td></td></tr>
<tr><td>4.01</td><td>Average precipitation (in inches)</td><td><table><tr><th>J</th><th>F</th><th>M</th><th>A</th><th>M</th><th>J</th><th>J</th><th>A</th><th>S</th><th>O</th><th>N</th><th>D</th><th>Total</th></tr><tr><td>1.5</td><td>2.0</td><td>2.0</td><td>0.7</td><td>0.3</td><td>0.4</td><td>3.1</td><td>2.5</td><td>1.4</td><td>1.6</td><td>2.2</td><td>1.4</td><td>19.0</td></tr></table></td><td>Based on elevation-precipitation correlation of regional climate stations; Superior (ID: 028348), Miami (ID: 025512), Kearny (ID: 024590), San Carlos Reservoir (ID: 027480), Roosevelt 1 WNW (ID: 027281) and Oracle 2 SE (ID: 026119).
Confirmed with regional estimate from Arizona Water Atlas.</td></tr>
<tr><td>4.02</td><td>Wet and dry year precipitations</td><td>Consideration to wet and dry years for the water balance will not be made at this stage of design.</td><td></td></tr>
<tr><td>4.03</td><td>Average annual pan evaporation</td><td>91.3 in</td><td>Pan evaporation data collected at the San Carlos Reservoir climate station (ID: 027480)</td></tr>
<tr><td>4.04</td><td>Evapotranspiration for reference surface/crop (in inches)</td><td><table><tr><th>J</th><th>F</th><th>M</th><th>A</th><th>M</th><th>J</th><th>J</th><th>A</th><th>S</th><th>O</th><th>N</th><th>D</th><th>Total</th></tr><tr><td>2.9</td><td>3.4</td><td>5.0</td><td>6.6</td><td>8.5</td><td>9.2</td><td>9.0</td><td>8.0</td><td>7.0</td><td>5.8</td><td>3.8</td><td>3.1</td><td>72.3</td></tr></table></td><td>Calculated using the Penman-Monteith combined equation in Hydrus1D based on the generated Superior climate data set and reference vegetation parameters.</td></tr>
<tr><td>4.05</td><td>Natural catchment runoff coefficient</td><td>0.15</td><td>Calculated by dividing the average annual runoff from the nearby USGS hydromet station by the average annual precipitation at site (KCB 2014).</td></tr>
<tr><td>4.06</td><td>Probable Maximum Precipitation (PMP)</td><td><table><tr><th rowspan="2">Storm Type</th><th colspan="3">PMP Depth (inches)</th></tr><tr><th>6 hour Duration</th><th>24 hour Duration</th><th>72 hour Duration</th></tr><tr><td>General Winter</td><td>5.2</td><td>9.7</td><td>14.9</td></tr><tr><td>Tropical</td><td>11.8</td><td>16.6</td><td>22.1</td></tr><tr><td>Local</td><td>11.7</td><td>-</td><td>-</td></tr></table></td><td>Applied Weather Associates PMP Evaluation Tool.
Determined as the critical storm for design.
For the Skunk Camp site catchment.</td></tr>
<tr><td>4.07</td><td>Runoff coefficient during storm events</td><td>1.0</td><td>To account for high antecedent moisture conditions and the predominantly exposed rock in the catchment</td></tr>
<tr><td>4.08</td><td>Extreme point precipitation depths</td><td>See Table 3.3</td><td>From NOAA Atlas 14 (NOAA 2018).</td></tr>
</table>

Table 3.1 Design Assumptions, Constraints & Data Sources (cont'd)

	Item	Design Basis		Comments
5.0	**Tailings Characteristics and Deposition**			
		Scavenger Tailings	**Pyrite Tailings[1]**	
5.01	Target gradation produced at mill	*"Total" Tailings:* Target P80 = 160 microns 50% fines (<74 microns) <10% clay (<2 microns)	Target P80 = 75 to 80 microns 80% fines (<74 microns) <20% clay (<2 microns)	See Figure 3.3
5.02	Target gradation produced by cyclones	*Cycloned Sand (Underflow)*: Target P80 = 200 microns <20 % fines (<74 microns) 0% clay (<2 microns) *Cyclone Overflow:* Target P80 = 60 microns 90% fines (<74 microns) 15% clay (<2 microns)	N/A	See Figure 3.3. Target fines content for cycloned sand to be less than 20%, based on seepage performance and constructability from other cycloned sand embankment case histories.
5.03	Specific gravity	2.78	3.87	Average values from KCB laboratory testing programs on scavenger "total" tailings and cleaner tailings.
5.04	Solids content pumped from the mill	60%	50%	Provided by RC
5.05	Cyclone solids content	*Cyclone Feed:* 35% *Cyclone Overflow:* 25% *Cycloned Sand:* 70%	N/A	From most recent Krebs simulations (dated January 10, 2018) for "average" case. Cyclone overflow and cycloned sand solids content adjusted from the "average" simulation to account for the reduced cyclone recovery (see Table 3.1, Item 1.12).

[1] Previous tailings characterization was based on the Bulk Flowsheet which produced cleaner tailings as an end-product. However, RC updated their preferred process flow sheet to the Selective Flowsheet in 2012, which produces "pyrite tailings" as the end-product instead of "cleaner tailings". In the Selective Flowsheet, the scavenger tailings are further desulfurized. The cleaner tailings and the scavenger concentrate de-sulfurization by-product are combined to produce pyrite tailings. Further laboratory testing to characterize the scavenger and pyrite tailings from the Selective Flowsheet has been proposed and will be completed in future designs. For the purposes of this study, it is assumed that the cleaner tailings and pyrite tailings are physically and geochemically similar.

Table 3.1 Design Assumptions, Constraints & Data Sources (cont'd)

	Item	Design Basis		Comments
5.06	Solids content discharged into TSF	*"Total" Tailings:* 60% *Cyclone Overflow:* 60% *Cycloned Sand:* 60%	50%	Cycloned sand solids content based on case history data and construction performance at other large cycloned sand embankments that use hydraulic cell construction. To be confirmed from ongoing rheology testing.
5.07	Liquefaction assumption	All potentially liquefiable tailings will liquefy at the TSF, regardless of triggering mechanism.		
5.08	Pyrite tailings management	N/A	Subaqueous deposition	
5.09	Tailings beach slopes (above water)	1% within 1,500 ft of discharge point, 0.5% thereafter	N/A	Scavenger Tailings - Based on topography and bathymetry surveys from two large, cycloned sand impoundment beaches and slopes below water. These facilities have long exposed beaches, up to five miles. Pyrite Tailings - Based on topography and bathymetry surveys of subaqueous disposal of high-pyrite tailings from floating barges. To be reviewed in future design stages.
5.10	Tailings beach slopes (below water)	2.5% within 1,000 ft of water's edge; 1.0% thereafter	10% within 100 ft of discharge point; 0.5% thereafter	
5.11	Dry beach runoff coefficient	0.15	N/A	Estimated based on Hydrus1D infiltration modeling
5.12	Dry density for staging assessment	*Interlayered "Total" Tailings and Cyclone Overflow (Composite Beach):* 75 pcf (first 5 years of operations); 81 pcf (remaining years of operations) *Cycloned Sand (compacted):* 113 pcf	106 pcf	KCB (2018)

Table 3.1 Design Assumptions, Constraints & Data Sources (cont'd)

	Item	Design Basis	Comments
6.0	**Tailings Storage Facility (TSF) Impoundment Design**		
6.01	Design criteria	As per Table 2.1.	
6.02	Stability	Embankment section (Figure 3.2) assumed to meet design stability criteria for DEIS	Based on preliminary stability analyses reported in KCB (2017a) and typical assumed foundation conditions for the Near West site (KCB 2017b)
6.03	Main Embankment Crest width	100 ft	Sufficient to accommodate 2-way vehicle traffic, pipelines and any other equipment required to be on the crest (e.g. cyclones).
6.04	Main Embankment Downstream Slope	3H:1V (see Figure 3.2)	
6.05	Main Embankment Upstream Slope	vertical slope (centerline raise; see Figure 3.2)	
6.06	Main Embankment Crest width	100 ft	
6.07	Pyrite Saddle Embankment Slopes	2.5H:1V	
6.08	Engineered Low-permeability Layer	Pyrite cell: Engineered low-permeability layer[2] beneath the cell, and extended on the upstream dam face to separate from scavenger tailings Scavenger area: foundation treatment to control seepage	Layout and design details to be confirmed in later design stages
6.09	Drainage	Sand and gravel drainage blanket in the embankment footprint; gravel/rockfill finger drains in existing drainage channels in the embankment footprint	Layout and design details to be confirmed in later design stages

[2] The engineered low-permeability layer could be comprised of one or more of the following: compacted fine tailings, geomembrane liner, asphalt, slurry bentonite, and/or cemented paste tailings

Table 3.1 Design Assumptions, Constraints & Data Sources (cont'd)

	Item	Design Basis	Comments
6.10	Closure	TSF Surfaces: slope, cover and revegetate to shed water, limit infiltration, limit erosion and return the landscape to a similar condition prior to mining. Pyrite management: limit oxygen ingress through subaqueous deposition, cover and encourage saturation of the pyrite tailings in the long term (i.e. after removal of the pond).	Approach agreed by RC
7.0		**Pond Management**	
7.01	Pond Management	▪ No permanent water pond in the scavenger tailings area; permanent pond maintained in the pyrite cell. Ponded water on the scavenger tailings surfaces will be collected and transferred to the pyrite cell.	
7.02	Minimum operating pond volume	▪ Minimum amount to keep pyrite tailings saturated and provide operating pond depth.	
7.03	Minimum operating pond depth	▪ Seepage Collection Dam: 0 ft (could be accounted for by a sump or other means). ▪ Minimum Water Cover above Maximum Tailings El. in pyrite cell: 10 ft	Preliminary allowances; to be confirmed in later design stages based on seepage collection pond and deposition barge design

Table 3.2 Mine and Tailings Production Schedule

Description	Year	Mine Year	Modeling Year	Tailings Tonnage (tons/year)		
				Scavenger	Pyrite	Total
Care and Maintenance	2017	-	1	-	-	-
Care and Maintenance	2018	-	2	-	-	-
Care and Maintenance	2019	-	3	-	-	-
Care and Maintenance	2020	-	4	-	-	-
Construction	2021	-	5	-	-	-
Construction	2022	-	6	-	-	-
Construction	2023	-	7	-	-	-
Construction	2024	-	8	-	-	-
Construction	2025	-	9	-	-	-
Construction	2026	-	10	-	-	-
Construction	2027	-	11	-	-	-
First Ore	2028	1	12	5,346,486	766,631	6,113,118
Ramp up	2029	2	13	7,187,504	991,640	8,179,144
Ramp up	2030	3	14	7,897,945	1,014,556	8,912,501
Ramp up	2031	4	15	15,085,826	2,110,526	17,196,352
Ramp up	2032	5	16	21,902,288	3,328,288	25,230,577
Ramp up	2033	6	17	28,780,765	4,569,518	33,350,283
Ramp up	2034	7	18	34,178,734	5,793,075	39,971,810
Full Production	2035	8	19	37,849,588	7,340,459	45,190,047
Full Production	2036	9	20	37,128,274	8,184,034	45,312,308
Full Production	2037	10	21	36,749,978	8,772,867	45,522,845
Full Production	2038	11	22	37,121,210	8,792,910	45,914,120
Full Production	2039	12	23	38,040,923	8,019,027	46,059,950
Full Production	2040	13	24	37,486,298	6,800,935	44,287,232
Full Production	2041	14	25	39,582,789	6,518,836	46,101,626
Full Production	2042	15	26	39,666,729	6,589,905	46,256,634
Full Production	2043	16	27	39,211,923	6,919,174	46,131,097
Full Production	2044	17	28	38,679,739	7,360,739	46,040,478
Full Production	2045	18	29	38,273,841	7,838,027	46,111,868

Table 3.2 Mine and Tailings Production Schedule (cont'd)

Description	Year	Mine Year	Modeling Year	Tailings Tonnage (tons/year)		
				Scavenger	Pyrite	Total
Full Production	2046	19	30	38,130,733	8,150,877	46,281,610
Full Production	2047	20	31	38,448,597	7,968,471	46,417,068
Full Production	2048	21	32	38,926,908	7,537,946	46,464,854
Full Production	2049	22	33	39,028,952	7,382,565	46,411,517
Full Production	2050	23	34	39,006,219	7,367,901	46,374,120
Full Production	2051	24	35	38,564,309	7,824,341	46,388,650
Full Production	2052	25	36	38,008,651	8,406,901	46,415,552
Full Production	2053	26	37	37,822,090	8,629,862	46,451,952
Full Production	2054	27	38	38,599,981	7,902,469	46,502,450
Full Production	2055	28	39	39,472,443	6,988,070	46,460,513
Full Production	2056	29	40	39,579,974	6,796,869	46,376,843
Full Production	2057	30	41	39,595,841	6,786,681	46,382,522
Full Production	2058	31	42	39,503,382	6,740,343	46,243,725
Ramp Down	2059	32	43	31,481,866	5,391,484	36,873,350
Ramp Down	2060	33	44	24,576,943	4,320,111	28,897,054
Ramp Down	2061	34	45	18,707,166	3,478,519	22,185,685
Ramp Down	2062	35	46	13,146,108	2,643,079	15,789,186
Ramp Down	2063	36	47	9,566,562	1,952,428	11,518,989
Ramp Down	2064	37	48	4,993,554	1,079,281	6,072,835
Ramp Down	2065	38	49	2,121,484	545,241	2,666,725
Ramp Down	2066	39	50	928,110	274,819	1,202,929
Ramp Down	2067	40	51	326,877	99,724	426,602
Ramp Down	2068	41	52	19,505	4,936	24,440
Closure	2069	-	53	-	-	-
			TOTAL TAILINGS	**1,150,727,095**	**219,984,066**	**1,370,711,161**

Notes: Tailings production schedule supplied by Resolution Copper in an email dated December 12, 2017.
Mine plan descriptions, mine years and modeling years supplied by Resolution Copper in an email dated January 12, 2018.

Table 3.3 Precipitation Depth-Duration-Frequency Estimates for the TSF

Average Recurrence Interval (years)	5 min	10 min	15 min	30 min	60 min	2 hr	3 hr	6 hr	12 hr	24 hr	2 day	3 day	4 day	7 day	10 day	20 day	30 day	45 day	60 day
Precipitation in inches																			
1	0.3	0.4	0.5	0.7	0.9	1.0	1.0	1.3	1.6	2.0	2.3	2.5	2.7	3.1	3.4	4.3	5.2	6.2	7.2
2	0.4	0.5	0.7	0.9	1.1	1.3	1.3	1.6	2.0	2.5	2.9	3.2	3.4	3.9	4.3	5.5	6.6	7.8	9.1
5	0.5	0.7	0.9	1.2	1.5	1.7	1.7	2.0	2.4	3.1	3.7	4.1	4.4	5.1	5.5	7.0	8.4	10.0	11.5
10	0.6	0.9	1.1	1.4	1.8	2.0	2.0	2.4	2.8	3.6	4.4	4.8	5.3	6.1	6.6	8.3	9.9	11.7	13.3
25	0.7	1.0	1.3	1.7	2.1	2.4	2.5	2.8	3.4	4.3	5.3	5.9	6.5	7.6	8.1	10.0	12.0	14.0	15.8
50	0.8	1.2	1.5	2.0	2.4	2.7	2.8	3.2	3.8	4.9	6.0	6.7	7.4	8.8	9.3	11.4	13.6	15.8	17.7
100	0.9	1.3	1.6	2.2	2.7	3.0	3.2	3.6	4.2	5.5	6.8	7.6	8.5	10.1	10.7	12.9	15.3	17.6	19.6
200	0.9	1.4	1.8	2.4	3.0	3.3	3.5	3.9	4.6	6.1	7.6	8.6	9.6	11.6	12.1	14.4	17.1	19.5	21.6
500	1.1	1.6	2.0	2.7	3.4	3.8	4.0	4.4	5.2	6.9	8.8	10.0	11.2	13.7	14.2	16.5	19.5	22.1	24.2
1000	1.2	1.8	2.2	3.0	3.7	4.1	4.4	4.8	5.6	7.6	9.7	11.1	12.5	15.5	16.0	18.2	21.5	24.2	26.2

Note: From NOAA Atlas 14 (NOAA 2018) for the Skunk Camp site.

Figure 3.1 Process Schematic

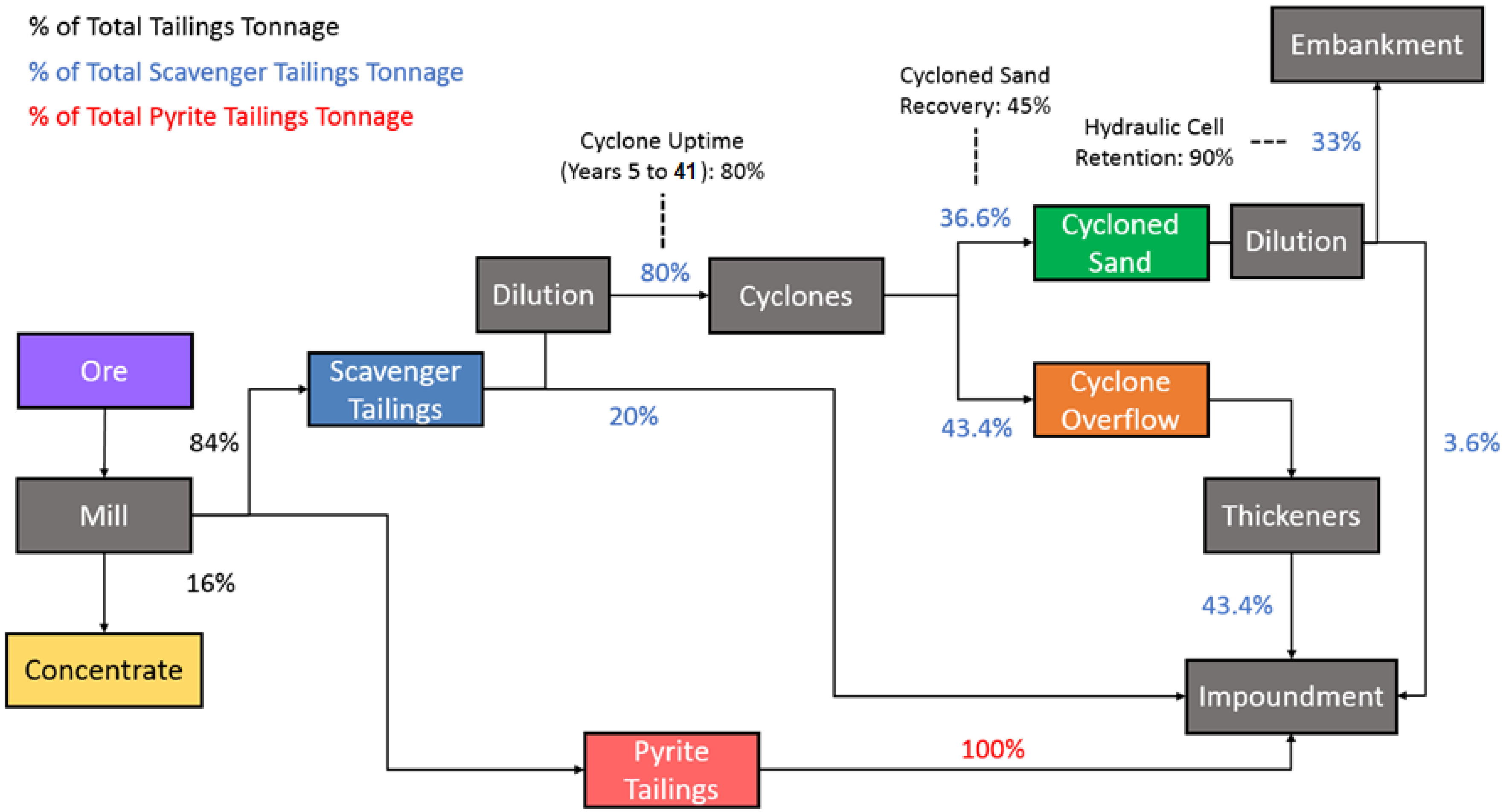
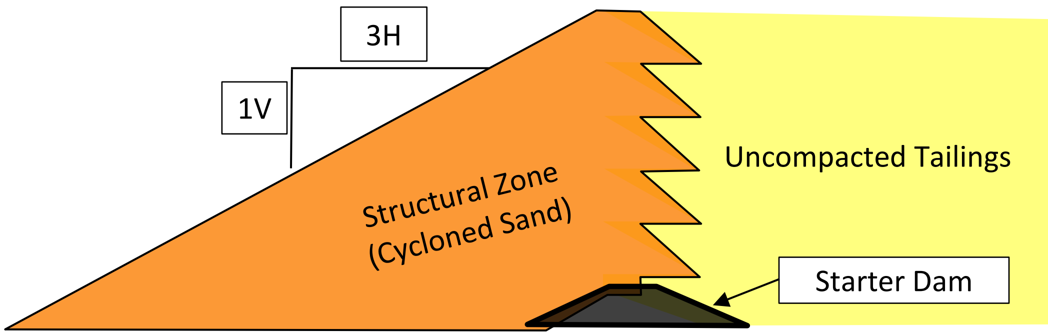


Figure 3.2 Embankment Centerline Raise and Embankment Design Schematic



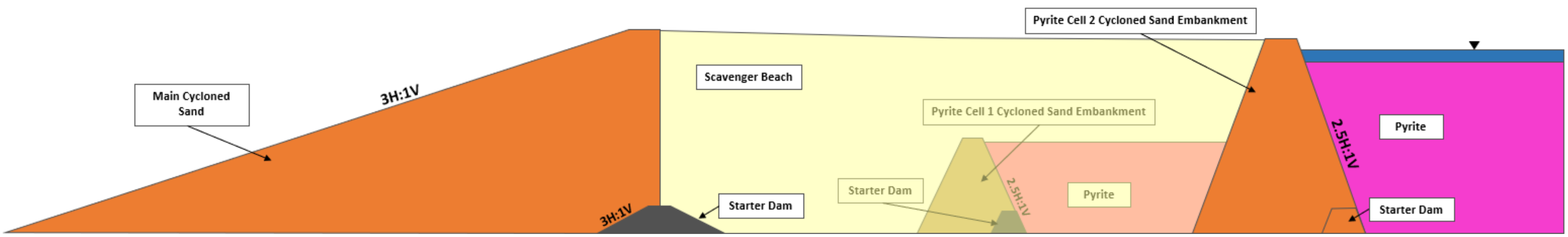
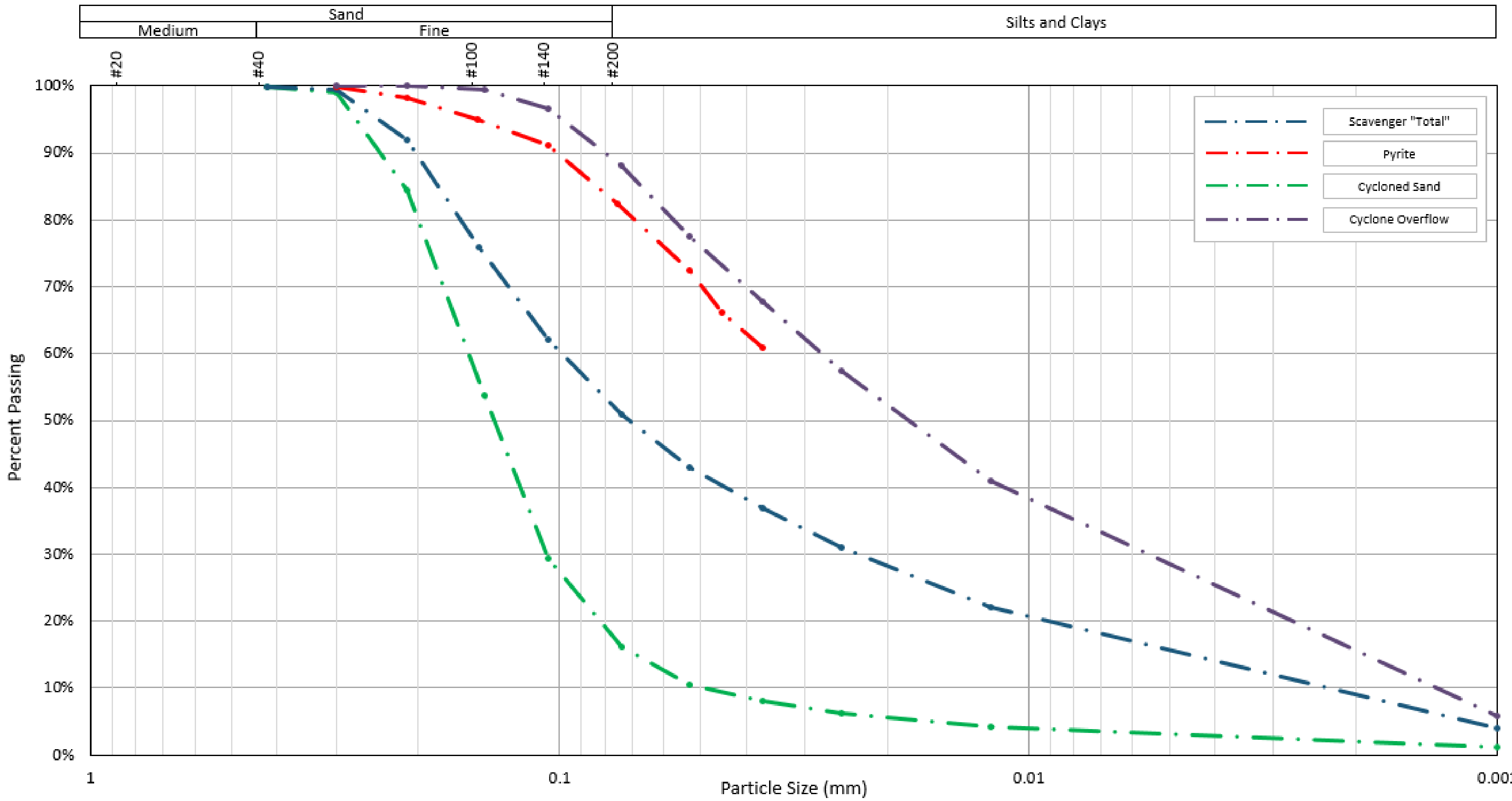


Figure 3.3 Target Tailings Gradations for Design



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APPENDIX II

Impoundment Layout and Tailings Staging

Resolution Copper Project

DEIS Design for Alternative 6 – Skunk Camp

Technical Memorandum

Appendix II – Impoundment Layout and Tailings Staging

DISCLAIMER

Appendix II
Impoundment Layout and Tailings Staging
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II-1 INTRODUCTION

This appendix presents the tailings staging plan for the Draft Environmental Impact Statement (DEIS) design for the Alternative 6 Skunk Camp tailings storage facility (TSF). Tailings deposition was simulated using Muck3D (MineBridge Software Inc, version 2018.1.4) to forecast the ultimate configuration, embankment raising plans and stage-storage curves.

Key objectives of this work were to:

- size the starter dams;
- develop a tailings deposition strategy that:
    - deposits the pyrite tailings subaqueously in a segregated cell within the TSF;
    - provides required tailings and flood storage volumes; and
    - manages the scavenger tailings beaches as dry where practical.
- estimate annual cycloned sand requirements to support embankment construction;
- approximate the embankment crest elevations and rate of rise over the life of the mine; and
- determine the ultimate elevation of the cycloned sand embankment.

II-2 DEPOSITION STRATEGY AND STAGING

II-2.1 Deposition Strategy

The proposed OoM ultimate Skunk Camp TSF configuration is shown on Figure 5.2 of the main report.

The key features of the Skunk Camp ultimate layout are as follows:

- Upstream non-contact water would be diverted as much as practical.
- The pyrite tailings would be stored in two pyrite cells within the impoundment; both cells would eventually be encapsulated by the scavenger tailings. The pyrite cells embankments would be constructed using the cycloned sands with upstream and downstream slopes of 2.5H:1V.
- The pyrite cell would include an engineered low-permeability layer for vertical and lateral containment.
- Starter dams would be constructed from locally sourced borrow materials to store the tailings in the scavenger impoundment and Pyrite Cell1 in early years, prior to sufficient cycloned sand is produced to raise the embankment. Section II-3.5 describes the starter dams sizing assumptions.
- The scavenger tailings would be impounded by a cross-valley, centerline-constructed, cycloned sand embankment (referred to as the main embankment) with a downstream slope of 3H:1V.

The tailings and operating pond management strategy are as follows:

- A portion of the scavenger tailings would be cycloned for embankment construction. Total scavenger tailings that bypasses the cyclones and thickened cyclone overflow would be deposited into the impoundment from the main embankment crest.
- Scavenger beach would be maintained dry (i.e. no pond) where possible. Precipitation runoff from scavenger beach would be temporarily collected in low spots or routed directly to the Reclaim Tank or the reclaim pond in the pyrite cells.
- Pyrite tailings would be deposited from a floating barge or pipelines subsequently into the pyrite cells. The pyrite cells would be operated with a 10 ft water cover over the pyrite tailings with additional flood storage and freeboard allowance.
- Water in the pyrite cell (reclaim pond) would be reclaimed from a floating barge to a tank prior to being pumped back to the West Plant, where it would be reintroduced back into the processing circuit. During times of a negative water balance, water would be pumped into the pyrite cells to maintain the required water cover.

II-2.2 Deposition Staging

The tailings deposition strategy is characterized by four stages, further described below and tailings tonnages placed during each of these stages in Table II-1. For the location of the catchments and key structures (e.g. general fill dams) described, refer to Figure II-A.1 to Figure II-A.2.

- Stage I – Years 0 to 2 (1% of total tailings volume) – See Figure 5.4 in the main text and Figure II-A.2:
  - construction of the scavenger tailings main embankment and Pyrite Cell 1 starter dams (prior to Year 0);
  - impounding of water behind the Pyrite Cell 1 starter dam to establish a minimum water cover for the pyrite tailings and to float the pyrite deposition system and reclaim barge;
  - pyrite tailings deposition into Pyrite Cell 1 from the pyrite deposition barge;
  - scavenger tailings deposition from the crest of the main embankment. Slurry bleed water that collects on the scavenger tailings surface is collected in low points and pumped to Pyrite Cell 1; and
  - cycloning of scavenger tailings to produce cyclone sand for embankment construction at the main and Pyrite Cell 1 embankments.
- Stage II – Years 3 to 15 (35% of total tailings volume) – See Figure II-A.3 to Figure II-A.5:
  - continued subaqueous pyrite tailings deposition in Pyrite Cell 1;
  - continued scavenger tailings deposition within the scavenger beach. Slurry bleed water and runoff that collects on the scavenger tailings surface is collected in low points and pumped to Pyrite Cell 1;

    - continued cycloning of scavenger tailings to produce cyclone sand for embankment construction of the main and Pyrite Cell 1 embankments, as well as for the establishment of the starter embankment for Pyrite Cell 2 (starting in Year 5 to contain scavenger tailings in the scavenger beach area); and
    - impounding of water behind the Pyrite Cell 2 starter dam to establish a minimum water cover for the pyrite tailings and to float the pyrite deposition system and reclaim barge.
- Stage III – Years 16 to 36 (64% of total tailings volume) – See Figure II-A.6 and Figure II-A.7:
    - pyrite tailings deposition into Pyrite Cell 2 from the pyrite deposition barge;
    - scavenger tailings deposition in Pyrite Cell 1, to cover the pyrite tailings and displace the pond. As the pond is displaced it would be either syphoned or channeled to Pyrite Cell 2;
    - continued scavenger tailings deposition within the main impoundment, eventually inundating Pyrite Cell 1 (between Year 15 and 30, depending on operations). Slurry bleed water and runoff that collects on the scavenger tailings surface is collected in low points and pumped to Pyrite Cell 2; and
    - continued cycloning of scavenger tailings to produce cyclone sand for embankment construction at the main and Pyrite Cell 2 embankments.
- Stage IV – Years 36 to 41 (1% of total tailings volume) – See Figure II-A.8:
    - pyrite deposition into Pyrite Cell 2 from the pyrite deposition system;
    - continued scavenger tailings deposition within the main impoundment, as well as north of Pyrite Cell 2 to form the ultimate tailings surface that slopes to the north. Slurry bleed water and runoff that collects on the scavenger tailings surface is collected in low points and pumped to Pyrite Cell 2 or the reclaim tank;
    - continued cycloning of scavenger tailings to produce cyclone sand for embankment construction at the main and Pyrite Cell 2 embankments; and
    - towards the end of Stage IV, scavenger tailings are deposited within Pyrite Cell 2 to cover the pyrite tailings and promote drainage towards the north (where a closure channel would be constructed), reducing the area of pyrite tailings that would need to be covered and reclaim pond to be managed at the end of operations.

Table II-1 Summary of Tailings Tonnage per Stages

Stage	Mine Years	Scavenger Tailings (MTons)						Pyrite Tailings (MTons)	
		Cyclone Sand			Total Scavenger or Overflow				
		Main Emb.	Pyrite Cell 1 Emb.	Pyrite Cell 2 Emb.	Scavenger Beach – Upstream of Main Emb.	Scavenger Beach – North of Pyrite Cells	Pyrite Cells[1]	Pyrite Cell 1	Pyrite Cell 2
I	0 - 2	1.3	1.3	0	9.8	0	0.2	1.8	0
II	3 - 15	68	42	23	271	0	9	78	0
III	16 - 36	81	0	45	580	0	16	0	138
IV	36 - 41	0.2	0	0.2	0	7.8	0.2	0	2

Notes: 1. A percentage of the overflow tailings are assumed to be deposited in the Pyrite Cells to account for the 15% storage contingency.

II-2.3 Modeling Approach

The staging assessment was carried out in two general phases:

1. **Phase 1** – Confirm ultimate configuration and estimate annual raising using stage storage relationships.
2. **Phase 2** – Three-dimensional (3D) modeling of the TSF for key years during operations to confirm the estimates from Phase 1.

Phase 1

The ultimate TSF configuration (developed in MUCK3D) was divided into six regions and stage-storage relationships developed for each: main cycloned sand embankment; the two pyrite cell cycloned sand embankments; scavenger beach (north and south); and the two pyrite tailings cells (see Figure 5.2 from the main report for the locations). The forecasted annual tailings production in each region was used to estimate the annual crest/impoundment level, based on the following assumptions:

- Pyrite Cell 1 is filled first, the annual embankment elevation is estimated based on the average elevation of the tailings deposited into the cells and the pyrite cell storage requirements outlined in Section II-4.7 and Section II-3.9.
- Pyrite Cell 2 is filled after Pyrite Cell 1 is full and has similar pond depth and storage requirements as Pyrite Cell 1. However, the annual embankment elevation is estimated based on the maximum elevation required to either contain the pyrite tailings or to stop the encroachment of the scavenger tailings beach into Pyrite Cell 2. This was estimated by assuming the Pyrite Cell 2 embankment crest elevation needs to be at the same elevation of the scavenger tailings beach adjacent to the Pyrite Cell 2 embankment. This was estimated by:
    - Distance from main embankment to the Pyrite Cell 2 = 6,400 ft.
    - Beach Slope = 0.5%.

    - Scavenger beach elevation difference over the beach length ≈ 32 ft.
    - Difference between average scavenger beach elevation and Pyrite Cell 2 toe ≈ 16 ft.
    - Therefore, the Pyrite Cell 2 embankment crest needs to be 16 ft below the average scavenger beach elevation.
- Main cycloned sand embankment crest must be approximately 24 ft higher than the average scavenger beach elevation, to account for scavenger beach tailings deposition slopes, which are not considered in the stage storage curves.
- Scavenger tailings that are not cycloned for embankment construction report to the scavenger beach upstream of the main embankment until Year 36, when it would be deposited north of the pyrite cells.

Phase 2

Based on the results of Phase 1, select years were modeled in MUCK3D to confirm the interim configurations with tailings deposition slopes. In other words, modeling was completed to confirm the embankment crest elevations and volumes for each section of the TSF.

II-3 MODELING INPUT PARAMETERS AND ASSUMPTIONS

II-3.1 General

The required model input parameters for this assessment are:

- baseline topography;
- discharge locations (i.e. spigots);
- tailings subaerial beach and below water slopes (see SectionII-3.4);
- tailings dry density (see Section II-3.4); and
- deposition rate (tons/year) (see Section II-3.3).

Design criteria, basis and assumptions for the TSF are included in the Design Basis Memorandum, included in Appendix I.

II-3.2 Topography

The baseline topography was provided by Resolution Copper (purchased from NEXTMap). KCB converted the original file which was in NAD83 to Arizona State Plane (the elevation was also converted to feet too). The accuracies of the topography are region dependent but NEXTMap specified it as “1.0 m Root mean square error (RMSE) / 1.65 m LE90” (i.e. 90% of the sampling would be within 1.65 m from true vertical elevation). The baseline used for Muck 3D modelling was the topography with 40 ft contour intervals.

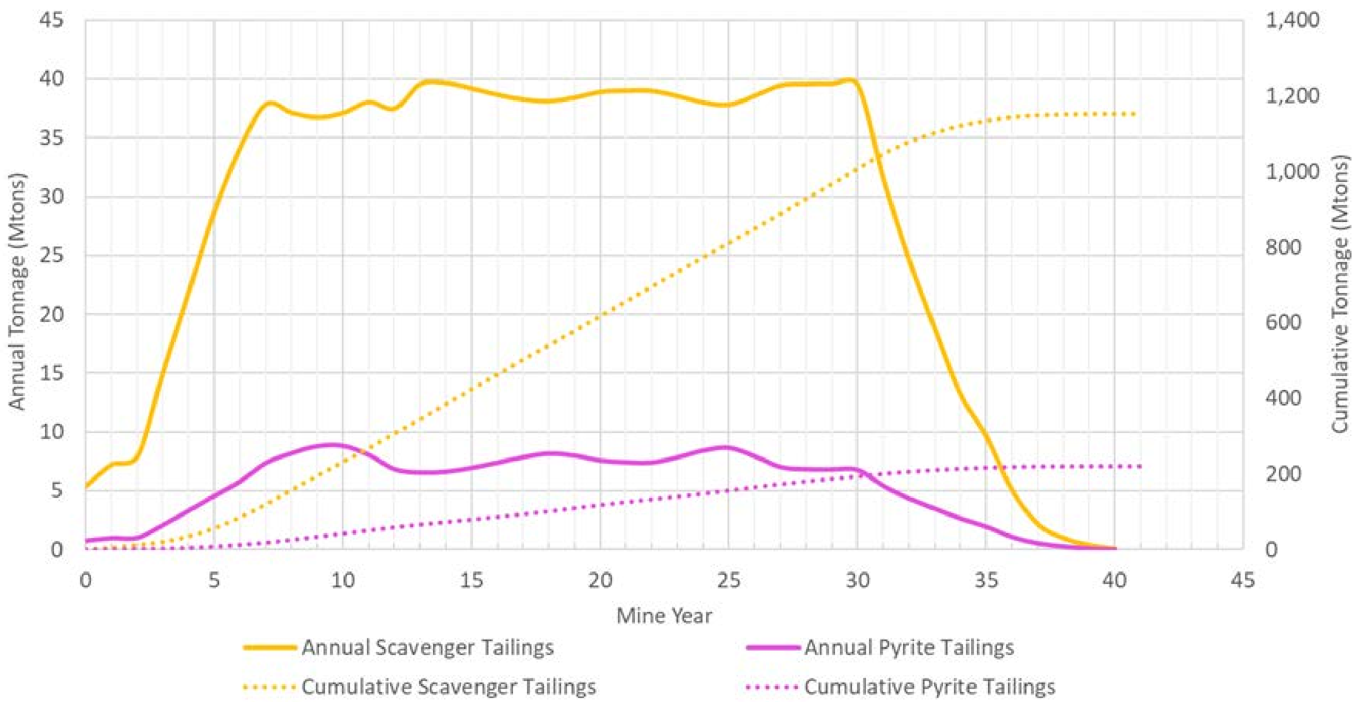
II-3.3 Tailings Production Schedule

Figure II-1 shows the forecasted OoM tailings production schedule provided by RC. Total tailings production is summarized in Table II-2.

Table II-2 Total Tailings Production Comparison

Item	Production Schedule
Scavenger Tailings	1,151 Mtons (84% of total tailings by weight)
Pyrite Tailings	220 Mtons (16% of total tailings by weight)
Total Tailings (scavenger and pyrite)	1,371 Mtons
Number of Production Years	41

Figure II-1 Tailings Production Schedule



II-3.4 Tailings Properties

Table II-3 summarizes the tailings deposition properties and model inputs for Muck 3D tailings deposition simulations, refer to the DBM in Appendix I for further details. A lower dry density was assumed for the deposited tailings in first 5 years of operation to account for lower degree of consolidation and elevated rate of rise.

Table II-3 Tailings Deposition Properties

Tailings Stream	Tailings Type	Dry Density (pcf)	Deposition Solids Content (%)	Tailings Slopes[1]	Mine Life Total Tonnage (Mtons)	Total Available Volume (Myd^3)[3]
Scavenger	Total	Years (0-5): 75 Years (6-41): 81	60%	Above Water: 1% for the first 1,500 ft, 0.5% after 1,500 ft.	1150	958
	Cyclone Overflow		60%		544	499
	Cycloned Sand	113	60%		370	243
Pyrite	Total	106	50%	Below Water: 10% for the first 100 ft, 0.5% after 100 ft. Pyrite tailings was modelled assuming horizontal filling and 5 ft depth allowance for pyrite deposition slopes.[2]	220	154

Notes:
1. Scavenger tailings slopes are based on topography and bathymetry surveys from two benchmark projects with large, cycloned sand impoundment beaches and slopes below water. These facilities have long exposed beaches, up to five miles. Pyrite tailings slopes are based on topography and bathymetry surveys of subaqueous disposal of high-pyrite tailings from floating barges.
2. These slopes are preliminary estimates at this stage of design and will be reviewed in future design stages.
3. Volumes given assume all available scavenger tailings is cycloned. Therefore, these are the same as the final staging results presented in Section II-4.

II-3.5 Starter Dams

Starter dams for Pyrite Cell 1 and the main embankment would be constructed out of locally sourced borrow materials using the assumptions summarized in Table II-4. It is assumed that the Pyrite Cell 2 starter dam would be constructed of cycloned sand. The borrow material fill volume for the starter dams has been accounted in required cycloned sands estimation.

Details on the design are included in Section 9.1 of the main text.

Table II-4 Starter Dam Sizing Assumptions and Results

Parameter	Scavenger Starter Dam	Pyrite Cell1 Starter Dam Assumptions
Crest width	50 ft	
Side Slopes	3H:1V	2.5:1
Number of years of storage	2[1]	2[1]
Tailings storage	12.4 Myd^3	1.4 Myd^3
Design flood storage to contain the PMF[2]	17,223 acre-ft	10,027 acre-ft
Allowance for pyrite deposition slopes and minimum water cover	N/A	10 ft (Note 3)
Minimum "Dry" Freeboard	5 ft	3 ft
Required fill volume/borrow	6.4 Myd^3	5.5 Myd^3
Required Dam Height	146	166
Dam Elevation	3252 ft	3417ft

Notes:
1. Assuming total scavenger tailings (no cycloning)
2. Based on scavenger and pyrite starter dam catchment areas (with no diversions) of 9,331 acres and 5,432.7 acres, respectively; and PMP-72-hr depth = 22.15 inches (see Appendix I DBM).
3. Underwater pyrite tailings deposition surface was conservatively designed 5 ft above the average pyrite tailings elevation surface to account for possible pyrite tailings slopes. The operating pond above this surface was assumed to maintain a minimum depth of 5 ft. considered.

II-3.6 Cycloned Sand Embankment Raise Methodology

Two approaches to constructing the cycloned sand embankments were considered:

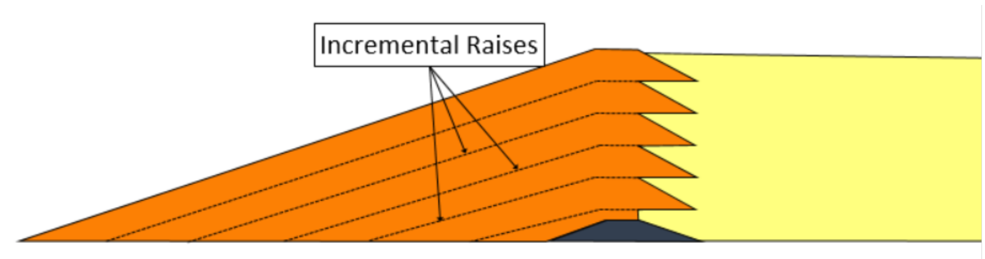
- "Sloped methodology": the downstream slope of the embankment is maintained at all times, refer to Figure II-2a. This represents the minimum amount of cycloned sand that must be placed annually to meet the crest elevation requirement but does not allow for progressive reclamation to begin.
- "Horizontal slice methodology": the embankment is constructed in horizontal slices that extend to the ultimate downstream face, refer to Figure II-2b. This represents the minimum amount of cycloned sand that must be placed annually to meet the crest elevation requirement and establish the downstream slope so that progressive reclamation of the entire exterior embankment slope can be completed shortly after an embankment raise.

The preferred method to raise the cycloned sand main embankment is raising it through horizontal lifts which allows for the reclamation of the embankment as it is raised. Due to constraints on cycloned sand availability, and the desire to establish the downstream slope of the embankment as soon as possible to begin progressive reclamation, the actual embankment raising methodology would use a combination of these strategies, refer to Figure II-2c. Hydraulic cell construction and sequencing of construction to balance the rate of rise with the downstream expansion of the cycloned sand shell, would be addressed in future design stages.

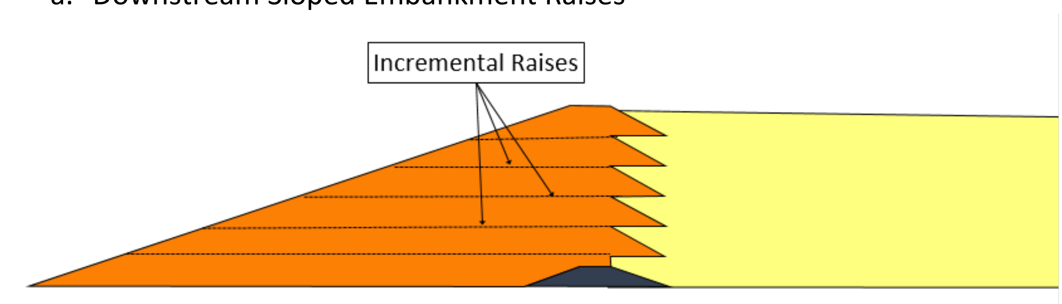
The crest elevation of the cycloned sand embankment was set at the start of each year to be high enough to store all tailings produced that year as well as flood storage.

Section II-4.1 describes the logic of selecting raising methods for pyrite cells and the main embankment.

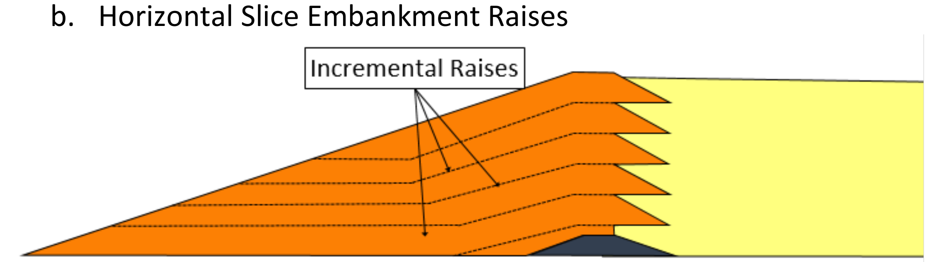
Figure II-2 Cycloned Sand Embankment Raise Methodology



a. Downstream Sloped Embankment Raises



b. Horizontal Slice Embankment Raises

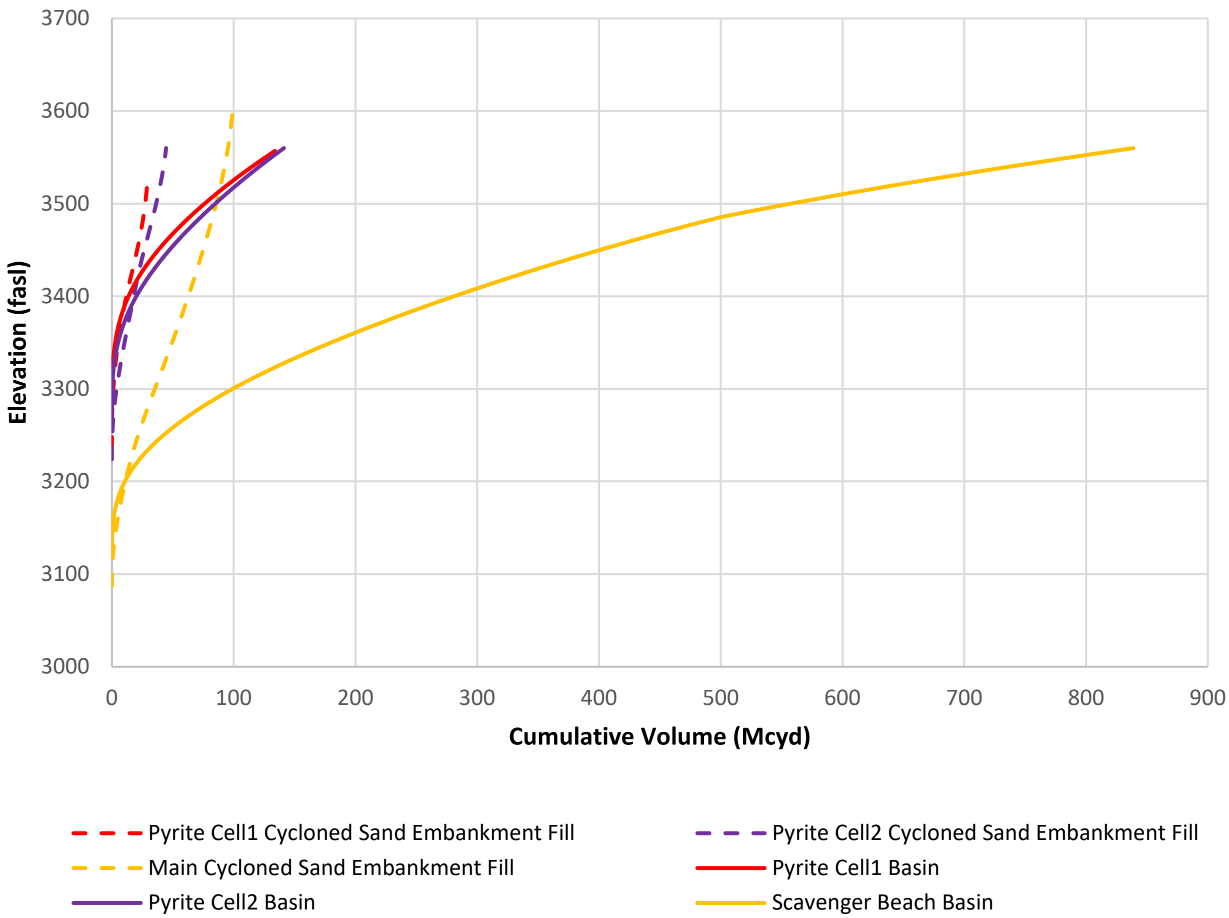


c. Combined Method of Embankment Raises

II-3.7 Stage Storage Curves

Figure II-3 shows the stage-storage curves that were created for the cycloned sand embankment fills and impoundment basins using Muck3D (MineBridge Software Inc, version 2018.1.4) based on the ultimate configuration. These stage-storage curves were input assumptions for Phase 1 modeling.

Figure II-3 TSF Region Horizontal Stage-Storage Curves



II-3.8 Flood Management

The precipitation runoff from the areas of the scavenger beach and upstream catchments would be collected in low points in the impoundment and pumped or routed to the pyrite cells or storage tanks. Internal ditches may be required during interim stages to manage the storm water.

The upstream non-contact water diversions are sized to store or convey the 100-year 24-hour storm event. Therefore, the TSF is required to have the capacity to store the local and upstream catchment for the 72-hour Probable Maximum Flood (PMF), with adequate freeboard or scavenger beach lengths (400 ft) as outlined in the DBM (Appendix I). If the scavenger beach does not have an adequate beach length, an emergency spillway would be constructed.

II-3.9 Pyrite Cell Sizing

The pyrite cells were sized to store pyrite tailings plus 15% contingency to account for variations in tailings production, tailings slopes and operating pond volumes. Table II-5 shows the assumptions for sizing the Pyrite Cells.

Table II-5 Pyrite Cell Sizing Assumptions

Item	Design Assumptions	Comments
Pyrite Tailings	220 Mt (154 Myd^3)	DBM (Appendix I)
Contingency Storage in the Pyrite Tailings	23 Myd^3	15% contingency storage volume for pyrite tailings and constructability allowance for developing a scavenger beach.
Depth Allowance for Underwater Deposition Slopes	5 ft	Based on: Subaqueous deposition slope = 10% (see DBM) “Point of Deposition” Spacing[1] = 100 ft Depth between the lowest and highest portions of the pyrite tailings surface = 10 ft
Minimum Depth of Operating Pond	5 ft	Allowance for water cover over the pyrite tailings and floating barge tailings pipeline discharge
Depth Allowance for Storm Storage within Pyrite Cell 1	18 ft to 55 ft	Calculated as the Pyrite Cell 1 upstream catchment area without diversions (5,400 acres) multiplied by the 72-hr PMF (22.15 inches), assuming a runoff coefficient of 1.0. Note: the depth is adjusted throughout the mine life based on the upstream catchment area reporting to the cell and the stage storage relationship.
Depth Allowance for Storm Storage within Pyrite Cell 2	9 ft to 20 ft	Calculated as the Pyrite Cell 1 upstream catchment area without diversions (2,900 acres) multiplied by the 72-hr PMF (22.15 inches), assuming a runoff coefficient of 1.0. Note: the depth is adjusted throughout the mine life based on the upstream catchment area reporting to the cell and the stage storage relationship
Freeboard	3 ft	‘dry’ freeboard above peak flood level for wind setup and wave runup

Notes: 1. Pyrite tailings would be deposited by a floating barge or from pipelines extended into the pyrite cell. Details will be confirmed in future design stages.

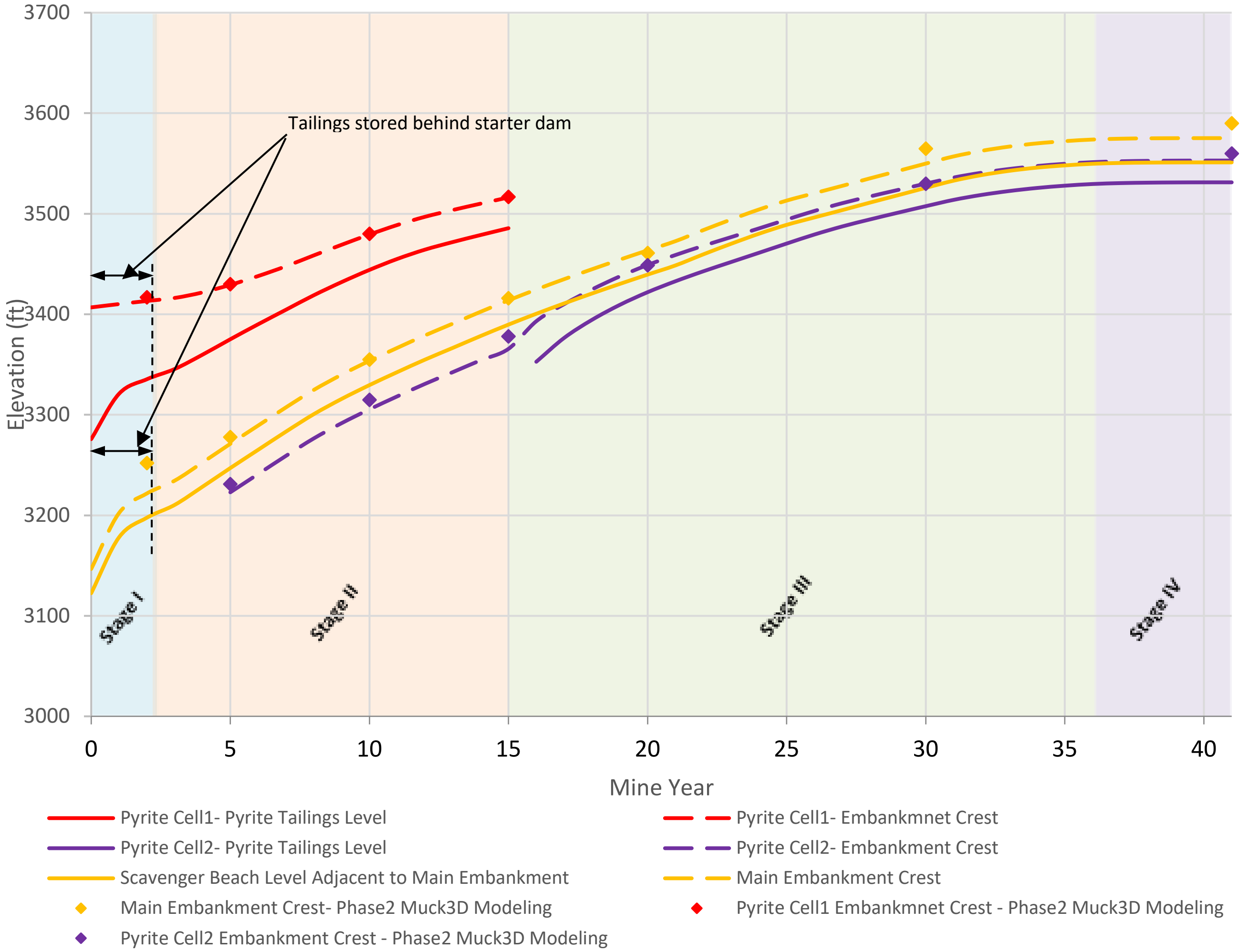
II-4 TAILINGS DEPOSITION RESULTS

II-4.1 General

Phase 1 Tailings deposition staging was developed based on the ultimate configuration of the main embankment and the pyrite cells, and related stage-storage curves. These were checked in Phase 2 with interim MUCK3D layouts. Phase 2 tailings staging figures are provided in Appendix II-A.

Figure II-4 shows the elevations of the scavenger beach, pyrite tailings and the cycloned sand embankment dams through the mine life.

Figure II-4 Elevation vs Mine Year



II-4.2 Cycloned Sand Usage

Figure II-5 compares the required and available cycloned sand through the mine life. It is predicted only 70% of cycloned sand available would be used to construct the embankment dams.

Figure II-5 Comparison of Total Cumulative Available and Required Cycloned Sands

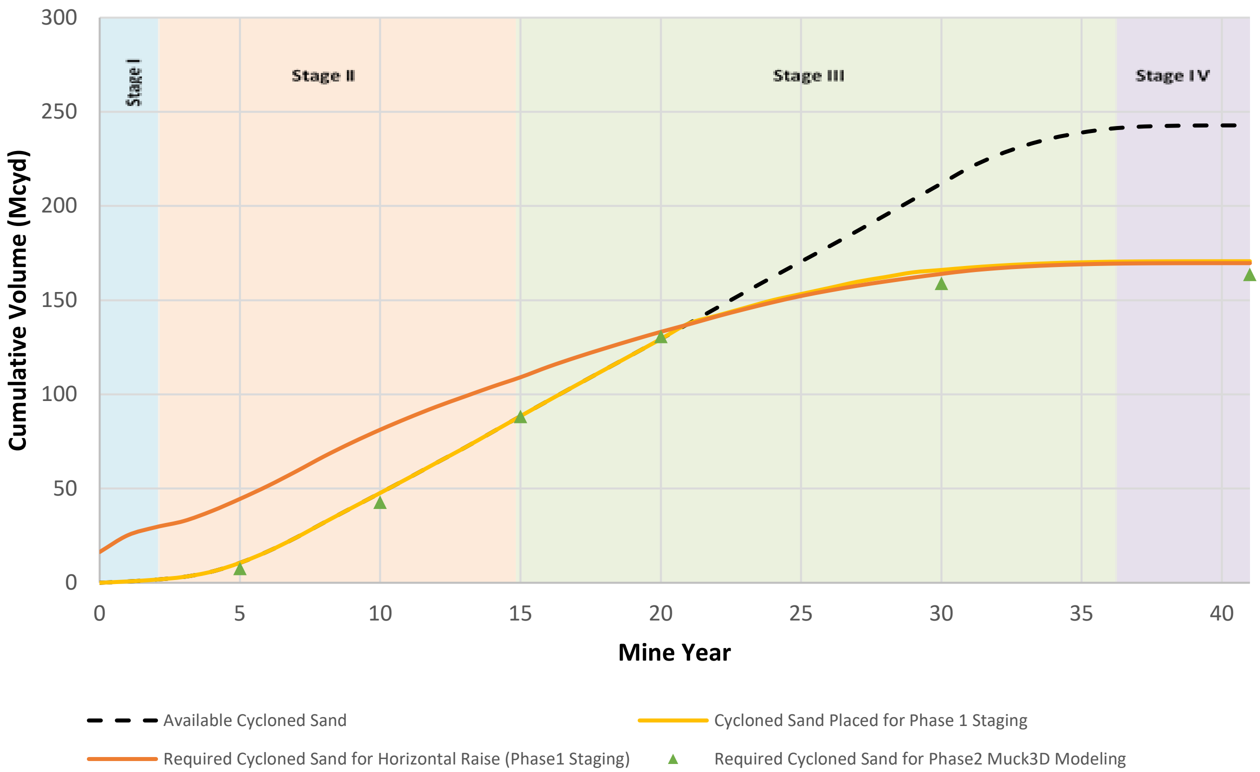


Figure II-6, Figure II-7, and Figure II-8 compare the estimated cumulative cycloned sands to be placed in the dam embankments and cycloned sands for Phase 1 and Phase 2 of the staging modeling. The forecasted available cycloned sand is adequate for sloped raising method of embankment dams. However due to the relative alignment of the pyrite cells and main embankment, and to meet the requirements for the minimum height above the tailings surfaces as outlined in Section II-33, KCB proposed the following methodologies for different cycloned sand embankments:

- As shown in Figure II-6, the main cycloned sand embankment could be built using the downstream sloped methodology prior to Year 10, and could be built using the horizontal filling from Year 20 onwards. The combined method could be used to raise the dam between Year 10 and Year 20.
- As shown in Figure II-7, there is not enough cycloned sand available to raise the Pyrite Cell 1 in horizontal lifts. Therefore, prior to Year 7, it is assumed that embankment could be built using downstream sloped methodology. However, the scavenger tailings deposition extent reaches

to the Pyrite Cell 1 ultimate footprint in Year 7, therefore combined raising methodology could be used from Year 7 onwards.

- Scavenger tailings would reach to the Pyrite Cell 2 footprint by the end of Year 4, therefore construction of Pyrite Cell 2 embankment would be launched at this time. The embankment would be to be raised in horizontal lifts. Construction of Pyrite Cell 2 north embankment can be delayed up to Year 16 when construction is required to contain the pyrite tailings.

Figure II-6 Comparison of Cumulative Available and Required Cycloned Sands for Main Embankment

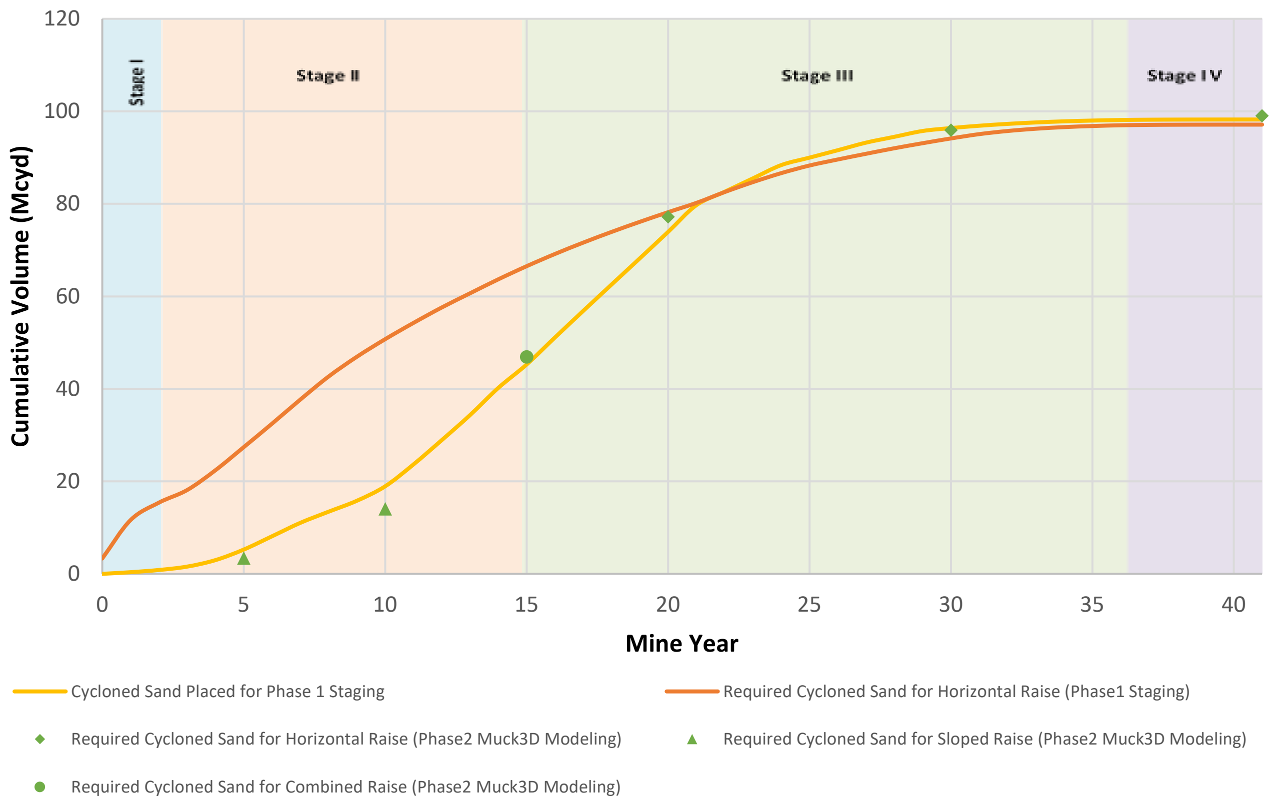


Figure II-7 Comparison of Available and Required Cycloned Sands for Pyrite Cell 1 Embankment

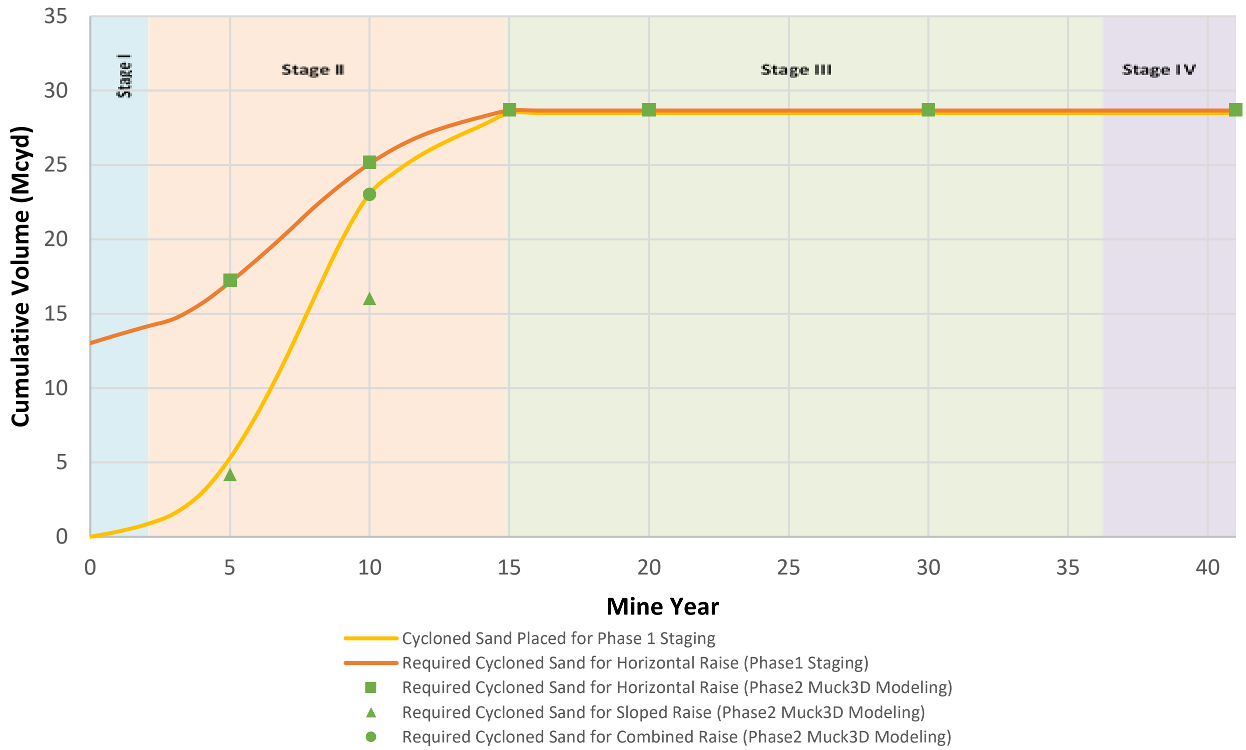


Figure II-8 Comparison of Available and Required Cycloned Sands for Pyrite Cell 2 Embankment

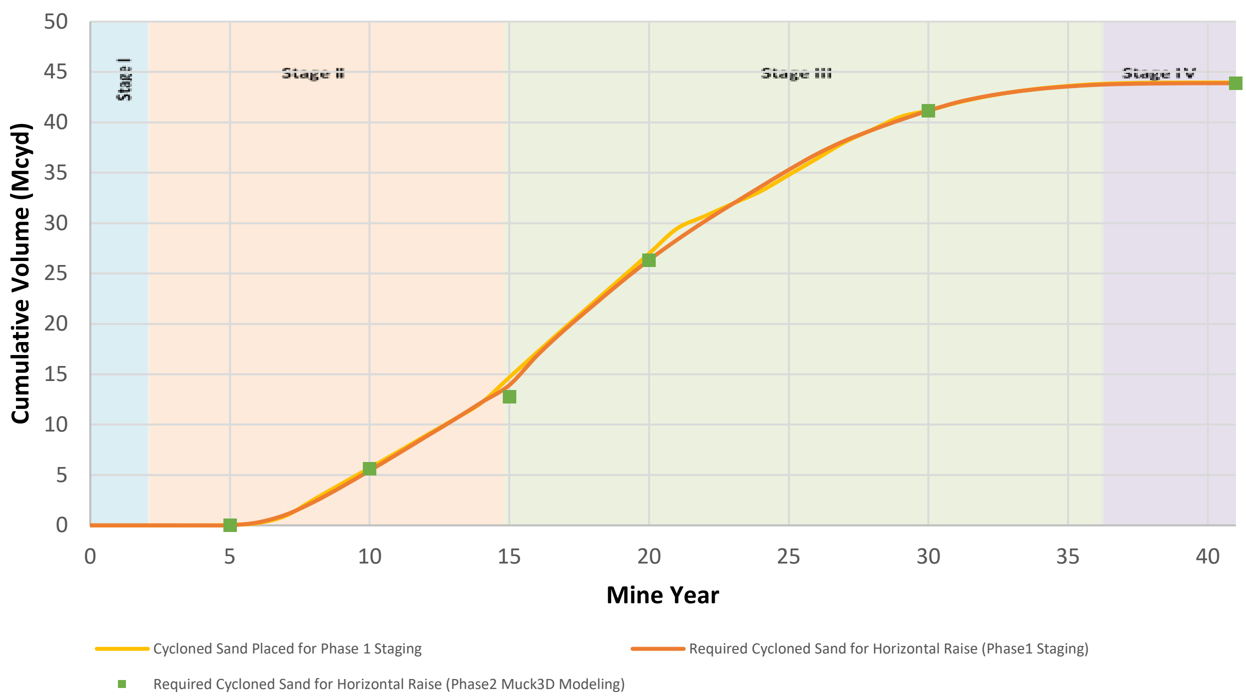
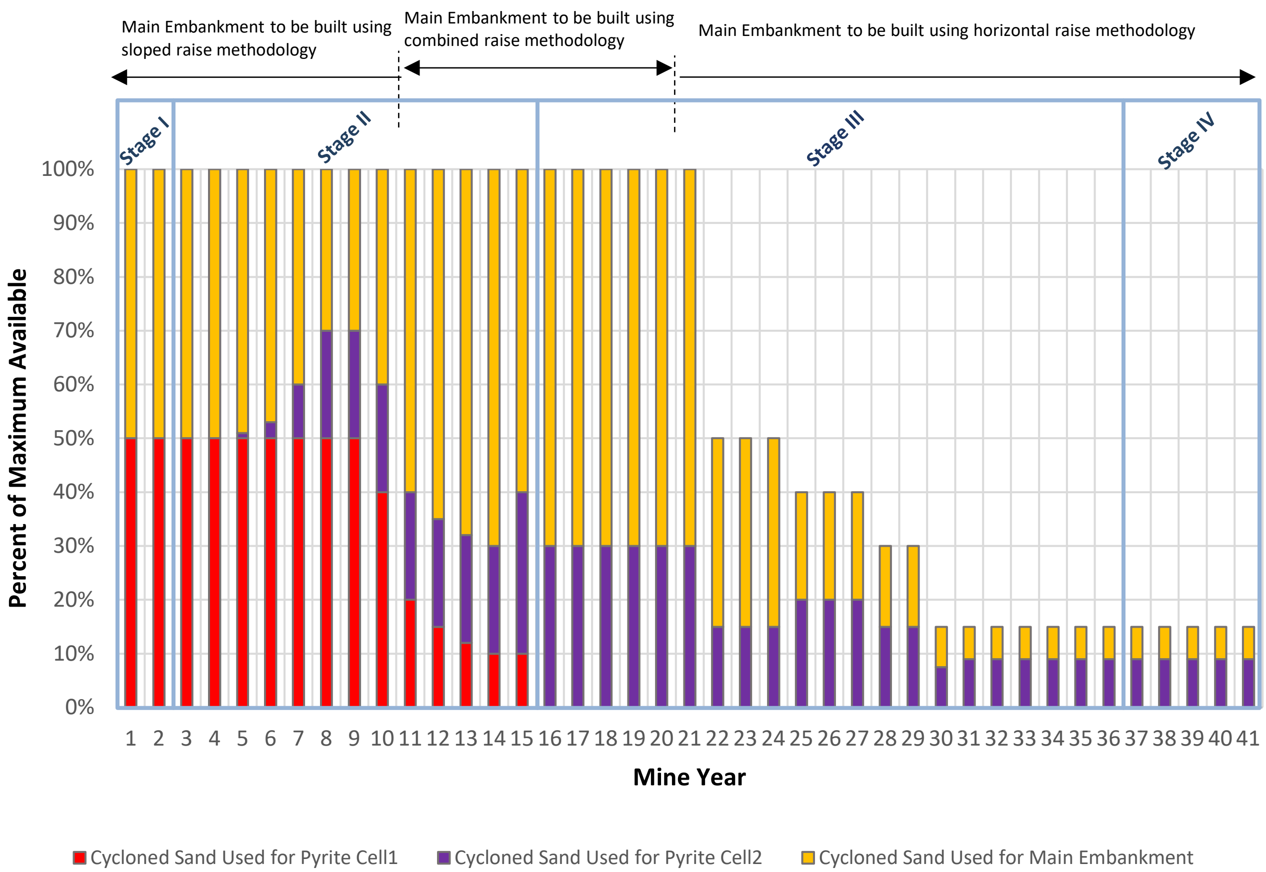


Figure II-9 shows the distribution of cycloned sand used over the mine life.

Figure II-9 Annual Distribution of Available Cycloned Sand Used for Construction*

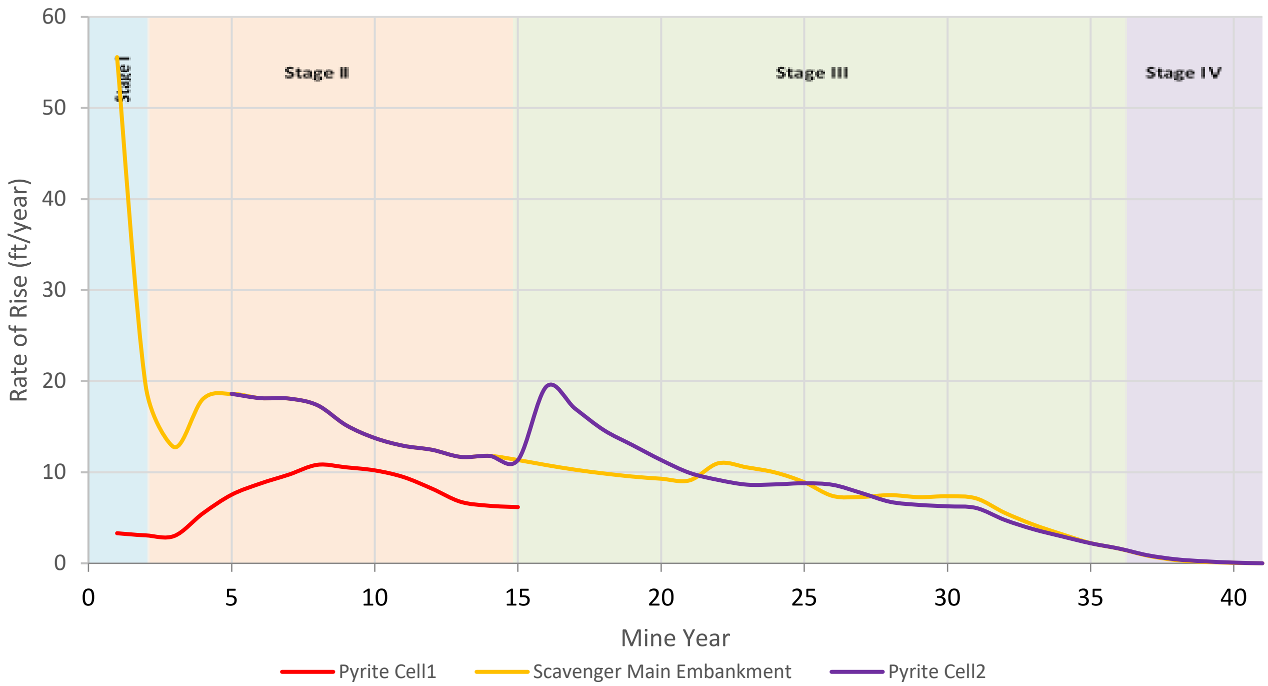


* See Appendix I (DBM) for assumptions on available cyclone sand quantity and Table II-3 for available cycloned sand quantity.

II-4.3 Rate of Rise

Figure II-10 shows the rate of rise over the mine life.

Figure II-10 Annual Embankment Dams Rate of Rise

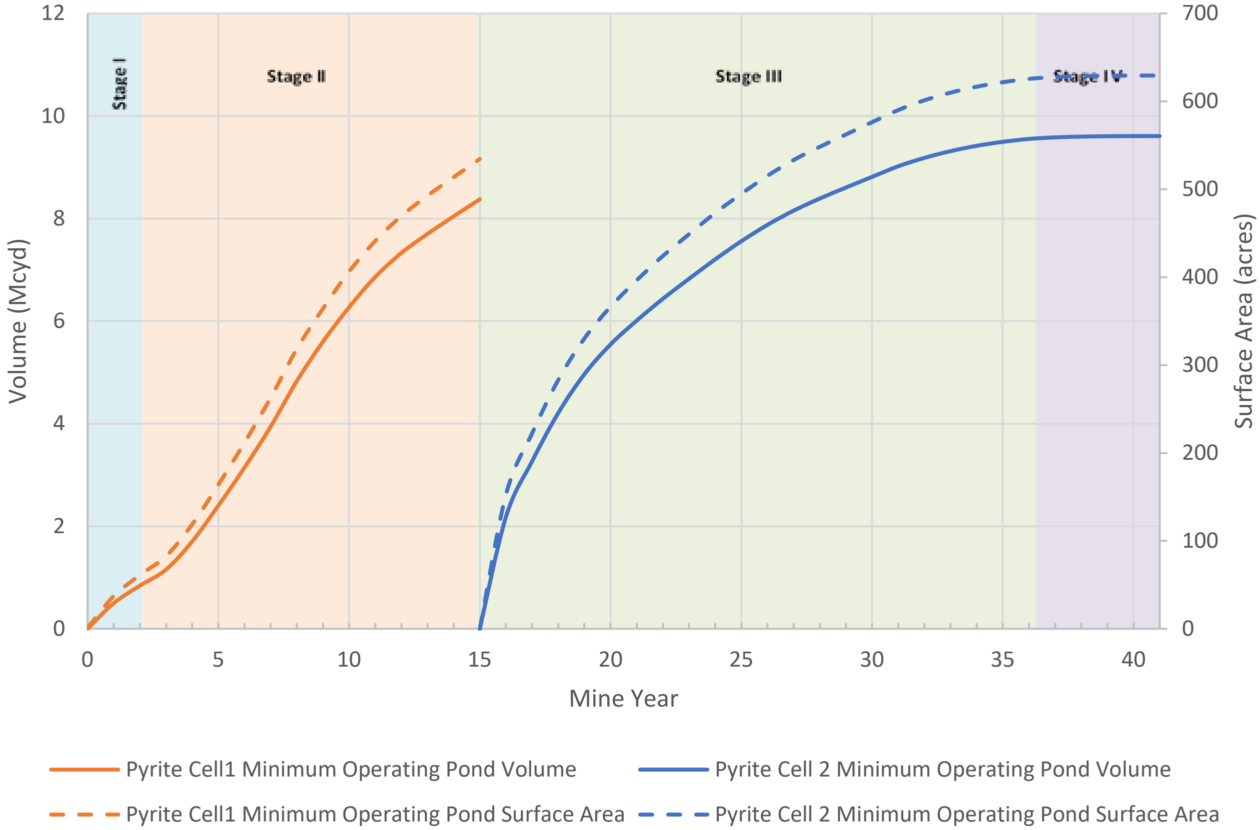


II-4.4 Water Management

Pyrite Cells would maintain a permanent operating pond and are sized to store the 72-hr PMF. During the storm event, the storm water collected on scavenger beach would be also pumped to the pyrite cells.

Figure II-11 shows the volumes and surface areas of the operating ponds in pyrite cells. The ultimate pond volume in Pyrite Cell 1 and Pyrite Cell 2 are 8.4 Mcyd and 9.6 Mcyd, respectively.

Figure II-11 Minimum Operating Pond Volumes and Areas



From start-up through Year 15, the Pyrite Cell 1 accepts flows from the natural catchment between the upstream diversions and the pyrite cell pond. In Year 16, the water would be transferred to Pyrite Cell 2 and/or reclaim tanks and the pyrite tailings would be covered with scavenger tailings.

Scavenger starter dam would receive the runoff from the upstream catchments until Year 5 when the construction of Pyrite Cell 2 southern embankment begins. The runoff which is collected in the Pyrite Cell 2 area would be pumped to Pyrite Cell 1 and or the storage tanks. Table II-6 shows the scavenger beach length in the event of a 72-hr PMF. The planned impoundment can store the PMF with a minimum beach length of 400 ft in all years except Year 2 through Year 5. Potential mitigation measures during this period could include: mobilizing additional pumps to the TSF to draw down the water level until adequate beaches are re-established or construction of an emergency spillway for these years.

Table II-6 Scavenger Beach Dry Beach Length During 72-hr Probable Maximum Flood

Mine Year	2	5	10	15	20	30	41
Dry Beach Length (ft)	-	-	840	2400	1100	4300	4680

II-4.5 Closure Strategy

In the final years of operations construction, scavenger tailings would be deposited in Pyrite Cell 2 with a surface grade towards the north to both cover the pyrite tailings and reduce the operating pond surface by pushing the water to the north. Ultimately the area of the Pyrite Cell 2 would be fully covered by total scavenger tailings.

The overall elevation of the pyrite tailings is lower than the surrounding scavenger tailings. This can be used to the benefit of placement of enough scavenger tailings with appropriate thickness to maintain long-term saturation.

II-5 CONCLUSIONS

Key conclusions from the tailing staging assessment are as follows:

- Pyrite Cell 1 and Scavenger Starter dams require significant borrow fill material, approximately 12 Mcyd. It is expected that the borrow material is sourced from within the footprint of the TSF to reduce the ground disturbance as little as possible and to provide additional tailings storage capacity.
- The deposition strategy is generally capable of achieving the performance objectives:
  - Pyrite tailings are deposited subaqueously in a segregated cell within the TSF.
  - Scavenger tailings are managed without an operating pond.
  - The impoundment layout is capable of storing the required tailings and flood storage volumes.
  - Long beaches (>400 ft) are maintained during flood conditions for all years except for earlier years. Mobilization of pumps, or modifications to the staging, plan or other methods to remove water may be required during this time to maintain an adequate beach length. This will be further evaluated during the PFS staging.
  - Rate of embankment crest rise between 10 ft/yr and 20 ft/yr is expected in the first 20 years before leveling out to less than 10 ft/yr for the remainder of operations. High rates of rise present a construction challenge, but there is precedent in industry for hydraulic cell embankment construction at the rates predicted. The potential for static liquefaction resulting from the rate of rise would be managed by compacting the cycloned sand to maintain a dilatant condition and compaction of a portion of the upstream beach.
- The total cycloned sand volume required (170 Myd^3) is less than the total amount that can be produced (243 Myd^3). This provides a benefit to operational flexibility (i.e. the cyclone plant can have longer periods of downtime and still meet volume requirements) and an opportunity to reduce the period before progressive reclamation of the embankment slopes can begin. There is also the opportunity to improve the stability of the main embankment by decreasing the downstream slope. Details would be confirmed in future design stages.

- Tailings deposition slope assumptions have a significant impact on the staging plan. More refined estimates, specific to the Resolution tailings, should be developed, and the staging plan adjusted as necessary during operations based on achieved slope angles.
- The use of compacted scavenger total tailings instead of cycloned sand and/or general fill for some structures or in some stages of operation represents a potential design optimization. The suitability of scavenger total tailings is being assessed in the ongoing tailings laboratory testing program.
- The locations of the pyrite cells provide easy access to the cells and minimize pond areas.

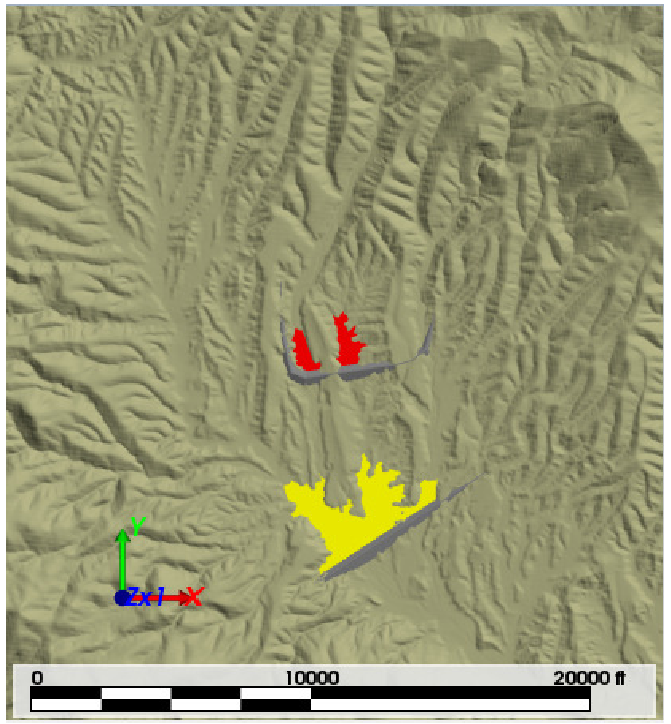
REFERENCES

MineBridge Software Inc. 2018. Muck3D Ooze Version 1.4. [Computer software].

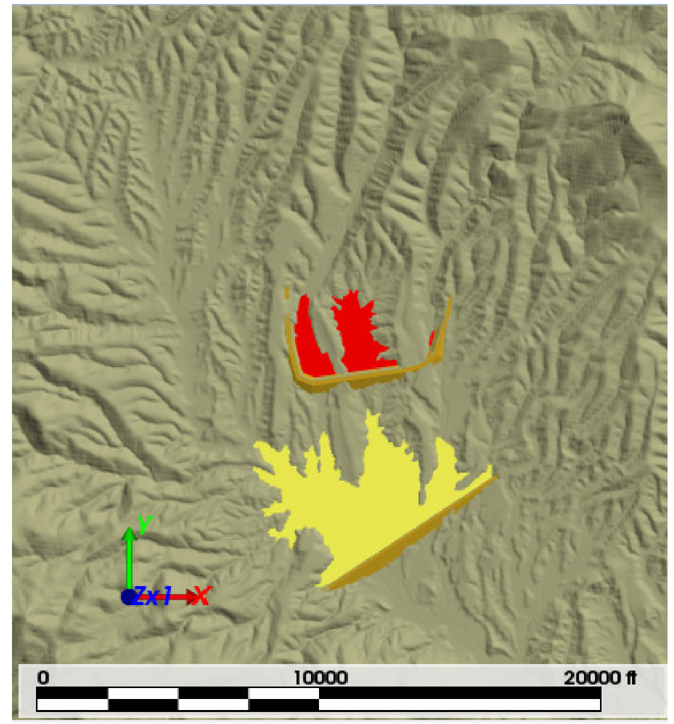
APPENDIX II-A

Tailings Staging Figures

YEAR 2



YEAR 5



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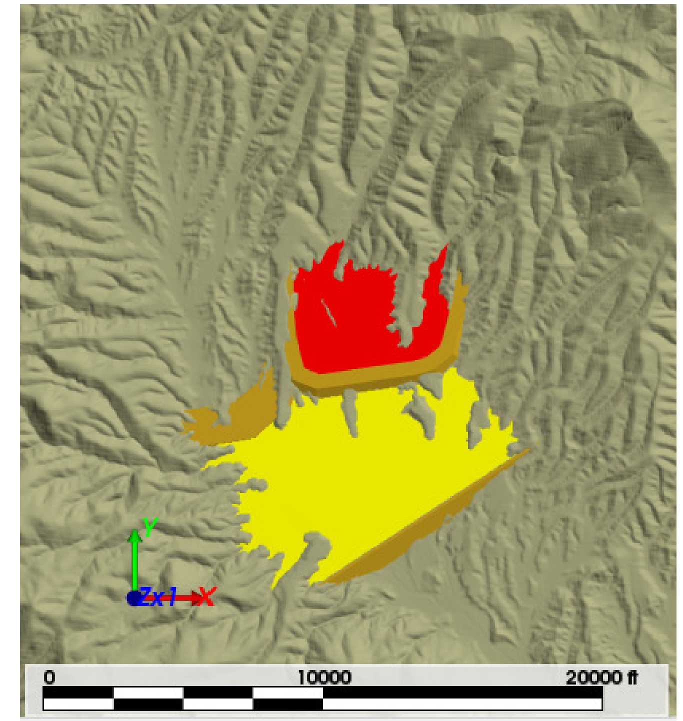
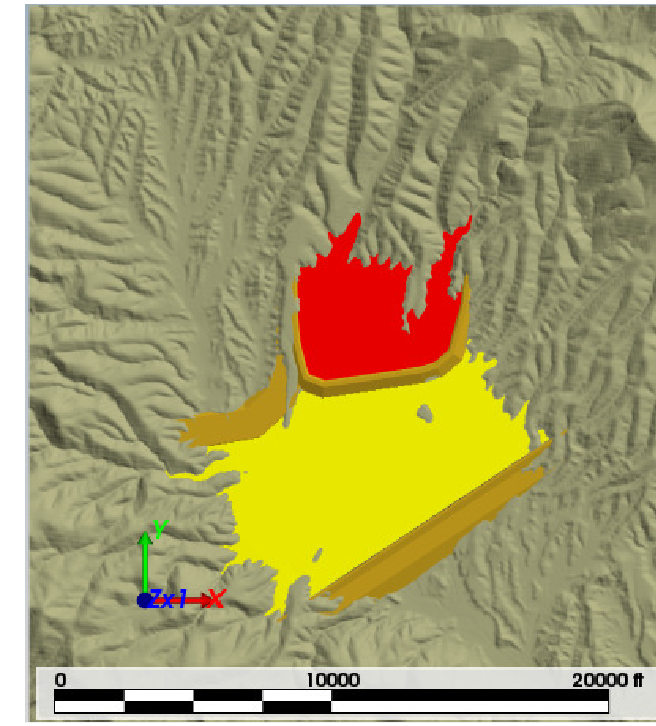


YEAR 15



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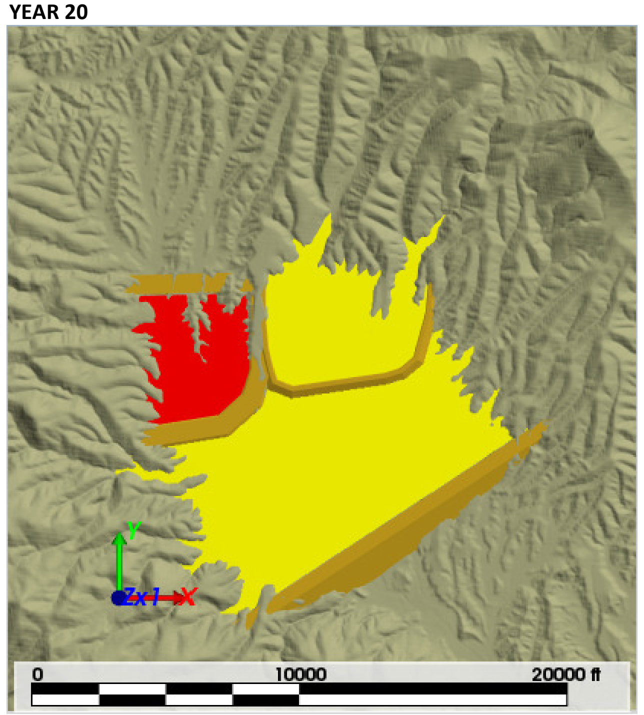

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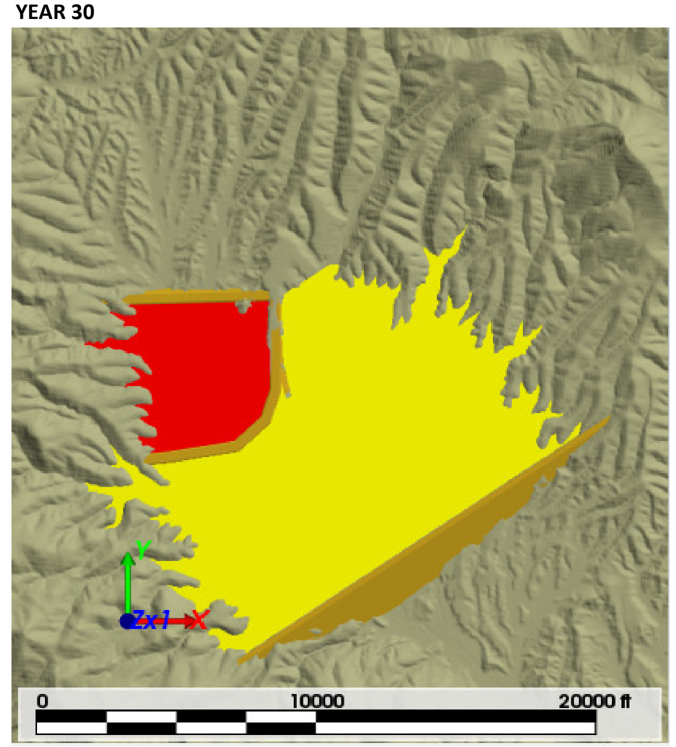

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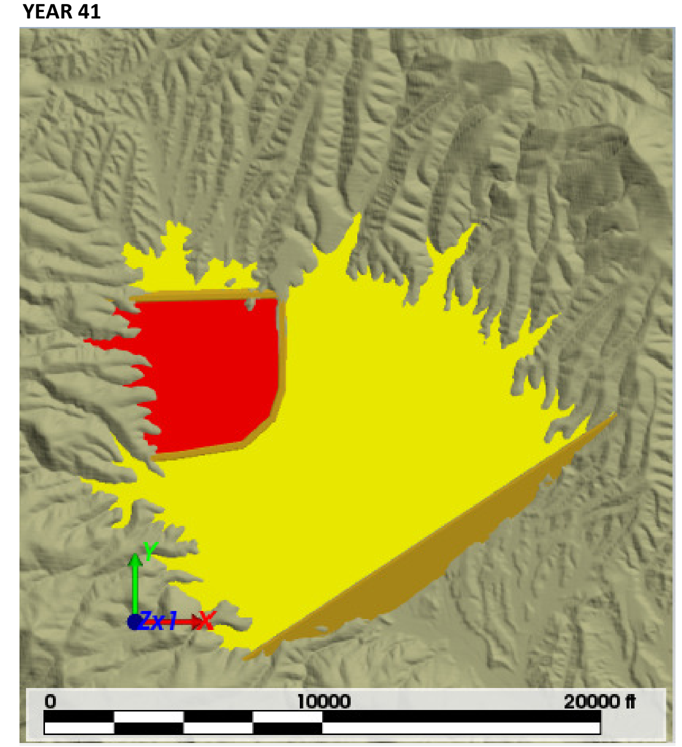

LEGEND

- SCAVENGER TAILINGS (CYCLONE OVERFLOW/TOTAL TAILINGS)
- PYRITE TAILINGS
- STARTER DAM
- CYCLONED SAND EMBANKMENT

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TAILINGS STAGING SUMMARY

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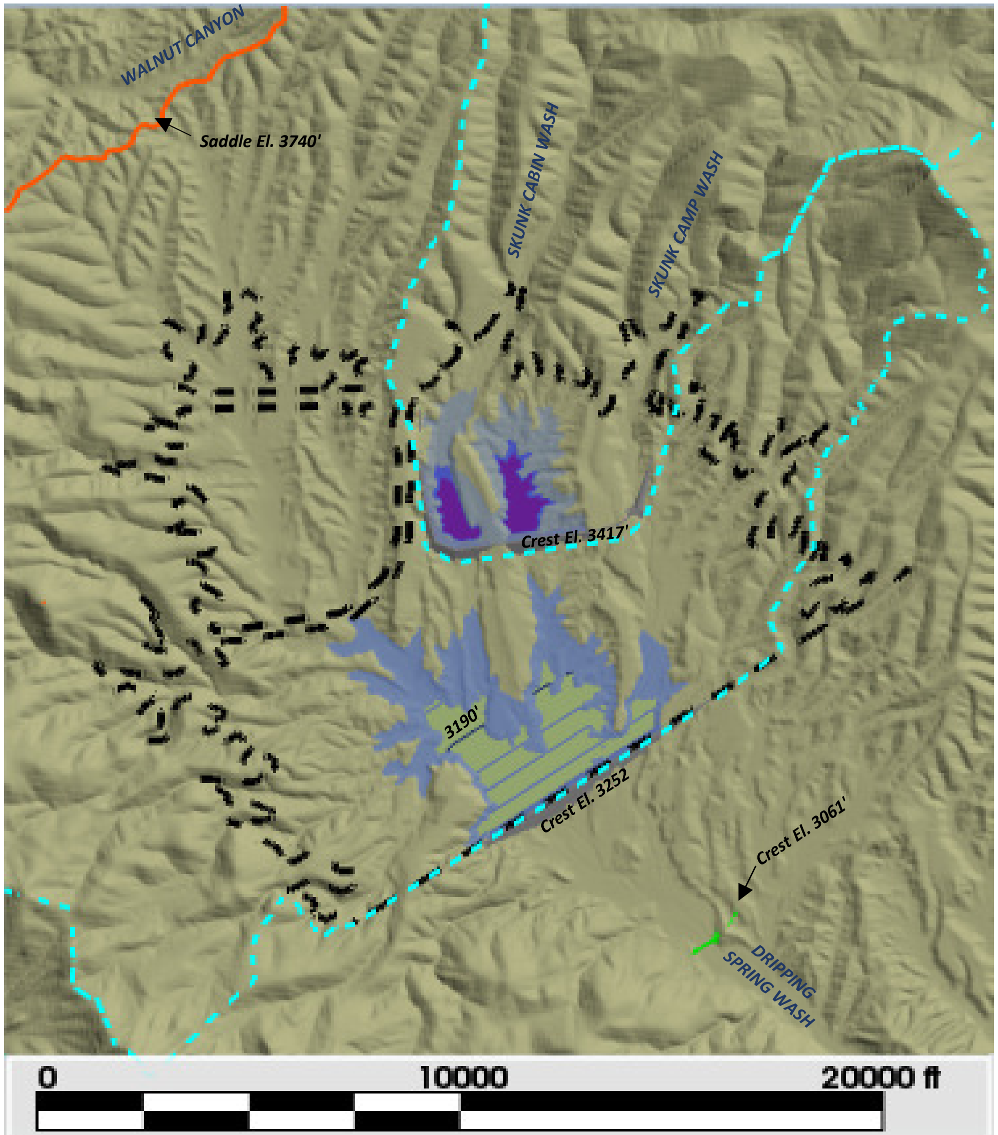
FIG No. II-A.1



LEGEND

- MINERAL CREEK | DRIPPING SPRINGS WASH CATCHMENT DIVIDE
- CATCHMENTS FOR PMF VOLUME ESTIMATES
- 5 FT. CONTOUR
- 10 FT. CONTOUR
- ULTIMATE TAILINGS OUTLINE
- SCAVENGER OVERFLOW/TOTAL TAILINGS
- PYRITE TAILINGS
- OPERATING POND
- 72-HR PROBABLE MAXIMUM FLOOD
- SEEPAGE COLLECTION DAM

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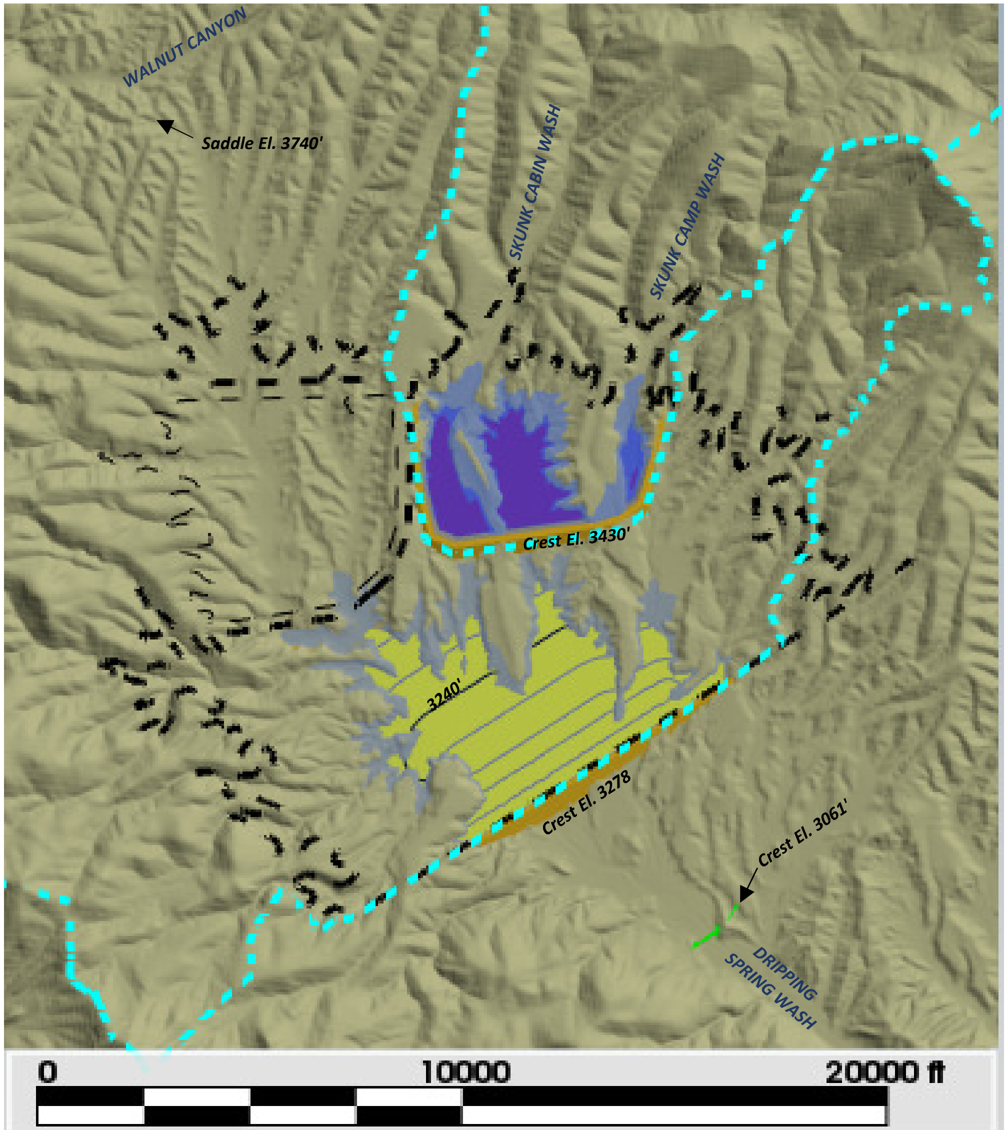
(END OF STAGE I)

PROJECT No. M09441A20

FIG No. II-A.2



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TITLE

YEAR 5
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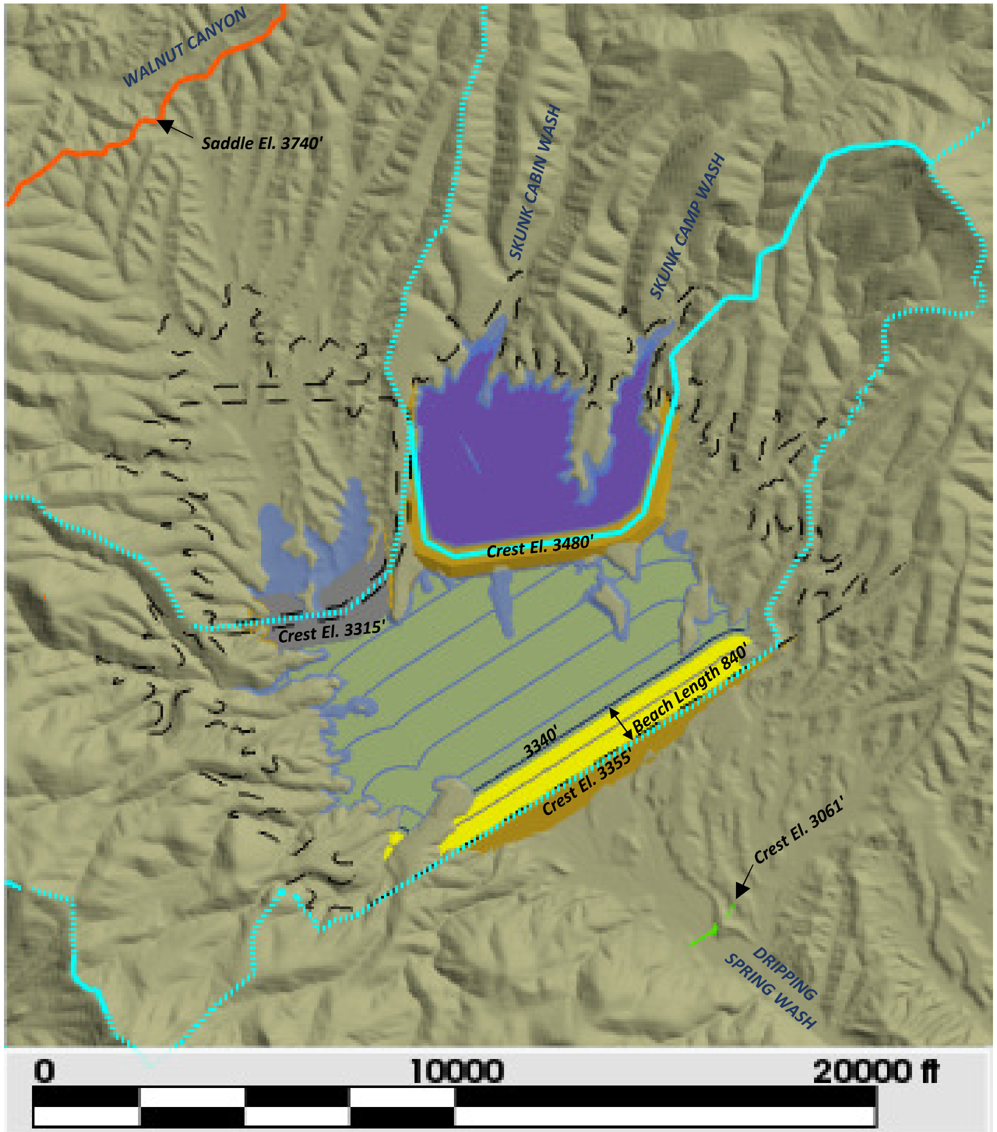
FIG No. II-A.3



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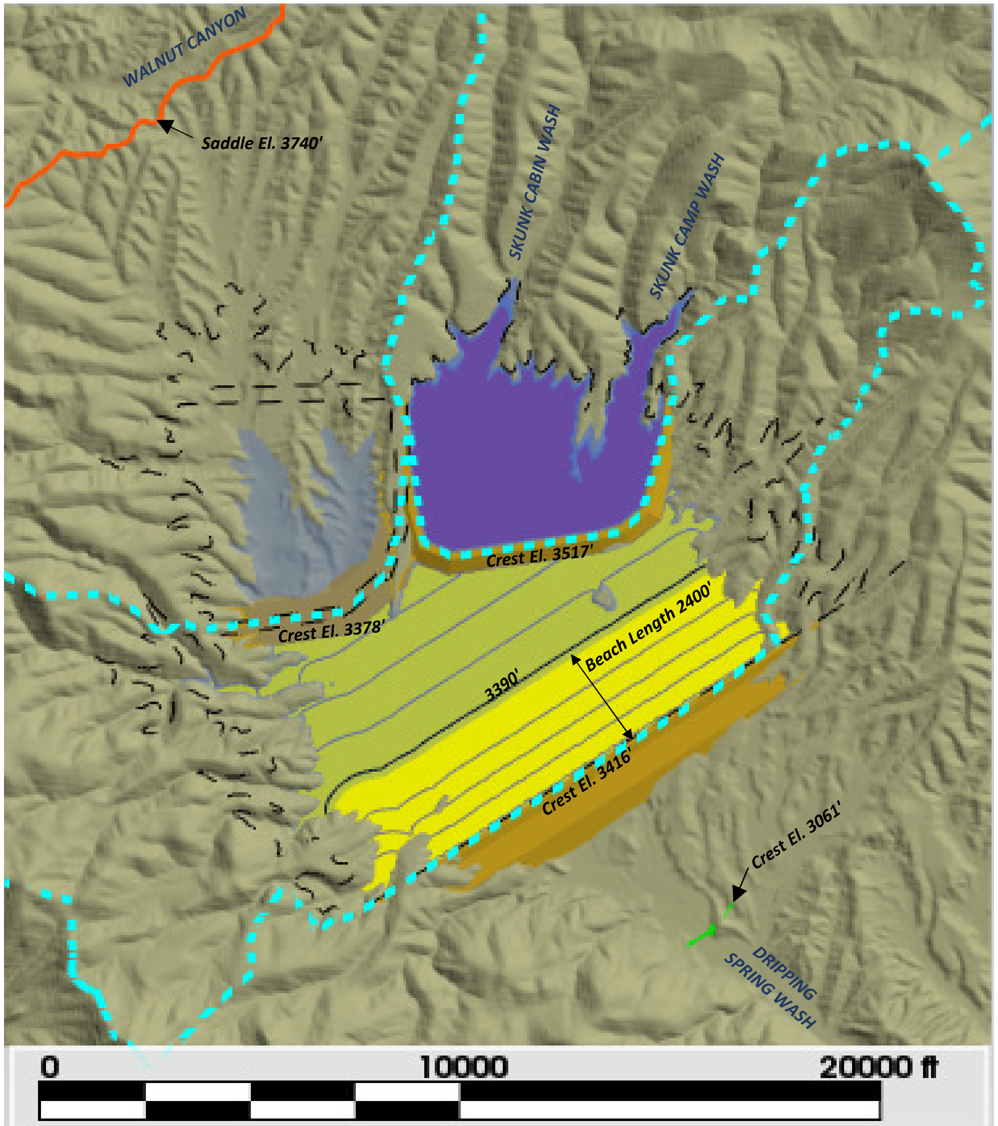
TITLE

YEAR 10
(STAGE II)

PROJECT No.	FIG No.
M09441A20	II-A.4



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TITLE

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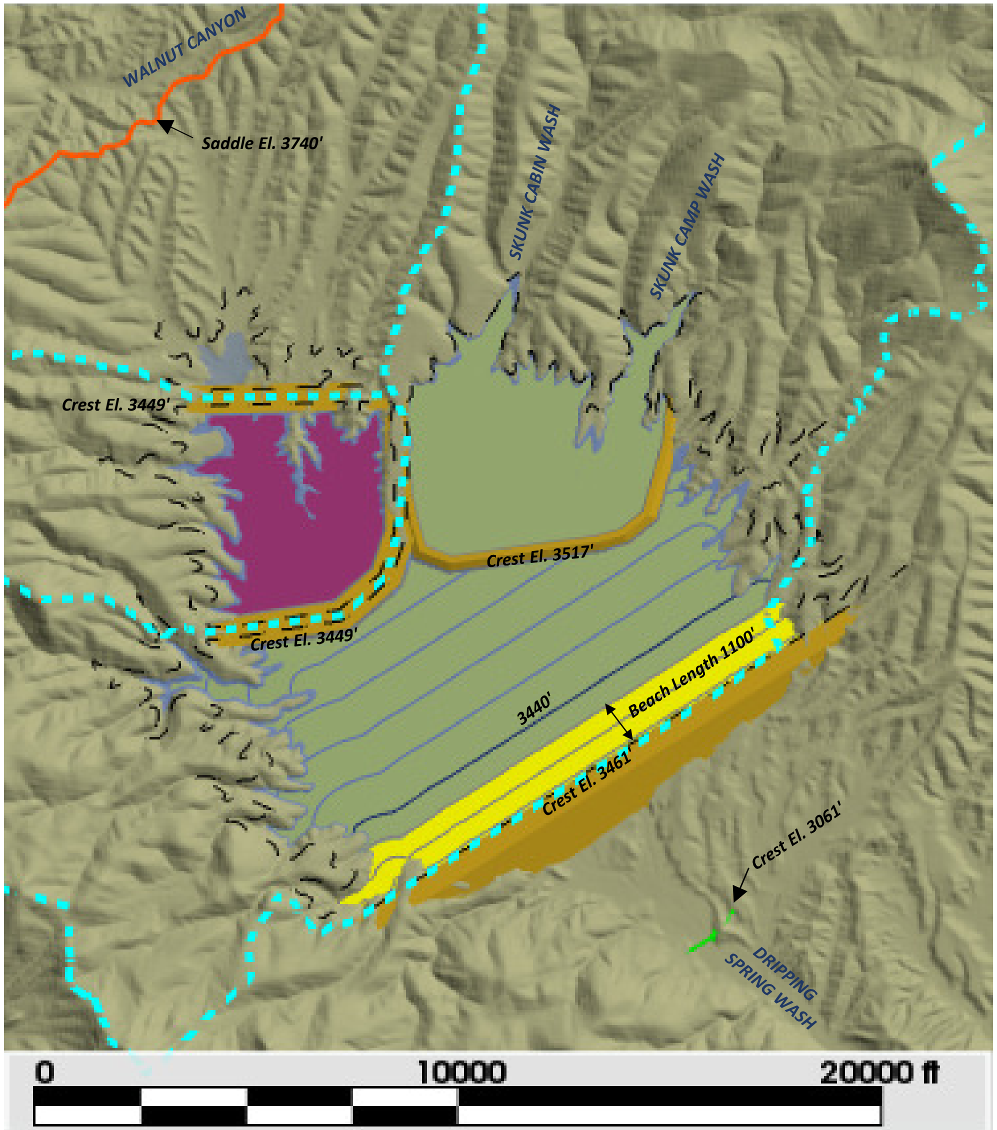

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- CATCHMENTS FOR PMF VOLUME ESTIMATES
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(STAGE III)

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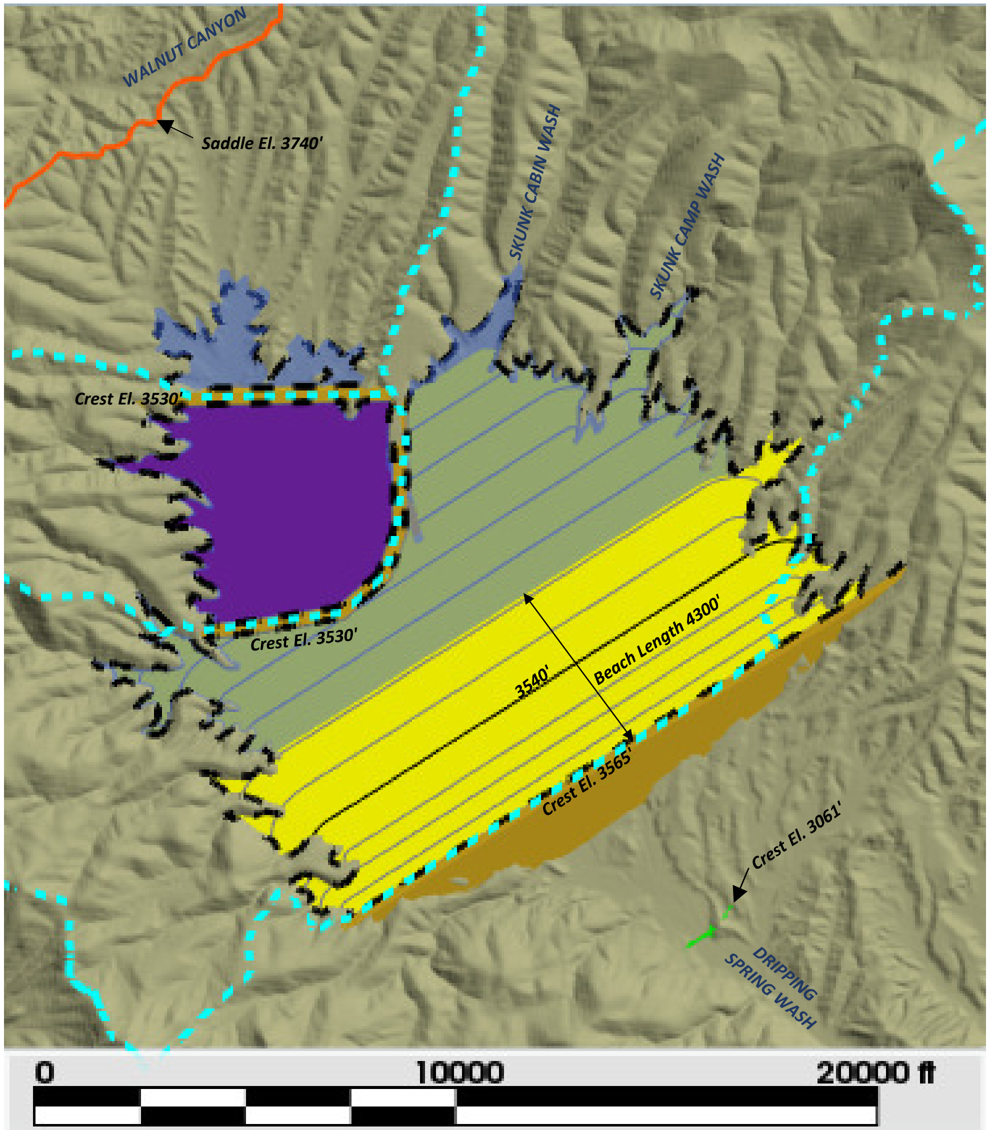
FIG No. II-A.6



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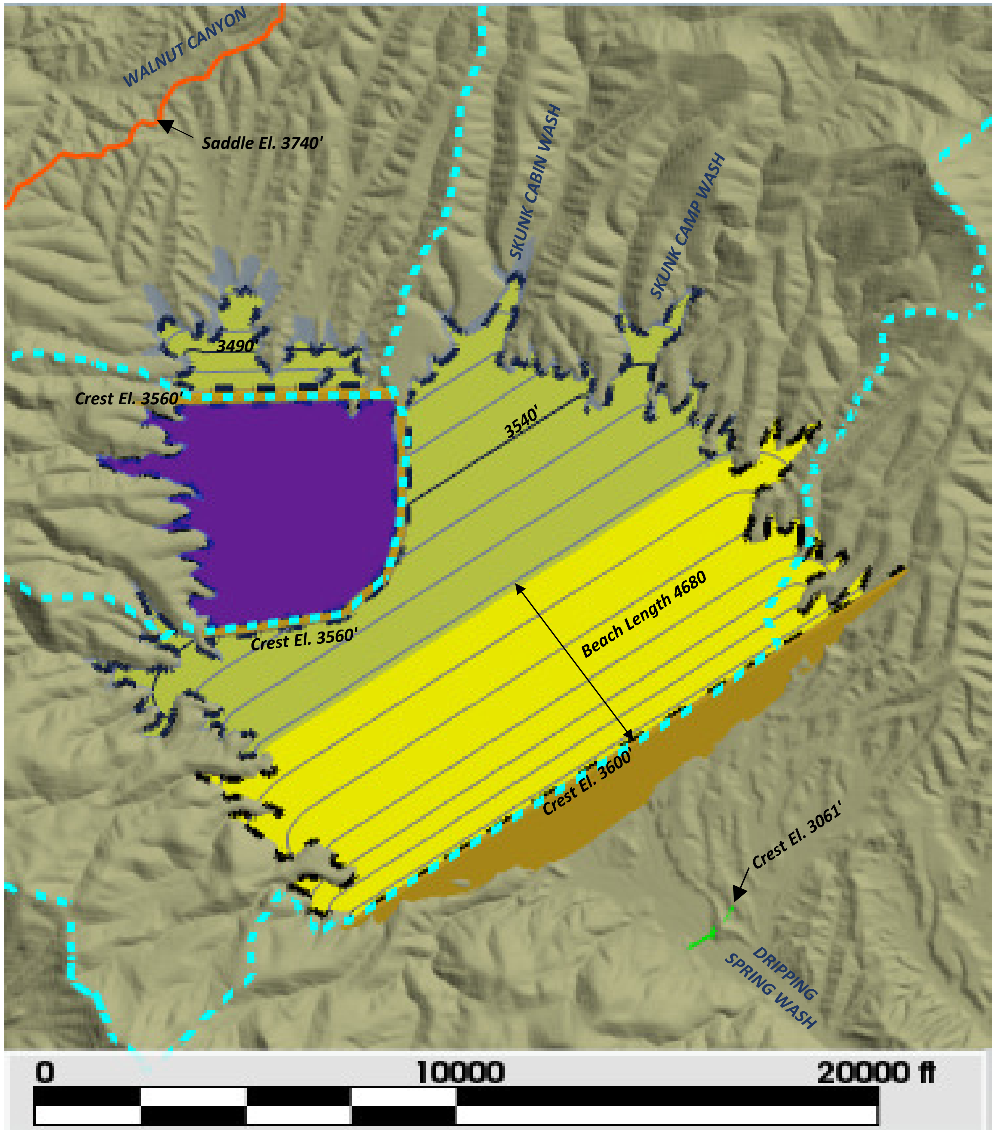
TITLE: YEAR 30
(STAGE III)

PROJECT No. M09441A20

FIG No. II-A.7



LEGEND

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TITLE

YEAR 41
(END OF STAGE IV)

PROJECT No. M09441A20

FIG No. II-A.8

APPENDIX III

Water Balance

Resolution Copper Project

DEIS Design for Alternative 6 – Skunk Camp

Technical Memorandum

Appendix III – Water Balance

DISCLAIMER

Appendix III
Alternative 6 - Water Balance

Table of Contents

List of Tables

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III-1 INTRODUCTION

This appendix summarizes the preliminary water balance results for DEIS Alternative 6 – Skunk Camp Tailings Storage Facility (TSF).

The purpose of the water balance assessment is to provide inputs into the following assessments completed by others:

- site-wide water balance to estimate make-up water requirements; and
- downstream solute transport.

The scope of this work is to estimate the water flows associated with the TSF for three periods of the mine life. These periods are: production ramp-up, full-production and production ramp-down.

The water balance results presented herein have been estimated using simplified analyses and are meant for comparative analyses between TSF alternatives only.

III-1.1 General

A water balance of the TSF was completed to estimate the water flows for three periods of the mine life; these periods are: production ramp-up, full-production and production ramp-down.

The water balance concept is shown in Figure III-1; input parameters and assumptions are summarized in Figure III-2, these are based on the design basis memorandum (DBM) in Appendix I, the tailings staging plan in Appendix II, and the seepage estimate in Appendix IV.

Key assumptions for the Skunk Camp water balance are:

- climate and hydrology inputs are estimated based on regional trends;
- the upstream catchments would be diverted around the proposed TSF as much as possible (runoff from these catchments are not included in this assessment);
- scavenger tailings would be thickened and deposited in the TSF at 60% solids content;
- tailings hydraulic properties are from the tailings characterization (KCB 2018a);
- saturation of total scavenger, thickened scavenger and cyclone overflow at placement is 80% based on a relationship derived from 1D seepage analyses results (KCB 2018b);
- ponding would be minimized on the scavenger beach surface and in the seepage collection pond to limit evaporation losses; and
- seepage losses are based on the assumptions presented in Section III-1.2.

III-1.2 Seepage Lost to the System Assumptions

Seepage from the TSF was separated into three areas:

1. seepage through the engineered low-permeability layer from the pyrite cell pond directly above the layer;
2. seepage through the engineered low-permeability layer from the pyrite tailings; and
3. seepage from the scavenger tailings.

III-1.2.1 Seepage from the Pyrite Pond

Seepage from the pyrite cells ponds is the seepage from the pond that is in direct contact with the liner. All seepage from the pyrite cells pond through the low-permeability liner (modeled as a geomembrane) was assumed to not be collected downstream and lost from the TSF System. The seepage rate was estimated using the Giroud (1997) equation (as shown in Equation 1 below) for flow through a circular defect in a geomembrane liner. The estimated unit seepage flux is multiplied by the defect density and the pond area to get total seepage out of the ponds.

Giroud (1997) Unit Seepage = $C_{qo}\,[1+0.1(h/t_s)^{0.95}]a^{0.1}h^{0.9}k_s^{0.74}$ [in m^3/s/defect] (Equation 1)

Where:

- C_{qo} is 0.21 for good contact conditions between the liner and the foundation;
- h is the liquid head above the liner (m), which is taken as the height of water cover (estimated in the water balance model) divided by 2 to represent the average head above the liner;
- t_s is the thickness of the soil beneath the liner (m), assumed to be 1 m (conservative value to estimate seepage, however, increasing the thickness has only a minor effect on the seepage rates at the operating pond levels);
- a is the area of the defect (m^2/defect) (assumed to be $1.03 \times 10^{-5} m^2$/defect, see footnote[1]); and
- k_s is the permeability of the soil beneath the liner (m/s), assumed to be 8.2×10^{-6} cm/s based on Near West site investigation permeability estimate for weathered Gila (KCB 2017).

The resulting flux through the engineered low-permeability liner is approximately 1.3×10^{-9} ft/s, and is adjusted for the Pyrite Cell pond area over the mine life.

[1] For average condition, based on U.S. Department of the Interior Bureau of Reclamation (USBR). 2014. Design Standards No 13 – Embankment Dams. Chapter 20: Geomembranes. DS-13(20)-16 Phase 4 (Final). March.

III-1.2.2 Seepage from the Pyrite Tailings

Seepage from the pyrite tailings is the seepage through the tailings that is in contact with the liner. All seepage from the pyrite tailings through the low-permeability liner was assumed to not be collected downstream and lost to the TSF System. The flux of seepage through tailings and a low-permeability liner would be much less than the flux from a free pond through a low-permeability liner due to the presence of the tailings which restricts seepage loss. Therefore, the seepage flux from the pyrite tailings was assumed to be one order of magnitude less than the seepage flux estimated for the Pyrite Cell pond.

The resulting flux through the engineered low-permeability liner is approximately 1.0×10^{-10} ft/s which is adjusted for the pyrite tailings area over the mine life.

III-1.2.3 Seepage from the Scavenger Tailings

Lost seepage from scavenger tailings is the portion of total seepage that is not captured at the seepage collection ponds. Lost seepage is estimated to be 410 gpm (660 acre-ft/yr) at the end of operations (see Appendix IV) and is assumed to scale proportional to the scavenger beach area throughout operations.

The lost seepage rates estimated for the water balance are summarized in Table III-1.

Table III-1 Lost Seepage Comparison

Mine Years	Water Balance Seepage Estimate		
	Pyrite Cell Lost Seepage	Scavenger Tailings Lost Seepage	Total Lost Seepage
	(acre-ft/yr)	(acre-ft/yr)	(acre-ft/yr)
1 to 7	2	112	114
8 to 31	3	449	452
32 to 41	3	624	627

III-1.3 Results

The water balance results are given on Figure III-1 and the estimated losses from the TSF system over the mine life are shown on Figure III-3.

TSF Water Balance Inflows

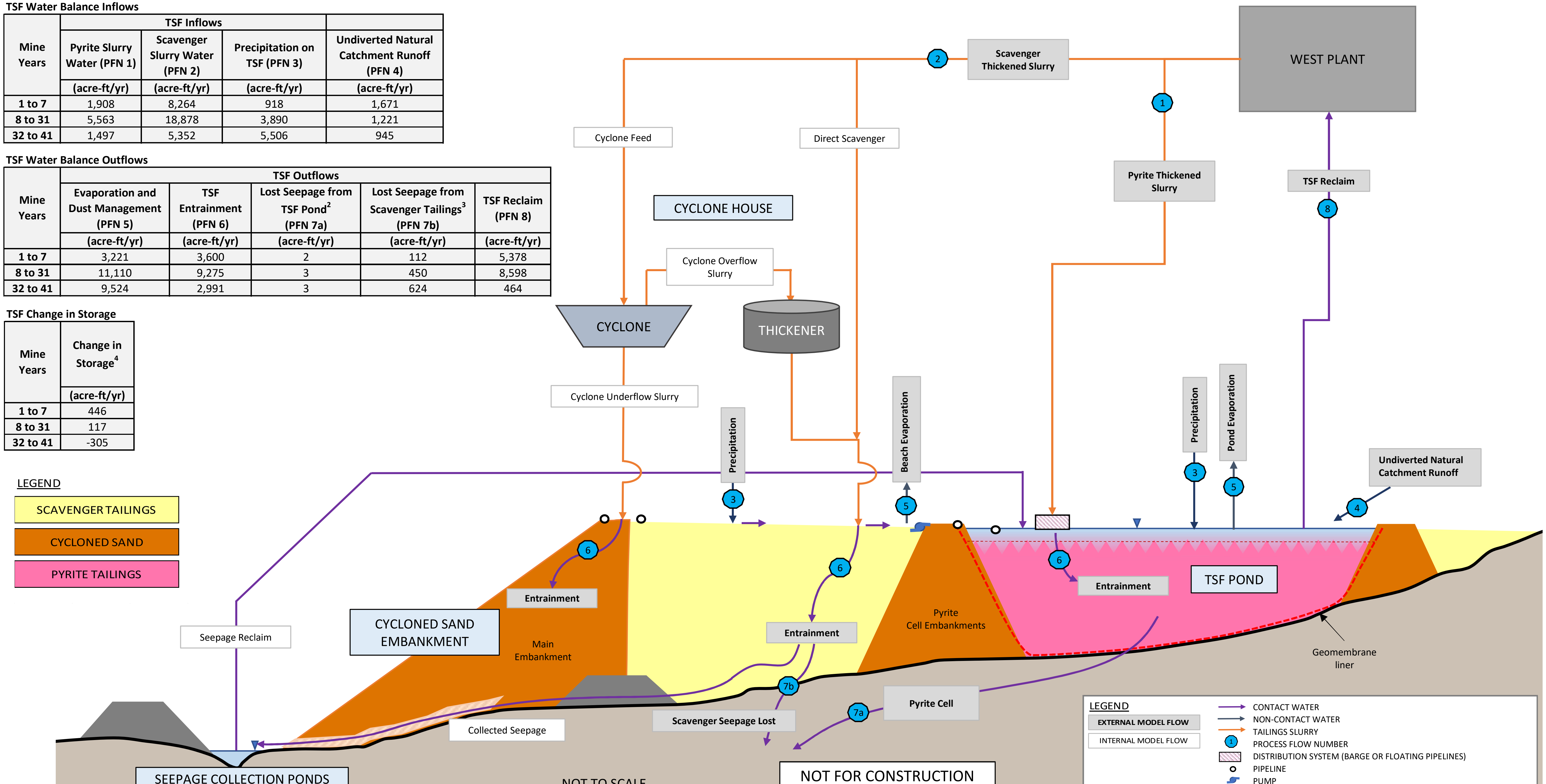
Mine Years	TSF Inflows				Undiverted Natural Catchment Runoff (PFN 4)
	Pyrite Slurry Water (PFN 1)	Scavenger Slurry Water (PFN 2)	Precipitation on TSF (PFN 3)		
	(acre-ft/yr)	(acre-ft/yr)	(acre-ft/yr)		(acre-ft/yr)
1 to 7	1,908	8,264	918		1,671
8 to 31	5,563	18,878	3,890		1,221
32 to 41	1,497	5,352	5,506		945

TSF Water Balance Outflows

Mine Years	TSF Outflows				
	Evaporation and Dust Management (PFN 5)	TSF Entrainment (PFN 6)	Lost Seepage from TSF Pond[2] (PFN 7a)	Lost Seepage from Scavenger Tailings[3] (PFN 7b)	TSF Reclaim (PFN 8)
	(acre-ft/yr)	(acre-ft/yr)	(acre-ft/yr)	(acre-ft/yr)	(acre-ft/yr)
1 to 7	3,221	3,600	2	112	5,378
8 to 31	11,110	9,275	3	450	8,598
32 to 41	9,524	2,991	3	624	464

TSF Change in Storage

Mine Years	Change in Storage[4]
	(acre-ft/yr)
1 to 7	446
8 to 31	117
32 to 41	-305



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Notes:
1. See Figure III-2 for process flow summary tables and equations.
2. Lost seepage from the TSF Pond through the geomembrane liner was estimated using the Giroud (1997) equation.
3. Lost seepage from the Scavenger Tailings was estimated using a 2-dimensional SEEP/W model (see Appendix IV).
4. Change in storage reflects change in water volume stored in the TSF Pond and Seepage Collection Ponds, and excludes water entrained in tailings.

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TITLE

OPERATIONAL WATER BALANCE
SCHEMATIC AND RESULTS

SCALE	PROJECT No.	FIG No.
AS SHOWN	M09441A20	III-1

Process Flow 1 - Pyrite Slurry Water

Years	Pyrite Production[1] (million ton/yr)	Pyrite Solids Content[1] (%)	Pyrite Water Content	Pyrite Slurry Water (PFN 1) (acre-ft/yr)
1 to 7	2.7	50%	1.00	1,908
8 to 31	7.6	50%	1.00	5,563
32 to 41	2.0	50%	1.00	1,497

Slurry water is calculated based on the tailings production schedules and slurry percent solids using Equation 1 below.

$$slurry\ water\ (tons) = tailings\ mass\ (tons)\ x\ \frac{(100\% - slurry\ \%\ solids)}{slurry\ \%\ solids} \quad \textit{(Equation 1)}$$

Process Flow 2 - Scavenger Slurry Water

Years	Thickened Scavenger[1] (million ton/yr)	Scavenger Solids Content[1] (%)	Scavenger Water Content	Scavenger Slurry Water (PFN 2) (acre-ft/yr)
1 to 7	17.2	60%	0.67	8,264
8 to 31	38.5	60%	0.67	18,878
32 to 41	10.6	60%	0.67	5,352

Precipitation on ponds is calculated using Equation 2 below.

$$Precipitation\ on\ TSF = TSF\ area\ x\ precipitation \quad \textit{(Equation 2)}$$

Process Flow 3 - Precipitation on TSF

Years	Precipitation[1] (ft/yr)	TSF Area[2] (acre)	Precipitation on TSF (PFN 3) (acre-ft/yr)
1 to 7	1.58	574	918
8 to 31	1.58	2453	3,890
32 to 41	1.58	3518	5,506

Process Flow 4 - Undiverted Natural Catchment Runoff

Undiverted Natural Catchment Area[2] (acre)	Runoff Coeff.[3]	Natural Catchment Runoff (PFN 4) (acre-ft/yr)
7014	0.15	1,671
5134	0.15	1,221
3975	0.15	945

Runoff from undiverted upstream natural catchment areas is calculated using Equation 3 below.

$$Runoff = natural\ catchment\ area\ x\ runoff\ coeff.\ x\ precipitation \quad \textit{(Equation 3)}$$

Process Flow 5 - Evaporation

Years	Evaporation[1] (ft/yr)	Pond Area[2] (acre)	Wetted Beach and Embankment Area[4] (acre)	Evaporation (acre-ft/yr)	Dust Management[5] (acre-ft/yr)	Evaporation and Dust Management (PFN 5) (acre-ft/yr)
1 to 7	6.0	135	385	3,132	90	3,221
8 to 31	6.0	437	1,372	10,898	211	11,110
32 to 41	6.0	527	1,040	9,445	80	9,524

Evaporation is calculated using Equation 4 below.

$$Evaporation = (pond\ area + wetted\ beach\ area)\ x\ evaporation \quad \textit{(Equation 4)}$$

Process Flow 6 - TSF Entrainment

Years	Production Rates (million ton/yr)				TSF Entrainment (PFN 6) (acre-ft/yr)
	Cyclone Underflow	Cycloned Overflow	Total Scavenger	Pyrite	
1 to 7	6.3	7.5	3.4	2.7	3600
8 to 31	10.3	12.2	16.0	7.6	9275
32 to 41	0.6	0.7	9.3	2.0	2991

Tailings Properties

Property	Cyclone Underflow	Cyclone Overflow	Total Scavenger	Pyrite
Specific Gravity[3]	2.78	2.78	2.78	3.5
Placed Dry Density (pcf)[3]	113	81	81	106
In-Situ Saturation[3]	0.5	0.8	0.8	1
In-Situ Water Content	0.10	0.33	0.33	0.30

Entrainment is calculated as the water stored in the pores of the tailings at the placed saturation using Equation 5 below.

$$water\ entrained\ in\ tailings\ (tons) = tailings\ mass\ (tons)\ x\ in\ situ\ tailings\ water\ content \quad \textit{(Equation 5)}$$

In situ tailings water content is calculated using Equation 6 below.

$$in\ situ\ water\ content = \frac{saturation\ x\ (\frac{specific\ gravity\ of\ tailings\ x\ density\ of\ water}{dry\ density\ of\ tailings} - 1)}{specific\ gravity\ of\ tailings} \quad \textit{(Equation 6)}$$

Total Water Entrained is the sum of water entrained in cyclone underflow, cyclone overflow, total scavenger and pyrite tailings.

Notes:
1. Values taken from DBM (Appendix I).
2. Values taken from Tailings Staging (Appendix II).
3. Runoff coefficient applies to natural ground areas only.
4. Wetted beach and embankment areas were estimated for the purpose of calculating evaporation based on average precipitation, rate of tailings and cycloned sand deposition, downward seepage rates, and progressive reclamation of the embankment.
5. Dust management is required on unreclaimed areas of the embankment where cycloned sand is not being actively deposited.

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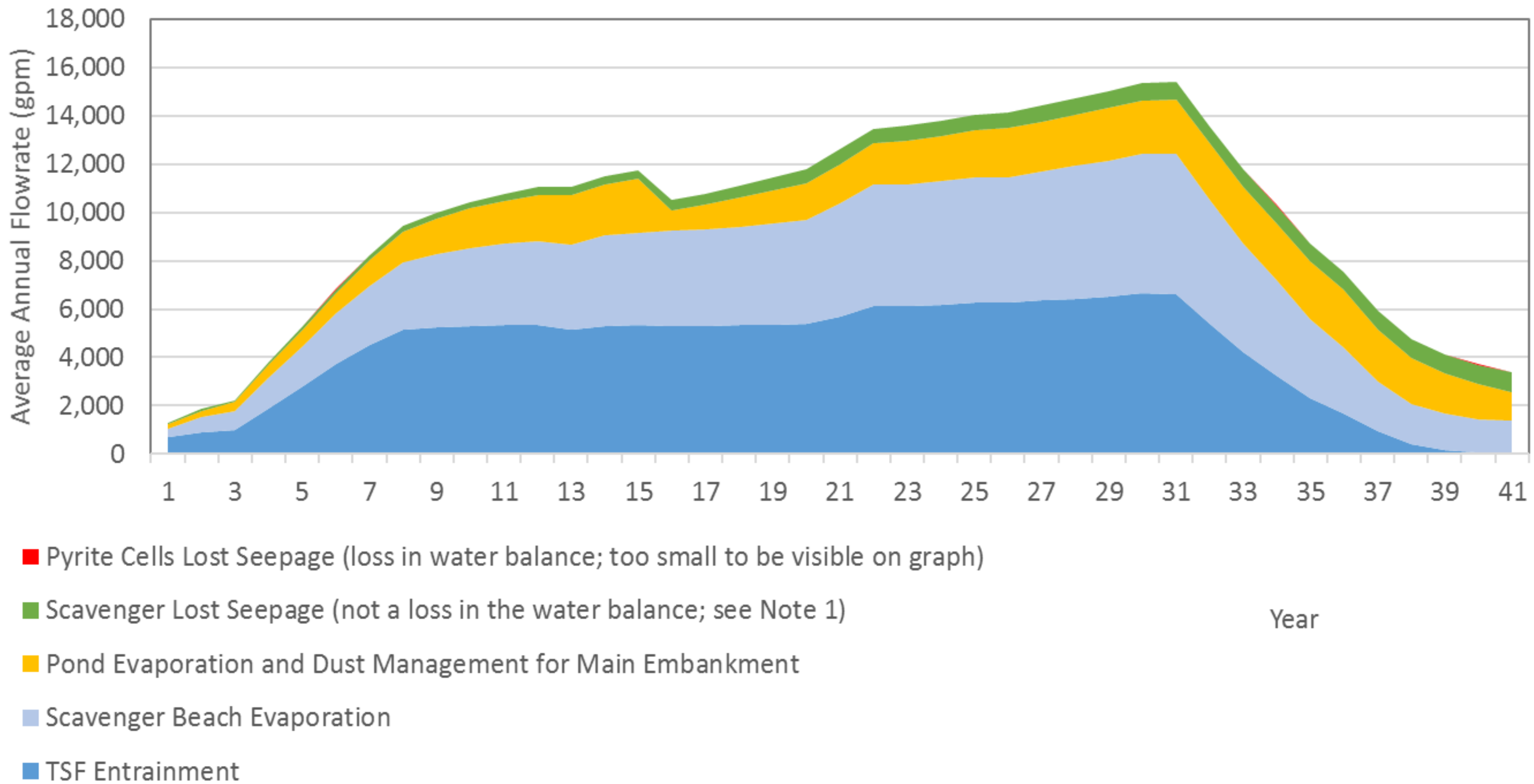
TITLE: OPERATIONAL WATER BALANCE ASSUMPTIONS

SCALE: AS SHOWN | PROJECT No.: M09441A20 | FIG No.: III-2

Figure III-3 TSF System Losses during Operation



Note 1: Scavenger lost seepage is the leakage/infiltration rate through the scavenger tailings

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APPENDIX IV

Seepage

Resolution Copper Project

DEIS Design for Alternative 6 – Skunk Camp

Technical Memorandum

Appendix IV – Seepage Estimate

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Appendix IV
Alternative 6 - Seepage Estimate

IV-1 INTRODUCTION

This appendix summarizes the simplified seepage assessment methodology and results for the Draft Environmental Impact Statement (DEIS) Alternative 6 – Skunk Camp Tailings Storage Facility (TSF). The basis for the seepage assessment is the ultimate TSF layout (see Appendix II), the tailings properties (see the design basis memorandum (DBM) in Appendix I) and assumed foundation conditions for the Skunk Camp site, which is based on a preliminary review of available background information, including regional geological maps, well log information for a small number of wells, and preliminary site reconnaissance visits by RC and KCB.

The conceptual seepage model was developed based on a previous version of the TSF layout. The TSF layout has since been updated to reduce the exposed Pyrite Cell pond surface area, to limit the effect of evaporation and ease water management challenges. The revised layout consists of two pyrite cells: Pyrite Cell 1, operated from Year 1 to Year 15 and subsequently covered by scavenger tailings in Year 16, and Pyrite Cell 2, operated from Year 16 to Year 41. The seepage model is assumed to be appropriate for the new layout because of the similar configuration in two-dimensions (2D), as shown on Figure IV-1.

IV-2 HYDROGEOLOGICAL SETTING

Limited sub-surface information is available for the Skunk Camp TSF site (the Dripping Springs Wash Basin). Characterization of the hydrogeological setting has been developed based on a review of regional mapping by the U.S. Geological Survey (Cornwall and Krieger 1978, Cornwall and Banks 1971) and Arizona Geological Survey (Dickinson 1992), as well as notes from preliminary site visits by KCB and RC staff, commentary from the Arizona Department of Water Resources (2009), and existing well logs and springs inventory, where available. Depth to water has been measured by RC staff in a few wells during their site visits.

Further details on the site characterization is included in Section 2 of the main text of the report.

A conceptual understanding of the hydrogeological setting has been developed based on a desktop review of available literature, which is to be updated during later stages of design through site specific geotechnical and hydrogeological investigations.

Regional groundwater is assumed to flow from northwest to southeast within the proposed TSF area at the Skunk Camp site. The majority of groundwater flow is expected to occur within the surface alluvial channels and upper weather zone of the bedrock, the Gila Conglomerate. Alluvium is the principal aquifer for wells within the region (ADWR 2009), noted in literature as being less than 150 ft. thick. Recent measurements of depth to groundwater levels within the Gila Conglomerate, undertaken by RC, indicate that groundwater levels are approximately 70 ft. below the ground surface, or deeper, along the eastern edge of the site.

It is anticipated that several regional features may also affect the regional groundwater flow and potential TSF seepage within the basin, including:

- The Gila Conglomerate, which forms the foundation of the proposed facility, is variable across the site, and has been noted to be less cemented at surface than the Gila Conglomerate observed at the Near West site, particularly in areas towards the north of the site.
- The highland areas of Dripping Springs Wash Basin, including Pinal Peak, are anticipated to be areas of high groundwater recharge for the region. These recharge areas cover a large proportion of the surface area within the catchment upstream of the proposed Skunk Camp TSF, which would result in groundwater flow contributing to the site from the catchment to the east of the facility.
- A surface water divide is located between Dripping Springs Wash, where Skunk Camp TSF is proposed to be located, and Mineral Creek. It is anticipated that this surface water divide is also a potential groundwater divide. Further assessment of this groundwater divide is required to assess the potential for TSF seepage to migrate towards the north into Mineral Creek, once the Skunk Camp TSF has been established.
- Downstream of the site, the Gila River acts as the regional drainage point. This river collects surface and groundwater runoff from the surrounding areas and flows year-round.
- The Ray Mine open pit is located in an adjacent surface water catchment, across a catchment divide to the east of the proposed Skunk Camp TSF area. This operational pit likely acts as a regional groundwater sink; however, it is not clear if the faults and associated bedrock units located between the Skunk Camp site and the Ray Mine Open Pit would act as a low permeability boundary between the sites. Based on preliminary discussions, we understand that active dewatering is currently being undertaken in the Ray Mine open pit.

Based on this understanding of the hydrogeological setting for the proposed TSF, the working assumptions for the seepage assessment are:

- the alluvium is the major pathway for groundwater flow, and acts as the primary aquifer in the region;
- the Gila Conglomerate at depth has a relatively low permeability compared to the alluvium and some of the other bedrock units in the area and may also act as a limited regional aquifer;
- the direction of groundwater flow is predominantly northwest to southeast, with no groundwater flow contribution towards the north across the catchment divide to Mineral Creek; and
- groundwater flow contribution from the Pinal Peak catchment to the east of the facility does not contribute to near-surface groundwater flow at the proposed TSF location; and, groundwater flow/seepage towards the north of Ray Mine from the proposed TSF does not occur.

These working assumptions are based on our current understanding of the foundation and should be re-evaluated when more information on the foundation is available.

IV-3 CONCEPTUAL MODELS

Based on the hydrogeological setting described above, two conceptual two-dimensional (2D) seepage models for the basin were developed in order to undertake a preliminary estimate of groundwater seepage and to aid in locating seepage mitigation and collection measures for the DEIS design for operation, and following closure. Steady-state models of the groundwater regime for operations and post-closure were developed using the software package SEEP/W. 2D models were assumed to be reasonable at this level of design as the majority of the groundwater flow is anticipated to be from the northwest to the southeast through near-surface alluvium. The steady-state condition was assumed to be applicable and conservative at this level of design; furthermore, due to limited site information a transient simulation was not undertaken.

The conceptual models consider 2D sections through the proposed TSF centerline, see Figure IV-1.

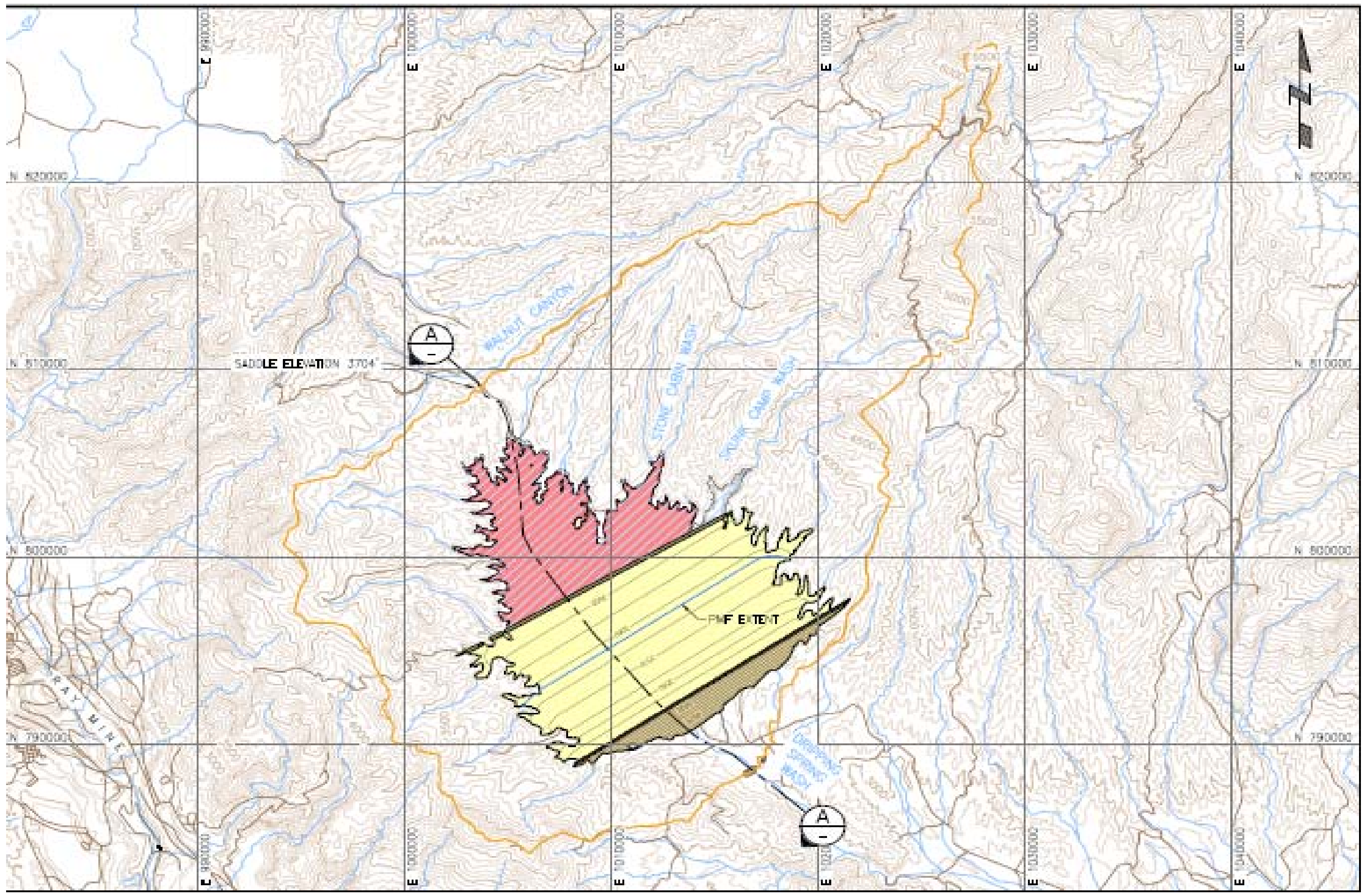
IV-3.1 Operations Seepage Model

The conceptual representation of seepage during operation is presented as Figure IV-2, which shows the simplified geometry for the TSF and the boundary conditions. The conceptual model incorporates the effects of natural groundwater recharge upstream of the pyrite tailings cell (between the groundwater divide to Mineral Creek and the TSF), and downstream of the TSF, as well as the anticipated infiltration from the tailings into the natural ground.

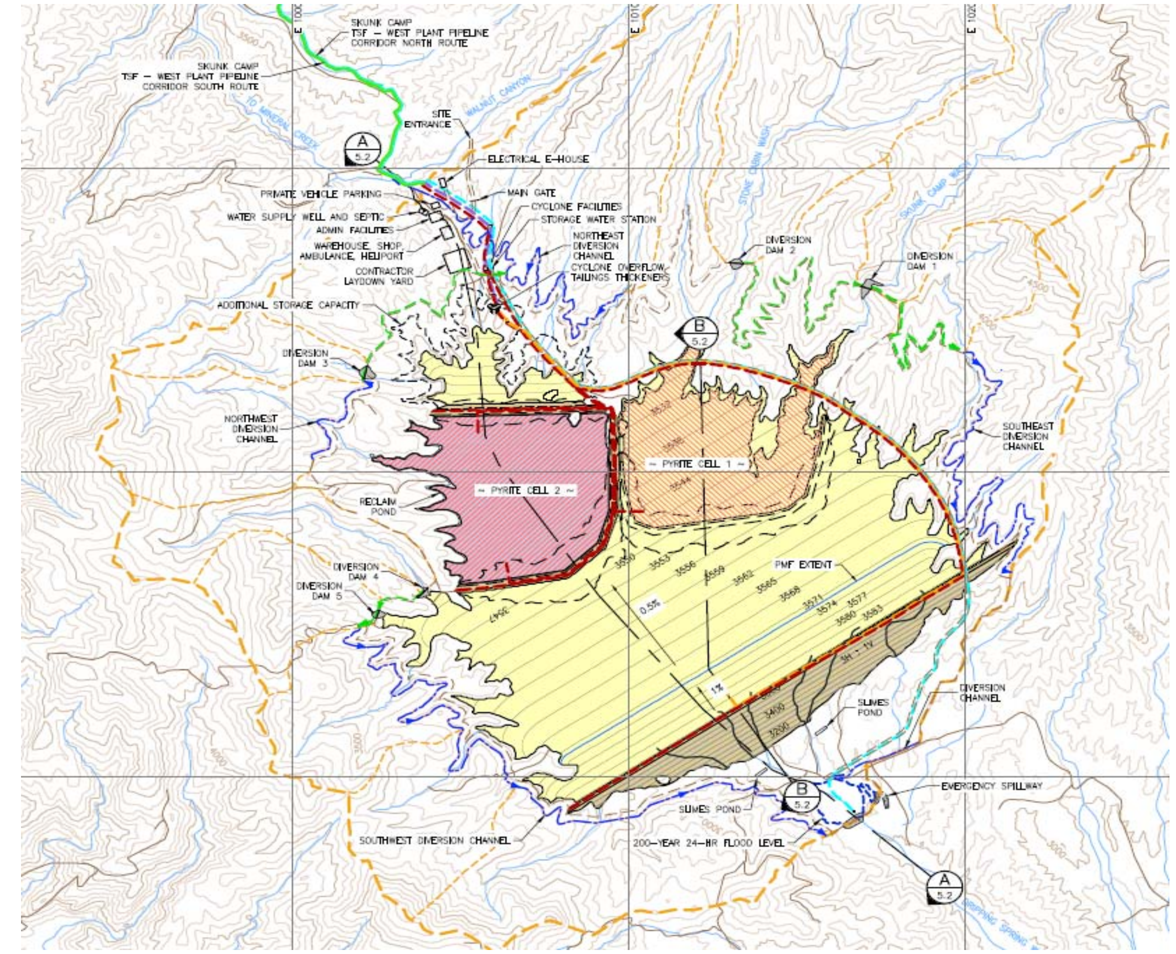
The foundation of the facility is assumed to be on an approximately 20 ft thick alluvium layer, which is assumed to directly overlay a 50 ft thick weathered Gila Conglomerate layer, which is assumed to overlay the more competent Gila Conglomerate. For the purposes of analysis, we have assumed that the underlying competent Gila Conglomerate extends to 1,000 ft below the ground surface, based on regional well logs reviewed during model development.

The proposed Skunk Camp TSF includes two cycloned sand embankments that separately store the scavenger tailings and pyrite tailings. Both embankments are proposed to be centerline-raised, cross-valley embankments. Uncycloned scavenger tailings and cyclone overflow would be stored behind the main embankment. The pyrite tailings would be subaqueously deposited behind a second embankment, upstream from the main embankment and scavenger tailings. The pyrite tailings cell would include engineered, low-permeability layers to minimize seepage and maintain a pond for pyrite tailings saturation, which is modeled as a constant head boundary condition.

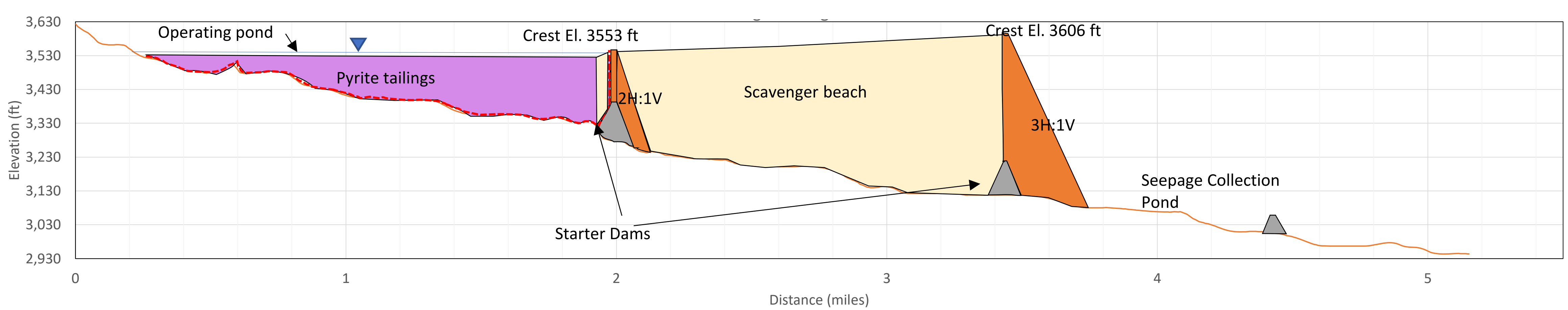
Boundary conditions assumed for the model include a no-flow boundary established at the surface water / groundwater divide north of the proposed facility, groundwater recharge in areas not covered by the proposed TSF and infiltration through the tailings for areas covered by the proposed TSF. Boundary conditions are further described in Section IV-4.2.



Previous Skunk Camp Design



Updated Skunk Camp Design



CONCEPTUAL CROSS SECTION

LEGEND

- PYRITE TAILINGS
- SCAVENGER TAILINGS
- CYCLONED SAND MAIN EMBANKMENT AND PYRITE CELL EMBANKMENT
- SEEPAGE COLLECTION DAM AND STARTER DAMS
- ENGINEEERED LOW-PERMEABILITY LAYER
- 60 FT CONTOUR INTERVAL

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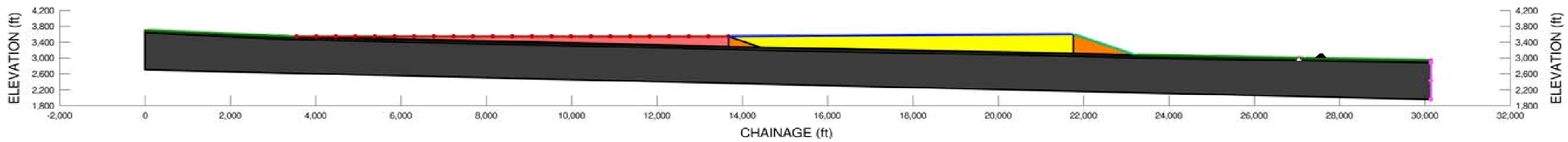
DEIS DESIGN FOR ALTERNATIVE 6 - SKUNK CAMP

TITLE: APPROXIMATE CONCEPTUAL SEEPAGE MODEL SECTION LOCATION

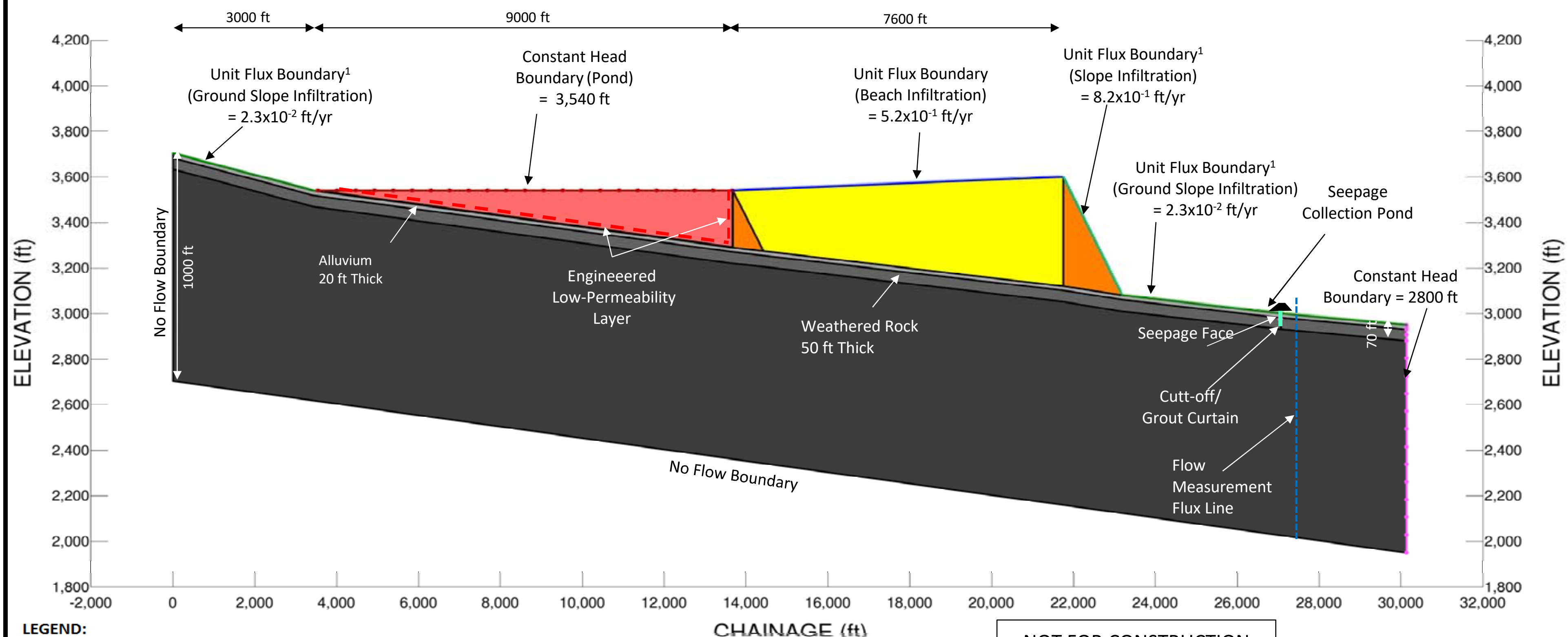
PROJECT No. M09441A20 | FIG No. IV-1

2018-08-08
Z:\M\VCR\M09441A20 - RES-Near West PFS-PES\700 Deliverables\730 Issued\738 DEIS SkunkCamp\180808-Report-App-Final_Rev1\04-App IV - Seepage\Figures\[Figure IV-1.xlsx]Fig IV-1

Natural Scale:



5x Vertical Exaggeration:



NOT FOR CONSTRUCTION

LEGEND:

	Cyclone Sand
	Scavenger Tailings
	Pyrite Tailings
	Alluvium
	Weathered Rock
	Base Rock
- - -	Engineered Low-Permeability Layer

NOTES:

1. Seepage face review allowed.

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DEIS DESIGN FOR ALTERNATIVE 6 - SKUNK CAMP

TITLE

CONCEPTUAL SEEPAGE MODEL

OPERATIONS

PROJECT No. M09441A20

FIG No. IV-2

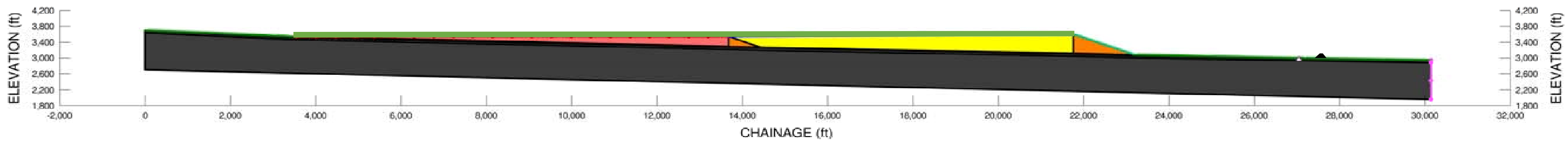
IV-3.2 Closure Seepage Model

The conceptual representation of seepage post-closure is presented as Figure IV-3, which is based on the simplified geometry for the TSF, as developed for the Operations Seepage Model, with changes to the defined boundary conditions to reflect the closure design for the facility.

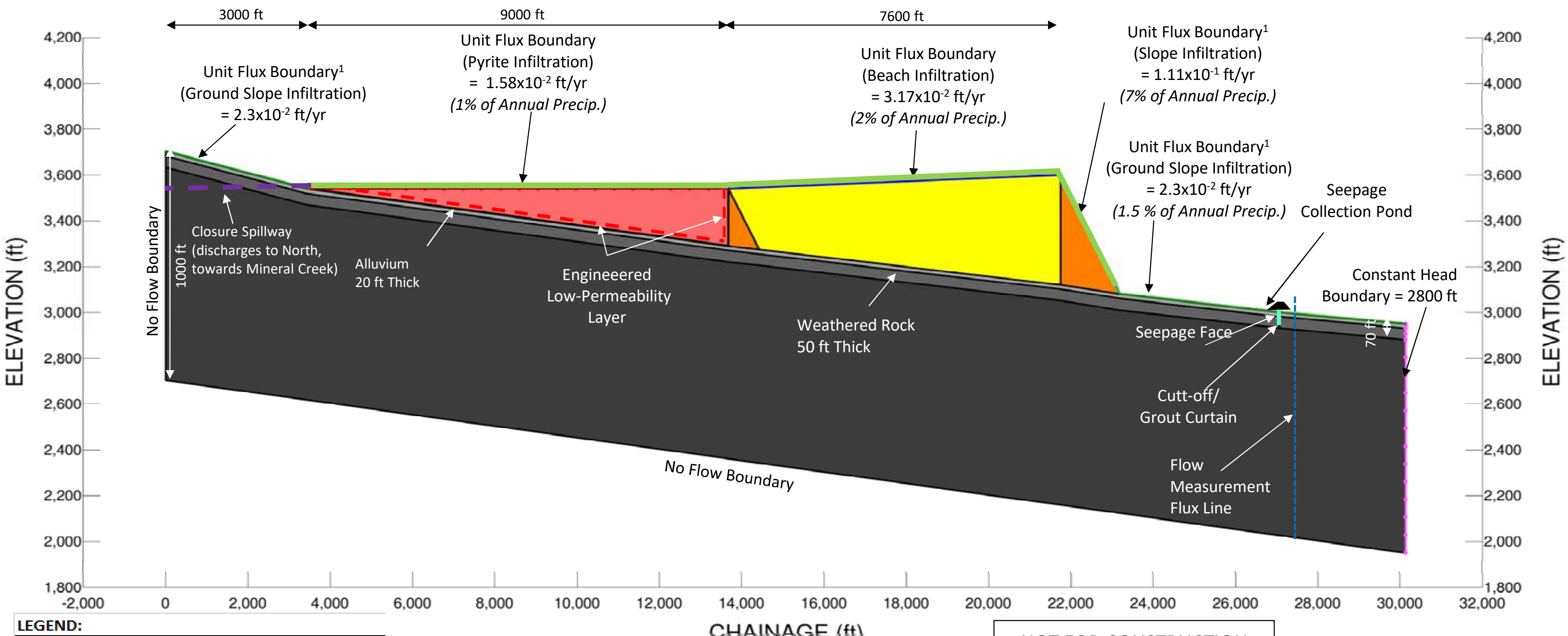
At the end of operations, the pyrite tailings cell will be covered with a layer of scavenger tailings, followed by the construction of a cover system, placed over the top of both the scavenger and pyrite impoundment surfaces. This cover would be shaped to shed water to a closure spillway, so that no permanent ponds would be impounded on surface, and the surface would be revegetated.

Boundary conditions assumed for the model include a no-flow boundary established at the surface water / groundwater divide north of the proposed facility, groundwater recharge in areas not covered by the proposed TSF and infiltration through the closure cover for areas covered by the proposed TSF.

Natural Scale:



5x Vertical Exaggeration:



LEGEND:

	Cyclone Sand
	Scavenger Tailings
	Pyrite Tailings
	Alluvium
	Weathered Rock
	Base Rock
	Engineered Low-Permeability Layer
	Closure Cover

NOTES:

1. Seepage face review allowed.

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DEIS DESIGN FOR ALTERNATIVE 6 - SKUNK CAMP

TITLE

CONCEPTUAL SEEPAGE MODEL
STEADY-STATE POST-CLOSURE

PROJECT No. M09441A20

FIG No. IV-3

IV-4 MODEL INPUTS AND ASSUMPTIONS

IV-4.1 Material Properties

The material properties for the units included in the analysis are presented in Table IV-1.

Table IV-1 Summary of Material Properties

Unit	Assumed Foundation Thickness (ft)	Horizontal Hydraulic Conductivity, k_h (ft/yr)	Horizontal Hydraulic Conductivity, k_h (cm/s)	Anisotropic k_h/k_v Ratio	Comments / Reference
Pyrite Cell Low Permeability Layer	--	0.0001	1×10^{-10}	1	Assumed to be a geomembrane liner.
Cycloned Sand	--	5,200	5×10^{-3}	10	KCB 2018a
Pyrite Tailings	--	0.52	5×10^{-7}	1	KCB 2018a
Scavenger Tailings	--	10	1×10^{-5}	10	KCB 2018a
Cut-off/ Grout Curtain	--	1.0	1×10^{-6}	1	70'deep cut-off trench at the seepage collection pond.
Alluvium	20	10,000	1×10^{-2}	1	Assumed to be similar to the Near West site (M&A 2017)
Gila Conglomerate (weathered surficial layer)	50	100	1×10^{-4}	10	Assumed to be higher permeability in comparison to the Near West site (M&A 2017) based on less cementation observed at Skunk Camp
Gila Conglomerate (fresh, at depth)	930	10	1×10^{-5}	10	Assumed to be higher permeability in comparison to the Near West site (M&A 2017) based on less cementation observed at Skunk Camp. well logs indicate some cementation at depth, but needs to be verified during PFS.

IV-4.2 Boundary Conditions

The model boundary conditions are as presented in Table IV-2 for the Operations Seepage Model, and Table IV-3 for the Post-Closure Seepage Model.

Table IV-2 Summary of Model Boundary Conditions – Operations Seepage Model

Boundary	Assumed Condition	Comments
Groundwater Divide	No Flow Boundary	Assumed that groundwater would not flow north. This should be evaluated when more information on the foundation is known.
Natural Ground	Infiltration at 0.23 ft/yr	Assumed to be 1.5% of annual precipitation, which is typical for the area.
Pyrite Cell	Constant Head at 3,540 fasl	Elevation of the pond.
Scavenger Beach	Infiltration at 0.52 ft/yr	Prorated, based on slurry solids contents, from the estimated infiltration for Near West Alternative 3A and Alternative 3B (KCB 2018b, KCB 2018c).
Embankment Face	Infiltration at 0.82 ft/yr	Based on the predicted Near West Alternative 3A infiltration (KCB 2018b).
Downstream	Constant Head at 2,800 fasl	Located 1,000 ft downstream of facility, prior to next major wash. Based on depth to groundwater at 70 fbgs (measured depth at one well at the site).
Foundation	No Flow Boundary	Located at a depth of 1,000 ft below facility, based on the assumption that the majority of flow would be near surface

Table IV-3 Summary of Model Boundary Conditions – Post-Closure Seepage Model

Boundary	Assumed Condition	Comments
Groundwater Divide	No Flow Boundary	Assumed that groundwater would not flow north. This should be evaluated when more information on the foundation is known.
Natural Ground	Infiltration at 0.23 ft/yr	Assumed to be 1.5% of annual precipitation, which is typical for the area.
Reclaimed Pyrite Cell	Infiltration at 0.16 ft/yr	Assumed to be 1% of annual precipitation (based on KCB 2016).
Reclaimed Scavenger Beach	Infiltration at 0.32 ft/yr	Assumed to be 2% of annual precipitation (based on KCB 2016).
Embankment Face	Infiltration at 1.11 ft/yr	Assumed to be 7% of annual precipitation (based on KCB 2016).
Downstream	Constant Head at 2,800 fasl	Located 1,000 ft downstream of facility, prior to next major wash. Based on depth to groundwater at 70 fbgs (measured depth at one well at the site).
Foundation	No Flow Boundary	Located at a depth of 1,000 ft below facility, based on the assumption that the majority of flow would be near surface

IV-5 RESULTS

Assuming a representative length of 15,000 ft (approximately 2.8 miles) for the TSF embankment, cross-valley length, the results of the model are as presented in Table IV-4 for the Operations Seepage Model, and Table IV-5 for the Post-Closure Seepage Model.

Table IV-4 Summary of Model Results – Operations Seepage Model

Model Location	Flow (gpm)
Pyrite Cell Leakage	30
Scavenger Tailings Leakage	1,130
Seepage Collected at Seepage Pond	800
Flux Downstream of Seepage Dam and Grout Curtain(1)	410
Uncollected TSF Seepage(2)	350 – 410

Notes:
1. Calculated from a flux line and includes inflow from natural recharge and the TSF.
2. Range is estimated based on TSF seepage (tailings leakage less collected tailings leakage at the seepage collection pond) and total groundwater flux past the seepage dam.

Table IV-5 Summary of Model Results – Post-Closure Seepage Model

Model Location	Flow (gpm)
Pyrite Cell Leakage	35
Scavenger Tailings Leakage	90
Seepage Collected at Seepage Pond	0
Flux Downstream of Seepage Dam and Grout Curtain(1)	160
Uncollected TSF Seepage(2)	125 - 160

Notes:
1. Calculated from a flux line and includes inflow from natural recharge and the TSF.
2. Range is estimated based on TSF seepage (tailings leakage less collected tailings leakage at the seepage collection pond) and total groundwater flux past the seepage dam.

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