APPENDIX C. PRACTICABILITY ANALYSIS IN SUPPORT OF CLEAN WATER ACT 404(B)(I) ALTERNATIVES ANALYSIS

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PRACTICABILITY ANALYSIS IN SUPPORT OF CLEAN WATER ACT 404(B)(1) ALTERNATIVES ANALYSIS

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1. INTRODUCTION

Resolution Copper Mining, LLC (Resolution, or the Applicant) proposes to develop and operate an underground copper and molybdenum mine near Superior, Arizona. As proposed, the tailings storage facility (TSF), associated pipelines, and appurtenant infrastructure require the discharge of fill to surface water features that the U.S. Army Corps of Engineers (Corps) is anticipated to determine to be potentially jurisdictional waters of the United States (waters of the U.S.) pursuant to a preliminary jurisdictional determination (PJD). Based on the presumption that potentially jurisdictional waters of the U.S. will be impacted by discharges of dredged or fill material resulting from portions of Resolution's planned mine development, Resolution will need to make an application for a Clean Water Act (CWA) Section 404 permit for these discharges.

Because portions of Resolution's planned mine development occur on lands managed by the U.S. Forest Service (USFS) Tonto National Forest (TNF), Resolution submitted a General Plan of Operations (GPO) to the TNF in 2013 and subsequently amended it (Resolution 2016) to account for the USFS plan completeness review and the Southeast Arizona Land Exchange (land exchange) authorized in the National Defense Authorization Act (NDAA) for Fiscal Year 2015. The TNF deemed the GPO to be complete for the purpose of initiating review under the National Environmental Policy Act (NEPA) and has developed a draft of an Environmental Impact Statement (EIS) for the planned mine development and land exchange. Section 3003 of the NDAA authorized the exchange of lands between the federal government and Resolution and directed the USFS to prepare a single EIS as the basis for all decisions under federal law related to Resolution's proposed mine development. The NEPA analysis will ultimately lead to the issuance of a Record of Decision (ROD) by the USFS for Resolution's planned mining-related activities on National Forest System lands. The Corps is acting as a cooperating agency in the EIS process to meet its NEPA obligation triggered by Resolution's presumed need for a Section 404 permit authorizing the discharge of dredged or fill material to potential waters of the U.S.

Independent of the requirement to develop the EIS pursuant to NEPA and Section 3003 of the NDAA, an analysis of alternatives is required as part of Section 404 permitting in order to demonstrate compliance with guidelines established under CWA Section 404(b)(1) (40 CFR § Part 230; the Guidelines) for avoidance, minimization, and mitigation of impacts to waters of the U.S. A demonstration of compliance with the Guidelines is required before a Section 404 permit may be issued. The 404(b)(1) alternatives analysis is intended to ensure that no discharge be permitted "if there is a practicable alternative to the proposed discharge which would have less adverse impact on the aquatic ecosystem, so long as the alternative does not have other significant adverse environmental consequences" (40 CFR § 230.10(a)).

As discussed above, the Draft EIS (DEIS) analyzes the entirety of Resolution's planned mine development activities, as well as the congressionally authorized land exchange. Because only certain elements of Resolution's overall mine development activities involve a discharge of dredged or fill material into potential waters of the U.S. (i.e., the development of the TSF, associated pipelines, and auxiliary infrastructure), only those activities are required to be analyzed by the Corps under the Guidelines. This practicability analysis has been developed to support compliance with the Guidelines, identifies the basic and overall project purpose, describes the alternatives selected for detailed analysis, evaluates the practicability of each selected alternative, and discusses the environmental effects of each practicable alternative. Once finalized, the Corps will use this practicability analysis to complete its 404(b)(1) alternatives analysis, which will be used in the Corps permitting decision-making process.

2. PROJECT DESCRIPTION AND PURPOSE

2.1. Project Description

Resolution's planned mine development is located near Superior in Pinal County, Arizona (**Figure 1**) in an area called the Copper Triangle and specifically within the Pioneer Mining District. Mine exploration and operations have been conducted in the area since the early 1860's, when the discovery of silver led to the development of the Silver King Mine. Magma Copper Company (Magma) took over the Silver King Mine and operated it as the Magma Mine from 1912 until the concentrator was finally shut down in 1996. After Magma's shutdown, the Resolution ore deposit was discovered 1.2 miles south of the existing Magma Mine and 7,000 feet below the ground surface.

Resolution was formed as a limited liability company in 2004 by Rio Tinto and BHP Billiton. Rio Tinto is the managing entity and possesses a 55-percent ownership stake in Resolution, while BHP Billiton maintains 45-percent ownership. Since 2004, Resolution has steadily worked to investigate and delineate the Resolution ore body, develop a mine design, prepare environmental and engineering studies to support the mine permitting and approvals effort, and conduct multiple community outreach efforts and public meetings to inform and involve the public as plans were developed. These efforts led to the submittal of the GPO to the USFS in November 2013.

Resolution proposes the development of the Resolution ore body using panel caving, a type of cave mining. The copper and molybdenum ore will be mined, undergo primary crushing underground, and then be sent to a concentrator facility to be constructed at the existing West Plant Site north of Superior. Concentrate produced here will be transported offsite for additional processing, while the resulting tailings will be transported via a pipeline to the proposed TSF location. Under the current proposed operating conditions and Life of Mine (LOM) planning parameters, the Resolution ore body is sufficient to support the concentrator operations for approximately 41 years. As currently configured, operations are anticipated to result in the mining of approximately 1.4 billion tons of copper and molybdenum ore and the production of approximately 1.37 billion tons of tailings. While the mining process in general, and the planned locations of the ore and processing facilities in particular, are described in the GPO, locations for the TSF, pipelines, and auxiliary infrastructure are the primary subject of the alternatives analysis in the NEPA DEIS and the sole focus of this practicability analysis document. As configured, only the development of the TSF, pipelines, and auxiliary infrastructure require a discharge of dredged or fill material into potential waters of the U.S. Discharge of fill for the development of these features, particularly the TSF, consists mostly of the levelling of existing topography through cut and fill of the natural ground surface. Materials to be discharged to potential waters of the U.S. during this process would consist primarily of native soil and rock taken from the footprint of the constructed features during the grading process.

Processing of the copper and molybdenum ore from the Resolution ore body will result in the production of two physically, mineralogically and geochemically distinct types of tailings: 1) the scavenger or non-potentially acid generating (NPAG) tailings, and 2) the pyrite or potentially acid generating (PAG) tailings. NPAG tailings contain less than 0.1 percent of pyrite by weight (Duke HydroChem 2016). NPAG tailings will account for approximately 84 percent, or approximately 1.15 billion tons, of the tailings produced during the LOM. In contrast, PAG tailings contain a much higher amount of pyrite (>20% by weight) and will account for 16 percent, or approximately 0.22 billion tons, of the tailings produced during the LOM (KCB 2018a). These two very distinct types of tailings, and the management requirements for each (especially the PAG tailings) informed the design and operation of the proposed TSF alternatives evaluated in both the DEIS and this document.

2.2. PURPOSE AND NEED FOR THE PROJECT

The Applicant's overall project purpose and need is to construct and operate a TSF and associated infrastructure capable of storing approximately 1.37 billion tons of tailings produced through milling copper and molybdenum ore from the Resolution ore body (plus approximately 12 million cubic yards of on-site borrow material used to construct the starter embankments), along with the pipelines and associated infrastructure needed to transport tailings to the TSF and recycled water from the TSF back to the concentrator facility. Capacity to deposit approximately 1.37 billion tons of tailings is required to allow for utilization of the Resolution ore body to the extent described in the GPO (mining of approximately 1.4 billion tons of ore). The Applicant's basic project purpose is mine tailings storage, which is not water-dependent. However, the proposed discharge will not affect a special aquatic site, so the rebuttable presumption in 40 C.F.R. § 230.10(a)(3) is not triggered.

3. FORMULATION OF PROJECT ALTERNATIVES

The USFS and cooperating agencies (including the Corps)[1] have evaluated a number of alternative TSF designs and locations for detailed analysis in the DEIS. This evaluation is contained in the DEIS and other documents cited herein but will be summarized in the balance of this **Section 3** to explain the selection of the alternatives analyzed in detail for compliance with the Guidelines. This practicability analysis document has been designed to be consistent with, and relies on, the detailed analysis of TSF alternatives contained in the DEIS and supporting documents. Most of these

1 Henceforth in this document, references to the USFS in the context of development of the DEIS should be understood to include the agencies cooperating in the development of that document, including (but not limited to) the Corps.

alternatives, and the methodology for identifying them, are discussed in detail in the *Resolution Copper Project and Land Exchange Environmental Impact Statement DRAFT Alternatives Evaluation Report, November 2017* (SWCA 2017). Subsequently, another alternative (Skunk Camp) was identified for detailed analysis in the DEIS (USFS 2019).

The USFS utilized information gathered from public scoping, government-to-government consultation with Native American groups, and alternatives workshops to identify public values and develop screening criteria for reviewing alternative TSF development scenarios. Some of the key public issues raised during this scoping analysis were public health and safety, proximity to existing communities, and protection of aquatic and wildlife habitat (SWCA 2017). With these issues in mind, the USFS began evaluating the regional landscape to identify potential alternative TSF locations to that TSF location proposed in the GPO. The USFS systematically evaluated dozens of potential tailings locations and technologies for both the full volume and partial volumes (split volume storage) of tailings.

3.1. Geographic Scope for TSF Alternatives

In practice, transport distance for tailings is a significant factor in the economic recovery of the copper and molybdenum ore from the Resolution ore body, and the placement of tailings is not functionally independent of the fixed locus of that ore body. The USFS evaluated the landscape surrounding the Resolution mine to identify initial potential alternative locations for the TSF. Factors considered in this evaluation included locations within a reasonable proximity to the Resolution mine site, favorable topography, sufficient storage capacity, and a configuration suitable for conventional tailings impoundment construction as described in the GPO. As a part of this evaluation, the potential for use of previously disturbed, or 'brownfield', sites for TSF development was also included.

3.1.1. Brownfield Sites

The USFS evaluated brownfield sites associated with other current and previous mining operations not under the ownership of Resolution in locations up to 200 miles from the Resolution ore deposit. This evaluation included 15 brownfield sites not under Rio Tinto or Resolution Copper ownership, as well as the future subsidence zone anticipated from mining the Resolution ore deposit itself, as potential areas for the storage of tailings that might be available and practicable as alternatives to the development of a new TSF in a previously undisturbed location (SWCA 2017). These sites are shown in **Figure 2.** The evaluation considered whether the brownfield site had ongoing or publicly stated planned future mining operations, had other ongoing site activities, and had the capacity to contain a necessary volume of tailings (factors relating to the availability of the site under the Guidelines). Included in the evaluation of capacity for tailings storage was an investigation of the use of multiple brownfield sites so site capacity was evaluated for both storage of the total volume of tailings and storage of only the total volume of PAG tailings. If sites were available and practicable under these initial screening factors, they were further evaluated to determine if they were within a reasonable distance for the pumping of tailings. The evaluated sites are listed in **Table 1**.

Table 1. Brownfields Sites Investigated for Potential Tailings Storage (adapted from SWCA 2017)

Site Name	Ownership	Mining Activity Status	Approximate Distance (miles)[1]
Ajo	Freeport-McMoRan	Copper mine, potential for future operation	120
Carlota	KGHM International Ltd.	Copper mine, current operation	10
Casa Grande	ASARCO LLC	Copper mine, closed operation	49
Copper Queen	Freeport-McMoRan	Copper mine, closed operation, tourism	145
Copperstone	Kerr Mines Incorporated	Gold mine, closed operation	190
Sierrita	Freeport-McMoRan	Copper mine, current operation	100
Johnson Camp	Excelsior Mining Corp.	Copper mine, potential for future operation	100
Miami and Inspiration	Freeport-McMoRan	Copper mine, closing	15
Miami Unit and Copper Cities	BHP Copper Inc.	Copper mine, closing	15
Pinto Valley Mine	Pinto Valley Mining Corp.	Copper mine, current operation	11
Ray Mine	ASARCO	Copper mine, current operation	11
Resolution Copper Subsidence Zone (potential future brownfield site)	Resolution Copper	Copper mine, potential for future operation	3
San Manuel	BHP Copper Inc.	Copper mine, closed operation	45
Tohono Cyprus	Freeport-McMoRan	Copper mine, potential for future operation	70
Twin Buttes	Freeport-McMoRan	Copper mine, potential for future operation	95
United Verde	Phelps Dodge Corporation	Copper mine, closed operation	115

1 Distances measured in aerial miles between Resolution ore body and brownfields facility. The total length to construct appropriate infrastructure (pipelines, etc.) would be considerably longer.

The initial evaluation of the brownfield sites indicated that almost none of the sites had the capacity to accommodate the total volume of tailings from the Resolution ore body and were, therefore, not practicable alternatives to the operation of a single TSF as described in the GPO. Nine of the alternatives either have current operations or proposed future operations that would make them unavailable for the storage of tailings from the Resolution ore body. The closed operations at Casa Grande, Copperstone, and United Verde lacked the capacity to completely contain even the PAG portion of the anticipated tailings and would require the operation of multiple TSFs solely for the PAG tailings (SWCA 2017). These operations were not practicable alternatives for the TSF and were dropped from further consideration. Copper Queen in Bisbee, Arizona is currently used for tourism and was considered unavailable as a potential tailings storage site. Additionally, this site would require an extensive pipeline traversing more than 145 straight-line miles and crossing multiple divisions of federal, state, tribal, and private lands such as to be technologically impracticable.

The Miami and Inspiration site, the Miami Unit and Copper Cities sites, and the San Manuel site were dismissed from consideration because of environmental considerations related to potential ground and surface water quality impacts associated with the storage of the PAG tailings (SWCA 2017). The Miami and Inspiration site and the Miami Unit and Copper Cities sites are located within the Pinal Creek Water Quality Assurance Revolving Fund (WQARF) site and are currently undergoing closure and remediation activities for impacts to groundwater. Similarly, storage of the PAG tailings in the San Manuel pit was determined to have the potential to deliver poor quality groundwater to the San Pedro River, given the characteristics of the PAG material and the pit's proximity to the river (SWCA 2017). As such, none of these three alternatives could be considered practicable alternatives for a TSF.

Use of the final brownfield site, the future subsidence zone anticipated from mining the Resolution ore deposit itself, was reviewed as a potential TSF location. The scenario included the placement of either conventional or dry stack tailings on the land above the mining panels, which would gradually become the subsidence pit. The subsidence pit would continue to be filled with tailings as mining continued and the subsidence expanded over time. Safety concerns to operations and personnel both aboveground and belowground from the deposition of tailings above the active panel caving operations (SWCA 2017) make this alternative impracticable and it was removed from further consideration.

It was ultimately determined that none of the brownfield sites were available, feasible, or reasonable alternatives for TSF locations and those sites were therefore dismissed from detailed analysis (SWCA 2017). As none of these sites meets the criteria for availability and/or practicability under the Guidelines, even using these limited screening criteria, they were also dismissed form further consideration in this practicability analysis.

3.1.2. Multiple TSF Locations

Although the potential for use of multiple sites for the storage for tailings was investigated by the USFS as part of the evaluation of brownfield TSF locations, the use of multiple TSFs was also considered in the development of the alternatives evaluated in this practicability analysis. In general, the use of multiple smaller sites for the storage of tailings is problematic from an operations and maintenance (as well as environmental) perspective, when compared to a single TSF site. Splitting the footprint of a TSF designed for a given capacity into multiple smaller TSFs designed to store that same capacity often results in a greater overall footprint, given the need to duplicate infrastructure.

Impoundment embankments, pipelines, seepage controls, and other auxiliary infrastructure (e.g., roads, power, pumping stations, buildings, vehicle storage/maintenance, and various environmental-management measures such as stormwater ponds, run-off collection, and run-on diversion structures) are required for the operation of a TSF of any size. All these structural components and appurtenant features would need to be constructed and operated at each of the smaller TSFs in a multiple TSF scenario. Starter dam, embankment, and capping materials would be required for each of the multiple

TSF locations. Separate tailings delivery and recycle water return pipelines would also be necessary for each TSF, further increasing the disturbance footprint. As described in **Section 3.2.2**, the transport of the two types of tailings, NPAG and PAG, will be through separate pipelines, further increasing the infrastructure needs associated with multiple TSFs. The duplicative infrastructure required for multiple TSF sites as compared to use of a single site would be expected to result in a larger combined footprint of impact for the multiple TSF over a single TSF of the same storage capacity.

In addition to the consideration of the physical footprint of a single TSF facility in one location versus multiple TSF footprints dispersed over a larger area, the use of multiple TSFs also spreads the potential for environmental effects to additional locations. Effects such as impacts to the aquatic ecosystem, visual impacts, land use compatibility, ground and surface water quality, and air quality would occur at multiple locations, rather than a single location. These effects would be spread over a much larger area when considering the separate facilities, as would the potential for impacts from process upsets, pipeline failures, or seepage. Operating multiple TSF sites when a single site with the necessary capacity exists increases both the operations and maintenance requirements and potential environmental impacts from process upsets.

Given the extensive infrastructure requirements for multiple TSFs and the potential spread of environmental effects to multiple locations, the use of multiple TSFs compared to a single TSF was not carried forward in this analysis.

3.1.3. Initial TSF Alternative Screening

After dismissal of the brownfield alternatives, 15 initial alternative TSF locations to that location proposed in the GPO were further evaluated (SWCA 2017, USFS 2019). The 15 initial locations (**Figure 3**) were screened and assessed using criteria developed from the public and agency scoping processes conducted by the USFS (SWCA 2017) as well as input from cooperating agencies and Resolution Copper. These general screening criteria included locations that were within approximately 20 miles of the West Plant Site, sites that avoided landscape barriers such as mountains or rivers, sites outside rugged terrain to steep for TSF development, and sites potentially near existing or historic mining operations. Resolution Copper's feedback was informed by input from the Resolution Copper Independent Tailings Review Board (ITRB), comprised of internationally recognized industry experts in the field of tailings, with involvement in post tailings failure reviews. Numerous aspects of TSF design and construction such as embankment type (e.g., upstream, centerline, modified centerline, and downstream embankments), foundation treatment and lining options, management of PAG tailings, and deposition methods (e.g., conventional thickened, high-density thickened, and filtered, or 'dry-stack') were assessed for use at these locations as described in the DEIS (USFS 2019). Pertinent portions of this analysis are discussed below in the context of the Guidelines.

3.2. Tailings Impoundment Design and Operations

Brief descriptions of the types of TSF embankment design and tailings placement technologies are provided as follows. Additional detail is available in the DEIS (USFS 2019).

3.2.1. Tailings Embankment

There are four main embankment types for constructing a raised TSF, which are known as upstream, centerline, modified centerline, and downstream. The names of the types refer to the direction of movement of the TSF embankment's centerline in relation to the starter dam initially constructed at the toe of the TSF impoundment. Filtered tailings stacks also require an outer structural zone to meet stability requirements, as discussed in **Section 3.2.1**. The differences in embankment design for each of the TSF alternatives are included in the TSF descriptions in **Section 4**.

Upstream Raised Embankment

For a TSF using an upstream raised embankment, the starter dam is constructed at the ultimate TSF toe and successive, or 'lifts,' are constructed with the crest of each berm offset towards the interior of the TSF or 'upstream' of the starter dam. This form of embankment is constructed of the tailings themselves and is generally considered the least robust and resilient embankment type as it relies on a well-drained shell and the strength of the tailings themselves for stability. The upstream method of embankment construction, which had been proposed in the GPO, was formally dismissed as part of the USFS alternatives analysis for the DEIS.

Downstream Raised Embankment

For a TSF using a downstream raised embankment, the starter dam is constructed within the ultimate impoundment and successive berms, or 'lifts,' are constructed with the crest of each berm offset towards the exterior of the TSF or 'downstream' of the starter dam. This form of embankment is typically constructed for containment of water for reservoirs or flood control. This can be a very robust and resilient embankment type because the embankment stability is not reliant on the strength of the tailings but generally requires the largest volume of material to construct. Due to the large volume required for this embankment type, it can present a challenge for three-sided embankments and areas where topography and land ownership constrains the TSF footprint. This embankment type is proposed for the secondary PAG tailings storage embankment within the larger Skunk Camp and Peg Leg TSFs.

Centerline Raised Embankment

For a TSF with a centerline raised embankment, the starter dam is constructed within the ultimate impoundment and successive berms, or 'lifts', are constructed with the crest of each berm directly above the starter dam and previous lift, the embankment crest not moving either towards or away from the TSF interior. As with the downstream embankment, this embankment type requires a relatively large volume of materials for construction and is a very robust and resilient embankment type. This embankment type is proposed for storage of the NPAG tailings embankments for the Peg Leg and Skunk Camp TSF alternatives.

Modified Centerline Embankment

Some of the TSF alternatives considered in detail in the DEIS and, therefore, in this practicability analysis document, utilize what are known as 'modified centerline' embankments. As described in Chapter 2 of the DEIS (USFS 2019), modified centerline embankments do move 'upstream' of the starter dam over time and involve some construction of embankments over tailings, but contain a more substantial structural zone as compared to an 'upstream' embankment design. The Near West 'Wet' and Near West 'Dry' TSF alternatives propose use of this embankment method.

3.2.2. Tailings Processing and Placement Technologies

The processing and placement method used for the deposition of tailings can be a determining factor in the design of the TSF and generally has a great effect on the delivery of tailings from the concentrator facility to the TSF for storage. Where differences in tailings placement methods are pertinent to the analysis of alternatives, this information is included in the TSF descriptions in **Section 4**. All TSF alternatives, included in Chapter 2 of the DEIS (USFS 2019), consist of separation and thickening of the NPAG and PAG tailings at the concentrator facility. Thickening tailings involves the mechanical process of removing some water from the tailings while still maintaining a concentration of water that allows the tailings to be transported via pipeline. The two types of tailings, NPAG and PAG, are transported to the TSF facility though separate pipelines within the same corridor. Brief descriptions of tailings placement technologies evaluated are provided as follows.

Sub-aqueous Deposition of PAG Tailings

In this method of tailings placement, PAG tailings are thickened at the concentrator to 50 to 55 percent solids and then transported to the TSF via pipeline. Sub-aqueous deposition of PAG tailings is a Best Management Practice (BMP) method used to prevent and minimize acid rock drainage (ARD). For all alternatives except Silver King (Filtered), the PAG tailings are discharged sub-aqueously into the reclaim pond from a barge in a separate area to the NPAG tailings deposition area. Near West 'Wet' includes the reclaim pond and PAG tailings area within the NPAG beach (not in a separate cell).

Near West 'Dry', Peg Leg and Skunk Camp alternatives all store PAG tailings in physically separate cells. However, Peg Leg PAG cells are separate from the NPAG impoundment, whereas, the Near West 'Dry' and Skunk Camp PAG cells would ultimately be encapsulated by the NPAG impoundment. As a result, the reclaim water pond would only overlie the PAG tailings, reduced in size from that typically needed for Near West 'Wet'. Limited and small low spots that accumulate water either released from the tailings or stormwater on the NPAG surface would also be directed to the PAG tailings cell.

Tailings Placement via Conventional Thickened Deposition

In this method of tailings placement, NPAG tailings are thickened at the concentrator facility to 60 to 65 percent solids and transported to the TSF via pipeline. At the TSF, the NPAG tailings are processed through hydrocyclones to produce a coarse particle tailings stream used to construct the embankment, and the finer particle tailings stream is deposited into the interior of the impoundment. Hydrocyclones require the input tailings stream to be between 30 to 40 percent solids, resulting in the finer particle tailings stream to have a high water content. Typically, the finer particle tailings stream is directly discharged into the facility with the high water content. Alternatively, the finer particle tailings stream can be thickened at the TSF site prior to discharge. This tailings placement technology is evaluated in the Near West 'Wet' TSF alternative with the finer particle tailings stream thickened to 50-percent solids.

Tailings Placement via High-density Thickened Deposition

Similar to conventional thickened deposition, tailings are transported to the TSF via pipeline after thickening at the concentrator facility. Additional thickeners located at the TSF facility remove and recycle water to further thicken the tailings prior to deposition. These tailings are deposited at between 60- to 70-percent solids. Like conventional thickened tailings, the NPAG tailings are processed through hydrocyclones to produce a coarse particle tailings stream used to construct the embankment, and a finer particle tailings stream that is placed into the interior of the impoundment. The high-density thickened deposition also involves, to the extent practicable, placement of tailings in thin layers, called "thin-lift," to further reduce entrained water through evaporation and thus reduce seepage. Alternatives that incorporate this type of tailings placement technology include the Near West 'Dry', Peg Leg, and Skunk Camp TSF alternatives.

Filtered Tailings ('Dry-Stack')

In this method of tailings placement, tailings are transported to the TSF via pipeline where they are filtered to reduce the moisture content to approximately 85-percent solids. This process reduces the moisture content to the point where transportation and placement via pipeline is no longer possible and placement of the dewatered tailings in the TSF must be accomplished via mechanical means, such as by truck or conveyor. Dry-stack impoundments can be constructed in horizontal lifts using of a structural outer shell that supports the non-structural zone upstream.

Key considerations when assessing the reasonableness, practicality, and benefits of a tailings management strategy are the precedents and lessons learned from case histories. Most dry-stack tailings facilities operate with throughput capacity between 2,000 and 10,000 tons per day (tpd) with dam heights of less than 200 feet. The current demonstrated industry maximum throughput capacity for operating dry-stack facilities at other mines is approximately 20,000 tpd to more recently approximately 40,000 tpd. The proposed concentrator facility for the Resolution Copper Project will have a throughput of approximately 132,000 tpd and a dam height of approximately 1000 feet for the Dry Stack alternative. To date, the maximum slope height of filtered tailings embankments achieved is approximately 200 feet (further detail can be found in **Appendix A**: *Resolution Copper Mining, LLC – Mine Plan of Operations and Land Exchange – USFS Alternatives Data Request #3-F, Information on Potential Tailings Alternatives*). While the dry-stack technology needed to meet the overall project purpose is unproven, this method was carried forward for further analysis in one TSF alternative to remain consistent with the analysis provided in the DEIS. This tailings placement technology is evaluated in the Silver King TSF alternative.

3.3. Initial Alternatives Dismissed from Further Consideration

The 15 initial alternative TSF locations to that location proposed in the GPO were analyzed for improvements upon key issues of concern identified in scoping by the public and agencies, and screened to identify potential environmental impacts that could result from the development of a TSF under that alternative. The 15 alternative locations, as well as the construction of a dry-stack impoundment at the proposed GPO TSF location, were included in this screening (**Figure 3**) using the screening criteria described in **Section 3.1**. These sites and their disposition are listed in **Table 2**.

Table 2. Initial Alternative TSF Locations Dismissed from Consideration (adapted from USFS 2019, Appendix B)

Alternative Location	Dismissed?	Rationale
BCG A	Yes	Closer to potential receptors and includes lands not available as described in the Far West alternative below. Dismissed from further consideration.
BCG B	Yes	Partially located on Bureau of Land Management (BLM) lands that are withdrawn from mineral entry by the Bureau of Reclamation (BOR) and therefore not available. Dismissed from further consideration.
BCG C	Yes; but became Peg Leg alternative	Partially located on BLM lands that are withdrawn from mineral entry by the BOR and therefore not available. Although dismissed from consideration another configuration of BCG C became the Peg Leg alternative.
BCG D	Yes	Partially located on BLM lands that are withdrawn from mineral entry by the BOR and therefore not available. Proximity to the Gila River presents challenges for seepage and therefore not technologically practicable. Dismissed from further consideration.
Dry-Stack at GPO	Yes; but became Near West alternatives	Water management issues and pipeline corridor are logistically impracticable. Although dismissed from consideration, configurations of conventional tailings and high-density thickened tailings at this location became the Near West 'Wet' and 'Dry' alternatives.
Far West	Yes	The USFS approached the Arizona State Land Department (ASLD) about the potential availability of these State Trust lands for a TSF. The ASLD plans to use these lands for residential development and expressed an unwillingness to sell them. They are therefore not available as an alternative. Dismissed from further consideration.

Table 2. Initial Alternative TSF Locations Dismissed from Consideration (adapted from USFS 2019, Appendix B)

Alternative Location	Dismissed?	Rationale
Hewitt Canyon	Yes	Location in proximity to Superstition Wilderness Class I airshed would prevent air permit compliance. Substantial watershed without a means to divert upper catchment around tailings and all runoff would have to be captured and contained within the TSF. Embankment would be approximately 1,000 feet in height, an unprecedented height for TSF embankments in North America, with a likely determination of extreme consequence based on dam classification. Considered not technologically or logistically practicable. Dismissed from further consideration.
Lower East	Yes	Location and configuration similar to impacts and challenges of Near West alternatives, but closer to sensitive receptors of Boyce Thompson Arboretum, residents, and U.S. 60. Extreme consequence of failure due to proximity to sensitive receptors and critical infrastructure. Dismissed from further consideration.
Silver King	Yes; but became Silver King Dry-Stack alternative	Conventional tailings deposition design at this location was not available because of historic cemetery and adverse mineral estate, and technologically impracticable because of historic mine workings. Although dismissed from consideration another configuration using dry-stack tailings is carried forward for analysis.
SWCA 1	Yes	Located adjacent to BLM lands withdrawn from mineral entry by the BOR. Seepage collection and other appurtenant infrastructure would need to be located on these withdrawn lands and therefore the alternative is not available. Proximity to the Gila River and terrain also present challenges for seepage and stormwater management. Dismissed from further consideration.
SWCA 2	Yes	Partially located on BLM lands that are withdrawn from mineral entry by the BOR; therefore, the alternative is not available. Proximity to the Gila River and terrain present challenges for seepage and stormwater management. Dismissed from further consideration.
SWCA 3	Yes	Location is on steep ridge crest and occupies portions of both the Queen Creek and Gila River watersheds. As such, it would require substantial engineering controls to minimize seepage from multiple locations that would be impracticable to implement. Rugged topography makes it unlikely to have available capacity for all tailings volume and presents substantial difficulties for infrastructure, structures, and equipment. Not in keeping with good engineering practices and technologically impracticable. Dismissed from further consideration.
SWCA 4	Yes	Partially located in Superstition Wilderness and therefore not available. Dismissed from further consideration.
Telegraph Canyon	Yes	Telegraph Canyon contains a perennial stream segment along with valuable riparian habitat identified as Important Bird Areas, as well as several springs, and may contain wetlands associated with the perennial flow. Dismissed from further consideration.

Table 2. Initial Alternative TSF Locations Dismissed from Consideration (adapted from USFS 2019, Appendix B)

Alternative Location	Dismissed?	Rationale
Upper Arnett	Yes	Alternative contains a perennial segment of Arnett Creek. This creek may support wetlands associated with the perennial flow. The location is also proximate to State Route 177 that constrains TSF design and the steep canyon sidewalls do not provide sufficient capacity for all the tailings volume. Dismissed from further consideration.
Whitford Canyon	Yes	Location in proximity to Superstition Wilderness Class II airshed would prevent air permit compliance. Substantial watershed without a means to divert upper catchment around tailings and all runoff would have to be captured and contained within the TSF. Embankment would be approximately 1,000 feet in height, an unprecedented height for TSF embankments in North America. Considered not technologically or logistically practicable. Dismissed from further consideration.

As none of the initial alternatives met the general screening criteria defined herein and the criteria for practicability under the Guidelines, they were dismissed from further consideration in the DEIS (SWCA 2017, USFS 2019) and this practicability analysis. The upstream method of tailings embankment construction was dismissed from further analysis, as well. This screening analysis did, however, identify four new TSF alternatives at three of the previously investigated locations. The Peg Leg Alternative resulted from a reconfiguration of the TSF proposed at BCG C, and the Near West 'Wet' and 'Dry' Alternatives resulted from the screening and analysis performed for the Dry-Stack at GPO Alternative. The Silver King location was identified for analysis as a potential dry-stack TSF. These four alternatives are described in **Section 3.4** and are considered in detail in both the DEIS and this practicability analysis document.

Two additional alternatives at locations not previously considered were brought forward for screening at this time. These alternatives, the Mineral Creek Headwaters Alternative and the Upper Dripping Springs Wash Alternative, are shown in **Figure 4**. Although the Mineral Creek Headwaters Alternative site may have sufficient capacity to store the total anticipated volume of tailings, it is located within a perennial segment of Mineral Creek (SWCA 2017) that is designated as critical habitat for the endangered Gila Chub (*Gila intermedia*) and may also support wetlands associated with the perennial flow. The Mineral Creek Headwaters Alternative was considered unavailable and dismissed from further review in both the DEIS and this practicability analysis document.

The initial screening of the Upper Dripping Springs Wash Alternative did not identify any high-level availability or practicability issues with this alternative location. The alternative footprint includes only ephemeral drainages, does not contain any potential wetlands, and avoids seeps and springs in the area. The alternative was renamed the Skunk Camp Alternative and carried forward for detailed review in both the DEIS and this practicability analysis document.

3.4. Alternatives Considered in Detail

Five TSF alternatives were considered for detailed analysis in the DEIS (USFS 2019), which included a mix of locations, embankment types, and tailings deposition and placement technologies. These same alternatives passed the general screening criteria described above and are carried forward for more detailed consideration in this practicability analysis. The alternatives for detailed analysis are as follows:

- Near West 'Wet' TSF (conventional thickened tailings)
- Near West 'Dry' TSF (ultra thickened tailings)
- Silver King TSF (dry-stack tailings)
- Peg Leg TSF (ultra thickened tailings)
- Skunk Camp TSF (ultra thickened tailings)

These final TSF alternatives are fully analyzed in the DEIS to disclose impacts to the natural and social environment. Per the Guidelines, the evaluation of these alternatives provided herein will focus on alternative practicability, impacts to the aquatic ecosystem, and other significant adverse environmental consequences.

4. TSF ALTERNATIVES DESCRIPTION AND PRACTICABILITY DETERMINATION

This section describes the five TSF alternatives (**Figure 5**) identified for detailed analysis by the USFS in the DEIS (USFS 2019) and provides description for each , including the acreages of impacted undisturbed land reported to the nearest whole acre. An alternative is to be deemed practicable, "if it is available and capable of being done after taking into consideration cost, existing technology, and logistics in light of overall project purposes" (40 CFR § 230.10(a)). The alternatives considered in this analysis have been evaluated for these elements of practicability. Details of each alternative are followed by a determination of the alternative's practicability based on the criteria defined in the Guidelines at 40 CFR §230.10(a)). One of the key practicability criteria applied to this analysis of TSF alternatives is discussed in **Section 4.1**.

4.1. Project-Specific Practicability Criteria

A critical element in determining the logistical and technological practicability of a TSF alternative is the ability (or lack thereof) to capture and control seepage from the TSF in a manner that reliably allows the facility to meet all applicable standards and obtain and operate in compliance with required environmental permits. Numerical models were developed for each TSF to predict the amount of uncollected seepage for each TSF alternative. These seepage models were developed based on the hydrogeological setting of each TSF site and represent steady-state conditions assuming operational conditions at full TSF build-out. Levels of engineering seepage controls were also developed for implementation at each TSF site and are described in detail in Section 3.7 of the DEIS (USFS 2019).

The levels of engineering control and estimated efficiency are based on Best Available Demonstrated Control Technology (BADCT) for seepage controls, as well as other discharge control technologies, as defined by the Arizona Department of Environmental Quality (ADEQ). Engineering controls to reduce seepage are characterized in the models by level, or efficiency, of control. These levels are generally specific to each alternative and location. Descriptions of each TSF alternative's levels are described in **Section 4.2** and tables taken from the *Resolution Copper Project Summary of DEIS Tailings Alternatives Seepage Control Levels* (KCB 2019) are included as **Appendix B** of this document. It should be noted that the seepage engineering controls included within each defined level are slightly different for each TSF alternative due to site-specific conditions. However, the greater the number of controls required in each level, and the presence of higher level controls, denote an increased degree of complexity in terms of those engineered controls.

The numerical models, described above and explained in detail in the DEIS, were used to estimate the uncaptured seepage in acre-feet per year (AF/yr). GoldSim models taking into account these engineered controls were then used to predict potential transport of any uncollected seepage through the aquifer to surface water receptors. In order to operate a TSF, Resolution must obtain an Aquifer Protection Permit (APP) from ADEQ, which requires the mine facility to demonstrate that it will not cause or contribute to an exceedance of Aquifer Water Quality Standards (AWQS) at the point of compliance, or, if, AWQS for a pollutant has been exceeded in an aquifer, that no additional degradation will occur [A.R.S. § 49-243(B)(2)-(3); AAC R18-9-A202(A)(8)(a)]. Seepage must also not contribute to the exceedance of any ADEQ surface water quality standards where groundwater may emerge and contribute to surface flow [AAC R18-11-405(b)].

The concentrations of regulated constituents in the seepage were modeled both with and without the background water quality. An analysis of the total predicted concentrations (modeled plus background) of pollutants was used to calculate the preliminary allowable seepage rate in AF/yr that would allow each TSF to operate over the LOM and post-closure (245 years) periods without exceeding water quality standards. The total predicted concentrations are compared to the ADEQ groundwater and surface water quality standards at the Points of Compliance (POC) downgradient of each TSF footprint (750 ft downgradient for groundwater; site-specific locations for surface water). The POC for Near West 'Wet' and 'Dry', and Silver King alternatives, is in the last groundwater cell nearest to Whitlow Ranch Dam, which provides the majority of surface flow at the dam. The POC for Peg Leg and Skunk Camp alternatives is located at the confluence of Gila River at Donnelly Wash and Dripping Springs Wash, respectively. The background water quality, surface water flow rate, and distance to the POC are critical in determining the potential seepage impacts to downstream surface water quality.

For each alternative, a maximum uncollected seepage rate was modeled that would allow compliance with surface water quality standards at the POCs noted above, as is necessary in order to secure an APP. If exhaustive and multiple seepage controls are installed and the TSF cannot meet standards and secure an APP, then it was determined that the TSF is technologically impracticable for the purposes of this assessment.

4.2. Detailed Evaluation of DEIS Alternatives

A description and discussion on the practicability of each TSF alternative is provided in the following sub-sections. The alternatives evaluated are as follows:

- Near West 'Wet' TSF
- Near West 'Dry' TSF
- Silver King TSF
- Peg Leg TSF
- Skunk Camp TSF

4.2.1. Near West 'Wet' TSF Alternative

4.2.1.1. Description

The Near West 'Wet' TSF Alternative (Alternative 2 in the DEIS) proposes the construction of a modified centerline embankment on USFS lands with approximately 1.37 billion tons of tailings storage capacity using conventional thickened tailings deposition as described in **Section 3.3**. The associated tailings transportation corridor would also be located on USFS and private lands owned by Resolution. This TSF alternative would be approximately 4,909 acres in size with an ultimate embankment crest reaching 520 feet in height.

The location of the Near West 'Wet' TSF is underlain by a mix of different age bedrock incised with narrow channels infilled with alluvial, colluvial and undifferentiated sediments (KCB 2018a). Gila Conglomerate makes up 55 percent of the Near West 'Wet' TSF overall foundation, while a mixture of limestones, sandstones and quartzites are located along the footprint of the NPAG's starter dam, the TSF embankment, and the northern portion of the TSF. The conglomerate, limestone, and sandstone sediments all possess a potential for reduced foundation strength, especially if exposed to long-term saturation and have potential to allow seepage into adjacent canyons (KCB 2018a).

The proposed Near West 'Wet' TSF is located near the center of Superior Basin, which drains ultimately into Queen Creek. Stormwater diversion channels would be required for this TSF alternative to redirect flow from the 4.91-square-mile upper watershed of Bear Tank Canyon to adjacent watershed of Roblas Canyon and Potts Canyon (SWCA 2018).

The Queen Creek aquifer in the vicinity of the Near West TSF location is relatively small with groundwater levels approximately 50 feet below ground surface and in relatively close proximity to the TSF footprint. As such, extensive seepage controls have been proposed for this alternative, including the following (KCB 2018a, 2019):

Level 0

- Underdrain system comprising a drainage blanket and finger drains beneath the entirety of the embankment to drain to seepage collection ponds

Level 0-1

- Extension of embankment underdrains beneath the entirety of the starter dam and into the impoundment under the entire NPAG tailings beach area
- In each drainage channel surrounding the TSF there will be a primary seepage collection system including lined seepage collection ponds, cutoff walls and pump back wells to return and recycle the collected seepage
  - A total of 12 cutoff walls will be excavated through alluvium, filled with compacted granular fill and grouted to competent bedrock

Level 1

- Further extension of the underdrain system an additional 200 feet into the impoundment beyond the beach area
- Lined channels downgradient of the embankment to direct captured seepage to the primary seepage collection system
- Foundation treatments and/or selective engineered low permeability layers in areas of the foundation where Gila Conglomerate not present
- Placement of an engineered low permeability layer for the PAG tailings starter facility
- Encapsulation of PAG into the low permeability NPAG tailings fines and sealing of the NPAG foundation with fines
- Addition of grout curtains extending to 100 feet below ground paired with each cutoff wall as part of the primary seepage collection system

Level 2

- Further extensions and deepening of the grout curtains described in Level 1 to target higher permeability zones and potential seepage pathways

Level 3

- Auxiliary seepage collection system downgradient of the primary seepage collection system in drainages surrounding the TSF facility comprising additional cutoff walls, seepage collection ponds, and wells to pump the collected and recycle water back to the TSF

Level 4

- Low permeability liners in areas of the foundation where Gila Conglomerate not present
- Engineered low permeability liner for the entire PAG cell
- Addition of an auxiliary grout curtain extending to 100 feet below ground paired with cutoff walls as part of the auxiliary seepage collection system; total of 7.5 miles in length
- Up to 21 pump back wells between the auxiliary seepage collection system and Queen Creek

Seepage modeling studies indicate that by using Levels 0 through 4 (KCB 2018a, 2019) of the engineered seepage controls detailed above, this facility would have uncollected seepage rates of 20.7 AF/yr and that the concentration of selenium will ultimately exceed state-established surface water quality standards. Montgomery (2019b) modeled a preliminary allowable maximum uncollected seepage rate of 3 AF/yr for compliance with surface water quality standards, well below the 20.7 AF/yr estimate. This allowable rate of uncollected seepage was based on the constituent that resulted in the lowest seepage flow rate prior to exceeding the regulatory threshold (selenium).

4.2.1.2. Practicability of Alternative

The Near West 'Wet' TSF Alternative is determined to be not practicable. While this alternative would meet the overall project purpose, the allowable seepage rate needed to avoid exceeding the aquatic and wildlife warm water quality standard for selenium is unachievable, even with extreme and extensive seepage controls. As such, it is unlikely that Resolution could secure the required APP from ADEQ. Therefore, this alternative is not technologically practicable and is not carried forward for further analysis.

As noted above, development of this alternative would result in concentrations of selenium above state-established surface water quality standards. In addition, seepage from this tailings facility would result in dissolved copper loading of Queen Creek, which has been determined to be impaired for copper by ADEQ. This alternative would increase the copper loading in Queen Creek by 7 to 22 percent, interfering with the state's efforts to reduce the loading in this impaired feature.

4.2.2. Near West 'Dry' TSF Alternative

4.2.2.1. Description

The Near West 'Dry' TSF Alternative also proposes the construction of a modified centerline embankment on USFS lands with approximately 1.37 billion tons of tailings storage capacity. The approximate TSF footprint is 4,909 acres in size with an ultimate embankment crest 510 feet in height. The tailings transportation corridor would also be located on USFS and private lands owned by Resolution (KCB 2018b). Compared to the 'Wet' Alternative, the Near West 'Dry' Alternative physically separates the PAG and NPAG tailings with a splitter berm and proposes ultra thickening of NPAG tailings. By isolating PAG tailings and ultra thickening the NPAG tailings, drier conditions are maintained, resulting in reduced seepage into the foundation.

The proposed Near West 'Dry' TSF Alternative is located within the same footprint as the Near West 'Wet' TSF Alternative and, therefore, possesses similar geologic and hydrologic conditions. This alternative would require upstream stormwater diversions and all the same Levels 0 through 4 of extensive engineered seepage controls as the Near West 'Wet' TSF Alternative described above. However, this configuration does allow the interior finger drain system to function more effectively for greater seepage capture. This more effective seepage capture, in combination with the Levels 0 through 4 seepage controls (KCB 2018a, 2019), the physical separation of PAG and NPAG tailings, and high-density thickening the NPAG tailings, is modeled to result in 2.7 AF/yr of uncollected seepage, which is slightly below the modeled allowable maximum seepage of 3 AF/yr (Montgomery 2019b) needed to meet surface water quality standards at the POC identified for this alternative. No chemical constituents are anticipated in concentrations above established surface and groundwater quality standards.

4.2.2.2. Practicability of Alternative

The Near West 'Dry' TSF Alternative is determined to be practicable, although it would require implementation of a degree of engineering control that is not typical of large-scale copper porphyry tailings facilities. Individually, the seepage control measures have been implemented at small, medium and large-scale projects, but the engineering controls described for this alternative combine a multitude of the available seepage controls and would be implemented on a larger scale than typical. The location of this alternative is currently available and has the capacity to meet the overall project purpose. Like the Near West 'Wet' TSF Alternative, this alternative would still require an extreme and extensive seepage control system, in comparison to the other TSF designs, in order to maintain ADEQ water quality standards. However, more extensive finger drains and thickening of tailings reduces overall seepage, allowing the engineered controls to capture enough seepage to meet water quality standards and potentially secure an APP from ADEQ. Based on the predicted uncollected seepage rates being so close to the allowable maximum rates to achieve compliance with water quality standards, this TSF alternative would need to consistently capture 99.5 percent of seepage. As noted in the DEIS (USFS 2019), "the high capture efficiency required of the engineered seepage controls could make meeting water quality standards under this alternative challenging. The number and types of engineered seepage controls represent significant economic and engineering challenges."

Seepage from this tailings facility would result in dissolved copper loading of Queen Creek, an impaired water. This alternative would increase the copper loading in Queen Creek by 1 to 2 percent, impeding the state's efforts to reduce the loading in this impaired feature.

Impacts to the aquatic ecosystem as well as other potential adverse environmental consequences of this alternative are described further in **Section 5**.

4.2.3. Silver King TSF Alternative

4.2.3.1. Description

The Silver King TSF Alternative proposes the construction of two separate impoundments using the dry-stack method, one with approximately 1.15 billion tons of NPAG tailing capacity and one with 0.22 billion tons of PAG tailing capacity. In contrast to the other TSF alternatives, the dry-stack TSF would not require an embankment, but rather the compacted zone of tailings around the perimeter of the dry-stack facility provides structural support (USFS 2019). Both the TSF and pipeline corridor would be located on USFS lands. Due to topography and land constraints, NPAG and PAG tailings would need to be placed in separate impoundments. The PAG tailings would be placed and maintained unsaturated, and would be exposed to continual wetting and drying cycles associated with natural precipitation (average of 18 inches per year). This TSF alternative would be approximately 5,661 acres in size, and the ultimate embankment crests for NPAG and PAG would reach 1,040 feet and 750 feet in height, respectively.

The location of the Silver King TSF sits across the Concentrator, Main, and Conley Springs faults. It is predominantly underlain by Quaternary deposits overlaying Pinal Schist bedrock. A complex geologic sequence of Pinal Schist, Tertiary Gila Conglomerate, Mescal Limestone, Apache Group, Bolsa Quartzite, Dripping Spring Quartzite, and Tertiary Tuff occur along the southwestern portion of the TSF with Quartz Diorite occurring along the northeastern corner, all of which is covered by Quaternary deposits and incised with alluvial filled channels. Additionally, the Pinal Schist unit is known to have reduced strength along foliations which appear at the southeastern portion of the TSF (KCB 2018c).

The proposed Silver King TSF is situated at the northeast edge of the Superior Basin, which drains into Queen Creek and Potts Canyon and ultimately to the Whitlow Ranch Dam. Due to the topography, land constraints, and large volume of tailings, large diversion dams, underground tunnels, and pipelines would be required to reroute surface water from large upstream drainage basins, particularly from Comstock Wash and Whitford Canyon, around the TSF.

The Queen Creek aquifer in this area is relatively small with groundwater levels approximately 100 to 300 feet below the surface of the TSF. The three faults beneath the TSF are likely leaky barriers to groundwater flow, causing higher groundwater levels to the northeast of the faults (KCB 2018c). Seepage controls proposed for this alternative include the following (KCB 2018a, 2019):

Level 0

- Dewatering of tailings to 85-percent solids prior to placement in a dry-stack
- Underdrain system comprising a drainage blanket beneath the entirety of the compacted structural zone of the dry-stacked tailings

Level 1

- Lined channels downgradient of the tailings facility to direct captured seepage to the primary seepage collection system
- Primary seepage collection system in drainages surrounding the TSF comprising multiple lined seepage collection ponds, cutoff walls and pump-back wells to return the collected seepage
    - Cutoff walls will be excavated through the small amount of alluvium present, filled with compacted granular fill and grouted to competent bedrock

Level 2

- Targeted grouting of fractures in the foundation
- Pump back wells down gradient of the primary seepage collection cutoff walls

Seepage modeling studies determined that Levels 0 to 2 controls (KCB 2018a, 2019) would only reach 90 percent efficiency, leading to uncollected seepage rates of 9 AF/yr with Level 2 controls, which exceeds the preliminary modeled maximum allowable seepage of 6 AF/yr (Montgomery 2019a) needed to meet surface water quality standards at the POC identified for this alternative. As such, selenium is modeled to exceed surface water quality standards beginning in model year 59 (USFS 2019).

4.2.3.2. Practicability of Alternative

The Silver King TSF Alternative is not logistically or technologically practicable. While the land for this alternative is available, the dry-stack technology is not proven at this scale and seepage quantities are modeled to result in exceedances of surface water quality standards in downstream surface waters.

The current proven maximum throughput capacity for operating dry-stack facilities is approximately 20,000 tpd (at the La Coipa mine in Chile), or approximately 15 percent of the Resolution Copper Project's anticipated initial operating capacity of approximately 132,000 tpd. Most filtered tailings capacities in operation are less than 10,000 tpd. Furthermore, with land constraints and capacity requirements, the Silver King TSF would reach heights of 750 and 1,040 feet, both unprecedented heights for existing TSFs, in which structural stability is unknown. The embankment heights for the other proposed TSF alternatives for the project range between 200 and 520 feet in height.

As noted above, development of this alternative would result in concentrations of selenium above state-established surface water quality standards. In addition, seepage from this tailings facility would result in dissolved copper loading of Queen Creek, which has been determined to be impaired for copper by ADEQ. This alternative would increase the copper loading in Queen Creek by 11 to 21 percent, interfering with the state's efforts to reduce the loading in this impaired feature.

Additionally, the filtered tailings are placed partially saturated and exposed to the natural elements, an approach that goes against current BMP for PAG tailings that are highly pyritic and acid generating. Such designs are more prone to wetting and drying cycles than typical TSF systems, resulting in low pH and an increase in Total Dissolved Solids (TDS), as well as elevated metals in seepage during the LOM. Only the dry-stack is as affected by the cyclical wetting and drying that leads to oxidation.

Given the lack of demonstrated dry-stack technology at the scale contemplated by the project and seepage control issues, this alternative would not be considered logistically or technologically practicable. This alternative is not carried forward for further analysis.

4.2.4. Peg Leg TSF Alternative

4.2.4.1. Description

The Peg Leg TSF Alternative proposes the construction of two separate impoundments with a dual-embankment approach, a centerline embankment for containment of approximately 1.15 billion tons of NPAG tailings and a downstream embankment for containment of approximately 0.22 billion tons of PAG tailings capacity. These impoundments would be located on a mix of public lands managed by the BLM and State Trust lands that would need to be purchased from the ASLD prior to construction and operation of the TSF. The transportation corridor would be located on a combination of lands owned by the USFS, BLM, Bureau of Reclamation, Department of Defense, ASLD, and Resolution. Similar to Near West 'Dry', PAG tailings would be discharged sub-aqueously into a separate impoundment, a BMP for PAG tailings. However, with the Peg Leg TSF Alternative, the PAG facility would be contained behind a separate downstream embankment and separated into smaller operating cells to reduce pond size, seepage, and water required during the LOM (Golder 2018). These two impoundments would total approximately 10,782 acres in size with the ultimate height of the NPAG and PAG impoundments reaching 310 and 200 feet in height, respectively.

The Peg Leg TSF is underlain by exposed granitic bedrock towards the eastern portion of the site with younger alluvial deposits over a gently sloping bedrock pediment within the western half of the footprint (Golder 2018). Ruin Granite and Tea Cup Granodiorite are the main bedrock units in the eastern portion. The thickness of the unit varies widely within the area and has been noted that decomposed and unsolidified granite makes up the first 90 feet of depth. The granite bedrock units possess both low permeability ratings and high strength characteristics. The NPAG footprint is mainly on a mix of alluvial deposits that reach depths of as much as 2,000 feet.

The proposed Peg Leg TSF is adjacent to Donnelly Wash which drains ultimately into the Gila River. Stormwater diversion channels would be required for this TSF alternative. The aquifer is relatively large, and groundwater tests in the area reveal water elevation ranging from 50 feet below ground surface in the fractured bedrock aquifers to several hundred feet near the center of Donnelly Wash basin (Golder 2018).

The site's geology and hydrology make the application of cutoff walls and grout curtain technically infeasible, requiring a higher number of pump-back wells than the other TSF alternatives. The following levels of controls would be implemented for the Peg Leg TSF alternative (Golder 2018, KCB 2019):

Level 0

- Underdrain system comprising a drainage blanket beneath the entity of the embankment

Level 1

- Lined channels downgradient of the tailings facility to direct captured seepage to lined seepage collection ponds with pump-back wells
- Extension of embankment underdrains with fingers drains extending beneath the impoundment under the entire NPAG tailings beach area
- HDPE lining of the recycled water pond area
- Engineered low permeability layers for the entire PAG cell
- Extensive network of pumpback wells down gradient of the lined channels and ponds to form a continuous cone of depression below the NPAG embankment

Level 2

- Engineered low permeability liner for the entire PAG cell
- Excavation and removal of alluvium above the bedrock below PAG cells
- Utilization of thin lift deposition beginning when sufficient operating area becomes available
- Adjustments and refinements to the network of pump-back wells for seepage capture

Seepage modeling studies indicate that by implementing the Levels 0 to 2 seepage controls, this facility can obtain uncollected seepage rates of 261 AF/yr, which is equal to the allowable seepage of 261 AF/yr (Montgomery 2019a) modeled as necessary to meet surface water quality standards at the POC identified for this alternative. Modeling does not indicate that any constituents will occur in concentrations above established water quality standards as a result of tailings seepage. Currently, this alternative meets the allowable uncollected seepage rates with the Levels 0 to 2 seepage controls, and additional controls could be added. The location, geology, and distance to the Gila River allows for flexibility in implementing additional seepage control measures, if necessary.

4.2.4.2. Practicability of Alternative

The Peg Leg TSF Alternative is not practicable. While this alternative has the capacity to meet the project's purpose and is logistically and technologically practicable, the site is not available. The ASLD has indicated that this site is more suitable for future residential development and that it is not available for the use of a TSF. The area is relatively flat and in the vicinity of the limits of the Town of Florence. Since no configuration of this TSF alternative is available without encroachment onto ASLD or BOR withdrawn lands, this alternative is not available and thus impracticable. It is not carried forward for further analysis.

4.2.5. Skunk Camp TSF Alternative

4.2.5.1. Description

The Skunk Camp TSF Alternative is very similar to the Peg Leg TSF, with a dual embankment incorporating a robust centerline embankment for the NPAG tailings, and a downstream embankment for the PAG tailings. The TSF alternative is located on a mix of private and ASLD-managed State Trust lands that would be purchased prior to construction and operation of the TSF. In contrast to the Peg Leg alternative, the ASLD has indicated that it is willing to consider the land at this location for development of a TSF. Two potential pipeline corridors are being analyzed for this TSF alternative: 1) the North Pipeline Corridor, and 2) the South Pipeline Corridor. Both would be located on USFS, private, and State Trust lands. The North Pipeline Corridor is currently the preferred corridor due to a smaller disturbance footprint, shorter length, lower required operating pressure, and lower pumping requirements. Impacts to the aquatic ecosystem and potential waters of the U.S. associated with the pipeline construction are anticipated to be largely temporary impacts and generally not material to the identification of the LEDPA.

The cross-valley design of the Skunk Camp TSF requires far less material to construct the embankment compared to three-sided ring-impoundment TSF designs needed at Near West and Peg Leg, thus reducing construction and operational complexity (KCB 2018d). Much like the Near West 'Dry' and Peg Leg TSF alternatives, the PAG tailings are physically isolated from the NPAG and are sub-aqueously placed into separate smaller operating cells located at the northern end of the NPAG tailings to reduce pond size, seepage, evaporative losses, and water required to maintain a water cover over the PAG tailings. The ultimate footprint would be approximately 4,002 acres in size with the ultimate height of the embankment crest reaching 490 feet in height.

The Skunk Camp TSF is situated along a north-trending normal fault and is underlain by a tertiary age Gila Conglomerate that is partially covered by Quaternary deposits, including alluvium in the base of the major valleys (KCB 2018d). There is some potential for relatively shallow Gila Conglomerate thickness west of the normal fault but greater depths along the eastern edge (Montgomery 2019a). Alluvial channels located throughout the site are considered pathways for groundwater flow and are noted to be less than 150 feet thick. Recent measurement of depth to groundwater taken within the alluvium and Gila Conglomerate, suggests that groundwater levels are approximately 70 feet below the ground surface in some locations (KCB 2018d).

This TSF alternative is located within the Dripping Spring Wash basin, which drains 13 miles to the southeast and discharges into the Gila River. Currently, several unnamed drainages report to Dripping Spring Wash. Stormwater diversion channels and dams are proposed on either side of the TSF, with one set of channels discharging into Dripping Spring Wash and the other set of channels diverting surface runoff into the upper reaches of Mineral Creek (SWCA 2018).

The site's geology and hydrology coupled with the overall design of the TSF allow for a less complex seepage collection system compared to the Near West 'Wet' and Near West 'Dry' TSF alternatives. The topography and geologic configuration of the site generally funnels seepage to one location, as compared to the topography and geologic configuration at Near West, which would allow seepage to move in multiple directions and thus require far more extensive engineering controls. This alternative would include only one cut-off wall, one grout curtain of far less length, and fewer pump-back wells.

For the Skunk Camp TSF, the differences in levels of seepage controls between Levels 1 and 3 are variations on the depth of the grout curtain and pump-back wells and not additional engineered controls. Seepage collection (KCB 2018d, 2019) for this TSF is summarized as follows:

Level 0

- Underdrain system comprising a drainage blanket beneath the entirety of the embankment

Level 1

- Extension of embankment underdrains beneath the entirety of the starter dam and into the impoundment between 100 and 200 feet under the NPAG tailings beach area
- Placement of an engineered low permeability layer for the PAG facility
- Seepage collection system including a lined seepage collection pond with a cutoff wall and pump-back wells to return and recycle the collected seepage
- Grout curtain to a depth of 70 feet
- Downgradient seepage pump-back wells to a depth of 20 feet

Level 2

- Extend Level 1 grout curtain to a depth of 100 feet
- Extend Level 1 downgradient seepage pump back wells to a depth of 70 feet

Level 3

- Extend Level 2 downgradient seepage pump back wells to a depth of 100 feet

Seepage modeling studies indicate that by using these Levels 0 to 3 seepage controls (KCB 2018d, 2019), this facility could obtain uncollected seepage rates of 65 to 178 AF/yr, which is well below the allowable maximum of 329 AF/yr (Montgomery 2019a) modeled as necessary to meet surface water quality standards at the POC identified for this alternative. No constituents were modeled to result in concentrations above established water quality standards.

4.2.5.2. Practicability

The Skunk Camp TSF Alternative is practicable. This alternative is available and both technically and logistically practicable. The ASLD has indicated that it is willing to sell this land to Resolution for the development of a TSF. The seepage collection system is simpler in design with a higher efficiency than the other TSF alternative designs, and there is substantial opportunity to implement additional seepage control measures for this alternative when compared to other alternatives. The design of the TSF under this alternative has the capacity to meet the overall project purpose.

Table 3. TSF Alternative Practicability Analysis Results Summary

TSF Alternative	Tailings Placement Method	Key Geologic and Hydrogeologic Characteristics	Available	Logistically Practicable	Technologically Practicable	Economically Practicable	Practicability Determination
Near West 'Wet'	Conventional thickened; modified centerline embankment.	Distance to Queen Creek is ~0.25 miles.	Yes	No	No – Significantly exceeds uncollected seepage maximums even with Level 4 controls.	Yes	**Not Practicable (technology and logistics)**
Near West 'Dry'	Ultra thickened NPAG; modified centerline embankment for NPAG; physically separated PAG cell using splitter berm.	Distance to Queen Creek is ~0.25 miles.	Yes	Yes	Yes – However, this TSF requires Level 4 seepage controls consistently operating at 99.5 percent efficiency. No known TSFs that use this degree of extensive seepage control technology to date.	Yes	**Practicable**
Silver King	Dry-stack NPAG and PAG; structural outer shell	Mix of diverse and complex geology with higher potential for weathering and fracturing. Requires extensive surface water diversion tunnels, dams, and channels.	Yes	No	No – Technology for dry-stack methodology at the scale needed to meet the project purpose has not been demonstrated, is at an unprecedented height, and lacks ability to meet water quality standards and secure an APP.	Yes	**Not Practicable (technology and logistics)**
Peg Leg	Ultra thickened NPAG; robust and resilient double embankment approach (full centerline for NPAG and downstream for PAG).	Geology is a mix of fractured bedrock for PAG and alluvial under NPAG. Distance to Gila River is ~2 miles.	No	Yes	Yes	Yes	**Not Practicable (not available)**
Skunk Camp	Ultra thickened NPAG; robust and resilient double embankment approach (full centerline for NPAG and downstream for PAG).	Geology is composed of Gila Conglomerate with thin alluvial cover. Distance to Gila River ~13 miles.	Yes	Yes	Yes	Yes	**Practicable**

5. ENVIRONMENTAL EFFECTS OF PRACTICABLE ALTERNATIVES

This section provides a comparative analysis of environmental impacts for those alternatives determined to be practicable in **Section 4**. This comparative analysis includes a discussion of impacts to the aquatic ecosystem and other anticipated adverse environmental consequences under each of the practicable alternatives. Identification of these other adverse environmental consequences is based on information contained in the baseline resource reports and DEIS prepared for Resolution's proposed mine development. Analyses of these other adverse environmental consequences are necessary to ensure that the Corps may identify the LEDPA, as required by the Guidelines (40 CFR § 230.10(a)).

The 404(b)(1) alternatives analysis is intended to ensure that no discharge be permitted "if there is a practicable alternative to the proposed discharge which would have less adverse impact on the aquatic ecosystem, so long as the alternative does not have other significant adverse environmental consequences" (40 CFR § 230.10(a)). The aquatic ecosystem, in turn, is defined as waters of the U.S., including wetlands, that serve as habitat for interrelated and interacting communities and populations of plants and animals (40 C.F.R. § 230.3(c)). In evaluating practicable alternatives, the Guidelines' preliminary focus is thus on assessing effects on waters of the U.S., but the analysis can extend to other adverse environmental consequences occurring outside of waters of the U.S.

The definition of "waters of the U.S." has been a source of considerable confusion for many years, particularly since the United States Supreme Court's 2006 decisions in *Rapanos v. United States and Carabell v. United States*. Following those decisions, the Environmental Protection Agency (EPA) and the Corps issued interpretive guidance, last modified in December 2008. In this 2008 CWA guidance document, entitled *Clean Water Act Jurisdiction Following the U.S. Supreme Court's Decision in Rapanos v. United States and Carabell v. United States* (the Guidebook), non-navigable tributaries that are not relatively permanent (which represent the majority of features present at all of the TSF alternatives) can be found jurisdictional only if they have a significant nexus with a Traditional Navigable Water (TNW). This represented a significant departure from the prior agency interpretation, which categorically regulated all tributaries, even ephemeral tributaries.

On June 29, 2015, the Corps and EPA adopted a new rule defining waters of the U.S. The new rule returned to a more categorical regulation of tributaries, including ephemeral tributaries. However, implementation of the 2015 rule is currently enjoined in 28 states, including Arizona, while being effective in 22 other states. That injunction is not permanent, and there is a chance that the 2015 rule could become effective in Arizona at some point.

Meanwhile, EPA and the Corps have proposed to repeal the 2015 rule, and separately proposed in early 2019 a new definition of waters of the U.S. that would exclude ephemeral features from regulation as waters of the U.S. Under the newly proposed definition, however, ephemeral features could serve as point sources if they conveyed pollutants to a regulated water, even if the ephemeral feature itself is not considered to be a water of the U.S.

In this analysis, identification of waters of the U.S. (or potential waters of the U.S.) is based on the 2008 Guidebook, which is still applicable in Arizona. Under the Guidebook, no waters of the U.S. exist in the footprint of the Near West alternatives (analyzed as Alternatives 2 and 3 in the DEIS), based on an approved jurisdictional determination issued by the Corps (SPL 2014-00064-MWL), but potential waters of the U.S. are believed to exist at the Skunk Camp alternative location (analyzed as Alternatives 6 in the DEIS), although no jurisdictional determination has yet been completed by the Corps. However, during the pendency of the Corps' review of Resolution's Section 404 permit application, the governing law on waters of the U.S. may change by the time the permit is issued. Were the 2015 rule to become effective in Arizona, ephemeral features at Near West and Skunk Camp would likely be considered jurisdictional; by contrast, if the 2019 proposed rule were adopted as proposed, neither site would likely contain any jurisdictional waters.

Given the uncertainty of whether ephemeral features within the footprints of the two practicable TSF alternatives could be considered jurisdictional waters of the U.S., the evaluation provided in this section focuses on impacts more broadly, informed by an evaluation completed by WestLand (2018) in support of the development of the DEIS. The evaluation that follows focuses on the extent of the OHWM in ephemeral systems (washes and ponds) and the location and extent of other aquatic features, such as seeps and springs. The identification of OHWM for the remaining practicable alternatives is based on a desktop review of high-quality, recent aerial photographs supplemented by field verification through collection of geolocated ground photography. The identification of seeps and springs was completed via review of U.S. Geological Survey topographic maps and other publicly available data, supplemented by full field inventory of the Near West (DEIS Alternatives 2 and 3) and Skunk Camp (DEIS Alternative 6) alternatives (Montgomery & WestLand 2017). Even if these features are not jurisdictional waters of the U.S. because they lack a "significant nexus" with a downstream TNW, they still provide wildlife habitat and other benefits (i.e., they still serve as "habitat for interrelated and interacting communities and populations of plants and animals"). Even if not waters of the U.S. (and thus not part of the "aquatic ecosystem" as defined in the Guidelines), impacts to these features can be considered other significant adverse environmental consequences, and thus may be considered in identifying the LEDPA.

5.1. Near West 'Dry' TSF Alternative

5.1.1. Impacts to the Aquatic Ecosystem and Surface Water Features

The estimated total impacts to surface water features and waters of the U.S. associated with this alternative (TSF footprint, pipelines, and associated facilities) are provided in **Table 4** and depicted in **Figure 6**.

Table 4. Near West 'Dry' TSF Alternative Impacts to Aquatic Ecosystem and Surface Water Features

Feature Type	Impact Area (ac)	
	Surface Water Features	Waters of the U.S.
Ephemeral features	36.89	0
Wetlands	0.2	0
Total Impacts	**36.89**	**0**

Aquatic Ecosystem and Surface Water Resources

The Near West 'Dry' TSF Alternative, located in the Queen Creek watershed, contains ephemeral drainages that possess an OHWM, but have been previously determined non-jurisdictional by the Corps. The ephemeral channels within the site and pipeline corridor contain functions and values typical of desert ephemeral systems. In addition to the ephemeral wash systems, three springs (Bear Tank Canyon, Benson, and Perlite springs) have been identified within the TSF footprint. While not jurisdictional, these features have wetland (i.e., special aquatic site) characteristics and have a cultural value to local tribes. Wetland features are particularly rare and valuable in arid areas.

5.1.2. Other Adverse Environmental Consequences

Identification of the other adverse environmental consequences of the development of Near West 'Dry' TSF Alternative is based on information contained in the baseline resource reports and DEIS. Focus is only on those resource effects which substantially distinguish one practicable alternative from the others. These adverse environmental consequences are compared to those of the other practicable TSF Alternatives to determine if selection of an alternative other than that identified as LEDPA is warranted (40 CFR §230.10(a)). As noted above, these other adverse environmental consequences include direct and indirect effects of the project on resources other than the aquatic ecosystem.

Environmentally damaging effects include the loss of surface water resources, including wetlands, within the footprint of Near West 'Dry' TSF Alternative, even if those resources do not constitute jurisdictional waters of the U.S. In addition, construction of the TSF under this alternative will directly affect approximately 3,308 acres of previously undisturbed National Forest System Lands.

Seepage Potential

This alternative is sited on a foundation comprised of bedrock incised with narrow channels infilled with alluvial, colluvial, and undifferentiated sediments. The relatively small Queen Creek alluvial aquifer lies approximately 50 feet below the surface, with Queen Creek less than 0.25 miles from the TSF. Whitlow Ranch Dam occurs approximately three miles downstream. The ring impoundment would produce seepage along all three sides. The extensive combined Levels 0 to 4 seepage controls, which go well beyond the typical copper porphyry TSF, would be required to meet ADEQ's surface water quality standards in Queen Creek and at Whitlow Ranch Dam. Uncaptured seepage would reach the ground surface at Queen Creek and travel downgradient to Whitlow Ranch Dam. Groundwater modeling studies for this location indicate a preliminary maximum allowable of uncaptured seepage rate of 3 AF/yr. By using the extensive Level 4 seepage control measures, modelled uncollected seepage rates are 2.7 AF/yr, just meeting the allowable uncaptured seepage rate, thereby requiring the extensive engineering controls to work at maximum efficiency with little to no room for error over the life of the mine and in post-closure.

Tailings Safety

As part of the evaluation of tailings alternatives, a failure modes analysis of each of the alternatives was conducted and included in the DEIS. For each failure mode, relevant protection measures and design features in line with best practice international standards and state and federal regulations were identified to prevent the failure. The USFS then completed an effects analysis of potential tailings dam failures using the Rico Empirical Method; see Section 3.10.1.2 of the DEIS (USFS 2019). This evaluation method represents a "worst case" scenario as it does not consider embankment type, design features used to address failure modes, foundation conditions, or operational approaches.

As noted above, the Near West 'Dry' TSF Alternative has been designed with a modified-centerline embankment, which is inherently more resilient than upstream-type embankments, but less resilient to any accumulated missteps or unforeseen events than true centerline-type embankments. For this alternative, the embankment is required to extend to three sides of the facility, is generally free-standing and not anchored to consolidated rock, and as such is the longest of the embankments proposed (10 miles). These design features are not inherently unsafe, but are potentially less resilient than a shorter, well-anchored embankment.

An estimated 600,000 people are in the modeled potential area of effect should a tailings dam failure occur at this alternative. Given the proximity of the community of Queen Valley to the alternative location, there would be relatively little time for an evacuation. An estimated eight water supply systems, serving approximately 700,000 people, would be adversely impacted by such a failure, as would significant agricultural irrigation and water supply infrastructure, such as the Central Arizona Project (CAP) and other canals. Impact to the CAP canal would have the potential to disrupt water supplies well beyond the tailings failure flow path, as the City of Tucson and other communities rely heavily on CAP water.

Visual Resources

This alternative would be visible from U.S. Highway 60, Superior, and Queen Creek, which are located 1.7 miles to the south, 4.5 miles to the southeast, and approximately 3 miles southwest of the TSF, respectively. Because this alternative has a more prominent dam height than the Skunk Camp TSF alternative, and it is located proximal to the public, it would have substantially greater visual impacts than the Skunk Camp TSF alternative.

Recreation

The Arizona National Scenic Trail (AZT), an 800-mile trail system that covers the length of the state, passes approximately 0.75 miles east of the Near West 'Dry' TSF alternative site, through Rice Water Canyon and Whitford Canyon. The pipeline corridor and access roads associated with the Near West 'Dry' alternative would cross the AZT, affecting the users experience and potential becoming a safety concern with mining vehicles crossing a remote hiking trail. Being National Forest System lands, this alternative's location also contains highly used public recreation areas, such as hiking, which would be impacted by the construction of this alternative.

5.1.3. Compliance with the Guidelines

As previously described, a demonstration of compliance with the Guidelines at 40 CFR § Part 230 is required before a Section 404 permit may be issued for a project. The analysis of alternatives included in this practicability analysis document and made final in the Corps's 404(b)(1) alternatives analysis document is intended to facilitate compliance with 40 CFR § Part 230.10(a) that no discharge of dredged or fill material be permitted if there is a practicable alternative to the proposed discharge that would have less impact on the aquatic ecosystem, so long as the alternative does not have other significant adverse environmental consequences. The information on the range of alternatives analyzed, the availability and/or practicability of analyzed alternatives, the impacts to the aquatic system of the practicable alternatives, and the other significant adverse environmental consequences of the practicable alternatives described herein is intended to provide the Corps with the information necessary to make this determination under 40 CFR § Part 230.10(a).

The Guidelines also contain three other independent requirements at 40 CFR § Parts 230.10(b), (c), and (d) that must be met prior to the decision by the Corps to issue a permit. The requirement at 40 CFR § Part 230.10(b) prohibits discharges that will result in a violation of water quality standards or toxic effluent standards, will jeopardize a threatened or endangered species, or violate requirements imposed to protect a marine sanctuary. Operation of the TSF under the Near West 'Dry' alternative will require that Resolution obtain an APP from ADEQ, which requires the mine facility to demonstrate that it will not cause or contribute to an exceedance of AWQS at the point of compliance, or, if AWQS for a pollutant has been exceeded in an aquifer at the time of permit issuance, that no additional degradation will occur [A.R.S. § 49-243(B)(2)-(3); AAC R18-9-A202(A)(8)(a)]. Seepage must also not contribute to the exceedance of any ADEQ surface water quality standards where groundwater may emerge and contribute to surface flow [AAC R18-11-405(b)]. The extensive seepage control measures and control efficiencies required to meet this standard for the Near West 'Dry' alternative are described above; as discussed therein, 99.5-percent seepage capture efficiency, a standard not seen at any known TSF, is required to avoid causing an exceedance of surface water quality standards in Queen Creek.

As described in the DEIS (USFS 2019), the Near West 'Dry' alternative is not anticipated to jeopardize the continued existence of species listed as threatened or endangered under the Endangered Species Act (ESA) or result in the destruction or adverse modification of such species' designated critical habitat. The Near West 'Dry' alternative also will not violate any requirement designed to protect a marine sanctuary.

The requirement at 40 CFR § Part 230.10(c) prohibits discharges that will cause or contribute to significant degradation of jurisdictional waters of the U.S. Although not jurisdictional waters of the U.S., the discharge of fill for the construction and operation of the TSF will result in the loss of the structure and aquatic function of the ephemeral drainages and groundwater-dependent wetland ecosystems within the footprint of fill. As described above, the extensive seepage control measures and control efficiencies necessary for the Near West TSF to meet AWQS under the APP are intended to prevent significant adverse effects from seepage.

Other indirect and cumulative effects from the discharge on the aquatic environment are anticipated to be minimal and will not cause significant degradation. There are not anticipated to be significantly adverse effects on human health or welfare, on life stages of aquatic life and other wildlife dependent on aquatic ecosystems, or on aquatic ecosystem diversity, productivity and stability. There will be some indirect effect on recreational, aesthetic, and economic values of the lands surrounding the TSF as disclosed in the DEIS, but these effects are not significant adverse effects to or significant degradation of recreational, aesthetic, and economic values of the waters of the U.S. that result from the construction and operation of the TSF.

The requirement at 40 CFR § Part 230.10(d) prohibits discharges unless all appropriate and practicable steps have been taken to minimize potential adverse impacts of the discharge on the aquatic ecosystem. The development of the TSF design included a significant effort to avoid and minimize impacts to the ephemeral drainages and groundwater-dependent ecosystems in the area of the TSF. Although the area beneath the footprint of the TSF and its appurtenant features will no longer contribute runoff from precipitation to downstream drainage reaches, the TSF design minimizes impacts to downstream waters of the U.S. by diverting upstream stormwater flows around the facility. Similarly, the stormwater controls, run-on diversions, and engineering controls have been designed to maintain downstream stormwater flows while minimizing the risk of contaminant discharge to downstream surface water features to the maximum extent practicable.

5.2. Skunk Camp TSF Alternative

5.2.1. Impacts to the Aquatic Ecosystem and Surface Water Features

The estimated total impacts to surface water features and potential waters of the U.S. associated with this alternative (TSF footprint, pipelines, and associated facilities) are provided in **Table 5** and depicted in **Figures 7a and 7b**.

Table 5. Skunk Camp TSF Alternative Impacts to Aquatic Ecosystem and Surface Water Features

Feature Type	Impact Area (ac)	
	Surface Water Features	Potential Waters of the U.S.
Ephemeral Features	153.4	126.2
Wetlands	0	0
Total Impacts	**153.4**	**126.2**

Aquatic Ecosystem and Surface Water Resources

Potentially jurisdictional waters of the U.S. were mapped on the Skunk Camp TSF site using a recent ESRI Online aerial imagery analysis. Field reconnaissance and geolocated ground photography were used to further refine the delineation of OHWM characteristics. Potential waters identified within the site and pipeline corridor are dominated by both relatively confined and braided ephemeral channels with functions and values typical of desert ephemeral systems. No special aquatic sites (e.g., wetlands) or seeps and springs are located within the footprint of this TSF or either potential pipeline corridor.

5.2.2. Other Adverse Environmental Consequences

As indicated in **Section 5**, identification of the other adverse environmental consequences of the development of Skunk Camp TSF Alternative is based on information contained in the baseline resource reports and DEIS prepared for the proposed project.

Adverse direct effects include the loss of those resources within the footprint of Skunk Camp TSF Alternative. Construction of the TSF and associated infrastructure (including pipelines) under this alternative will directly affect approximately 4,002 acres of previously undisturbed private and state lands.

Seepage

This alternative's required seepage controls are much less extensive than the Near West 'Dry' TSF due to the foundation being located on less complex geology comprising Gila Conglomerate overlain with alluvial sediments. The cross-valley impoundment, located within a basin, allows for seepage to a singular point downgradient of the TSF. Groundwater modeling studies conducted indicate a preliminary maximum allowable of uncaptured seepage to be 329 AF/yr. Seepage control measure of a Level 3 indicate uncollected seepage rates of 65 to 178 AF/yr, which is below the maximum allowable by 46 to 80.3 percent.

Tailings Safety

A number of design and location considerations differentiate the Skunk Camp TSF Alternative from the Near West 'Dry' TSF Alternative. First, the embankment for the Skunk Camp TSF Alternative uses a cross-valley construction, which would have a single face instead of three faces and would be tied into consolidated rock on either end. In addition to being anchored to consolidated rock, the embankment face would be considerably shorter—3 linear miles compared to 10. While the embankments for both alternatives would be designed to the same safety standards, the simpler construction of the Skunk Camp TSF Alternative embankment, combined with the ability to implement a dual-embankment approach (a full centerline embankment for NPAG; downstream embankment for PAG) would be considered more resilient to any accumulated missteps or unforeseen events. The design for this tailings alternative also effectively isolates the PAG material with a downstream embankment, making it less likely that these materials would be released in the event of a tailings failure.

Downstream communities potentially affected by the modeled dam failure total approximately 3,000 people and the larger population centers (Winkelman, Hayden, and Kearney) are over 20 miles downstream of the TSF, allowing adequate time for evacuation, if necessary. Four water supply systems, serving approximately 3,000 people, are downstream of the TSF and would potentially be affected by a tailings failure.

Visual Resources

This alterative is not highly visible from towns, cities, or densely populated areas.

Recreation

The Skunk Camp TSF Alternative is relatively remote and would not include National Forest System lands within the TSF footprint. The location of this TSF sees less recreational use compared to the Near West 'Dry' TSF Alternative. No known hiking trails (including the AZT) or recreational areas would need to be relocated due to the construction of this TSF alternative.

5.2.3. Compliance with the Guidelines

The information on the range of alternatives analyzed, the availability and/or practicability of analyzed alternatives, the impacts to the aquatic system of the practicable alternatives, and the other significant adverse environmental consequences of the practicable alternatives described herein is intended to provide the Corps with the information necessary to make the determination of LEDPA under 40 CFR § Part 230.10(a). The following section is intended to demonstrate the compliance of the Skunk Camp TSF alternative with the other three independent requirements at 40 CFR § Parts 230.10(b), (c), and (d) that must be met prior to the decision by the Corps to issue a permit.

The requirement at 40 CFR § Part 230.10(b) prohibits discharges that will result in a violation of water quality standards or toxic effluent standards, will jeopardize a threatened or endangered species, or violate requirements imposed to protect a marine sanctuary. As with the Near West 'Dry' alternative, the Skunk Camp TSF alternative requires an APP from ADEQ to demonstrate that it will not cause or contribute to an exceedance of AWQS at the point of compliance, or, if, AWQS for a pollutant has been exceeded in an aquifer at the time of permit issuance, that no additional degradation will occur [A.R.S. § 49-243(B)(2)-(3); AAC R18-9-A202(A)(8)(a)]. Seepage must also not contribute to the exceedance of any ADEQ surface water quality standards where groundwater may emerge and contribute to surface flow [AAC R18-11-405(b)]. The seepage control measures and control efficiencies required to meet this standard for the Skunk Camp TSF alternative are described above. It is anticipated that seepage control using recognized technologies will be well above what is required to meet surface water quality standards.

As described in the DEIS (USFS 2019), the Skunk Camp TSF alternative is not anticipated to jeopardize the continued existence of species listed as threatened or endangered under the ESA or result in the destruction or adverse modification of such species' designated critical habitat. The Skunk Camp TSF alternative also will not violate any requirement designed to protect a marine sanctuary.

The requirement at 40 CFR § Part 230.10(c) prohibits discharges that will cause or contribute to significant degradation of jurisdictional waters of the U.S. The discharge of fill for the construction and operation of the TSF will result in the loss of the structure and aquatic function of the jurisdictional waters of the U.S., comprised entirely of ephemeral drainages, within the footprint of fill. Indirect and cumulative effects from the discharge on the aquatic environment are anticipated to be minimal and will not cause significant degradation. There are not anticipated to be significantly adverse effects on human health or welfare, on life stages of aquatic life and other wildlife dependent on aquatic ecosystems, or on aquatic ecosystem diversity, productivity and stability. There will be some indirect effect on recreational, aesthetic, and economic values of the lands surrounding the TSF as disclosed in the DEIS, but these effects are not significant adverse effects to or significant degradation of recreational, aesthetic, and economic values of the waters of the U.S. that result from the construction and operation of the TSF.

The requirement at 40 CFR § Part 230.10(d) prohibits discharges unless all appropriate and practicable steps have been taken to minimize potential adverse impacts of the discharge on the aquatic ecosystem. The development of the TSF design included a significant effort to avoid and minimize impacts to the ephemeral drainages and groundwater-dependent ecosystems in the area of the TSF. Although the area beneath the footprint of the TSF and its appurtenant features will no longer contribute runoff from precipitation to downstream drainage reaches, the TSF design minimizes impacts to downstream waters of the U.S. by diverting upstream stormwater flows around the facility. The Skunk Camp TSF has been located relatively high in the watershed of Dripping Spring Wash, minimizing the size of the upgradient watershed for which stormwater must be managed. Similarly, the stormwater controls, run-on diversions, and engineering controls have been designed to maintain downstream stormwater flows while minimizing the risk of contaminant discharge to downstream surface water features to the maximum extent practicable.

6. SUMMARY AND CONCLUSIONS

While the Skunk Camp TSF Alternative has impacts to currently jurisdictional waters of the U.S., and greater impacts to surface water (ephemeral wash) resources generally, the other practicable alternative, Near West 'Dry', would result in other significant adverse environmental consequences that must be factored into a LEDPA determination. First and foremost, seepage control under the Near West 'Dry' alternative would require the implementation of a level of engineering controls well beyond that which has been implemented and typical for copper porphyry TSFs, and would require those controls to work almost perfectly for long periods of time, in order for seepage from the TSF not to result in a violation of water quality standards. By contrast, the Skunk Camp alternative, due to less complex geology and topography, allows for use of significantly less complex engineering controls that can more reliably be expected to function effectively for long periods of time. The modeled seepage using these simpler and more reliable controls is significantly below that required to meet water quality standards. Skunk Camp is also located significantly further from any major surface water feature (approximately 13 miles from the Gila River, compared to Near West 'Dry' being only 0.25 miles from Queen Creek), allowing for substantial opportunity to incorporate additional engineering controls (e.g., cutoff walls, grout curtains, etc.), should any be necessary.

Other significant adverse environmental consequences of the Near West 'Dry' alternative in comparison to the Skunk Camp alternative are as follows: 1) Near West 'Dry' would result in the loss of surface water features with wetland (special aquatic site) characteristics (none are present at Skunk Camp); 2) Near West 'Dry' design and location present more challenges and far greater impacts affecting the potential for and consequences of tailings failure; 3) Near West 'Dry' would adversely impact existing recreational uses to a much greater degree; 4) Near West 'Dry' would require relocation of a portion of the Arizona Trail; 5) Near West 'Dry' would have significantly greater visual resource impacts due to its greater proximity to populated and traveled areas; and 6) Near West 'Dry' would impact over 3,000 acres of National Forest Service System land, whereas Skunk Camp would impact under 100 acres (solely in the pipeline corridor).

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FIGURES

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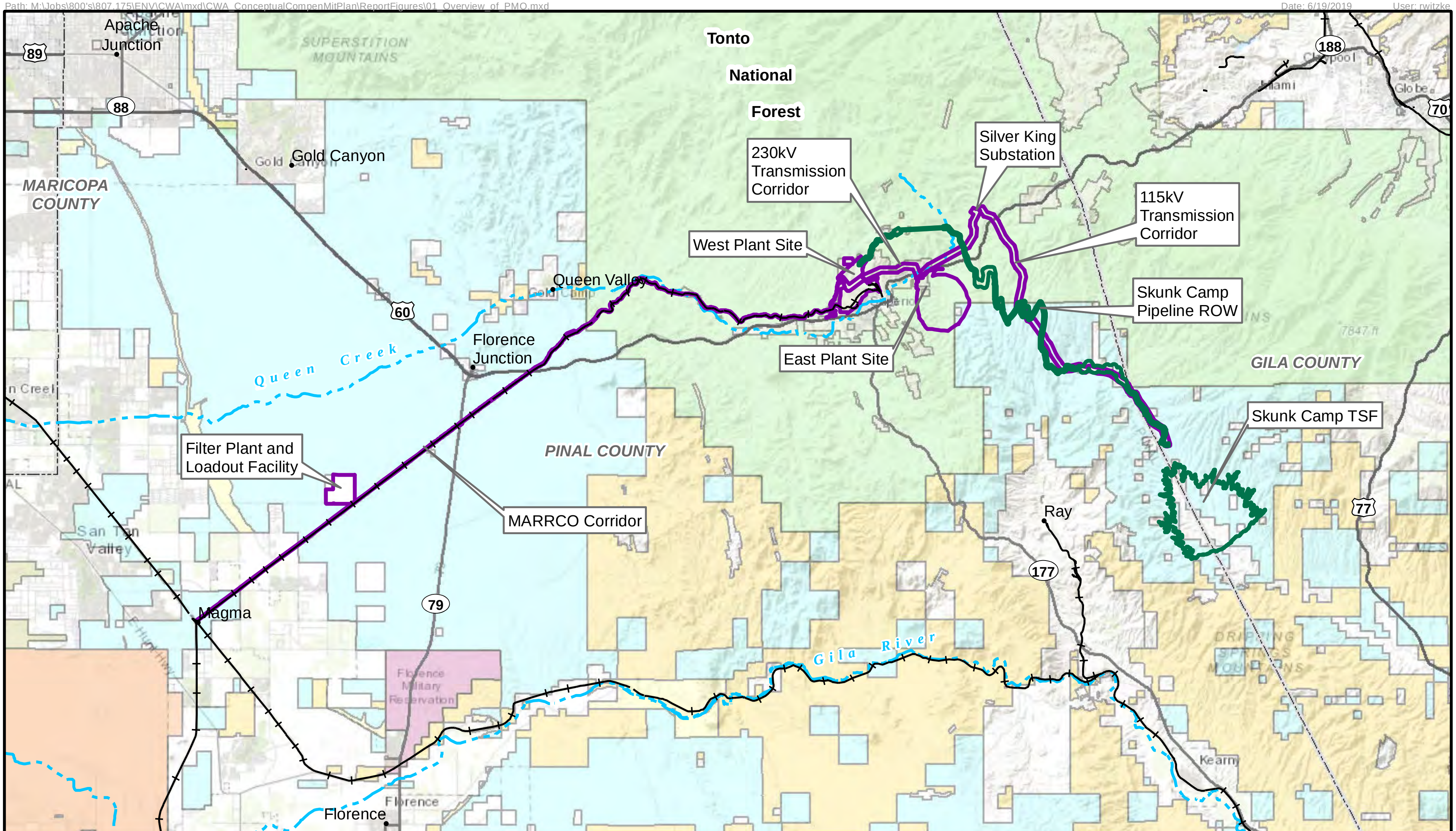

Pinal and Gila Counties, Arizona,
Data Source: BLM 2018, WRI Modified 2019,
ALRIS, SWCA, and USFS
Image Source: ArcGIS Online, World Topo Map

Legend

- Proposed Action
- GPO Mine Elements

Surface Management (BLM)

- County
- Indian Lands
- Local or State Parks
- Other
- State Trust Land
- Bureau of Land Management (BLM)
- Military
- Bureau of Reclamation
- Private Land
- US Forest Service (USFS)

N

0 2.5 5 Miles

0 4 8 Kilometers

WestLand Resources

RESOLUTION COPPER
DRAFT Practicability Analysis

OVERVIEW OF
PROPOSED MINING OPERATION

Figure 1

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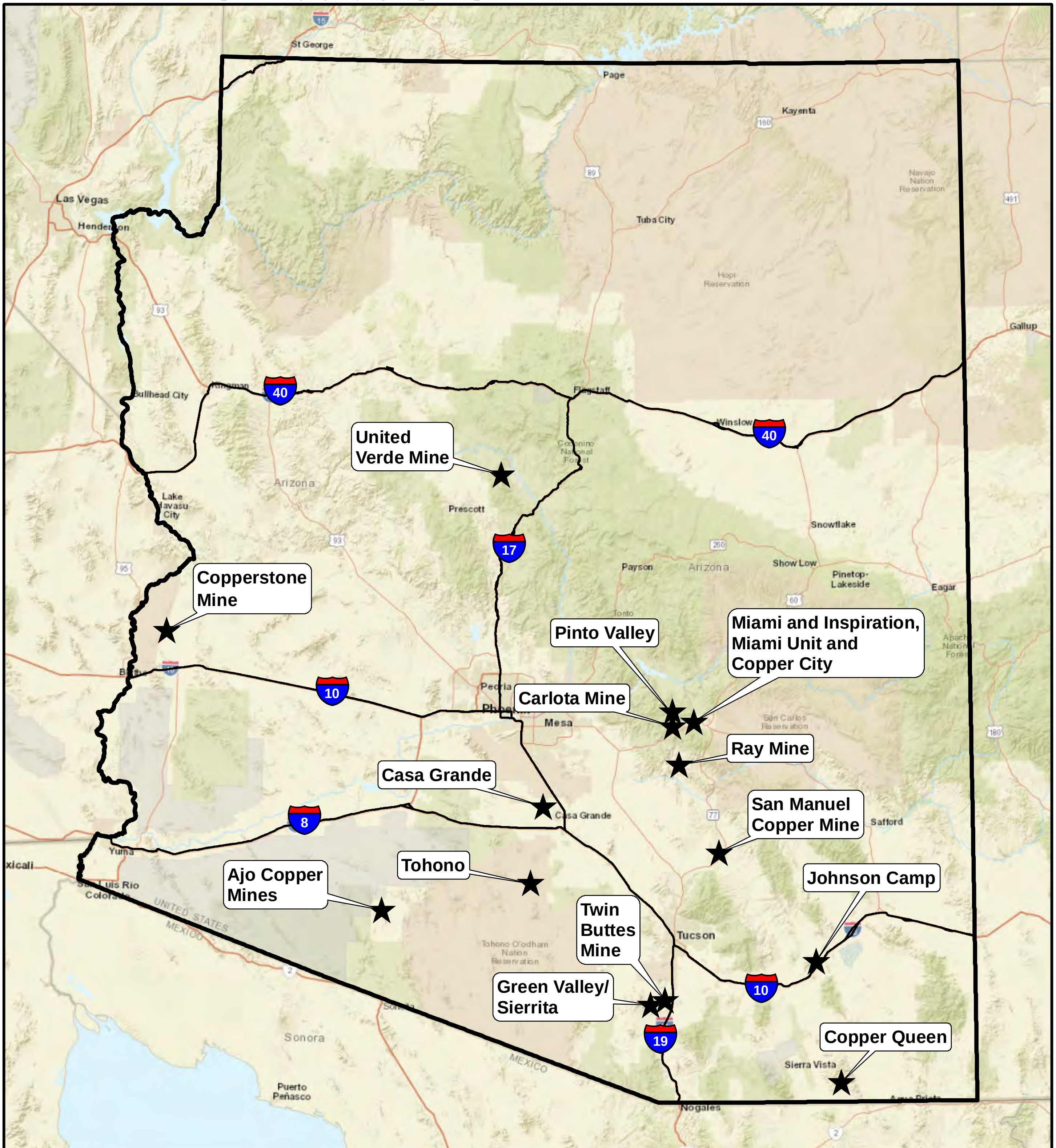

Data Source: ARLIS, USDA, USFS 11-1-2017
Image Source: ArcGIS Online World Street Map

Legend

★ Brownsfield Site

— Interstates (ALRIS)

N

0 25 50 Miles

0 50 100 Kilometers

WestLand Resources

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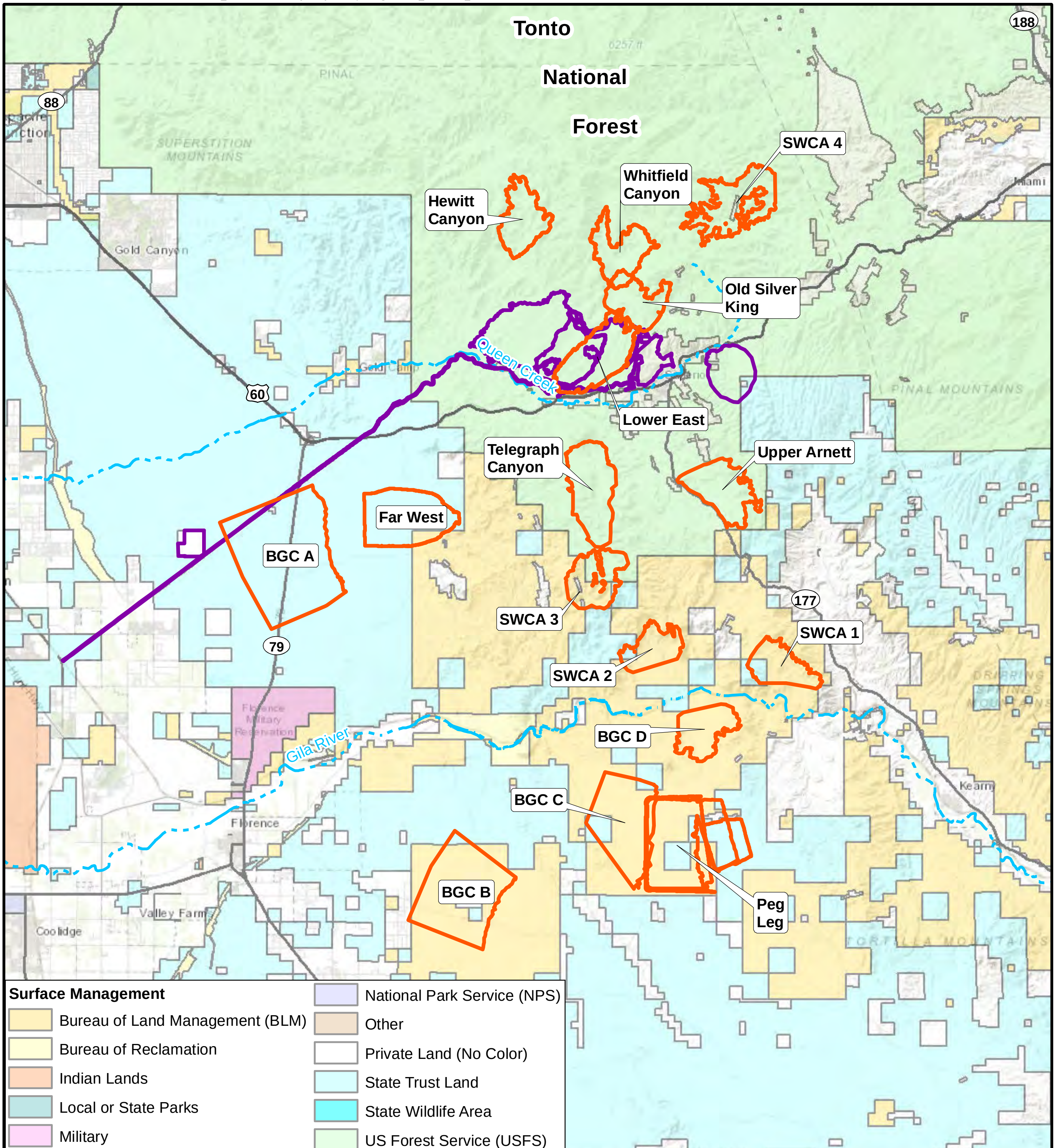
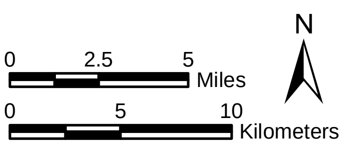
DRAFT Practicability Analysis

BROWNSFIELD TAILINGS STORAGE FACILITY LOCATIONS

Figure 2



Data Source: 08-17-2018
Image Source: ArcGIS Online World Topo Map



WestLand Resources

Legend

- Tailings Alternatives Dismissed
- Proposed Action

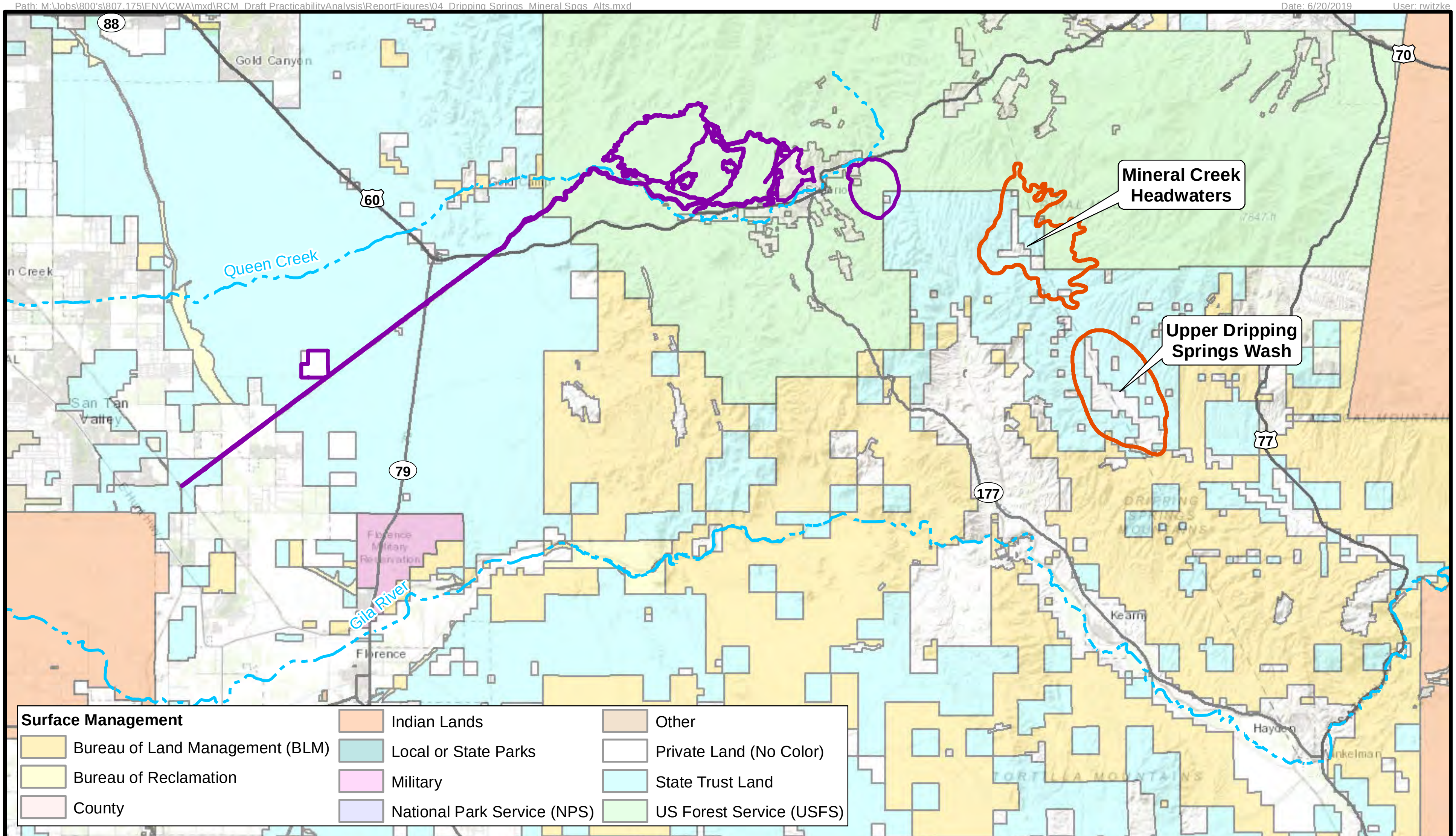
RESOLUTION COPPER

DRAFT Practicability Analysis

INITIAL TAILINGS STORAGEFACILITY ALTERNATIVES
DISMISSED FROM FURTHER CONSIDERATION

Figure 3

Path: M:\Jobs\800's\807.175\ENV\CWA\mxd\RCM_Draft PracticabilityAnalysis\ReportFigures\04_Dripping Springs_Mineral Spgs_Alts.mxd Date: 6/20/2019 User: rwitzke



Data Source: 08-17-2018
Image Source: ArcGIS Online World Topo Map

0 2.5 5 Miles
0 5 10 Kilometers
N

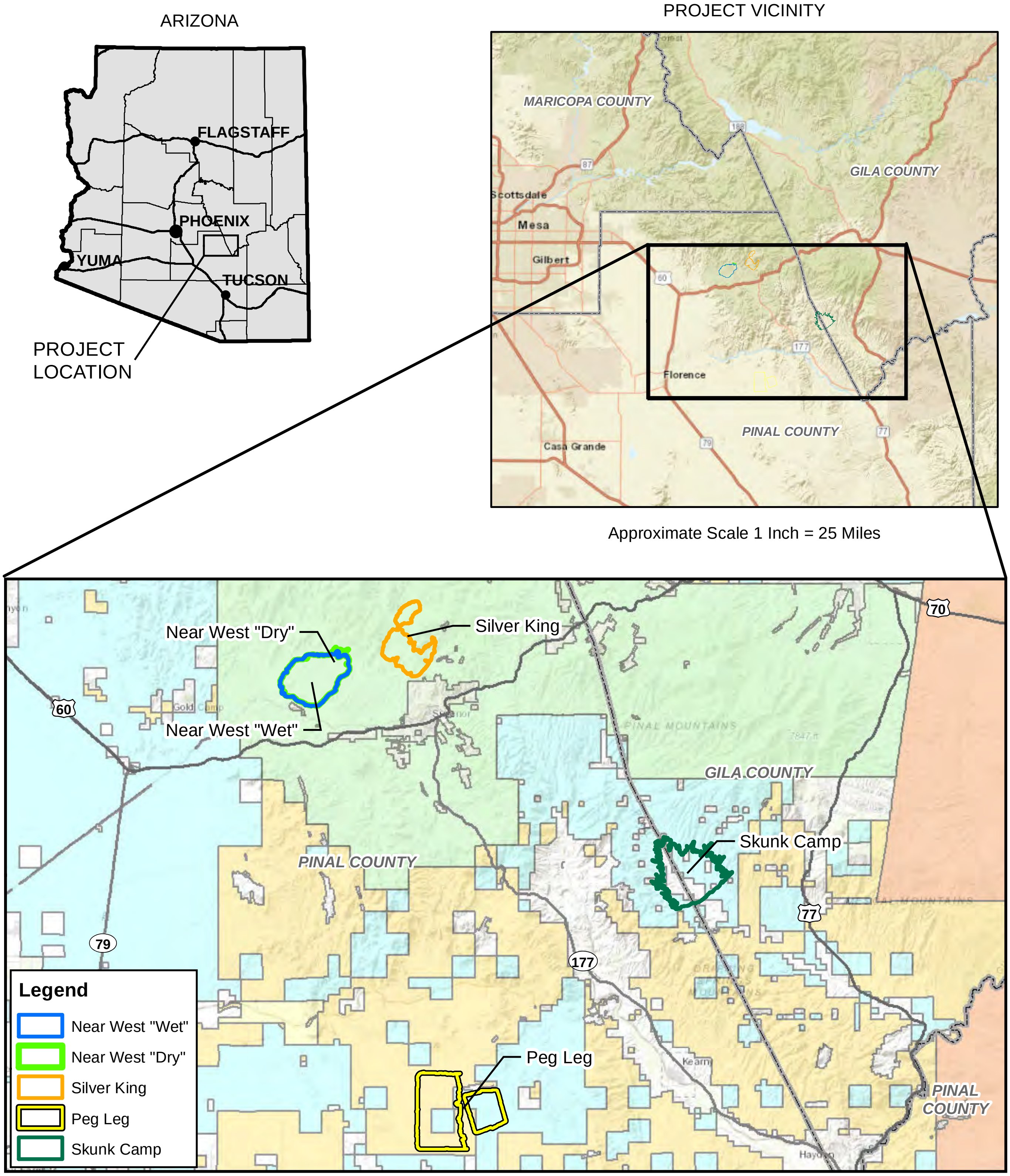
WestLand Resources

Legend

Proposed Action

RESOLUTION COPPER
DRAFT Practicability Analysis

MINERAL CREEK AND UPPER DRIPPING SPRINGS ALTERNATIVES
Figure 4



Portions of T1S R11 and 12E; T2S R14E; T3S R14E;
T4S R12 and 13E; and T5S R12 and 13E,
Pinal and Gila Counties, Arizona,
Image Source: ArcGIS Online, World Topo and World Street Maps

WestLand Resources

N

0 3 6 Miles

0 6 12 Kilometers

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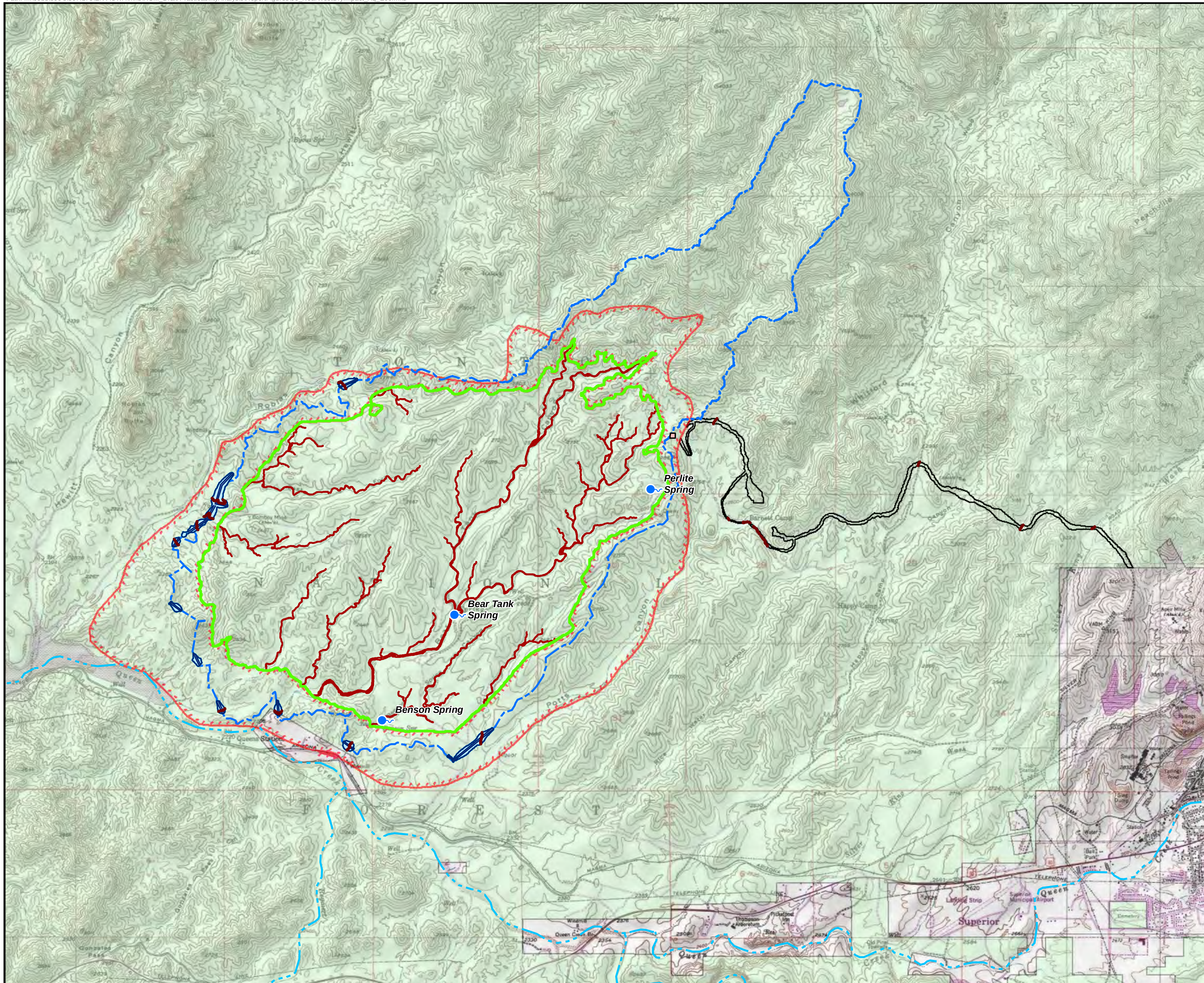
OVERVIEW OF TAILINGS STORAGE FACILITY
ALTERNATIVES LOCATIONS CONSIDERED IN DETAIL

Figure 5

Path: M:\Jobs\800's\807.175\ENV\CWA\mxd\RCM_Draft PracticabilityAnalysis\ReportFigures\06_NearWestDryImpact_Aq_Eco.mxd Date: 6/19/2019 User: rwitzke



Near West 'Dry' TSF within:
T1S, R11E, Portions of Sections 23-27, 34-36,
T1S, R12E, Portions of Sections 18, 19, 30, and 31,
Pinal County, Arizona,
Picketpost Mountain USGS 7.5' Quadrangle
Data Source: SWCA and Golder
Surface Management: BLM 2018, WRI modified 2019

Legend

- Spring (Montogermey & Assoc. 6-4-2018)
- Near West Seepage Dams
- Near West Dams
- Cyclone Plant
- Near West Catchment
- Near West 'Dry' Impacted Ordinary High Water Mark
- Near West 'Dry' Tailings Storage Facility
- Near West 'Dry' Tailings Corridor
- Proposed Fenceline

Surface Management (BLM)

- Private Land (No Color)
- US Forest Service (USFS)

N

0 1,750 3,500 Feet

0 600 1,200 Meters

WestLand Resources

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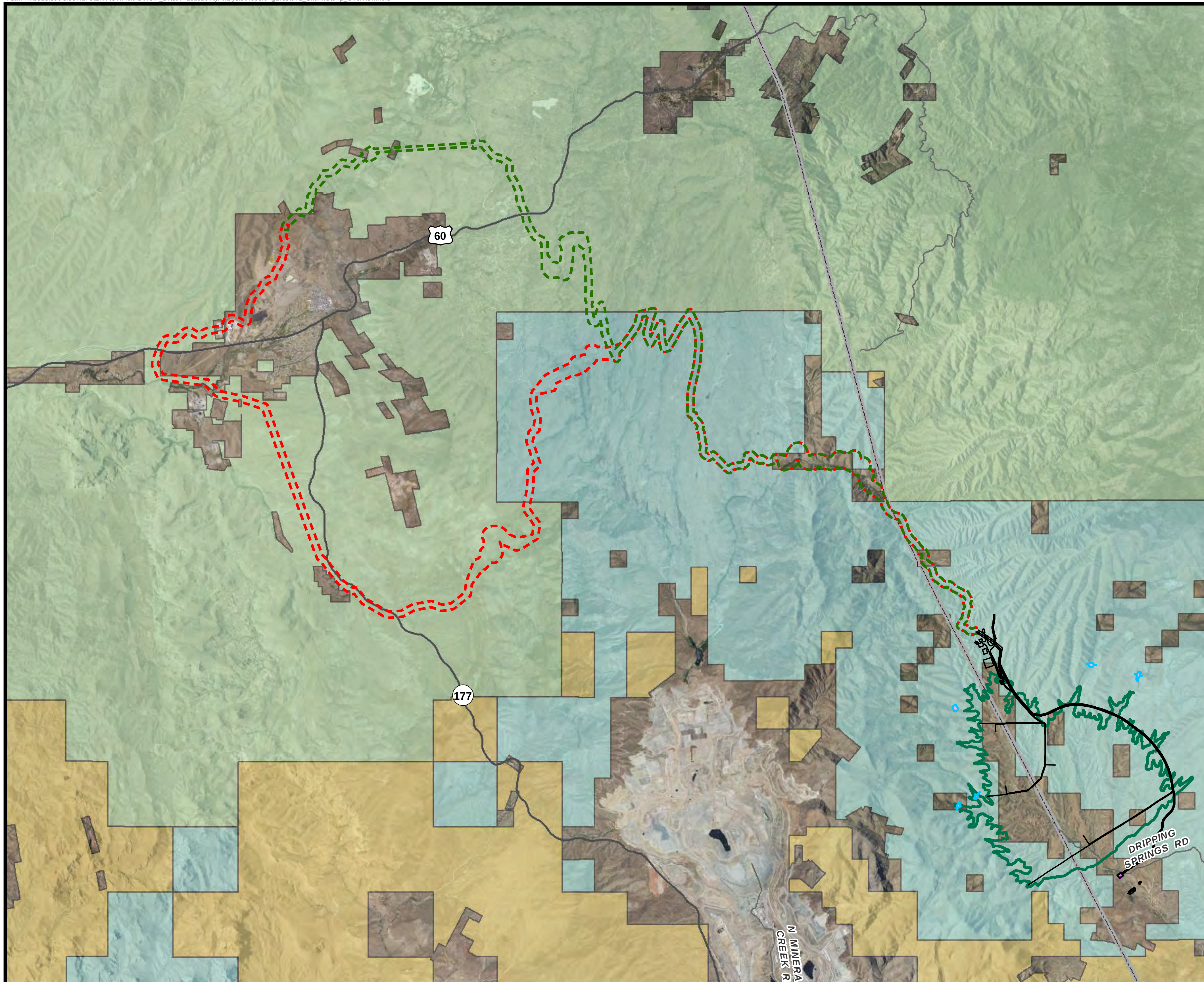
NEAR WEST 'DRY' IMPACTS TO AQUATIC ECOSYSTEMS

Figure 6

Path: M:\Jobs\800's\807.175\ENV\CWA\mxd\RCM_Draft PracticabilityAnalysis\ReportFigures\07a_SkunkCamp_Overview.mxd

Date: 6/19/2019 User: rwitzke



T1S, R12 and 13E, T2S, R12-14E, and T3S, R14E,
Gila and Pinal Counties, Arizona,
Data Sources: Golder and Associates, SWCA and RCM
Surface Management, BLM 2018, WRI modified 2019
Image Source: 2017 USDA NAIP Orthophoto

Legend

- Ancillary Facilities
- Skunk Camp Seepage Dam
- Skunk Camp Diversion Dyke
- Skunk Camp Toe Collection Pond
- Skunk Camp TSF
- North Skunk Camp 500 foot Pipeline ROW
- South Skunk Camp 500 foot Pipeline ROW

Surface Management

- Bureau of Land Management (BLM)
- Private Land (No Color)
- State Trust Land
- US Forest Service (USFS)

N

0 4,000 8,000 Feet

0 1,500 3,000 Meters

WestLand Resources

RESOLUTION COPPER

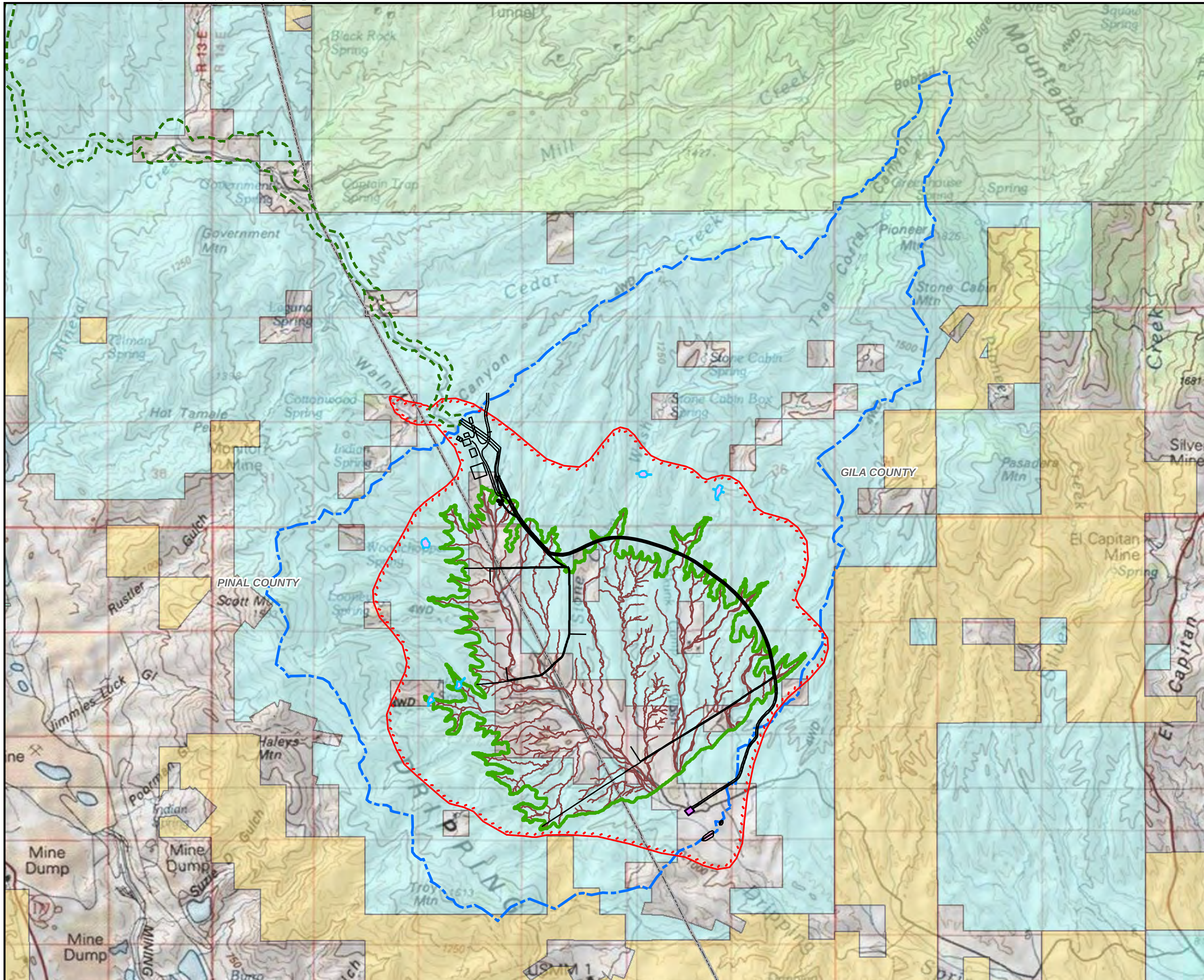
DRAFT Practicability Analysis

SKUNK CAMP IMPACTS TO
AQUATIC ECOSYSTEMS OVERVIEW

Figure 7a

Path: M:\Jobs\800's\807.175\ENV\CWA\mxd\RCM_Draft PracticabilityAnalysis\ReportFigures\07b_SkunkCampImpactsAqEco.mxd

Date: 6/19/2019 User: rwitzke



Skunk Camp TSF within:
T2S, R14E, Portions of Sections 33-35,
T3S, R14E, Portions of Sections 1-4, 9-12, and 14-16,
Pinal and Gila Counties, Arizona,
Globe USGS 1:100,000 USGS Quadrangle
Surface Management: BLM 2018, WRI Modified 2018,
Data Source: Golder and SWCA

Legend

- Ancillary Facilities
- Skunk Camp Seepage Dam
- Skunk Camp Diversion Dyke
- Skunk Camp Toe Collection Pond
- Skunk Camp Impacted Ordinary High Water Mark
- North Skunk Camp 500 foot Pipeline ROW
- Proposed Fenceline
- Skunk Camp Catchment
- Skunk Camp Tailings Storage Facility

Surface Management (BLM)

- Bureau of Land Management (BLM)
- Private Land
- State Trust Land
- US Forest Service (USFS)

N

0 2,500 5,000 Feet

0 1,000 2,000 Meters

WestLand Resources

RESOLUTION COPPER
DRAFT Practicability Analysis

SKUNK CAMP IMPACTS TO
AQUATIC ECOSYSTEMS
Figure 7b

APPENDIX A

Resolution Copper Mining, LLC Mine Plan of Operations and Land Exchange USFS Alternatives Data Request #3-F, Information on Potential Tailings Alternatives

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August 30, 2017

Ms. Mary Rasmussen
US Forest Service
Supervisor's Office
2324 East McDowell Road
Phoenix, AZ 85006-2496

Subject: Resolution Copper Mining, LLC – Mine Plan of Operations and Land Exchange – USFS Alternatives Data Request #3-F, Information on Potential Tailings Alternatives

Dear Ms. Rasmussen,

In a letter Resolution Copper received from the USFS dated July 19, 2017 (Alternatives Data Request #3), the USFS requested Resolution Copper (RC) to provide information related to tailings storage facility concepts and locations. For your review and consideration, please find RC's response to item F of that request listed below.

USFS Item F*: The Forest may consider tailings alternatives that would involve filtered tailings, more commonly known as "dry-stack" tailings. The Forest requests that Resolution provide input on technical or logistical concerns of using filtered tailings. We request that these specific topics be considered:*

1. *What technical or logistical limitations does Resolution foresee regarding the ultimate height or footprint of a filtered tailings facility, or regarding the proposed disposal rate (tonnage per day)?*

2. *What technical or logistical limitations does Resolution foresee regarding the distance that filtered tailings could be reasonably conveyed? Alternatively if tailings were instead pumped via pipeline as a slurry to a tailings disposal facility and then filtered at that location prior to stacking, what is the potential acreage or infrastructure that would be needed for the filter equipment?*

3. *What potential concerns does Resolution foresee with respect to controlling acid rock drainage if scavenger and pyrite/cleaner tailings are disposed in a filtered tailings facility?*

Resolution Copper Response to F:

RC has studied filtered tailings as a tailings management strategy and found that filtered tailings are not a beneficial, reasonable or practicable tailings management strategy for the Resolution

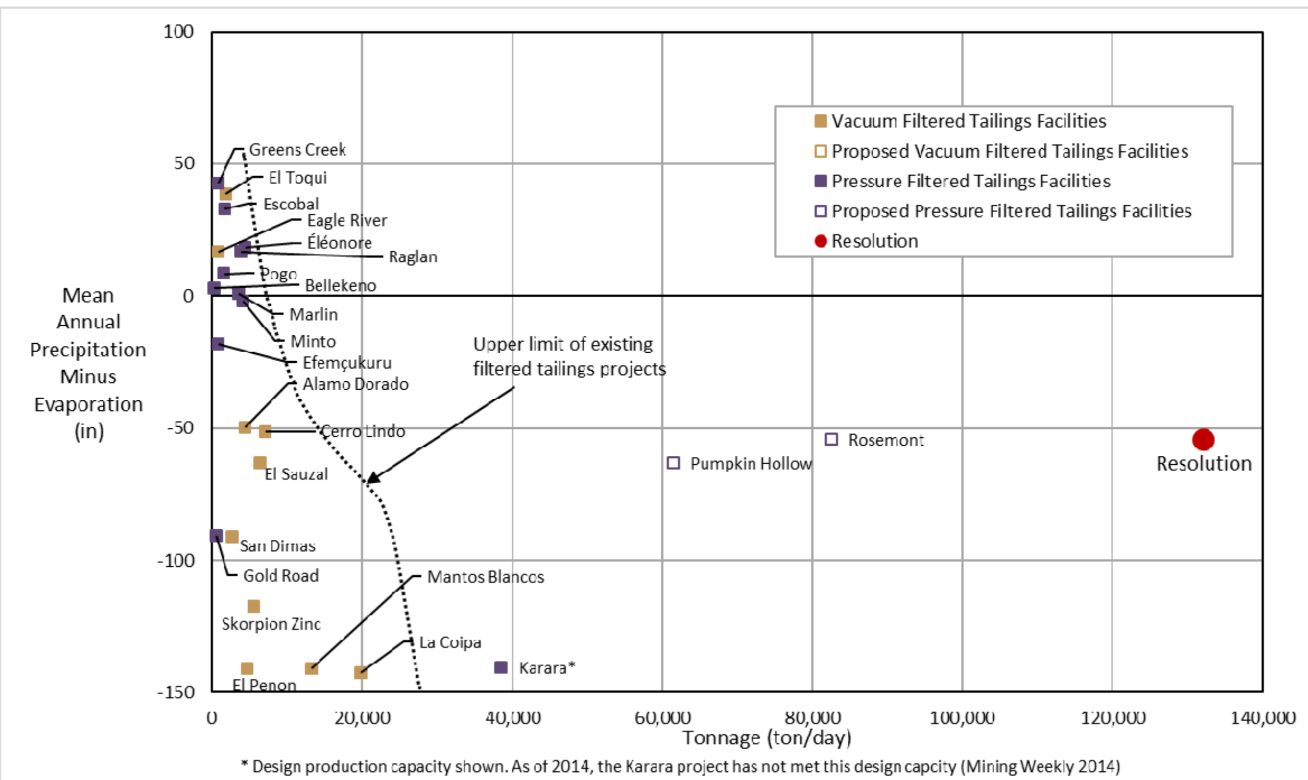
Project primarily because the scale is unprecedented and not demonstrated at an equivalent tonnage rate as well as other factors related to transportation, construction, water management and dust management challenges which are outlined herein.

RC has responded to each sub question of the Forest's item F separately below.

Resolution Copper Response to F-1: Technical and Logistical Limitations of Filtered Tailings for the Resolution Project

A key consideration when assessing the reasonableness, practicality and benefits of a tailings management strategy is precedents and lessons learned from case histories. A review of case histories was completed as part of the filtered tailings study, completed by RC's tailings engineer Klohn Crippen Berger, Ltd, whom have been involved with the Greens Creek filtered tailings facility for approximately 20 years and have been involved in several tailings technology reviews over recent years. An output from the review was a comparison of climate conditions to daily tailings production rate for operating mines and proposed projects, shown in Figure 1. The Resolution Project is also plotted on the figure for comparison.

Figure 1 Summary of Review Filtered Tailings Cases



Note: Net precipitation = mean annual precipitation minus mean annual evaporation. RC is in a semi-arid climate zone with low mean annual precipitation of 18 inches and high estimated mean annual potential evapotranspiration of 72 inches, for a mean annual precipitation minus evaporation of -54 inches per year.

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Based on the case history review of current and existing operations across the industry:

- Filtered tailings have never been applied at the production scale (130,000 ton per day) proposed for the Resolution Project or stored in a *dry-stack* pile of equivalent height.
    - Most filtered tailings are less than 10,000 tons per day. The La Coipa mine which is currently in care and maintenance did implement filtered tailings technology to a 20,000 tons per day operation. RC's estimated tailings production is 130,000 tons per day, 650% greater than La Copia.
    - Karara Mining Ltd. had proposed filtered tailings to manage a 40,000 ton per day operation, but returned to a conventional slurry facility after challenges with filtering and conveying limited production ramp-up.
    - To date, the maximum slope height of filtered embankments achieved is approximately 200 feet (La Coipa – from toe to crest, although maximum thickness of filtered tailings is approximately ~70 feet). A filtered tailings facility for the Resolution Project would be around 560 feet.

Given the vast differences between the tested and demonstrated limits of filtered tailings at the scale required for this project, RC will not consider this as a reasonable or practicable method for tailings management. In addition to precedents, additional key findings from RC's study of filtered tailings also are not in support of this tailings management strategy for this project, such as:

- Processing and Transportation
    - Most filtered tailings projects have reported challenges achieving target moisture contents and throughputs from filter plants on a reliable basis, especially at start-up. Conventional tailings facilities typically do not have this problem.
- Construction and Operations
    - Filtered tailings at the Near West site would be mechanically placed in rugged terrain which requires a significant construction fleet. The scale of the construction fleet for this operation would be much larger than a typical operation and be logistically challenging. See response to F-2 as well.
    - Due to potential upsets/unreliability of the filter plant and conveyor systems (i.e., mechanical break-downs, material produced at the filter plant that is too wet for transportation, flood events, wind events, etc.), multiple layers of back-up storage would be required (at the filter plant, at the filtered facility and potentially a separate back-up conventional tailings facility, like the Karara case history). At the Resolution Project's production rates, a back-up facility or stockpile would not be feasible within the current proposed disturbance footprints. Therefore, there would be significant additional disturbance on National Forest Service land.
- Water Management
    - Water management for filtered tailings for the Resolution Project would be complex. Runoff and seepage water would be managed in large external collection

ponds rather than within the tailings impoundment as with conventional tailings facility. Therefore, there will be additional water retaining dams around the site, larger in size than those required for conventional slurry tailings options, and increased disturbance on National Forest Service land.

- Dust Management
    - Walking stacker conveyors for transporting and placement of filtered tailings would likely be required in a scenario for RC, a large active placement area is required, which cannot be progressively reclaimed. Therefore, there will be large areas requiring dust mitigation measures.
    - Unsaturated filtered tailings are prone to dusting and require active dust management if they can't be progressively reclaimed; requiring regular wetting, temporary covers, or some other measures to suppress dust (such as polymer suppressants).
    - Conventional slurry tailings facilities (as proposed in the mine plan of operations) would also have large exposed areas, but are more easily managed with multiple spigots to maintain a wet beach to reduce dust creation.
    - Due to the lower water content of the filtered tailings, more water (or other measures) would need to be used for dust mitigation than for conventional slurry. If water sprinklers are used as the dust management methodology, the make-up water benefits from using filtered tailings in comparison to conventional slurry tailings will be lessened significantly.

Resolution Copper Response to F-2: Transportation Logistics Considerations and Filter Plant Size

Due to the difficulty in transporting filtered tailings in comparison to slurry, it is not practical to have the filter plant at the WPS. The filter plant would be located at the tailings site, increasing the disturbance of National Forest Service lands. For this scale of operation, a filter plant would have a footprint of approximately 10 acres based on an estimate of the number of filter presses required. Once filtered, the tailings then require transportation to the tailings site and placement. Filter tailings can be transported via trucks or conveyors.

Many projects transport filtered tailings with trucks. The highest production mine reviewed that is using trucks as the primary method of filtered tailings transportation was Cerro Lindo at 7,100 tons per day. RC would need to place 130,000 tons per day. At 20 tons per load, RCM would require 6,500 dump truck loads per day to be moved from the filter plant to the tailings facility for placement. This method of placement would not be reasonable or practicable and therefore, walking stacker conveyors would be used for transportation, plus equipment to spread and compact the tailings. The rough terrain at the Near West site and at potential alternative locations would require the use of conveyors before valleys are filled, which is exceedingly difficult because walking stacker conveyors don't walk on rough rugged steep terrain and therefore re-handling of the tailings is likely required (additional earth-moving equipment). The substantial amount of

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heavy equipment would contribute significant amounts of noise and emissions above what is normal for conventional tailings facilities.

Resolution Copper Response to F-3: Acid Rock Drainage (ARD) Management

RC ore processing will generate two mineralogically and geochemically discrete tailings streams known as "scavenger" tailings and "cleaner" (or pyrite) tailings. Pyrite tailings are classified as Potentially Acid Generating (PAG). The management approach per the mine plan of operations for pyrite tailings involves subaqueous placement during operations (submerged beneath the reclaim pond) and then progressive covering with a thick sequence of scavenger tailings which would limit oxygen and thus minimize acid rock drainage.

If the pyrite tailings were filtered and stacked, they would be placed and kept in an unsaturated state. Thus, will oxidize under wetting and drying cycles from storm events, which would generate ARD and produce poorer water quality runoff compared to pyrite tailings stored in a saturated state (e.g. beneath a pond in a conventional facility). In a submittal to the USFS dated March 9, 2017 Resolution Copper provided a detailed technical report evaluating the chemistry of unsaturated pyrite tailings. The report is titled "*Geochemical Reactivity of Unsaturated Pyrite Tailings Technical Memorandum*" and included in Attachment 4 of this submittal.

As described in the response to F-1 above, external water management facilities are required to manage the water that can't be stored on the tailings surface. These can be large depending on topography, operational water balance, and storm storage requirements. In the case of the proposed location in the mine plan of operations, a filtered tailings scenario would require external water management facilities containing poor quality contact storm water to be located closer to Queen Creek.

Should you have any questions or require further information please contact me.

Sincerely,

Vicky Peacey

Vicky Peacey,
Senior Manager, Permitting and Approvals; Resolution Copper Company, as Manager of Resolution Copper Mining, LLC

Cc: Ms. Mary Morissette, Senior Environmental Specialist; Resolution Copper Company
Mr. Andrew Luke, Metallurgical Engineer; Resolution Copper Company
Ms. Kate Patterson, P.Eng., M.Eng., PE, Associate, Tailings and Water Resources Engineer, Klohn Crippen Berger, Ltd

APPENDIX B

**Tables 3.1 – 3.7
Adapted from
Klohn Crippen
Berger
(KCB) 2019**

APPENDIX B. TABLES 3.1 – 3.7 ADAPTED FROM KLOHN CRIPPEN BERGER
SUMMARY OF DEIS TAILINGS ALTERNATIVES SEEPAGE CONTROL LEVELS
(Section 3, Pages 2 – 11, February 22, 2019)

Table 3.1 TSF Alternatives References

TSF Alternative	Seepage Control Design for Draft EIS	Uncaptured Seepage Estimate
2 Near West ("wet")	KCB (2018a)	M&A (2018b, 2019)
3 Near West ("dry")	KCB (2018b)	M&A (2018b, 2019)
4 Silver King	KCB (2018c)	KCB (2019b)
5 Peg Leg	Golder (2018a, 2018b)	Golder (2019)
6 Skunk Camp	KCB (2018d)	KCB (2019a)

Table 3.2 Summary of TSF Alternatives Seepage Control Levels

Seepage Control Measures	Alternative 2 Near West – "wet"				Alternative 3 Near West – "dry"				Alternative 4 Silver King Filtered		Alternative 5 Peg Leg		Alternative 6 Skunk Camp		
Seepage Control Level:	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**	**1**	**2**	**1**	**2**	**1**	**2**	**3**
Discharge control systems to achieve BADCT for base metal TSFs (ADEQ 2005)															
Storm water and shallow aquifer intercepts	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Natural geologic features functioning as liners	✓	✓	✓	✓	✓	✓	✓	✓			✓	✓			
Localized liners of geosynthetics and/or clay	✓	✓	✓	✓	✓	✓	✓	✓			✓	✓	✓	✓	✓
Fine Sealing	✓	✓	✓	✓	✓	✓	✓	✓			✓	✓	✓	✓	✓
Sub-drainage beneath the impoundment	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Leachate collection systems (finger or blanket drains)	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Lining beneath main underdrains													✓	✓	✓
Centerline embankment construction	✓	✓	✓	✓	✓	✓	✓	✓			✓	✓	✓	✓	✓
Drains and reclaim water pump-back systems	✓	✓	✓	✓	✓	✓	✓	✓			✓	✓	✓	✓	✓
Free draining rockfill zones in the embankment															
Runoff water collection via channels and dikes or berms from embankment surface	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Engineered hydraulic barriers – grout curtains with pump-back wells	✓	✓	✓	✓	✓	✓	✓	✓		✓			✓	✓	✓
Engineered hydraulic barriers – reclaim wells and trench drains with clay or geomembrane				✓				✓					✓	✓	✓
Other seepage control measures															
Tailings thickening	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
High-density thickening of tailings (and implementation of thin lift placement)					✓	✓	✓	✓				✓			
Dewatering (filtering)									✓	✓					
Downgradient pump-back wells			✓	✓			✓	✓		✓	✓	✓	✓	✓	✓
Extended engineered hydraulic barriers – grout curtains with pump-back wells		✓	✓	✓		✓	✓	✓						✓	✓
Additional downgradient pump-back wells				✓				✓						✓	✓

Table 3.3 Alternative 2 Near West Modified Proposed Action (Modified Centerline Embankment – "wet") Seepage Control Levels

Level of Seepage Control	Seepage Control Description (see KCB 2018a)	From M&A (2018b, 2019)				
		Average Seepage Capture Efficiency (%) (Note 1)	Average Scavenger (NPAG) Seepage (acre-ft/yr)	Average Pyrite (PAG) Seepage (acre-ft/yr)	Average Collection Pond Seepage (acre-ft/yr)	Average Uncaptured Seepage (acre-ft/yr)
0	Features required for stability and act as seepage control features include modified centerline-raised compacted cycloned sand embankments and an embankment underdrainage system.	*not explicitly modeled*				
Between 0 and 1 (Note 2)	Seepage control measures represented in the 2018 Alternative 2/3 steady-state model report[2] (M&A 2018) include: ▪ features for stability described above; ▪ embankment underdrains extend into the impoundment under the entire scavenger beach; and ▪ seepage collection ponds with cut-offs walls and pump-back wells.	91%	1,912	220	8	194
1	Seepage control measures as presented in the DEIS report (KCB 2018a) include: ▪ features for stability described above; ▪ embankment underdrains extend into the impoundment for 200 ft; ▪ foundation treatment or selective engineered low-permeability layers in areas that are not Gila Conglomerate; ▪ engineered low-permeability layers for the pyrite starter facility; ▪ encapsulation of pyrite tailings in the scavenger tailings fines; and ▪ seepage collection ponds with cut-offs, grout curtains and pump-back wells. Grout curtain would extend from the ground surface to 100 ft below ground.	*not explicitly modeled*				
2	To increase Level 1 seepage capture, Level 2 (as described in KCB 2018a) includes extending the grout curtain to target high-permeability zones and seepage pathways.	*not explicitly modeled*				
3	To increase Level 2 seepage capture, Level 3 (as described in KCB 2018a) includes adding additional seepage collection ponds/facilities downstream.	*not explicitly modeled*				

Level of Seepage Control	Seepage Control Description (see KCB 2018a)	From M&A (2018b, 2019)				
		Average Seepage Capture Efficiency (%) (Note 1)	Average Scavenger (NPAG) Seepage (acre-ft/yr)	Average Pyrite (PAG) Seepage (acre-ft/yr)	Average Collection Pond Seepage (acre-ft/yr)	Average Uncaptured Seepage (acre-ft/yr)
4	To increase Level 3 seepage capture, Level 4 (as described in KCB 2018a) includes additional pump-back wells and grout curtain/cut-off walls. Seepage control measures represented in modified steady-state model report[2] (M&A 2019), in addition to the simulation described in M&A (2018), include: ▪ low-permeability liners in areas that are not Gila Conglomerate; ▪ engineered low-permeability liner for the entire pyrite cell; ▪ downgradient grout curtain extending from the ground surface to 100 ft below ground; and ▪ additional pump-back wells (see Note 3).	99%	1,910	223	0.6	21

Notes:

1. Seepage capture efficiency is calculated from the tailings seepage that enters the foundation, it does not account for dewatering (thickening/filtering) or climate effects.
2. Seepage control modeled by M&A were based on the seepage control measures described in KCB (2018a).
3. Pump back wells were added in the model by M&A in locations to maximize seepage capture.

Table 3.4 Alternative 3 Near West Modified Proposed Action (High-density thickened NPAG Scavenger and Segregated PAG Pyrite Cell) - Seepage Control Levels

Level of Seepage Control	Seepage Control Description (see KCB 2018b)	From M&A (2018b, 2019)				
		Average Seepage Capture Efficiency (%) (Note 1)	Average Scavenger (NPAG) Seepage (acre-ft/yr)	Average Pyrite (PAG) Seepage (acre-ft/yr)	Average Collection Pond Seepage (acre-ft/yr)	Average Uncaptured Seepage (acre-ft/yr)
0	Features required for stability and act as seepage control features include modified centerline-raised compacted cycloned sand embankments and an embankment underdrainage system.	*not explicitly modeled*				
Between 0 and 1 (Note 2)	Seepage control measures represented in the steady-state model report[2] (M&A 2018) include: ▪ embankment underdrains extend into the impoundment under the entire scavenger beach; and ▪ seepage collection ponds with cut-offs walls and pump-back wells.	84%	508	220	5	116
1	Seepage control measures as presented in the DEIS report (KCB 2018a) include: ▪ features for stability described above; ▪ embankment underdrains extend into the impoundment under the entire scavenger beach; ▪ foundation treatment or selective engineered low-permeability layers in areas that are not Gila Conglomerate; ▪ engineered low-permeability layers for the entire pyrite cell; and ▪ seepage collection ponds with cut-offs, grout curtains and pump-back wells. Grout curtain would extend from the ground surface to 100 ft below ground.	*not explicitly modeled*				
2	To increase Level 1 seepage capture, Level 2 (as described in KCB 2018b) includes extending the grout curtain to target high-permeability zones and seepage pathways.	*not explicitly modeled*				
3	To increase Level 2 seepage capture, Level 3 (as described in KCB 2018b) includes adding additional seepage collection ponds/facilities downstream.	*not explicitly modeled*				

<table>
<tr><th rowspan="2">Level of Seepage Control</th><th rowspan="2">Seepage Control Description (see KCB 2018b)</th><th colspan="5">From M&A (2018b, 2019)</th></tr>
<tr><th>Average Seepage Capture Efficiency (%) (Note 1)</th><th>Average Scavenger (NPAG) Seepage (acre-ft/yr)</th><th>Average Pyrite (PAG) Seepage (acre-ft/yr)</th><th>Average Collection Pond Seepage (acre-ft/yr)</th><th>Average Uncaptured Seepage (acre-ft/yr)</th></tr>
<tr><td>4</td><td>To increase Level 3 seepage capture, Level 4 (as described in KCB 2018b) includes additional pump-back wells and grout curtain/cut-off walls.

Seepage control measures as represented in modified steady-state model report (M&A 2019), in addition to the simulation described in M&A (2018), include:
▪ selective engineered low-permeability liners in areas that are not Gila Conglomerate;
▪ engineered low-permeability liners for the entire pyrite cell;
▪ grout curtain would extend from the ground surface to 100 ft below ground, extending to target high-permeability zones and seepage pathways; and
▪ additional pump-back wells (see Note 3).</td><td>99.5%</td><td>630</td><td>130</td><td>15</td><td>3</td></tr>
</table>

Notes:

1. Seepage capture efficiency is calculated from the tailings seepage that enters the foundation, it does not account for dewatering (thickening/filtering) or climate effects.
2. Seepage control modeled by M&A were based on the seepage control measures described in KCB (2018b).
3. Pump back wells were added in the model by M&A in locations to maximize seepage capture.

Table 3.5 Alternative 4 Silver King Seepage Control Levels

<table>
<tr><th>Level of Seepage Control</th><th>Seepage Control Description (see KCB 2018c, 2019b)</th><th>Average Seepage Capture Efficiency (%) (Note 1)</th><th>Average Scavenger (NPAG) Seepage (acre-ft/yr)</th><th>Average Pyrite (PAG) Seepage (acre-ft/yr)</th><th>Average Collection Pond Seepage (acre-ft/yr)</th><th>Average Uncaptured Seepage (acre-ft/yr)</th></tr>
<tr><td>0</td><td>Features required for stability and act as seepage control features include dewatered tailings, compacted structural zone with an underdrainage system.</td><td>n/a</td><td rowspan="3">77.5</td><td rowspan="3">1.9</td><td rowspan="3">0.6</td><td>n/a</td></tr>
<tr><td>1</td><td>In addition to the features for stability, seepage collection, as presented in the DEIS report (KCB 2018c), includes lined collection ditches and collection ponds that cut-off the alluvium. There is potential that a portion of the seepage would not be collected with this approach. A preliminary estimate of up to 80% capture is assumed because seepage can be collected in the underdrains and the alluvial channels will be cut-off.
There is a remaining risk that a large portion of the flow paths would bypass seepage collection.</td><td>less than 80%</td><td>greater than 17 acre-ft/yr</td></tr>
<tr><td>2</td><td>In addition to the features described for Level 1, additional seepage control measures would include targeted grouting of fractures (potential seepage pathways) in the foundation and pump-back wells for seepage return.
A preliminary estimate of up to 90% capture is assumed because of the uncertainty in the foundation conditions.
There is a remaining risk that a portion of the flow paths would bypass seepage collection.</td><td>up to 90%</td><td>greater than 9 acre-ft/yr</td></tr>
</table>

Notes:

1. Seepage capture efficiency is calculated from the tailings seepage that enters the foundation, it does not account for dewatering (thickening/filtering) or climate effects.

Table 3.6 Alternative 5 Peg Leg Seepage Control Levels

Level of Seepage Control	Seepage Control Description (see Golder 2018a, 2018b, 2019)	Average Seepage Capture Efficiency (%) (Note 1)	Average Scavenger (NPAG) Seepage (acre-ft/yr)	Average Pyrite (PAG) Seepage (acre-ft/yr)	Average Collection Pond Seepage (acre-ft/yr)	Average Uncaptured Seepage (acre-ft/yr)
0	Features required for stability and to act as seepage control features include modified centerline-raised compacted cycloned sand embankments and an embankment underdrainage system. Separate NPAG and PAG cells	n/a	2,660	1,270	<1	3,930
1	Seepage control measures as presented in the DEIS report (Golder 2019) include: ▪ features for stability described above; ▪ surface water diversions around the NPAG and PAG facilities to minimize run-on surface water; ▪ lined Seepage collection ponds and ditches; ▪ finger drains extending from the embankment underdrains below the impoundment beach and along the existing drainages; ▪ HDPE lining of reclaim pond area (300 acres) where reclaim pond is in contact with native materials; ▪ engineered low-permeability layers for the entire pyrite cell; and ▪ pump-back wells to form a continuous cone of depression (cut off) and collect surface seepage below the NPAG embankment.	65%	2,537	1,211	<1	1,317
2	Seepage control measures, as described above with the addition of: ▪ complete synthetic lining of PAG cells base and embankment; ▪ removal of alluvium and pervious sediments above bedrock below PAG cells; ▪ utilization of thin-lift deposition beginning in year 7 when sufficient operating area becomes available; and ▪ adjusting pump back wells to allow 261 acre-ft/yr to bypass system (requires less pumping than level 1).	84%	1,640	25	<1	261

Notes:

1. Seepage capture efficiency is calculated from the tailings seepage that enters the foundation, it does not account for dewatering (thickening/filtering) or climate effects.

Table 3.7 Alternative 6 Skunk Camp Seepage Control Levels

Level of Seepage Control	Seepage Control Description (see KCB 2018d, 2019a)	Average Seepage Capture Efficiency (%) (Note 1)	Average Scavenger (NPAG) Seepage (acre-ft/yr)	Average Pyrite (PAG) Seepage (acre-ft/yr)	Average Uncaptured Seepage (acre-ft/yr)
0	Features required for stability and also act as seepage control features include centerline-raised compacted cycloned sand embankments and an embankment underdrainage system.	n/a	1,820	50	n/a
1	Seepage control measures as presented in the DEIS report (KCB 2018d) include: ▪ features for stability described above; ▪ embankment underdrains extend into the impoundment for 100 ft to 200 ft; ▪ engineered low-permeability layers for the pyrite cells; ▪ seepage collection ponds with cut-offs, grout curtains and pump-back wells. Grout curtain would extend from the ground surface to 70 ft below ground and the seepage pump-back wells at 20 ft below ground level (estimated to be the base of the alluvium).	64%[1]	1,820	50	580-660
2	To increase Level 1 seepage capture, Level 2 (as described in KCB 2019) includes an extension of the grout curtain to 100 ft and the seepage pump-back wells installed at 70 ft below ground (estimated to be the base of the weathered Gila Conglomerate layer).	80%[1]	1,840	50	270-370
3	To increase Level 2 seepage capture, Level 3 (as described in KCB 2019) includes an installation of the seepage pump-back wells at 100 ft below ground, at the depth of the grout curtain.	90%[1]	1,840	50	70-180

Notes:

1. Seepage capture efficiency is calculated from the tailings seepage that enters the foundation, it does not account for dewatering (thickening/filtering) or climate effects.