ARCTIC MINE DEVELOPMENT PROJECT

Environmental Evaluation Document and Alternatives Analysis

April 2026

FINAL

Prepared for:

Ambler Metals LLC
2550 Denali St. Suite 1605
Anchorage, Alaska 99503

Prepared by:

DOWL
5015 Business Park Blvd., Suite 4000
Anchorage, Alaska 99503

This page intentionally left blank.

TABLE OF CONTENTS

ACRONYMS AND ABBREVIATIONS i
GLOSSARY vii
1.0 INTRODUCTION 1
1.1 Project Setting, History, and Land Ownership 3
1.2 Access to the Project Area 5
1.3 Applicant's Stated Purpose and Need 6
1.4 Secondary Benefits of the Project 6
1.5 Permits and Regulatory Approvals 6
1.6 Alternatives Development 11
1.7 Preliminary Stakeholder Engagement 11
1.8 Preliminary Project Schedule 12
1.9 Key Issues 12
2.0 PROJECT DESCRIPTION 13
2.1 Mining Facilities 17
2.1.1 Open Pit 17
2.1.2 Tailings Management Facility 17
2.1.3 Waste Rock Facility and Overburden Stockpiles 24
2.1.4 Surface Water and Groundwater Management 24
2.1.5 Water Treatment Plant 35
2.2 Processing Facilities (Operation Pad) 37
2.2.1 Mine Infrastructure Area 39
2.2.2 Laboratory 40
2.2.3 Mill Dry Facility 40
2.2.4 Plant Workshop and Warehouse 40
2.2.5 Primary Crushing Area and Ore Stockpiles 40
2.2.6 Concentrate Storage and Loadout Building 40
2.2.7 Reagent Storage and Handling 41
2.3 Fuel Supply Storage Tanks 41
2.4 Gravel Pads 41
2.4.1 Camps 41
2.4.2 Other Laydown/Storage and Logistics Yards 43
2.5 Access and Transportation 44
2.5.1 Gravel Roads 44
2.5.2 Air Service and Transport 48
2.5.3 Concentrate Transportation 49
2.6 Material Sites 51
2.7 Other Infrastructure and Utilities 53
2.7.1 Potable Water Sources and Use 53
2.7.2 Fuel Supply, Storage, and Distribution 53

2.7.3 Power Generation and Distribution 53
2.7.4 Lighting 54
2.7.5 Site Communications 54
2.7.6 Fire Protection 55
2.7.7 Waste Disposal 55
2.8 Snow Removal and Maintenance 55
2.9 Erosion and Dust Control 56
2.10 Closure and Reclamation 56
2.10.1 Closure Objectives and Closure Criteria 56
2.10.2 Closure Activities 57
2.10.3 Post-Closure 62
2.10.4 Reclamation and Closure Financial Assurance 63
2.11 Schedule and Logistics 63
3.0 ENVIRONMENTAL EVALUATION 65
3.1 Scope of Analysis 65
3.2 Geology, Mineral Resources, and Soils 65
3.2.1 Existing Data 65
3.2.2 Existing Conditions 66
3.2.3 Preliminary Analysis of Impacts 71
3.3 Surface Water Hydrology and Water Quality 72
3.3.1 Existing Data 72
3.3.2 Existing Conditions 75
3.3.3 Preliminary Analysis of Impacts 82
3.4 Groundwater 91
3.4.1 Existing Data 92
3.4.2 Existing Conditions 92
3.4.3 Groundwater Quality 93
3.4.4 Operating and Closure Conditions 93
3.4.5 Preliminary Analysis of Impacts 94
3.5 Fish 94
3.5.1 Existing Data 94
3.5.2 Existing Conditions 94
3.5.3 Preliminary Analysis of Impacts 99
3.6 Climate and Air Quality 100
3.6.1 Existing Data 100
3.6.2 Existing Conditions 101
3.6.3 Preliminary Analysis of Impacts 106
3.7 Wetlands and Vegetation 107
3.7.1 Existing Data 107
3.7.2 Existing Conditions 108

3.7.3 Preliminary Analysis of Impacts 111
3.8 Birds 114
3.8.1 Existing Data 114
3.8.2 Existing Conditions 114
3.8.3 Preliminary Analysis of Impacts 117
3.9 Terrestrial Mammals 117
3.9.1 Existing Data 117
3.9.2 Existing Conditions 118
3.9.3 Preliminary Analysis of Impacts 122
3.10 Special Status and Invasive Species 124
3.10.1 Existing Data 124
3.10.2 Existing Conditions 124
3.10.3 Preliminary Analysis of Impacts 125
3.11 Land Management, Use, and Recreation 126
3.11.1 Existing Data 126
3.11.2 Existing Conditions 126
3.11.3 Preliminary Analysis of Impacts 126
3.12 Transportation 128
3.12.1 Existing Data 128
3.12.2 Existing Conditions 128
3.12.3 Preliminary Analysis of Impacts 128
3.13 Cultural Resources 131
3.13.1 Existing Data 131
3.13.2 Existing Conditions 131
3.13.3 Preliminary Analysis of Impacts 132
3.14 Socioeconomics 132
3.14.1 Existing Data 132
3.14.2 Existing Conditions 132
3.14.3 Preliminary Analysis of Impacts 133
3.15 Subsistence and Traditional Use 135
3.15.1 Existing Data 135
3.15.2 Existing Conditions 135
3.15.3 Preliminary Analysis of Impacts 138
3.16 Visual and Aesthetic Resources 138
3.16.1 Existing Data 138
3.16.2 Existing Conditions 138
3.16.3 Preliminary Analysis of Impacts 140
3.17 Human Health and Safety 140
3.17.1 Existing Data 140
3.17.2 Existing Conditions 141

3.17.3 Preliminary Analysis of Impacts 141
4.0 AVOIDANCE, MINIMIZATION, AND MITIGATION MEASURES 142
4.1 Project Design and Siting Minimization Measures 142
4.1.1 Minimizing New Disturbance Areas 142
4.1.2 Minimizing Impacts to Water Quality 142
4.1.3 Minimizing Impacts to Air Quality 142
4.1.4 Minimizing Mined Construction Material 142
4.1.5 Cleanup of Existing Contamination 142
4.2 Wetland Avoidance, Minimization 143
4.3 Wetland Mitigation 143
5.0 LITERATURE CITED 150

TABLES

Table 1.1. Distance between the Arctic Deposit and nearby Communities 5
Table 1.2. Applicable Federal Laws and Executive Orders 7
Table 1.3. Applicable Federal Permits or Approvals 8
Table 1.4. Applicable State and Local Permits or Approvals 9
Table 2.1. Project Components 14
Table 2.2. Tailings Management Facility Design Parameters and Design Criteria 20
Table 2.3. Process Water Supply Summary 28
Table 2.4. On-Site Personnel during Project Operations 43
Table 2.5. Milepost References for the South and North Routes 45
Table 2.6. Design Criteria Details for Project Access Roads 45
Table 2.7. Project Roads – Length, Area, Culverts, and Bridges 48
Table 2.8. Mode of Transport and Distances for Concentrate Shipping 50
Table 2.9. Preliminary Project Schedule by Project Phase 64
Table 3.1. Potential Effects to Key Resources 65
Table 3.2. Estimated Acid Rock Drainage Potential by Lithologic Unit 69
Table 3.3. Characteristics of Streams that Intersect the Project 76
Table 3.4. Baseline Water Quality Conditions at Selected Sites 79
Table 3.5. WTP Influent and Effluent Water Quantity and Quality Estimates for Mine Operations 84
Table 3.6. WTP Influent and Effluent Water Quantity and Quality Estimates for Mine Closure Phase 1 86
Table 3.7. WTP Influent and Effluent Water Quantity and Quality Estimates for Mine Closure Phase 2 88
Table 3.8. Existing Meteorological, Climatic, and Air Quality Data Sources for the Project Area 101
Table 3.9. Surface Air Temperatures at Subarctic Valley and Ambler Airport Locations 103
Table 3.10. Subarctic Valley Station: Relative Humidity, Barometric Pressure, and Solar Radiation 105
Table 3.11. Precipitation and Snowfall Data Collected at Ambler West NOAA COOP 106
Table 3.12. Direct Impacts from Mining and Support Facilities to Wetlands and Other Waters by Habitat Type (acres) 112
Table 3.13. Direct Wetland and Other Water Impacts by Watershed (acres) 113
Table 3.14. Direct Wetland and Other Water Impacts by Project Component (acres) 113
Table 3.15. Potential Wetland and Other Water Impacts at New Material Sites 113
Table 3.17. Summary of Raptor Nest Surveys near the Project Area (2016 and 2017) 115

Table 3.18: Previous Cultural Resources Surveys for the Proposed Project 131
Table 3.19. Populations of Upper Kobuk River Communities (1990-2022) 133
Table 3.20. Effects to Community and Social Characteristics 134
Table 4.1. Design Features and BMPs to Avoid and Minimize Impacts 145

FIGURES

Figure 1.1. Location and Vicinity 2
Figure 1.2. General Setting and Land Ownership 4
Figure 2.1. Proposed Project 15
Figure 2.2. Proposed Mining Facilities 16
Figure 2.3. Support and Transportation Facilities 42
Figure 2.4. Material Sites 52
Figure 3.1. Water Quality Monitoring Locations 74
Figure 3.2. Operations Water and Load Balance 89
Figure 3.3. Closure Phase 1 Water and Load Balance 90
Figure 3.4. Closure Phase 2 Water and Load Balance 91
Figure 3.5. Fish Resources Monitoring Locations 96
Figure 3.6. Wetlands in the Project Area 109
Figure 3.7. Raptor Nest Locations in the Project Area (2016 and 2017) 116
Figure 3.8. Western Arctic Caribou Herd Ranges – Seasonal (2012 through 2017) 119
Figure 3.9. Western Arctic Caribou Herd Ranges – Composite (2012 through 2017) 120
Figure 3.10. Project Area Zoning Districts 127
Figure 3.11. Existing Trails that Would Intersect the Project 130

GRAPHICS

Graphic 2.1. Rendering of the Open Pit 18
Graphic 2.2. Rendering of WRF and TMF 18
Graphic 2.3. Tailings Management Facility Starter Dam Cross-Section (to 805 meters elevation) 23
Graphic 2.4. Cross-Section: Dam Raises and Tailings Management Facility to Final Design Elevation 23
Graphic 2.5. Surface Water Management Plan Features for Operations (Year 2) 26
Graphic 2.6. Surface Water Management Plan Features for Operations (Life of Mine) 27
Graphic 2.7. Waste Rock Collection Pond and Process Pond 32
Graphic 2.8. Waste Rock Collection Pond and Process Pond Section A-A' (as noted in Graphic 2.7) 33
Graphic 2.9. Waste Rock Collection Pond and Process Pond Embankment Detail (as noted in Graphic 2.8) 34
Graphic 2.10. Proposed Water Treatment Plant Configuration during the Operations Phase 36
Graphic 2.11. Proposed Water Treatment Plant Configuration during the Closure Phase 36
Graphic 2.12. Rendering of the Mining and Processing Facilities in Subarctic Valley 38
Graphic 2.13. Rendering of the Operations Pad 38
Graphic 2.14. Rendering of Processing Activity on the Operations Pad 39
Graphic 2.15. Phase 1 Closure 58
Graphic 2.16. Phase 2 Closure 59
Graphic 3.1. Photograph of the Upper Subarctic Valley 66
Graphic 3.2. Waterfall and Anadromous Fish Barrier on the Shungnak River 95

Graphic 3.3. Shungnak River Sampling Location (ADF&G photo)..... 98
Graphic 3.4. Lower Subarctic Creek (left) and Upper Subarctic Creek (right) 99
Graphic 3.5. Wind Roses: Subarctic Valley Annual, Summer, and Winter Wind Frequency..... 104
Graphic 3.6. Looking South over the Location of the Proposed Mining Facilities 139
Graphic 3.7. Looking Southeast at a Representation of the Proposed Mining Facilities..... 140

APPENDICES

Appendix A: Alternatives Development

ACRONYMS AND ABBREVIATIONS

AAAQS	Alaska Ambient Air Quality Standards
AAC	Alaksa Administrative Code
AAP	Ambler Access Project
ADEC	Alaska Department of Environmental Conservation
ADF&G	Alaska Department of Fish and Game
ADNR	Alaska Department of Natural Resources
AHRS	Alaska Heritage Resources Survey
AIDEA	Alaska Industrial Development and Export Authority
Ambler District	Ambler Mining District
AMC	Ambler Metals LLC
AMJ	Arctic Mine junction
ANCSA	Alaska Native Claims Settlement Act
ANILCA	Alaska National Interest Lands Conservation Act
ARD	acid rock drainage
AS	Alaska Statute
asl	above sea level
ASOS	Automated Surface Observing System
ATV	all-terrain vehicle
Ausenco	Ausenco Engineering Canada, Inc.
BGC	BGC Engineering, Inc.
BGEPA	Bald and Golden Eagle Protection Act
BLM	U.S. Bureau of Land Management
BMP	Best Management Practice
°C	degrees Celsius
CAA	Clean Air Act
$CaCO_3$	calcium carbonate
CCAR	Cabin Creek sample
CC/PAC	Construction Camp and Permanent Accommodation Camp
CEQ	Council on Environmental Quality
CO	carbon monoxide
CO_2	carbon dioxide
COD	chemical oxygen demand
CWA	Clean Water Act
cy	cubic yard(s)

Dash 8	de Havilland DHC-8-100
dmt	dry metric tonne(s)
DOI	U.S. Department of Interior
DOT&PF	Alaska Department of Transportation and Public Facilities
DTY	Dalton Transfer Yard
EEA	Environmental and Economic Analysis
EED	Environmental Evaluation Document
EIS	Environmental Impact Statement
EO	Executive Order
EPA	U.S. Environmental Protection Agency
EPT	*Ephemeroptera*, *Plecoptera*, and *Trichoptera*
ESA	Endangered Species Act
°F	degrees Fahrenheit
FAST-41	Fixing America's Surface Transportation Act of 2015
ft	foot/feet
ft^2	square foot/feet
ft^3/s	cubic feet per second
g	gravity
gpd	gallons per day
H:V	horizontal to vertical
ha	hectare
HDPE	high-density polyethylene
HIA	Health Impact Assessment
Kennecott	Kennecott Copper Corporation
km	kilometer(s)
km^2	square kilometer(s)
kph	kilometers per hour
KRAA	Kogoluktuk River sample
L	liter(s)
LCRS	leak collection and recovery sump
LLDPE	linear low-density polyethylene
m	meter(s)
m^2	square meter(s)
m^3	cubic meter(s)
m^3/d	cubic meters per day
mg	milligram(s)

µg/L	micrograms per liter
m/s	meter(s) per second
m^3/s	cubic meter(s) per second
Magnuson–Stevens Fisheries Act	Magnuson-Stevens Fishery Conservation and Management Act
mb	millibars
MBTA	Migratory Bird Treaty Act
mgd	million gallons per day
mg/L	milligram(s) per liter
mm	millimeter(s)
Mm^3	million cubic meters
MP	milepost
mph	miles per hour
MT	million tons
MW	megawatt
N/A	Not Applicable
NAAQS	National Ambient Air Quality Standards
NANA	NANA Regional Corporation
NEDC	National Energy Dominance Council
NEPA	National Environmental Policy Act
N/L	nitrogen per liter
NO_2	nitrogen dioxide
NOA	naturally occurring asbestos
NOAA	National Oceanic and Atmospheric Administration
NovaGold	NovaGold Resources, Inc.
NPS	National Park Service
NRHP	National Register of Historic Places
NWAB	Northwest Arctic Borough
O^3	ozone
ORL	Owner-Requested Limit
PAFM	Ambler Airport
PAG	potentially acid generating
Pb	lead
PJD	Preliminary Jurisdictional Determination
$PM_{2.5}$	particulate matter with an aerodynamic diameter less than 2.5 microns

PM_{10}	particulate matter with an aerodynamic diameter less than 10 microns
the Project	Arctic Mine Development Project
PSD	Prevention of Significant Deterioration
PRM	Permittee-Responsible Mitigation
RCDN	Lower Ruby Creek Gaging Station
RIBF	Riley Creek sample
RO	reverse osmosis
ROD	Record of Decision
ROW	right-of-way
RS 2477	Revised Statute 2477
RUBY	Ruby Creek sample
SAG	semi-autogenous grinding
SCDN	Subarctic Creek Down
SCEC	Subarctic Creek Emergency Cabin
SCGS	Subarctic Creek Gaging Station
SCMET	Subarctic Creek Meteorological Station
SCMI	Subarctic Creek Middle
SCUP	Subarctic Creek Up
SEIS	Supplemental Environmental Impact Statement
SHPA	Alaska State Historic Preservation Office
SO_2	sulfur dioxide
South32	South32 Limited
SRB&A	Steven R. Braund & Associates
SRGS	Shungnak River Gaging Station
SRK	SRK Consulting, Inc.
SWPPP	Stormwater Pollution Prevention Plan
TBD	to be determined
TCC	Temporary Construction Camp
t/cy	short tons per cubic yard
t/d	short tons per day
TDS	total dissolved solids
Tetra Tech	Tetra Tech, Inc.
TMDL	total maximum daily load
TMF	tailings management facility
TNW	traditional navigable waterway

tonnes/d	tonnes per day
tonnes/m^3	tonnes per cubic meter
Trilogy	Trilogy Metals, Inc.
UF	ultra filtration
USACE	U.S. Army Corps of Engineers
USFS	U.S. Forest Service
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
VHF	very high frequency
VWPs	vibrating wire piezometers
WACH	Western Arctic Caribou Herd
WCBR	Wesley Creek sample
W/m^2	watts per square meter
wmt	wet metric tonnes
WOTUS	Waters of the U.S.
WQS	water quality standards
WRCP	waste rock collection pond
WRF	waste rock facility
WTP	water treatment plant
YKCA	Yukon Koyukuk Census Area

This page intentionally left blank

GLOSSARY

Acute – A short duration exposure to an environmental hazard or toxic substance.

Aeolian – Relating to or arising from wind action.

Anadromous fish – Fish that are born in freshwater, live most of their lives in saltwater, but return to freshwater to spawn (e.g., Pacific salmon).

Chronic – The continuous or repeated exposure to a toxic substance over a long period of time (e.g., months, years).

Class I area – Areas such as national parks, national wilderness areas, and national monuments. These areas are granted special air quality protections under Section 162(a) of the federal CAA.

Class II area – Areas of the country that are protected under the CAA but that are identified for somewhat less stringent protection from air pollution damage than Class I areas, except in specified cases.

Collection Pond – A constructed pond used to capture water and to protect nearby lake or stream water quality. Both the WRCP and Process Pond are collection ponds.

Compensatory Mitigation – Refers to the restoration, establishment, enhancement or, in certain circumstances, preservation of wetlands, streams or other aquatic resources for the purpose of offsetting unavoidable adverse impacts. In the context of Clean Water Action Section 404 permitting, compensatory mitigation may be accomplished through three distinct mechanisms: PRM, mitigation banking, or in-lieu fee mitigation.

Critical Habitat – Geographic areas that contain features essential to the conservation of a federally listed endangered or threatened species and may require special management and protection.

Dust shadow – Area of deposition of airborne dust generated by traffic or other activities on gravel surfaces.

Ephemeral – Lasting a very short amount of time.

Essential Fish Habitat – As designated by the Magnuson-Stevens Fisheries Conservation and Management Act, the waters and substrate necessary for spawning, breeding, feeding, or growth to maturity for certain federally protected species.

Filtration curtain – A floating or suspended barrier curtain used in water treatment to improve treatment efficiency by increasing residence time, improving settling time, or preventing the “short circuiting” of treatment.

Flocculation – The process in which a chemical coagulant is added to water (or solutions) to facilitate the bonding between particles, creating larger aggregates that may settle or be filtered out.

Fluvial – Originating from rivers or streams.

Footprint – The portion of the Arctic Mine Development Project area that would be physically occupied by Project infrastructure.

Freshet – The flood or swelling of a river or creek resulting from spring thaw of snow and ice.

Fugitive emissions – Those emissions that could not reasonably pass through a stack, chimney, vent, or other functionally equivalent opening.

Grubbing – The clearing of trees, vegetation, and other debris.

Logistics yard – An area dedicated for storing supplies and equipment.

Lime slurry – A suspension of calcium hydroxide in water used in the processing of mineral ore.

Material site – The site from which construction material (e.g., gravel, riprap) would be taken for use in other locations (e.g., roads, pads).

Mill – Mining equipment that breaks solid materials into smaller pieces by grinding, crushing, or cutting.

Mill dry – Employee showers and locker room located at the mill.

Milling – The process of breaking down, separating, sizing, and/or classifying aggregate material.

Mine dry – Employee showers and locker room located at the truck shop and mine offices.

Naturally occurring asbestos – The mineral (asbestos) when found as a natural component of soils or rocks (as opposed to asbestos used in commercial products, mining, or processing operations).

Open pit – An open excavation and the site of active mining.

Operations pad – The Arctic Mine Development Project's constructed pad that would contain processing and other support facilities (e.g., power plant, offices, truck shop).

Overburden – The material that overlies a useful resource (e.g., , economic mineral).

Permafrost – Perennially frozen ground with subfreezing temperatures for at least 2 consecutive years.

Permeate – Gas or liquid that has passed through a membrane material.

Permittee-Responsible Mitigation – Restoration, establishment, enhancement or preservation of wetlands undertaken by a permittee in order to compensate for wetland impacts resulting from a specific project. The permittee performs the mitigation after the permit is issued and is ultimately responsible for implementation and success of the mitigation. PRM may occur at the site of the permitted impacts or at an off-site location generally within the same watershed.

Perpetuity – An endless or indefinitely long duration.

Prevention of Significant Deterioration – A program established by the CAA that limits the amount of additional air pollution allowed in Class I and Class II areas (Class I areas include certain federally managed lands such as national parks and wildernesses; Class II areas include all other U.S. federally managed lands not designated as Class I).

Process water – Water used to support the extraction of mineral concentrates from mined ore.

Reagent – A substance or compound added to a system to cause a chemical reaction.

Reclaim pond – Water collected in the tailings management facility (over the tailings) and used for processing mineral ore.

Riprap – Large rock material used to armor or protect shores, slopes, bridges, and other structures against scour and water, wave, or ice erosion.

Solifluction – The gradual process in which a land mass moves downslope, usually related to freeze/thaw cycles.

Spillway – A passage or structure that provides for the controlled release of water from a dam.

Starter dam – The initial structure used for the storage of tailings.

Stockpile – Piles of material stored for later use, including topsoil, overburden, or ore.

Stormwater – Water from snow and ice melt or precipitation that either soaks into exposed soil or flows overland.

Subaqueous – Occurring underwater.

Tailings management facility – A structure, usually one or more dams, built to store the water and leftover rock, sand, and silt from processing operations.

Thermokarst – Irregular topography and landforms that occur in regions of permafrost developed when ground ice melts, and the ground subsides forming depressions, mounds, and lakes.

Total suspended solids – Non-dissolved particles in the water column.

Waste rock facility – Storage facility that contains rock that has been mined and holds no economic value.

Water Quality Standards –Title 18 AAC Chapter 70 established by ADEC to protect Waters of the State of Alaska from pollutants. Alaska WQS include designated water uses, numeric and narrative criteria to protect designated uses (e.g., criteria), and Alaska's anti-degradation policy.

Waters of the U.S. – Waterbodies and wetlands under federal jurisdiction under the CWA, including regulation by the USACE under Section 404.

Weir – A low dam used to raise or lower the level of water upstream or regulate its downstream flow.

Wind rose – A graphic expression (e.g., wind rose diagram) that depicts wind speed and direction at a particular location over a defined period.

1.0 INTRODUCTION

Ambler Metals LLC (AMC) proposes to access and recover ore by developing an open pit mine at the Arctic Deposit in the Ambler Mining District (Ambler District), approximately 168 miles (270 kilometers [km]) east of Kotzebue, 22 miles (36 km) north of Kobuk, and 162 miles (260 km) west of the Dalton Highway (Figure 1.1).

The Arctic Mine Development Project (the Project) is nominally designed to process approximately 11,000 short tons per day (t/d) (10,000 tonnes per day [tonnes/d]) of ore to produce three primary concentrates: 1) copper, 2) zinc, and 3) lead. Commercial quantities of gold and silver are also expected to be recovered. The Project would require approximately three years to construct and has a projected operating life of approximately 13 years. A complete description of the Project is in Chapter 2.0, *Project Description*.

The Project would require the dredging and filling in Waters of the U.S. (WOTUS), including wetlands, which requires a Clean Water Act (CWA) Section 404 permit from the U.S. Army Corps of Engineers (USACE).

The Project would have a total footprint of approximately 1,727.2 acres (699 hectares [ha]), of which approximately 120.7 acres (48.9 ha), approximately 7 percent of the project footprint, would result in impacts to wetlands and other waters (i.e., ponds and streams), with approximately 110.6 acres (44.8 ha) within wetlands and approximately 10.1 acres (4.1 ha) in other waters. Approximately 80 percent of the streams in the impact area areas are less than 1 foot (ft) (0.3 m) wide.

The purpose of this Environmental Evaluation Document (EED) is to provide the lead federal agency (USACE) detailed information regarding the proposed action, alternatives considered, and a summary description of key resources in the project area. Relevant resources considered in this EED include subsistence, wetlands and vegetation, cultural resources, socioeconomics, fish and wildlife, air quality, hydrology, and water quality.

The EED includes a high-level summary of the potential environmental impacts, and reflects some of the indicators (e.g., amount and type of wetlands filled) used to demonstrate how AMC intends to address environmental considerations throughout Project development. AMC presents this information to assist in the lead federal agency's decision regarding the appropriate level of National Environmental Policy Act (NEPA) documentation. It should be noted that the analysis is based on preliminary design and best available information at the time of writing. Project details will continue to be developed as the level of design progresses.

The EED is not intended to be an encyclopedic analysis of impacts. It is assumed impacts will be further determined and analyzed by the lead federal agency and the third-party contractor during the NEPA process.

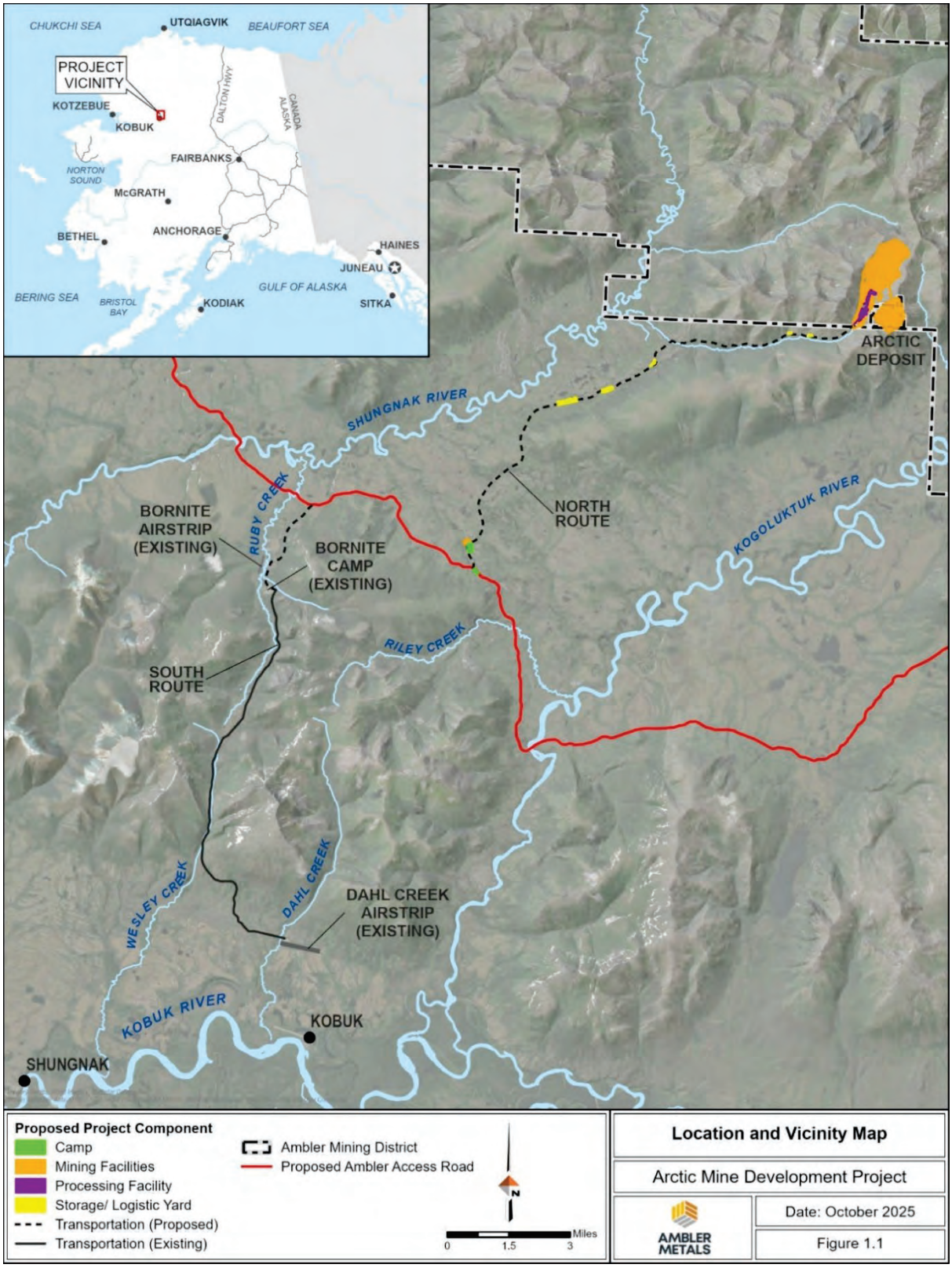


Figure 1.1. Location and Vicinity

1.1 Project Setting, History, and Land Ownership

The Project would be within the Subarctic Valley in the foothills of the Brooks Range, approximately 16 miles (26 km) northeast of AMC's existing Bornite Camp, with most of the mine infrastructure sited within the Subarctic Creek watershed, a tributary to the Shungnak River (Figure 1.2).

The Ambler Metals mining claim block comprises approximately 231,008 acres (93,446 ha) of State of Alaska mining claims and U.S. federal patented mining claims in the Kotzebue Recording District and lies within the Northwest Arctic Borough (NWAB). The land tenure consists of 2,136 claims, including approximately 230,736 acres (93,376 ha) of State of Alaska claims and 18 federal patented claims comprising 272 acres (110 ha).

NovaGold Resources Inc. (NovaGold) acquired the Arctic Project in 2004 from Kennecott Exploration Company and Kennecott Arctic Company. In 2011, NovaGold transferred the project to NovaCopper Inc. and in 2016, NovaCopper Inc. changed its name to Trilogy Metals, Inc. (Trilogy). In 2020, the Project became a 50/50 joint venture called Ambler Metals LLC (Ambler Metals), held by both South32 Limited (South32) and Trilogy.

The tailings management facility (TMF), waste rock facility (WRF), processing facilities, and material stockpiles would be sited on state land. The open pit would be almost completely on private land held by Ambler Metals. Material sites, temporary construction camp, operations camp, explosives storage sites, and access roads would be on NANA Regional Corporation (NANA)-owned lands (Figure 1.2). NANA is one of 13 Alaska Native regional corporations created by the Alaksa Native Claims Settlement Act (ANCSA) passed by Congress and signed into law in 1971.

AMC and NANA entered into a formal agreement to consolidate approximately 471,893 acres (190,929 ha) of AMC claims and NANA lands to provide a framework for exploration and development of the area. The agreement has a term of 20 years (expiring 2031), and AMC has the right to extend the term for an additional 10 years.

Mineral exploration in the Ambler District began early in the twentieth century, with exploration in the Cosmos Hills beginning in earnest in 1947 and in the Schwatka Mountains in the 1960s. The Kennecott Copper Corporation (Kennecott) conducted extensive exploration from the 1960s until the mid-1970s. After 1977, exploration by Kennecott was intermittent until 1998, and then no drilling or additional exploration was conducted until 2004, when NovaGold optioned the Project from Kennecott.

To facilitate exploration, the Arctic Airstrip (now abandoned) was cleared approximately 3 miles (5 km) southwest of the Subarctic Valley entrance (Figure 1.2). The abandoned airstrip is adjacent to a primitive (i.e., without gravel grading) access trail connecting the existing Bornite Camp to the Arctic Deposit. The access trail consists of a winter trail from the Bornite Camp to the Arctic Airstrip and a one-lane dirt track suitable for high-clearance vehicles or construction equipment between the Arctic Airstrip and the Arctic Deposit. In the intervening years, the airstrip, roads, and trails have degraded through vegetative overgrowth. In addition, trails were developed by Kennecott in the Subarctic Valley that are now used during exploration (Figure 1.2).

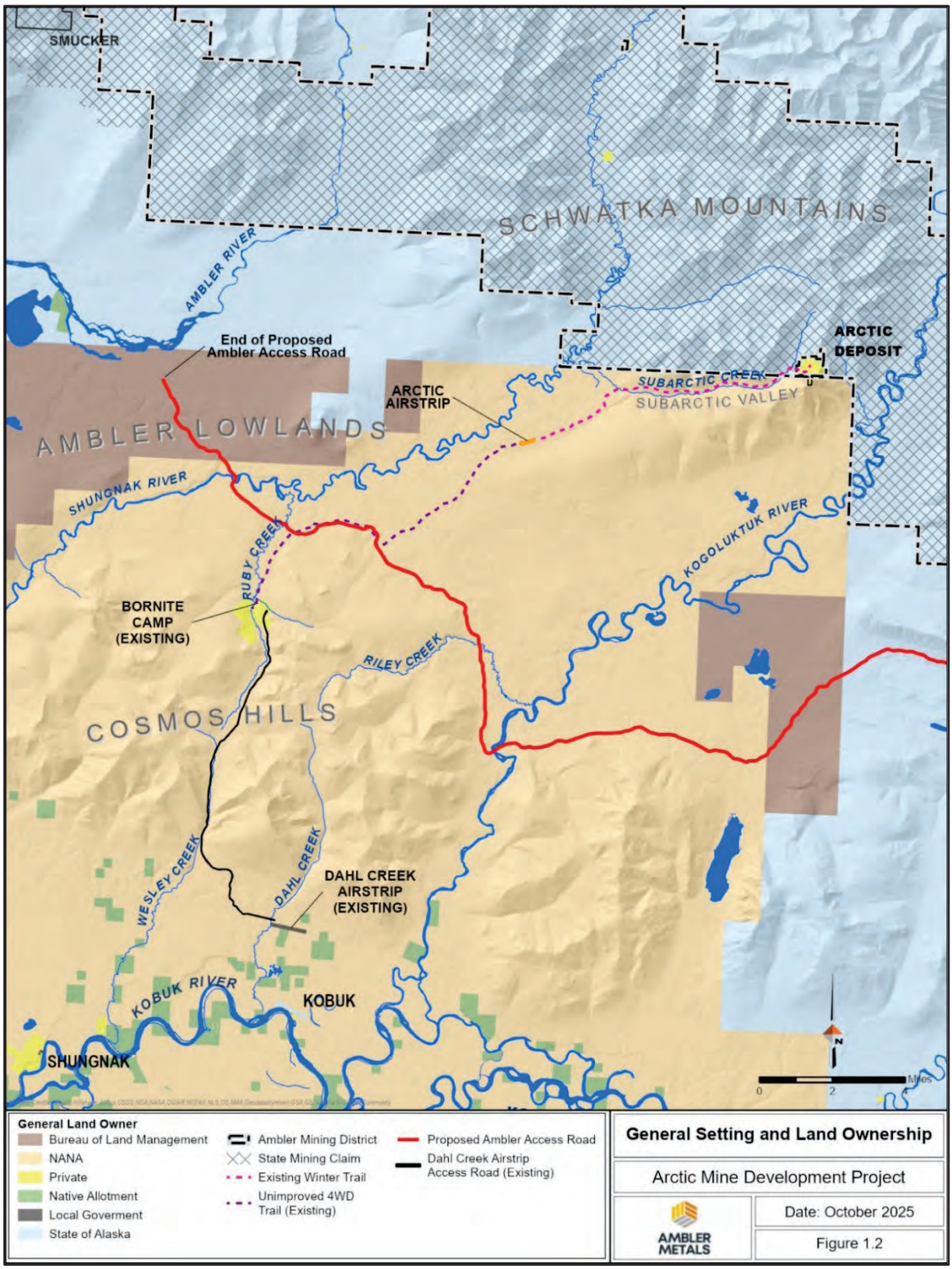


Figure 1.2. General Setting and Land Ownership

1.2 Access to the Project Area

The Project is geographically isolated, with the closest regular commercial aircraft transportation based in the community of Kobuk, approximately 22 air miles (35 km) from proposed mining infrastructure, and Dahl Creek for chartered aircraft at approximately 21 miles (34 km) away. The Project area is currently accessed from the existing Bornite Camp by snowmachine, tracked vehicles or helicopter in winter, and only helicopter in summer. An existing gravel road connects Kobuk and the Bornite Camp. The Project would require construction of additional surface transportation infrastructure to support mining operations. Access to the site would be obtained through a combination of existing State of Alaska-operated highways, the Alaska Industrial Development and Export Authority (AIDEA) proposed Ambler Access Project (AAP), and new AMC-proposed Project access roads (North Route and South Route). AMC proposes to truck concentrate in specialized 20-foot (6-m) intermodal bulk shipping containers from the mine site to Fairbanks, where it would be transferred to rail for delivery to Anchorage. In Anchorage, the shipping containers would be emptied directly into bulk carrier marine vessels for transport to a smelter or refinery outside of Alaska.

In addition to the roadway access noted above, AMC proposes to use the State of Alaska-owned Dahl Creek Airstrip to support the planned regular transportation of employees to and from Fairbanks and regional communities (Table 1.1).

Table 1.1. Distance between the Arctic Deposit and nearby Communities

COMMUNITY	DISTANCE TO ARCTIC DEPOSIT BY AIR
Kobuk	22 miles (35 km)
Shungnak	29 miles (47 km)
Ambler	40 miles (64 km)
Huslia	101 miles (163 km)
Alatna	109 miles (175 km)
Evansville	133 miles (214 km)

AIDEA's proposed AAP would connect the Ambler Mining District to the Dalton Highway via a 211-mile-long (340 km) gravel road, permitted under a separate action with the U.S. Bureau of Land Management (BLM) as the lead federal agency. Congress recognized the mineral potential and the specific need for access to the Ambler Mining District to ensure Alaskans' economic and social needs are met. In 1979, Congress mandated surface access to the Ambler Mining District through the Gates of the Arctic National Park and Preserve in Section 201(4) of the Alaska National Interest Lands Conservation Act (ANILCA), which states:

> *Congress finds that there is a need for access for surface transportation purposes across the Western (Kobuk River) unit of the Gates of the Arctic National Preserve (from the Ambler Mining District to the Alaska Pipeline Haul Road) and the Secretary shall permit such access in accordance with the provisions of this subsection.*

In addition, ANILCA Section 201(4)(d) directs that an Environmental and Economic Analysis (EEA) be prepared for the right-of-way (ROW) across National Park Service (NPS) lands to (1) determine a preferred road alignment and (2) develop appropriate terms and conditions for the ROW permit.

Concurrent with the NPS EEA, an Environmental Impact Statement (EIS) was initiated by BLM for the AAP (i.e., Ambler Road Environmental Impact Statement) on February 28, 2017, and the joint Record of Decision (ROD) was signed in July 2020 by BLM and USACE. In January 2021, the 50-year-ROW permit allowing the privately owned AAP to pass through lands controlled by the federal government was signed by NPS, BLM, and AIDEA; however, litigation was filed and in February 2022 the U.S. Department of the Interior (DOI) requested the U.S. District Court grant a voluntary remand, allowing for additional analysis under a Supplemental Environmental Impact Statement (SEIS). The SEIS process addressed identified deficiencies within the BLM analysis of subsistence impacts under ANILCA Section 810 and consultation with tribes pursuant to Section 106 of the National Historic Preservation Act. The SEIS was finalized April 2024, with a ROD issued June 2024 that selected the No Action Alternative.

AIDEA appealed the decision under Section 1106(a) of ANILCA on June 6, 2025, and was granted the reinstatement of the previously issued federal permits. On October 6, 2025, the appeal was approved, directing BLM, NPS and USACE to reissue necessary permits to construct. The AAP is now in the Pre-Construction phase of the project, completing necessary studies to support early design of the proposed road.

1.3 Applicant's Stated Purpose and Need

AMC's purpose for the Project is to profitably extract commercial quantities of critical and strategic minerals including copper, zinc, lead, and other valuable minerals from the Arctic Deposit ore reserves, using proven economic mining and milling methods.

The primary need for the Project is to bring domestic supplies of critical minerals including copper, lead, zinc, silver, and gold to market and maximize value to AMC partners, as further described below.

1.4 Secondary Benefits of the Project

In addition to meeting the stated purpose and need, the Project would also enable NANA to provide significant economic benefits for its Native shareholders. Payments to the Northwest Arctic Borough (NWAB) would increase economic activity in the NWAB, including the closest communities to the Project: Kobuk, Shungnak, and Ambler. In 2021, the unemployment rate in the NWAB was approximately 11.5 percent (State of Alaska 2023), with higher rates locally of 22% in 2022 in Shungnak and Ambler (McKinley 2024) In addition, approximately 22% families across Ambler, Kobuk, Shungnak live below the poverty level compared to 7% statewide (McKinley 2024).

Construction and operation of the mine could directly generate approximately 430 jobs during operations, with a total of 870 combined from direct, indirect, and induced employment (McKinley 2024). In addition, construction spending related to materials and services is estimated to indirectly support approximately 137 additional jobs throughout Alaska annually (Ausenco Engineering Canada, Inc. 2023).

1.5 Permits and Regulatory Approvals

The Project will require other permits, authorizations, and consultations from federal and state agencies, in addition to the CWA Section 404 permit. Table 1.2 through Table 1.4 list the federal laws, Executive Orders (EO), permits, authorizations, and consultations AMC anticipates will apply or be required for the Project.

Table 1.2. Applicable Federal Laws and Executive Orders

FEDERAL LAW OR EXECUTIVE ORDER	DESCRIPTION
National Environmental Policy Act of 1969 (42 USC 4321)	The National Environmental Policy Act requires all federal agencies to prepare a detailed statement of the environmental effects of proposed major federal actions with potential to significantly affect the quality of the human environment.
National Historic Preservation Act of 1966 (16 USC 470)	Before issuing a federal permit, federal agencies must consider the effect of the undertaking on historic properties (resources listed or determined eligible for the National Register of Historic Places) and must consult with the State Historic Preservation Office, Indian Tribes, and other parties. Federal agencies must provide the Advisory Council on Historic Preservation with a reasonable opportunity to comment on the Project.
EO 13175 (2000) – Consultation and Coordination with Indian Tribal Government	EO 13175 requires federal departments and agencies to consult with Indian tribal governments when considering polices that would impact tribal communities.
EO 11514 (1970) – Protection and Enhancement of Environmental Quality	EO 11514 directs the U.S. government to provide leadership in protecting and enhancing the quality of the environment. Federal agencies are to initiate measures to direct their policies, plans, and programs to meet national environmental goals.
EO 11988 (1977) – Floodplain Management	EO 11988 requires federal agencies to reduce the risk of flood loss; minimize the impact of floods on human safety, health, and welfare; and restore and preserve the natural and beneficial values served by floodplains when carrying out agency responsibilities.

Table 1.3. Applicable Federal Permits or Approvals

FEDERAL AGENCY	PERMIT OR APPROVAL
U.S. Environmental Protection Agency	Spill Prevention, Control, and Countermeasures Plan (administered by State of Alaska) Facility Emergency Response Plan Emergency Planning and Community Right-to-Know Act (hazardous substances) Hazardous waste generator identification number Used oil generator notification and identification number
U.S. Army Corps of Engineers	Clean Water Act Section 404 Permit (Waters of the U.S. dredge and fill)[a] Lead federal agency for Section 106 National Historic Preservation Act review
Bureau of Alcohol, Tobacco, Firearms and Explosives	License to transport explosives Permit and license for use of explosives
Federal Aviation Administration	Notice of Landing Area Proposal (existing airstrip) Notice of Controlled Firing Area for Blasting
Federal Communications Commission	Radio license
U.S. Department of Homeland Security	Transportation Security Administration inspection program at airstrip Chemical facility anti-terrorism standards
U.S. Department of Transportation	Hazardous materials registration
Mine Safety and Health Administration	Mine identification number Notification of legal identity Training and Retraining of Miners Plan

[a] EPA provides federal oversight

Note: There are no known federally listed threatened or endangered species present in the Project area; thus, there is no nexus for consultation under Section 7 of the Endangered Species Act (ESA) for the Project. There is no designated essential fish habitat in the Project area, thus there is no nexus for coordination under the Magnuson-Stevens Fishery Conservation and Management Act. Thus, these authorizations are not described further in this document.

Table 1.4. Applicable State and Local Permits or Approvals

AGENCY	PERMIT OR APPROVAL
State of Alaska *Department of Natural Resources* Division of Mining, Land and Water	• Plan of operations approval (operations on state land) • Reclamation plan and financial approval • Mining license • Upland Mining Lease/Millsite Lease • Rights-of-way, easements, material sales, etc. • Certificate of Approval to Construct a Dam • Certificate of Approval to Operate a Dam • Temporary Water Use Authorization • Water Rights Authorization to appropriate water
State of Alaska *Department of Natural Resources* Office of History and Archaeology/State Historic Preservation Office	• Section 106 National Historic Preservation Act review[b] • Compliance with Alaska Historic Preservation Act (AS 41.35) • Archaeology collection permit • Field archaeology permit
State of Alaska *Department of Natural Resources* Division of Forestry	Burn permits
State of Alaska *Department of Environmental Conservation* Division of Water	• Clean Water Act Section 401 Water Quality Certification[a] • Clean Water Act Section 402 Alaska Pollutant Discharge[a] Elimination System permit (discharges to Waters of the U.S.) • Multi-Sector General Permit (for stormwater discharge) • Non-Domestic Wastewater Disposal permit • Stormwater Discharge Permit – Construction, Operations, and Closure (typically under general permit) • Integrated waste management permit and financial assurance (waste rock facility, tailings management facility, and other hazardous and solid waste management) • Domestic Wastewater Disposal permit • Public Water System review and approval
State of Alaska *Department of Environmental Conservation* Division of Environmental Health	• Food establishment permit
State of Alaska *Department of Environmental Conservation* Division of Air Quality	• (2) Minor Permits • Prevention of Significant Deterioration Permit
State of Alaska *Department of Environmental Conservation* Division of Spill Prevention and Response	Oil Discharge Prevention and Contingency Plan

AGENCY	PERMIT OR APPROVAL
State of Alaska *Alaska Department of Public Safety* Office of the State Fire Marshal	• Approval to transport hazardous materials • Life and Fire Safety Plan check • Plan review certificate of approval for each building
State of Alaska *Alaska Department of Fish and Game*, Habitat Section	• Title 16 Fish Habitat permits • Fish passage permits (culverts and bridges)
State of Alaska *Alaska Department of Labor and Workforce Development* Division of Labor Standards and Safety	• Certificates of inspection for fired and unfired pressure vessels • Occupational safety and health inspections and certificates • Employer Identification Number
Northwest Arctic Borough *Planning Department*	Land Use Permit (Title 9) for Rezone and Master Plan

[a] EPA provides oversight
[b] The U.S. Army Corps of Engineers will lead the consultation with the Alaska State Historic Preservation Office for Section 106 National Historic Preservation Act review.

Key Updates and Changes

- 2025 Executive and Emergency Orders. Three EOs signed in 2025 apply directly to the proposed Project:
    - EO 14156: Declares a national emergency under the National Emergencies Act due to the energy crisis and cites threats from foreign actors and the need to protect critical infrastructure, through the following:
        - Emergency Approvals: heads of executive departments and agencies to facilitate the identification, leasing, siting, production, transportation, refining, and generation of domestic energy resources
        - Expedites completion of infrastructure, energy, environmental, and natural resources projects
        - Directs federal agencies to identify and expedite energy projects; use emergency authorities to streamline leasing, siting, and permitting of energy infrastructure; and prioritize domestic production and refining of energy and critical minerals
        - Directs federal agencies including the USACE to fast-track energy related projects using emergency permitting authorities
    - EO 14153: Aims to maximize the development of Alaska's natural resources by:
        - Placing a temporary moratorium on all activities granted under the ROD for the Ambler Road Supplemental EIS.
        - Ordering review of Ambler Road ROD in light of alleged legal deficiencies for consideration of public interests and mandates conducting a new comprehensive analysis of deficiencies and environmental impacts.
        - Directing the Assistant Secretary of the Army for Civil Works to immediately rescind any agency action that hinders or slows critical projects in the state of Alaska.
        - Making more federal land available to Alaska Native Corporations under ANCSA

- EO 14241: Bolsters national and economic security by maximizing domestic mineral output by,
    - Directing each federal agency, within 10 days, to submit a list of all pending mineral-project applications and then, within another 10 days, identify "priority projects" that can be immediately approved or permitted.
    - Mandating agencies use all available authorities—and reallocate existing federal funds and incentives—to accelerate leasing, permitting, and financing of those projects.
    - Authorizing the Secretary of Defense under Section 303 of the Defense Production Act, in consultation with the Secretary of the Interior, the Secretary of Energy, the Chair of the National Energy Dominance Council (NEDC), and the heads of other agencies as the Secretary of Defense deems appropriate, for the domestic production and facilitation of strategic resources the Secretary of Defense deems necessary or appropriate to advance domestic mineral production in the United States.

1.6 Alternatives Development

The alternative components described in this EED respond to AMC's purpose and need (Section 1.4, *Applicant's Stated Purpose and Need*) to profitably construct and operate an open pit surface mine at the Arctic Mine site. To achieve the Project's purpose, some Project components would only be feasible or practicable when used in specific locations or incorporated into specific Project configurations. The alternatives development process is described in Appendix A, *Alternatives Development* including AMC's approach to integrating environmental considerations into the development of Project components as they are currently proposed. Appendix A discusses various technologies or methodologies applicable to the individual Project components, the reasons for evaluating them, and the rationale for excluding certain components from the proposed Project.

1.7 Preliminary Stakeholder Engagement

AMC engagement with local communities and regional organizations began in 2004 with NovaGold initial Project plans. Informal and formal meetings have been held since then to provide local communities with updates on field season plans, review the overall status of the Project, recruit employees, share information, and provide an interactive forum for the local public to voice their questions, concerns, and support. Separate meetings with city officials and tribal governments have been held in conjunction with community visits.

Between 2005 and 2025, AMC and its predecessors hosted or participated in more than 280 meetings and events to engage regional communities. These meetings included public open houses, tribal government meetings, city government meetings, and other meetings with NWAB and NANA organizations.

AMC and its predecessors have actively engaged with NANA since 2006, with increased collaboration since 2011 following the formalized cooperation agreement between Trilogy/AMC and NANA. In 2011, an Oversight Committee was established with NANA consisting of four representatives from each organization to review and issue guidance for the Project.

Subcommittees were formed with additional community representatives to provide oversight on specific topics. A Subsistence Committee was formed in 2013 to consider potential impacts on subsistence resources resulting from the Project and measures that would avoid or minimize those impacts. The

Subsistence Committee includes representatives from local communities, where information can be shared between communities and AMC. The Subsistence Committee meets to discuss current work plans, provide updates on the AAP and other studies conducted by AMC, and allow subsistence users to share concerns or ask questions about the Project. The Subsistence Committee also provides recommendations and guidance to the Oversight Committee.

1.8 Preliminary Project Schedule

The entire Project is anticipated to last approximately 19 years, before long-term water treatment would begin, from construction through facilities closure. Pre-production (i.e., the start of pit excavation and material stockpiling) would begin in Year -3 and continue through construction ending in Year 0. Production would begin in Year 0 and run for the life of mine; approximately 13 years. Initial closure activities, including removal of the mine facilities, are expected to be completed within approximately five years following the end of mining activity.

Dewatering and treatment of the water in the TMF would begin upon closure and continue for approximately 15 years, allowing the tailings to consolidate and allow for closure of the TMF (Sec. 2.10.2 *Closure Activities*). Long-term water treatment and discharge from the pit would begin and continue throughout closure (Table 1.5).

Table 1.5. Anticipated Schedule of Project Activities

ACTIVITY	START YEAR	END YEAR	NUMBER OF YEARS
Construction	-3	0	3
Pre-production	-3	0	3
Production	0	13	13
Facilities Closure	14	17	3
TMF Dewatering	14	29	15
Open Pit Water Treatment	30	TBD	TBD

1.9 Key Issues

Potential key issues related to the development of the Project are anticipated to include:

- Protection of subsistence resources, especially caribou
- Avoidance and minimization of wetlands impacts
- Potential impacts to surface water and groundwater quality during operations and post-closure
- Potential structural failure of mine infrastructure including the TSF
- Potential to affect socioeconomic conditions, cultural resources, and traditional ways of life in the region

2.0 PROJECT DESCRIPTION

The Project would consist of four main components: mining, processing, support, and transportation facilities (Table 2.1 and Figure 2.1 and Figure 2.2). For the purposes of the Project description and alternatives presented in this EED, it is assumed the proposed AAP will receive all necessary permitting approvals and land access agreements, and that construction of AAP will begin prior to initial Arctic Mine Project construction activities.

The Project would extend one gravel road from the existing Bornite Camp to the proposed AAP, allowing road access to the existing Dahl Creek Airstrip. An additional road would connect the AAP with the mine facilities (Figure 2.1). Gravel pads would be constructed for a Project camp, processing facilities, utilities, logistics and laydown yards, construction camp, and other associated Project infrastructure.

The mining process would start with drilling and blasting at the mine pit to break rock into smaller pieces that can be loaded onto trucks carrying approximately 158 tons (144 tonnes) of material. Waste rock would be hauled to the waste rock facility (WRF) near the head of the valley and ore-grade material would be hauled to a crusher on the operations pad for further size reduction. The ore would be fed through a semi-autogenous grinding (SAG) mill-ball mill circuit that would grind the ore. Flotation circuits would separate the sulfide minerals into three concentrates: copper, zinc, and lead, which also will contain gold and silver. The final tailings from the zinc flotation circuit would be thickened and pumped to the tailings management facility (TMF).

Copper, lead, and zinc concentrates would be thickened and pressure-filtered before being delivered to a storage shed, where they would then be loaded into 20-foot intermodal bulk shipping concentrate containers with latching lids, using a wheeled loader which would prevent concentrate loss to the environment during concentrate loading and hauling. The concentrate containers would then be loaded onto flatbed trucks. The trucks would not enter the concentrate storage shed and therefore would not be contaminated with metal dust. Approximately 46 trucks per day would then transport the concentrate containers to the AAP junction. Approximately 23 trucks per day, hauling two concentrate containers each, would then travel along the approximately 211-mile-long (340-km-long) AAP to the Dalton Highway, where they would be stored until being transported by trucks hauling a single concentrate container to Fairbanks. Concentrate containers would then be transported by flatbed railcar to the Port of Alaska in Anchorage. In addition, approximately five supply trucks per day would haul supplies to the Project.

At the Port of Alaska, the containers would be offloaded and stacked until they are emptied into bulk carrier marine vessels using a special mechanism fitted to an overhead crane. This approach would minimize dust. Approximately 0.5 million tons (470,586 tonnes) of concentrate would be shipped per year using this process. The concentrate would be transported to smelters in North America and/or elsewhere with the capacity to process the concentrates into saleable metals.

Table 2.1. Project Components

PROJECT COMPONENT	KEY ELEMENTS
Mining Facilities	
Open pit	Active mining site
TMF	Starter dam and subsequent raises, water management pool and return, and delivery systems
Waste Rock Facility	Structure below the TMF dam
Stockpiles	Topsoil, overburden, and ore stockpiles
Waste Rock Collection Pond (WRCP)	Dam, pond, and water delivery system to the mill and water treatment plant
Process Pond	Dam, pond, and water delivery system to the mill
Water Treatment Plant	Water treatment plant, diversion and collection channels, containment structures, pumps, and pipelines to transfer reverse-osmosis rejection water to the TMF and treated water discharge facilities to Subarctic Creek.
Processing Facilities	
Operations pad	Ore stockpile area, power plant, gasoline and diesel storage area, plant workshop/warehouse, administrative building, mill dry facility, laboratory, primary crushing building, fine ore stockpile, processing plant, concentrate loadout building, reagent storage building, raw water supply building, crushed ore stockpile area, truck workshop, truck wash, mine offices, mine dry facility, and warehouse
Support Facilities	
Camps	Temporary Construction Camp; Construction Camp and Permanent Accommodation Camp with a power plant to house personnel; Bornite Camp with a power plant to house personnel
Laydown and Storage Yards	Three gravel pads would be used for miscellaneous storage, and one gravel pad would serve as a concentrate logistics yard; two gravel pads would be used to store explosives
Explosives storage facilities	Two locations identified
Site communications	One communications tower
Material sites	Eight potential sites identified
Transportation	
North Route (MP 0.0 –13.6)	13.6 miles (14.1 km) of new gravel access road between the mine site and the AAP
South Route (MP 0.0 –13.4)	10.6 miles (17.0 km) of widening the existing gravel access road to the Dahl Creek Airstrip and 2.8 miles (4.5 km) of new road between the existing Bornite Camp and AAP
Haul roads	2.9 miles (4.6 km) of gravel road connecting the open pit with the WRF and TMF
Operation Camp Access Road	0.3 mile (0.5 km) of gravel road connecting the operations camp with the North Route
Dahl Creek Airstrip	Additional navigation and lighting features, and ROW maintenance

MP = milepost

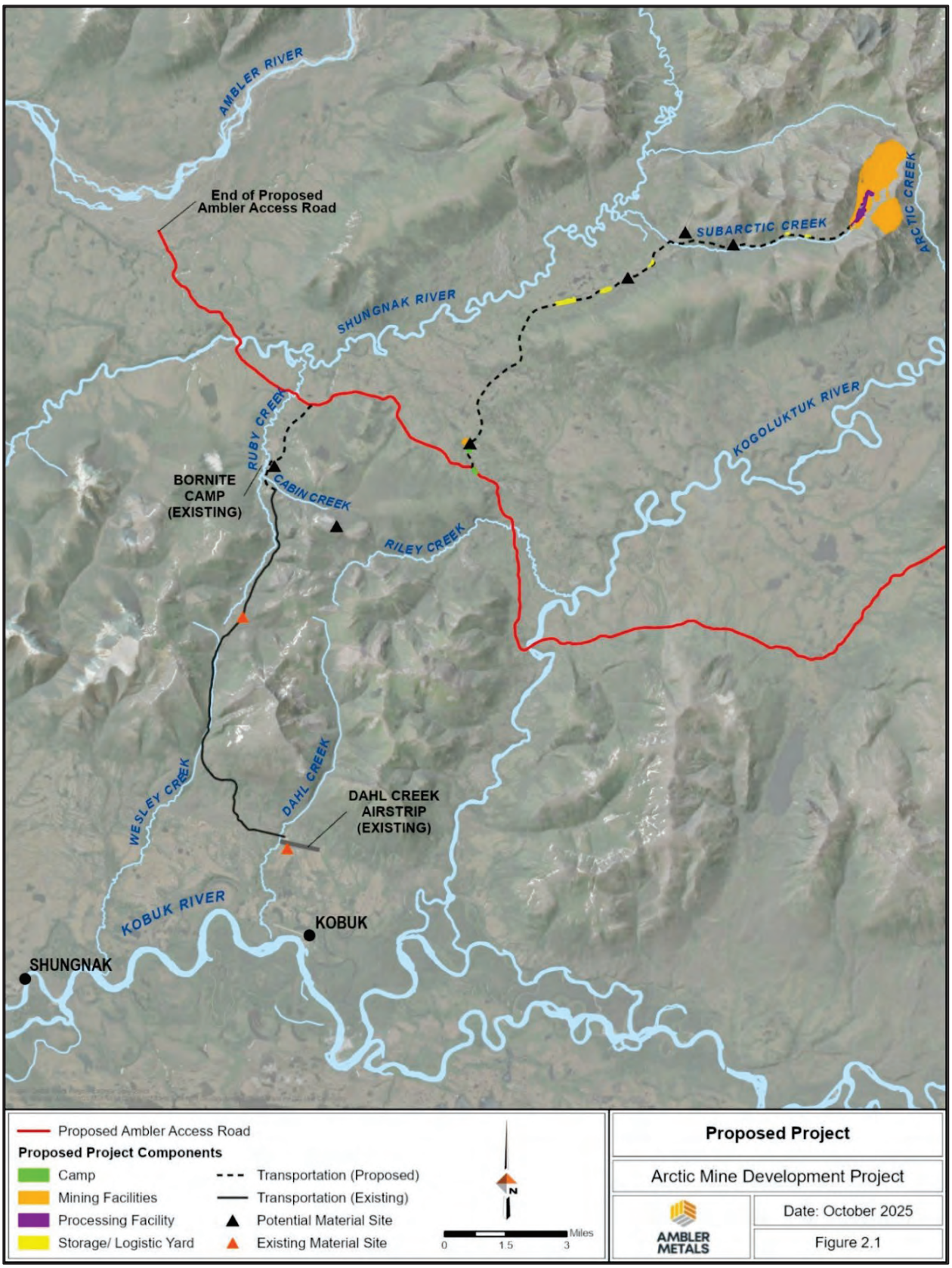


Figure 2.1. Proposed Project

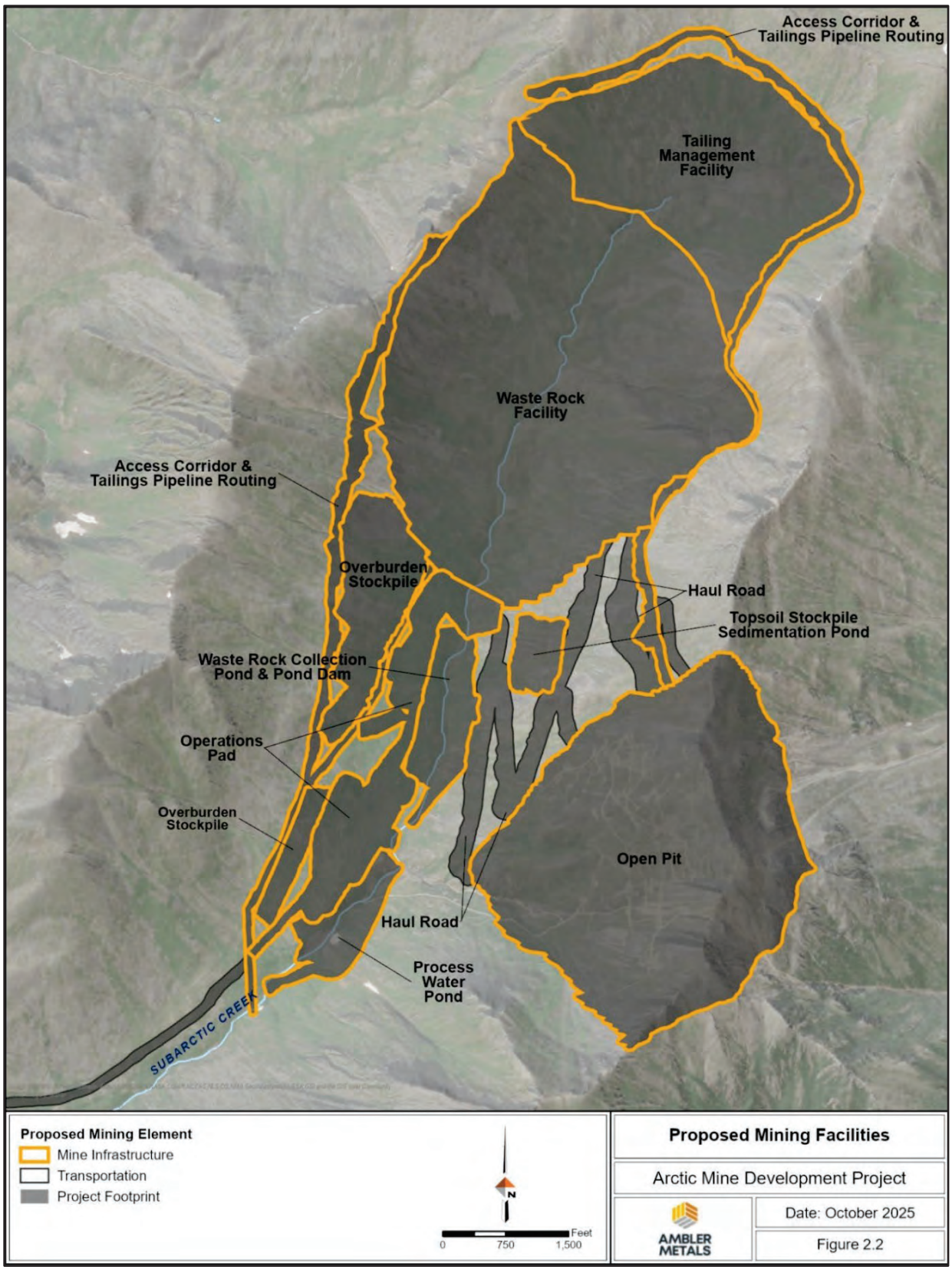


Figure 2.2. Proposed Mining Facilities

2.1 Mining Facilities

Mining facilities include all Project elements required to access and recover ore and manage waste rock, overburden, and tailings (Figure 2.1). Mining facilities would be confined to the upper Subarctic Valley.

2.1.1 Open Pit

Ore would be recovered using a conventional truck-shovel operation, assuming approximately 158-short-ton (144 metric-tonnes) trucks and approximately 20-cubic-yard (cy) (15-cubic-meter [m^3]) shovels. The pit design would include four phases including the ultimate pit limit to balance stripping requirements while satisfying the process plant requirements.

The mine pit design parameters include the following:

- Ramp width of 98.4 ft (30 m)
- Maximum 10 percent road grades
- Bench height of 16.4 ft (5 m)
- Variable slope angles based on geotechnical parameters
- Minimum mining width of 98.4 ft (30 m)

The final pit design would contain approximately 51 million short tons (46.7 million tonnes) of ore and approximately 375 million short tons (340 million tonnes) of waste rock for a resulting stripping ratio of 7.3:1. A rendering of the pit is shown in Graphic 2.1.

A surface water management system would segregate contact and non-contact water. Non-contact water would be diverted around mine infrastructure to Subarctic Creek. Groundwater in the pit would be managed with in-pit sumps. Downgradient of the WRF, seepage and runoff would be collected in the WRCP) from which it would be pumped to the Project Pond for re-used in processing or sent to the water treatment plant (WTP) for treatment before discharge to Subarctic Creek (Section 2.1.5, *Water Treatment Plant*).

2.1.2 Tailings Management Facility

The TMF would be located at the headwaters of Subarctic Creek, in the uppermost portion of the Subarctic Valley. The maximum storage capacity of the TMF (tailings and process water) would be approximately 53.2 million cy (40.7 million cubic meters [Mm^3]) at an elevation of approximately 2,927 ft above mean sea level (asl) (892 m), plus an additional 8.2 ft (2.5 m) of freeboard. The proposed TMF would be designed as a fully lined conventional tailings facility buttressed by the WRF. Multiple liner options were evaluated to reduce water treatment requirements by minimizing infiltration and oxidation of the waste rock (Klohn Crippen Berger 2021). The approximately 145.8-acre (59-ha) TMF footprint would be fully lined with an impermeable linear low-density polyethylene (LLDPE) liner.

A rendering of the TMF and WRF is shown in Graphic 2.2.



Graphic 2.1. Rendering of the Open Pit



Graphic 2.2. Rendering of WRF and TMF

Tailings containment would be provided by an engineered dam that would be buttressed by the WRF, constructed immediately downstream of the TMF, and the natural topography of the valley sides. A starter dam would be constructed to an elevation of 2,641 ft (805 m) asl two years prior to mine startup and then increased to approximately 2,723 ft (830 m) by the end of the construction period (see Graphic 2.3). Three subsequent raises would result in a final dam crest elevation of approximately 2,927 ft (892 m). The starter dam and subsequent raises are described and depicted in more detail in Section 2.1.2.2, *Starter Dam*, and Section 2.1.2.3, *Dam Raises and Final Dam*. The expected maximum tailings production rate is approximately 9,811 t/d (8,900 tonnes/d), and the TMF would be designed to store approximately 50 million cy (37.4 Mm^3) of tailings plus approximately 3,650 acre-feet (4.5 Mm^3) of water produced over the 13-year mine life as well as the probable maximum flood.

Tailings would be deposited as conventional slurry from multiple spigots. For this design, a dry density of 0.93 short tons per cubic yard (t/cy) (1.1 tonnes per cubic meter [$tonnes/m^3$]) was used to estimate the facility's storage capacity. As the impoundment base would be impermeable, the final consolidated tailings dry density is assumed to be 1.06 t/cy (1.25 $tonnes/m^3$) based on simple two-dimensional consolidation calculations. The facility operation scheme would result in a subaqueous tailings deposition with a rate of rise varying from 82 ft per year (25 m per year) at startup to 13.1 ft per year (4 m per year) at the end of operations. It is assumed that an underwater one percent slope would be created during tailings deposition. The Reclaim Pond would form over the top of the tailings and against the natural terrain upstream of the dam and would reach a maximum design elevation of approximately 2,927 ft (892 m) by the end of operations. Water from the Reclaim Pond would be pumped to the Process Water Pond prior to use in processing.

2.1.2.1 *Design Criteria*

The basis of the TMF design is provided in Table 2.2. Values were determined from Project-specific information, professional judgment, and experience gained from other similar projects. The design was developed in accordance with the following guidelines and regulations and complies with general industry guidelines and standards of practice:

- Guidelines for Cooperation with the Alaska Dam Safety Program. Alaska Department of Natural Resources (ADNR) (ADNR 2017)
- 11 Alaska Administrative Code (AAC) 93, Article 3, Dam Safety
- Alaska Mining Laws and Regulations from ADNR Division of Mining, Land and Water
- Canadian Dam Association Technical Bulletin: Application of Dam Safety Guidelines to Mining Dams (2014)
- Global Industry Standard on Tailings Management (International Council of Mining and Metals 2020)

Table 2.2. Tailings Management Facility Design Parameters and Design Criteria

DESIGN ITEM	DESIGN CRITERION
Operational life of the tailings management facility	13 years
Total tailings	45.4 million tons (41.2 million tonnes)
Annual tailings production (solids)	3.92 million cy per year (3 million m^3 per year)
Tailings grind size	74 micrometers at 80% passing
Tailings percent solids (in slurry pipeline)	50%
Tailing solids specific gravity	3.0
Tailings settled dry density	0.93 t/cy (1.1 tonnes/m^3)
Expected tailings deposition angle	1% (subaqueous)
Tailings deposition method	Spigots from dam crest
Target storage requirement	50.7 million cy (38.8 million m^3)
Reclaimed water storage requirement	Minimize level
Dam hazard classification (Alaska Dam Safety Program)	Class 1
Minimum freeboard above tailings	8.2 ft (2.5 m)
Tailings dam crest width	98 ft (30 m)
Tailings dam maximum height	629 ft (192 m)
Tailings dam maximum elevation	2,927 ft (892 m) asl
Design earthquake	1:10,000 years (peak ground acceleration = 0.374 g)
Stability factor of safety	1.0 (seismic) to 1.5 (static)
Dam construction materials	Waste rock compacted in 3.3-foot (1-m) lifts
Dam downstream and upstream slopes	2.5 horizontal to 1 vertical
Starter dam storage capacity and elevation, year 1	2.0 million cy at 2,641 ft asl (1.5 million m^3 at 805 m asl)
End of Dam construction storage capacity and elevation, year 0	8.5 million cy at 2,723 ft asl (6.5 million m^3 at 830 m asl)
Dam raise 1 storage capacity and elevation, year 1	18.2 million cy at 2,788 ft asl (13.9 million m^3 at 850 m asl)
Dam raise 2 storage capacity and elevation, year 4	32.4 million cy at 2,854 ft asl (24.8 million m^3 at 870 m asl)
Dam raise 3 storage capacity and elevation, year 7	3.2 million cy at 2,927 ft asl (40.7 million m^3 at 892 m asl)
Storm inflow design flood (without overtopping)	1.5 x probable maximum flood
Maximum allowed vertical crest deformation due to dynamic loading	1.6 ft (0.5 m)

g = standard acceleration due to earth gravity

The TMF design criteria are based on site conditions as of March 2022, interpreted assumptions from a review of available information, and feasibility-level field investigations and associated reporting.

2.1.2.2 *Starter Dam*

A starter dam for the TMF would be constructed as part of the initial Project development using waste rock sourced from the initial development of the open pit. The starter dam would be required to provide enough accumulated water before production mining operations could commence. Water would be stored behind the starter dam, and into the WRCP, and Process Pond for startup. The overburden would be excavated underneath the footprint of the starter dam and removed to reduce potential settlement and deformation of the TMF dam; overburden removal would therefore reduce the potential underperformance of the liner that would be installed on the dam's upstream face. The topsoil and overburden material would be stockpiled near the pit for use in future Project closure and reclamation.

The starter dam would be constructed in two phases to an ultimate lined elevation of approximately 2,723 ft (830 m) asl, which would allow for storage of pre-production water and approximately one year of storage (approximately 2.0 million cy [1.5 Mm^3]) to supply the mill during startup.

The upstream and downstream faces of the starter dam would be constructed at 2.5 horizontal to 1 vertical ratio (2.5:1 horizontal to vertical [H:V]) and constructed entirely of waste rock from the open pit. Waste rock would be placed in approximately 3.3-foot (1-m) lifts and compacted by the mine fleet haul trucks. Most of the waste rock is anticipated to be potentially acid generating (PAG) and there would be no separation of waste rock based on acid generation potential; as such, all seepage collected in the WRCP would be treated by the WTP or reused in the mill for process water. The WRF would be constructed directly below the dam and would give additional strength to the dam. The dam and WRF would both be considered when conducting stability testing and failure analysis.

Graphic 2.3 shows a cross-section through complete TMF and WRF, illustrating the starter dam in relation to the final dam and the abutting WRF. The TMF footprint and the upstream face of the dam would be grubbed, bedded with a fine material, and compacted. An underliner and liner would be installed to prevent leakage.

2.1.2.3 *Dam Raises and Final Dam*

The TMF dam would be raised in three lifts and when completed would reach the final dam elevation of approximately 2,927 ft (892 m) asl. The construction for the raises would be completed in Project Years 1, 4, and 7 to elevations of approximately 2,805 ft (850 m), 2,890 ft (870 m), and 2,927 ft (892 m) asl, respectively.

Construction would be completed using the downstream method and would connect the structural fill in the tailings dam with the WRF. Tailings deposition would be required from the perimeter of the TMF during the construction sequence of the dam crest. The dam crest would be constructed to a width of approximately 98 ft (30 m) at the end of each construction campaign.

An upstream slope of 2.5:1 H:V would be maintained throughout the construction of the dam to facilitate the placement of the bedding layer and the installation of the liner. The downstream portion of the TMF dam would abut the WRF at each stage of dam raising. Waste rock from the mine site pit would be used for dam construction and would be compacted in approximately 3.3-foot (1-m) lifts.

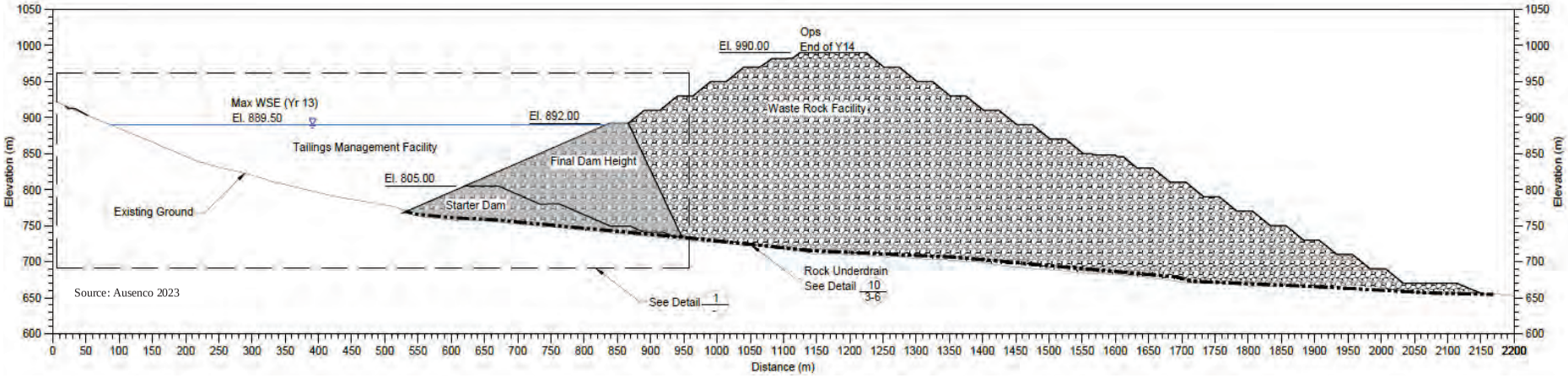
An additional liner would be placed within the expanded TMF footprint using the same procedures as the initial starter dam. The TMF area would be cleared and grubbed, and bedding material and geotextile would be placed prior to the 80-mil single-sided textured LLDPE geomembrane being laid down and seamed to the existing liner. Graphic 2.4 shows a cross-section at the final design elevation.

2.1.2.4 *Tailings Management Facility Reclaim Pond and Water Return*

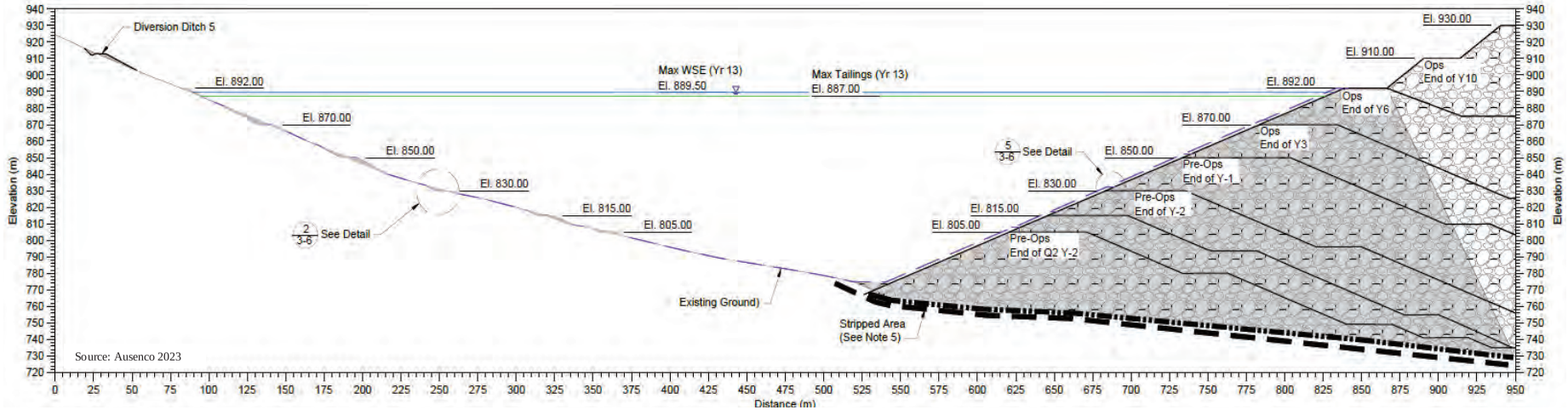
The TMF Reclaim Pond would be maintained at a deeper depth toward the northern portion of the TMF. Reclaimed water would be obtained using a floating barge and pipeline system situated on the pond. Reclaim water would support processing at the mill and be returned to the TMF with processed tailings. The mill tailings would be thickened prior to being deposited in the TMF. A Process Pond would contain the mill thickener overflow. Reclaim water from the TMF and the Process Pond would be used as make-up water for the mill.

The tailings delivery system would transport slurried tailings from the processing plant to the TMF via a ground-laid pipeline. The 1.9-mile (3-km) tailings delivery system would use a 20-inch diameter (500-mm-diameter) carbon steel, rubber-lined pipeline for 1.2 miles (2 km) and a 24-inch-diameter (600-millimeter[mm]-diameter) high-density polyethylene (HDPE) pipeline for 0.6 mile (1 km). The pipeline would transport up to 2,411 cy per hour (1,843 m^3 per hour) of tailings to the TMF. Tailings deposition in winter would be managed to limit ice formation.

The return water delivery system for recycled water from the TMF has been sized based on approximately 345,500 gallons per hour (1,308 m^3 per hour) of water being pumped from the TMF to the Process Pond. This system would include a barge-based pump and a 1.9-mile-long (3-km-long) pipeline adjacent to the tailings pipeline. The pipeline would consist of 1.2 miles (2 km) of an 18-inch-diameter (457-mm-diameter) carbon steel pipeline and 0.6 mile (1 km) of 20-inch-diameter (500-mm-diameter) HDPE. Both pipelines would be installed aboveground, and heat traced to prevent freezing.



Graphic 2.3. Tailings Management Facility Starter Dam Cross-Section (to 805 meters elevation)



Graphic 2.4. Cross-Section: Dam Raises and Tailings Management Facility to Final Design Elevation

2.1.3 Waste Rock Facility and Overburden Stockpiles

The approximately 355.1-acre (108.2-ha) WRF would be developed north of the planned Arctic pit in the upper part of the Subarctic Valley (Figure 2.2). The waste rock placed in the northernmost portion of the WRF would be compacted to provide structural fill for the TMF dam. Three small overburden stockpiles would store the stripped topsoil and overburden from the TMF footprint (Figure 2.2).

2.1.3.1 *Waste Rock Facility*

The total volume of waste rock is expected to be approximately 212.7 million cy (162.6 Mm^3); however, there is potential for increased volume in the WRF if the placement density is less than 1.7 t/cy (2.0 tonnes/m^3). Most of the waste rock is anticipated to be PAG and there would be no separation of waste based on acid generation potential; as such, all seepage collected in the WRCP would be treated at the WTP. An underdrain at the WRF base would be built to collect and manage seeps and leakage.

The WRF would be constructed in approximately 16.4-foot (5-m) lifts with benches set back at approximately 77 ft (23.5 m) after every fourth lift to achieve an overall slope of approximately 2.5H:1V. The final design is anticipated to have variations in the slope aspect to best manage overland flow, resulting in a transitioning convex to concave WRF face shape.

The WRF would have a maximum planned stacking height (i.e., the height above existing grade) of approximately 1,115 ft (340 m) to reach an elevation of approximately 3,051 ft (990 m) asl.

A rockfill underdrain would be constructed under the WRF in the current Subarctic Creek channel bed. The underdrain would be excavated into the overburden prior to WRF construction and would be capable of handling base flow through the Subarctic Creek valley. The underdrain would drain into the WRCP, a pond at the base of the WRF, where water would be collected and held for treatment or use in the mill (Figure 2.2 and Graphic 2.2; Section 2.1.4.2.3.1, *Waste Rock Collection Pond*). The underdrain system would be used to maintain the phreatic water level as low as practicable within the WRF to maintain the stability of the facility.

2.1.3.2 *Overburden and Topsoil Stockpiles*

Three stockpiles would be developed on the northwestern side of the planned pit to store topsoil and overburden materials for use in final reclamation of the site (Figure 2.2). The topsoil stockpile would be placed between the haul roads and would store up to 425,000 cy (325,000 m^3) of material, while the overburden stockpiles would be below the lower haul road between the pit and the mill site located south of the WRF with storage capacity up to 2,900,000 cy (2,200,000 $m^{3)}$. The overburden stockpiles may be modified to act as, or integrate with, avalanche deflection berms.

2.1.4 Surface Water and Groundwater Management

The proposed mine development is in the upper reach of the Subarctic Creek valley, a tributary of the Shungnak River. The combination of climate, terrain, soils, and sparse vegetation results in high runoff potential, especially when soils are frozen.

The catchment area of Subarctic Creek is approximately 10.0 square miles (25.8 square km [km^2]). All mine infrastructure and mine-affected water would be within the Subarctic Creek valley. A surface water management system would be constructed to segregate contact and non-contact water. Non-contact water would be diverted around mine infrastructure (e.g., pit, TMF, WRF) to Subarctic Creek and contact water would be collected and re-used or treated prior to discharge to Subarctic Creek (Section 2.1.5, *Water Treatment Plant*).

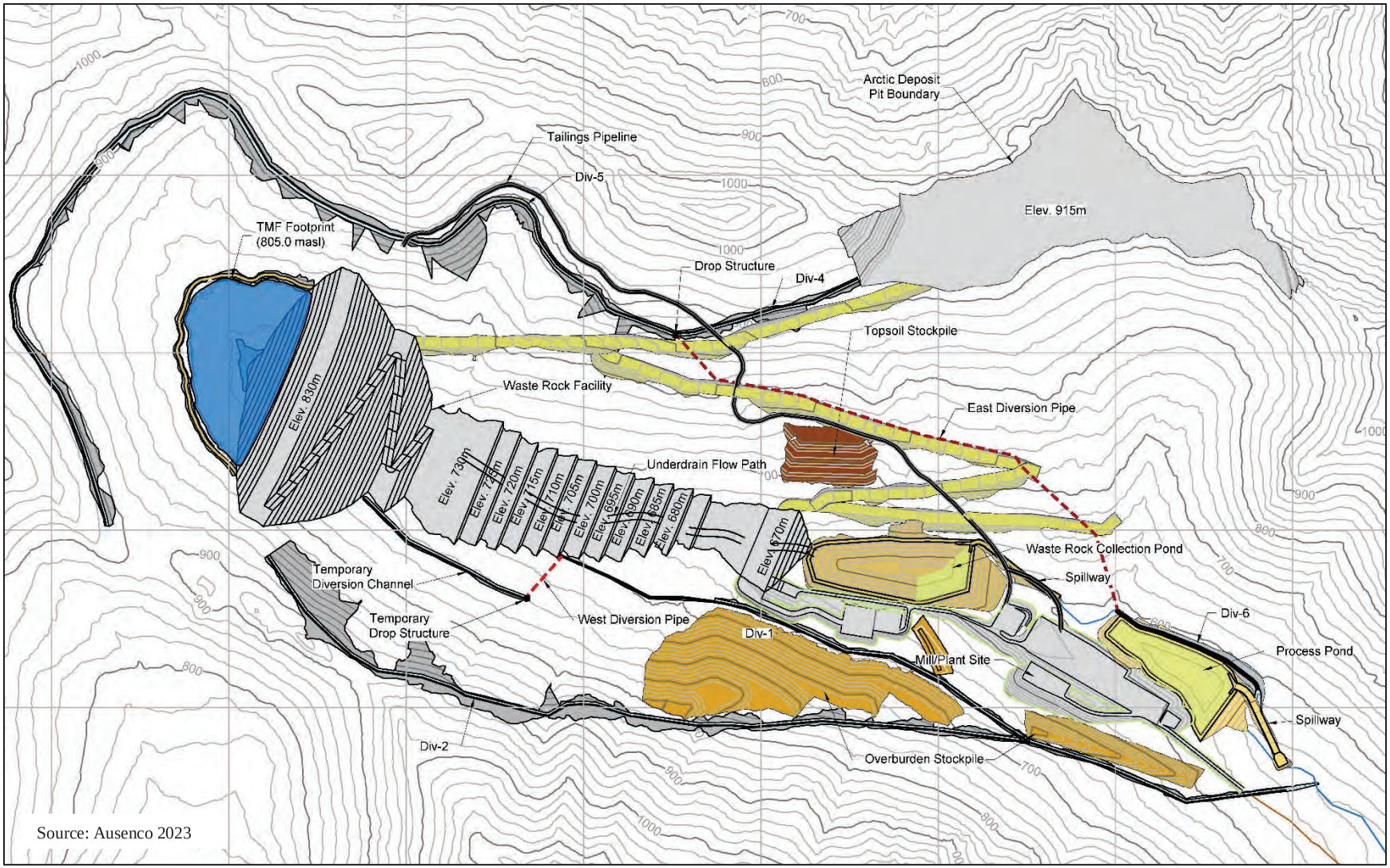
The objectives of the surface water management systems are:

- Ensure sufficient water quantity is available to support processing
- Manage contact and non-contact water separately to minimize volume of contact water collected on site
- Collect and treat contact and high-sediment water that could otherwise impair the water quality of receiving streams
- Protect mine infrastructure from damage caused by unmanaged runoff water
- Use best management practices (BMPs) to reduce suspended solid loadings in surface runoff prior to discharge
- Have sufficient storage capacity in the WRCP to collect and store water from freshet and storm events
- Store process water to provide for mill water needs

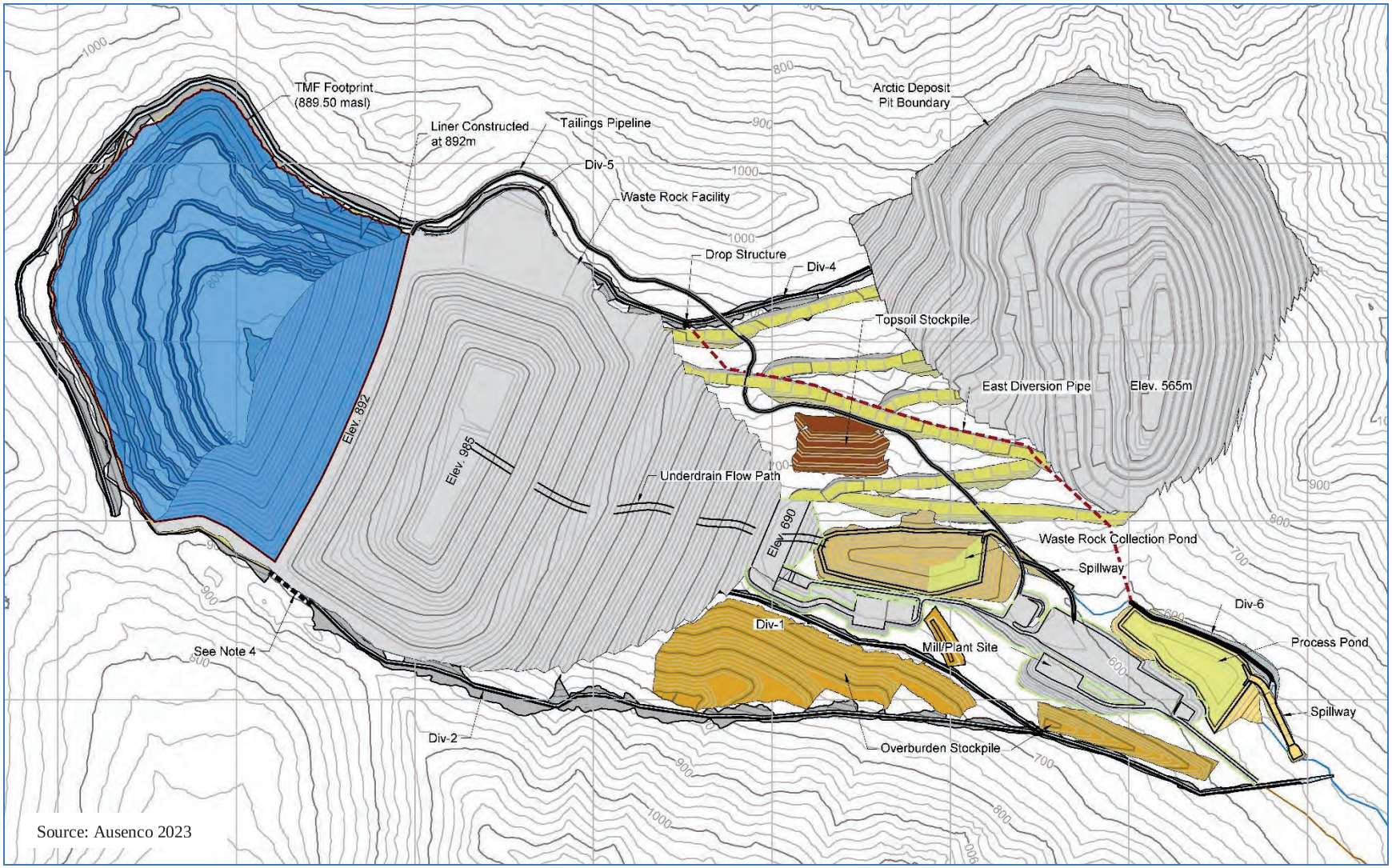
Water on site would be managed as one of the following:

- Non-contact water: non-contact water would be diverted away from mine infrastructure to the greatest extent possible to reduce infiltration into the WRF, TMF inflows, and pit inflows. Non-contact water would be discharged to Subarctic Creek during mine operations and after closure.
- Contact water: contact water would be generated when precipitation or runoff comes into contact with mine waste rock, tailings, facilities, or is collected in the pit. Contact water would be treated prior to discharge to Subarctic Creek (Section 2.1.5, *Water Treatment Plant*).
- Stormwater runoff: high-sediment water (i.e., surface flows from gravel pads and topsoil stockpiles) would be collected and conveyed to downstream sedimentation ponds to treat for total suspended solids prior to discharge in Subarctic Creek during mine operations and after closure (Section 2.1.4.2.3, *Collection Ponds*).

Graphic 2.5 and Graphic 2.6 provide an overview of the surface water management infrastructure during Project operations and for the life of the mine.



Graphic 2.5. Surface Water Management Plan Features for Operations (Year 2)



Graphic 2.6. Surface Water Management Plan Features for Operations (Life of Mine)

2.1.4.1 *Process Water Supply*

Process water, gland water, and reagent make-up water would be supplied primarily from the TMF Reclaim Pond and Process Pond. When additional water is needed, it will be taken from the WRCP. Table 2.3 summarizes the process water supply throughout the year. The TMF starter dam, WRCP, and Process Pond would be constructed prior to ore processing. Water would be allowed to initially collect in these three ponds to a volume of approximately 340 million gallons (1.3 Mm^3) to supply the mill during startup.

Table 2.3. Process Water Supply Summary

MONTHS	SUPPLY SOURCE	NOTES
October through May	Process Pond, TMF Reclaim Pond and WRCP	All water from the WRCP would be pumped to the mill from October through May. This water would accumulate from groundwater flows during the winter months.
June through September	Process Pond, TMF Reclaim Pond, WRCP (as needed)	From June through September, excess water from the WRCP would be treated and discharged to Subarctic Creek. WRCP water would be pumped to the mill as needed.

Note: WRCP (waste rock collection pond).

2.1.4.2 *Water Management Infrastructure*

Stormwater would be managed within the Project's boundaries by capturing and conveying contact and high-sediment water for treatment and diverting non-contact water away from developed areas. Water conveyance and storage facilities would include the following structure types (each detailed in subsequent sections below):

- Diversion and collection channels
- Drop structures, diversion pipes, and culverts
- Collection ponds

Soils within the Project limits consist of alluvial sands and gravels, with limited fine sediments. Runoff from the overburden stockpile and mill site areas would be mitigated by temporarily seeding or using material to create durable and less-erodible surfaces to prevent or reduce erosion prior to entering sedimentation ponds. In addition, water could be recirculated into the TMF or mill-flow stream in extreme circumstances. Sediment that accumulates in the Process Pond would be periodically removed to maintain the design capacity.

2.1.4.2.1 Diversions and Collection Channels

The steep, mountainous terrain and compact development footprint would require additional geotechnical and geochemical studies to confirm soil and bedrock depths along the proposed conveyance alignments and acid rock drainage (ARD)/metal leaching potential. Bedrock is expected to be relatively shallow, creating challenges for construction of the channels; however, shallow bedrock may increase the collection efficiency of surface and shallow subsurface water interception systems. In addition, construction of channels within bedrock would reduce or eliminate the need for riprap protection while reducing potential seepage through soils in the channel bottom.

Diversion channels would be constructed around the perimeter of the TMF and WRF, above the overburden stockpiles, and above the mill site infrastructure area. The channels would convey non-contact water runoff to Subarctic Creek. Runoff from haul roads is anticipated to be managed within the road footprint via roadside ditches, and runoff would be routed to the WRCP. The main purpose of the diversion channels would be to reduce the amount of runoff contacting mined materials to avoid potential contamination. The diversion of non-contact water would reduce water treatment costs and required storage volumes. Channel construction would be phased during the construction period and prior to the commencement of mining operations to maximize non-contact water diversion.

Non-contact and contact-water diversions are designed to convey the peak flow from a 100-year, 24-hour rain-on-snow event. All channels would be open and have a minimum depth and width of 3.3 ft (1 m) and would be lined with either bedrock or riprap to provide erosion protection. Riprap would be sized to provide a stable, non-erodible conveyance route with reasonably sized riprap sourced on-site. The riprap would be placed on geotextile fabric to limit erosion below the armor and reduce sediment loading downstream. Channel depths would be designed to have a minimum freeboard of 1 foot (0.3 m) above the design peak flow depth to accommodate potential ice or sediment accumulation, unforeseen climatic events, or other uncertainties.

Where feasible, a 13-foot-wide (4-m-wide) access road would be located adjacent to each of the channels to provide access during construction and then for maintenance and cleaning of ice and sediment accumulation during operations and closure. Accumulated sediment may be disposed of in the TMF or added to the overburden or soil stockpiles.

Localized seeps are anticipated to be encountered along the alignments during construction. A thorough survey prior to development of engineered design will be required to identify areas of potential seep locations and accommodate mitigation measures as needed. Seepage collection and management may require widening of channels in the immediate area to allow for ice buildup during the late fall, as conditions change from flowing to frozen water, or to intercept and manage subsurface flowing water within talus slopes. Maintenance of these seeps during the winter could prove challenging during freeze up and prior to breakup. Prior to breakup flows, adequate channel maintenance would ensure that adequate freeboard is available, and runoff is contained within the channels.

2.1.4.2.2 Culverts

Culverts would be required to manage contact water intercepted on the haul roads and to pass diverted non-contact water through access and haul road corridors. The haul road corridors would traverse the hillside above the WRCP, between the mine pit and the WRF (Graphic 2.2). The layout of haul roads may present a challenge to manage contact water for each of the small catchment areas, which would change throughout the life of the Project. However, the location of the WRCP immediately downslope of the haul road corridor would allow for contact water to be collected in roadside channels and discharged downslope toward the WRCP for collection. The location and sizing of the culverts along the haul road would be incorporated into the haul road design.

A large culvert (the eastern diversion culvert) would be located above the haul road corridors on the eastern Project edge. This culvert would collect and convey non-contact water collected upslope of the diversion channels and discharge into Subarctic Creek downstream of the overburden stockpile. Concrete inlet or drop structures would be constructed at the terminus of the channels connecting to the diversion culvert.

A temporary diversion channel and culvert (upper reaches of diversion channel 1) would be constructed during the pre-operations period on the western boundary of the WRF. The temporary diversion channel would terminate in an excavated sump, precast manhole, or constructed concrete manhole. A pipe would be installed in the sump or manhole to convey water immediately downslope into a receiving channel. The temporary diversion channel culvert and sump would be buried at the end of the pre-operations period.

All culverts would be designed to accommodate the 100-year, 24-hour rain-on-snow event. The culverts would be trenched in and backfilled with fine-grained engineering fill. Diversion culverts located on hillsides would be stabilized by burial or mounding of soils sourced in the immediate area, trenching and backfill, or placed on a prepared bed and secured with concrete thrust-block anchors if shallow bedrock prevents conventional trenching or burial anchors. All culverts would discharge onto a stabilized riprap apron to reduce erosion potential.

2.1.4.2.3 Collection Ponds

Contact and high-sediment water would be routed to either the WRCP or Process Pond. Water collected in the WRCP would be pumped into the process plant or WTP. Water collected in the Process Pond would be used as make-up water for the mill.

2.1.4.2.3.1 Waste Rock Collection Pond

The approximately 25.8-acre (7.7-ha) WRCP would be directly below the toe of the WRF (Graphic 2.7). The pond would collect seepage from the WRF, runoff from the WRF and haul road corridor area, and water pumped from the pit. The pond would be sized to store the volume of a three days of maximum runoff during the 1 in 25-year freshet plus the 1 in 100-year 24-hour event. The pond capacity would be approximately 185 million gallons (700,000 m^3) to the spillway with a crest height of approximately 642 m 2,106 ft (642 m) asl.

Contact water would be collected in the WRCP. Water from the WRCP would be pumped to the Process Pond for reuse as process water or to the WTP to be treated (Section 2.1.5, *Water Treatment Plant*) and discharged to Subarctic Creek. WTP is designed to operate during the open water season (May to October) but may be operated year-round if needed during extreme water years.

The dam to contain the WRCP would be constructed using the overburden and bedrock material stripped from within the WRCP excavation footprint or from a suitable material source. All overburden within the WRCP footprint would be excavated to bedrock, and excess material not used for the WRCP dam would be placed in the overburden stockpile for use as cover material during closure activities.

Overburden material below the WRCP dam footprint would be removed and backfilled with well-drained soils (as needed) to provide foundation stability. The design assumes all material upstream of the embankment centerline would be excavated to bedrock and material downstream excavated to suitable soils; the exact excavation limit would be confirmed with additional geotechnical s. The embankment would be constructed in approximately 1-foot (0.3-m) lifts, or as determined by the engineer. The downstream pond face would be constructed to 3H:1V and the upstream face would be 2.5H:1V. The upstream face of the pond would be lined with an LLDPE geomembrane liner connected to a concrete plinth (i.e., curb) and a grouted curtain wall to maximize interception of surface water and shallow subsurface groundwater (Graphic 2.8 and Graphic 2.9).

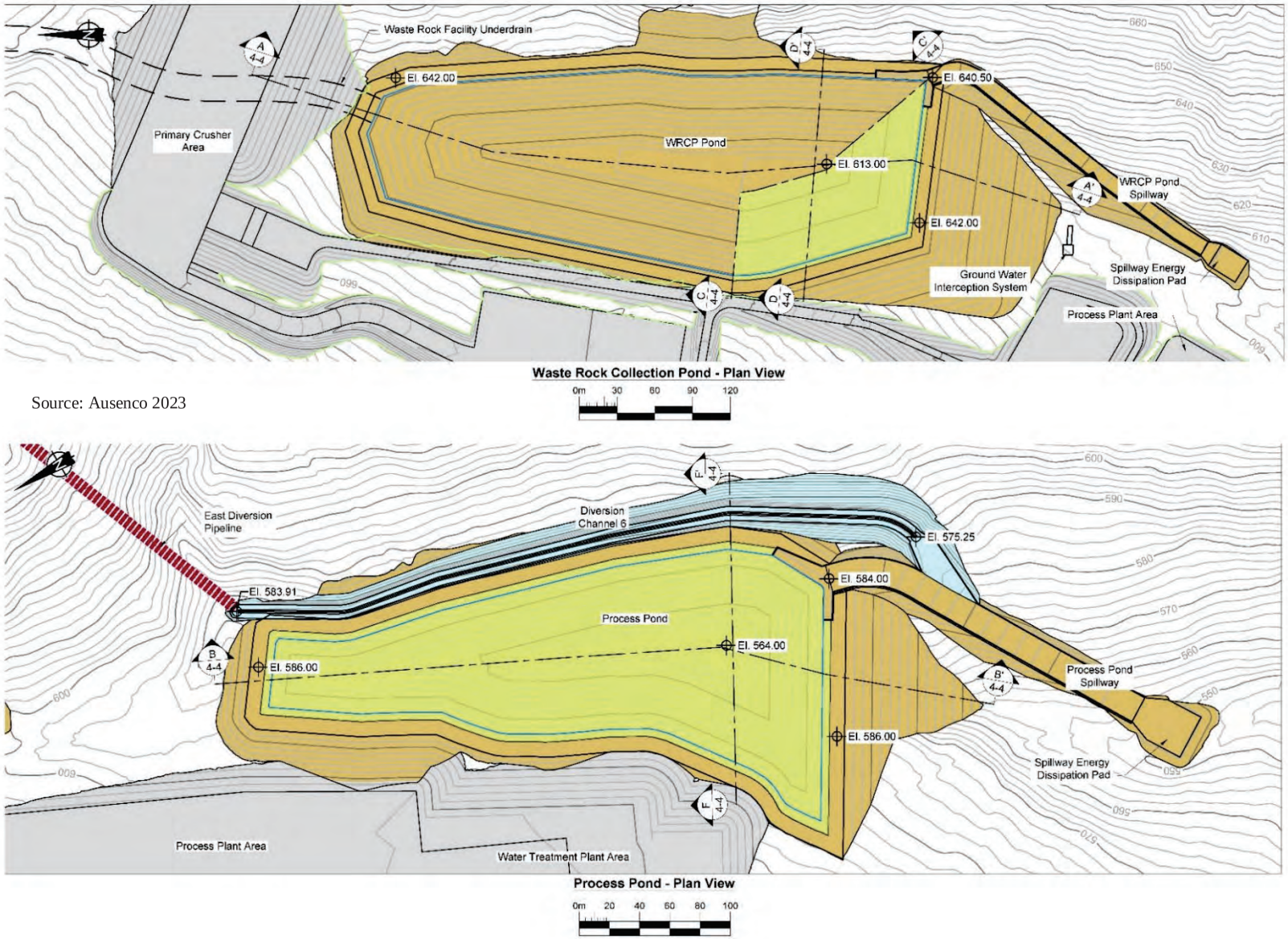
A concrete-lined spillway would be constructed to manage flows up to the potential maximum flood event (modeled using a 100-year, 24-hour rain-on-snow event). The spillway would include an intake weir and collection throat prior to discharging in the spillway. A stilling basin would be located at the spillway outfall (Graphic 2.7) to reduce flows to non-erosive velocities. The concept of a riprap-lined spillway was investigated; however, steep terrain, and the channel configuration would likely result in a large costly excavation that could encroach on the haul road located up-slope of the WRCP.

2.1.4.2.3.2 Process Pond

The Process Pond would be directly below the process plant. The pond would retain water from the mill for 30 days to allow for precipitation of reagents prior to reuse as process water. The pond capacity would be approximately 80 million gallons (300,000 m^3) to the spillway at 1,916 ft (584 m) asl with a crest height of 1,923 ft (586 m) asl.

The dam to contain the Process Pond would be constructed using the overburden and bedrock material stripped from within the Process Pond footprint or a suitable material source. Excess overburden would be stockpiled for use during closure activities.

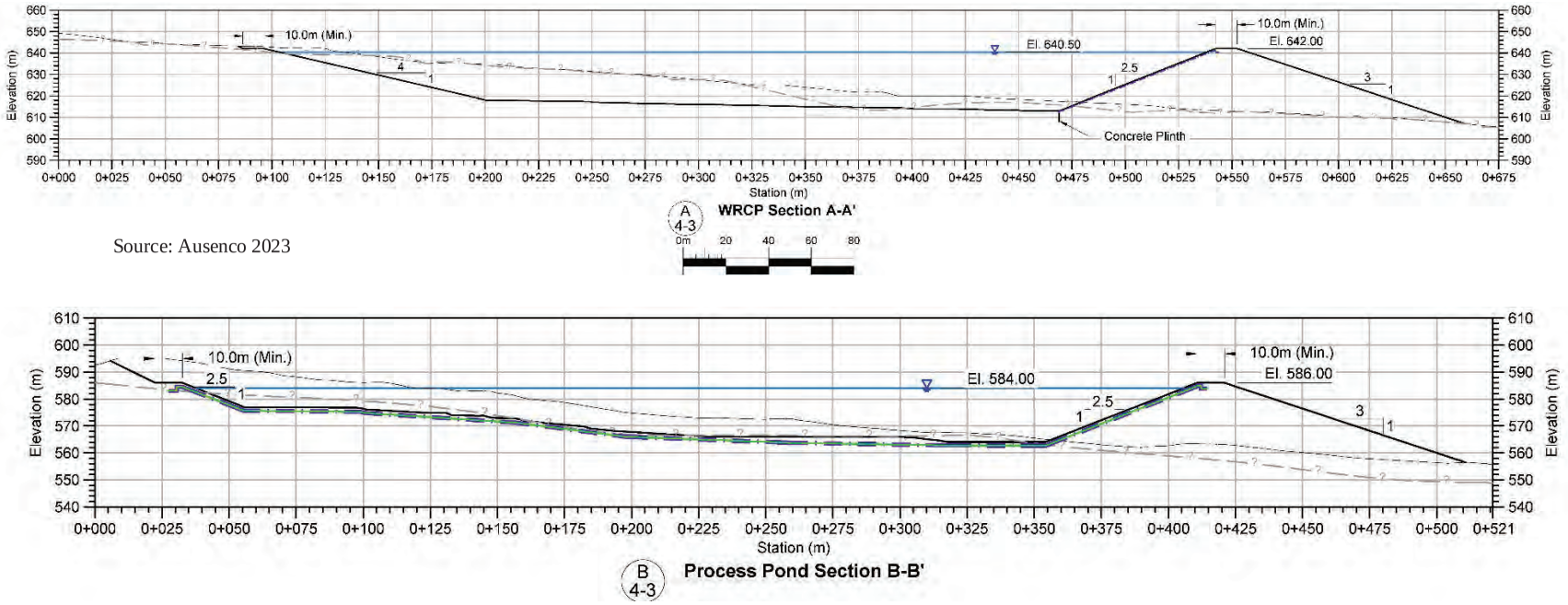
Overburden material below the footprint of the dam would be removed and backfilled with well-drained soils (as needed) to provide foundation stability. Determination of the excavation limit and dam foundation design requires additional geotechnical investigation. The design presented assumes all material upstream of the embankment centerline would be excavated to bedrock and material downstream excavated to suitable soils. The embankment will be constructed in approximately 1-foot (0.3-m) lifts, or as determined by the engineer. The downstream face of the dam would be constructed to 3H:1V while the upstream face will be 2.5H:1V. The pond would be lined to crest level with 80-mil primary and 60-mil secondary LLDPE geomembrane liners. A geonet or similar drainage layer would be installed above the secondary liner to convey any leak through the primary liner to a leak collection and recovery (LCRS) sump. An underdrain would be constructed beneath the Process Pond to convey any shallow groundwater below the pond and prevent liner uplift.



Source: Ausenco 2023

Graphic 2.7. Waste Rock Collection Pond and Process Pond

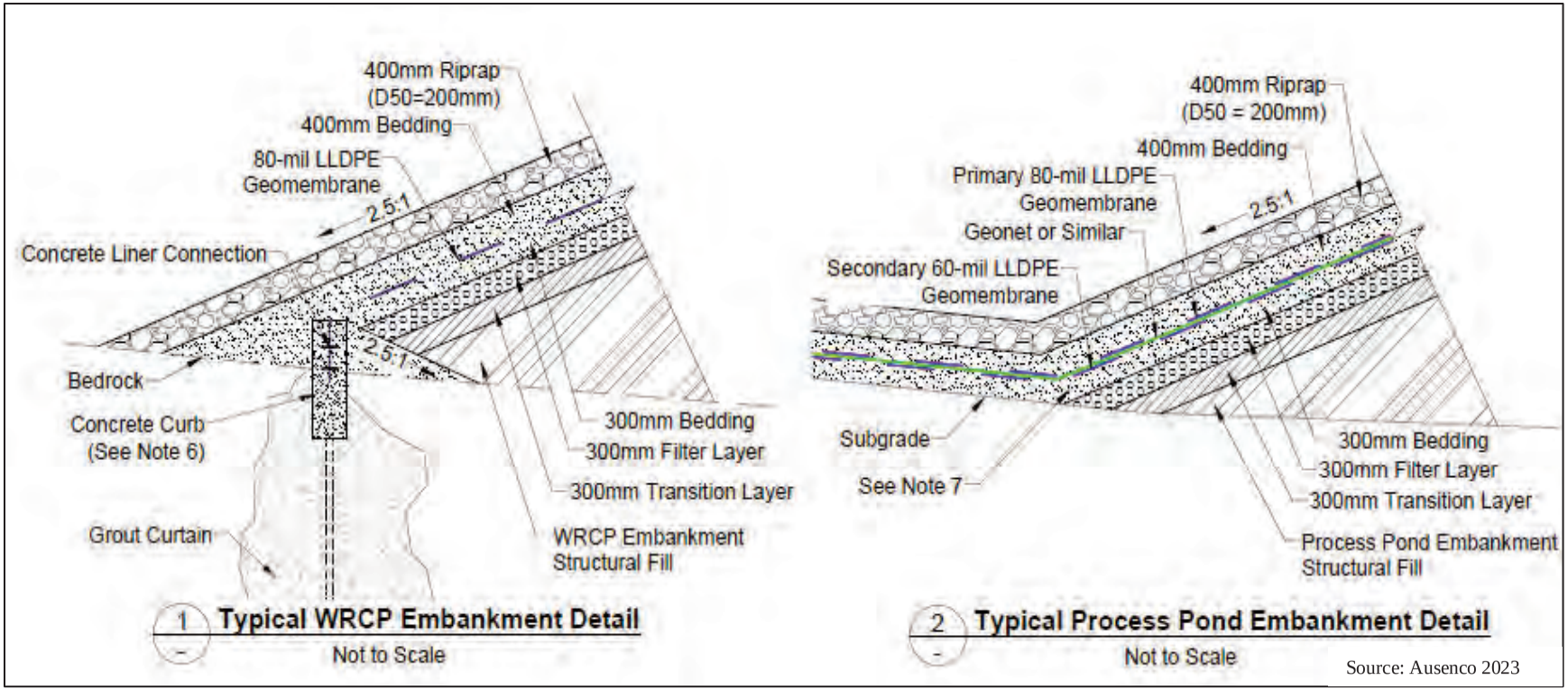
Note: The graphic shows the design as of January 2023 and the design is subject to change based on further Project engineering.



Source: Ausenco 2023

Graphic 2.8. Waste Rock Collection Pond and Process Pond Section A-A' (as noted in Graphic 2.7)

Note: The graphic shows the design as of January 2023 and the design is subject to change based on further Project engineering.



Graphic 2.9. Waste Rock Collection Pond and Process Pond Embankment Detail (as noted in Graphic 2.8)

Note: The graphic shows the design as of January 2023 and the design is subject to change based on further Project engineering.

2.1.4.3 *Groundwater Management System*

Results from the water and load balance studies suggest that small amounts of groundwater that bypass the WRCP and cut-off wall may need to be collected to prevent degradation of Subarctic Creek water quality (Ausenco Engineering Canada, Inc. 2023). A groundwater interception system downgradient of the WRCP would include the following:

- Shallow collector trench across the Subarctic Valley bottom for overburden water
- Small-diameter collector-pumping wells constructed in bedrock for deep-water bypass
- Downgradient performance monitoring wells with completions in overburden, weathered bedrock, and competent bedrock

A second system located downgradient of all site water management infrastructure would be included as a contingency for the closure period when the open pit contains water and leakage from mine components could bypass the primary system. This system would include small-diameter collector-pumping wells completed in bedrock and downgradient performance monitoring wells.

2.1.4.4 *Site Water and Load Balance*

A water and load balance model was built using annual precipitation, evaporation, and runoff to predict water use, surpluses, and deficits for the site over the mine life through mine closure and post-closure (SRK Consulting Inc [SRK] 2024). The model will be updated by the end of 2026 for preparation of the Water Management Plan. Mine facility footprints would vary according to the mine plan over the life of the Project. The model evaluated the following hydrological conditions:

- Average hydrological conditions with mean annual precipitation of 50.9 inches (1,294 mm per year) over the life of the Project
- Consecutive 1-in-25-year wet years with an annual precipitation of 69.6 inches (1,769 mm per year) in Project Years 10 and 11, at the maximum extent of site infrastructure buildout
- Consecutive 1-in-25-year dry years with an annual precipitation of 38.9 inches (988 mm per year) in Project Years 10 and 11

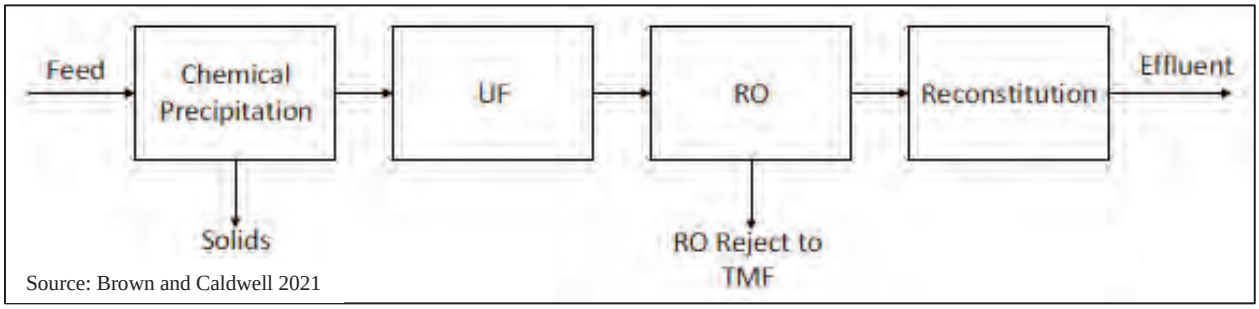
The water balance model estimates the change in water storage in water management facilities on an annual basis, based on the contributing catchments and milling rates. The output was used to inform preliminary design criteria for developing water management options to meet the water management objectives described in Section 2.1.4, *Surface Water and Ground Water Management*. The resulting water treatment strategy is described in Section 2.1.5, *Water Treatment Plant*.

2.1.5 Water Treatment Plant

The results from the water and load balance were used to develop a water treatment strategy. The treatment processes were defined based on the approximately 25 parameters predicted in the load balance to be present in WTP influent at peak concentrations above the Water Quality Standards (WQS) applicable to Subarctic Creek, including pollutants with a range of treatment mechanisms—cationic metals (such as cadmium and copper), anions (sulfate, fluoride), forms of nitrogen (ammonia, cyanide, and nitrate), selenium, other oxyanions (such as arsenic), and temperature.

Key aspects of the selected water management overall approach include:

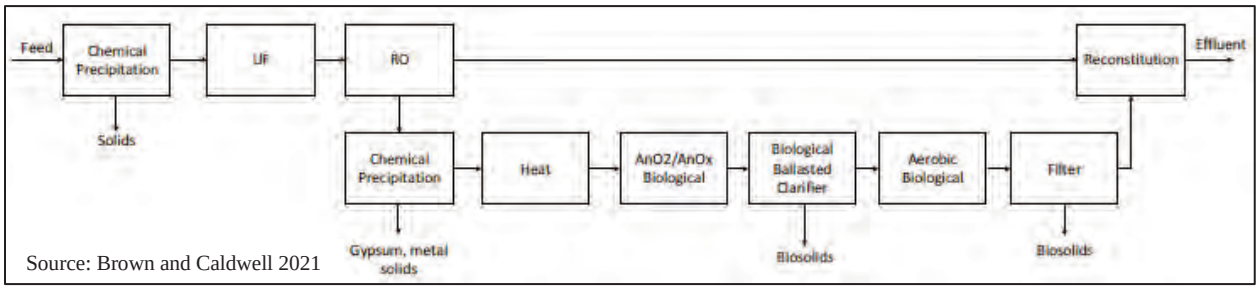
- Assume the site will be assigned water quality-based effluent limits matching the Alaska WQS for Subarctic Creek. Therefore, design the WTP to treat to all parameters to the WQS applicable to Subarctic Creek, so the Project is not reliant on receiving a permit allowing a mixing zone for compliance.
- Provide a single WTP, built in stages. The WTP will initially consist of a chemical/physical plant with reverse osmosis (RO) (Graphic 2.10). In the Operations phase, when the TMF is in use, the RO reject will be sent to the TMF, and only RO permeate will be discharged to Subarctic Creek. The plant will include:
    - Chemical treatment
    - Ultrafilter
    - RO
    - Reconstitution



Graphic 2.10. Proposed Water Treatment Plant Configuration during the Operations Phase

UF = ultrafiltration

- When mining operations have concluded, the TMF would be closed and drained. WTP would be expanded to include a biological/chemical/physical treatment system to treat the RO brine (Graphic 2.11). The RO brine would be treated by a gypsum chemical treatment and a biological treatment system to remove sulfate, selenium, nitrate, and cationic metals. During closure, the treatment solids would initially be disposed in the open pit until it reaches capacity after which they we disposed on a lined area of the closed TMF.
- This water treatment plant will operate in perpetuity.



Graphic 2.11. Proposed Water Treatment Plant Configuration during the Closure Phase

AnO2/AnOx = active anaerobic/anoxic

Each treatment step would be housed in a separate building. All equipment would be indoors to maximize reliability and operability while minimizing the need for heat tracing and outdoor operator activities

during winter months. Soda ash, lime silos, and lime slurry systems would be outdoors due to size and for dust control.

During the operations phase, mill water demands would affect site water flows such that the WTP could be shut down and discharges eliminated during approximately half the year (winter). During the closure phase, the WTP would be operated year-round.

2.1.5.1 *Water Treatment Train*

The currently proposed water treatment train would include the following unit processes:

- **Chemical treatment**: Would include the addition of lime, caustic, soda ash, ferric chloride, and polymer. Solids formed would then settle out and be removed in a ballasted clarifier. This step would remove a significant portion of cationic metals such as cadmium and zinc.
- **Ultrafiltration**: Would protect the RO system by removing suspended solids carrying over from the chemical treatment system.
- **RO**: Would concentrate contaminants into the RO brine stream. Permeate water quality would meet Alaska WQS.
- **RO Brine**: When the RO plant is operating, biologically treated RO brine will be reconstituted with the RO permeate and discharged to Subarctic Creek. When the RO plant is not operating the RO brine would be returned to the pit for further treatment prior to discharge unless it could meet Alaska WQS.
- **Amendment:** Calcite contactor would dissolve carbonate into the discharge water to maintain an alkalinity greater than 20 milligrams per liter (mg/L) as calcium carbonate. Caustic and hydrochloric acid would be provided as needed to adjust pH.
- **Gypsum clarifier**: Would reduce sulfate concentration in the brine treatment stream train down to the gypsum saturation limit (approximately 1,800 mg/L as sulfate) by adding lime so the blended discharge would be below the 250 mg/L Alaska WQS. The system would also remove cationic metals such as cadmium and zinc.
- **Anaerobic biological treatment**: Would biochemically reduce nitrate to nitrogen gas and selenate and selenite to elemental selenium (a solid). Selenium and metal solids removed in the sludge would settle out and be removed by the biological ballasted clarifier.
- **Aerobic biological treatment**: Would polish residual chemical oxygen demand by adding carbon during the anaerobic treatment. Solids would be separated via a membrane filter with iron coprecipitation for polishing selenium.

2.2 Processing Facilities (Operation Pad)

Processing facilities include all Project elements required to process and store ore. These elements would primarily be housed on the approximately 56.9-acre (23.0-ha) operations pad (Figure 2.2), which would also contain the main mill site and support facilities. Renderings of the mine site and operations pad are shown in Graphic 2.12 through Graphic 2.14.



Graphic 2.12. Rendering of the Mining and Processing Facilities in Subarctic Valley



Graphic 2.13. Rendering of the Operations Pad



Graphic 2.14. Rendering of Processing Activity on the Operations Pad

The operations pad would contain:

- Mine infrastructure area
- Truck shop and mine offices
- Laboratory
- Processing plant
- Administration building
- Mill dry facility
- Plant workshop and warehouse
- Primary crushing area
- Ore stockpiles
- Concentrate storage and loadout building
- Reagent storage and handling building
- Power plant and fuel supply storage tanks

2.2.1 Mine Infrastructure Area

The mine infrastructure area would be positioned on an upper pad adjacent to the fuel storage area. The area would house the processing plant, truck workshop, and mine offices.

2.2.1.1 *Processing Plant*

The processing plant building would house all of the milling, flotation, and concentrate thickening equipment. The building would be divided into two distinct sections: 1) the mill and 2) flotation, regrind, and thickening equipment. The building would be a pre-engineered steel-frame and metal-clad building with internal insulation. The building would be heated using an air-handler system that would use waste heat produced by the diesel generators.

2.2.1.2 *Administration Building*

The administration building would house offices for human resources, accounting, and senior mine site management. The building would be constructed as a single-story modular wood-frame building and heated using an air-handler system that would use waste heat produced by the diesel generators.

2.2.2 Laboratory

The laboratory would be sited adjacent to the processing building. The building would house all laboratory equipment needed for daily operational process control, including the metallurgical and environmental requirements. The facility would be constructed as a single-story modular wood-frame building and heated using an air-handler system that would use waste heat produced by the diesel generators.

2.2.3 Mill Dry Facility

The mill dry facility would consist of changing rooms for workers in the processing plant area. The facility would include showers, basins, toilets, and lockers. The building would be constructed as a single-story modular wood-frame building and heated using an air-handler system that would use waste heat produced by the diesel generators.

2.2.4 Plant Workshop and Warehouse

The plant workshop would be used to perform maintenance on processing equipment and store spare parts and equipment. The building would be a pre-engineered steel-frame and metal-clad building and be heated using an air-handler system that would use waste heat produced by the diesel generators.

2.2.5 Primary Crushing Area and Ore Stockpiles

Run-of-mine ore would be trucked to the crushing station and dumped into a receiving bin screened to sort out oversized material, which would be passed to the primary jaw crusher to reduce its size. The crushed material would be discharged to the conveyor and crushed ore would be sent to a single covered conical stockpile via the stockpile feed conveyor.

The crushed ore stockpile would be a covered facility to mitigate freezing of the stockpiled material and equipped with a dust-collecting system. The coarse ore stockpile building would have sufficient space to allow for operation of mobile equipment as required. Reclaimed material from the apron feeders will be discharged onto the SAG mill feed conveyor.

2.2.6 Concentrate Storage and Loadout Building

The concentrate loadout building would provide a covered area for storing and loading the concentrate into closed containers. The concentrate product would have a six percent to eight percent moisture content and would produce little to no dust. The building would be an unheated structure separate from the processing plant building (Section 2.2.1.1, *Processing Plant*) to minimize the building volume that would require processing ventilation equipment.

2.2.7 Reagent Storage and Handling

Chemical reagents used in the griding and flotation circuits include flocculants, sodium isopropyl xanthate, Aerophine®, methyl isobutyl carbinol, lime, descalant, cyanide, zinc sulfate, copper (II) sulfate, and sodium metabisulfite. These reagents will be stored in a separate, self-contained storage and handling building outside the processing plant building. The pre-engineered steel-frame and metal-clad building would be heated using an air-handler system that would use waste heat produced by the diesel generators. All reagents would be prepared via a bulk reagent handling system, with mixing and holding tanks.

2.3 Fuel Supply Storage Tanks

Diesel will be stored on site in 12 horizontal double-wall steel tanks for use in the power plant at the processing facility and for use in the mine fleet vehicles. Each tank will hold approximately 30,000. gallons (113,500 liters) and each tank adjacent to the power plant will hold approximately 27,000 gallons (103,000 liters). The volume stored at the mine infrastructure area will represent nine days of storage and the volume stored at the power plant will represent seven days of storage.

2.4 Gravel Pads

In addition to the operations pad, the Project would require several other gravel pads to support Project facilities and activities including camps, other laydown/storage and logistics yards, and a gatehouse pad.

2.4.1 Camps

Three camps are proposed for use during construction and operations of the Project: the existing Bornite Camp for initial short-term intermittent use, a Temporary Construction Camp (TCC) to house up to 100 persons and a Construction Camp and Permanent Accommodation Camp (CC/PAC). Each camp would generally be self-contained and have its own power generation, heating capability, potable water treatment plant, garbage incineration, and domestic wastewater treatment plant. Potable water would be sourced from groundwater.

2.4.1.1 *Bornite Camp*

The existing Bornite Camp (Figure 2.3) is on patented land owned by NANA and would accommodate approximately 80 people with minor upgrades. Upgrades would include increased insulation and heating capacity within tent structures and upgrades to the camp electrical system. Bornite Camp would provide early short-term support during construction of roads to the mine site and early construction activities. After the preliminary camp upgrades are completed, the camp will be used to support summer regional exploration activities.

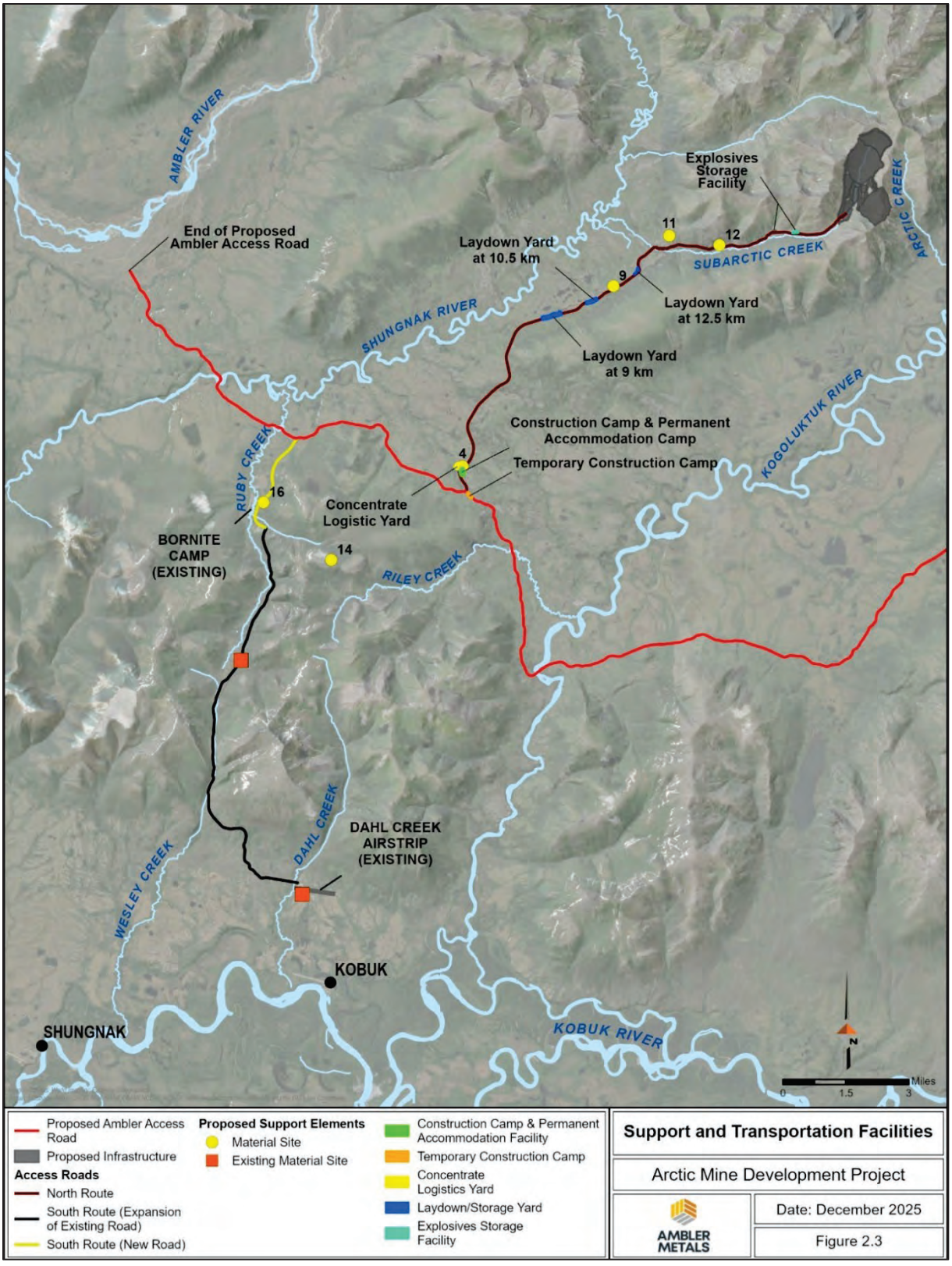


Figure 2.3. Support and Transportation Facilities

2.4.1.2 *Temporary Construction Camp*

An approximately four-acre TCC would be built along the Arctic Mine Junction (AMJ), the junction of the AAP and the North Route (*see Section 2.5.1.1 Access Roads*), to provide room and board for approximately 75 persons during initial mine construction. The TCC would be designed to operate year-round and be of a modular type that can be transported to the site via the Dalton Highway on a semi-prepared AAP road route prior to full truck access being available to the site. It is anticipated that the TCC would be relocated to the initial CC/PAC and demobilized once the CC/PAC is completed.

2.4.1.3 *Construction Camp and Permanent Accommodation Camp*

The approximately 12.3 (3.8-ha) CC/PAC would be constructed approximately 0.8 mile (1.3 km) north of AMJ, and TCC along the eastern side of the North Route. The CC would house approximately 250 persons and would operate during construction and commissioning to full production, when the AAP road is available for the transport of the modules, and the pad is upgraded. The PAC would be constructed to provide room and board for approximately 450 people for the duration of the Project. The PAC would include construction of a sewage treatment plant and other infrastructure to support a combined total occupancy of approximately 650 persons. Table 2.4 lists personnel expected to be on site during Project operations.

Table 2.4. On-Site Personnel during Project Operations

PERSONNEL DESCRIPTION	NUMBER
Owner's Staff	
General and administration	61
Mill operations	69
Mill maintenance	74
Mine operations and maintenance	135
Contractor Staff	
Concentrate trucking contractor	56
Camp contractor	24
Other contractors	8
Other guests and non-employees	7
Total personnel	**434**

2.4.2 Other Laydown/Storage and Logistics Yards

Various laydown and storage areas would be needed for Project construction and operations as described below.

2.4.2.1 *Laydown/Storage Yards*

Three additional laydown yards would be along the North Route access road to stage construction materials and equipment during construction and operations. Two storage yards would also be along the North Route to specifically store explosives (described in Section 2.4.2.3 *Explosives Storage Facility*). The sites were selected for their proximity to the road, flat terrain, and limited wetland presence. The pads would be near North Route MPs 0, 9.0, 10.5, and 12.0.

2.4.2.2 *Concentrate Logistics Yard*

The base for the trucking operations would be at the Logistics Yard at the intersection of the North Route and the AAP. The approximately 11.5-acre (4.6-ha) pad would be a construction staging area for trucking operations and the primary laydown yard for concentrate transport (Section 2.5.3, *Concentrate Transportation*).

2.4.2.3 *Explosives Storage Facility*

The explosives provider would transport explosive material from Fairbanks to the Explosives Storage Facility locations near the mine facilities. The explosives would be stored in four silos with approximately 80-ton capacity each: two silos for storing ammonium nitrate and the two for storing emulsion. Detonators and high explosives (e.g., boosters, surface delays) would be stored in separate magazines. The silos storing explosives would be on two separate pads (3.1 acres and 2.8 acres [1.25-ha and 1.13-ha]). The silos storing explosives will meet minimum spacing requirements as per 27 CFR Part 555 subchapter C, Chapter II subpart K.

2.5 Access and Transportation

Transportation infrastructure includes all Project elements required to transport personnel and materials and export product using all-season gravel roads and an existing airstrip (Figure 2.3).

2.5.1 Gravel Roads

Gravel roads would be needed at various locations around the Project area to facilitate access for development, monitoring, and closure.

2.5.1.1 *Access Roads*

The Project would have two main gravel access roads: The South Route would connect the existing Dahl Creek Airstrip to the AAP, and the North Route would connect the AAP to the Arctic Mine (Figure 2.3). Road development would include upgrade of existing roads and trails and construction of new road segments where no roads currently exist. Both roads would be designed to accommodate the types of vehicles expected to be used on the Project.

- South Route: The South Route would be approximately 13.3 miles (21.4 km) long and would transport employees and air freight from the Dahl Creek Airstrip to the Project site. Approximately 10.6 miles (17.1 km) would follow an existing road alignment between the airstrip and the existing Bornite Camp. The remaining approximately 2.8 miles (4.5 km) would require a new road to the junction with the AAP.
- North Route: The North Route would be approximately 13.6 miles (22 km) long and would support operations at the Arctic Mine for transporting employees, mining equipment, supplies, and ore concentrate to and from the mine site. The North Route would be the sole method for transporting ore concentrate from the mine to the junction at the AAP at approximately MP 13.6. Approximately 8.1 miles of this route would follow a previously disturbed summer/winter trail that has previously been used to haul equipment. Table 2.5 lists MP start and end labels for each segment.

Table 2.5. Milepost References for the South and North Routes

ACCESS ROAD SEGMENT	MP START	MP END	NOTES
South Route (one-lane)			
Existing road	0.0	10.6	Dahl Creek Airstrip to the existing Bornite Camp
New road construction	10.6	13.3	Existing Bornite Camp to the AAP
North Route (two-lane)			
New road construction	0.0	5.5	AAP to the existing summer/winter trail
	5.5	8.8	Existing summer/winter trail to the Subarctic Creek crossing
	8.8	13.6	Subarctic Creek crossing to the Arctic Mine

Both the South Route and North Route access roads would be gravel and have a design life of approximately 15 years, matching the expected life of the Arctic Mine. Both access roads are designed to accommodate the anticipated size and class of vehicles. Design criteria for Project access roads are provided in Table 2.6.

Table 2.6. Design Criteria Details for Project Access Roads

DESIGN ELEMENT	SOUTH ROUTE	NORTH ROUTE MP 0.0 TO MP 8.8	NORTH ROUTE MP 8.8 TO MP 13.6
Design vehicle	Passenger bus	Semi-truck	Semi-truck
Lanes	1 lane	2 lanes	2 lanes
Design life	15 years	15 years	15 years
Design speed	35 mph (56 kph)	45 mph (72 kph)	35 mph (56 kph)
Design vehicle – width × length	8.5 ft × 40.5 ft (2.6 m × 12.3 m)	8.5 ft × 69 ft (2.6 m × 21 m)	8.5 ft × 69 ft (2.6 m × 21 m)
Minimum road surface width	20 ft (6.1 m)	28 ft (8.5 m)	28 ft (8.5 m)
Maximum grade in rolling terrain	10%	9%	10%
Minimum turn radius	275 ft (84 m)	510 ft (155 m)	275 ft (84 m)

kph = kilometers per hour
mph = miles per hour

Site-specific soil information along the road corridors will determine embankment depths. In general, well-drained and non–frost susceptible soils can accommodate shallower embankment depths, typically to approximately 3 ft (0.9 m) deep. Road segments over moderate and poor soils will generally require thicker fill depths to minimize settling, heaving, cracking, and other failures, protect permafrost, and provide a stable foundation for vehicle traffic. All typical sections would include approximately 6 inches of crushed aggregate surface course for the driving surface. The South Route would have three turnouts to allow for vehicles to pass – near the Dahl Creek Airstrip, Bornite Camp, and the intersection at AAP.

Stream crossing dimensions, flood occurrences, and potential for anadromous fish presence were considered at stream crossings to identify recommended crossing structures. Both access roads would use the following culvert types:

- **Cross-drainage culverts**: Gravel roads require cross-drainage culverts to maintain natural drainage patterns throughout the Project area. Culvert spacing would be determined by desktop analysis and confirmed by an on-site engineer who would walk and stake the alignment prior to construction. In spring, following initial gravel placement, the hydrology at previously placed culverts would be observed, and culvert adjustments (including the placement of new culverts) would be completed, as necessary.
- **Stream-crossing culverts**: Stream crossing culverts would maintain natural drainage patterns under roads and would be circular corrugated steel pipes or structural plate culverts. The culverts would convey flows from diversion channels and collection channels and would be sized for the 50-year, 24-hour rain-on-snow event. The culverts would be placed in compacted engineered fill according to the manufacturers' specifications and project design.
- **Fish-passage culverts**: Stream crossings of waterways with resident fish would require fish-passage culverts that meet Alaska Department of Fish and Game (ADF&G) Title 16 Fish Passage permit requirements.

2.5.1.1.1 South Route

The South Route would be designed as a one-lane roadway to accommodate the expected largest vehicle, an approximately 40.5-ft (12.3-m)-long passenger bus. Cross-drainage culverts would be installed as needed to maintain natural drainage patterns. Fish passage culverts would be installed to maintain naturally occurring fish passage along the alignment. The South Route design life would be 15 years.

The existing road segment of the South Route has 26 minor crossing culverts and two existing bridges at Dahl Creek and Wesley Creek that would be upgraded or replaced. Because no significant drainage concerns have been observed, culverts would be replaced in the same general locations. All existing culverts smaller than 24 inches (0.6 m) diameter would be replaced with culverts 24 inches (0.6 m) diameter or greater. Four stream crossings were identified along the existing road segment, including Dahl Creek, Wesley Creek, and two unnamed streams. Existing culverts at the unnamed streams would be replaced with larger culverts to provide hydraulic capacity for the 50-year peak flood.

Dahl Creek and Wesley Creek would be crossed using a 20-ft (6.1-m)-span buried bridge (i.e., structural plate culvert, typically bottomless on footers or foundation) with a length of 60 ft (18.3 m). The structures would meet fish passage criteria and provide sufficient hydraulic capacity to convey the 50-year peak flood.

The section of road from the existing Bornite Camp to the AAP would require two new stream crossings and approximately 17 cross-drainage culverts. Stream crossing structures would be a 72-inch (1.8-m)-diameter culvert where the road crosses Cabin Creek near the confluence with Ruby Creek and a 48-inch (1.2-m) diameter culvert where Cabin Creek crosses an unnamed stream.

2.5.1.1.2 North Route

The North Route would be designed as a two-lane road to accommodate large trucks hauling ore concentrates between Arctic Mine and the AAP, as well as buses and light-duty vehicles.

The first approximately 5.5 miles (8.9 km) would be new construction across the Ambler Lowlands that would extend north from the AAP and cross the edge of the Ambler Lowlands adjacent to the Shungnak River. The alignment was optimized to avoid wetlands by staying near the upland areas that divide the Shungnak and Kogoluktuk river watersheds. This causes the road alignment to meander as it follows the contours of hillsides and fluctuates vertically as it crosses short distances of lowlands between upland areas. This road section would require approximately four stream crossings and approximately 33 cross-drainage culverts.

The remaining approximately 8.1 miles (13.0 km) of the North Route would generally follow an existing summer/winter trail previously established by Kennecott to the Arctic Mine.

The North Route, between MP 5.5 and MP 8.8, would improve an existing summer/winter trail. The first approximately 3.3 miles (5.3 km) of the existing trail follow the ridgeline of a glacial moraine to Subarctic Creek. In this route segment, gravelly moraine soils and slightly higher elevation above the surrounding wetlands provide conditions suitable for construction of the Permanent Accommodations Facility at approximately MP 7.4. This road segment would not cross any streams but would likely require cross-drainage culverts to maintain hydraulic connectivity.

Subarctic Creek is the largest water crossing on the North Route. The existing trail crosses Subarctic Creek immediately downstream of an island where the creek is wider (approximately 58 ft (18 m) and shallower than adjacent portions of the creek. Therefore, the location of the proposed road crossing was moved approximately 170 ft (52 m) downstream from the current crossing to a narrower section of Subarctic Creek. The stream width at the revised crossing location would be reduced to approximately 30 ft (9 m). A span buried bridge would be installed at the crossing. The crossing structure would be sufficient to span the approximate channel width, would meet fish passage criteria, and would provide sufficient hydrologic capacity to convey the 50-year peak flood (DOWL 2019).

Beyond Subarctic Creek, the North Route would ascend Subarctic Creek Valley from MP 8.8 to MP 13.6, from the Subarctic Creek crossing to the Arctic Mine at the head of the Subarctic Valley. The North Route would match the same two-lane road typical section as the other two segments of the North Route. This segment would generally follow the existing trail that is cut into the south-facing slope of the valley but would be shifted upslope in some locations to reduce steep grades and prevent the widened footprint from impacting Subarctic Creek. To strike a balance between reducing environmental impacts and meeting design criteria, the speed limit along this segment would be reduced so it could be designed with slightly steeper grades and tighter curves. Cut-and-fill volumes would be balanced during detailed design to the greatest extent feasible. The only permanent drainage structure along this segment would be a single culvert approximately 30 inches (0.8 m) in diameter located approximately halfway up the Subarctic Creek Valley. This culvert is likely past its serviceable design life and would be replaced. No permanent bridge or culvert crossing has been established at Subarctic Creek. This section would require four stream crossings and approximately 29 cross-drainage culverts.

2.5.1.1.3 Access Roads Summary

Table 2.7 lists length, area, culverts, and bridges proposed new and upgraded roads for the Project.

Table 2.7. Project Roads – Length, Area, Culverts, and Bridges

ROAD	SOUTH ROUTE	NORTH ROUTE	HAUL ROADS	TOTAL
New gravel road length	2.8 miles (4.5 km)	13.6 miles (21.9 km)	2.4 miles (3.9 km)	**18.8 miles (30.3 km)**
Upgraded gravel road length	10.6 miles (17.1 km)	0.0 mile (0.0 km)	0.0 mile (0.0 km)	**10.6 miles (17.1 km)**
Gravel road total length	13.3 miles (21.4 km)	13.6 miles (21.9 km)	2.4 miles (3.9 km)	**29.4 miles (47.3 km)**
New gravel roads area	23.9 acres (9.7 ha)	109.8 acres (44.5 ha)	46.5 acres (18.8 ha)	**180.2 acres (73.0 ha)**
Upgrade gravel roads area	63.7 acres (25.8 ha)	0.0 acre (0.0 ha)	0.0 acre (0.0 ha)	**63.7 acres (25.8 ha)**
Gravel roads total area	87.6 acres (35.5 ha)	109.8 acres (44.5 ha)	46.5 acres (18.8 ha)	**244.0 acres (98.7 ha)**
Minor culverts (number	43	82	Unknown	**125**
Major culverts (number)	4	6	Unknown	**10**
Bridges (number)	2	2	0	**4**

2.5.1.2 *Haul Roads*

The Project would use different configurations of haul roads depending on mine stage to efficiently move waste rock to the WRF and ore to the stockpiles and crusher (Figure 2.2).

The all-season gravel roads would connect the open pit to the WRF and the operations pad and accommodate heavy-haul mine trucks (i.e., rock trucks). Haul roads would be wide enough to allow two rock trucks to pass safely, in addition to accommodating light-duty trucks and other service vehicles as needed. Haul roads would be constructed to minimize disturbance impacts and would not include turnouts.

2.5.2 Air Service and Transport

The State of Alaska-owned Dahl Creek Airstrip would be upgraded to support chartered air traffic between the Project and Fairbanks. The Dahl Creek Airstrip is a 4,780-ft (1,460-m)-long runway with limited infrastructure, situated approximately 20 miles (32 km) south of the Arctic Deposit (DOWL, 2017). The airstrip is capable of handling landings and takeoffs during summer months of aircraft up to and including McDonnel Douglas DC-6s and Lockheed C-130 Hercules. The expected passenger aircraft that would be used for the Project are anticipated to be the de Havilland DHC-8-100 (i.e., Dash 8) and the Beechcraft 1900C, as these are used by companies currently operating charter services out of Fairbanks International Airport. Air freight aircraft used during construction and ongoing mine operations would be a mix of cargo aircraft such as the DC-6, Embraer Brasilia EMB 120, or Cessna Caravan 208. Each of these passenger and cargo aircraft can operate from a 4,500-ft (1,370-m)-long runway.

Although the Dahl Creek Airstrip runway is operational during the summer, it is not currently maintained, and snow removal or grading is not regularly conducted. Recent observations have noted that erosion channels are starting to develop from the runway center to the southern edge of the runway, and some obstruction from tall shrubs along the runway edges are present. In order to make the airstrip operational to support the Project, the Dahl Creek Airstrip would be upgraded, including the following:

- Minor grading of the airstrip surface
- Installation of a new lighting system
- Installation of an automated weather observation system to support the use of Dash 8 aircraft
- Installation of a prefabricated 970-square-foot (ft^2) (90-square-meters [m^2]) passenger building to accommodate waiting personnel
- Installation of an approximately 1,880-ft^2 (175-m^2) fabric structure to accommodate snow-removal and aircraft servicing equipment
- Installation of precision approach pathway indicators on each end of the runway to aid pilots in acquiring and maintaining the correct approach
- Upgrade local utilities (e.g., power generators, water service)
- Regular grubbing of vegetation to meet Federal Aviation Administration standards for proposed aircraft

It is assumed the proposed upgrades would be accepted by the airstrip owner (State of Alaska) if funded by the Project.

The use of fixed-wing aircraft is needed to transport personnel between the Dahl Creek Airstrip and Fairbanks International Airport. During construction, approximately three flights per week are anticipated to support a total Project crew of approximately 975 using aircraft such as a Dash 8 or Beechcraft 1900C. During operations, three flights per week are anticipated to support a total operations crew of approximately 430.

Freight, such as fuel, construction materials, construction equipment, groceries, and other consumables, would be flown between the Dahl Creek Airstrip and Fairbanks or Anchorage during construction until the AAP is operational. These materials would generally be delivered using DC-6 or C-130 Hercules aircraft.

The use of aircraft to transport freight once the AAP is operational would be on an emergency basis only.

2.5.3 Concentrate Transportation

Concentrate would be shipped from the concentrate loadout building to the Port of Alaska in Anchorage in specialized 20-foot (6-m)-long intermodal bulk shipping containers with locking lids for direct loading into bulk carrier vessels for ocean transport to the smelter or refinery. Containers would be trucked from the mine to Fairbanks via the AAP and the Dalton Highway and then transferred to rail for delivery to the Port of Alaska terminal.

Containers would be loaded in the concentrate loadout building using a wheeled loader. Each container would carry approximately 28.1 wet metric tonnes (wmt) of concentrate, resulting in approximately 34.4 short tons (31.2 tonnes) gross weight per container. Based on the projected daily production of approximately 1,289 wmt of concentrates per day (approximately 470,586 wmt per year), approximately 46 containers would be loaded and shipped from the Project site per day. Each container would be completely enclosed to minimize potential dispersal of airborne dust or contaminants.

Trucking containers to Fairbanks would be in three stages:

1. Load containers at the Arctic Mine concentrate loadout building and transport them to Concentrate Logistics Yard at the AMJ.
2. Truck the containers from the AMJ to the Dalton Transfer Yard (DTY) via the AAP. The DTY would be located near the intersection of the AAP and the Dalton Highway. Each truck would haul two containers. At the DTY, each truck would offload the two containers and return to the mine with two empty containers. This would require approximately 23 roundtrips per day. Drivers would be based at the Arctic Mine site and would complete one roundtrip per day from the AMJ to the DTY.
3. Move the containers from the DTY to an existing depot in Fairbanks using a Fairbanks-based fleet with a single-trailer configuration. Upon return from Fairbanks to the DTY, each truck would transport one empty concentrate container.

In Fairbanks, the containers would be loaded on railcars for transport to the Port of Alaska. At the port, the containers would be staged for direct loading into marine vessels, where port cranes would lift and lower the containers into the ship's hold, remove the container lid, and empty the concentrate. Concentrate is expected to be shipped from Alaska in approximate parcels of 10,000 dry metric tonne (dmt) for copper and zinc and approximately 5,000 dmt parcels for lead. Table 2.8 lists the planned concentrate transport.

Table 2.8. Mode of Transport and Distances for Concentrate Shipping

SEGMENT	MODE	DISTANCE	ROUNDTRIPS PER DAY	ROUNDTRIPS PER WEEK	ROUNDTRIPS PER YEAR [a]
Arctic Mine site to the Concentrate Logistics Yard	Truck – single trailer and container	13.3 miles (21.4 km)	46	322	**16,744**
Concentrate Logistics Yard to DTY	Truck – double trailer and 2 containers	201 miles (324 km)	23	161	**8,372**
DTY to Fairbanks	Truck – single trailer and container	243 miles (391 km)	46	322	**16,744**
Fairbanks to Port of Alaska	Rail	356 miles (573 km)	NA	3	**156**
Port of Alaska to North American and Asian ports	Marine bulk carrier	5,600 miles (9,000 km)	Unknown	Unknown	**Unknown**

NA = not applicable.
[a] Based on a 13-year life-of-mine.

2.6 Material Sites

Potential material sites along the proposed access roads from the existing Bornite Camp to the proposed mine site were evaluated for their potential to provide gravel and riprap for construction. Sites were evaluated using published data, data obtained during development of the AAP EIS, and aerial imagery interpretation.

Naturally occurring asbestos (NOA) is known to occur in the region. All material sites would be sampled during future site investigations using the California Air Resources Board Test Method 435, *Determination of Asbestos Content of Serpentine Aggregate*. Material sites would only be developed if the NOA content is below State of Alaska established threshold levels (0.25 percent NOA). AMC may elect to submit site specific plans to the Alaska Department of Transportation and Public Facilities (DOT&PF). AMC would adopt DOT&PF published best practices for working with NOA (DOT&PF 2013) where NOA material may occur on the Project.

Sixteen undeveloped and two existing material sites were assessed in the field in September 2018 for the quality and quantity of available resources (Figure 2.4). Six of the undeveloped material sites and the two existing sites were recommended for further evaluation and use based on the anticipated quantity and quality of material required by the Project. The recommended material sites are:

- Material Site 4
- Material Site 9
- Material Site 11
- Material Site 12
- Material Site 14
- Material Site 16
- Dahl Creek Airstrip Pit (existing)
- NANA Pit #5 (existing)

Additional work will be done on the viability and requirements for the potential material sites in 2026. Not all material sites identified would likely be used, and the footprint of the currently defined material sites is subject to change.

A complete analysis and selection of material sites, including wetland impacts, would be conducted to support permitting prior to Project development. Additional information about recommended material sites is included in Appendix A, *Alternatives Development*.

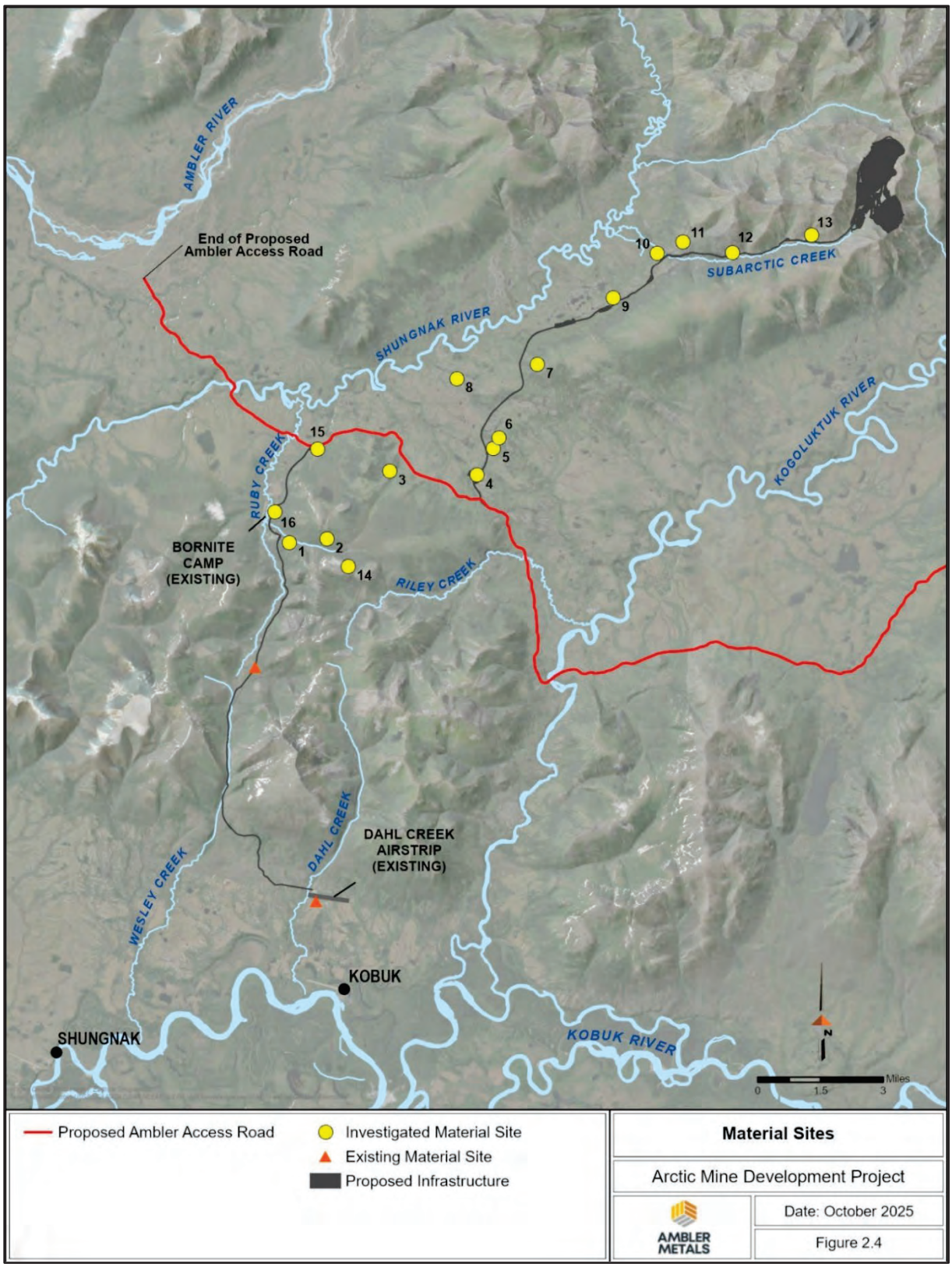


Figure 2.4. Material Sites

2.7 Other Infrastructure and Utilities

Support facilities include all Project elements required to maintain equipment used in ore mining and processing, house staff, maintain communications, and obtain material (Figure 2.3).

2.7.1 Potable Water Sources and Use

Groundwater wells would be the primary source of potable water for domestic use. Water infrastructure would include cased wells, pumps, and WTPs. Modularized, potable WTPs would be installed at the temporary CC/PAC. The potable WTPs would treat groundwater from water wells. All potable water would meet Alaska Department of Environmental Conservation (ADEC) drinking water standards. Potable water requirements are based on an estimated demand of 75 gallons per day per person but would vary over the life of the mine. Water would be required for domestic use at camps (for both construction and operations). To reduce water demands, the Project would reuse water from the TMF, Process Pond, and WRCP to support processing activity (Section 2.1.2.4, Tailings Management Facility Reclaim Pond and Water Return) and water from local creeks or rivers to support dust suppression (Section 2.9, Erosion and Dust Control).

2.7.2 Fuel Supply, Storage, and Distribution

Diesel fuel would be stored on site in double-wall steel tanks for use in the power plant at the processing facility and for use in the Project's fleet vehicles. Approximately 12 horizontal tanks would be used: four tanks on the operations pad to supply the Project's fleet fuel requirements and eight tanks adjacent to the power plant that would be used for generator fuel.

Capacity of each of the four tanks in the mine infrastructure is 30,000 gallons (113,500 liters), and capacity of each tank adjacent to the power plant is 27,000 gallons (103,000 liters); approximately 338,000 gallons (1,280,000 liters) of fuel capacity could be available at the Project site. The volume stored at the mine infrastructure area would provide for approximately nine days of operations and the volume stored at the power plant would provide for approximately seven days of power generation.

Fuel would be transported to the site by tanker truck. Approximately 1,450 trips would be needed annually for a total of approximately 17,300 trips over the life of the Project.

2.7.3 Power Generation and Distribution

2.7.3.1 *Mine and Processing Plant Power Generation*

The Project's power would be generated on site without the use of an interconnected utility (i.e., grid power). A series of diesel generator sets would be installed to operate in parallel with a total output capacity of approximately 27 megawatts (MW) of power at 13.8 kilovolts. All generators would be housed within a shared power plant building on the operations pad. The mine and processing plant would also have backup generators and emergency engines along with miscellaneous heaters and boilers.

Power would be distributed on aboveground cables to area electrical substations. There would be a total of four major electrical substations, including one in the power plant building. The remaining three would be in the grinding, processing, and crushing areas. The smaller electrical substation for the reclaim water barge would be supplied with and integrated into the barge.

2.7.3.2 *Ancillary Power Generation*

Diesel generators with a total output capacity of about 4.6 MW would be at the CC/PAC. Diesel generators would also power Bornite Camp with output capacity estimated at 1.4 MW. Both camps would have backup and emergency generators along with miscellaneous heaters and boilers. The CC/PAC may also have a camp waste incinerator depending on the final waste management plan adopted.
There are no existing power facilities at the Dahl Creek Airstrip. Power would be required to operate the proposed lighting and navigational aid systems and would likely be provided by two generators (one unit operating and one serving as a backup/standby unit). Generators have not been sized at this time. Alternatively, power could potentially be supplied from Kobuk using the existing Alaska Village Electric Cooperative power generation, if an agreement could be reached to extend power transmission to the Dahl Creek Airstrip.

Portable light plants and welders would require temporary power throughout the Project area on an as-needed basis.

2.7.4 Lighting

Area lighting would be installed at major infrastructure and high-traffic areas throughout the Project area. Lighting fixtures would generally be downcast light emitting diode–style fixtures with hoods and diffusers to reduce light pollution. Roads would not be illuminated.

Diesel-powered, mobile light plants would be used throughout the site during construction and operations to provide temporary work lighting. The Dahl Creek Airstrip would have lighting for precision approach pathway indicators, runway lighting, taxiway edge lighting, an airport beacon, and illuminated wind cones for navigational and taxi safety. Area lighting around the ramp would be provided for personnel and equipment safety; these facilities would be illuminated only on an as-needed basis.

2.7.5 Site Communications

External communications, including voice and data, would use a satellite connection with line-of-sight or surface-mounted satellite dish and an orbiting geostationary satellite. Communications stations would be located at the processing plant area, camp area, laydown yard (at the junction between the mine access road and the AAP), and the Dahl Creek Airstrip. Communications towers may be needed; however, the location and quantity of towers have not been determined. All towers would adhere to applicable regulations.

Radio communications would be used on site for operations communications using a very high frequency (VHF) Hi-Band system with radios in all mobile equipment and operations offices. Small tower VHF radio repeaters would be installed on ridgetops to provide radio coverage between the mine site, Bornite Camp, the Dahl Creek Airstrip, and other regional exploration locations. The repeaters would consist of a small structure to house electronics, solar panels, batteries, a backup generator, fuel, and an approximately 20-foot-tall antennae mast.

The Dahl Creek Airstrip would have an ultra-high frequency radio to communicate with in-bound aircraft. Truck operators on the AAP would use VHF radios compatible with a system that would be installed as part of the proposed AAP.

2.7.6 Fire Protection

The firewater distribution network would be maintained under constant pressure using a jockey pump and would be looped and sectionalized to minimize loss of fire protection during maintenance. Where firewater lines would be run outside buildings, firewater piping would be aboveground, heat traced and insulated.

Fire protection within buildings would include standpipe systems, sprinkler systems, and portable fire extinguishers. Standpipe systems would be provided in structures that exceed 45.9 ft (14 m) in height and additionally where required by regulations, local authorities, or the insurance underwriter.

Each camp would have its own fire detection and suppression system. Mobile equipment would be equipped with a combination of an installed fire suppression system and/or fire extinguishers. Mine water trucks would be equipped with monitors to assist in firefighting.

2.7.7 Waste Disposal

Waste produced by the Project would be managed under ADEC and U.S. Environmental Protection Agency (EPA) regulations and disposed of in accordance with regulatory requirements.

2.7.7.1 *Solid Waste*

Solid waste would be collected and managed based on ADEC requirements under a Waste Management Permit. Trash and burnables would be burned in an on-site incinerator, and the ash would be deposited in a permitted landfill near the camp. Inert material would also be disposed of in the permitted landfill.

2.7.7.2 *Hazardous Waste*

Hazardous waste produced by the Project would be collected and stored in environmentally appropriate containers using standard spill risk precautions (e.g., trained personnel for waste handling, secondary containment as appropriate) until it can be disposed of according to EPA regulations at an approved site. Hazardous waste would be removed from the Project site by truck using contractors and equipment certified in the transport of such material. All hazardous waste would be transported to approved sites capable of handling, recycling, and/or disposing the material.

2.7.7.3 *Domestic Wastewater*

Scalable wastewater treatment plants (e.g., Lifewater Systems) would be installed to treat domestic wastewater, similar to what is in operation at the existing Bornite Camp. With ADEC approval, treated wastewater would be discharged to the tundra. Exact locations and sizing of wastewater treatment plants have not yet been determined and will depend on the Project's schedule and workforce needs.

2.8 Snow Removal and Maintenance

Snow cleared from contact areas within the mill would be pushed into piles on the gravel pads and kept within the contact water boundary. If necessary, snow cleared from contact areas may also be hauled to inactive areas of the WRF or TMF.

Snow cleared from pads outside of the contact area would be stored on the pad and/or hauled to other locations, such as unused construction laydown areas. Snow cleared from non-contact roads would be plowed off the edges of the road.

2.9 Erosion and Dust Control

The Project would implement a Dust Control Plan to minimize and control fugitive dust. The Dust Control Plan would identify Project sources of fugitive dust, dust control methods and measures to be used for each type of source, and monitoring and record keeping parameters. Dust abatement on Project roads and pads would be done as needed according to standard DOT&PF dust control procedures and any provisions of the Project's air quality control permits, as needed. Dust control would include watering gravel roads and pads as needed to minimize dust impacts to the surrounding vegetation and waterways, and to maintain gravel infrastructure integrity. Dust control may include the use of palliative applications such as calcium chloride during summer months. Dust abatement would continue in winter as needed to ensure that traffic on snow free roads and facilities does not contribute to fugitive dust.

Water required for these dust control operations would be withdrawn from local creeks under ADNR Temporary Water Use Authorizations. Dust suppression water for the mine may be extracted from the WTP discharge, depending on need, although that level of design has not yet been completed.

The Project would develop and follow a Stormwater Pollution Prevention Plan (SWPPP) that would describe the site management procedures to prevent stormwater contamination. The SWPPP would detail the erosion control procedures and operations, monitoring, and maintenance of control devices.

2.10 Closure and Reclamation

Mine reclamation and closure considerations are largely determined by state regulations (11 AAC 86.150, 11 AAC 97.100-910, and 18 AAC 70) and statutes (AS 27.19) that specify that a mine must be reclaimed concurrently with mining operations to the greatest extent possible and then closed in a way that leaves the site stable in terms of erosion and avoids degradation of water quality from acid rock drainage (ARD) or metal leaching on the site. A detailed reclamation plan would be submitted to state agencies to review and approve as part of the State of Alaska mine permitting process. The approval process for the reclamation plan varies somewhat depending on the land status for any particular mine component. Because the Project is likely to have facilities on a combination of private (patented mining claims and Native land) and state land, the Reclamation Plan would be submitted and approved concurrent with the Plan of Operations, which is authorized by ADNR. The Reclamation Plan discusses short-term and long-term waste and water management, thus ADEC would also review it. In addition, private landowners must formally concur with the portion of the Reclamation Plan that would apply to their lands to ensure the Reclamation Plan is compatible with their intended post-mining land use.

2.10.1 Closure Objectives and Closure Criteria

The overall closure objective is to establish stable chemical and physical conditions that would protect the environment and human health. To the extent practicable, rehabilitation efforts would return the site to a condition which would generally conform with the surrounding terrain. The site would be monitored and maintained post-closure to demonstrate objectives are met.

The following general closure objectives would be considered:

- Demolish and remove all construction, camp, and industrial facilities and reclaim affected infrastructure footprints
- Achieve long-term slope stability of the mine pit, WRF, and TMF
- Meet water-quality criteria for all mine water and seeps prior to discharge to the surrounding environment
- Prevent the intrusion and migration of tailings porewater and mine-pit water into the regional groundwater
- Prevent and limit, to the extent practicable, human and wildlife contact with mine waste (e.g., waste rock and tailings)
- Establish adequate vegetation density to ensure slopes are protected from erosion
- Re-establish vegetation on areas returned to normal land use.

2.10.2 Closure Activities

Closure activities would be undertaken at the end of mine life to bring the mine facilities into a state consistent with stated closure and post-closure objectives and compliance with State regulations for closure and abandonment. The closure plan would be conducted in the following two phases:

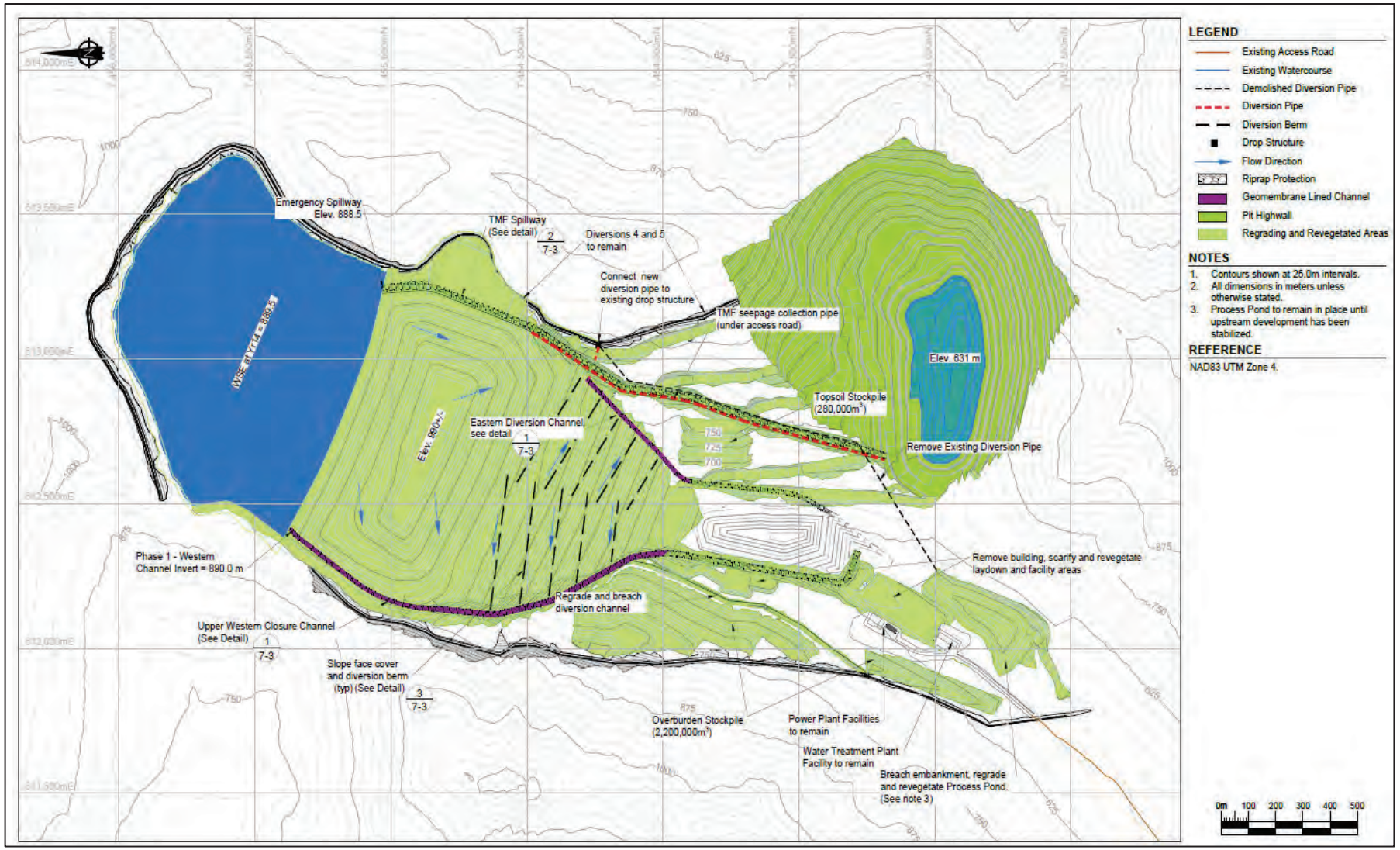
- Phase 1 – Reclamation of the majority of the Project site (Graphic 2.15)
- Phase 2 – Closure of the TMF (Graphic 2.16)

2.10.2.1 *Mine Pit Closure*

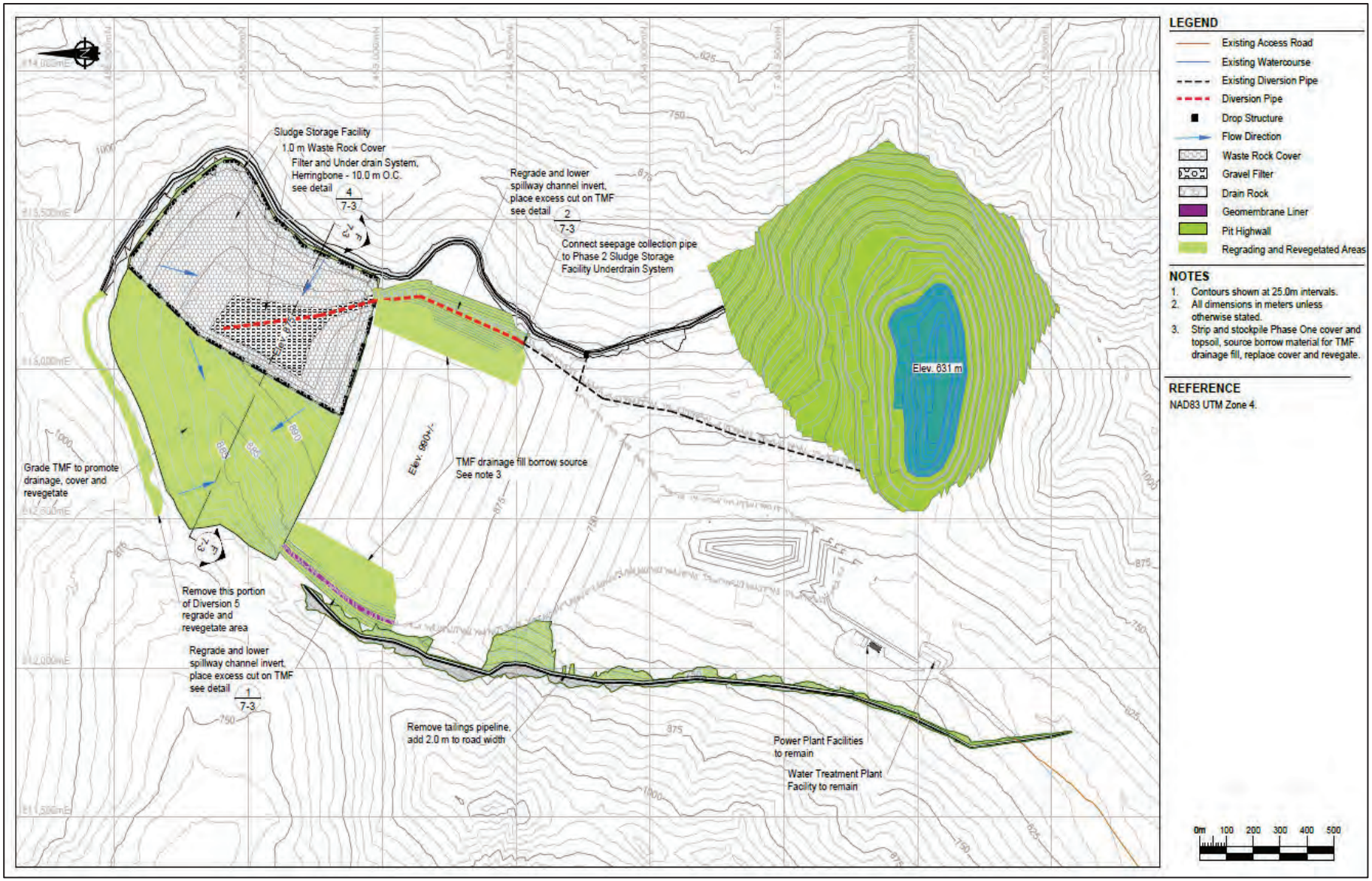
The Project anticipates the mine pit wall would be geotechnically stable in the long term and no in-pit work would be required at closure. The pit perimeter would straddle a steep ridgeline, and installation of typical preventative safety measures (e.g., fencing, warning berms) would not be practical. Signage would be installed in areas which could potentially be accessed by the public to warn of existing dangers, such as highwall presence and the potential for falling rock.

Following mine closure, groundwater in the pit would be allowed to rise, and a pit lake would form. Water from the tailings consolidation, tailings cover infiltration, and WRF seepage would flow to the open pit for year-round treatment and discharge. Sludge generated from water treatment would be filtered through filter bags and initially managed in the open pit until capacity is reached. After that, the solids would be managed on a lined portion of the tailings area and filtrate solution would be returned to the pit to be treated through the WTP.

The pit lake would not be allowed to overflow, and the water surface elevation would be carefully monitored to provide storage of the anticipated freshet volume and probable maximum precipitation event. Further hydrological and geotechnical studies, including for development of the updated Water Management Plan in 2026,would be completed to determine the maximum elevation at which water could be stored in the pit without seepage occurrence through the bedrock and into the environment. It is currently anticipated that the maximum pit lake elevation would be maintained at approximately 130 ft (40 m) below the top of the competent bedrock surface. An emergency spillway would be constructed as a matter of best practice.



Graphic 2.15. Phase 1 Closure



Graphic 2.16. Phase 2 Closure

Source: Ausenco 2020

2.10.2.2 *Waste Rock Facility and Tailings Management Facility Closure*

It is anticipated that the WRF will be PAG after closure and into the foreseeable future. A geomembrane (i.e., plastic) cover liner would be added to the entire upper WRF surface at closure, which would reduce WTP influent volume. A soil cap would be placed on the geomembrane liner and vegetation would be established on the surface.

The face of the WRF would be regraded at closure for long-term stability at an overall slope of approximately 2.5H:1V to 3H:1V. Efforts would be made to construct a convex shape on the WRF face, which is the predominant shape of natural slopes in mature landscapes in the area. The shape, together with installation of intermittent diversion berms on the face of the WRF slope, would reduce rilling and erosion from uncontrolled runoff.

The diversion berms on the WRF face would divert water to the perimeter, where geosynthetic-lined and armored perimeter channels would be installed at the interface of the existing ground and the WRF. The lined channels would limit infiltration of collected runoff from both the WRF surface and upstream run-on, thus limiting the volume of seepage reaching the WRCP that would require treatment. Upon completion of grading, all surface areas of the WRF would be covered with approximately 2.7 ft (0.8 m) of overburden and 0.5 ft (0.17 m) of growth media, for a full cover thickness of approximately 3.3 ft (1 m).

After the completion of mining, approximately 85.9 million gallons of water (3.25 Mm^3) would be stored in the TMF. Over the course of approximately 15 years post-closure, water would be removed from the TMF via the drainage system to the open pit, treated, and discharged. Tailings consolidation is expected to continue for up to 100+ years, but the majority of consolidation is expected to occur in the first 15 to 20 years post-closure. Once substantial consolidation has occurred, Phase Two of closure would commence, and waste and drain rock would be placed on the exposed tailings.

Waste rock would be relocated to the west half of the tailings surface to provide positive drainage toward the western diversion channel. Upon completion of grading and waste rock placement, the western half of the TMF would be covered with approximately 2.7 ft (0.8 m) of overburden and 0.5 ft (0.2 m) of growth media, for a full cover thickness of approximately 3.3 ft (1 m).

The eastern half of the TMF would serve as the future WTP sludge repository. An engineered drainage layer would be placed on top of the tailings in the eastern half of the TMF. The drainage layer would collect seepage, consolidation tailings water, and precipitation falling on the eastern half of the TMF. An underdrain and control structure would remove collected water and convey it through a pipe adjacent to the spillway, ultimately to the pit for treatment. The pipe would collect seepage water and attenuate larger storm events, eliminating the need to line the spillway to the pit to limit infiltration of impacted water. An engineered spillway would be installed at the completion of mining. The spillway would be designed to safely convey the probable maximum flood event from the TMF to the pit, during both Phase 1 and Phase 2 of closure.

Material for covering the WRF and TMF would be relocated from the overburden and topsoil stockpiles. Once all of the material has been relocated, the stockpile footprints will be reclaimed, and the sedimentation pond will be graded and revegetated.

All disturbed areas would be seeded with native grass and shrub species to re-establish vegetation. Efforts would be taken to work with the Alaska Plant Materials Center to maximize the potential for sustainable regrowth.

2.10.2.3 *Building and Equipment Closure*

The WTP and a modified power generation plant would be left in place, together with all appurtenant facilities and utilities. All other steel-frame buildings (e.g., mill, truck shop) would be selectively demolished by removing the roof and siding and then dismantling the steel frames and trusses. Resulting debris would be disposed of in an approved landfill that would be located on the WRF. Concrete walls, pillars, and beams would be demolished to the ground, and concrete foundations would be left in place and covered. Controlled blasting may be used to help with demolition. All sumps and cavities would be backfilled and graded to the surrounding ground level and the gravel pads would be regraded to prevent permanent ponding.

Non-hazardous and hazardous waste would be segregated. Hazardous waste would be placed in suitable containers and hauled to a licensed disposal facility, and non-hazardous waste would be placed in the landfill.

Any unwanted mobile or stationary equipment would be stripped of electronics and batteries, drained of all fluids (e.g., fuels, lubricants, coolants), decontaminated by power washing, and placed in the landfill for final disposal.

2.10.2.4 *Mine Infrastructure Closure*

Mine support infrastructure would consist of internal access roads, haul roads, and gravel pads. Ditches would be created where needed to allow continued use of the roads into post-closure water treatment, monitoring, and maintenance. Roads that would not be needed to support post-closure activities would be stripped of gravel and revegetated.

After removal of Project buildings and facilities, the surface of their gravel pads would be regraded and/or crowned as necessary to prevent water ponding. The pads would be scarified and revegetated. Up to 1 ft (0.3 m) of additional overburden may be applied, as needed, to promote revegetation.

Site access would be maintained for as long as water treatment is actively occurring on site.

2.10.2.5 *Landfill Closure*

An unlined, non-hazardous material landfill would be located in the WRF. Demolition waste and other non-hazardous waste would be placed in the landfill and consolidated to minimize the overall volume. The waste would then be covered with at least 3.3 ft (1 m) of waste rock. The final surface would then be graded to prevent permanent ponding and covered similarly to the rest of the WRF.

2.10.2.6 *Water Management System*

The water management system, consisting of the pit lake, Process Pond, WRCP, TMF, diversion channels, and various pipelines would be largely decommissioned. The dams and sediment ponds would be breached, regraded, and revegetated. New diversion channels along the perimeter of the WRF, as well as intake and discharge pipelines between the pit, WRCP, and WTP, would be created to manage surface runoff on and around the TMF and WRF. Runoff from the surface of the lined WRF is expected to meet Alaska WQS and would be discharged to the environment. Seepage from the WRF would be conveyed to the WRCP and then pumped to the pit for treatment. As the pit naturally fills, water levels would be managed by treating and discharging water for the long term (Section 2.1.5, *Water Treatment Plant*).

The WRCP would collect seepage from the WRF in perpetuity. Prior to winter closure, the WRCP would be pumped dry to provide storage capacity for spring freshet and minimal seepage flows over the winter. Water treatment is expected to occur year-round. The WTP will either be run year-round or for part of the year based on water storage requirements. During the Operations phase, mill water demands will affect site water flows such that the WTP can be shut down and the discharge eliminated during roughly half of the year (winter).

2.10.3 Post-Closure

The Project site would require on-site personnel presence in the post-closure period for as long as water treatment is necessary. This would require maintaining road access, a seasonal camp, and the water discharge pipeline to Subarctic Creek. Generators and mobile equipment would also be required for WTP operations, and to support sampling and monitoring activities.

In the short term (up to 10 years following closure), monitoring would be required to confirm that the closure objectives have been met and would be based on the following requirements:

- The site would be visually inspected annually by a qualified professional engineer for three consecutive years, and less frequently thereafter, for up to 10 years to ensure that erosion-prone areas have stabilized
- The soil and geosynthetic liner covers over the WRF and TMF would be regularly inspected by a qualified inspector to ensure the physical integrity of the cover is maintained; inspection intervals would be biannually for the first 10 years after construction
- The site would be inspected by a vegetation specialist to confirm suitability of the revegetation efforts; inspections would be completed at the following intervals, unless otherwise recommended by the vegetation expert: year 1, year 3, year 7, and year 10 post-closure

In the long term, continuous water quality monitoring would be implemented at sampling frequencies prescribed by future discharge permits.

Maintenance would be performed on areas where monitoring identifies as needing repairs. Water treatment in perpetuity over the long-term will be required to meet discharge quality criteria.

2.10.4 Reclamation and Closure Financial Assurance

In the absence of activities on federal lands in the mine area, and excluding the AAP, there would be no financial assurance requirements from the federal government to construct the Project. However, there are two State of Alaska agencies (ADNR and ADEC) that would require financial assurance in conjunction with approval and issuance of large-mine permits.

ADNR, under AS 27.19, would require a Reclamation Plan be submitted prior to mine development and includes the requirement for financial assurances, typically prior to construction, to assure reclamation of the Project site. The ADNR Dam Safety & Construction Unit would also require a financial assurance sufficient to cover the cost of decommissioning dams or the cost for long-term maintenance and monitoring of dams that would remain in place. ADEC would require financial assurance both during and after operations to cover short- and long-term water treatment, if necessary, as well as reclamation costs, monitoring, and maintenance needs. The State would require that the financial assurance amount also include the property-holding costs for a one-year period.

The final financial assurance amount would be calculated through the process of reviewing and approving the Reclamation Plan during the formal permitting process. In general, the approach is to combine the reclamation costs, post-closure monitoring costs, and the long-term annual water treatment costs into a financial amount that includes deriving the net present value of the long-term costs and combining that with the reclamation cost. The costs assume that the State through a third-party contractor will perform and manage the reclamation project.

AMC may satisfy the State financial assurance requirement by providing any of the following:

- Surety bond
- Letter of credit
- Certificate of deposit
- Corporate guarantee that meets the financial tests set in regulation by the ADNR commissioner
- Payments and deposits into the trust fund established in AS 37.14.800

For the dam or ADEC-related obligations, any other form of financial assurance that meets the financial test or other conditions set in regulation by the ADNR or ADEC commissioners is acceptable.

The adequacy of the reclamation plan and the amount of the financial assurance are reviewed by the state agencies at a minimum of every five years and must be updated whenever there is a significant change to the mine Plan of Operations or other costs that could affect the Reclamation Plan costs.

2.11 Schedule and Logistics

As described in Section 1.9, *Preliminary Project Schedule*, the Project would occur over approximately 19 years, from construction through mining and the commencement of initial closure activities. The three-year construction period is anticipated to begin after completion of permitting and a positive investment decision. Table 2.9 summarizes the Project schedule by phase.

Table 2.9. Preliminary Project Schedule by Project Phase

YEAR(S)	ACTIVITY	DESCRIPTION
Construction		
-3	Road construction, pad construction, AMJ laydown yard construction, develop material site(s), begin pit construction	Construct North Route and South Route; construct mining and support facility gravel pads; construct AMJ laydown yard and TCC; develop material site(s) for road and pad construction; begin pit construction
-2	Processing facility construction	Construct processing and support facilities
-1	Processing facility construction	Construct processing and support facilities
Pre-production Mining		
-3	Pit mining	Mined material to be used to support Project construction; begin TMF construction
-2	Pit mining	Mined material to be stockpiled for processing plant startup; continue TMF construction to store startup water
-1	Pit mining	Mined material to be stockpiled for processing plant startup
Production Mining		
1 – 13	Pit mining and processing	Mined material to be processed and shipped
Closure		
14 – 17	Site closure and reclamation – Phase	Pit lake forms, structures, roads, pads, pipelines, dams, and diversion ponds and channels not required for post-closure monitoring demolished and sites restored; closure landfill constructed in WRF.
14 – 28	TMF closure – Phase 1	Power plant and WTP modified to support closure and post-closure water treatment; TMF begins dewatering and year-round water treatment.
29+	TMF closure – Phase 2	The TMF would be modified to support long-term project closure, including surface revegetation; WTP sludge placed into open cells at the TMF; year-round water treatment continues in perpetuity.
Post-Closure		
29 – 40	Monitoring	Short-term post-closure-period monitoring to confirm the closure objectives have been met
40+	Monitoring	Long-term post-closure period for continuous water quality monitoring; maintenance would be performed on an as-needed based on monitoring reports; water treatment will continue in perpetuity or until Alaska WQS can be met without treatment.

The mine would operate 24 hours per day, seven days per week using three rotating crews working 12-hour shifts. Blasting operations would begin in Year -3 to support construction and continue through the life of the mine, ending in Year 13 with the end of production mining.

3.0 ENVIRONMENTAL EVALUATION

3.1 Scope of Analysis

AMC evaluated the potential impacts of the proposed Project by first considering the regulatory thresholds or standards that would be applicable (e.g., minimizing wetland impacts, meeting Alaska WQSs) and the concerns expressed by stakeholders and regulatory agency representatives during preliminary Project meetings. AMC modified the Project to avoid and minimize impacts to the extent practicable. This chapter of the EED evaluates the potential effects of the proposed Project and summarizes available data for each resource (citing the available resource reports), the resource's existing condition in the Project area, and the Project's potential effects on those resources.

Table 3.1 outlines the potential effects to key resources identified through preliminary scoping meetings with stakeholders and agencies and through analysis in this EED.

Table 3.1. Potential Effects to Key Resources

KEY RESOURCES	POTENTIAL EFFECTS
Wetlands	Fill of wetlands and streams from construction of new gravel pads, dams, TMF, WRF, WRCP, roads, bridges, and other Project infrastructure; loss of wetlands and/or streams from excavation at the mine site pit and material sites.
Water Quality	• Use and diversion of a portion of Subarctic Creek and treated wastewater discharge to Subarctic Creek. • The need for perpetual water treatment may present the potential to cause adverse effects over the long term.
Cultural Resources	Previous cultural resources field surveys were conducted for the Project footprint, with the exception of material sites. Previous surveys did not identify pre-Contact cultural materials. However, the studies are not fully complete for the purposes of analysis of impacts. Additional fieldwork is planned for 2026, including historic structure survey and documentation as well as evaluation of potential Traditional Cultural Properties/Landscapes.
Subsistence	Changes to resource availability, resource abundance, or harvester access.

Design features and proposed BMPs to avoid or minimize impacts to resources are described in Chapter 5.0, *Avoidance and Minimization Measures*.

3.2 Geology, Mineral Resources, and Soils

3.2.1 Existing Data

Information about the Project area is available from a variety of sources. Studies by ADNR, Pessel et al. (1973), Wiltse (1975), Hitzman et al. (1982), Travis/Peterson Environmental Consulting, Inc. (2007), BGC Engineering, Inc. (BGC) (2013), and SRK (2018a, 2019) provide background information on the geologic setting of the Project area. AMC's technical reports and pre-feasibility studies (Ausenco Engineering Canada Inc. 2023; Trilogy Metals Inc. 2018) provide details on the minerology of the target mineral deposit. Reports from the DOT&PF and ADNR provided background information regarding potentially hazardous mineral (e.g., NOA) occurrences in the area (Perkins et al. 2009; Solie 2015).

3.2.2 Existing Conditions

3.2.2.1 *Physiography and Topographic Setting*

The Arctic Mine site would be in the Schwatka Mountains on the southern flank of the Brooks Range. In this area, the Brooks Range is bisected by north-south trending glacial valleys now occupied by river systems that flow south to the Kobuk River, which drains west into Kotzebue Sound. The Project would be near the headwaters of Subarctic Creek (a tributary to the Shungnak River); Subarctic Valley is characterized by steep topography, as shown in Graphic 3.1.



Graphic 3.1. Photograph of the Upper Subarctic Valley

The Shungnak and Kogoluktuk rivers are to the west and east of the Project area, respectively (Figure 2.1). A prominent glacial moraine extends southwest toward the Ambler Lowlands from the point close to where Subarctic Creek emerges from the Subarctic Valley. The topography of the lowlands is generally flat, with local topographic variations attributable to aeolian and glacial processes, resulting in dune and moraine deposits further altered by active permafrost and alluvial processes and steep-sided U-shaped valleys (BGC 2013). The Cosmos Hills, in which the existing Bornite Camp is situated, are across the Ambler Lowlands farther to the south. The Cosmos Hills are characterized by moderately rugged topography with approximate relief of 3,000 ft (914 m) (Fritts 1970).

3.2.2.2 *Geologic Setting*

The Ambler District is in an east-west trending zone of Devonian to Jurassic age metavolcanic and metasedimentary rocks along the southern margin of the Brooks Range (BGC 2013). The southern Brooks Range has experienced an intense and complex history of deformation and metamorphism (SRK 2012). The Project would target rocks within the Ambler Sequence, comprised of Devonian age carbonate and siliciclastic rocks with interlayered lava flows and sills believed to have been deposited in a rifted continental margin tectonic environment that underwent deformation. The sedimentary rocks were deposited primarily by mass gravity flow into the marine environment of the extending marginal basin (Trilogy 2018). A large anticline fold structure trends northwest-southeast across the region, known as the Kalurivik Arch (Hitzman et al. 1982).

An overturned syncline and north-trending recumbent fold known as the Arctic Synform is within the Project area. This complex structure was formed thrusting carbonate rocks over a complex of metamorphic and carbonate rocks, forming a structural-stratigraphic thrust belt with mineralization along the planes of the thrust faults (Pessel et al. 1973). The structural geology of the site is discussed in greater detail in the AMC technical report (Trilogy 2018).

The bedrock lithology in the vicinity of the Project area consists of the Ambler Sequence of metasediments and metavolcanics, including various schists, porphyritic rhyolite, serpentine, greenstone, metabasite, marble, dolomite, and chloritic dolomite (Hitzman et al. 1982; Pessel et al. 1973; Wiltse 1975). The Cosmos Hills are comprised of interlayered marble, graphitic marble, phyllitic marble, and dolostone, and the copper mineralization occurs in late Devonian carbonate sediments (Travis/Peterson Environmental Consulting, Inc. 2007).

Surficial geology of the Subarctic Valley is generally colluvium of varying thickness comprised of rock debris and weathering products over bedrock. The lowlands are dominated by sandy gravel stream channels; glacial outwash; alluvial terraces; piedmont gravels; glacial moraines (glacial drift); aeolian sand dunes; and young organic deposits along streams, lakes, and wetlands. Glacial drift deposits are characterized by gravel, cobbles, and boulders within a silt matrix, while glacial outwash deposits typically consisting of sand and gravel mixtures and aeolian deposits are typically composed of silt and sand mixtures. In the Cosmos Hills, talus covers the upper portions of the hills and glacial and fluvial sediments occupy valleys (BD Resource Consulting Inc. 2014).

3.2.2.3 *Seismicity*

The design seismic event is based on a 1:2,475 annual exceedance probability, which corresponds to a two percent probability of occurrence in 50 years. The U.S. Geological Survey (USGS) seismic design tools were used to determine a peak ground acceleration of 0.2645 percent of gravity during the design earthquake at the TMF location (SRK 2018).

3.2.2.4 *Slope Stability of the Open Pit, TMF, WRF, WRCP and Overburden Stockpiles*

The stability and designs of the TMF, WRF, WRCP, and overburden stockpiles were assessed in the Feasibility Study (SRK 2024). A configuration of a lined TMF, with approximately 37.8 million tonnes (MT) of tailings storage, buttressed downstream by the approximately 298 MT unlined WRF was selected and determined to exceed the minimum static factor of safety of 1.5 during operations and closure. A Tailings Management Report will be prepared by the end of 2026.

The proposed WRCP dam configuration and overburden stockpiles also were assessed and found to meet or exceed the static factor of safety of 1.5 during operations and closure (SRK 2024).

Detailed slope stability assessments and slope design recommendations were provided with a focus on the slope stability risk related to potential sliding failure along talc zones (Ausenco Engineering Canada Inc., 2023). Open pit mine designs include interim and final phases using these recommendations. Slope stability risks were assessed for open pit phasing using 3D finite element numerical models with simplified geometries and groundwater conditions.

3.2.2.5 *Mineralogy*

The target minerals of the Project are within a volcanogenic massive sulfide deposit containing copper, zinc, lead, gold, and silver. The mineralogy of the deposit is described in Trilogy's 2018 technical report (Trilogy 2018).

3.2.2.6 *Potentially Hazardous Mineral Occurrences*

NOA minerals have been documented in mafic and ultramafic igneous and metamorphic rocks in the region. Typical asbestos-bearing or potentially asbestos-bearing minerals include asbestos, chrysotile, tremolite, actinolite, talc, soapstone, nephrite (jade), magnesite, nemalite, and serpentine. DOT&PF determined that the Ambler District has significant amounts of ultramafic rocks that contain both serpentine and amphibole mineral forms that contain asbestos (Perkins et al. 2009). ADNR, Division of Geological and Geophysical Surveys, has published maps showing the distribution of relative NOA potential in bedrock units across Alaska, including the Project area (Solie 2015).

It is important to understand that NOA minerals usually constitute only a portion of the rock in which they occur and form as secondary alteration products requiring specific conditions for growth (Solie 2015). Therefore, rock types rated as having higher NOA potential do not necessarily contain NOA, and bodies of rock rated as having low potential could include localized NOA. Significant on-site asbestos testing will be required prior to construction.

Selenium is a naturally occurring element that is essential to human and animal health in trace amounts but is harmful if consumed in excess (Fordyce 2013). Selenium rarely occurs in pure elemental form, but it is often found in sulfide ores, such as those targeted by the Project. Although selenium is only present in trace amounts in the minerals in which it occurs, mining operations can expose selenium-bearing minerals to air and water through waste rock disposal and mine site tailings. At the Project mine site, selenium concentration in the TMF water and waste rock runoff are predicted to be above WQS (Trilogy 2018) and would need to be treated to remove or reduce concentrations before discharging to receiving waters (Section 2.1.5, *Water Treatment Plant*). Additional information on anticipated selenium mobilization is provided in the Project's geochemical testing reports (SRK 2021, 2024).

3.2.2.7 *Geochemical and Potential to Generate Acid Rock Drainage*

The Arctic deposit is a deposit containing sulfide-bearing minerals, as well as metals; as such, there is a potential to generate acid and leach metals if the Project is not properly designed and managed. Arctic's geochemical analysis began in 2015 with the initiation of static and kinetic testing, as well as the establishment of on-site leachate barrels. The samples used in the static, kinetic, and leachate barrels were representative of the waste rock that would be produced by the Project. The selection of sample intervals sed the testing was performed in 2015 (Ausenco 2023).

Static testing uses short-term procedures to determine the general geochemical characteristics of rock samples. Static tests are designed to characterize potential acid generation, determine overall material composition, and identify readily leachable metals. The Project completed static testing on 1,557 total samples in all major lithologic units in the waste rock and overburden at the Arctic deposit and testing indicated that much of the rock in the Project area has the potential for ARD (SRK 2021). Table 3.2 provides the estimated ARD potential for the Project based on the completed static testing.

Table 3.2. Estimated Acid Rock Drainage Potential by Lithologic Unit

LITHOLOGIC UNIT	NUMBER OF SAMPLES	PROPORTION PAG	PROPORTION NON-PAG	PROPORTION OF MODELED PIT
Aphanitic metarhyolite	33	42%	58%	2%
Metarhyolite porphyry	162	60%	40%	14%
Grey schist	212	96%	4%	10%
Debris flow of metarhyolite porphyry clasts in grey schist matrix	58	91%	9%	
Quartz feldspar mica schist	698	79%	21%	66%
Chlorite/talc schist	197	64%	36%	
Calcareous	22	18%	82%	
Ore	88	98%	2%	8%
Altered dykes	47	62%	38%	Less than 0.2%
Barite	4	100%	0%	Insignificant
Quartzite	3	67%	33%	Insignificant
Quartz vein	17	76%	24%	Insignificant
Overburden	16	19%	81%	Insignificant
Total	**1,557**	**76%**	**24%**	**100%**

Source: SRK 2021

Kinetic testing, the chemical analysis of leachate generated by humidity cells or in-situ test barrels, provides further detail on the acid generating potential and anticipated acid generation timing for the respective lithologic units. This modeling data is used to inform the Project's predicted water quality and water treatment needs to mitigate the anticipated analysis results. To date, AMC has completed analyses of 24 kinetic samples, including all significant overburden and waste rock lithologic units, as well as tailings samples. Some of the kinetic tests have been underway since 2015, with additional tests being conducted as the analyses have progressed (SRK 2021).

The humidity cells provide an accelerated prediction of the future water quality by exposing the ground-up lithologic units to near ideal weathering conditions, while the in-situ test barrels kept at the Project site are subject to on-the-ground site conditions, including cold, low activity winter conditions. Comparing the "ideal" rapid weathering to the slower site conditions provides insight into the anticipated weathering and water quality predictions. The preliminary results of the geochemical analyses indicate that some lithologic units have rapidly decreasing pH measurements in the first year of weathering, such as grey schist, while others exhibit a steady decline and remain at near neutral pH, such as quartz feldspar mica schist (SRK 2021).

Additional kinetic samples were added in 2019 to capture the variability in the different lithologic units, such as high and low sulfur content. As predicted, there is a strong correlation between sulfur content and pH.

In addition, sub-aqueous column testing is being conducted on the tailings to predict effects of sub-aqueous tailings disposal on water quality and metal leaching potential.

The results of the geochemical analysis being completed to support the Project are preliminary and the analysis will be ongoing. The current understanding of the Project's geochemistry is detailed in *Characterization of Acid Rock Drainage and Metal Leaching Potential, 2020 Progress* (SRK 2021), and will be updated with results from subsequent years and as data becomes available. Updated source terms for water that contacts tailings, waste rock, and the open pit will be included in the Water Management Plan to be completed by the end of 2026.

3.2.2.8 *Permafrost*

Permafrost is defined as ground with subfreezing temperatures for at least two consecutive years, although most permafrost is hundreds to thousands of years old (Jorgenson 2011). Ground temperatures within boreholes at the Project site in 2011 showed that only one of four holes tested contained permafrost and the permafrost was located near the ridgetop and was inferred to be less than 65 ft (20 m) thick at the location. This suggests the Project site contains limited discontinuous permafrost, or is possibly permafrost free, with the exception of the ridgetop (BGC 2013). More recent investigations within the Project footprint did not encounter frozen soils or permafrost (SRK 2019).

The most recent (2018) temperature, borehole, and test pit results indicate that ice-bonded permafrost and ground ice were absent from the WRF and TMF footprints. Frozen ground was also not indicated by the geophysical survey results (SRK 2018). Additional subsurface investigations consisting of 24 boreholes, ground temperature measurements, and 41 test pits across the planned mine waste management facilities and infrastructure sites did not encounter frozen materials (SRK 2019).

3.2.2.9 *Surficial Deposits and Overburden*

Overburden geotechnical investigations were carried out in 2017 and 2018 to provide overburden characterization in support of the waste facility siting evaluation and the WRF and TMF geotechnical design. Surficial deposits mapped in the Project area include glacial, aeolian, and fluvial deposits, with colluvium covered slopes. Most morainal deposits at the site are from the late Pleistocene Walker Lake glaciation, and consist of drift deposits characterized by boulders, cobbles, and gravels in a fine-grained matrix as well as silty sand outwash deposits. The Subarctic Creek Valley mainly consists of well-graded silty sand and gravel colluvium and alluvium, with some zones of large cobbles and boulders. Overburden thickness within the Subarctic Creek Valley generally increases down-valley toward the Shungnak River Valley.

Most true soils (the upper layer of the substrate that is naturally capable of supporting plant life or that has been observably modified from parent material by mechanical processes) were stripped by Pleistocene glaciations (about 2.6 million to 11,700 years ago), so soil layers are relatively thin in the region. Thin residual soils are present in the upland areas, and thicker organic-bearing sediments are present in the valley floors and along stream channels.

Overburden in the TMF starter dam location is characterized as thin, well-graded silty sand with gravel or silty gravel with sand. The contact with the underlying fractured weathered bedrock occurs at depths

varying between 0.7 and 10.2 ft (0.2 and 3.1 m) in the TMF area and between 3.6 and 29.9 ft (1.1 and 9.1 m) in the starter dam area. The thicker overburden occurs in the center of the valley, south of the toe of the starter dam area. The overburden is interpreted to be colluvial in origin. Bedrock is exposed at the north end of the TMF.

In the proposed TMF and starter dam footprints, groundwater was encountered during drilling and excavation of test pits at depths between 0.7 and 16.1 ft (0.2 and 4.9 m). Groundwater was encountered at depths between 19.7 and 68.9 ft (6 and 21 m) in bedrock around the perimeter of the TMF. Based on groundwater elevation records in these areas, the planned facilities would be in groundwater recharge zones.

The overburden in the WRF area is characterized as well-graded silty sand with gravel or silty gravel with sand and angular cobbles, interpreted to be colluvial in origin. Overburden is slightly thicker on the western side of the valley (±32.8 ft [± 10 m]) than on the eastern side of the valley (± 19.7 ft [± 6 m]), and ranges between 9.8 and 18.4 ft (3.0 and 5.6 m) in the valley center. Based on locations of exposed bedrock, overburden is inferred to be thin on the valley sides.

In the proposed WRF footprint, groundwater was encountered during drilling and excavation of test pits at depths between 2.6 and 44.3 ft (0.8 and 13.5 m). Groundwater levels are generally near the surface on the western and central parts of the footprint and deeper on the eastern side of the footprint. Drill holes on both sides of the valley appear to be located in groundwater recharge zones. The center of the valley may correspond to both recharge and discharge zones.

The groundwater level within the footprint of each planned structure within the Subarctic Creek Valley is relatively shallow. The average depth to groundwater is 4.9 ft (1.5 m) and seems to correspond to the weathered bedrock-overburden contact. The groundwater level seems to be relatively constant despite varying surface slope angles.

3.2.3 Preliminary Analysis of Impacts

Permafrost is not known to be present across the planned mine waste management facilities and infrastructure areas and therefore impacts to permafrost are unlikely at the mine site. However, the subsurface properties along the proposed North Route and South Route and adjacent gravel pads (e.g., laydown yards) are relatively unknown and permafrost may be present. Degradation of permafrost beneath gravel infrastructure can occur due to changes in the thermal regime where permafrost is present and may have to be managed.

If permafrost areas are encountered, gravel infrastructure could result in upslope water impoundment and thermokarst erosion next to areas covered by gravel fill (Walker and Everett 1987). Thicker organic-bearing sediments in the valley floors and along stream channels provide insulation for maintaining permafrost. Maintaining the vegetative mat below the gravel fill can help mitigate risk of permafrost thaw. Thick fill material can also provide an insulating effect on permafrost, although solar radiation has the potential to warm gravel fill to the point of melting shallow permafrost and creating thaw bulbs. Adjacent areas may be indirectly affected by changes in the surficial drainage patterns, including ponding and channelizing of water, which would accelerate permafrost thaw. If permafrost is encountered along the North Route or South Route, thicker gravel fill sections, insulation, and drainage improvements can be implemented to mitigate the impacts. In areas with permafrost, gravel infrastructure could result in upslope water impoundment and thermokarst erosion next to areas covered by gravel fill (Walker and Evertt 1987).

Excavations will likely accelerate the slow creep of material where solifluction is present and may require regular maintenance to remove and maintain road cuts (SRK 2018). Project elements such as gravel roads and pads would be constructed from alluvial gravel deposits, glacial outwash, piedmont gravels, and glacial moraine deposits. These landforms would be disturbed by quarrying operations, and some of these deposits may contain hazardous minerals such as NOA, which could become airborne during quarrying, placement, or use of gravel infrastructure. Testing for NOA would be done prior to using the material.

Topsoil would be removed in all impacted areas and stockpiled. Areas identified for reclamation after mine closure would be regraded and reclaimed using stockpiled topsoil. BMPs would be used to contain sediment during fill placement, and areas not actively being used would be stabilized after construction.

The topography will be altered from the existing conditions. At mine closure, the open pit would be geotechnically stable and therefore no in-pit work would be conducted, and the mine pit would be left open. The WRF and TMF would be graded to promote long-term stability, shaped to approximate a natural drainage and revegetated, although the infilling of the upper portion of the Subarctic Valley would be permanent (SRK 2018).

Project elements, including the pit, TMF, WRF, and geologic resources, have the potential to expose elements within mine tailings, ore, and waste rock to water and air that could be mobilized to the environment; some of these elements may be toxic. It is anticipated that ARD will occur within two to five years of mining completion and selenium is expected to be released from the rock materials through weathering and oxidation of sulfide minerals (SRK 2021). The WTP would operate during the operations phase and after mine closure to ensure discharge water meets Alaska WQS. Long-term water treatment would be required in perpetuity (SRK 2018).

3.3 Surface Water Hydrology and Water Quality

3.3.1 Existing Data

Water quality data were collected from Arctic, Riley, Ruby, Cabin, Camp, Subarctic, and Wesley creeks, as well as the Kogoluktuk and Shungnak rivers, from over 80 distinct locations between 2007 and 2025 (Figure 3.1). Many of these sites were sampled once, while others were routinely sampled over several years in various seasons and flow regimes. Quarterly samples from water quality monitoring sites have been collected from several sites on Subarctic Creek, Ruby Creek, and the Shungnak River; other sites in the project area were collected more sporadically (Figure 3.1). Table 3.3 lists the number of samples collected and analyzed from various locations. Table 3.4 provides a summary of water samples and analytical results.

Water quality data collected included in situ parameters (e.g., temperature, dissolved oxygen, pH, turbidity) and/or laboratory tested analytes (e.g., heavy metals, minerals, total dissolved solids, hardness, nutrients).

Water depth is measured hourly and correlated streamflow is calculated at four hydrological gaging stations installed in the Project area:

- Subarctic Creek Gaging Station (SCGS) is in lower Subarctic Creek and was installed in 2012.
- Subarctic Creek Emergency Cabin (SCEC) is in Subarctic Creek near the proposed WRCP and was installed in 2022. This station was moved from a previously installed station (Subarctic Creek Meteorological Station [SCMET], installed in 2021) to a better location upstream.
- Shungnak River Gaging Station (SRGS) is in the Shungnak River downstream of the confluence with Subarctic Creek and was installed in 2012.

Water quality, flow and precipitation were routinely measured at three additional stations in the Project area:

- Subarctic Creek Middle (SCMI) is a water quality and flow measurement site at the base of the Arctic deposit where the historical road crosses the creek.
- Subarctic Creek Up (SCUP) is a water quality and flow measurement site at the headwaters of Subarctic Creek. The site is at a point downstream from where multiple branches of groundwater fed streams coalesce.
- Subarctic Creek Down (SCDN) is a water quality and flow measurement site near the confluence with the Shungnak River.

Table 3.3 Surface Water Samples Location Count

SITE	YEAR														TOTAL SAMPLES
	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	
SCUP	1	1	1	1	2	3	4	4	0	5	2	1	0	0	25
SCEC	0	0	0	0	0	0	0	0	0	0	1	1	1	1	4
SCMI	0	0	0	0	0	3	4	4 [a]	0	5	3	0	0	0	19
SCGS	1	1	1	1	2	5	4	4	0	5	3	1	1	1	30
SCDN	1	2	1	1	2	4	3	3	0	3	2	0	0	0	22
SRGS	0	1	1	1	2	5	4	3	0	4	3	1	1	1	27

[a] 2019 total would be 6 samples if samples above SCMI are included.

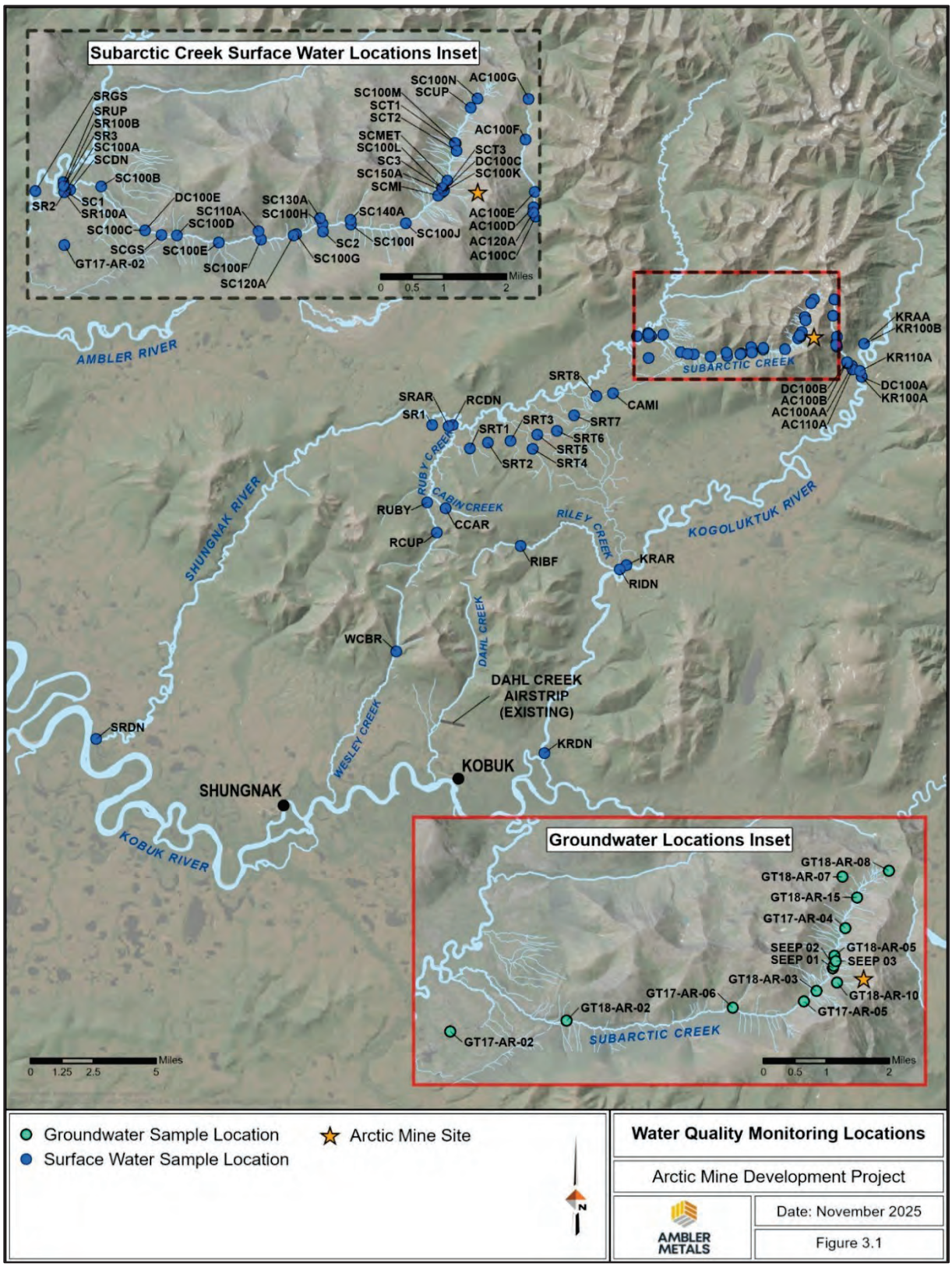


Figure 3.1. Water Quality Monitoring Locations

3.3.2 Existing Conditions

The Arctic deposit is in the Subarctic Valley which drains to the Shungnak River and ultimately the Kobuk River. The Middle Kobuk River Subbasin drains approximately 3,080,000 acres (1,246,432 ha), of which approximately 148,500 acres (60,096 ha), or 4.85%, is contributed by the Shungnak River (USGS Watershed Boundary). The Kobuk River flow pattern is typical of large Arctic rivers, with low discharge from late October to May, a rapid increase in discharge during late May snowmelt, and peak runoff in June. Flows then fluctuate throughout summer with rainfall before declining again in October as winter begins. The average annual flow for the Kobuk River at Kiana has historically ranged from 10,020 cubic feet per second (ft^3/s) to 24,960 ft^3/s (284 m^3/s to 706 m^3/s), with peak flows 45,000 ft^3/s to 161,000 ft^3/s (1,274 m^3/s to 4,559 m^3/s) (USGS 2001).

The Project would traverse several tributaries of the Shungnak and Kogoluktuk rivers, including Subarctic, Camp, and Ruby creeks (which drain directly to the Shungnak River), Cabin Creek (a small tributary to Ruby Creek), and Riley Creek (which drains to the Kogoluktuk River). Like the Shungnak, the Kogoluktuk River also drains to the Kobuk River.

The most significant hydrologic intersections within the Project area occur at Subarctic Creek and the Shungnak River. Subarctic Creek would be intersected by multiple major proposed Project facilities, including the TMF, WRF operations pad, stockpiles, and portions of the open pit and haul routes. Treated effluent from the proposed WTP and non-contact diversion water would discharge to Subarctic Creek, representing the largest Project-related contribution to streamflow within the area. The Shungnak River would be intersected by proposed material site options and laydown yards. These two systems represent the largest drainage features that would be affected by the Project. Table 3.2 lists the characteristics of streams that would be intersected by the Project.

3.3.2.1 *Baseline Flow Characteristics*

Table 3.3 summarizes the character of streams that intersect the Project.

Table 3.3. Characteristics of Streams that Intersect the Project

WATERSHED	STREAM	GENERAL CHARACTERISTICS	INTERSECTION WITH PROJECT
Shungnak River	Shungnak River	Meandering, low gradient (0.0005 feet per foot); peak mean monthly flow occurs in June	Material site options and laydown yards
	Subarctic Creek	High gradient (0.02 feet per foot); flanked by exposed bedrock; peak mean monthly flow occurs in May/June during spring breakup and August during the rainy season Strong diurnal flow fluctuations during early summer; a channelized series of riffles and pools is present at the gaging station	TMF, WRF, operations pad, stockpiles, North Route, material site options, and a portion of the open pit
	Ruby Creek	Low gradient, sinuous, with silty sand bed substrate	South Route
	Cabin Creek	High gradient small ephemeral creek near the Bornite Camp	South Route
Kogoluktuk River	Kogoluktuk River	Low gradient meandering river with a broad floodplain	A portion of the North Route access road and the Arctic Mine Junction pad
	Riley Creek	Low gradient, sinuous, with gravelly substrate	North Route
Kobuk River	Wesley Creek	High gradient riffle/pool habitat with gravel and cobble substrate	Road improvements from the existing access road
	Dahl Creek	Moderate gradient riffle/pool habitat with gravel substrate	Road improvements from the existing access road

Source: ADF&G

Flows within Subarctic Creek, the primary receiving waterbody for Project discharges, follow a snowmelt-dominated hydrologic regime characteristic of Arctic watersheds. Hydrographs for the period 2012-2021 indicate the majority of annual runoff occurs during spring breakup, when rapid snowmelt produces a distinct freshet and high streamflow through May and June. Following the melt period, discharge declines steadily through late summer as surface runoff diminishes and the system transitions toward low-flow conditions. By late fall, typically October, Subarctic Creek becomes ice-covered, and streamflow is minimal to absent through the frozen season, reflecting cessation of runoff and frozen channel conditions. Measured flows during winter are generally unavailable or estimated due to channel freeze-up and ice effects, indicating negligible open-water discharge. The Shungnak River exhibits a similar snowmelt-driven pattern, with pronounced freshet peaks, declining late-summer flows, and little to no measurable discharge during winter months. Together, the gaging records demonstrate a highly seasonal flow regime controlled by temperature-driven snowmelt and short open-water periods, with most annual discharge concentrated within a few weeks each year (Brailey Hydrologic Consultants LLC 2022).

3.3.2.2 *Baseline Water Quality*

Alaska WQS (18 AAC 73) includes waterbody use classifications, numeric and/or narrative water quality criteria, and an antidegradation policy. The use classification system identifies the designated uses that a waterbody is expected to achieve. The numeric and/or narrative water quality criteria are the criteria deemed necessary to support the designated use classification of the waterbody. Compliance with the antidegradation policy protects and maintains existing uses and water quality necessary.

Waterbodies in Alaska are designated for all uses unless the water has been reclassified under 18 AAC 70.230 as listed under 18 AAC 70.230(e). Water quality criterion for some waterbodies maybe site-specific per 18 AAC 70.235, such as those listed under 18 AAC 70.236(b). The receiving waters of discharge from the proposed Project (Shungnak River, Subarctic Creek, Riley Creek, Ruby Creek, Cabin Creek, Kogoluktuk River, Wesley River, and Dahl Creek) have not been reclassified, nor have site-specific water quality criteria been established. Therefore, existing uses and designated uses are the same and must be protected for all use classes as per 18 AAC 70.020(a)(2) and 18 AAC 70.050. The designated use classes for fresh water include water supply for drinking, culinary, and food processing; water supply for agriculture, including irrigation and stock watering; water supply for aquaculture and industry; contact and secondary recreation; and growth and propagation of fish, shellfish, other aquatic life, and wildlife.

Any part of a waterbody for which the water quality does not, or is not expected to meet, applicable Alaska WQS is defined as a “water quality limited segment” and placed on the ADEC impaired waterbody list. For an impaired waterbody, Section 303(d) of the CWA requires states to develop a Total Maximum Daily Load (TMDL) management plan. The TMDL documents the amount of a pollutant a waterbody can assimilate without violating a state’s WQS and allocates that load to known point sources and nonpoint sources. The State of Alaska 2022 *Final Integrated Water Quality Monitoring and Assessment Report* does not include the Kogoluktuk River and Kobuk River; however, the 2024 Integrated Report Assessed Waters mapper identifies both waterbodies as Category 3 for “waterbodies for which there is not enough information to determine their status.” As such, the *Final Integrated Water Quality Monitoring and Assessment Report* does not list the Project area as impaired and subject to a proposed or approved TMDL.

Discharges to the identified receiving waters from the Project will be required to meet the Alaska WQS. Baseline monitoring to date indicates that most parameters are within Alaska WQS, with a few individual samples exceeding Alaska WQS for freshwater criteria. Median concentrations of selenium, cadmium, copper, zinc, and mercury were within the Alaska WQS for aquatic life in the Shungnak River, upper and lower Ruby Creek, upper and lower Subarctic Creek, and lower Riley Creek (ADF&G 2020).

Overall, the average concentrations of all parameters remain within Alaska WQS, except for cadmium in the Subarctic Creek watershed. Analysis of individual baseline water quality samples from the Subarctic Creek watershed indicates concentrations of cadmium, copper, and zinc exceed Alaska WQS for freshwater criteria. In addition, analysis of individual samples from Shungnak River indicate temperature and cadmium concentrations have exceeded WQS for freshwater criteria.

Baseline watershed temperature monitoring of Subarctic Creek at mean elevation shows that water temperatures are consistently cold throughout the year. Average temperatures range from 5 degrees Fahrenheit (°F) (-15 degrees Celsius [°C]) to 2°F (-19°C) during the winter and spring months (November-March). During summer (June-August), stream temperatures average between 46°F (8°C) and 54°F (12°C), influenced by the high-elevation setting, cold groundwater input, and seasonal snowmelt. Seasonal stream temperatures are strongly tied to air temperature and snowmelt, with average air temperatures in June and July around 54°F (12°C). Summer stream temperatures remain relatively cool, consistent with small, high-elevation Arctic catchments, while winter flows are primarily groundwater-fed, keeping streams cold but not entirely frozen.

Table 3.4 lists baseline water quality conditions for selected sites in the Project area

Table 3.4. Baseline Water Quality Conditions at Selected Sites

SITE	CONSTITUENT	FRACTION	UNITS	ALAKSA WQS	REFERENCE STANDARD	MAXIMUM VALUE	MINIMUM VALUE	AVERAGE	SAMPLE COLLECTION DURATION (START YEAR/END YEAR)	NUMBER OF SAMPLES
SRGS	*Shungnak River*[a]									
	Temperature	N/A	ºC	<15ºC	Drinking, culinary, and food processing	10.3	-0.1	5.2	2012/2025	32
	Hardness	N/A	mg/L as $CaCO_3$	No standard	N/A	107.0	29.9	73.1	2012/2025	24
	pH	N/A	N/A	6.5 to 8.5[b]	Freshwater aquatic life	8.1	5.2	7.1	2012/2025	33
	Selenium	Dissolved	mg/L	0.0046	Freshwater aquatic life; chronic	0.0030	0.0003	0.0009	2012/2025	29
	Cadmium[c]	Dissolved	mg/L	0.00017		0.00037	0.00005	0.00019	2012/2025	29
	Copper[c]	Dissolved	mg/L	0.0058		0.0022	0.0003	0.0009	2012/2025	29
	Zinc[c]	Dissolved	mg/L	0.076		0.034	0.003	0.014	2012/2025	29
	Mercury	Dissolved	µg/L	0.05	Human health[d]	0.0044	0.0005	0.0012	2012/2025	27
SCGS	*Subarctic Creek*[e]									
	Selenium	Dissolved	mg/L	0.0046	Freshwater aquatic life; chronic	0.0030	0.0003	0.0009	2012/2025	30
	Cadmium[c]	Dissolved	mg/L	0.00011		0.00030	0.00005	0.00012	2012/2025	30
	Copper[c]	Dissolved	mg/L	0.0033		0.0043	0.0003	0.0010	2012/2025	30
	Zinc[c]	Dissolved	mg/L	0.043		0.045	0.005	0.013	2012/2025	30
	Mercury	Dissolved	µg/L	0.05	Human health[d]	0.0046	0.0005	0.0010	2012/2025	26
RUBY	*Ruby Creek*[f]									
	Selenium	Dissolved	mg/L	0.0046	Freshwater aquatic life; chronic	0.0030	0.0003	0.0010	2012/2023	29
	Cadmium[c]	Dissolved	mg/L	0.00027		0.00030	0.00003	0.00008	2012/2023	28
	Copper[c]	Dissolved	mg/L	0.01		0.0023	0.0003	0.0007	2012/2023	29
	Zinc[c]	Dissolved	mg/L	0.13		0.022	0.002	0.006	2012/2023	28
	Mercury	Dissolved	µg/L	0.05	Human health[d]	0.0178	0.0005	0.0015	2012/2023	28

SITE	CONSTITUENT	FRACTION	UNITS	ALAKSA WQS	REFERENCE STANDARD	MAXIMUM VALUE	MINIMUM VALUE	AVERAGE	SAMPLE COLLECTION DURATION (START YEAR/END YEAR)	NUMBER OF SAMPLES
CCAR	*Cabin Creek*[g]									
	Selenium	Dissolved	mg/L	0.0046	Freshwater aquatic life; chronic	0.0012	0.0005	0.0010	2017/2022	8
	Cadmium[c]	Dissolved	mg/L	0.00015		0.00005	0.00002	0.00003	2017/2022	8
	Copper[c]	Dissolved	mg/L	0.0049		0.0010	0.0002	0.0004	2017/2022	8
	Zinc[c]	Dissolved	mg/L	0.064		0.011	0.003	0.005	2017/2022	8
	Mercury	Dissolved	µg/L	0.05	Human health[d]	0.0023	0.0005	0.0009	2017/2022	8
KRAA	*Kogoluktuk River*[h]									
	Selenium	Dissolved	mg/L	0.0046	Freshwater aquatic life; chronic	0.0030	0.0004	0.0009	2013/2022	12
	Cadmium[c]	Dissolved	mg/L	0.0003		0.00030	0.00006	0.00016	2013/2022	11
	Copper[c]	Dissolved	mg/L	0.011		0.002	0.001	0.001	2013/2022	12
	Zinc[c]	Dissolved	mg/L	0.15		0.015	0.003	0.009	2013/2022	12
	Mercury	Dissolved	µg/L	0.05	Human health[d]	0.0017	0.0005	0.0008	2013/2022	12
RIBF	*Riley Creek*[i]									
	Selenium	Dissolved	mg/L	0.0046	Freshwater aquatic life; chronic	0.0025	0.0004	0.0008	2016/2022	12
	Cadmium[c]	Dissolved	mg/L	0.00024		0.00025	0.00002	0.00005	2016/2022	12
	Copper[c]	Dissolved	mg/L	0.0089		0.0005	0.0002	0.0003	2016/2022	12
	Zinc[c]	Dissolved	mg/L	0.12		0.005	0.003	0.004	2016/2022	12
	Mercury	Dissolved	µg/L	0.05	Human health[d]	0.0009	0.0005	0.0006	2016/2022	12

SITE	CONSTITUENT	FRACTION	UNITS	ALAKSA WQS	REFERENCE STANDARD	MAXIMUM VALUE	MINIMUM VALUE	AVERAGE	SAMPLE COLLECTION DURATION (START YEAR/END YEAR)	NUMBER OF SAMPLES
WCBR	*Wesley Creek*[j]									
	Selenium	Dissolved	mg/L	0.0046	Freshwater aquatic life; chronic	0.0025	0.0005	0.0009	2016/2022	23
	Cadmium[c]	Dissolved	mg/L	0.00024		0.00025	0.00002	0.00003	2016/2022	23
	Copper[c]	Dissolved	mg/L	0.0089		0.0011	0.0002	0.0004	2016/2022	23
	Zinc[c]	Dissolved	mg/L	0.12		0.0166	0.0009	0.0047	2016/2022	23
	Mercury	Dissolved	µg/L	0.06	Human health[d]	0.0034	0.0005	0.0008	2016/2022	24

[a] Alaska chronic water quality criteria for freshwater aquatic life calculated based on the 15th percentile hardness of 60 mg/L as CaCO3.
[b] May not vary more than 0.5 pH unit from natural conditions.
[c] Hardness-dependent criteria.
[d] Consumption of water and aquatic organisms. For Clean Water Act implementation purposes, a chronic aquatic life standard of 0.012 µg/L is applied.
[e] Alaska chronic water quality criteria for freshwater aquatic life calculated based on the 15th percentile hardness of 31 mg/L as CaCO3.
[f] Alaska chronic water quality criteria for freshwater aquatic life calculated based on 15th percentile hardness of 116 mg/L as CaCO3.
[g] Alaska chronic water quality criteria for freshwater aquatic life calculated based on 15th percentile hardness of 49 mg/L as CaCO3.
[h] Alaska chronic water quality criteria for freshwater aquatic life calculated based on 15th percentile hardness of 133 mg/L as CaCO3.
[i] Alaska chronic water quality criteria for freshwater aquatic life calculated based on 15th percentile hardness of 99 mg/L as CaCO3.
[j] Alaska chronic water quality criteria for freshwater aquatic life calculated based on 15th percentile hardness of 99 mg/L as CaCO3.

3.3.3 Preliminary Analysis of Impacts

Construction

During construction, many impacts to surface water hydrology and water quality would be localized and temporary and would be mitigated through the use of BMPs and project controls. Without planned control measures, potential impacts to surface water hydrology and water quality could generally include increased turbidity and sedimentation in streams from ground disturbance, stormwater runoff from gravel infrastructure, and dust or gravel spray from vehicle traffic on unpaved roads. BMPs such as sediment fencing, water sprays, surface stabilization, and dust suppression would be used to minimize effects.

Culvert and bridge installation may temporarily increase suspended sediment concentrations in waterbodies, but erosion and sediment control practices would limit sediment delivery to receiving streams.

Construction of the TMF and the WRF would require approximately 45,550 ft (13,870 m) of Subarctic Creek and its tributaries to be filled or otherwise rerouted. These diversions would permanently alter localized drainage patterns but would be designed to maintain overall flow continuity and minimize downstream hydrologic disruption.

Open pit construction and dewatering would not affect groundwater levels or reduce baseflow contributions to Subarctic Creek due to low total pit inflow rates, which would be managed with in-pit sumps (SRK 2017).

Operation

During mine operations, airborne material generated from blasting, mining, crushing, and concentrate transfer and transport processes could settle in surface waters. BMPs such as water sprays, surface stabilization, and dust suppression would be used to minimize effects.

The WRCP, TMF, and Process Pond would collect, store, and recycle contact water. The water accumulated in these impoundments may warm seasonally due to their larger surface areas and longer residence times compared to natural creeks. However, all contact water would be treated prior to discharge, and effluent would be released at or near ambient stream temperatures. Typical ambient air and water temperatures do not naturally approach 15°C (the Alaska WQS for temperature) (SRK 2024). Therefore, discharge temperature will not naturally exceed these limits without significant energy inputs during processing.

Non-contact water will be diverted around mine infrastructure to Subarctic Creek. Groundwater in the pit would be managed with in-pit sumps and a groundwater seepage monitoring and collection system will be located down gradient of the WRF and WRCP. Groundwater would be conveyed to the WRCP for temporary storage then directly to the WTP for treatment before discharge to Subarctic Creek.

The WTP for the Project is designed with a maximum discharge capacity of 18,500 cubic meters per day (m^3/d) (4.9 million gallons per day [mgd[), which is the highest monthly average flow the facility is designed to handle during any phase of the Project. Design of the WTP is based on geochemical analysis results and the water and load balance model (SRK 2024).

During the operational period (Mine Years 1-13), the expected average daily flow is about 15,000 m^3/d (4.0 mgd), with seasonal variation driven by snowmelt and runoff. Treated effluent from the RO system (RO permeate) would be discharged to Subarctic Creek, while RO reject (concentrated brine and treatment residuals) would be returned to the TMF for containment and storage. This operational discharge would be released primarily from May through December, with flows tapering during winter months, or eliminated dependent on mill water demands (SRK 2024).

Influent to the WTP would consist primarily of contact water collected in the WRCP, including runoff, pit inflows, and seepage from the WRF. This water would be moderately buffered, with alkalinity ranging from approximately 25 to 35 mg/L)as $CaCO_3$. Major ions in the influent would include sulfate concentrations between about 200 and 500 mg/L, chloride between 3 and 8 mg/L, and calcium and magnesium typically ranging from 50 to 100 mg/L each. Nitrogen would be present primarily as nitrate (15-20 mg of nitrogen per liter [N/L]), with ammonia (1-3 mg N/L) and trace nitrite (~0.8 mg N/L). Dissolved metals are dominated by iron (50-120 mg/L) and manganese (1-3 mg/L), with measurable concentrations of copper and zinc (0.05-0.2 mg/L). Selenium concentrations would be generally between 0.1 and 0.3 mg/L, while cyanide and thiocyanate would be present at low levels (typically <0.002 mg/L) (SRK 2024).

Anticipated Treatment Performance

The WTP is designed to effectively treat all parameters to meet Alaska WQS (18 AAC 70) prior to discharge to Subarctic Creek. A mass balance was developed to monitor key parameters, chemical inputs, and residuals at the WTP. Mass balances were prepared for maximum and average water quality and quantity conditions across three phases: Operations, Closure Phase 1, and Closure Phase 2. The WTP is anticipated to meet Alaska WQS throughout all phases, as shown in Tables 3.5 through 3.7. Note that all of these projections will be updated during preparation of Water Management Plan by the end of the 2026 but the results are not anticipated to change the determination that all WQS will be met at the discharge.

The following components warrant special consideration in the design and operation of the WTP:

- **Cadmium**: Cadmium would require a very high removal rate during Project closure to comply with Alaska WQS. Cadmium would be removed in each chemical treatment system as well as during the ultrafiltration process, allowing multiple opportunities to achieve the high removal rate. High-rejection rate RO membranes would be used and replaced more frequently than in typical applications to maximize rejection (i.e., minimize leakage of cadmium into the RO permeate). Additional RO polishing could be used during WTP operation to further treat the RO permeate if needed.
- **Zinc**: Like cadmium, zinc would require a very high removal rate, which would be achieved through several chemical treatment systems and ultrafiltration.
- **Sulfate**: Sulfate can be removed in the RO reject based on the saturation limit of the gypsum.
- **Selenium**: Selenium requires a high removal rate to comply with Alaska WQS. High-rejection RO membranes would be used and replaced more frequently than in typical applications to maximize rejection (i.e., minimize leakage of selenium into the RO permeate). Additional RO polishing could be used during WTP operations to further treat the permeate if needed. Once the RO brine is added, the biological treatment system would treat the RO brine to below Alaska WQS.
- **Total dissolved solids**: These would be removed through various treatment processes to meet Alaska WQS. Chemical addition (e.g., caustic, soda ash, hydrochloric acid, ferric chloride) will

contribute to total dissolved solids; therefore, chemical selection would be evaluated further in design engineering to properly balance total dissolved solids and constituent limits.

Table 3.5. WTP Influent and Effluent Water Quantity and Quality Estimates for Mine Operations (Year 1 through Year 12)

PARAMETER	UNITS	SUBARCTIC CREEK WQS	PROJECTED AVERAGE INFLUENT [a]	ESTIMATED AVERAGE EFFLUENT
Flow [b]	gpm		2,504	2,199
	mgd		3.61	3.17
Alkalinity	mg/L $CaCO_3$	> 20	28.2	20.0
Ammonia, total	mg-N/L	5.9	1.80	0.11
Nitrate	mg-N/L	10	14.2	0.223
Nitrite	mg-N/L	1	0.622	0.013
Chloride	mg/L	230 [c]	6.932	0.429
Fluoride	mg/L	1	0.498	0.000
Sulfate	mg/L	250	468	1
Total cyanide	mg/L	0.0052	0.001	1.57E-05
Aluminum	mg/L	0.087	13.2	2.98E-04
Antimony	mg/L	0.006	0.0039	5.46E-05
Arsenic	mg/L	0.01	0.0040	1.03E-07
Barium	mg/L	2	0.058	0
Cadmium	mg/L	0.00011	0.096	3.24E-05
Calcium	mg/L		111	8
Chromium	mg/L	0.011 [d]	0.00025	1.58E-05
Cobalt	mg/L	0.05	0.053	3.27E-04
Copper	mg/L	0.0033	3.424	0.0008
Iron	mg/L	1	1.985	0.073
Lead	mg/L	0.0007	0.0036	1.20E-06
Lithium	mg/L	2.5	0.0212	2.78E-05
Magnesium	mg/L		25.48	0.06
Manganese	mg/L	0.2	1.885	0
Mercury	ng/L	50	1.92	0.001
Molybdenum	mg/L	0.01	0.0019	9.90E-06
Nickel	mg/L	0.019	0.270	6.06E-05
Potassium	mg/L		6.874	0.078
Selenium	mg/L	0.0046	0.088	0.0009
Silicon	mg/L		2.941	0.022

PARAMETER	UNITS	SUBARCTIC CREEK WQS	PROJECTED AVERAGE INFLUENT [a]	ESTIMATED AVERAGE EFFLUENT
Silver	mg/L	0.0004	0.00008	3.41E-08
Sodium	mg/L		4.225	0.125
Strontium	mg/L		0.676	0.00E+00
Thallium	mg/L	0.0017	0.00012	7.68E-08
Uranium	mg/L	0.03	0.253	0.0027
Zinc	mg/L	0.043	17.25	0.0029
Total dissolved solids [e]	mg/L	500	709	30
Total suspended solids [f]	mg/L		100	0
Chemical Oxygen Demand (COD)	mg/L			0

[a] WTP influent flow and water quality forecast by SRK for the "L-Base" case, February 3, 2022.
[b] Flows and concentrations presented do not include values for months outside of the WTP operating season.
[c] When associated with sodium
[d] Cr(VI) WQS shown. Cr(III) WQS = 0.028 mg/L
[e] Total dissolved solids assumed to be equal to the sum of the ions
[f] The total suspended solids present in the WTP influent were not projected as part of SRK's water chemistry balance. The value presented was assumed based on prior experience and that RO essentially removes all suspended solids.

Table 3.6. WTP Influent and Effluent Water Quantity and Quality Estimates for Mine Closure Phase 1 (Year 13 through Year 27)

PARAMETER	UNITS	SUBARCTIC CREEK WQS	PROJECTED AVERAGE INFLUENT [a]	ESTIMATED AVERAGE EFFLUENT WQ
Flow [b]	gpm		2,045	2,174
	mgd		2.94	3.13
Alkalinity	mg/L $CaCO_3$	> 20	25.2	20.0
Ammonia, total	mg-N/L	5.9	0.106	0.09
Nitrate	mg-N/L	10	2.627	0.161
Nitrite	mg-N/L	1	0.191	0.185
Chloride	mg/L	230 [c]	32.305	103.714
Fluoride	mg/L	1	0.799	4.04E-05
Sulfate	mg/L	250	711	212
Total cyanide	mg/L	0.0052	0.003	1.85E-04
Aluminum	mg/L	0.087	33.909	2.46E-03
Antimony	mg/L	0.006	0.0038	5.08E-05
Arsenic	mg/L	0.01	0.0038	3.65E-07
Barium	mg/L	2	0.053	2.7885E-06
Cadmium	mg/L	0.00011	0.180	5.41E-05
Calcium	mg/L		142	9
Chromium	mg/L	0.011 [d]	0.00119	1.04E-03
Cobalt	mg/L	0.05	0.085	4.94E-04
Copper	mg/L	0.0033	2.143	0.0005
Iron	mg/L	1	11.307	0.849
Lead	mg/L	0.0007	0.0270	9.43E-06
Lithium	mg/L	2.5	0.0457	3.28E-04
Magnesium	mg/L		18.78	0.23
Manganese	mg/L	0.2	2.593	5.47E-04
Mercury	ng/L	50	8.78	0.003
Molybdenum	mg/L	0.01	0.0183	3.13E-04
Nickel	mg/L	0.019	0.426	1.07E-04
Potassium	mg/L		7.885	3.842
Selenium	mg/L	0.0046	0.184	0.0021
Silicon	mg/L		6.688	3.247
Silver	mg/L	0.0004	0.00332	1.49E-06
Sodium	mg/L		24.004	76
Strontium	mg/L		0.594	3.13E-05

PARAMETER	UNITS	SUBARCTIC CREEK WQS	PROJECTED AVERAGE INFLUENT [a]	ESTIMATED AVERAGE EFFLUENT WQ
Thallium	mg/L	0.0017	0.00013	8.22E-08
Uranium	mg/L	0.03	0.990	0.0102
Zinc	mg/L	0.043	33.67	0.0051
Total dissolved solids [e]	mg/L	500	1,058	430
Total suspended solids [f]	mg/L		100	0
Chemical Oxygen Demand (COD)	mg/L			1.1

[a] WTP influent flow and water quality forecast by SRK for the "L-Base" case, February 3, 2022.
[b] Flows and concentrations presented do not include values for months outside of the WTP operating season.
[c] When associated with sodium
[d] Cr(VI) WQS shown. Cr(III) WQS = 0.028 mg/L

Table 3.7. WTP Influent and Effluent Water Quantity and Quality Estimates for Mine Closure Phase 2 (Year 28+)

PARAMETER	UNITS	SUBARCTIC CREEK WQS	PROJECTED AVERAGE INFLUENT [a]	ESTIMATED AVERAGE EFFLUENT WQ
Flow [b]	gpm		1,554	1,543
	mgd		2.24	2.22
Alkalinity	mg/L $CaCO_3$	> 20	20.507	20.0
Ammonia, total	mg-N/L	5.9	0.055	0.05
Nitrate	mg-N/L	10	0.279	0.017
Nitrite	mg-N/L	1	0.158	0.155
Chloride	mg/L	230 [c]	19.657	93.091
Fluoride	mg/L	1	0.433	2.24E-05
Sulfate	mg/L	250	463	214
Total cyanide	mg/L	0.0052	0.002	1.51E-04
Aluminum	mg/L	0.087	34.713	2.56E-03
Antimony	mg/L	0.006	0.0009	1.27E-05
Arsenic	mg/L	0.01	0.0037	3.60E-07
Barium	mg/L	2	0.042	2.2512E-06
Cadmium	mg/L	0.00011	0.160	4.81E-05
Calcium	mg/L		59.18	9
Chromium	mg/L	0.011 [d]	0.00046	4.13E-04
Cobalt	mg/L	0.05	0.093	5.38E-04
Copper	mg/L	0.0033	2.459	0.0006
Iron	mg/L	1	14.923	0.861
Lead	mg/L	0.0007	0.0343	1.20E-05
Lithium	mg/L	2.5	0.0453	3.31E-04
Magnesium	mg/L		15.70	0.19
Manganese	mg/L	0.2	1.751	3.77E-04
Mercury	ng/L	50	5.67	0.002
Molybdenum	mg/L	0.01	0.0016	2.69E-05
Nickel	mg/L	0.019	0.541	1.36E-04
Potassium	mg/L		4.298	2.133
Selenium	mg/L	0.0046	0.019	0.0002
Silicon	mg/L		7.439	3.679
Silver	mg/L	0.0004	0.00033	1.47E-07
Sodium	mg/L		4.662	37
Strontium	mg/L		0.341	1.84E-05

Thallium	mg/L	0.0017	0.00007	4.65E-08
Uranium	mg/L	0.03	0.965	0.0099
Zinc	mg/L	0.043	32.64	0.0050
Total dissolved solids [e]	mg/L	500	684	380
Total suspended solids [f]	mg/L		100	0
Chemical Oxygen Demand (COD)	mg/L			1.2

[a] *WTP influent flow and water quality forecast by SRK for the "L-Base" case, February 3, 2022 (SRK 2022).*
[b] *Flows and concentrations presented do not include values for months outside of the WTP operating season.*
[c] *When associated with sodium*
[d] *Cr(VI) WQS shown. Cr(III) WQS = 0.028 mg/L*
[e] *Total dissolved solids assumed to be equal to the sum of the ions*
[f] *The total suspended solids present in the WTP influent were not projected as part of SRK's water chemistry balance. The value presented was assumed by BC based on prior experience.*

Figure 3.2 is a flow diagram of Operations water and load balance.

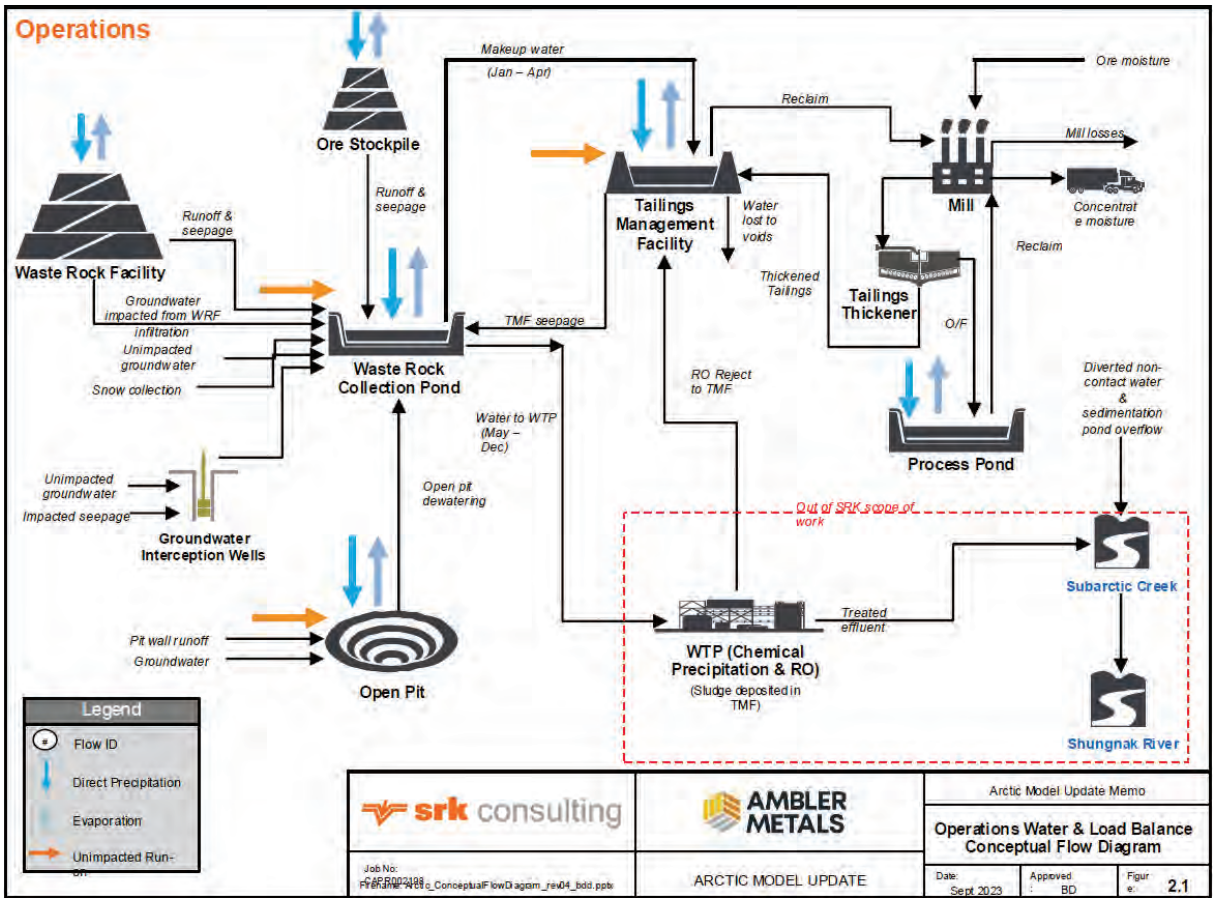


Figure 3.2. Operations Water and Load Balance

Closure (Phase I)

As the mine transitions into closure, treatment volumes would decrease along with reduced water inputs from mine facilities. In Closure Phase 1 (Mine Years 14-28), the WTP is projected to treat an average of 11,145 m^3/d (2.9 mgd). In the first three years of Phase 1, facilities would be removed and the WRF would be covered. During Mine Years 17-28, the TMF would be actively dewatered, with supernatant and porewater directed to the pit, gradually filling from TMF drainage, WRCP inflows, and direct precipitation.

Water from the pit would be pumped to the WTP for metals and sulfate removal prior to discharge. Influent chemistry during Closure Phase 1 reflects a mixture of pit water, tailings supernatant, and WRCP drainage. Relative to operations, concentrations of nitrogen compounds decline, while sulfate and dissolved metals (iron, manganese, zinc, and copper) would remain elevated. Selenium concentrations would persist in the range of approximately 0.1-0.2 mg/L. Influent alkalinity remains moderate (25-35 mg/L as $CaCO_3$) (SRK 2024).

A biological treatment system would be installed at the beginning of Closure Phase 1 to treat RO reject and water from the TMF, which could potentially increase temperature. Should discharge temperatures vary significantly from Subarctic Creek at the point of discharge, as determined by compliance with the WQS for temperature, heat exchangers may be necessary to lower the temperature.

Figure 3.3 is a flow diagram of Closure 1 Water and Load Balance.

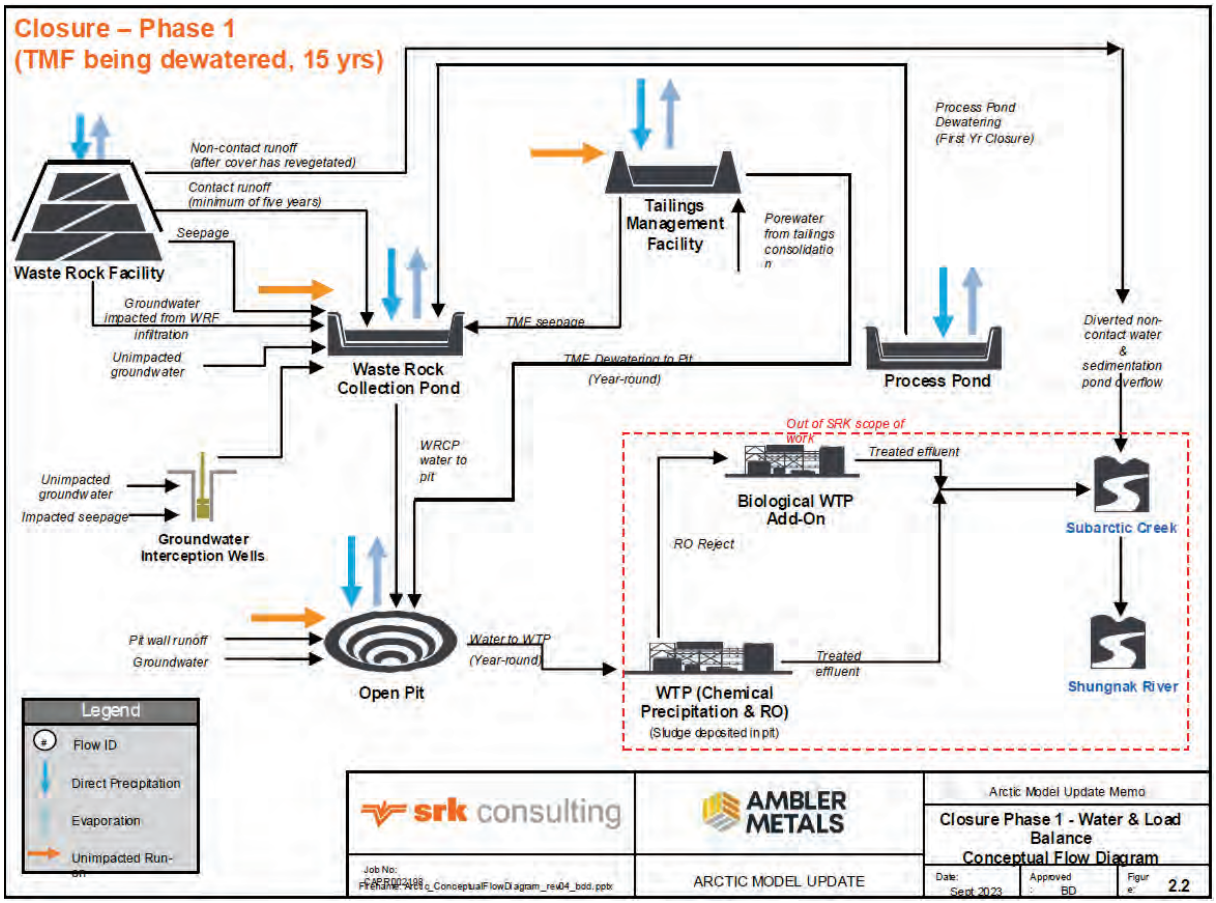


Figure 3.3. Closure Phase 1 Water and Load Balance

Closure (Phase 2)

By Closure Phase 2 (Mine Year 29 and beyond), flows would decline to approximately 8,469 m^3/d (2.2 mgd) to the WTP and occur year-round, driven by groundwater inflow and residual seepage rather than seasonal runoff. The TMF would continue to drain to the pit. The WRCP would continue to capture minor seepage and route it to the pit, but overall inflows to the WTP would decrease as the site transitions to passive containment and surfaces are revegetated. Pit water would remain the primary WTP influent, exhibiting modestly higher total dissolved solids and sulfate concentrations compared to operations but generally stable or declining metals.

Figure 3.4 is a flow diagram of Closure Phase 2 water and load balance.

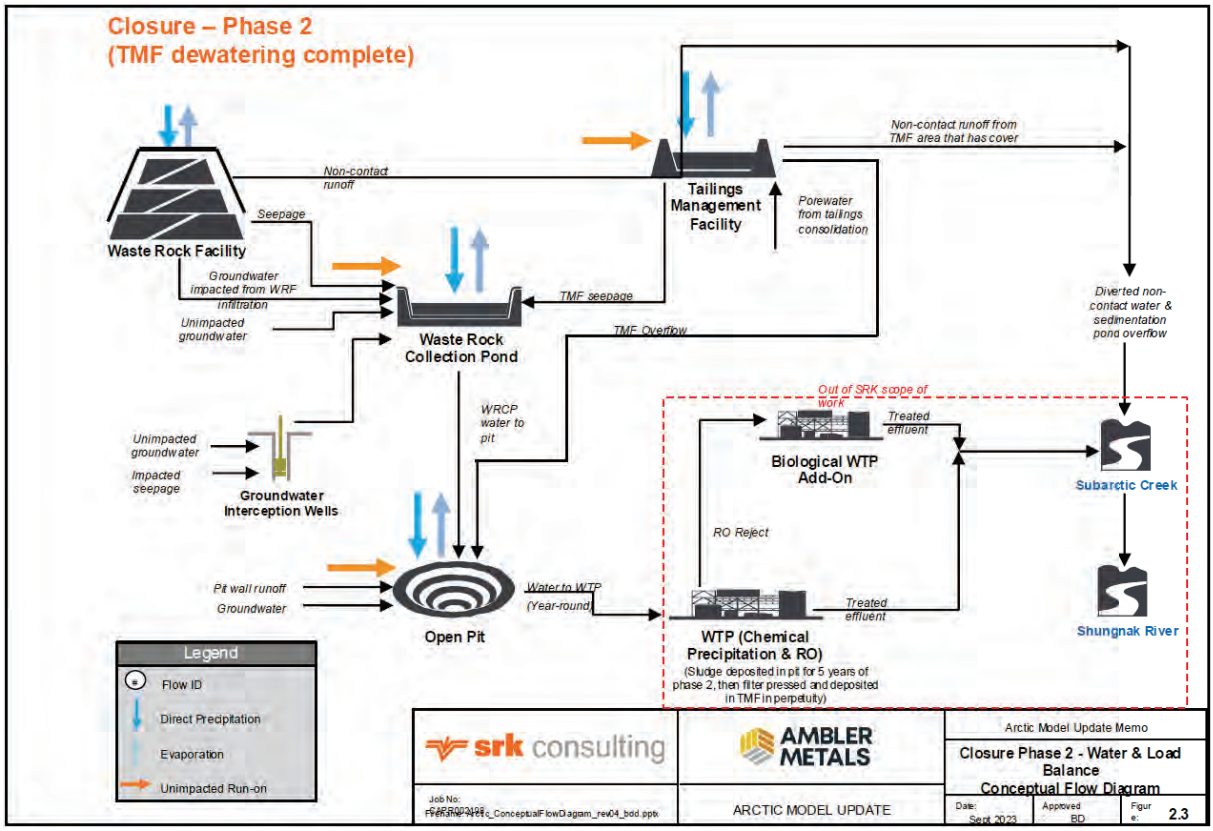


Figure 3.4. Closure Phase 2 Water and Load Balance

Water management and treatment is discussed in Section 2.1.4 and Section 2.1.5, respectively.

3.4 Groundwater

In total, from all programs over the last 10+ years, hydrogeological data is available from:

- 21 monitoring wells including two pumping wells in the valley bottom area; 12 boreholes with single or multiple vibrating wire piezometers (i.e., 25 VWP sensors in total) and seven standpipe piezometers in proposed pit area.
- 39 boreholes; 15 in the area of the proposed open pit and 24 in the valley bottom area

- Hydrogeologic testing data from 74 packer-based hydraulic tests; 19 slug tests; two pumping tests in valley bottom, each with an observation well; three extended injection tests in planned open pit area, one of six hours duration and two greater than 24 hours, each with monitoring at nearby vibrating wire piezometers (VWPs); 122 particle size distributions from test pits in valley floor
- Groundwater level series data from 24 VWPs and two standpipe piezometers in pit area; 20 water level dataloggers in the valley bottom, and manual observations from the monitoring wells
- Dedicated ground temperature cables at six locations in the valley floor; temperature from all VWP sensors, including those in the planned open pit area
- Groundwater quality data from 11 monitoring wells, collected quarterly to once per year, depending on access and location. Most wells are within the Subarctic Creek valley bottom, upgradient, within and downgradient of the proposed mine footprint.
- Data were compiled into conceptual models for the planned valley bottom WRF and water management areas, as well as for the open pit area. Hydraulic head data indicate that groundwater flow is topographically driven, with recharge in the uplands and discharge in the valley bottom. At the large scale, hydrostratigraphic units include overburden, weathered bedrock, and competent bedrock.

3.4.1 Existing Data

Data used to characterize subsurface hydrology and groundwater was collected for approximately ten years in the Subarctic Creek watershed. Groundwater chemistry data (water temperature, conductivity, pH, and dissolved oxygen) are available from 14 sites (Figure 3.1). The groundwater recharge rate is estimated to be between five percent and 30 percent of the Project area's mean annual precipitation, which is estimated to be approximately 51 inches (1,294 mm) per year (SRK 2017, 2020b; SRK 2022).

3.4.2 Existing Conditions

Throughout the Project area, groundwater conditions vary dependent on subsurface geology and other environmental factors. Overburden is generally thin with depths ranging from 0 to 50 ft (0 to 15 m) in the proposed TMF and WRF locations and generally thinner in the mine pit area. Pervasive weathering is present in the upper bedrock. If present, permafrost can also influence groundwater flow and recharge, although neither ice-bonded permafrost nor ground ice have been observed during drilling or excavating test pits at any of the proposed infrastructure locations (SRK 2019).

Subarctic Creek is primarily fed by snowmelt from the highlands. The streamflow regime occurs mostly as runoff in spring and early summer due to the melting snowpack. Low flows occur in winter when streams that are flowing are supplied by groundwater discharge (SRK 2020b). The subsurface flow pattern in the upper Subarctic Creek watershed is generally characterized by shallow subsurface flows within colluvium and alluvium deposits generally consisting of silty sand and gravel and silty gravel with sand, with zones of large cobbles and boulders. Morainal material is also present in the Subarctic Valley but it is very tight and dense, which has been interpreted to have low hydraulic conductivities to not conduct large volumes of water (SRK 2018). Very little groundwater is believed to flow through deep (intact) bedrock within the Subarctic Valley, and it is very likely most of the groundwater flows within the overburden, along the bedrock-overburden contact, and within weathered, fractured bedrock near the surface (SRK 2019).

Seeps and small streams occur where the top of bedrock is generally within 2 ft (0.6 m) or less of the surface. Groundwater flow is generally along the bedrock where the bedrock surface is greater than 2 ft

(0.6 m) . Groundwater along the Subarctic Valley is expressed at surface seeps (sampling sites SEEP 01, 02, 03 [Figure 3.1]) and to depth of 60 ft (18 m).

Testing in the open pit area revealed a groundwater depth range of 19 ft to over 330 ft (5.9 m to over 100 m) (BGC 2013; SRK 2024). The open pit area has low hydraulic conductivity and recharge but also contains multiple water systems, including a (regional) shallow perched water table in the northeastern corner and a deeper water table extending over most of the proposed pit footprint (SRK 2017). The annual groundwater recharge rate is estimated to be 7.4 inches (187 mm) per year and groundwater inflow into the pit represents between seven percent to 34 percent of total inflow into the pit; the primary source of pit inflow would be runoff from the pit walls. Groundwater inflow into the open pit is estimated to range from a low of approximately 34,000 gallons per day (gpd) (130 m^3/d) during Year 2, to a high of approximately 261,500 gpd (990 m^3/d) during Year 12. The base case groundwater inflows range from approximately 79,200 to 111,000 gpd (300 to 400 m^3/d) from Year 2 to Year 12. Pit wall runoff is anticipated to contribute between 500,000 to 875,000 gpd (1,900 to 3,300 m^3/d) into the pit (SRK 2024).

3.4.3 Groundwater Quality

Groundwater quality data indicates that calcium is the dominant cation in all groundwater samples, with sulfate being the dominant or partially dominant anion. Sulfate concentrations were generally low, with only one sample above the Alaska WQS. The dominant presence of sulfate suggests groundwater may be locally affected by sulfur-containing minerals in the ore body. Dissolved metal concentrations were below the Alaska WQS with the exception of dissolved cadmium and total manganese. Considering groundwater is naturally affected by the ore body chemistry, the occurrence of associated trace elements is expected under baseline conditions (SRK 2020).

3.4.4 Operating and Closure Conditions

During Operations, pit wall runoff and groundwater discharge would be pumped to the WRCP prior to treatment in the WTP. After closure, water collected at the WRCP and pit wall runoff would be stored in the pit prior to being pumped to the WTP for treatment (Section 2.1.5, *Water Treatment Plant*).

Water from the WRCP would be prevented from reentering the groundwater system prior to being pumped to the WTP through the use of an impermeable liner and two interception systems. The first interception system would be a cutoff wall constructed as a grout curtain installed through the overburden and fractured rock, and keyed into competent bedrock. The second interception system would consist of a series of pumping wells downgradient from the cutoff wall and extending into the competent rock to create a cone of depression, which would intercept any groundwater that may bypass the cutoff wall.

A water balance model for the pit indicates that low groundwater flows can be managed with in-pit sumps and require no specific dewatering efforts (SRK 2020b). At mine closure, water from the pit lake would be managed and treated before being discharged into Subarctic Creek (SRK 2018).

3.4.5 Preliminary Analysis of Impacts

Excavation of the open pit and construction of the TMF and WRF would interrupt the interaction of shallow groundwater and surface water and is a prime consideration of the overall water management plan. Diversion channels would be constructed around the pit edge and at the outer extents of the WRF (Figure 2.2; Graphic 2.5 and Graphic 2.6) to divert non-contact water away from these areas to Subarctic Creek (SRK 2018). Surface runoff and seepage from the WRF would be collected in the WRCP. Diversions are designed to convey 100-year, 24-hour rain-on-snow event peak flows. Collection channels would convey non-contact runoff to settling ponds prior to discharging to Subarctic Creek downgradient. Three diversion channels are proposed for non-contact water sources (Figure 2.2). Diversion channels would be excavated and armored (e.g., riprap) and carry both surface water and shallow groundwater. In addition, two groundwater interception systems would be located downgradient of the WRCP to intercept seepage into groundwater and contact water from the TMF, WRF, and WRCP. Pit inflows would be managed through in-pit sumps (SRK 2020b).

During operations and closure, groundwater flow would be altered by being rerouted and treated before discharge into Subarctic Creek, potentially in perpetuity. Elemental concentrations in groundwater exposed to and collected by mining operations and infrastructure would be treated to meet Alaska WQS.

3.5 Fish

3.5.1 Existing Data

Tetra Tech, Inc. conducted aquatics sampling in 2010 (Tetra Tech 2010) in relation to a proposed road alignment between the Bornite and Arctic deposits and documented the presence or absence of fish species. ADF&G conducted sampling in 2016 to 2019 and 2021 to 2025 to characterize aquatic habitats and species in the Project area (ADF&G 2018a, 2020, 2022, 2023, 2024, 2025a). ADF&G has documented fish species, distribution, sizes, and the location of possible spawning locations as well as aquatic invertebrate species and densities. A subset of sampled fish was analyzed annually for whole body element concentrations. ADF&G also collected periphyton to characterize in-situ productivity. ABR, Inc. (ABR) (2014) and Lemke et al. (2013) also documented fish habitat characterization. Sampling locations are shown in Figure 3.5.

3.5.2 Existing Conditions

The Project would be constructed in the upper Kobuk River watershed along the southern flank of the Brooks Range and would impact named and unnamed tributaries to the Shungnak and Kogoluktuk rivers, which are tributaries of the Kobuk River (ADF&G 2020). Sampled Shungnak River tributaries include Ruby, Cabin, Camp, Jay, Subarctic, Sunshine, Red Rock, and Center of the Universe creeks (Figure 3.2). Riley Creek, a tributary to the Kogoluktuk River, has also been sampled, because the Riley Creek watershed would contain the camps and the concentrate laydown yard.

3.5.2.1 *Fish*

The Shungnak River drainage supports self-sustaining populations of Arctic grayling (*Thymallus arcticus*), Dolly Varden (*Salvelinus malma*), round whitefish (*Prosopium cylindraceum*), longnose sucker (*Catostomus catostomus*), Alaska blackfish (*Dallia pectoralis*), and slimy sculpin (*Cottus cognatus*).

A large waterfall (approximately 15- to 30-foot [4.5- to 9-m]-tall) downstream of the Project in the lower Shungnak River lacks resting or transition areas for fish and therefore prevents fish passage into upstream reaches of the River (ADF&G 2017; Tetra Tech 2011). As a result, no anadromous fish occur in the Project area, and resident fish in the Shungnak River watershed complete their life cycle upstream of the waterfall (ADF&G 2020). The waterfall is approximately 17 miles (27 km), straight-line distance, south of where Subarctic Creek enters the Shungnak River (Graphic 3.2 and Figure 3.5).



Graphic 3.2. Waterfall and Anadromous Fish Barrier on the Shungnak River

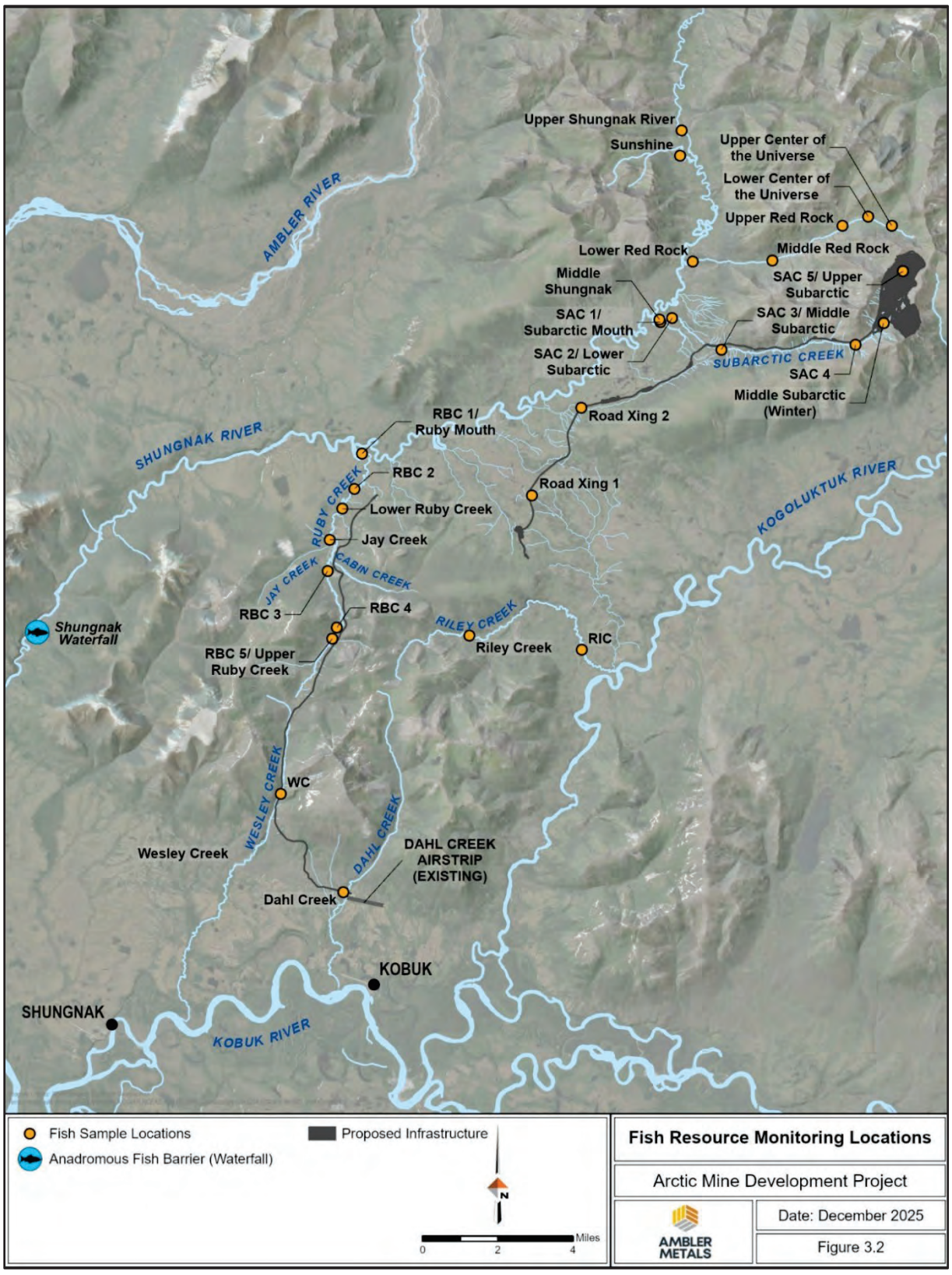


Figure 3.5. Fish Resources Monitoring Locations

Slimy sculpin occurred in most creeks sampled in the Project area but were generally limited to lower gradient areas. No slimy sculpin were caught in upper Subarctic Creek, upper Red Rock Creek, or Center of the Universe Creek. Larval slimy sculpin have been captured in lower Subarctic and upper Ruby creeks, indicating that spawning occurs in these areas (ADF&G 2017, 2018a).

Dolly Varden were observed at every sampling site and were the dominant fish species in Subarctic and Red Rock creeks; Dolly Varden spawning has been confirmed in upper Subarctic Creek and Red Rock Creek with the capture of young fish and ripe females (ADF&G 2020). The September 2018 and 2019 sampling provided additional spawning evidence with the capture of ripe males and likely females at upper Center of the Universe Creek (ADF&G 2020). Dolly Varden captured in 2016 to 2024 ranged from 0.8 to 7.4 inches (20 to 189 mm) in length. Reproductively mature fish captured in the fall sampling (September 2018 and 2019) (i.e., fish that expelled milt or eggs when gently squeezed), ranged in length from 4.3 to 6.9 inches (110 to 176 mm).

Fish sampling in March 2021 and April 2022 confirmed that Dolly Varden overwinter in Upper Subarctic Creek and Center of the Universe Creek, where portions of each creek remain open all winter due to consistent groundwater flows (ADF&G 2022, 2023).

The Dolly Varden captured in Riley Creek have the potential to be anadromous, as there is no permanent physical barrier downstream. Additional fall surveys in the Kogoluktuk River for Dolly Varden could confirm the presence or absence of anadromous fish. The genetic baseline information for Subarctic Creek Dolly Varden shows they are reproductively isolated from anadromous populations in the greater Kobuk River drainage and have less genetic variation than anadromous Dolly Varden found in the Kobuk River. Additional genetic samples taken from Red Rock Creek Dolly Varden indicate that Upper Subarctic Creek and Red Rock Creek have separate breeding populations (ADF&G 2020).

Arctic grayling, round whitefish, Alaska blackfish, Dolly Varden, slimy sculpin, and longnose suckers use Lower Ruby Creek. Juvenile Arctic grayling, round whitefish, and longnose suckers have been caught in a fyke net near the mouth of Ruby Creek, but it is unknown where spawning occurs (ADF&G 2020).

3.5.2.2 *Aquatic Invertebrates*

Aquatic invertebrates observed in the Shungnak River watershed are comprised of *Diptera* (primarily chironomids), invertebrates from the orders *Ephemeroptera* (mayflies), *Plecoptera* (stoneflies), and *Trichoptera* (caddisflies), and other species; the orders *Ephemeroptera, Plecoptera, and Trichoptera* are commonly referred to as EPT. *Diptera* were the most prevalent invertebrates documented in the watershed and EPT were the least prevalent. Over all years of sampling (2016-2024), Upper Ruby Creek and Upper Subarctic Creek typically have the highest aquatic invertebrate densities. Lower Red Rock Creek and the Shungnak River site generally have the lowest densities (ADF&G 2025a).

3.5.2.3 *Fish Habitat*

The substrate of the Shungnak River is comprised of boulders, cobbles, gravel, and sand where the River has riffle-run flow. The cobble and gravel-rich substrate provides suitable spawning habitat for Arctic grayling, Dolly Varden, round whitefish, longnose sucker, and slimy sculpin. In places where there is slack water, the substrate is dominated by fine sediments such as silt and clay. Instream coverage of vegetation is sparse to moderately abundant (ABR 2014). Filamentous algae, woody debris, and overhanging vegetation provide refuge for smaller fish. At the confluence with Subarctic Creek, the river channel is slightly to moderately incised, and the dominate river substrate is gravel and small cobble (Graphic 3.3).

Ruby Creek is a large stream with gravel to silt substrates that drains to the Shungnak River (Tetra Tech 2011). Upper Ruby Creek is characterized by dense vegetative cover, beaver ponds, deep water, short channels between beaver dams, and minimal gravel and cobbles. Lower Ruby Creek contains grass riparian habitats, pool/riffle habitat with shallower water, and gravel and cobble substrate. Throughout Ruby Creek, slimy sculpin dominated catches, followed by Dolly Varden, round whitefish, longnose sucker, and Alaska blackfish. Beaver dams are found throughout the watershed, which may impede upstream fish passage, though beaver ponds may also provide overwintering habitat in upper Ruby Creek by creating large, deep pools (ADF&G 2020). Cabin Creek, a small tributary to Ruby Creek, has very dense vegetation with a thick canopy cover and a high density of aquatic invertebrates (ADF&G 2020). Two kettle lakes display no signs of fish and no visible surface connections to fish-bearing streams (Tetra Tech 2011). Riley Creek is a tributary of the Kogoluktuk River and has a morphology similar to Ruby Creek. It has several fish habitat features such as pools, runs, and riffles. The stream substrate is dominated by gravel (Tetra Tech 2011). Slimy sculpin make up the majority of minnow trap catches in Riley Creek, followed by Dolly Varden. Arctic grayling are occasionally captured in minnow traps, and adult Arctic grayling have been observed in Riley Creek (ADF&G 2018a, 2025a).



Graphic 3.3. Shungnak River Sampling Location (ADF&G photo)

Lower Subarctic Creek is moderately entrenched with stable banks undercut and anchored by willow and other riparian vegetation with a substrate of gravel and small cobble (Tetra Tech 2010). Subarctic Creek in mid-valley is highly incised in a canyon with stable banks anchored by rock, dense willow, and other riparian vegetation. The dominant river substrates are large cobbles and boulders (Tetra Tech 2010) (Graphic 3.4).



Graphic 3.4. Lower Subarctic Creek (left) and Upper Subarctic Creek (right)

3.5.3 Preliminary Analysis of Impacts

Impacts to aquatic resources would be mitigated through the use of BMPs and project controls. Without planned control measures, potential impacts to aquatic resources could include the following:

- Increased turbidity and suspended sediments in streams from construction, stormwater runoff from gravel infrastructure, and dust and gravel spray from roads
- Airborne contaminants settling in water from blasting, mining, crushing, and concentrate transfer and transport processes that could create dust
- Disturbance and displacement of fish at stream crossings if culverts are improperly installed or maintained
- Direct impacts from water withdrawal

Some loss of habitat is unavoidable, such as the area under the proposed TMF, WRF, and WRCP.

Construction of culverts at stream crossings may temporarily increase turbidity and suspended sediment in a localized area during construction. Stormwater runoff from gravel infrastructure, as well as deposition of dust and gravel spray from Project roads and pads, may add sediment to waterbodies in the dust shadow throughout the life of the Project.

Airborne contaminants created from blasting, mining, crushing, and concentrate transfer and transport processes could create dust that may settle in waterbodies within the dust shadow.

Discharge from the WTP would meet Alaska WQS for aquatic life in the receiving waterbody (Subarctic Creek). Discharge water is predicted to require long term treatment to meet Alaska WQS.

Construction of the TMF, WRF, and WRCP would permanently remove approximately 10,130.5 ft (3,087.8 m) of habitat for Dolly Varden in Subarctic Creek. Multiple areas of similar Dolly Varden habitat are available in the Shungnak River watershed.

3.6 Climate and Air Quality

3.6.1 Existing Data

Existing meteorological and ambient air available data sources in proximity to the Project area are limited. Site-specific meteorological data were collected at the Subarctic Valley Meteorological Station, in the Subarctic Valley at the Project location on the southern edge of the Brooks Range. These data were collected from October 1, 2018, through September 30, 2019. ADEC determined these meteorological data meets Prevention of Significant Deterioration (PSD) quality standards and accurately represents meteorological conditions for the Project vicinity. The station is still operating and collecting data. However, the more recently collected data have not been reviewed by ADEC and determined by ADEC to meet PSD quality standards.

Historical weather stations are limited in the Project area. Available meteorological and climatic data collected at the Ambler Airport (PAFM) National Oceanic and Atmospheric Administration (NOAA) Automated Surface Observing System (ASOS) station was selected to represent the meteorological and climate conditions of the Project area. The PAFM climatic data are based on a 30-year period of record (1991 through 2020) per World Meteorological Organization guidelines, except the PAFM precipitation data was selected from 1981 through 1992 because of significant data gaps during the 1993 through 2020 observation period.

Upper air meteorological data are available from the NOAA/Earth System Research Laboratory Radiosonde Database for Kotzebue, Alaska (Station ID: OTZ 26616 70133) if needed for any required Project dispersion modeling analyses. Upper air data are typically collected using a radiosonde (i.e., weather balloon) that measures the vertical distribution of physical atmospheric qualities such as pressure, temperature, wind speed, and wind direction.

The Graphite One Nome ambient air monitoring station is the closest ambient air quality station to the Project area that collects PSD-quality ambient air data. The Graphite One data set was collected from 2024 through 2025 and has been submitted to the ADEC for review and approval as meeting PSD data-quality standards. Pending the PSD quality review, ADEC has preliminarily approved the use of the Graphite One Nome data to represent ambient air background concentrations for any required dispersion modeling for the Project.

Table 3.8 lists the existing meteorology and climatic data sources used to characterize the climate and meteorology of the Project area.

Table 3.8. Existing Meteorological, Climatic, and Air Quality Data Sources for the Project Area

DATA TYPE	STATION NAME	STATION ID	LATITUDE, LONGITUDE	DATA PERIOD	DISTANCE AND DIRECTION FROM PROJECT
Climatic data	Ambler Airport NOAA ASOS	USC00500249 (GHCN)	67.11, -157.86	1981 through present	West 40 miles (64 km)
Surface meteorological data	ADEC-approved Trilogy Subarctic Valley Meteorological Station	N/A	67.18, -156.41	October 1, 2018, through September 30, 2019	Located at the Project site
Upper air meteorological data	NOAA Kotzebue, Alaska	OTZ 26616 70133	64.55, -165.41	October 2024 through September 2025	Southwest 298 miles (480 km)
Ambient air quality data	Graphite One Nome station	N/A	Approximately 69.37, -152.14	2024 through 2025	Northeast 180 miles (290 km)
Climatic data	Ambler West NOAA COOP Station	500260	67.05, -157.52	December 1, 1981 through March 31, 1992	West 31 miles (50 km)

3.6.2 Existing Conditions

The Project is in the northern region of the Central Interior climate zone, based on the climate boundary zones identified by NOAA. The Project area borders the Arctic Climate zone and can experience both Arctic and continental climates. The Arctic climate typically consists of very low mean annual temperatures and very low annual precipitation, while the continental climate consists of short, warm summers and long, very cold winters (Gallant et al. 1995). The regional climate is highly variable, and freezing temperatures can occur during any month. Precipitation increases with elevation.

3.6.2.1 *Climate and Meteorology*

3.6.2.1.1 Air Temperature

Table 3.9 lists the monthly mean, maximum, and minimum surface air temperatures and the maximum and minimum daily surface air temperatures observed at the Subarctic Valley Meteorological Station and the Ambler Airport. Note that the Subarctic Valley temperature statistics are based on 12 months of observations that the ADEC has determined meet PSD quality standards while the Ambler Airport temperature statistics are based on 30 years of observations.

The lowest temperatures typically occur during January, and the highest temperatures typically occur in July. This temperature pattern is consistent with the continental climate conditions in Interior Alaska.

The Project area has two main seasons that are characterized by ambient surface temperatures:

- Summer conditions occur May through September, during which the mean daily high temperature rises above 32°F (0°C).
- Winter conditions occur from October through April during which the mean daily high temperature rarely exceeds 32°F (0°C).

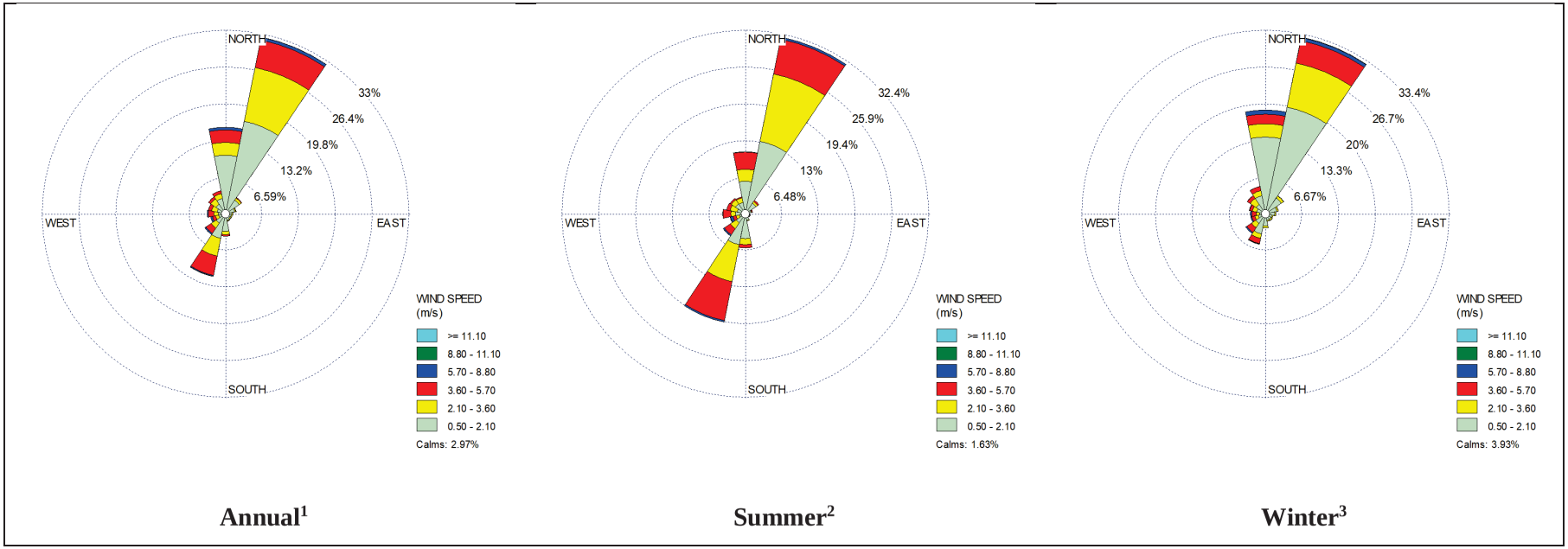
3.6.2.1.2 Wind

Annual summer and winter wind roses for the Subarctic Valley wind observations from October 1, 2018, through September 30, 2019, are provided in Graphic 3.5. The Subarctic Valley wind roses indicate prevailing winds at the Project location are typically from the north-northeast, with a more frequent south-southwesterly component in the summer. The annual average wind speed observed at the Subarctic Valley station from October 2018 through September 2019 was approximately 7.8 mph (3.5 meters per second [m/s]).

Table 3.9. Surface Air Temperatures at Subarctic Valley and Ambler Airport Locations

STATISTICAL PARAMETER	MONTH												ANNUAL
	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	
Subarctic Valley [a]													
Maximum daily mean temperature (°F)	29.4	30.2	33.8	39.7	47.2	64.5	72.4	52.2	51.7	55.1	26.1	25.5	72.4
Minimum daily mean temperature (°F)	-19.0	-10.1	1.3	12.7	26.3	45.0	45.1	41.7	29.6	3.2	4.0	-9.0	-19.0
Mean temperature (°F)	7.0	15.7	22.9	24.0	39.3	53.7	56.9	47.3	40.8	31.9	18.1	7.0	30.5
Maximum temperature (°F)	35.2	35.4	38.8	45.3	50.2	73.9	80.6	61.5	55.4	59.4	30.7	27.7	80.6
Minimum temperature (°F)	-23.1	-15.2	-1.7	7.7	20.3	38.7	41.7	36.3	24.3	0.5	1.2	-19.1	-23.1
Ambler Airport [b]													
Maximum daily mean temperature (°F)	2.1	7.8	8.6	31.3	50.1	61.4	61.2	56.3	47.9	33.5	13.5	6.5	61.4
Minimum daily mean temperature (°F)	-10.1	-7.6	-0.7	10.7	29.4	50.1	55.1	47.9	32.8	11.8	1.6	-6.4	-10.1
Mean temperature (°F)	-2.6	3.5	4.5	21.0	40.4	56.9	58.1	52.2	42.1	23.6	7.5	0.7	25.7
Maximum temperature (°F)	41.0	39.2	42.0	55.4	80.6	92.0	89.0	82.4	75.0	86.0	41.0	37.4	92.0
Minimum temperature (°F)	-52.6	-54.4	-51.9	-29.7	-0.4	24.8	32.0	25.0	9.0	-19.1	-40.0	-47.2	-54.4

Note: Subarctic Valley temperature statistics are based on 12 months of observations that the ADEC has determined meet all PSD quality standards while the Ambler Airport temperature statistics are based on 30 years of observations.
[a] Source: Trilogy Metals, Inc. and SLR International Corporation (2020), Subarctic Valley Meteorological Data - Period of Record (October 1, 2018, through September 30, 2019).
[b] Source: NOAA (2021); Iowa State University (2021).



Graphic 3.5. Wind Roses: Subarctic Valley Annual, Summer, and Winter Wind Frequency

Source: Trilogy Metals, Inc. and SLR International Corporation (2020)
Notes:
[1] Annual: October 1, 2018, through September 30, 2019
[2] Summer: May through September
[3] Winter: October through April

3.6.2.1.3 Relative Humidity, Barometric Pressure, and Solar Radiation

Table 3.10 lists the relative humidity, barometric pressure, and solar radiation observed at the Subarctic Valley Meteorological Station from October 2018 through September 2019. The mean solar radiation measurements are consistent with the seasonal changes between the summer and winter seasons. Higher solar radiation measurements are observed during the summer months, when the region experiences increased daily hours of sunlight typical of locations north of the Arctic Circle.

Table 3.10. Subarctic Valley Station: Relative Humidity, Barometric Pressure, and Solar Radiation

PERIOD	MEAN BAROMETRIC PRESSURE (mb)	MINIMUM BAROMETRIC PRESSURE (mb)	MAXIMUM BAROMETRIC PRESSURE (mb)	MEAN RELATIVE HUMIDITY (percent)	MINIMUM RELATIVE HUMIDITY (percent)	MEAN SOLAR RADIATION (W/m^2)	MAXIMUM SOLAR RADIATION (W/m^2)
October 2018	932.9	910.9	950.7	62.4	10.9	28.4	341.3
November 2018	933.7	909.6	951.5	72	25.6	4.4	93.9
December 2018	925.2	905.4	947.6	77.6	40.5	0.4	9.0
January 2019	934.9	902.4	950.3	69.3	24.6	2.1	39.5
February 2019	941.6	916.5	957.1	71.0	23.1	19.3	266.0
March 2019	935.8	906.1	961.3	75.8	28.6	65.6	529.2
April 2019	936.6	921.4	958.0	70.5	32.4	178.4	744.4
May 2019	939.1	926.2	952.0	67.0	35.6	221.0	859.0
June 2019	943.6	933.7	951.6	61.7	26.2	256.0	927.0
July 2019	941.4	931.4	956.2	75.4	29.9	165.7	772.7
August 2019	944.2	930.6	963.4	80.4	32.6	119.0	757.5
September 2019	935.2	921.6	952.9	74.4	39.5	63.2	616.4
Monitoring Year	937.0	902.4	963.4	71.5	10.9	93.8	927.0

Source: Trilogy Metals, Inc. and SLR International Corporation (2020).
mb= millibars; W/m^2 = watts per square meter

3.6.2.1.4 Precipitation

Table 3.11 lists average, maximum, and total precipitation and snowfall data collected at the Ambler West NOAA COOP meteorological station. The data are from December 1, 1981, through March 31, 1992, because of significant data gaps during the 1993 through 2020 observation period. Months with five or more missing days and years with one or more missing months were excluded from the mean and maximum totals. Precipitation usually accumulates during the late summer and fall. Snowfall typically occurs in September through May. The Ambler West area receives approximately 134 inches (340 cm) of total seasonal snowfall based on data collected from 1981 through 1992 (WRCC, 2012). The Ambler West location typically experiences 23 inches (584 mm) of precipitation per year based on data collected from 1981 through 1992 (WRCC 2012).

Table 3.11. Precipitation and Snowfall Data Collected at Ambler West NOAA COOP

STATISTICAL PARAMETER	MONTH												ANNUAL
	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	
Ambler West [1]													
Average Total Precipitation (inches)	1.15	1.13	0.92	1.59	1.48	1.33	2.66	4.50	4.35	1.72	0.55	1.67	23.06
Maximum Total Precipitation (inches)	3.31	3.04	2.49	5.05	2.88	2.87	5.07	7.47	8.73	3.01	0.87	3.05	25.26
Average Total Snowfall (inches)	19.7	16.7	17.6	17.2	4.1	0.0	0.0	0.0	3.7	17.9	9.6	27.5	134.0
Maximum Total Snowfall (inches)	44.3	41.8	45.0	65.7	15.9	0.2	0.0	0.1	7.8	37.0	18.1	54.3	141.4

Notes:
[1] Western Regional Climate Center (WRCC) 2012, NOAA COOP Station Climatic Data, Period of Record (1981-1992)

3.6.2.2 *Air Quality*

Under the Clean Air Act, the EPA established National Ambient Air Quality Standards (NAAQS) for six criteria air pollutants that are considered harmful to public health and the environment. The six criteria pollutants are: nitrogen dioxide (NO_2), carbon monoxide (CO), particulate matter ($PM_{2.5}$ [particulate matter with an aerodynamic diameter less than 2.5 microns] and PM_{10} [particulate matter with an aerodynamic diameter less than 10 microns]), sulfur dioxide (SO_2), ozone (O_3), and lead (Pb). Under 18 AAC 50.010, the State of Alaska adopted the federal NAAQS as Alaska Ambient Air Quality Standards (AAAQS) and established state ambient standards for two other air pollutants: reduced sulfur compounds and ammonia.

EPA has identified primary and secondary NAAQS. Primary standards have been established to protect the public health of sensitive populations, such as the elderly, children, or asthmatics. Secondary standards have been established for public welfare protection, including protection against decreased visibility, and impairment and preventing damage to crops, livestock, and vegetation.

The Project area is in the Northern Alaska Intrastate Air Quality Control Region. EPA has designated the Project area as in attainment or unclassifiable for all criteria air pollutants. The closest non-attainment area to the Project area is the Fairbanks North Star Borough $PM_{2.5}$ Nonattainment Area, approximately 292 miles (470 km) to the southeast.

3.6.3 Preliminary Analysis of Impacts

3.6.3.1 *Air Quality*

The Project area is within a Class II area for purposes of establishing requirements under the PSD air quality program. Four Class I areas exist in Alaska: Denali National Park, Bering Sea Wilderness Area, Tuxedni National Wilderness Area, and Simeonof National Wilderness Area. Denali National Park, including the Denali Wilderness Area, is the closest Class I area to the Project. The closest point on the boundary of the Denali National Park Class I area is approximately 250 miles (400 km) southeast of the Project.

Project emissions will be released from point sources, fugitive emission sources, and mobile equipment. Anticipated point emission sources include the processing plant/milling activities, fuel-powered generator engines, fuel-fired space heaters and boilers, emergency fuel-fired engines, fire pump engines, a camp waste incinerator, rock crushers, and fuel storage tanks. Anticipated fugitive emissions sources include the ore and overburden mining activities in the open pit, material stockpiles, material transfer activities, and traffic on unpaved roads. Anticipated mobile equipment emission sources include the engines on mining equipment (e.g., haul trucks, shovels, graders, front-end loaders), pick-up trucks, crew buses, and other tracked and wheeled equipment. A detailed inventory of the point, fugitive, and mobile equipment emission sources is not yet available.

The owner or operator of a new major stationary source is required to obtain an air quality permit before beginning any construction, as applicable under 18 AAC 50.306(a) and 40 CFR 52.21(a)(2)(iii), or 18 AAC 50.502(c)(1). Preliminary analyses suggest the Project will have three stationary sources for air permitting purposes – Arctic Mine including the mill, the CC/PAC, and Bornite Camp. Although only preliminary potential air pollutant emissions have been calculated, the Project would likely trigger the requirement to obtain a PSD permit for Arctic Mine prior to beginning actual construction. The CC/PAC would likely require a minor air quality construction permit pursuant to 18 AAC 50.502(c)(1), and Bornite Camp could likely avoid the need for an air permit by a combination of equipment selection and an owner-requested limit (ORL) under 18 AAC 50.225.

Among other requirements, the PSD permitting process includes preparing a source impact analysis to demonstrate the permitted air pollutant emissions will not cause or contribute to air pollution in violation of any NAAQS or any applicable maximum allowable increase over the baseline concentration. This ambient air quality modeling analysis may include near-field and far-field modeling of air quality impacts. The minor air quality construction permitting process also requires a near-field impact analysis to demonstrate compliance with the NAAQS. ORL sources are deemed too small to require a quantitative impact analysis.

The PSD permitting process includes preparing an additional impact analysis addressing the possible impairment to visibility, soils, and vegetation that could occur due to air emissions from the Project. Visibility impacts due to Project emissions at any Class I area are not expected because the nearest Class I area is over 250 miles (400 km) from the Project area. If requested by a federal land manager during the PSD permitting process, an analysis of anticipated visibility impacts on a Class I area would be prepared.

ADEC will not issue an air quality construction permit authorizing construction of the Project if protection of ambient air quality is not assured. As a result, air quality impacts will be limited, and protection of all ambient air quality standards and other applicable air quality criteria is assured. The NEPA document is expected to include more data, including, but not limited to, a summary of calculated concentrations of pollutants compared to NAAQS.

3.7 Wetlands and Vegetation

3.7.1 Existing Data

The Preliminary Wetlands Determination report (DOWL, 2018) was completed in 2018 and updated in 2019 and provides wetland information for the Project area. Wetlands were delineated in accordance with Part IV of the *Corps of Engineers Wetlands Delineation Manual* (USACE 1987) and the *Regional Supplement to the Corps of Engineers Wetland Delineation Manual: Alaska Region* (Version 2.0) (USACE 2007).

A Preliminary Jurisdictional Determination (PJD) was approved by USACE in June 2019 for a 10,171.7-acre (4,116-ha) study area, including the Arctic study area, the Subarctic study area, and the Bornite Lowlands study area. In subsequent years, additional wetland areas were delineated to address additional alternatives, bringing the total study area to 11,820 acres (4,783.4 ha).

3.7.2 Existing Conditions

USACE is the federal agency with authority to permit the discharge of dredged or fill material into WOTUS, including wetlands, under Section 404 of the CWA. The EPA and USACE define wetlands as areas that are inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions (USACE 1987).

Approximately 20 percent of the wetland delineation study area is comprised of wetlands (2,430.9 acres [983.8 ha]) and other waters (i.e., ponds and streams) (117.8 acres [47.7 ha]) (Figure 3.6). The majority, approximately 80 percent, of the delineation study area are uplands (9,271.3 acres [3,752 ha]) (Figure 3.6).

Plant communities in the Project area include spruce forests (*Picea glauca* and *P. mariana*); alder (*Alnus* spp.), willow (*Salix* spp.), and birch-dominated (*Betula* spp.) shrub communities; and herbaceous communities dominated by sedges (*Carex* spp.) and flowering herbaceous plants. Spruce forest habitat is primarily around the existing Bornite Camp and to the west of the Subarctic Creek drainage to the Shungnak River. The Ambler Lowlands have sparse spruce forests and mesic to wet herbaceous habitats (grasses, sedges, and flowering plants). Alder shrub habitat occurs on steep hillsides in the mountains around the Bornite Camp and the Subarctic Creek drainage. Low shrub dwarf birch (*Betula nana*) habitat occurs throughout the delineation study area, from alpine uplands to wetlands in the Ambler Lowlands. This habitat includes alpine blueberry (*Vaccinium uliginosum*), dwarf birch, and Labrador tea (*Rhododendron tomentosum*). Herbaceous habitat is also found on ridgetops.

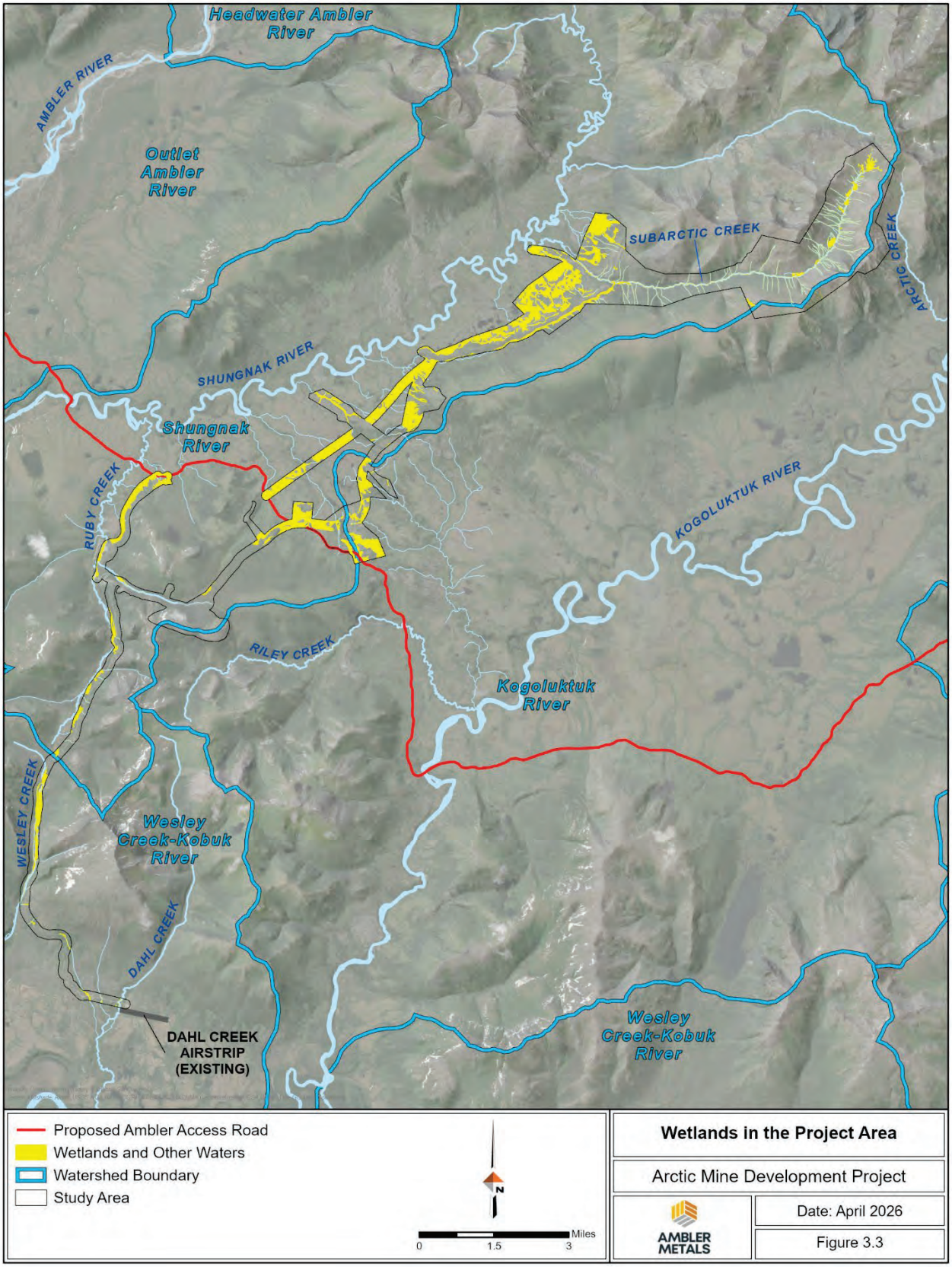


Figure 3.6. Wetlands and Other Water in the Project Area

The study area spans the following three ecoregions:

- Brooks Range (nine percent of the study area), which is characterized by steep, rugged mountains that are either barren of vegetation or contain dwarf scrub communities on drier sites with mesic to wet herbaceous communities in valleys (Gallant et al. 1995).
- Interior Highlands (68 percent of the study area), which is characterized by rounded, low mountains with dwarf scrub vegetation and open spruce stands (Gallant et al. 1005
- Interior Forested Lowlands and Uplands (23 percent of the study area), which is characterized by forests dominated by spruce and hardwood species (Gallant et al. 1995).

Vegetation communities in the study area include boreal forest, tundra, and riparian shrub communities. White and black spruce forests dominate vegetated hillslopes. Willows and alders inhabit most floodplain terraces and low scrub-shrub areas, whereas emergent tundra is more prevalent within the Subarctic Creek drainage.

3.7.2.1 *Identified Wetland Habitats and Other Waters*

The following seven habitat types were identified in the wetland delineation study area using Cowardin habitat classifications (Cowardin 1979):

1. **Emergent wetlands** (Cowardin classifications PEM1B, PEM1C, PEM1F, and PEM1H) are dominated by herbaceous vegetation highly adapted for life in saturated/flooded soil conditions. These wetlands are generally depressional or slightly concave (0 percent to 2 percent slopes). Emergent wetlands are closely associated with scrub-shrub drainages, riparian areas adjacent to upper perennial streams, on the fringes of open-water habitats, or at the toe of alpine slopes.
2. **Scrub-shrub wetlands** (Cowardin classifications PSS1/4B, PSS1/4C, PSS1B, PSS1C, PSS1F, PSS1H, PSS4/1B, PSS4B) are the second most abundant wetland habitat type in the study area and are characterized by less than 20 percent areal cover in the tree stratum and greater than 30 percent areal cover in the scrub-shrub stratum. These wetlands occur on a variety of terrains (e.g., hillsides, terraces, hummocks, swales) and are broadly dispersed throughout the study area.
3. **Scrub-shrub/emergent wetlands** (Cowardin classifications PSS1B/EM1B, PSS1/EM1C, PEM1/SS1B, PEM1/SS1C, PSS1/EM1H) are the most abundant wetland habitat type in the study area and are characterized by an herbaceous layer with at least 50 percent areal cover in combination with a robust scrub-shrub layer and either an absent or minimal tree layer (less than 30 percent areal cover). These wetlands are widely dispersed throughout the study area and occur on a variety of landforms.
4. **Scrub-shrub/forested wetlands** (Cowardin classification PSS1/FO4B) contain a dominant scrub-shrub layer in combination with at least 10 percent to 30 percent areal cover in the tree stratum. This habitat type was not identified in the Subarctic Valley. This wetland class is distinguished by a higher percentage of shrubs compared to trees.
5. **Forested/scrub-shrub wetlands** (Cowardin classifications PFO4/SS1B and PFO4/SS1C) mimic the scrub-shrub/forested wetlands in vegetation, soils, and hydrology; however, they are distinguished by having greater than 3 percent areal cover of black spruce rather than broad-leaved deciduous shrubs.
6. **Ponds/open water** (Cowardin classifications POW and PUBH) wetlands are characterized by open water that is permanently flooded. These ponds occur throughout the study area and are often associated with tussocky areas subject to regular sheet flow. Ponds provide a hydrologic connection between other wetland habitats. The substrates in open-water wetlands are typically unconsolidated muck, supporting little to no vegetation.

7. Riverine systems characterized by flowing water (exceptions apply), with clearly defined bed and banks, Two distinct riverine habitats that provide hydrologic connectivity to wetlands occur within the study area: upper perennial streams and intermittent streams as described below.
    a. Upper perennial streams (Cowardin classification R3UB1, R3UBH, R3USC, and R4UB1) are characterized by steep gradients, high-velocity flow, and no tidal influence; flow characteristics vary by levels of riffle glide morphology and intensity. These streams comprise nearly 100 percent of the total riverine habitats in the study area.
    b. Intermittent streams (Cowardin classification R4SBC) are characterized by deeply incised channels, slow water velocity, and intermittent flows. These streams were only identified in the Subarctic Valley area and occur within scrub-shrub swamps, bare rock swales, seep areas, or bare rock areas along old trails (within an established bed and bank). Flowing water is only present for part of the year (typically during the growing season); when water is not flowing, streams may remain in isolated pockets.

3.7.3 Preliminary Analysis of Impacts

3.7.3.1 *Mining and Support Facilities*

The Project's mining and support facilities would require fill of approximately 120.7 acres (48.9 ha) of wetlands and other waters (i.e., ponds and streams) to construct new gravel infrastructure (e.g., roads and pads), as listed in Table 3.12 by Cowardin habitat type. Wetland and other water impacts by watershed are provided in Table 3.13; impacts by Project component are summarized in Table 3.14.

Table 3.12. Direct Impacts from Mining and Support Facilities to Wetlands and Other Waters by Habitat Type (acres)

PROJECT COMPONENT	EMERGENT (PEM1C, PEM1F, PEM1H)	SCRUB-SHRUB/ EMERGENT (PSS1/EM1B, PSS1/EM1C)	SCRUB-SHRUB (PSS1B, PSS1C, PSS1/4B, PSS4/1B)	SCRUB-SHRUB/ FORESTED (PSS1/FO4B)	FORESTED/ SCRUB-SHRUB (PFO4/SS1B)	PONDS/OPEN WATER (POW)	RIVERINE (R3UB1, R3UBH, R4SBC)
Access Corridor & Tailings Pipeline Routing	0	0.04	0.12	0	0	0	0.03
Explosive Magazine Storage	0	0	0	0	0	0	0
Concentrate Logistics Yard	0	0	0	0	0	0	0
Construction & Permanent Camps	0.26	0	0.02	0	0	0	0.00
Laydown	0	0	0	0	0	0	0
Material Site 4	0.05	7.32	2.74	0	0	1.14	0.10
Material Site 9	0.71	14.63	1.51	2.32	0	1.82	0.19
Material Site 11	0.47	0	0.87	0	0	0	0.18
Material Site 12	0	0	0	0	0	0	0
Material Site 16	0	0	0	0	0	0	0
Mine Area Potential Impact Zone	0	1.70	0.72	0	0	0	0.81
North Route MP 0.0 – 8.8	0.21	7.36	4.43	0.10	0.81	0	0.18
North Route MP 8.8 – 13.6	0.27	0	0	0	0	0	0.20
Open pit	0	0	0	0	0	0	0.07
Operations Pad	0	10.69	0	0	0	0	0.38
Overburden stockpile	0		0	0	0	0	0.08
Overburden stockpile and Process plant pond	0	0.31	0	0	0	0	0.84
Mine Haul Roads	0		0	0	0	0	0.05
South Route MP 0.0 – 10.6	0.10	0.02	2.04	0	0	0.06	0.10
South Route MP 10.6 – 13.4	0	0.05	0	0.80	0.58	0	0.01
Tailing management facility	0	27.48	0	0	0	0	0.42
Tailings Pipeline	0	0.14	0	0	0	0	0.02
Temporary Construction Camp	0	0	0	0	0	0	0
Topsoil stockpile sedimentation pond	0	0	0	0	0	0	0.02
Waste Rock Facility	3.85	17.07	0	0	0	0	2.46
Waste Rock Collection Pond and Pond Dam	0	0.76	0	0	0	0	0.99
Widen Access Corridor & Remove Tailings Pipeline	0	0	0.01		0	0	0.01
Total [a]	5.93	87.56	12.47	3.21	1.39	3.02	7.12

Note: Habitat types are described using Cowardin (1979).
[a] Values may not total due to rounding.

Table 3.13. Direct Wetland and Other Water Impacts by Watershed (acres)

WATERSHED	CAMP	MINING FACILITIES	PROCESSING FACILITIES	SUPPORT FACILITIES	TRANSPORTATION FACILITIES	TOTAL
Kogoluktuk River	0.3	0	0	11.4	5.7	**17.3**
Shungnak River	0	57.9	11.1	22.7	9.6	**101.3**
Wesley Creek-Kobuk River	0	0	0	0	2.1	**2.1**
Total	**0.3**	**57.9**	**11.1**	**34.1**	**17.4**	**120.7**

Table 3.14. Direct Wetland and Other Water Impacts by Project Component (acres)

PROJECT COMPONENT	IMPACTS TO WETLANDS AND OTHER WATERS.
Camp facilities	0.3
Mining facilities	57.9
Processing facilities	11.1
Support facilities	34.1
Transportation facilities	17.4
Total	**120.7**

3.7.3.2 *Material Sites*

A total of 16 potential material sites were initially identified for the Project. Five material sites will be further considered for detailed screening analysis, including acid generating potential and NOA presence, which would be completed in 2026. The potential direct wetland and other water impact totals from material sites are included in Table 3.15.

Table 3.15. Potential Wetland and Other Water Impacts at New Material Sites

MATERIAL SITE NUMBER	TOTAL ACRES	UPLAND ACRES (PERCENT)	WETLAND ACRES (PERCENT)
4	**97.2**	85.9 (88.3)	11.4 (11.7)
9	**247.1**	225.9 (91.4)	21.2 (8.6)
11	**72.5**	71 (97.9)	1.5 (2.1)
12	**34.2**	34.2 (100)	0 (0)
16	**23.6**	23.6 (100)	0 (0)
Total	**474.61**	**440.6 (92.8)**	**34.1 (7.2)**

Although additional exploration and detailed analysis is needed to estimate the extent of disturbance to adequately develop any given material site, total material site wetland impacts would not exceed 34.1 acres (13.8 ha). It is anticipated that wetland impacts may be avoided or minimized based on the overall size of the identified material sites, the limited wetlands within a given material site, and the total volume of material required by the Project would be greatly less than the total volume available at the identified

material sites. A complete analysis and selection of material sites, including wetland impacts, acid generation potential, and presence of NOA, would occur during the NEPA process. Detailed information about material sites is included in Appendix A, *Alternatives Development.*

Sections 4.1.2 *Wetland Avoidance, Minimization* and 4.1.3 *Wetland Mitigation* discuss avoidance of wetlands and a discussion of mitigation.

3.7.3.3 *Indirect Impacts*

Indirect impact to wetlands and vegetation would occur in the Project's dust shadow, which is the area where airborne dust is deposited when generated by traffic, wind, or other Project activities on gravel surfaces. Previous studies on dust shadows from gravel surfaces estimate that the majority of dust fallout occurs within 328 feet (100 m) of roadway edges (Auerbach et al. 1997; Myers-Smith et al. 2006; Walker and Everett 1987). Using the 328-foot (100-m) estimated dust shadow to account for indirect effects, the Project may indirectly impact up to 507.72 acres (205.47 ha) of wetlands and 19.44 acres (7.87 ha) of other waters.

Concentrate containers would be completely enclosed to minimize potential dispersal of airborne dust or contaminants during transport and dust suppression on gravel roads would be applied as needed. Section 2.9 *Erosion and Dust Control* contains more details on Project dust control mitigation.

3.8 Birds

3.8.1 Existing Data

Surveys were conducted in the Project area in 2013, 2016, and 2017 to document the presence of raptors and the condition of their nests (ABR 2016, 2017; Ritchie 2013). A survey of other migratory birds has not been conducted in the Project area; however, regional data is available in reports produced to support the AAP right-of-way application.

3.8.2 Existing Conditions

Large trees suitable for tree-nesting raptors mainly occur in riparian areas along tributaries of the Kogoluktuk and Shungnak rivers (Ritchie, 2013). In the most recent survey (ABR 2017), occupied raptor nests for rough-legged hawk (*Buteo lagopus*), gyrfalcon (*Falco rusticolus*), and peregrine falcon (*Falco peregrinus*) were identified within the Arctic, Ruby, and Dahl creek watersheds. The 2016 survey revealed occupied nests in the same watersheds and also included a golden eagle (*Aquila chrysaetos*). Results from the 2016 and 2017 surveys are summarized in Table 3.17 and shown on Figure 3.7.

Table 3.17. Summary of Raptor Nest Surveys near the Project Area (2016 and 2017)

SPECIES	OCCUPANCY UNKNOWN	UNOCCUPIED	OCCUPIED	PROOF NESTING	NESTING SUCCESSFUL	TOTAL	DISTANCE TO NEAREST PROJECT ELEMENT (miles)[a]
2016							
golden eagle	0	3	1	0	0	**4**	0.4
rough-legged hawk	0	1	7	0	1	**9**	0.7
peregrine falcon	0	0	2	0	1	**3**	0.3
common raven	0	0	1	0	2	**3**	0.3
unidentified raptor	0	7	0	0	0	**7**	0.3
Total	**0**	**11**	**11**	**0**	**4**	**26**	N/A
2017							
golden eagle	1	4	0	0	0	**5**	0.3
rough-legged hawk [b]	0	2	0	2	2	**6**	0.3
peregrine falcon [c]	1	2	1	0	3	**7**	0.1
gyrfalcon	0	0	0	1	0	**1**	0.3
merlin	0	0	0	0	1	**1**	2.1
common raven	1	1	0	0	0	**2**	0.3
unidentified raptor [d]	0	6	1	0	0	**7**	0.3
Total	**3**	**15**	**2**	**3**	**6**	**29**	N/A

[a] Distance provided is straight-line distance to nearest Project infrastructure per species regardless of nest status.
[b] Two additional rough-legged hawk nests from 2016 fell and were therefore coded as "no nest," and one was used by gyrfalcons in 2017.
[c] Includes one nest approximately 1 mile outside the Project area not surveyed in 2016.
[d] Two additional unidentified raptor nests from 2016 fell and are therefore coded as "no nest."

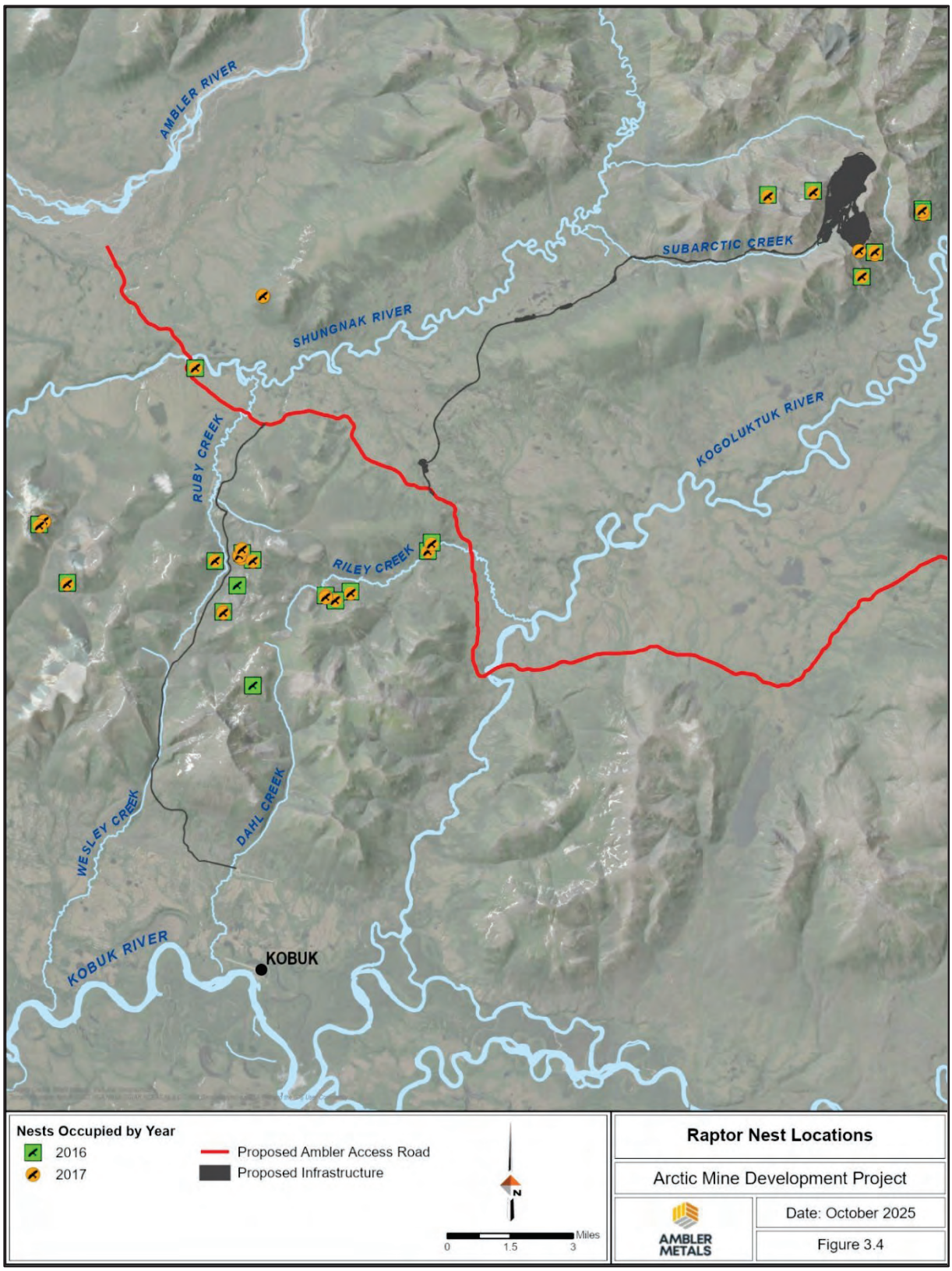


Figure 3.7. Raptor Nest Locations in the Project Area (2016 and 2017)

3.8.3 Preliminary Analysis of Impacts

Impacts to birds would be mitigated through the use of BMPs and project controls. Without planned control measures, potential impacts to birds could include the following:

- Loss of habitat in the Subarctic Creek watershed from gravel infrastructure and mine facilities
- Alteration of habitat due to dust and gravel spray from roads
- Disturbance and displacement of birds due to noise and blasting during construction and operations, facility lighting, and hazing of birds off the Dahl Creek Airstrip once it is upgraded for Project use
- Potential injury or mortality from vehicle or aircraft strikes

The Project would directly affect areas that may contain foraging and breeding habitat for migratory bird species. Loss of riparian or forested cover would be minimal (less than 3 acres [1.2 ha]). Other effects related to the Project may include mortality from human interactions (e.g., vehicle strikes).

3.9 Terrestrial Mammals

3.9.1 Existing Data

Terrestrial mammal surveys have not been conducted for the Project; however, the Project would be located within the boundaries of ADF&G Game Management Unit 23, for which regional data are available for caribou (*Rangifer tarandus granti*), moose (*Alces alces*), grizzly bear (brown bear) and black bears (*Ursus arctos* and *U. americanus*, respectively), and small furbearers. Available data sources include:

- Caribou
    - Herd numbers (DOWL 2016)
    - Western Arctic Caribou Herd (WACH) migration routes and population numbers (Joly 2020; Joly and Cameron 2015; Joly et al. 2010)
    - WACH use of project area (ABR 2024)
    - Caribou behavior (Wilson et al. 2014, 2016)
    - Analysis of Fish and Wildlife Resources Near the Proposed Project (ABR 2024)
- Moose
    - Moose and moose habitat (Mould 1977; NPS 2015; Saito and Johnson 2014)
    - Moose use of project area (ABR 2024)
    - Potential moose habitat (DOWL 2016)
- Bear
    - Grizzly bear behavior, including diet and interaction with the human population (Shideler and Hechtel 2000)
    - Existing conditions for grizzly and black bears (DOWL 2016)
- Furbearers
    - Fox behavior (Shideler and Hechtel 2000)

Also available are recent subsistence data gap analyses, literature reviews, and impact analyses resulting in maps of subsistence use areas for moose, caribou, bear, Dall sheep, small game and furbearers (SRB&A 2024a, b, c).

3.9.2 Existing Conditions

3.9.2.1 *Caribou*

The WACH numbered 490,000 animals in 2003; it was the largest herd in Alaska and one of the largest herds in the world. Rural residents from approximately 40 villages in the region rely on WACH animals as a subsistence resource. Between 2017 and 2022, the herd declined from approximately 259,000 to approximately 164,000 animals (Naiden 2022). The most recent population estimate was 121,000 (ADF&G 2025b).

The proposed Project occurs within the fall and winter range of the WACH. The percentage of the annual winter range of the WACH that is within 3.1 miles (5 km) of the proposed Project ranged from 0% in 2015 to 1.493% in 2021, with a mean of 0.202% (ABR 2024). The Arctic Mine area and associate Project roads were regularly used as low density wintering range but is used as high density wintering range in approximately 1 in 4 years (ABR 2024).

Use of the Arctic Mine Project area was generally a low percentage of collared caribou (average of 2%). There were no collared caribou observed in 6 of the 21 years analyzed, but usage was relatively high (>10%) in 4 out of the 21 years (ABR 2024).

Caribou have been observed to migrate through the Project area and may overwinter in the vicinity (Figure 3.8 and Figure 3.9). The Project area is not used by calving caribou, as this usually occurs in the northwestern region of the state. The closest that high-density populations are to the study area is in the late summer months and into the fall but are still more than 30 miles away (high-, medium-, and low-density areas are the 50 percent, 75 percent, and 95 percent utilization contours, respectively) (ADF&G 2018b).

Several studies have indicated that the Project area does not contain high-value caribou habitat because recent forest fires have altered habitat, and the overall winter habitat is low quality (Joly et al. 2010; Wilson et al. 2014). High-value habitat mostly occurs in terrain with less dense vegetation, such as valley bottoms and ridgelines.

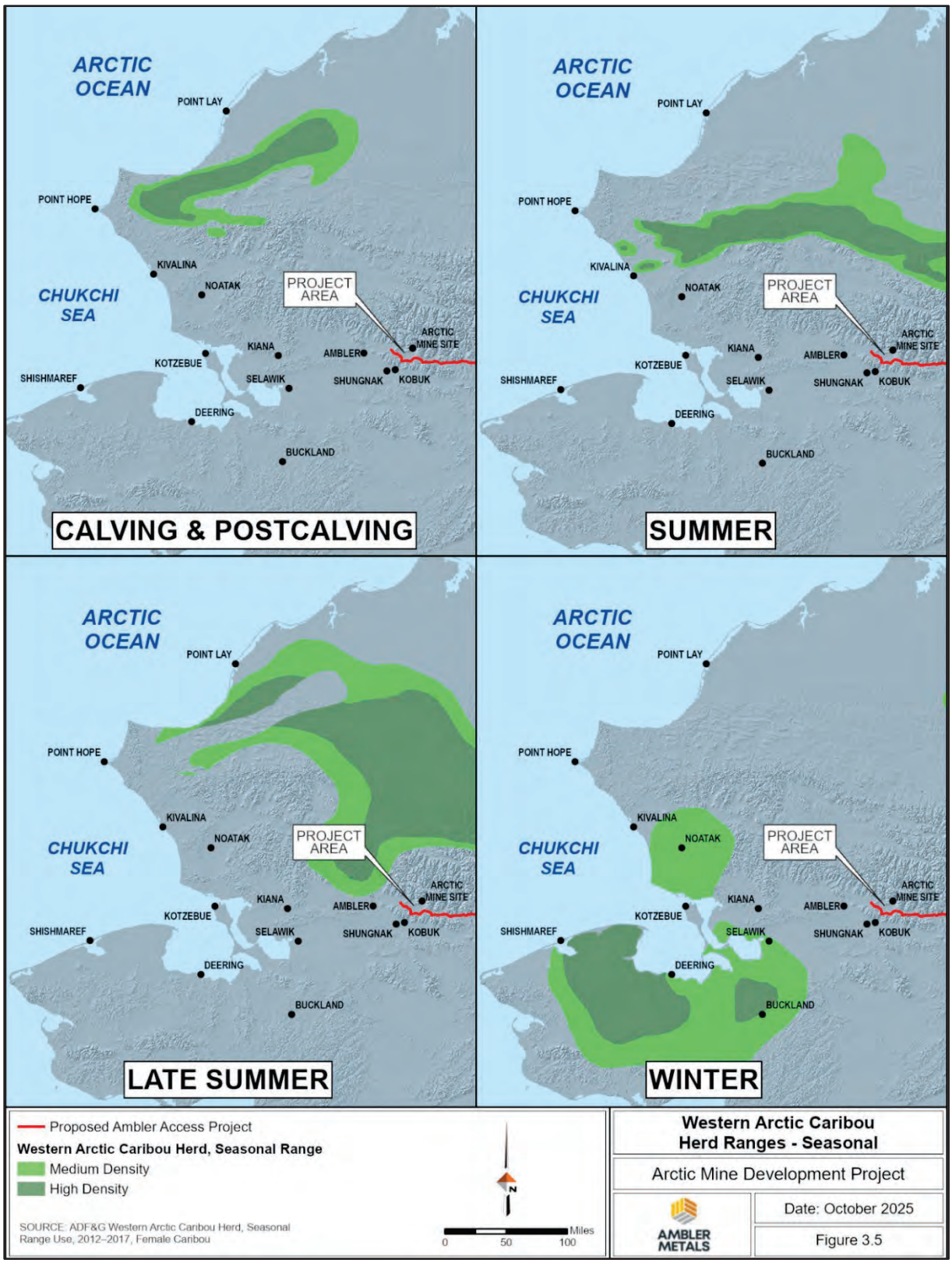


Figure 3.8. Western Arctic Caribou Herd Ranges – Seasonal (2012 through 2017)

Source: ADF&G 2018b

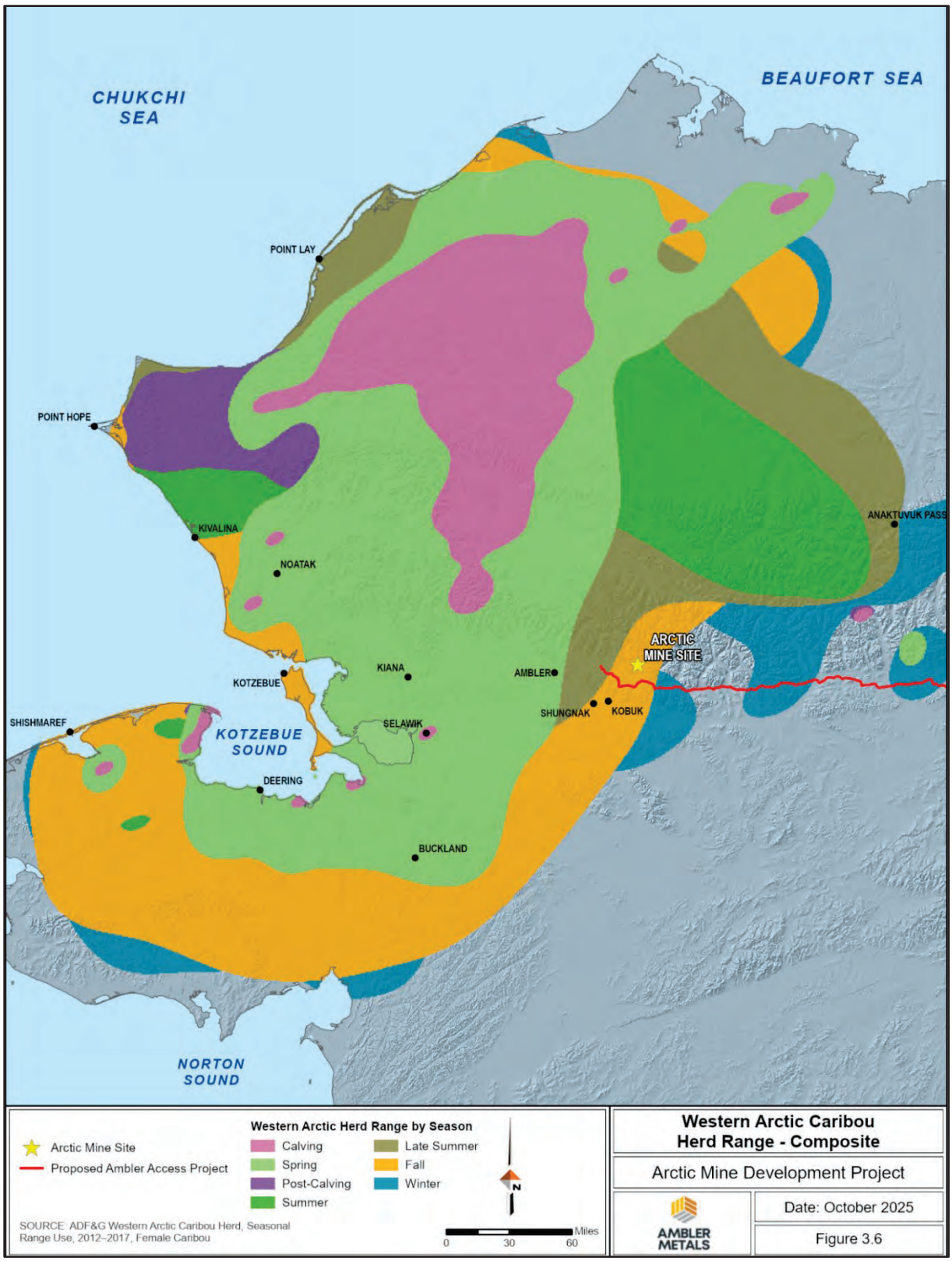


Figure 3.9. Western Arctic Caribou Herd Ranges – Composite (2012 through 2017)

Source: ADF&G 2018b

Data between 2002 and 2017 indicate the caribou migration pattern has moved near Bornite, but the migration season involves a low number of caribou (ADF&G 2018b). Throughout this 15-year time period, fall migration patterns have moved through the Project area and onto the Seward Peninsula. Migratory patterns stayed relatively similar over the 15-year period but still vary from season to season. Infrastructure can influence migratory patterns from one year to the next (ADF&G 2018b).

3.9.2.2 *Other mammals*

Several moose inventories have been conducted in the Project area, and overall populations appear stable (Saito & Johnson, 2014). An aerial survey of 1,000 square miles (2,590 km^2) that included the Project area in 2015 only noted 16 moose (NPS 2015). Willows are the primary forage of moose across most of Alaska (Shipley 2010), and moose in northern Alaska spend most of the winter in areas with tall shrubs (Mould 1977). Habitat mapping completed for the Project shows an abundance of potential moose habitat; alder shrub and willow shrub are the highest-value habitats, with additional habitat use in the spruce forest and water habitats. Wildlife observation logs maintained by AMC show somewhat regular employee observances of moose throughout the Project area (DOWL 2016).

Grizzly bears are omnivorous, and their diets change substantially throughout the year (McLoughlin et al. 2002; Shideler and Hechtel 2000). Overwintered berries, young grasses and sedges, and roots and tubers are major diet components in the spring, while caribou and moose calves are important sources of protein for some bears (Young and McCabe 1997). Grasses and sedges remain important forage plants during the summer as well as horsetails (*Equisetum* spp.), leaf buds, and forbs. Grizzly bears opportunistically scavenge carcasses and prey on bird eggs and nestlings, fox pups (*Vulpes* spp.), and rodents such as lemmings (*Lemmini* spp.) and voles (*Microtus* spp.) (Shideler and Hechtel 2000). In the fall, berries become an important source of carbohydrates for fall fattening prior to hibernation. Habitat mapping in the Project area shows an abundance of low shrub (blueberry) habitat that could be used as late summer forage for bears. AMC employees have observed a few grizzly bears each year, mostly in the mountains around the mine site area (NovaCopper 2016). Information on specific grizzly bear den locations within the Project area is not currently available.

Black bears are present in the Project area, and observations have been reported by AMC employees (NovaCopper 2016). There are no publicly available black bear survey data or annual reports of black bear in the Project area from ADF&G. Black bear habitat is abundant in the Project area, including low shrub (blueberry), wetland habitats, and protected spruce forest habitat suitable for den sites. Black bears exploit a variety of habitats that provide good denning opportunities and produce foods (e.g., berries, wildlife, fish) but are also drawn to disturbed habitats, such as recently burned areas. Black bear den locations include cavities in trees or rocks, brush piles, root excavations, and underground burrows. Den entrances tend to be fully or partially filled in during use and are likely to be reused each season, either by the same bear or by other individuals (Larivie’re 2001). Information on specific black bear den locations within the Project area is not currently available. Field surveys for bear den sites may be required prior to construction.

The following species, in addition to voles and lemmings, inhabit the Project area: Arctic fox (*Vulpes lagopus*), red fox (*Vulpes vulpes*), marten (*Martes americano*), mink (*Neovison vison*), beaver (*Castor canadensis*), wolverine (*Gulo gulo*), Canada lynx (*Lynx canadensis*), and shrews (*Sorex* spp.). Arctic fox range stretches from the North Slope of Alaska to the Brooks Range and along the western coast. They are found in treeless coastal areas of Alaska and prefer tundra habitat, sandy soil along riverbanks, hillocks, and occasionally talus for denning(ADF&G 2021). The red fox range is throughout Alaska. They prefer extensive lowland marshes, hills, and tundra habitat. Marten are found from southeast Alaska up to the northern and western portions of the state. They inhabit forested regions and are often associated with mature and old-growth evergreen forests. Mink are found in every part of the state and are found in close association with water, preferring riparian areas of lakeshores, marshes, and stream banks. Beaver are found throughout most forested portions of the state. They prefer aquatic environments, where they build dams and dens. Wolverine are found in low densities across Alaska and prefer large expanses of wilderness. Canada lynx inhabit much of Alaska's forested terrain and use habitats such as spruce and hardwood forests and successional and subalpine communities. Shrews live in all habitats, from the rainforests of the southeast to the Arctic tundra. They prefer moist habitats and are often found near streams, ponds, and marshes (ADF&G 2021).

3.9.3 Preliminary Analysis of Impacts

Impacts to terrestrial mammals would be mitigated through the use of BMPs and project controls. Without planned control measures, potential impacts to terrestrial mammals could include the following:

- Loss of habitat in the Subarctic Creek watershed from gravel infrastructure and mine facilities
- Alteration of habitat due to dust and gravel spray from roads
- Disturbance and displacement of wildlife due to noise and blasting during construction and operations, traffic, facility lighting, and hazing of wildlife off the Dahl Creek Airstrip once it is operational
- Potential attraction to facilities due to human activity and lighting
- Potential injury or mortality from vehicle strikes

Construction activities associated with Project development include clearing vegetation, placing gravel for roads and pads, excavating the mine site, and constructing waste rock and tailings storage areas. These activities would result in the direct and permanent loss of 1,220.7 acres (494.0 ha) of terrestrial wildlife habitat and the permanent loss of 11.2 acres (4.8 ha) of aquatic habitats. Although the Project footprint is approximately 1,300.9 acres, approximately 80 acres within the project footprint involves existing disturbance (e.g., existing roads).

These habitat types are common and extensive in this part of Alaska and are not considered unique for any species. Within the Ambler Lowlands, willow and alder are present within the riparian areas while spruce forests occur along the hillsides and in other elevated areas. Wetlands are also present and widespread in the Ambler Lowlands, mostly occurring in the tundra communities (Tetra Tech 2010).

Minor impacts may include water impoundments resulting from gravel roads that alter plant species composition, potentially eliminating foraging habitat for some species and increasing the amount of foraging habitat for others. Dust spray from vehicles traveling on gravel roads can result in the early green-up of plant communities adjacent to roads, providing early access to foraging habitat for some species but also potentially attracting animals to active roads and increasing the potential for injury and mortality from vehicle strikes.

Vehicle traffic and noise from roads may disturb and displace terrestrial mammals away from gravel roads, potentially causing them to expend additional energy in responding to the human activity.

Blasting and noise from heavy machinery used to remove waste rock and construct mine facilities could result in some behavioral disturbance to terrestrial mammals.

It is likely most mammals would leave the immediate Project area to avoid the loud, continuous sounds of people and machinery operating in the area that would disrupt their normal behavior. The avoidance zone distance would depend on the species and the type and level of activity occurring in the immediate vicinity, with noise from active mining operations and ore processing likely to cause the greatest amount of disturbance. Species that do not readily habituate to human presence or tolerate loud sounds such as grizzly bears and wolves (*Canis lupus*), would avoid the area by substantial distances and may result in the effective loss of habitat within the Project area.

In addition, the avoidance of construction and operations activities would cause animals to travel long distances around the mine site to reach preferred habitats, causing habitat fragmentation or abandonment of previously valuable habitats, which could reduce survival and reproductive success for some individuals.

The WACH winter range frequently includes the proposed Project (~13 out of 16 years) although it is only within the high-density winter range in some years (~4 of 16 years) The impact of development on caribou distribution and movements varies widely among studies and there is little scientific consensus on the distance that caribou distribution is altered by development (ABR 2024).

Influence from infrastructure heavily relies on the caribou seasonal migratory patterns and access to resources. Construction and operations that lead to a disruption in caribou migration patterns is a top concern for residents near the Project area (SRB&A 2012). Development can impact caribou populations directly by habitat conversion to infrastructure and indirectly by behavioral avoidance, even for high-value habitat. Because caribou will choose a route to minimize energic costs, they will defer to a less favorable migration route, such as toward predation or more snowpack, to avoid the development areas. Data suggests that caribou use developed areas more in the summer season due to less insect harassment; however, females with their young will avoid developed areas up to 3 miles (5 km) (Joly and Cameron 2015).

Foxes and grizzly bears are attracted to areas of human activity, where they feed on garbage and handouts (Shideler and Hechtel 2000). Foxes and, to a lesser extent, grizzly bears, may use human structures such as gravel embankments and culverts for denning (Burgess and Banyas 1993; Shideler and Hechtel 2000). Their presence near human activity increases the potential for animals to be struck by vehicles, ingest toxic substances, infect humans with rabies, or harm humans through aggressive behavior.

Stripping operations that precede development activities associated with Project construction and operations could cause injury and mortality to small mammals that have limited abilities to move away or avoid heavy machinery. Once the initial displacement of wildlife occurs, limited habitat value within the operating areas and developing facilities would discourage regular use by wildlife except those adapted to life in disturbed environments. Wildlife encounters, including nuisance species, would be managed through a game management plan.

Project vehicles could occasionally strike terrestrial mammals causing injury or mortality. Vehicles will yield to wildlife and wait for safe passage before proceeding.

Potential long-term consequences could be realized from the reclaimed TMF, WRF, or the pit lake, but these areas should not prove to be an attractant to wildlife. However, the potential for wildlife usage and impacts to individuals would remain.

3.10 Special Status and Invasive Species

3.10.1 Existing Data

WHPacific, Inc. (2017) reviewed the Project area for the presence of endangered species, critical habitat, and migratory birds. No endangered species or critical habitat were identified in the Project area, but nine migratory bird species and their nesting seasons were identified.

The Alaska Natural Heritage Program maintains a database of nonnative species range maps, habitat models, occurrence polygons, and other predictions of the spatial distribution of biological resources intended to inform parties of the known occurrence or likelihood of their presence.

3.10.2 Existing Conditions

3.10.2.1 *Regulatory Setting*

The following federal statutes protect wildlife and wildlife habitat:

- **Migratory Bird Treaty Act (MBTA)** makes it unlawful to pursue, hunt, take, capture, or kill; attempt to take, capture, or kill; possess; offer to or sell, barter, purchase, deliver, or cause to be shipped, exported, imported, transported, carried, or received any migratory bird, part, nest, egg, or product, manufactured or not. The MBTA is administered by U.S. Fish and Wildlife Service (USFWS). A migratory bird depredation permit may be required to operate an airstrip (50 CFR 21.41).
- **Bald and Golden Eagle Protection Act (BGEPA)** (16 USC 668-668c) prohibits anyone, without a permit issued by the Secretary of the Interior, from "taking" bald eagles, including their parts, nests, or eggs. The Act provides criminal penalties for persons who "take, possess, sell, purchase, barter, offer to sell, purchase or barter, transport, export or import, at any time or any manner, any bald eagle … [or any golden eagle], alive or dead, or any part, nest, or egg thereof." The BGEPA defines "take" as "pursue, shoot, shoot at, poison, wound, kill, capture, trap, collect, molest or disturb." The BGEPA is administered by USFWS.
- **Endangered Species Act (ESA)** provides for the conservation of fish, wildlife, and plant species considered to be at risk of extinction (threatened or endangered) in all or a substantial portion of their ranges, and to conserve ecosystems and habitats upon which they depend. USFWS and National Marine Fisheries Service share regulatory authority for implementing the ESA. Listed species are eligible for increased protective measures, including critical habitat designation.

3.10.2.2 *Species Presence*

An official species list from USFWS identified no threatened, endangered, or candidate species and no critical habitats in the Project area (USFWS 2021). While there are eight species in Alaska listed as threatened or endangered under the ESA by USFWS, none are likely to occur in the Project area.

The Birds of Conservation Concern 2021 list identifies the migratory and non-migratory bird species (beyond those already designated as federally threatened or endangered) that represent USFWS highest conservation priorities. The list is based on an assessment of several factors, including population abundance and trends, threats to breeding and nonbreeding grounds, and the size of breeding and nonbreeding ranges. According to WHPacific, Inc. (2017), nine bird species of conservation concern are expected to occur in the Project area or could potentially be affected by Project activities:

- Bald eagle (*Haliaeetus leucocephalus*)
- Fox sparrow (*Passerella iliaca*)
- Lesser yellowlegs (*Tringa flavipes*)
- Olive-sided flycatcher (*Contopus cooperi*)
- Peregrine falcon (*Falco peregrinus*)
- Rusty blackbird (*Euphagus carolinus*)
- Short-eared owl (*Asio flammeus*)
- Upland sandpiper (*Bartramia longicauda*)
- Yellow-billed loon (*Gavia adamsii*)

The Alaska Natural Heritage Program Alaska Exotic Plants Information Clearinghouse identified non-native species at the Dahl Creek Airstrip, including several locations with foxtail barley (*Hordeum jubatum*) and pineappleweed (*Matricaria discoidea*) (Alaska Exotic Plants Information Clearinghouse, 2019). These species were found in a large patch in the plane turnout area near the fuel cache, were sparsely distributed along the entire airstrip, and may be in other areas. Foxtail barley is ranked as highly invasive by U.S. Department of Agriculture and U.S. Forest Service (Carlson 2008). Pineappleweed is ranked as weakly invasive, although widespread and low in abundance.

3.10.3 Preliminary Analysis of Impacts

The Project would result in approximately 1,220.7 acres (494 ha) of cleared vegetation, resulting in a minor decrease in available habitat for migratory birds. The Project is not anticipated to result in injury, kill, or capture of migratory birds or their nests or permanent effects on any species.

To determine the Project's potential impacts to bald eagles, an eagle nest survey would be conducted to identify active eagle nests. If an active eagle nest is located within 660 feet (200 m) of Project activities, the USFWS would be consulted concerning the need for any mitigation measures once Project activities and their distance to active nests are determined.

There are two management zones to provide protection to active nest trees. Most adverse impacts to eagles occur during the nesting season (March to August) by human activities within the primary (330 feet [100 m]) or secondary (between 330 feet [100 m] and 660 feet [200 m]) of nest trees. These zones could be modified based on eagle behavior to previous disturbance or if in sparse stands of trees where activities may be in line of sight of the trees.

Although two invasive plant species are in the Project area, these species are common at remote airstrips throughout Alaska due to their spread by aircraft.

3.11 Land Management, Use, and Recreation

3.11.1 Existing Data

The Project would occur primarily on private lands with some of the more difficult areas to access owned by the State of Alaska. No comprehensive analysis or studies of land use or recreation in the Project area have been conducted. No available data exist that document incidental recreation in the Cosmos Hills, Schwatka Mountains, or Ambler Lowlands due to the lack of public lands. General land status and Native allotment location data exist adjacent to the Project area.

3.11.2 Existing Conditions

The Project is in the NWAB and primarily in the Subsistence Conservation Zoning District (Figure 3.10). A portion of the Project is within the General Conservation zoning district. Land ownership within the Project area is primarily private (NANA and AMC), with a portion of the upper Subarctic Valley owned by the State of Alaska. Subsistence use by NANA shareholders to varying degrees is occurring on NANA lands and anecdotal evidence exists of incidental recreation, such as backpackers traversing the area between the east and the west. Native allotments are located along the Kobuk River, approximately 2 miles (3.2 km) from the Dahl Creek Airstrip.

3.11.3 Preliminary Analysis of Impacts

The Project would have to obtain approval from the NWAB for rezoning to Resource Development and Transportation Corridors and may require a Master Plan and a Title 9 Land Use Permit. Any impacts to the minor amount of recreational activity would be primarily from increased noise and altered aesthetics.

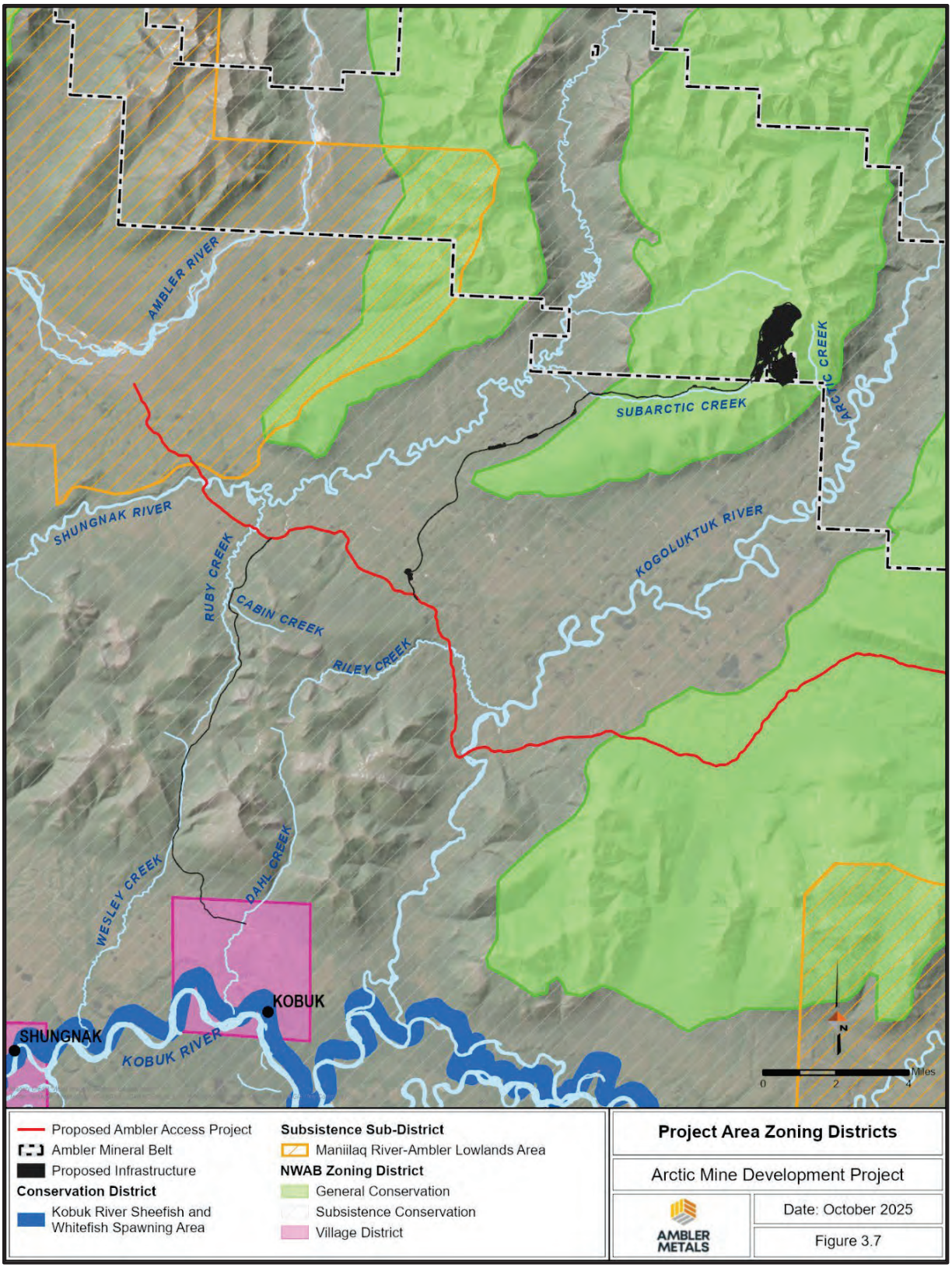


Figure 3.10. Project Area Zoning Districts

3.12 Transportation

3.12.1 Existing Data

A preliminary engineering report summarized a previous analysis of transportation options for the Project and identified the preferred transportation corridor alternatives (DOWL 2019) (Section 2.5, *Access and Transportation*).

3.12.2 Existing Conditions

Existing facilities in the Project area include the Dahl Creek Airstrip, an active mining exploration camp (Bornite Camp), a gravel road (South Route) connecting the Bornite Camp to the Dahl Creek airstrip, and several primitive trails between the Bornite Camp and the proposed mine site (Figure 1.2).

Revised Statute 2477 (RS 2477) of the 1866 Mining Law conditionally grants public ROW to trails across federal land for transportation that meet specific conditions. Trails constructed or used when land was unreserved federal land qualify as an "RS 2477 route." The existing portion of the South Route access road would intersect, or be adjacent to, three RS 2477 routes (Figure 3.11), as described by ADNR:

1. **Wesley Creek Trail (RST 1719)**: "The Wesley Creek Trail was used to reach mining areas near Kobuk and Shungnak and is included in the 1973 DOT&PF Trails Inventory on Map #126 (Ambler River 1:250,000) as trail #95a. Documentation in the file shows construction or use of the route occurred by 1910. The grant of the RS 2477 right-of-way for the trail was accepted by construction and use, subject to valid, existing rights, when the land was not reserved for public purposes."
2. **Dahl Creek-Wesley Creek Trail (RST 1720)**: "Another trail has been built from the Kobuk, near the mouth of Wesley Creek, to the mine near the forks of Ruby Creek. Connecting with this is a well-marked trail from Dahl Creek to Wesley Creek along the southern slopes of the Cosmos Hills. Documentation in the file shows construction or use of the route occurred by 1911. The grant of the RS 2477 right-of-way for the trail was accepted by construction and use, subject to valid, existing rights, when the land was not reserved for public purposes."
3. **Kobuk River-Junction Trail (RST 1744)**: "Kobuk River-Junction Trail is located in northwestern Alaska near the community of Kobuk. From a point on RST #1718, Kobuk-Dahl Creek Trail, near its junction with RST #1720, Dahl Creek-Wesley Creek Trail, the route runs southwestward to a cabin on the Kobuk River just east of sawmill. The location of the trail, based on historical evidence, has been mapped by ADNR, Division of Land personnel, on USGS 1:63,360 Shungnak D-2 and D-3 quadrangle maps. Documentation in the file shows that the construction and use of the route occurred by 1955. The grant of the RS2477 right-of-way trail was accepted by construction and use subject to valid, existing rights, when the land was not reserved for public purposes."

3.12.3 Preliminary Analysis of Impacts

The Project would not inhibit transportation on any public use transportation system and would result in an upgraded public use airstrip (Dahl Creek Airstrip), which would benefit other users.

Public access to revised statute trails would be maintained if necessary.

The Project would result in additional traffic along the Dalton Highway as a result of shipping ore concentrate from the Arctic Mine to processing facilities. Ore concentrate would be hauled from the Arctic Mine to the Port of Alaska (Anchorage) using specialized intermodal bulk shipping containers. Approximately 46 shipping containers would be loaded onto trucks at the Arctic Mine and transported to Fairbanks via the AAP, and the Dalton Highway. Two shipping containers would be carried on each truck along the approximately 201-mile-long (324-km-long) AAP trip, resulting in approximately 23 trips per day, each way, along this roadway segment. At the junction with the Dalton Highway, containers would be transferred to trucks carrying a single container for transport to Fairbanks (approximately 243 miles [391 km]), resulting in 46 trips per day, each way, along this segment. In Fairbanks, the ore concentrate containers would be loaded onto the Alaska Railroad and hauled approximately 356 miles (573 km) south to the Port of Alaska in Anchorage. At the Port of Alaska, the ore concentrate would be directly loaded onto bulk ore concentrate ships for transport to smelters outside of Alaska.

Additional ground traffic would occur from the shipping and transport of goods and materials (e.g., fuel, consumables) to the Project. The increase in traffic could impact localized traffic around Fairbanks and along the Dalton Highway, although given the scale of the anticipated Project traffic, the impacts are believed to be minimal.

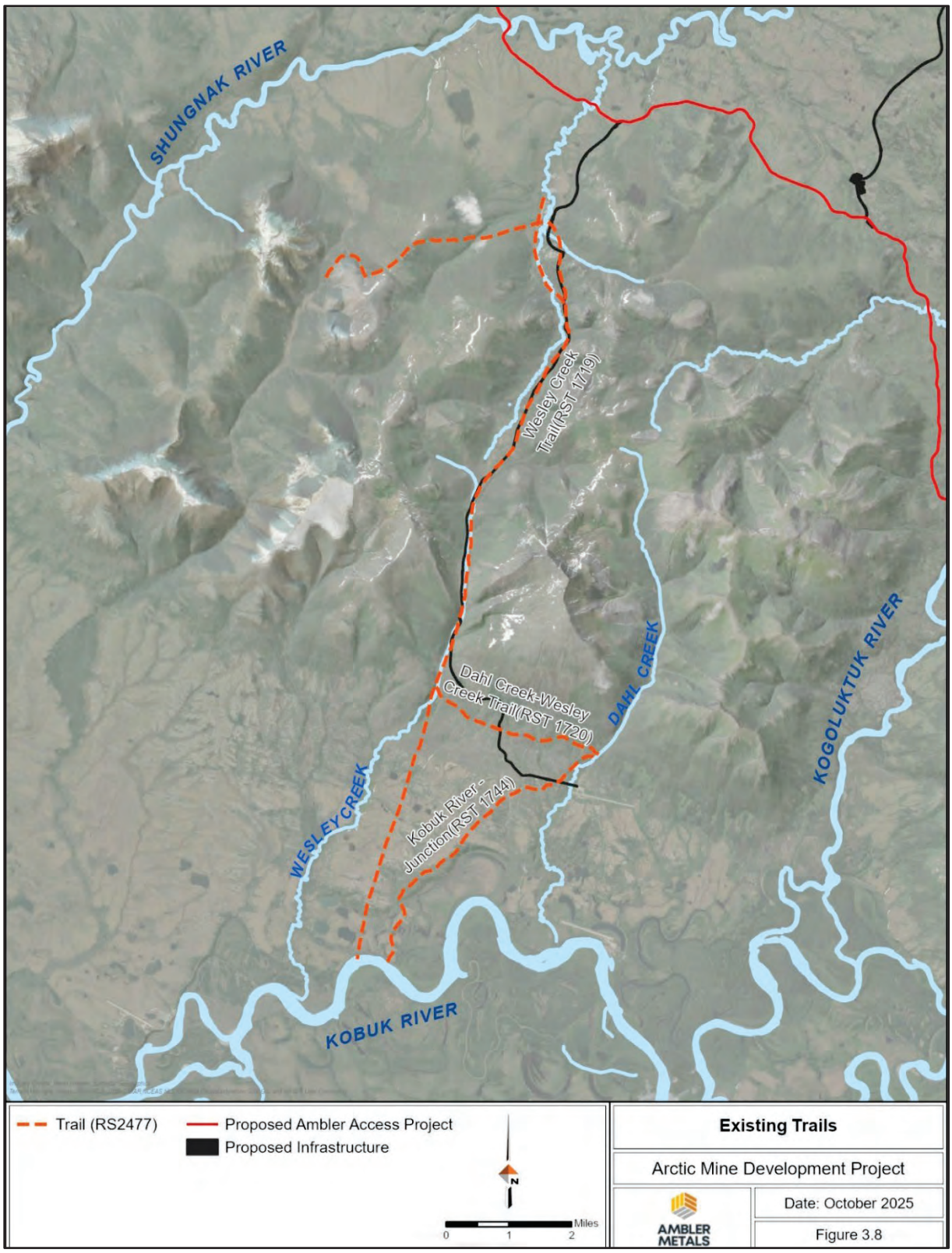


Figure 3.11. Existing Trails that Would Intersect the Project

3.13 Cultural Resources

3.13.1 Existing Data

Review of the Alaska Heritage Resource Survey (AHRS) database revealed that a total of five previous cultural resources survey efforts have occurred within the five Township/Ranges intersected by the Project (Alaska Industrial Development and Export Authority 2022; Blake and Brownwell 2016; Blanchard et al. 2015; Fulkerson 2018; Rigg 2010). Of these surveys, two were conducted on behalf of AMC to investigate the Project area for archaeological and historic materials (Blake and Brownwell 2016; Fulkerson 2018).

The three studies commissioned by ANC for the proposed Project include background research and cultural resources fieldwork in areas of potential Project development (Blake and Brownwell 2016; Fulkerson 2018). The fieldwork performed as part of these studies consisted of aerial and pedestrian surveys to identify cultural resources (Table 3.18). Subsurface testing was performed in high potential areas and where soils allowed excavation of test pits using hand tools (e.g., no bedrock). The surveys did not identify any pre-Contact cultural materials. Additional field to address data gaps will be conducted during the 2026 field season.

Table 3.18: Previous Cultural Resources Surveys for the Proposed Project

SURVEY SOURCE	FIELDWORK DATES	TOTAL STUDY AREA	AREA PEDESTRIAN SURVEYED	SUBSURFACE TESTS
Blake and Brownell 2016	June 28 - July 4, 2016	2,327 ac	530 ac	13[1]
Fulkerson 2018	August 20 - 25, 2018	5,998 ac	Not Reported	21[1]
Pipkin 2020	August 2019	1,738.5 ac	Not Reported	Not Reported

[1] Excavated sediment was not screened for artifacts.

3.13.2 Existing Conditions

As noted above, very few previous cultural resource surveys have been conducted in the area. The proposed Project footprint intersects with three previously recorded AHRS sites representing two distinct resources. SHU-00038/AMR-00225 are assigned to the Bornite Road, and AMR-00226 is assigned to the Bornite Prospect camp.

Past surveys have not revealed pre-Contact cultural material in the Project area; however, the presence of historical roads, equipment, buildings, and structures related to twentieth-century mining exploration were identified(Fulkerson 2018). Based on the history of mineral exploration in the region there is a moderate to high potential to encounter historic sites related to previous mining exploration activity in the area.

Several RS 2477 Trails intersect with the proposed Project, including:

- RST 1719: Wesley Creek Trail
- RST 1720: Dahl Creek-Wesley Creek Trail
- RST 1744: Kobuk River-Junction

3.13.3 Preliminary Analysis of Impacts

No pre-Contact archaeological resources were identified during the surveys performed in 2010, 2016, 2018, and 2019. The methods, adequacy, and currency of these surveys do not fully meet the current reasonable and good faith identification standard of the Section 106 compliance process.

Historical mining equipment, structures, and buildings were noted in 2010 and 2018 (Fulkerson 2018; Rigg 2010). The historic resources identified in 2010 were evaluated for eligibility for the National Register of Historic Places (NRHP) and determined to be not eligible. The Alaska State Historic Preservation Office (SHPO) concurred with that finding on January 12, 2011. No analysis of the equipment, structures, or buildings identified in 2018 has been undertaken. In an August 4, 2021, meeting between DOWL, AMC, and SHPO it was recommended by SHPO that the Dahl Creek Airstrip and Bornite buildings and structures be surveyed, documented, and evaluated for eligibility to the NRHP. Until that analysis is undertaken and has been reviewed and concurred on by SHPO, it remains an unresolved issue. As noted above, additional cultural resource surveys and evaluations will be conducted in 2026.

Consultation with SHPO will be necessary to determine if the proposed Project will result in impacts to historic properties.

3.14 Socioeconomics

3.14.1 Existing Data

Economic impact studies have been completed for the larger region to support the AAP (Alaska Department of Commerce, Community, and Economic Development 2014; Cardno 2015). In addition, an economic impact analysis directly related to development of the Project, including potential impacts from AAP was completed for both statewide and regional scales (McKinley 2024).

Existing data is available regarding the populations, demographics, incomes, and poverty rates of communities that could be affected by the Project. This data is available through the U.S. Census Bureau American Community Survey, Alaska Department of Labor and Workforce Development publications and statistics, NWAB socioeconomic survey reports and publications, industry reports, ADNR annual reports, Alaska Department of Revenue data, and Bureau of Economic Analysis data. Demographics and select economic characteristics data for Upper Kobuk communities summarized from 2013-2022 is also available (McKinley 2024).

3.14.2 Existing Conditions

The upper Kobuk River communities of Kobuk, Shungnak, and Ambler are the closest communities to the Project, with Ambler approximately 40 miles (64 km), Shungnak approximately 28 miles (46 km), and Kobuk approximately 22 miles (37 km) from the Project, respectively.

Residents of these three communities are predominantly of Iñupiaq descent (McKinley 2024), with Alaska Natives comprising between 84% to 100% of Kobuk, Shungnak and Ambler communities. Of the three communities, Shungnak and Kobuk have experienced population increases from 1990 through 2022 (Cardno 2015; McKinley 2024). Table 3.19 provides a population summary for the communities.

Table 3.19. Populations of Upper Kobuk River Communities (1990-2022)

COMMUNITY	1990	2000	2010	2013	2020	2022
Kobuk	69	109	151	171	191	169
Shungnak	223	256	262	300	272	251
Ambler	311	309	258	272	274	256

Source: Cardno 2015; Alaska Demographics 2021; McKinley 2024

High rates of unemployment persist in NWAB communities because of limited and seasonal employment opportunities. In 2022, the highest rates of unemployment were in Ambler and Shungnak, both 22%, compared to an average of 14 percent in the study region, and 6 percent statewide. About one quarter (26 percent) of study region families live below the poverty level compared to 7% statewide (McKinley 2024). In 2013, NWAB communities had a 19 percent poverty rate, with 60 percent of the total workforce employed by private industry (Cardno 2015).

3.14.3 Preliminary Analysis of Impacts

The social and economic effects of the Project would be primarily related to direct employment opportunities, royalty payments to NANA, and property tax revenues generated for NWAB.

3.14.3.1 *Population and Employment*

Direct on-site employment levels would be highest during construction, with an estimated 975 workers employed during peak construction. Construction employment would peak in Year 2 and Year 3. The operations workforce would be approximately 430 people for the 13-year mine life.

Approximately 120 NWAB residents are anticipated to be directly employed during the three-year construction period. Few construction-related services, supplies, and materials are expected to be procured from businesses within the NWAB. Therefore, the regional multiplier impacts associated with mine construction will be limited. Including all direct, indirect, and induced impacts, Arctic Mine construction is expected to support 160 temporary jobs and a cumulative $50 million in wages in the NWAB over the duration of the Project (McKinley 2024).

AMC works directly with Kobuk, Shungnak, Ambler, and other regional communities to employ NANA shareholders in the ongoing exploration program in a numbering of fields including; mechanics, geotechnicians, core cutters, administrative staff, camp services staff, heavy equipment operators, driller’s helpers, environmental technicians, and other jobs. AMC and NANA have established a Workforce Development Committee to assist with developing and training a local workforce. The total number of Project-related jobs generated for local residents would not be known until after construction contracts are awarded. Some of the workers hired for construction and mining would need skills and experience in mine construction; however, many other jobs would not require these specialized skills.

Many of the support services needed during construction could be provided by NANA or its subsidiaries, which may provide an additional source of employment for residents of the three upper Kobuk River communities as well as the NANA region as a whole. Increased tax and lease revenues from the Project may indirectly create additional jobs in the communities, and most of these jobs would be filled by local residents. Changes in employment (i.e., increased job opportunities) would likely occur for the duration of the Project.

3.14.3.2 *Revenues and Income*

Potential employment income generated by the Project would help maintain or improve average household incomes in many NWAB villages. Native corporation profits and shareholder dividends may increase because their companies may provide support services, and NANA would receive royalties throughout the life of the Project. There would be indirect employment and income effects related to revenues that the NWAB would receive from corporate contributions. There would also be induced benefits to NWAB and Yukon Koyukuk Census Area (YKCA) from households spending income received through Project employment and support services.

There would be indirect employment and income effects related to revenues that the State of Alaska would receive from corporate income taxes, mining license taxes, and lease revenues. The annual amount of these revenues would fluctuate from year to year. Some state agencies and programs would receive state funds because of revenues generated by the Project. The indirect income effects are unknown and would be related to how much revenue is allocated to individual state programs. These revenues would likely continue to fund existing programs, positions, and activities and would continue to support indirect employment and income throughout the Alaskan economy.

The revenues that fund state programs would create indirect and induced benefits in the private sector from state capital spending and nonpayroll operational spending.

3.14.3.3 *Community and Social Characteristics*

Factors with the potential to affect community characteristics and culture include changes in employment or income, changes in community demographics, changes in funds available to support cultural, civic, and educational programs, and impacts to subsistence resources and activities. Table 3.20 lists Project effects to these factors.

Table 3.20. Effects to Community and Social Characteristics

FACTOR	EXPECTED CHANGE FROM PROJECT	TYPE OF CHANGE
Changes in employment or income	Yes	Increased employment opportunities and incomes
Changes in community demographics	No	No change anticipated
Changes in funds available to support cultural, civic, and educational programs	Yes	Increased funding due to increased revenue for NWAB, NANA, and State of Alaska from taxes and leaseholds

A comprehensive assessment of local and regional economic conditions, current demographics, travel patterns, in-migration and out-migration and other indicators of community cohesion would be completed to support the NEPA document.

3.15 Subsistence and Traditional Use

3.15.1 Existing Data

In 2024, Stephen R Braund and Associates (SRB&A) conducted a literature review of subsistence activities for upper Kobuk communities (Ambler, Kobuk, and Shungnak) related to 12 subsistence baseline indicators for subsistence use areas, harvest data, and timing of subsistence activities (SRB&A 2024a,b,c). In addition, ADF&G conducted a comprehensive survey of subsistence users in the communities of Ambler, Kobuk, and Shungnak to document the use, harvest, and sharing of fish, terrestrial and marine mammals, marine invertebrates, birds, and wild plants and berries (Braem et al., 2015).

3.15.2 Existing Conditions

Residents in upper Kobuk communities primarily support themselves through subsistence lifestyles, relying on locally obtained wild resources by hunting, fishing, and gathering. Although targeted resources and harvest amounts vary among the three upper Kobuk communities, the primary harvested species in the region include caribou, salmon (*Oncorhynchus* spp.), sheefish (*Stenodus leucichthys*), arctic grayling, northern pike (*Esox lucius*), whitefishes (*Coregonus* spp.), moose, bears, small game, geese, ducks, and wild berries (Braem et al. 2015). However, northern pike, salmon, sheefish, and whitefish were not documented in the Project area in Project-specific studies (ADF&G 2015, 2017, 2018a; Tetra Tech 2011) (Chapter 3.5, *Fish*) and are not expected to be present.

The Iñupiaq communities of Kobuk, Shungnak, and Ambler comprise the “upper Kobuk” and are all within 50 miles (80 km) of the Project’s processing facilities and within 30 miles (48 km) of the existing Dahl Creek Airstrip. Subsistence use patterns (subsistence use areas, harvest amounts, and harvest timing) indicate that the proposed Project area is within the subsistence harvesting area for each of the three study communities, although for some resources subsistence use areas show a shift to the south and away from the Project area in recent years. The overlap of the Project area is only for some subsistence resources (SRB&A 2024). The following summaries are reported verbatim from the 2024 SRB&A report.[1]

Ambler

> Residents of the Native Village of Ambler conduct subsistence activities throughout the western Brooks Range, from the Colville River in the north to the headwaters of the Tagagawik River in the south, with some activities occurring in offshore use areas in Kotzebue Sound and the Chukchi Sea. Subsistence use areas overlap the entirety of the Project area and also occur downstream (downriver) from the Project area. Subsistence uses within the Project area include hunting of caribou, moose, large land mammals, small land mammals, and migratory birds; and harvesting of vegetation. In addition, harvests of salmon and non-salmon fish occur adjacent to or directly downstream (of the Kobuk River) from the Project area.
>
> Ambler subsistence harvests are characterized by high harvests of large land mammals — primarily caribou — and non-salmon fish. On an individual species level, caribou contribute the greatest amount to the overall subsistence harvest in Ambler, followed by broad whitefish, sheefish, and chum salmon.

[1] Note that the 2024 report will be shared with the Project’s Subsistence Committee in 2026 for comment.

Kobuk

Residents of Kobuk conduct subsistence activities throughout the Kobuk River valley and extend into the Brooks Range, around the Noatak River, and as far north as the Colville River. Offshore use areas occur within Kotzebue Sound. Subsistence use areas overlap the entirety of the Project area and also occur downstream from the Project area. Subsistence uses within the Project area include hunting of caribou, moose, large land mammals, small land mammals, and migratory birds; and harvesting of vegetation. In addition, harvests of salmon and non-salmon fish and hunting of upland game birds occur on the periphery of or directly downstream from the Project area. Kobuk subsistence harvests are characterized by high harvests of large land mammals, non-salmon fish, and salmon. On an individual species level, caribou contribute the greatest amount to the overall subsistence harvest in Kobuk, followed by sheefish, chum salmon, broad whitefish, and moose.

Shungnak

Shungnak residents conduct subsistence activities throughout the Kobuk River valley, extending from the Kobuk River north to the Colville River and south to the Koyukuk River (Huslia) and Buckland area. Offshore use areas occur within Kotzebue Sound. Subsistence use areas overlap the entirety of the Project area and also occur downstream from the Project area. Subsistence uses within the project area include hunting of caribou, moose, large land mammals, small land mammals, and migratory birds; and harvesting of vegetation. In addition, harvests of salmon and non-salmon fish occur on the periphery of or directly downstream from the Project area. Shungnak subsistence harvests are characterized by high harvests of large land mammals, non-salmon fish, and salmon. On an individual species level, caribou contribute the greatest amount to the overall subsistence harvest in Shungnak, followed by chum salmon, humpback and broad whitefish, sheefish, and moose.

As described in Chapter 3.9, *Terrestrial Mammals*, the upper Kobuk River basin lies within the winter and migratory ranges of the WACH. Project mining and processing facilities would be located in the migratory range of this caribou herd as they pass between summer and winter-feeding grounds.

Although residents may harvest WACH individuals during spring migration or winter, most caribou hunting typically occurs in the fall months, when the herd is migrating. For the communities of Kobuk, Shungnak, and Ambler, most subsistence harvest is comprised of caribou, moose, salmon, and non-salmon fish). The geography and location of these communities is an important indicator of the species harvested due to their availability. For example, Ambler residents have a higher reliance on caribou rather than aquatic species because caribou are located downriver of Kobuk and Shungnak (Braem et al. 2015).

The WACH Working Group is comprised of 42 communities (including Ambler, Kobuk, and Shungnak) that rely on the WACH for subsistence. The overall use of caribou among these communities is considered high, contributing about one third of all harvested subsistence food. Communities where subsistence access is limited rely on sharing subsistence harvests with nearby villages.

Most moose hunting in the region occurs along the Kobuk and Ambler rivers. Data on moose hunting focused around the Kobuk River, north into the Brooks Range, and south toward the Koyukuk River and shows the majority of moose hunting in the region occurs along the Kobuk and Ambler rivers (Braem et al 2015). Although less frequent, residents' subsistence use can also extend to the Chukchi Sea and Kotzebue Sound, depending on resource availability and season. Fishing locations in all three communities have shifted from nearby lakes to the Kobuk River.

Over half of Ambler's subsistence harvest is caribou while a quarter is non-salmon fish and less than five percent is salmon . The Ambler subsistence use area extends as far north as the headwaters of the Colville River on the North Slope, east to the headwaters of the Kobuk River, south near Huslia and Buckland, and west to Kotzebue Sound. Ambler residents also use marine nearshore areas from Kotzebue Sound to Point Hope and Shishmaref. Ambler consumes the most subsistence resources by weight of all three villages at 330 pounds per capita (Braem et al. 2015).

Kobuk's subsistence use area is the entire Kobuk River basin, north to the Brooks Range, west to Kotzebue Sound, and south the Selawik River. Kobuk has a similar subsistence use area as Ambler but has less reliance to the north and a greater focus on the Kobuk River. The majority of Kobuk's subsistence harvest is salmon, and to a lesser degree, caribou (Braem et al. 2015). The Kobuk subsistence use area for caribou covers a much larger area than for moose: the upper Kobuk River and southern Brooks Range. Caribou and salmon make up nearly half of subsistence users' diet and a quarter comes from non-salmon fish.

Shungnak's subsistence use area is the largest of the Kobuk River communities. It extends north, past the Brooks Range to the Colville River and Umiat, east to the headwaters of the Kobuk River, south from Huslia to Buckland, and west to Kotzebue Sound. Almost half of Shungnak residents' subsistence harvest is caribou, while
25 percent is non-salmon fish and 20 percent is salmon. Unlike the other two Kobuk River communities, Shungnak residents typically do not venture into Kotzebue Sound for subsistence activities. Their subsistence use area for caribou is larger than for any other subsistence resource.

The nearest documented salmon subsistence use area for residents of Shungnak is in the Kobuk River, just downstream from the community. Dahl Creek is not a source of fish for residents of Shungnak or Kobuk. Kobuk residents currently use the existing road between the Dahl Creek Airstrip and the existing Bornite Camp, as well as the local trail system, to access resources in Dahl and Cosmos creeks (Braem et al. 2015). The road to the Bornite Camp also provides access to the middle section of the Shungnak River.

Shungnak and Kobuk residents routinely hunt for caribou in the Ambler Lowlands, generally between the Shungnak and Kogoluktuk rivers. In addition, the Ambler Lowlands and portions of Dahl Creek are used by Kobuk residents to hunt for moose and black bear as well as small mammals.

Berry harvesting areas for Kobuk residents near the Project are along the lower portions of the Dahl Creek Airstrip access road. No subsistence use areas have been identified within the Subarctic Creek Valley, where the majority of Project activities and facilities would occur (Braem et al. 2015).

The Upper Kobuk Mineral Projects Subsistence Committee was established in 2013 to provide two-way communication between the Project and local communities and subsistence users. The subsistence committee consists of two members elected by their community from Kobuk, Shungnak, Ambler, Noorvik, and Kiana. The subsistence committee has typically met twice per year and discusses topics such as the planned Project facilities, impacts, and mitigation.

3.15.3 Preliminary Analysis of Impacts

Project activities and noise may disrupt local movements of caribou, moose, bear, and small mammals. Both Kobuk and Shungnak residents have subsistence use areas that would be bisected by the North Route and the South Route, and access to a large portion of their hunting, fishing, and gathering areas would require crossing the Project routes. These types of impacts could be mitigated by constructing subsistence ramps along these gravel roads, which would allow snowmachines and all-terrain vehicles (ATVs) to easily traverse the road embankments. AMC plans to work with the Subsistence Committee to determine appropriate locations for these ramps, as well as other potential mitigation measures.

Disturbance and displacement of individual caribou due to Project facilities, aircraft noise, road traffic, and other Project activities may affect subsistence users by altering the availability of resources in the Project area.

Subsistence access could be potentially affected during construction. During operations, residents would experience physical barriers preventing access to the Project area. The Project would improve some subsistence access by providing an upgraded road network for residents to use, although access to new roads north of the Bornite Camp would be prevented through the use of controlled access (i.e., gatehouses). However, regardless of new roads, some harvesters may avoid infrastructure due to discomfort in hunting and shooting near industrial infrastructure; lack of knowledge about security protocols; concerns about resource contamination; and/or an assumed lack of resource availability near infrastructure. Harvesters would be excluded from the mine site area when traveling overland out of safety concerns.

3.16 Visual and Aesthetic Resources

3.16.1 Existing Data

An assessment of visual and aesthetic resources for the Project area has not been completed, as visual resource management does not occur on private land. Visual impact analysis will likely be conducted as part of the NEPA process.

3.16.2 Existing Conditions

Visual and aesthetic features include scenic, cultural, or other resources visible to subsistence and recreational viewers. In general, the Project area has high topographic relief, and lines of sight are relatively short. In addition, the topographic geometry limits the visible distance; for instance, the proposed mining and operations facilities would be in the upper portions of the Subarctic Valley, which generally aligns north-to-south, but halfway down the valley, the orientation changes to east-to-west, so the line of sight is limited by the mountains (Graphic 3.6 and Graphic 3.7).

There are no visible anthropogenic structures in the Project area, and there are limited linear features, such as existing roads.



Graphic 3.6. Looking South over the Location of the Proposed Mining Facilities



Graphic 3.7. Looking Southeast at a Representation of the Proposed Mining Facilities

3.16.3 Preliminary Analysis of Impacts

Impacts to people based on changes to visual resources are determined based on the estimated contrasts caused by Project facilities, including nighttime or winter lighting, the distance to Project facilities and activities, and the number of users in the viewshed. The Project would not be expected to impact the visual or aesthetic resources for recreational backpackers or residents of Kobuk, Shungnak, or Ambler unless they are hunting, hiking, or working north of the Cosmos Hills. Subsistence users and visitors north of the Cosmos Hills may, depending on proximity to the Project, experience observable changes and contrasts to the characteristic landscape for the life of the Project. Some impacts, such as the mine pit, would persist post-closure. Project facilities and activities with visual impacts would include lighting, structural features, the open pit, dust, gravel roads, pipelines, stream crossings, water intakes, vehicle activity, and air and ground traffic. These strong contrasts to scenery would reduce the scenic quality of the immediate Project area.

3.17 Human Health and Safety

3.17.1 Existing Data

Many databases were used in the Ambler Road EIS Health Impact Assessment (HIA) to provide a human health baseline (Newfields 2019). The HIA was specific to communities within 50 miles of the AAP and alternatives and was not centered on communities near the Project. Ambler, Kobuk, and Shungnak all have health clinics with community health aides or practitioners. No health data specific to the communities of Ambler, Kobuk, and Shungnak are currently available.

3.17.2 Existing Conditions

Ambler, Kobuk, and Shungnak had 72 percent or greater intact family households. All three communities ban the sale and importation of alcohol. NOA was found in Ambler during tests from the airport expansion project (DOT&PF 2013).

As described in Chapter 3.15, *Subsistence and Traditional Use*, the Iñupiaq communities of Ambler, Kobuk, and Shungnak rely on subsistence resources to obtain a healthy and predictable food source. A subsistence way of life also reinforces community and individual cultural identity.

3.17.3 Preliminary Analysis of Impacts

The Project could affect human health and safety through increased opportunities for employment, increased income, interruptions of subsistence activities, vehicle collisions, and exposure to (or the perception of exposure to) environmental contaminants.

4.0 AVOIDANCE, MINIMIZATION, AND MITIGATION MEASURES

AMC has optimized the proposed Project by incorporating methods to avoid impacts to the human and natural environment and minimize impacts that could not be avoided. AMC would also avoid and minimize potential impacts to various resources through Project design or by implementing specific Project activity control measures and BMPs.

The following subsections describe Project design features intended to avoid or minimize impacts to the environment.

4.1 Project Design and Siting Minimization Measures

4.1.1 Minimizing New Disturbance Areas

AMC sited the North Route and South Route on existing winter trails to the extent practicable to reduce the overall Project impact to undisturbed terrain. AMC would use the existing Dahl Creek Airstrip for the Project to avoid constructing a new one (that could be substantially closer to Project facilities) to reduce impacts to wetlands and other waters.

4.1.2 Minimizing Impacts to Water Quality

Since the Project's earliest conceptual design, AMC has considered potential impacts to water quality by examining existing surface water and groundwater resources. Land locations for the TMF and WRF were selected at the head of the Subarctic Valley and not downstream near the mouth of the valley, in part to minimize impacts to water and wetlands. The Project initially considered discharging treated water above criteria in Alaska WQS into the Shungnak River using a mixing zone. The Project later developed a water treatment regime that would meet Alaska WQS without the need for a mixing zone.

4.1.3 Minimizing Impacts to Air Quality

Ore crushing and processing would occur in enclosed facilities with dust filtration systems to minimize the production of dust and release to the environment. The Project would containerize concentrate for transport between the Project and the Port of Alaska to minimize potential dust contamination. Diesel fuel has been selected to fuel the mine-site generators due to the lack of a sufficiently sized local source of liquified natural gas. If a reliable source of liquified natural gas is constructed in the future, the Project would evaluate the option of switching fuel source types.

4.1.4 Minimizing Mined Construction Material

Waste rock would be used to construct the starter dam and for tailings containment (the WRF), which would provide the necessary TMF volume without requiring additional mining to support infrastructure construction.

4.1.5 Cleanup of Existing Contamination

AMC has proactively completed the following clean-up activities to address existing wastes in the Project area that were created and abandoned by others during previous mining exploration activity:

- Approximately 600 drums were collected on site and consolidated at a single staging location; contents of 40 drums with petroleum products were subsequently tested and shipped off site to an approved disposal facility, while the remaining drums were cut up and scrapped.
- One 13,000-gallon tank found on site was decommissioned.
- Two geotechnical exploration drills and a large amount of drill parts and drill steel were removed off-site.

AMC intends to continue to complete reclamation activities of existing contaminated sites and remove hazardous materials, as needed.

4.2 Wetland Avoidance, Minimization

AMC sited and designed facilities to avoid and minimize effects to wetlands. The following optimizations were made:

- The Operations pad was designed to be compact and sited to avoid or minimize impacts to wetlands by placing it in a section of Subarctic Valley with a high percentage of upland areas.
- The Operations camp location was chosen to almost completely avoid wetlands; all other alternatives resulted in greater wetland impacts.
- Several aircraft transportation alternatives (e.g., airstrips) were evaluated for the Project; two identified alternatives would have resulted in wetland impacts (approximately five acres and greater than 40 acres [2 ha and greater than 16 ha]).
- Material Site 4 was selected as the site for the TCC to avoid the need for a separate construction camp pad. Further, the TCC would be converted into a laydown yard once operations commence, thereby avoiding the need to build an additional equipment and materials transfer site.
- The North Route MP 0.0 to MP 5.5 alignment was sited to avoid an area of the Ambler Lowlands with significant wetlands.
- Road shoulder widths were reduced from 20 feet to 12 feet to reduce footprint and thus wetlands impacts.
- The proposed open pit would be located near a mountain ridgetop, which would avoid impacts to wetlands along the valley floor. The open pit was designed based on access to mineral resources, maintaining pit wall stability, limiting waste rock, and minimizing disturbance to wetlands and other waters.

4.3 Wetland Mitigation

Compensatory mitigation is the restoration, establishment, enhancement, or, in certain circumstances, preservation of wetlands, streams, or aquatic resources to offset unavoidable adverse impacts that remain after all appropriate and practicable avoidance and minimization has been achieved (33 CFR 332.2). AMC has incorporated all practicable measures to avoid and minimize adverse impacts to wetlands and other aquatic resources through project planning, design refinement, and implementation of best management practices. Based on a watershed-level analysis, the Project would result in minimal effects to aquatic resources. The Project would affect three watersheds; following completion of the Project, total cumulative disturbance within the watersheds would be approximately 0.03 percent, 0.07 percent, and 1.04 percent, respectively, leaving the watersheds largely intact and relatively undegraded.

Due to the lack of historical anthropogenic disturbance within these watersheds, opportunities to implement commensurate compensatory mitigation that would meaningfully replace aquatic resource

functions and services are limited and not readily available. In consideration of the minimal magnitude of impacts, the intact watershed conditions, the lack of mitigation, and the extensive avoidance and minimization measures incorporated into the Project design, compensatory mitigation is not anticipated to be appropriate or practicable.

Consistent with 33 CFR § 320.4(r) and the mitigation sequencing requirements of the Section 404(b)(1) Guidelines, mitigation for the Project will consist of avoidance and minimization measures, including comprehensive reclamation of temporarily disturbed areas and post-closure water treatment and monitoring. These measures are intended to minimize long-term aquatic resource effects, restore disturbed areas to stable conditions following Project completion, and ensure protection of downstream water quality.

Design features and BMPs the Project would use to avoid and minimize impacts to all resources are summarized in Table 4.1.

Table 4.1. Design Features and BMPs to Avoid and Minimize Impacts

PROJECT COMPONENT OR ACTIVITY	DESIGN FEATURE OR BMP	PRIMARY AFFECTED RESOURCE(S) OR SUBJECT(S)											
		All	Air Quality	Cultural resources	Fish	Human/Public Health	Noise	Socioeconomics	Subsistence/Traditional Use	Water/Water Quality	Wildlife	Visual Resources	Wetlands and Vegetation
All	The Project would be audited periodically to ensure compliance with all environmental laws, commitments, regulations, local requirements and company policies and procedures.	X											
	A 500-foot disturbance buffer would be implemented around any identified cultural resources sites to avoid impacts to the resource.			X									
	The Project would continue consulting with affected subsistence communities (e.g., WACH Working Group) and through the Subsistence Committee to mitigate and minimize potential impacts to subsistence activities.								X				
Facilities and Operations	Good combustion practices would be implemented for all fuel-fired equipment, (e.g., regular maintenance) to reduce potential greenhouse gas emissions.		X			X							
	Facilities would be designed to minimize nesting, denning, or sheltering opportunities for ravens, raptors, and foxes. Intentional wildlife feeding would be prohibited.												
	Chemicals being considered for use on the Project would be reviewed to minimize the generation of hazardous waste or risk to employees.	X											
	The Project would use an enclosed or acoustically packaged permanent electric power generator sets to abate noise.						X				X		
	A Project lighting plan would be implemented to minimize light visible from outside Project facilities (e.g., directing artificial exterior lighting inward and downward).			X	X	X	X	X	X	X	X	X	

PROJECT COMPONENT OR ACTIVITY	DESIGN FEATURE OR BMP	PRIMARY AFFECTED RESOURCE(S) OR SUBJECT(S)											
		All	Air Quality	Cultural resources	Fish	Human/Public Health	Noise	Socioeconomics	Subsistence/Traditional Use	Water/Water Quality	Wildlife	Visual Resources	Wetlands and Vegetation
	The Project would use products that avoid ozone-depleting agents (e.g., Halon) for fire protection in industrial facilities (e.g., mill, truck shop) such as Finewater Mist.				X	X			X	X	X		
Gravel Infrastructure	Road surfaces would be constructed to minimum required widths to limit the placement of gravel fill.	X											
	Gravel roads would have subsistence ramps to allow snowmachine and ATVs to traverse road embankments to facilitate subsistence activities								X				
	The existing Bornite Camp would be used to support Project construction to minimize the need to build new, additional camp space.	X											
	The existing Dahl Creek Airstrip and connecting road would be upgraded to eliminate the need for a new project-specific airstrip and associated road.	X											
	The Project would use existing trails and winter routes to the extent practicable for aligning new roads.	X											
	Gravel fill would not be placed within the USFWS bird nesting window, or investigate the location beforehand, to minimize impacts to nesting birds and broods.										X		
	Cross-drainage culverts would be installed to maintain natural surface drainage to reduce the risk of sheet-flow interruption and impoundments.									X			
	A Dust Control Plan would be implemented to minimize the incidence of fugitive dust from gravel roads, pads, and mining operations.		X		X	X			X		X		X

PROJECT COMPONENT OR ACTIVITY	DESIGN FEATURE OR BMP	PRIMARY AFFECTED RESOURCE(S) OR SUBJECT(S)											
		All	Air Quality	Cultural resources	Fish	Human/Public Health	Noise	Socioeconomics	Subsistence/Traditional Use	Water/Water Quality	Wildlife	Visual Resources	Wetlands and Vegetation
	A maximum speed of 35 mpg on all Project roads would be used to minimize fugitive dust generation, noise, and wildlife impacts.				X		X		X	X	X		X
	An Erosion Control Plan would be implemented to minimize erosion and include a Pollution Prevention Plan to decrease stormwater runoff and limit pollutant loadings.				X				X	X	X		X
	Permanent wetland loss would be avoided by locating Project infrastructure in uplands to the greatest extent possible.												X
Personnel	Education and employment outreach efforts with local communities and Alaska Native organizations would be continued.							X					
	The Project would prohibit employees from hunting, trapping, and fishing activities while employees are on active work status to reduce impacts to subsistence and recreational wildlife resources.								X				
	Disturbance of caribou would be avoided to the greatest practicable extent, including stopping vehicles on roadways and prohibiting the chasing of wildlife in vehicles or equipment.								X		X		
	Contractors' health, safety, and environmental performance would be audited to ensure safe practices are followed.				X	X			X	X	X		X
Spill Prevention and Hazardous Materials	A spill prevention plan would be implemented to avoid or minimize impacts to the environment from Project spills using secondary containment, other spill prevention measures (e.g., use of drip pans/duck ponds), on-site cleanup materials, use of proper storage containers and liner materials, proper container identification, and notice of reportable spills.	X											
	All fuels and other products would be transported to the Project area using licensed commercial transporters following U.S. Department of Transportation regulations to minimize spills.				X	X			X	X	X		X

PROJECT COMPONENT OR ACTIVITY	DESIGN FEATURE OR BMP	PRIMARY AFFECTED RESOURCE(S) OR SUBJECT(S)											
		All	Air Quality	Cultural resources	Fish	Human/Public Health	Noise	Socioeconomics	Subsistence/Traditional Use	Water/Water Quality	Wildlife	Visual Resources	Wetlands and Vegetation
	Snow would be cleared and placed in designated snow-storage areas to prevent contaminated runoff during breakup.				X					X			X
	Implement a fuel transfer standard operating procedure regulated oil and hazardous materials storage tanks.	X											
Transportation	Equip vehicles with engine block heaters and institute Project practices to power off and plug in vehicle engines when temperatures are 0 ºF or above to conserve fuel and reduce air emissions.		X			X							
	Aircraft operating in the Project area would be required to maintain minimum elevations to minimize potential impacts to wildlife, except during takeoffs and landings.										X		
	Use ultra-low sulfur diesel (as defined by ADEC) in all diesel-fueled vehicles and equipment.		X			X							
	Use Tier IV engines (e.g., generators, heavy equipment) to reduce air quality emissions.		X										
Waste Management and Wildlife interaction	Manage all wastes in accordance with a comprehensive integrated waste management plan to reduce impacts to human health and safety and to minimize potential impacts to subsistence resources, including fish and wildlife.				X				X	X	X		X
	Policies, procedures, and training would be implemented to prevent wildlife attraction to Project facilities, including a wildlife avoidance and interaction plan, use of predator-proof dumpsters for food waste collection; a strict policy prohibiting the feeding of wildlife; and the use of sealed containers for meals-on-the-go to conceal food odors.										X		
Water Use and Wastewater	Install water treatment system that would treat water to a level that meets all Alaska WQS.				X	X			X	X			

PROJECT COMPONENT OR ACTIVITY	DESIGN FEATURE OR BMP	PRIMARY AFFECTED RESOURCE(S) OR SUBJECT(S)											
		All	Air Quality	Cultural resources	Fish	Human/Public Health	Noise	Socioeconomics	Subsistence/Traditional Use	Water/Water Quality	Wildlife	Visual Resources	Wetlands and Vegetation
	Use water collected in the WRCP and TMF to supply process water to mill facilities.									**X**			
	Discharge of untreated domestic wastewater to tundra would not be planned during normal conditions.				**X**	**X**			**X**	**X**	**X**		**X**
	Any surface water intake would be designed and operated in such a way as to prevent injury or mortality to fish (e.g., screened intake enclosure).				**X**				**X**				
	Water withdrawals from lakes and streams would be conducted in compliance with ADNR water rights and temporary water use authorizations and ADF&G fish habitat permit stipulations.				**X**				**X**	**X**			

X indicates primary affected resource
x indicates other affected resource

5.0 LITERATURE CITED

ABR, Inc. (ABR). 2014. Stream habitat surveys of proposed bridge crossings on the Brooks East Corridor.

-----. 2016. Aerial surveys of nesting raptors in the Upper Kobuk Mineral Project Area, Alaska, 2016.

-----. 2017. Aerial surveys of nesting raptors in the Upper Kobuk Mineral Project Area, Alaska, 2017.

-----. 2024. Analysis of fish and wildlife resources near the proposed Arctic Mine in northwestern Alaska. October 2024.

Alaska Department of Commerce, Community, and Economic Development (ADCCED). 2014. Ambler Mining District Industrial Access Road Economic Impact Study: Draft Executive Summary.

Alaska Department of Natural Resources (ADNR). 2017. Guidelines for cooperation with the Alaska Dam Safety Program. Draft Revision. Dam Safety and Construction Unit Water Resources Section Division of Mining, Land and Water Alaska Department of Natural Resources. July 2017. http://dnr.alaska.gov/mlw/water/dams/AK_Dam_Safety_Guidelines072817rev2.pdf

Alaska Department of Fish and Game (ADF&G). 2015. Wild food harvests in 3 Upper Kobuk River communities: Ambler, Shungnak, and Kobuk, 2012-2013. Division of Subsistence. Technical Paper No. 402. Fairbanks, Alaska.

Alaska Department of Transportation and Public Facilities (ADOT&PF). 2015. Wild food harvests in 3 Upper Kobuk River communities: Ambler, Shungnak, and Kobuk, 2012-2013. Division of Subsistence. Technical Paper No. 402. Fairbanks, Alaska.

ADF&G. 2017. Aquatic biomonitoring at the Arctic-Bornite Prospect, 2016. Technical Report No. 17-06. Fairbanks, Alaska.

-----. 2018a. Aquatic biomonitoring at the Arctic-Bornite Prospect, 2017. Technical Report No. 18-04. Fairbanks, Alaska.

-----. 2018b. Western Arctic caribou herd overview – Bornite Mine. Presentation to Ambler Metals LLC from ADF&G, Western Arctic Caribou Herd , Seasonal Range Use, 2012–2017, Female Caribou.

-----. 2020. Aquatic Biomonitoring at the Arctic-Bornite Prospect, 2019. Technical Report No. 20-01. Fairbanks, Alaska.

-----. 2021 Arctic Fox (Alopex lagopus). ADF&G website. https://www.adfg.alaska.gov/index.cfm?adfg=arcticfox.main

-----. 2022. Aquatic biomonitoring at the Arctic-Bornite Prospect, 2021. Technical Report No. 22-06. Fairbanks, Alaska.

-----. 2023. Aquatic biomonitoring at the Arctic-Bornite Prospect, 2022. Technical Report No. 23-04. Fairbanks, Alaska.

-----. 2024. Aquatic biomonitoring at the Arctic-Bornite Prospect, 2023. Technical Report No. 24-05. Fairbanks, Alaska.

-----. 2025a. Baseline aquatic biomonitoring at the Arctic-Bornite Exploratory Mining Prospects, 2024. Alaska Department of Fish and Game, Technical Report No. 25-09, Fairbanks, Alaska.

-----. 2025b. Alaska Department of Fish and Game, Western Arctic Caribou Herd Working Group December 10-11, 2025

Alaska Exotic Plants Information Clearinghouse (AKEPIC). 2019. AKEPIC Data Portal. https://aknhp.uaa.alaska.edu/apps/akepic/

Alaska Industrial Development and Export Authority (AIDEA). 2022. Ambler Access Project 2022 Annual Fieldwork Report.

Auerbach, N. A., Walker, M., and Walker, D. 1997. Effects of roadside disturbance on substrate and vegetation properties in Arctic tundra. Ecological Applications, Vol. 7 No. 1, pp. 218–235.

Ausenco Engineering Canada Inc. (Ausenco). 2023. Arctic Project Pre-Feasibility Study Update, Alaska.

BD Resource Consulting Inc. 2014. Bornite Project, Northwest Alaska, USA. NI 43-101 Technical Report.

BGC Engineering, Inc. (BGC). 2013. Ambler Project Arctic Deposit: Rock mechanics and hydrogeology study. Final Report. BGC Project Number 0651-004. https://www.sec.gov/Archives/edgar/data/1543418/000106299314001827/exhibit99-1.htm

Blake, K. L. and Brownwell, S. R. 2016. A Cultural Resources assessment of the proposed Arctic Pit and support facilities in Northwest Arctic Borough, Alaska.

Blanchard, M., McGowan, S., Olmedo, K., Smith, G., Hall, P. and Gordaoff, R. 2015. 2014 Cultural resources survey of the Ambler Mining District Industrial Access Road (AMDIAR) Project within Gates of the Arctic National Preserve, Alaska. Northern Land Use Research Alaska, LLC. April 2015.

Brailey Hydrologic Consultants LLC. 2022. Streamflow data compilation report: Upper Kobuk Mineral Projects.

Brown and Caldwell. 2021. DRAFT Water treatment strategy for the Arctic Deposit.

Burgess, R. M. and Banyas, P. W. 1993. Inventory of arctic fox dens in the Prudhoe Bay region, 1992.

Canadian Dam Association. 2014. Application of Dam Safety Guidelines to Mining Dams. Technical Bulletin.

Cardno Limited (Cardno). 2015. Ambler mining region economic impact analysis.

Carlson, M. L. 2008. Invasiveness ranking system for non-native plants of Alaska. Vol. 143. U.S. Department of Agriculture, U.S. Forest Service, Alaska Region. August 2008.

Cowardin, L. M. 1979. Classification of wetlands and deepwater habitats of the United States. https://www.fws.gov/media/classification-wetlands-and-deepwater-habitats-united-states

DOWL. 2016. Large mammal data analysis, NovaCopper Upper Kobuk Mining Project. Prepared for Trilogy Metals Inc. November 2016.

-----. 2017. Arctic Deposit airport pre-feasibility study – Final Report. Prepared for Trilogy Metals, Inc. October 2017.

-----. 2018. Preliminary Wetlands Determination. Prepared for Trilogy Metals, Inc. October 2018.

-----. 2019. Arctic Access Road design preliminary engineering report. Prepared for Trilogy Metals, Inc. September 2019.

Fordyce, F. M. 2013. Selenium deficiency and toxicity in the environment. In: Essentials of Medical Geology (pp. 375-416): Springer. 2013.

Fritts, C.E., 1970, Geology and geochemistry of the Cosmos Hills, Ambler River and Shungnak quadrangles, Alaska: Alaska Division of Mines and Geology Geologic Report 39, 63 p., 5 sheets, scale 1:63,360.

Fulkerson, D. 2018. 2018 Arctic Deposit and associated infrastructure archaeology site investigation report, Alaska.

Gallant, A. L., Binnian, E.F., Omernik, J.M., and Shasby, M.B. 1995. Ecoregions of Alaska. U.S. Geological Survey Professional Paper No. 1567. Washington, D.C. U.S. Government Printing Office.

Hitzman, M.W., Smith, T.E., and Proffett, J.M. 1982. Bedrock geology of the Ambler District, southwestern Brooks Range, Alaska. Alaska Department of Natural Resources, Division of Geological & Geophysical Surveys. Geologic Report 75, 2 sheets.

Iowa State University, Iowa Environmental Mesonet. 2021. Ambler Airport (PAFM) NOAA ASOS Data Set. https://mesonet.agron.iastate.edu/request/download.phtml?network=AK_ASOS

International Council of Mining and Metals (ICMM). 2020. Global Industry Standard on Tailings Management.

Joly, K. 2020. Arctic Network, Caribou Resource Brief. U.S. Department of the Interior, National Park Service, Alaska Region. Inventory & Monitoring Program. https://irma.nps.gov/DataStore/DownloadFile/656978

Joly, K. and Cameron, M. D. 2015. Caribou vital sign annual Report for the Arctic Network inventory and monitoring program: September 2014–August 2015. Natural Resource Report NPS/ARCN/NRR-2015/1090. National Park Service.

Joly, K., Chapin III, S.F., and Klein, D.R. 2010. Winter habitat selection by caribou in relation to lichen abundance, wildfires, grazing, and landscape characteristics in northwest Alaska. Pacific Northwest Research Station. Ecoscience. 17(3), 321-333.

Jorgenson, M.T. 2011. Coastal region of northern Alaska, guidebook to permafrost and related features. Alaska Department of Natural Resources, Division of Geological & Geophysical Surveys, Guidebook 10, 188 p. https://doi.org/10.14509/22762

Klohn Crippen Berger. 2021. DRAFT Alternatives Assessment - Tailings and Waste Rock Facilities.

Larivie’re, S. 2001. Mammalian species. Ursinus americanus. American Society of Mammalogists No. 647, pp. 1-11, 13 Figures.

Lemke, J. L., et al. 2013. Anadromous fish surveys within the Brooks East Corridor survey area, Alaska.

McKinley Research. 2024. Ambler Mining District: economic impact analysis. Prepared for Ambler Metals, LLC. November 2024.

McLoughlin, P. D., Ray, L., Robert J Gau, R.L., Cluff, D.H., Mulders, R. and Messier, F. 2002. Hierarchical habitat selection by barren-ground grizzly bears in the central Canadian Arctic. Oecologia, 132(1), 102–108.

Mould, E. 1977. Habitat relationships of moose in northern Alaska. In: Proceedings of the North American Moose Conference and Workshop (pp. 144–156). Alberta, Canada.

Myers-Smith, I. H., Arnesen, B.K, Thompson, R.M., and Chapin III, F. S. 2006. Cumulative impacts on Alaskan Arctic tundra of a quarter century of road dust. Ecoscience, Vol. 13 No. 4, pp. 503–510 https://www.jstor.org/stable/42901935

Naiden, A. 2022. Article: "Western Arctic Caribou Herd shrank more in 2022, hurting Northwest Arctic subsistence hunters." Anchorage Daily News. November 7, 2022

National Oceanic and Atmospheric Administration (NOAA). 2021. National Climatic Data Center, Climate Data Online: Dataset Discovery. http://www.ncdc.noaa.gov/cdo-web/datasets/

Regional Climate Centers (RCC) Applied Climate Information System (ACIS). 2021. Station Information, Daily and Monthly Normals, Daily Data for a Month Tables. https://xmacis.rcc-acis.org/

National Park Service (NPS). 2015. Aerial moose survey within and around Gates of the Arctic National Park and Preserve, March 2015. Natural Resource Report. NPS/GAAR/NRR—2015/967. National Park Service. Fort Collins, Colorado.

NewFields. 2019. Health impact assessment – Ambler Road, Alaska.

NovaCopper. 2016. Arctic Mine Project Staff Field Observations 2016. Excel spreadsheet.

Perkins, R. A., Hargesheimer, J., and Winderfeld, A. 2009. Naturally occurring asbestos in Alaska and experiences and policy of other states regarding its use. Alaska Department of Transportation & Public Facilities, Alaska University Transportation Center. Fairbanks, AK.

Pessel, G.H., Garland, R.E., Tailleur, I.L., and Eakins, G.R. 1975. Preliminary geologic map of southeastern Ambler River and part of Survey Pass quadrangles. Alaska Department of Natural Resources, Division of Geological & Geophysical Surveys Alaska Open-File Report 36, 2 sheets, scale 1:63,360. https://doi.org/10.14509/135

Pipkin, M.E. 2020. 2019 Cultural resource examination of supplementary areas in the vicinity of the Bornite to Arctic Deposit Road infrastructure, Alaska. Walking Dog Archaeology.

Rigg, D. 2010. Bornite Mine Road preliminary data. Cultural resources report. WHPacific. Prepared for ADNR Office of History and Archaeology.

Ritchie, B. 2013. Raptor surveys along the proposed Brooks East Corridor, Ambler Mining District Access Project, Alaska, 2013. ABR, Inc. Prepared for DOWL KLM.

Saito, B. and Johnson, M. 2014. 2014 Aerial moose survey in the Upper Kobuk Drainage, Alaska, April 4-16, 2014. (Draft).

Shideler, R. T. and Hechtel, J. L. 2000. Grizzly bear. In: J. C. Truett & S. R. Johnson (Eds.), The Natural History of an Arctic Old Field: Development and the Biota (pp. 105–132). San Diego, CA: Academic Press. https://www.sciencedirect.com/science/chapter/edited-volume/abs/pii/B9780127012353500088?via%3Dihub

Shipley, L. 2010. Fifty years of food and foraging in moose: lessons in ecology from a model herbivore. Journal: Alces, Vol 46, pp. 1–13.

Solie, D. N. and Athey, J.E. 2015. Preliminary evaluation of bedrock potential for naturally occurring asbestos in Alaska. Alaska Department of Natural Resources, Division of Geological & Geophysical Surveys Miscellaneous Publication 157.

Stephen R. Braund and Associates (SRB&A). 2012. Ambler Mining District Access Project: Subsistence data gap memo.

-----. 2024a. Ambler Metals Arctic Mine: Subsistence data gap analysis. Prepared for Ambler Metals, LLC. November 13, 2024.

-----. 2024b. Ambler Metals Arctic Mine: Subsistence literature review. Prepared for Ambler Metals, LLC. November 13, 2024.

-----. 2024c. Ambler Metals Arctic Mine: Subsistence impacts and mitigation measures. Prepared for Ambler Metals, LLC. November 13, 2024.

SRK Consulting, Inc. (SRK). 2012. Preliminary economic assessment. Ambler Project Kobuk, AK. NI 43-101 Technical Report. Prepared for Trilogy Metals, Inc.

-----. 2017. Pre-Feasibility slope geotechnical and hydrogeological report for the Arctic Deposit (2016).

-----. 2018. Technical report on the Arctic Project for PFS level waste management & water management design.

-----. 2019. Arctic project feasibility study mine waste management site investigation.

-----. 2020. Arctic Project Feasibility Study Groundwater Technical Report.

-----. 2021. Characterization of acid rock drainage and metal leaching potential, 2020 progress. May 2021.

-----. 2022. Ambler Pre-feasibility Study geotechnical and hydrogeological assessments.

-----. 2024. Arctic feasibility study water and load balance report. January 2024.

State of Alaska. 2023. Unemployment rates for Northwest Arctic Borough and Alaska 2013-2023. https://live.laborstats.alaska.gov

Tetra Tech, Inc. (Tetra Tech). 2010. Arctic deposit access environmental baseline data collection wetlands and vegetation.

-----. 2011. Arctic Deposit access environmental baseline data collection aquatics.

Travis/Peterson Environmental Consulting Inc. 2007. Bornite Mine camp, site characterization report.

Trilogy Metals Inc. (Trilogy). 2017. Workshop: “Trilogy Arctic Project, Site Infrastructure Location.” August 1, 2017.

-----. 2018. Pre-Feasibility Study. Arctic Project, Northwest Alaska, USA. National Instrument (NI) I 43-101 Technical Report.

Trilogy Metals Inc. and SLR International Corporation. 2020. Arctic Valley Station 2018-2019 Annual Data Report.

U.S. Army Corps of Engineers (USACE). 1987. Corps of Engineers Wetland Delineation Manual. Wetlands Research Program Technical Report Y-87-1. Washington, D.C.

-----. 2007. Regional Supplement to the Corps of Engineers Wetland Delineation Manual: Alaska Region (Version 2.0). Retrieved from Vicksburg, MS.

U.S. Fish and Wildlife Service (USFWS). 2021. Information for Planning and Consultation Resource List. https://ecos.fws.gov/ipac/

U.S. Geological Survey (USGS). 2001. Hydrologic data and a proposed water-quality monitoring network for the Kobuk River Basin, Gates of the Arctic National Park and Preserve, and Kobuk Valley National Park, Alaska. Water Resources Investigations Report 01-4141. Prepared in cooperation with the National Park Service.

Walker, D. A. and Everett, K. R. 1987. Road dust and its environmental impact on Alaska taiga and tundra. Arctic and Alpine Research, Vol. 19 No. 4, pp. 479–489.

WHPacific Inc. 2017. Report on: Endangered Species Act Consultation for the Upper Kobuk Mineral Project.

Wilson, R. R., Gustine, D.D., and Joly, K. 2014. Evaluating potential effects of an industrial road on winter habitat of caribou in north-central Alaska. Arctic, Vol. 67, No. 4., pp. 472-482. Arctic Institute of North America.

Wilson, R. R., Parrett, L. Joly, K., Dau J.R. 2016. Effects of roads on individual caribou movements during migration. Biological Conservation, Vol. 195, pp. 2-8. March 2016.

Wiltse, M.A. 1975. Geology of the Arctic Camp prospect, Ambler River Quadrangle, Alaska. Alaska Department of Natural Resources, Division of Geological & Geophysical Surveys Alaska Open-File Report 60, 43 p., 1 sheet, scale 1:12,000.

Western Regional Climate Center (2012), NOAA COOP Station Climatic Data, Period of Record (1981-1992) obtained from https://wrcc.dri.edu/cgi-bin/cliGCStP.pl?ak0260

Young, D. D. and McCabe, T. R. 1997. Grizzly bear predation rates on caribou calves in northeastern Alaska. The Journal of Wildlife Management, Vol. 61 No.4, pp. 1056-1066. https://www.jstor.org/stable/3802102?origin=crossref

Arctic Mine Development Project

Appendix A
Alternatives Development

April 2026

This page intentionally left blank.

Table of Contents

1.0 Introduction 1
2.0 Regulatory Setting for Alternatives Analysis 1
3.0 Alternatives Development 1
3.1 Overview of the Alternatives Evaluation Process 1
3.2 Alternatives Screening Criteria 2
3.2.1 Purpose and Need 2
3.2.2 Feasible and Practicable 2
3.2.3 Relative Environmental Effects 3
3.3 Alternative Components Considered during Project Development 3
3.3.1 Mine Type 3
3.3.2 Location of the Tailings Management Facility and Waste Rock Facility 4
3.3.3 Location of Gravel Pads 8
3.3.4 Access Options 13
3.3.5 Airstrip Options 17
3.3.6 Fuel Source Options 20
3.3.7 Material Site Options 21
3.3.8 Wastewater Treatment Options 22
3.3.9 Liner Options for the Waste Rock Facility 24
3.4 Alternative Components Considered but Eliminated from Further Analysis 26
4.0 References 29

List of Figures

Figure B.1. Alternate Tailings Management Facility and Waste Rock Facility Locations Considered During Project Development 5
Figure B.2. Potential Operations Pad Locations Considered during Alternatives Development 9
Figure B.3. Alternative Operations Camp Locations Considered during Project Development 11
Figure B.4. Access Road Alignment Alternatives 14
Figure B.5. Alternative Airstrip Locations Considered during Project Development 18

List of Tables

Table B.1. Mine Type Options Considered during Alternatives Development 3
Table B.2. Tailings Management Facility and Waste Rock Facility Locations Considered during Alternatives Development 6
Table B.3. Operations Pad Locations Considered during Alternatives Development 10
Table B.4. Camp Locations Considered during Alternatives Development 12
Table B.5. Summary of Operations Camp Siting Options Impacts 12
Table B.6. Access Options Considered during Alternatives Development 15
Table B.7. Summary of Access Road Alignment Option Impacts 16
Table B.8. Bridge Options Considered during Alternatives Development 17
Table B.9. Airstrip Options Considered during Alternatives Development 19
Table B.10. Summary of Airstrip Option Impacts 20
Table B.11. Fuel Source Options Considered during Alternatives Development 20
Table B.12. Material Site Options Considered during Alternatives Development 21
Table B.13. Water Treatment Options Considered during Alternatives Development 23
Table B.14. Liner Options Considered during Alternatives Development 25
Table B.15. Alternative Components Considered but Eliminated from Further Analysis and the Rationale for Elimination 26

List of Acronyms

AAP	Ambler Access Project
AMC	Ambler Metals, LLC
CEQ	Council on Environmental Quality
CWA	Clean Water Act
EED	Environmental Evaluation Document
ha	hectare
km	kilometer
LEDPA	least environmentally damaging practicable alternative
LNG	liquified natural gas
m	meter
NANA	NANA Regional Corporation
NEPA	National Environmental Policy Act
PAG	potentially acid generating
Project	Arctic Mine Development Project
TMF	tailings management facility
USACE	U.S. Army Corps of Engineers
WOUS	Waters of the U.S.
WQS	water quality standards
WRF	waste rock facility

Glossary Terms

Footprint – The portion of the Arctic Mine Development Project's area that would be physically occupied by Project infrastructure.

Material site – The site where construction materials (e.g., gravel, riprap) would be taken from for use (e.g., roads, pads) in other locations.

Mill – Mining equipment that breaks solid materials into smaller pieces by grinding, crushing, or cutting.

Open pit – An open excavation and the site of active mining.

Operations pad – The Arctic Mine Development Project's constructed pad that would contain processing and other support facilities (e.g., power plant, offices, truck shop).

Permeate – Gas or liquid that has passed through a membrane material.

Perpetuity – An endless or indefinitely long duration.

Process water – Water used to support the extraction of mineral concentrates from mined ore.

Tailings management facility (TMF) – A structure, usually including one or more dams, built to store the water and tailings from the milling process.

Waste rock facility (WRF) – Bedrock that has been mined and holds no economic value.

Water quality standards (WQS) – A level of water quality established by the Alaska Department of Environmental Conservation to protect Waters of the State of Alaska from pollutants; it includes designated water use, numeric or narrative parameters for designated use (i.e., criteria), and consistency with the State's anti-degradation policy.

Waters of the U.S. – Waterbodies and wetlands under jurisdiction of U.S. Army Corps of Engineers, as defined by 33 CFR 328.3.

1.0 INTRODUCTION

The U.S. Army Corps of Engineers (USACE) will be the lead federal agency responsible for federal permitting required for the Arctic Mine Development Project (Project). USACE has jurisdiction under the Clean Water Act (CWA) to issue permits for the placement of dredge or fill material in Waters of the U.S. (WOUS), including wetlands. Both the National Environmental Policy Act (NEPA) evaluation and USACE's permit review require consideration of project alternatives. This appendix provides a detailed overview of the alternative components and concepts considered by Ambler Metals, LLC (AMC) that have either been eliminated from the proposed project or that are still being considered but are not the preferred alternative at this time. AMC is providing this information, along with the rationale for elimination to support the alternatives analysis associated with the upcoming NEPA permitting process.

2.0 REGULATORY SETTING FOR ALTERNATIVES ANALYSIS

AMC considered how alternatives development factor into NEPA and CWA assessments in its evaluation of different Project components and alternatives. NEPA directs federal agencies to "study, develop, and describe appropriate alternatives to recommend courses of action in any proposal that involves unresolved conflicts concerning alternative uses of available resources" (42 USC 4332). In determining the alternatives to be considered in satisfying the project's purpose and need, the emphasis is on what is reasonable rather than whether the project proponent likes or is itself capable of implementing an alternative (40 CFR 1502.14). "Reasonable alternatives include those that are practical or feasible from the technical and economic standpoint and using common sense, rather than simply desirable from the standpoint of the applicant" (CEQ 1981).

Guidelines developed under Section 404(b)(1) of the CWA direct USACE to use the overall project purpose (based on the project proponent's stated purpose and need) to define alternatives and determine whether the proponent's proposed project is the least environmentally damaging practicable alternative (LEDPA) prior to making a permit decision. USACE determines whether an alternative is practicable based on whether it is available and capable of being implemented after taking into consideration cost, existing technology, and logistics, in light of the overall project purpose (40 CFR Section 230.3(q)).

The intent of the Alternatives Development appendix is to describe the evolution of Project components within the context of alternatives development. AMC's consideration of avoiding and minimizing impacts to WOUS including fill to wetlands and maintaining water quality throughout the Project planning and engineering design process has contributed to the ability to present USACE a proposed project that can ultimately be determined to be the LEDPA.

3.0 ALTERNATIVES DEVELOPMENT

3.1 Overview of the Alternatives Evaluation Process

AMC's plan to develop the Arctic Deposit, as reflected in the 404-permit application, is based on the Project's purpose and need (as discussed in Section 3.2.1, *Purpose and Need*). Design criteria from the earliest phases included environmental considerations such as avoidance and minimization of impacts to WOUS including wetlands. As individual Project components were considered from an engineering standpoint, AMC also assessed potential environmental effects, including direct impacts to WOUS, air emissions, and water balance/wastewater discharges, among others discussed below.

The process AMC used to evaluate alternative components as part of Project development included five steps, starting with preliminary designs:

1. Develop an initial range of potential Project components
2. Develop screening criteria
3. Evaluate potential alternative components against the screening criteria

4. Document the rationale for alternative component(s) being selected or eliminated
5. Carry remaining alternative components forward as AMC's proposed project

Key components necessary to meet the Project's purpose and need include the mine site, tailings management facility (TMF), waste rock facility (WRF), collection and storage ponds, water treatment technology/facilities, processing plant, power plant, support infrastructure, gravel roads, and airstrip.

3.2 Alternatives Screening Criteria

The following screening criteria describe AMC's internal process of assessing alternatives in assembling the Project described in the 404-permit application:

1. **Purpose and need**: AMC initially assumed that each Project component would meet the Project's purpose and need; alternatives that did not meet the overall Project's purpose were eliminated from further analysis.
2. **Feasible and practicable**: AMC's purpose in analyzing individual Project components was to determine whether, after considering the costs and benefits of the specific component, the component was feasible and practicable. Alternatives that clearly were not feasible or were impractical from a technological or economic standpoint were eliminated from further consideration. This included consideration of mining-specific technology and economic constraints. An alternative component was considered economically feasible if the cost did not result in the demise or substantial delay of the Project.
3. **Relative environmental effects**: Feasible alternative components that would not reduce adverse environmental effects or address resource conflict when compared with other more preferred alternatives were eliminated from further consideration as their relative benefit was negligible.

The three screening criteria guided alternatives development by providing a framework for eliminating impracticable or ineffectual options through a structured process.

3.2.1 Purpose and Need

AMC's purpose for the Project is to profitably extract commercial quantities of copper, zinc, lead, and other valuable minerals from the Arctic Deposit ore reserves, using proven and economic mining and milling methods.

The primary need for the Project is to bring essential base metals to market and maximize value to AMC partners. The additional positive benefits are to assist NANA Regional Corporation (NANA) to provide significant economic benefits for its Native shareholders, and income to the Northwest Arctic Borough to help provide essential services for the people in the region, as further described below.

3.2.2 Feasible and Practicable

AMC recognizes USACE will issue a Record of Decision for the Project, and USACE's requirements to select the least environmentally damaging practicable alternative require consideration of practicability during alternatives development. USACE 404(b)(1) guidelines use the term "practicable" and define it as "available and capable of being done after taking into consideration cost, existing technology, and logistics in light of overall project purposes" (40 CFR 230). Although the "practicable" threshold under the USACE 404(b)(1) guidelines may be considered a more specific and finer filter than the broader "reasonable" threshold from the Council on Environmental Quality (CEQ) guidance, the intent was to not separate or exclude reasonable options under either definition. Therefore, considering the broader CEQ guidance (CEQ 1981), as well as the more specific 404(b)(1) guidance (40 CFR 230), the screening criteria were developed to consider feasibility in terms of cost, logistics, and technology as well as common sense. These are further defined as follows:

- **Cost feasibility**: Alternatives should not involve components with potential costs that would render the project infeasible. Clean Water Act regulations cite cost as one of the considerations to be factored into determining whether an alternative is practicable.

- **Logistical feasibility**: Alternatives should consider whether there are any constraints to development in terms of location, infrastructure, laws, regulations, ability to be permitted, ordinances, or topography.
- **Technological feasibility**: Alternatives should not involve components that use uncertain or unavailable technology or introduce an increased risk of operational failure or accidents. Certain aspects of an alternative component may have technical constraints affecting the ability to practicably implement those components.

3.2.3 Relative Environmental Effects

The *Arctic Mine Development Project Environmental Evaluation Document* (EED) provides a detailed Project description and preliminary evaluation of potentially impacted environmental resources. Feasible alternative components resulting in less adverse environmental effects or addressing resource conflicts when compared to AMC's preliminary Project design were incorporated into the proposed project. Part of AMC's focus in developing an initial assessment of relative environmental effects was based on substantive issues raised during pre-NEPA scoping meetings conducted by AMC. These issues included potential effects on water quality, fish, and human health. AMC's rationale for submitting the Project as currently proposed incorporated consideration of the following goals:

- Reduce the overall Project footprint (i.e., direct impacts from facilities)
- Reduce impacts to water resources and aquatic habitat
- Reduce potential human health impacts (especially those relating to dust and contaminants)
- Reduce potential impacts to subsistence resources
- Reduce risks related to spills or other accidental releases
- Maximize the socioeconomic benefits to the public

3.3 Alternative Components Considered during Project Development

This section provides an overview of the various components considered during Project development. Project components are organized by the aspect of the Project being addressed: mine type, location of the TMF and WRF, location of gravel pads, access, airstrip(s), concentrate transport method, fuel source, material sites, water treatment, and liners. Each of these components is detailed in subsequent sections below.

All alternative concepts were constrained by two fixed geographic locations.

1. The ore body is within a mineral deposit located on the east side of the Subarctic Creek Valley, straddling a long ridge between two watersheds - Subarctic Creek and Arctic Creek. All alternatives are based on ore recovery originating from this fixed location.
2. Development of mine infrastructure and recovery of ore relies on the proposed Ambler Access Project (AAP) to both transport ore to market and to haul in equipment and materials that cannot be safely or feasibly be transported by air or barge. All transportation alternatives are based on the Project having access to the Ambler Access Project.

3.3.1 Mine Type

Both an open pit mine and an underground mine were evaluated and Table B.1 summarizes the different mine type options considered for the Project.

Table B.1. Mine Type Options Considered during Alternatives Development

Component Number	Component Considered	Description	Why Considered	Status
1	Open pit mine	This Project component would use an open pit mine to extract the targeted resources.	• Safety • Feasibility • Constructability	Carried forward as the preferred alternative

Component Number	Component Considered	Description	Why Considered	Status
2	Underground mine	This alternative concept would use an underground mine that would access the targeted resources through a series of tunnels and portals.	• Reduce surface footprint and disturbance • Reduce water treatment burden at closure (i.e., volume)	Rejected

Component Number 1 (Open pit mine): An open pit mine was analyzed in pre-feasibility studies (Ausenco 2023). This mine type was selected as the preferred alternative (see EED Section 2.1.1, *Open Pit*).

Component Number 2 (Underground mine): The Project's 2012 *Preliminary Economic Assessment* (SRK 2012) evaluated the option of an underground mine. An underground mine would access the targeted resources through a series of tunnels and would reduce the extent of surface impacts in the Project area. Under this concept, portals (i.e., mine entrances) would be constructed to provide access to the tunnel complex and provide for the hauling of excavated material to the Project's processing facilities. Subsequent analysis of an underground mine design revealed safety and cost concerns (SRK 2019).

The orebody's high talc content makes it prone to unstable conditions. Reinforcing the orebody to prevent cave-ins would require a specific method to control stress transfer onto the mining face. Although the underground mine alternative could theoretically be made safe, the particular method of making it so would significantly increase costs, and increase the time required to extract the targeted resources, increasing the life of the mine and the duration of effects from the Project. An underground mine would also reduce the extractable ore to the extent the Project may become uneconomic to develop.

The additional time required to extract the material would also reduce the revenue generated on an annual basis. For the reasons outlined above, an underground mine design was determined economically infeasible. Therefore, the underground mine concept would not meet the Project's purpose and need and was eliminated from further consideration.

Additionally, an underground mine would not have significantly resulted in fewer wetland impacts than an open pit mine because the orebody is located in a steeply sloped area dominated by uplands (i.e., there are few wetland impacts for either type of mine).

This mine type did not meet the Project's purpose and need because it was uneconomic and thus, this alternative was rejected.

3.3.2 Location of the Tailings Management Facility and Waste Rock Facility

The locations of TMF and WRF were evaluated both upstream and downstream of the open pit (Figure B.1)

Tailings disposal alternatives were considered including separate TMF and WRF facilities, co-mingled tailings and waste rock, and various liner options. Table B.2 summarizes the different location configurations considered for the Project.

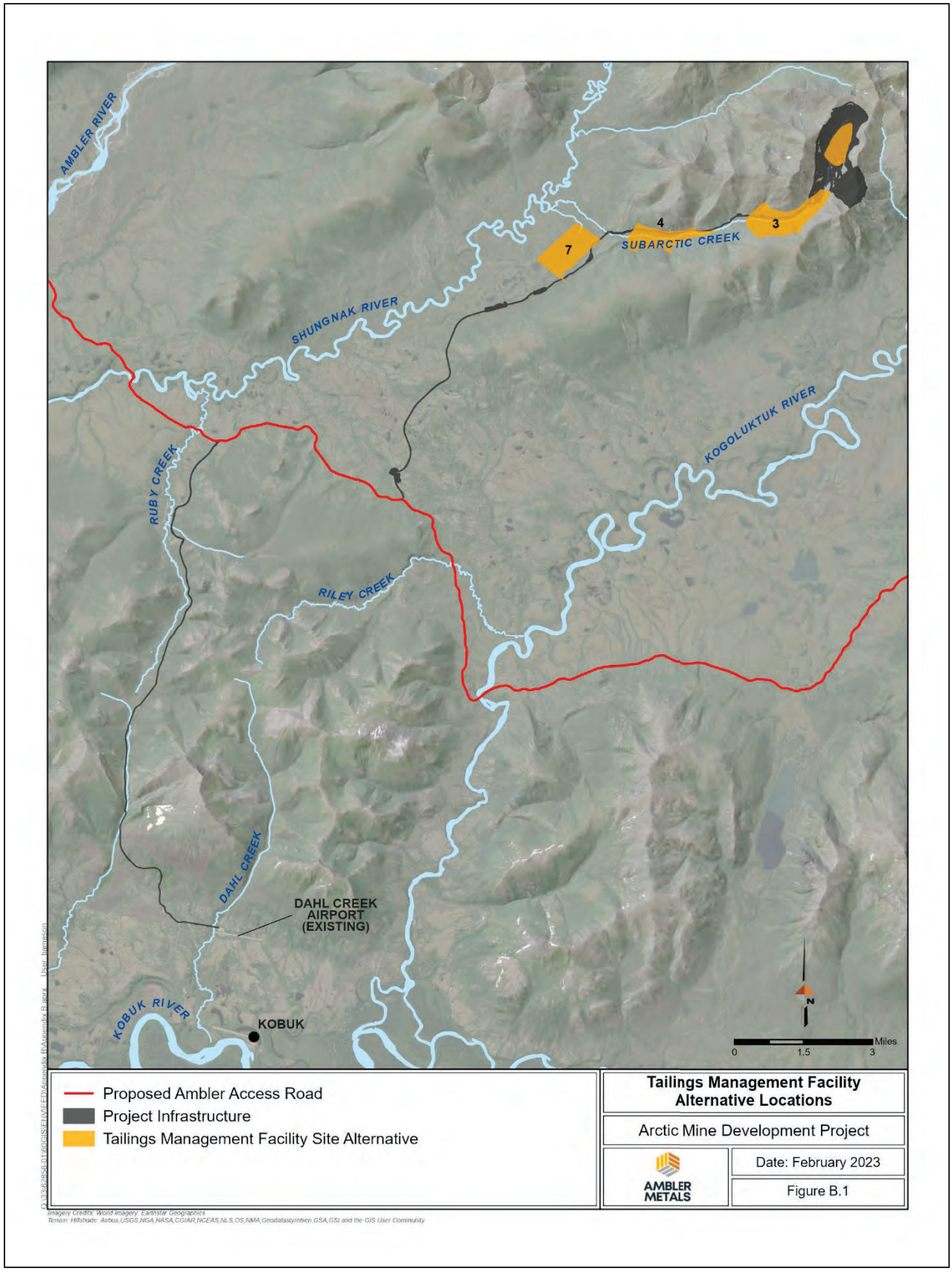


Figure B.1. Alternate Tailings Management Facility and Waste Rock Facility Locations Considered During Project Development

Table B.2. Tailings Management Facility and Waste Rock Facility Locations Considered during Alternatives Development

Component Number	Component Considered	Description	Why Considered	Status
3	TMF and WRF as separate, adjacent facilities located upgradient of the open pit	This Project component would place the TMF in the furthest location in Upper Subarctic Valley in a lined facility, with the waste rock being placed downslope of it, acting as a buttress. At closure, a liner would be placed over the WRF and part of the TMF to reduce water and air infiltration, acid generation, metal leaching, and some of the long-term water treatment needs.	• Less overall water to manage • Water would be collected and directed by gravity into the pit once the mine is closed • Fewer wetlands than down valley locations • Shorter haul distance (increased operations efficiency)	Carried forward as the preferred alternative
4	WRF located upgradient of the mine pit, with the TMF located downgradient in a separate lined facility	This alternative concept would separate the WRF and the TMF due to spatial constraints in the upper Subarctic Valley.	• Smaller facility that would more easily fit given the local topography	Rejected
5	Waste rock co-disposed with tailings	This alternative concept would dispose of waste rock and tailings together in one location, with a separate process water pond.	• Short haul distance (increased operations efficiency) • Space available for facilities up valley	Rejected
6	Waste rock co-disposed with tailings, but with the PAG material placed in a separate lined facility	This alternative concept would dispose of most of the waste rock and tailings in one location, with the PAG material being separated and placed in a separate lined facility. Under this concept, there would also be a separate process water pond.	• Reduce surface footprint • Potential geochemical benefits	Rejected
7	Drystack TMF with a process water pond	This alternative concept would dewater the tailings and place the dry tailings in a tailings storage facility. A separate process water pond would be needed.	• Potential geochemical benefits • Potential to reduce long-term water treatment	Rejected
8	Liner under the TMF and WRF	This alternative concept would place a geosynthetic liner underneath the TMF and WRF, reducing the overall water treatment demands at Project closure.	• Reduce long-term water treatment requirements and activity	Rejected

Note: PAG (potentially acid generating); TMF (tailings management facility); WRF (waste rock facility).

Component Number 3 (TMF and WRF as separate, adjacent facilities located upgradient of the open pit): A waste disposal layout that includes the TMF and WRF being at the head of Subarctic Valley was analyzed in the pre-feasibility studies (Ausenco 2018, 2023). This TMF and WRF layout was selected as the preferred alternative (see EED Section 2.1.2, *Tailings Management Facility*, and Section 2.1.3.1, *Waste Rock Facility*).

Component Number 4 (WRF located upgradient of the mine pit, with the TMF located downgradient in a separate lined facility): AMC evaluated placing the unlined WRF in upper Subarctic Valley, referred to as Site 1 with the tailings placed in a separate lined TMF at another location (SRK 2015). The facility would be built to fill part of the valley, leaving ample space for Project facilities. Potential acid generating (PAG) material could be disposed of in this location and used for construction without the need for a liner as the water could be collected by gravity into the pit once the mine is closed.

The TMF would be located either in Subarctic Valley below the mine pit, referred to as Site 4 (SRK 2015), or in the Ambler Lowlands, referred to as Site 7 (SRK 2015). It was believed at the time that the TMF and WRF would

not both fit in the available space up valley from the mine pit. That assumption was later proved to be false, but the difficulty managing and treating water for the two separate locations proved too costly, while the footprint and environmental impacts were higher.

Site 4, located much further down Subarctic Valley, would experience very large freshet events and would require the collection and treatment of substantially greater amounts of water when compared to up-valley locations. Site 4 would also have the greatest impact to Subarctic Creek, including reduction in viable fish habitat. Site 7, located in the Amber Lowlands, would have had a significantly greater wetland impact than the preferred alternative. All of these reasons resulted in a rejection of the separated TMF and WRF concepts.

This TMF and WRF configuration would meet the Project's purpose and need, but they were not deemed feasible or practicable for economic reasons and had greater relative environmental effects due to water treatment requirements, wetland impacts, and habitat loss. Thus, this alternative concept was rejected from further consideration.

Component Number 5 (Waste rock co-disposed with tailings): At the preferred alternative location, waste rock would be co-disposed with the tailings, as opposed to separated into a tailings facility and a waste rock facility. A larger downstream dam would be required as well as an upstream wall to accommodate the larger combined volume of tailings and waste rock as compared to just tailings. A liner would be required under the entire facility, instead of just the tailings. The downstream placement of waste rock was eliminated because it would require a very large amount of liner material compared to the smaller amount required for the tailings facility. The wetland impacts, total loss of streams, and impacts to the Subarctic Creek drainage would also have been greater.

This TMF and WRF layout would meet the Project's purpose and need but was deemed not feasible or practicable for economic reasons and having greater relative environmental effects due to the water treatment requirements, wetland impacts, and habitat loss. Thus, this alternative concept was rejected from further consideration.

Component Number 6 (Waste rock co-disposed with tailings, but with the PAG material placed in a separate lined facility): A variation of Component Number 5 was considered where PAG material would be separated. This alternative concept was rejected when geochemical analysis of the waste rock showed that greater than 70 percent of the material was PAG, meaning that it could not practically be separated and should all be treated as one disposal unit.

This TMF and WRF layout would meet the Project's purpose and need but was deemed not feasible or practicable for economic reasons, having a greater relative environmental effects due to water treatment requirements, wetland impacts, and habitat loss. Thus, this alternative concept was rejected from further consideration.

Component Number 7 (Drystack TMF with a process water pond): Drystack tailings would have the potential advantage of lower treatment costs at closure because the tailings would be essentially dry and geochemically less active. The downside would be that the Project would have to treat significantly more water during the Project's operations phase and without the benefit of the water storage provided under the preferred alternative's subaqueous tailings deposition. The pit walls would also contribute a significant amount of PAG and metal leaching potential, so the need for in-perpetuity water treatment would still be present in operations and at closure. Given the need for a separate process water pond, the footprint and wetland impacts would also be larger than the preferred alternative.

This TMF and WRF layout would meet the Project's purpose and need but was deemed not feasible or practicable for economic and technical reasons, having greater relative environmental effects due to the increased footprint, and greater initial water treatment requirements. Thus, this alternative concept was rejected from further consideration.

Component Number 8 (Liner under the TMF and WRF): Placement of a liner underneath the WRF would reduce the volume and improve the quality of the water requiring treatment at Project closure. However, the technical challenges of placing the liner under the TMF and WRF and the potential for failure, plus the cost of the

liner, would not justify the potential benefits. Water treatment in perpetuity would still be required due to the PAG and metal leaching potential of the mine pit walls.

This TMF and WRF layout would meet the Project's purpose and need but was found to be not feasible or practicable for economic reasons. Thus, this alternative concept was rejected from further consideration.

3.3.3 Location of Gravel Pads

3.3.3.1 Location of Operations Pad and Processing Facilities

Two locations for the operations pad were considered for evaluation (Figure B.2). Each of the operation pad options that were considered are summarized in Table B.3.

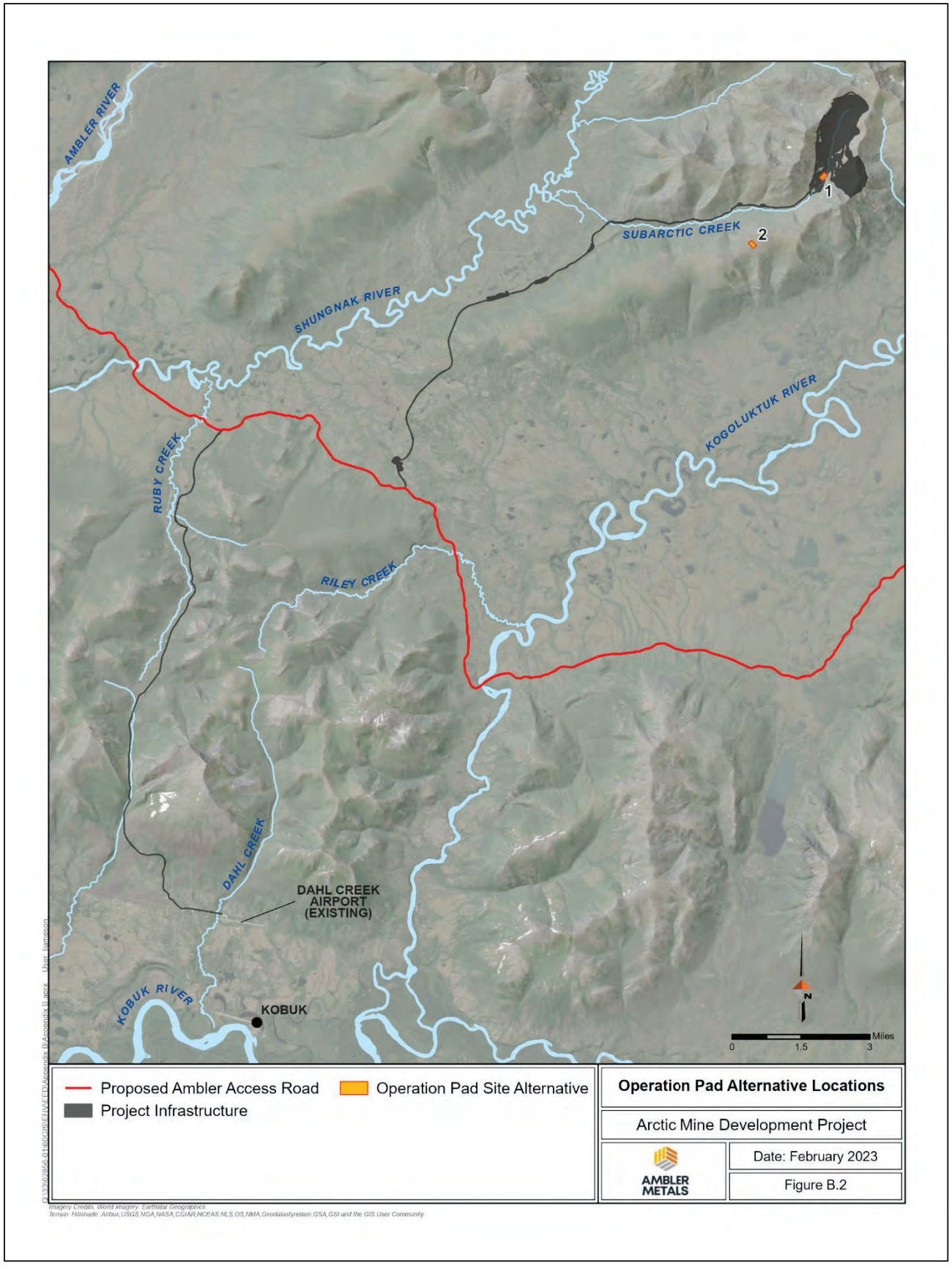


Figure B.2. Potential Operations Pad Locations Considered during Alternatives Development

Table B.3. Operations Pad Locations Considered during Alternatives Development

Component Number	Component Considered	Description	Why Considered	Status
9	Operations pad immediately down valley of the WRF	This alternative concept would place the operations pad just below the WRF, to the west of the open mine pit.	• More efficient mine operations and associated cost savings	Carried forward as the preferred alternative
10	Operations pad on top of the Arctic ridge	This alternative component would place the operations pad on top of the Arctic ridge, to the southwest of the mine pit.	• Anticipated the pad would not fit in the upper Subarctic Valley • Closer to TMF concept sites 4 and 7	Rejected

Note: TMF (tailings management facility); WRF (waste rock facility).

Component Number 9 (Operations pad immediately down valley of the WRF): The operations pad and processing facilities location below the WRF was analyzed in the pre-feasibility studies (Ausenco 2018, 2023). This operations pad location was selected as the preferred alternative (see EED Section 2.2, *Processing Facilities [Operations Pad]*).

Component Number 10 (Operations pad on top of the Arctic ridge): An operations pad and processing facilities location was evaluated on a flat area at the top of the Arctic ridge, approximately 3.7 miles (6 kilometers [km]) from the mine pit. Given the tight topography of Subarctic Valley, the ridge location was evaluated. The location would also be closer to proposed TMF location alternative sites 4 and 7, and tailings could be transported via gravity without pumping. However, given the long-haul distances and the potentially dangerous road alignment that would be required due to topography and avalanche conditions, the ridge location was deemed not feasible and was rejected.

This operations pad location would meet the Project's purpose and need but was not deemed feasible and practicable for economic and technical reasons. Thus, this alternative concept was rejected.

3.3.3.2 Camp Pads

Several locations for camp pads were evaluated. Camp siting options were focused on locations within a reasonable distance from the processing facilities, having the capacity for the minimum footprint (50.0 acres [20.2 hectares (ha)]) in terrain not requiring extensive excavation or fill, and having limited impacts to WOUS. Five potential locations were identified for the Operations Camp pad (Figure B.3).

Camp location #5 was chosen for the Project because it has the space necessary to meet footprint requirements, uses uplands and a previously disturbed site to the maximum extent practicable, has logistical advantages by being closer to the AAP junction, and has relatively flat topography that would require less ground disturbance to build a level pad.

The five alternative locations for the operations camp considered for evaluation are shown in Figure B.3 and each of the camp location options are summarized in Table B.4.

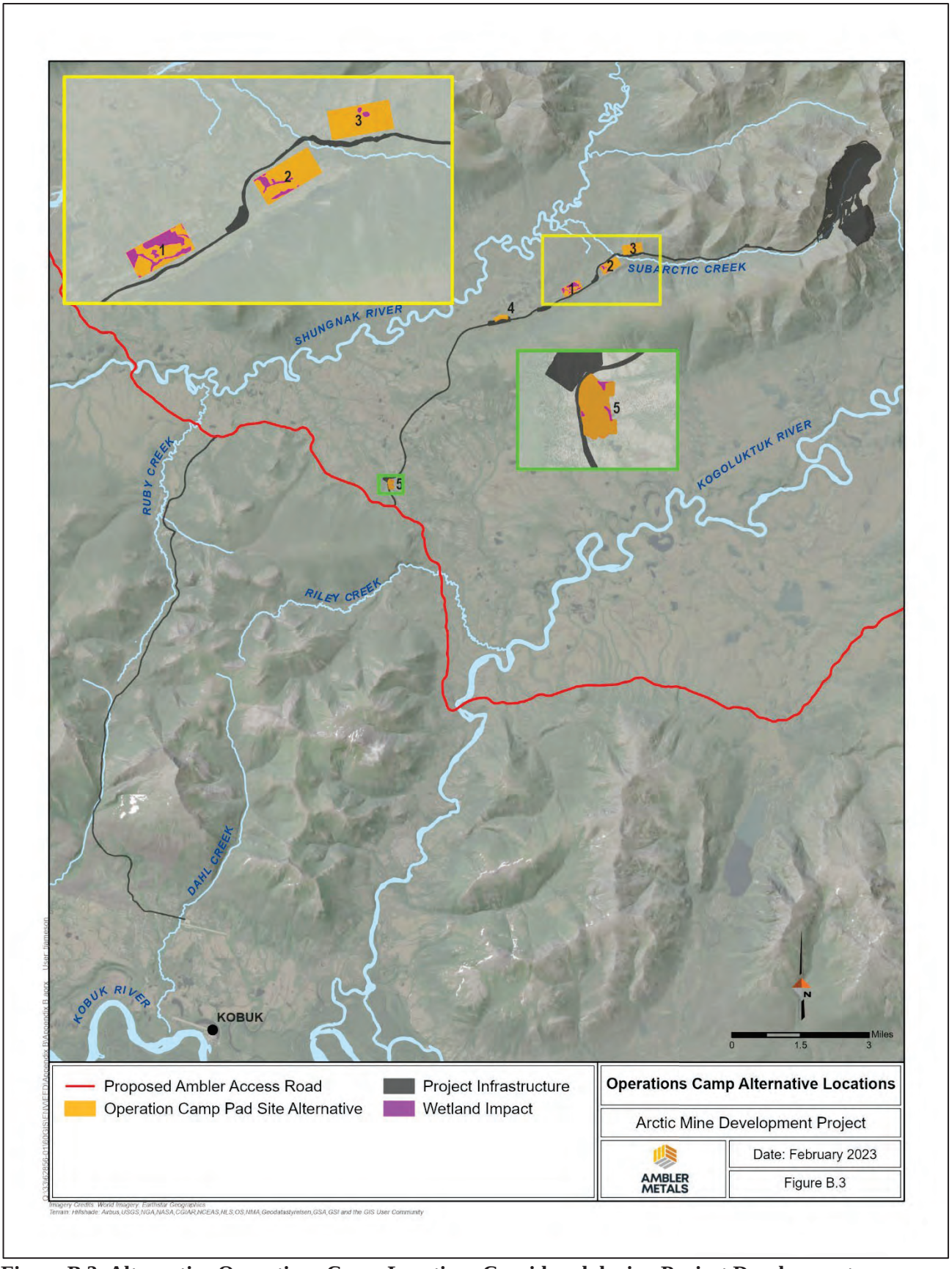


Figure B.3. Alternative Operations Camp Locations Considered during Project Development

Table B.4. Camp Locations Considered during Alternatives Development

Component Number	Component Considered	Description	Why Considered	Status
11	Operations camp pad site 5	This alternative component location would site the operations camp along the North Route access road approximately 0.8 miles north of the AMJ	• Utilizes Construction Camp footprint • Maximize use of existing infrastructure, i.e., power generation for Concentrate Logistics Yard • Minimal cut/fill required	Carried forward as the preferred alternative
12	Operations camp pad site 1	This alternative component would locate the Operations camp pad 5.1 miles (8.2 km) from the processing facilities.	• Centrally located to processing facilities	Rejected
13	Operations camp pad site 2	This alternative component would locate the Operations camp pad 4.4 miles (7.1 km) from the processing facilities.	• Reduce footprint/fill and loss of WOUS • Site has flat topography that would require less ground disturbance	Rejected
14	Operations camp pad site 3	This alternative component would locate the Operations camp pad 4.0 miles (6.4 km) from the processing facilities.	• Reduce footprint/fill and impacts to WOUS	Rejected
15	Operations camp pad site 4	This alternative component location would site the operations camp along the North Route access road at the abandoned Arctic Airstrip.	• Minimal cut/fill required	Rejected

Note: ha (hectare); km (kilometer); WOUS (Waters of the U.S.).

Component Number 11 (Operations camp pad site 5): The location of the Construction and Permanent camp for mine operation was analyzed in the pre-feasibility studies (Ausenco 2018, 2023). This operations pad location was selected as the preferred alternative (see EED Section 2.4.1, *Camps*). Impacts from the different camp siting locations are summarized in Table B.5.

Table B.5. Summary of Operations Camp Siting Options Impacts

Component Number	Component Considered	Wetland and Waters of the U.S. Impacts (acres)
11	Operations camp pad site 5	0.8
12	Operations camp pad site 1	22.6
13	Operations camp pad site 2	10.8
14	Operations camp pad site 3	1.8
15	Operations camp pad site 4	0.0

Component Number 12 (Operations camp pad site 1): This alternative concept would locate the operations camp near TMF alternative Site 7. When TMF Site 1 was selected, that became less desirable. This alternative location would impact 22.6 acres (9.1 ha) of wetlands and WOUS. Operations camp pad site 1 would meet the Project's purpose and need, is feasible and practicable, but would have higher relative environmental effects. Thus, this operations pad camp location was rejected.

Component Number 13 (Operations camp pad site 2): This alternative concept would locate the operations camp near TMF alternative Sites 7 and 4. When TMF Site 1 was selected, that became less desirable. This alternative location would impact 10.8 acres (4.4 ha) of wetlands and WOUS. Operations camp pad site 2 would

meet the Project's purpose and need, is feasible and practicable, but would have higher relative environmental impacts. Thus, this operations pad camp location was rejected.

Component Number 14 (Operations camp pad site 3): This alternative concept would locate the operations camp near TMF alternative Site 7. When TMF Site 1 was selected, that became less desirable. This alternative location contains relatively steep terrain and would have required extensive cut and fill to construct a relatively level pad, and it would have impacted 1.8 acres (0.6 ha) of wetlands and WOUS. Operations camp pad site 3 would meet the Project's purpose and need, is feasible and practicable (though it would require more extensive earthwork for construction), but it would have greater relative environmental effects than the selected location. Thus, this operations pad camp location was rejected.

Component Number 15 (Operations camp pad site 4): This alternative concept would locate the operations camp at the Arctic Airstrip along the North Route, approximately 8 miles (12.9 km) from the processing facilities and would have minimal impacts to wetlands or WOUS. Operations camp pad site 4 however is located approximately 7 miles (11.2 km) from the Concentrate Logistics Yard and thus would require separate power generation and other facilities, increasing cost and impact. Operations camp pad site 4 would meet the Project's purpose and need, is feasible and practicable, but would not have the lowest relative environmental effects. This operations pad camp location was not selected as the preferred alternative but was eventually selected as one of three laydown yards (see EED Section 2.4.1, *Camps*).

3.3.4 Access Options

Several options were considered to reduce the Project's impacts related to access road development (Figure B.4) and these options are summarized in Table B.6.

AMC evaluated potential access road routes based on the type of vehicle they would need to accommodate (e.g., interstate semi-trailer [Class WB-62], motor coach [Class BUS=40]), length of road, and relative environmental impacts from each alignment (DOWL 2019); they are summarized in Table B.7 and described in more detail below.

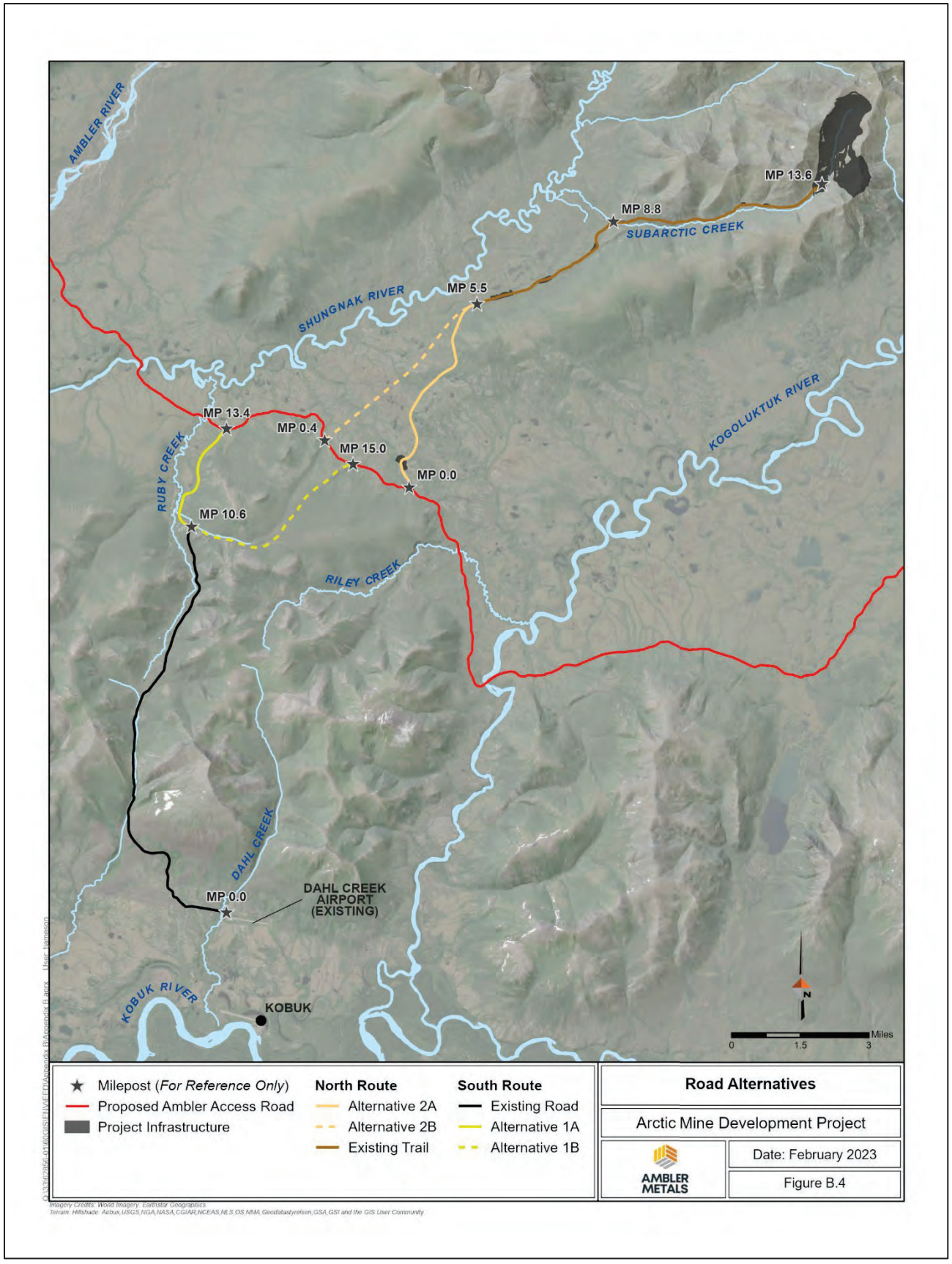


Figure B.4. Access Road Alignment Alternatives

Table B.6. Access Options Considered during Alternatives Development

Component Number	Component Considered	Description	Why Considered	Status
16	Access via Subarctic Creek drainage	This alternative concept would access the mine site from the Subarctic Creek drainage, which is not anadromous.	• Reduce impacts to anadromous streams	Carried forward as the preferred alternative
17	South Route Alternative 1A	This alternative would traverse north from the existing Bornite Camp and follow the contours of the western flanks of Moose Mountain; it would stay slightly uphill from the base of the mountain to minimize wetland impacts.	• Most direct route • Less steep terrain and road grade • Reduce impacts to wetlands and WOUS • Fewer culverts	Carried forward as the preferred alternative
18	North Route Alternative 2A	This alternative would cross the Ambler Lowlands using a slightly longer route that would circumvent much of the wetlands by staying near the upland areas that divide the watersheds of the Shungnak and Kogoluktuk rivers.	• Reduce impacts to wetlands and WOUS • Fewer creek crossings	Carried forward as the preferred alternative
19	Access via Arctic Creek drainage	This alternative concept would access the mine site from the Arctic Creek drainage, an anadromous stream and tributary to the Kogoluktuk River.	• Most direct route from the Ambler Access Project	Rejected
20	South Route Alternative 1B	This alternative would extend east from the existing Bornite Camp around Moose Mountain before descending to the Proposed Ambler Access Project.	• Reduce impacts to wetlands and WOUS	Rejected
21	North Route Alternative 2B	This alternative would cross the Ambler Lowlands directly; because of this, the alignment is relatively flat and straight compared to other alignments along the North Route.	• Reduce overall footprint/fill • Reduce road length	Rejected

Note: WOUS (Waters of the U.S.).

Component Number 16 (Access via Subarctic Creek drainage): Access from Dahl Creek and the Ambler Access Project to the Arctic Mine site via the Subarctic Creek drainage (Figure B.4) was analyzed in the pre-feasibility studies (Ausenco 2018, 2023). This access alternative would have lower relative environmental effects and was selected as the preferred alternative over Component 19, which would access the Arctic Mine from the Kogoluktuk Valley (see EED Section 2.5.1, *Gravel Roads*).

Component Number 17 (South Route Alternative 1A): Access from Dahl Creek and the Ambler Access Project to the Arctic Mine site via the South Route Alternative 1A was analyzed in the Preliminary Engineering Report (DOWL 2019) and pre-feasibility study (Ausenco 2023). This access alternative would have lower relative environmental effects and was selected as the preferred alternative (see EED Section 2.5.1.1.1, *South Route*).

Component Number 18 (North Route Alternative 2A): Access from the Ambler Access Project to the Arctic Mine site via the North Route Alternative 2A was analyzed in the Preliminary Engineering Report (DOWL 2019) and the pre-feasibility study (Ausenco 2023). This access alternative would have lower relative environmental effects and was selected as the preferred alternative (see EED Section 2.5.1.1.2, *North Route*).

Component Number 19 (Access via Arctic Creek drainage): The most direct access from the Ambler Access Project to the Project would be via the Arctic Creek drainage (see Figure B.4); however, given the abundance of wetlands in the Kogoluktuk Valley and the Kogoluktuk River being anadromous, this alternative concept would have more potential environmental impacts than Project access via Subarctic Creek and the upper reach of the Shungnak River, which are not anadromous. Access to the Project via the Kogoluktuk River would meet the Project's purpose and need and is assumed to be feasible and practicable, though it would create additional engineering design challenges. However, access via the Kogoluktuk River would exceed 20 miles and therefore

have greater relative environmental effects than access via the Subarctic Creek drainage. Thus, this alternative concept was rejected.

Component Number 20 (South Route Alternative 1B): This alternative concept would traverse from the Bornite Camp to the east of Moose Mountain. Route 1B would be longer than Route 1A, and would be in much steeper terrain, including having a maximum elevation difference of 589 feet and approximately 62 percent of the route would have grade exceeding six percent (compared to 204 feet and 16.5 percent for Alternative Route 1A). The cut and fill requirements would also be approximately 91,000 cubic yards greater (186,000 cubic yards versus 95,000 cubic yards), and this alignment would require 10 additional culverts.

Access to the Ambler Access Project via the South Route meets the Project's purpose and need. However, given the steeper road grade and significantly greater cut and fill requirements, South Route 1B is much less feasible and practicable. The relative environmental effects between South Route 1A and 1B are similar, with Route 1B having slightly less impacts to wetlands and WOUS, but it would be longer and require additional culverts. Thus, this access route was rejected.

Component Number 21 (North Route Alternative 2B): This alternative concept would provide the most direct and thus shortest route across the Ambler Lowlands, but the impact to wetlands and WOUS would be significantly greater (22.1 acres of wetland impacts versus 13.0 acres for the North Route Alternative 2A, and 4 additional stream crossings). Access from the Ambler Access Project to the Arctic Mine site via North Route 2A would meet the Project's purpose and need and it is feasible and practicable, but this route would have greater relative environmental effects versus North Route Alternative 2A. Thus, this access route was rejected.

Table B.7. Summary of Access Road Alignment Option Impacts

Component Number	Description of Alignment Option	Route Length (miles)	Wetland Impacts (acres)	Stream Crossings (number)	Culverts (number)
16	Access via Subarctic Creek drainage – Preferred[a]	7.6	15.4	21	6
17	South Route Alternative 1A – Preferred Alternative	2.7	1.6	5	2
18	North Route Alternative 2A- Preferred	4.9	13.8	16	4
19	Access via Arctic Creek drainage[b]	ND	ND	ND	ND
20	South Route Alternative 1B	4.4	2.2	1	2
21	North Route Alternative 2B	4.5	26.4	17	5

Note: ND (Not Determined) [a] This alternative is a sum of the preferred North Route and South Route [b] *This alignment option would be longer than 20 miles and was therefore only conceptually evaluated; environmental impacts are assumed to be much greater than Component 16.*

3.3.4.1 Stream Crossings

Two types of stream crossings were considered for Dahl Creek and Wesley Creek on the South Route access road and Subarctic Creek on the North Route access road. A prefabricated steel girder bridge and a buried bridge (i.e., structural plate culvert, typically bottomless on footers or foundation) were evaluated. The buried bridge alternative was selected for both crossings because it is the lowest cost alternative, it would meet State of Alaska fish passage criteria, and it would provide sufficient hydraulic capacity to convey the 50-year peak flood (DOWL 2019).

Each of the stream crossing bridge options are described in Table B.8.

Table B.8. Bridge Options Considered during Alternatives Development

Component Number	Component Considered	Description	Why Considered	Status
22	Buried bridge crossing of Dahl, Wesley, and Subarctic creeks	This alternative component would construct a 20-foot (6.1-m) span buried bridge (i.e., structural plate culvert, typically bottomless) with a length of 60 feet (18.3 m) at Dahl and Wesley creeks crossings on the South Route. A 30-foot-span (9-m-span) buried bridge 60-feet (18.3-m) long would cross Subarctic Creek.	• Reduce cost • Would meet hydrologic and fish passage requirements	Carried forward as the preferred alternative
23	Steel girder bridge crossing of Dahl, Wesley, and Subarctic creeks	This alternative component would construct a 40-foot-long (12.2-m) by 14-foot-wide (4.3-m) prefabricated steel girder bridge at either or both of the crossings at Dahl and Wesley creeks on the South Route.	• Would meet hydrologic and fish passage requirements	Rejected

Note: m (meter).

Component Number 22 (Buried bridge crossings of Dahl, Wesley, and Subarctic creeks): The use of buried bridges at Dahl, Wesley, and Subarctic creeks were analyzed in the Preliminary Engineering Report (DOWL 2019). The use of buried bridges would meet the Project's purpose and need and are feasible and practicable. Given that the relative environmental effects between buried bridges and steel girder bridges would be equivalent, the lower cost of buried bridges makes this the preferred alternative (see EED Section 2.5.1.1.1, *South Route*, and Section 2.5.1.1.2, *North Route*).

Component Number 23 (Steel girder bridge crossings of Dahl, Wesley, and Subarctic creeks): The prefabricated steel girder bridge was evaluated for the Project's three major creek crossings. Although the steel girder bridge would meet the Project's purpose and need, it would not provide relative environmental benefits compared to the significantly less expensive buried bridge. Thus, the prefabricated steel girder bridge for creek crossings was rejected.

3.3.5 Airstrip Options

Four airstrip alternatives were evaluated (Figure B.5) (Ausenco 2023; DOWL 2017; Tetra Tech 2013; Rowland 1998) to assess the Project's need for a 4,500-foot-long (1,375-m-long) runway.

Alternative airstrip locations are identified in Figure B.5 and each of the airstrip alternative concept is summarized in Table B.9. Impacts from the different airstrip options are summarized in Table B.10.

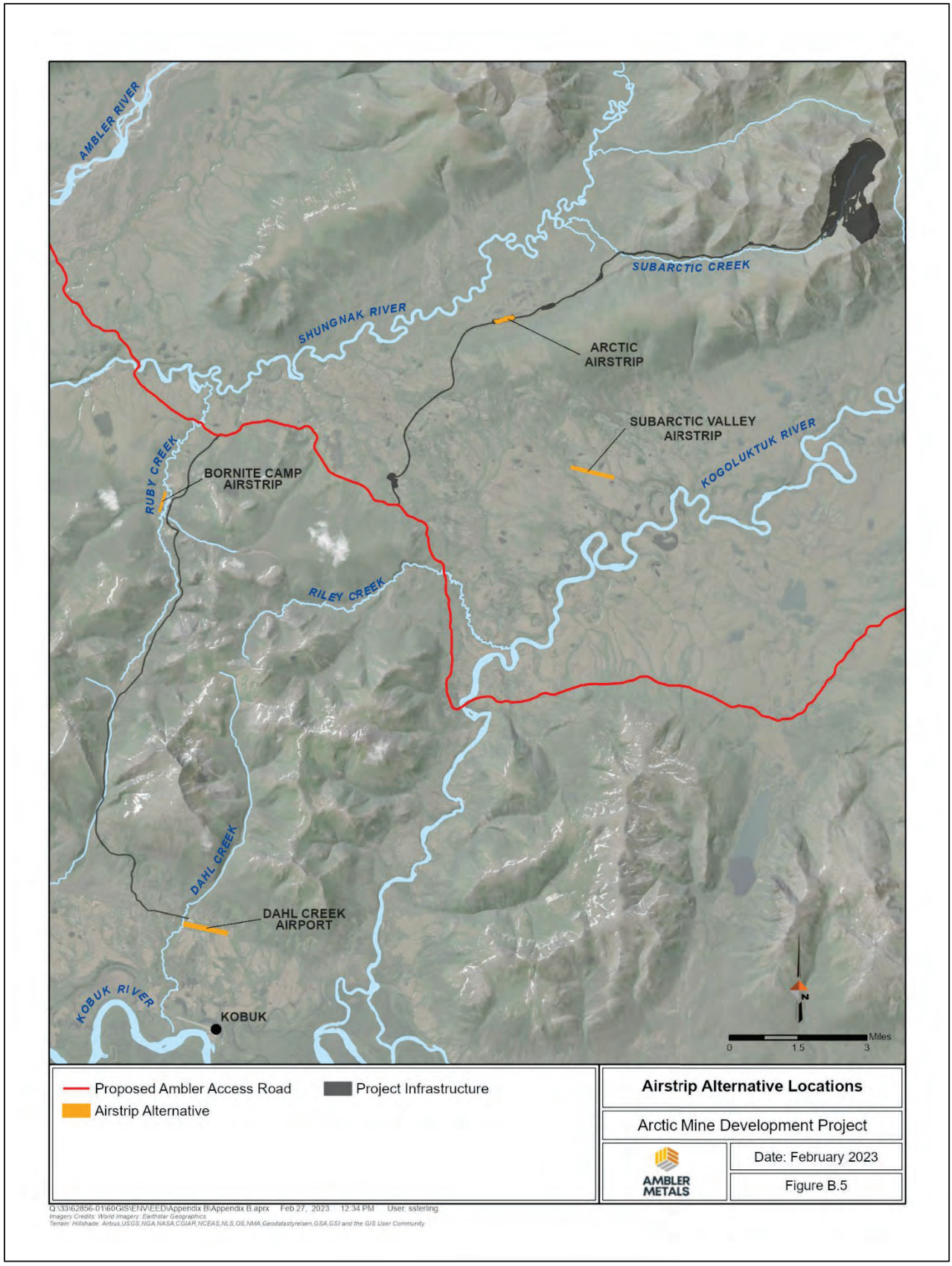


Figure B.5. Alternative Airstrip Locations Considered during Project Development

Table B.9. Airstrip Options Considered during Alternatives Development

Component Number	Component Considered	Description	Why Considered	Status
24	Airstrip alternative 3D: Upgrade the existing Dahl Creek airstrip	This alternative component would upgrade the existing 4,780 × 75-foot (1,460 × 23-m) Dahl Creek Airstrip and would not impact any wetlands.	• Reduce footprint/fill • Maximize the use of existing infrastructure • Reduce impacts to wetlands and WOUS	Carried forward as the preferred alternative
25	Airstrip alternative 3A: Upgrade the existing airstrip near the Bornite Camp	This alternative component would extend the existing 2,300-foot (700-m) airstrip adjacent to the existing Bornite camp.	• Use of existing infrastructure	Rejected
26	Airstrip alternative 3B: Construct a new Subarctic Valley airstrip	This alternative component would construct a new 4,500-foot-long (1,375-m-long) airstrip approximately 1 mile (1.6 km) east of the Kogoluktuk River.	• Operations proximity to the proposed Ambler Access Project	Rejected
27	Airstrip alternative 3C: Rehabilitate and extend abandoned airstrip	This alternative component would rehabilitate and extend an existing but unused 1,475-foot-long (450-m-long) airstrip to a 4,500-foot-long (1,375-m-long) airstrip; the existing location is currently overgrown with vegetation.	• Reduce footprint/fill • Use of existing infrastructure	Rejected

Note: km (kilometer); m (meter); WOUS (Waters of the U.S.).

Component Number 24 (Airstrip alternative 3D: Upgrade the existing Dahl Creek airstrip): This airstrip alternative concept was evaluated in the Dahl Creek airport study (DOWL 2017) and the Project's pre-feasibility study (Ausenco 2023). This alternative would upgrade the existing 4,780 × 75-foot (1,460 × 23–m) Dahl Creek Airstrip and would not impact any wetlands. However, the existing road connecting the Dahl Creek Airstrip to the existing Bornite Camp would require upgrades that would impact approximately 2.6 acres of wetlands and WOUS.

This alternative would meet the Project's purpose and need, is feasible and practicable, and would have the lowest relative environmental effects of the considered alternative concepts. Thus, this airstrip alternative was selected as the preferred alternative (see EED Section 2.5.2, *Air Service and Transport*).

Component Number 25 (Airstrip alternative 3A: Upgrade the existing airstrip near the Bornite Camp): This airstrip alternative concept would extend the existing 2,300-foot (700-m) airstrip adjacent to the existing Bornite Camp. This alternative would impact approximately 3.1 acres (1.3 ha) of wetlands and WOUS in order to widen the airstrip 20 feet (6 m) and extend the runway 2,200 feet (670 m) to meet Project aircraft needs. The extension would greatly impact Ruby Creek and adjacent wetlands, which surround the gravel runway. The topography surrounding this airstrip is also not compatible with the large aircraft anticipated for Project use and therefore was deemed as being not feasible or practicable. Thus, this airstrip alternative was rejected.

Component Number 26 (Airstrip alternative 3B: Construct a new Subarctic Valley airstrip): This airstrip alternative concept would construct a new 4,500-foot (1,375-m) airstrip approximately 1 mile (1.6 km) east of the Kogoluktuk River. This alternative would impact approximately 52 acres (21 ha) of undeveloped land, of which approximately 25 percent (12.8 acres [5.2 ha]) is estimated to be wetlands and WOUS. This potential airstrip location was selected based on the generally favorable surrounding topography and proximity to the initial Ambler Access Project alignment. Airstrip alternative 3B would result in the greatest extent of wetland impacts and incur the greatest costs. This airstrip alternative concept would meet the Project's purpose and need but given the extensive cost increase and greater wetlands and WOUS impacts over other alternatives, it was not considered feasible or practicable. Thus, this alternative concept with greater relative environmental impacts was rejected.

Component Number 27 (Airstrip alternative 3C: Rehabilitate and extend abandoned airstrip): This airstrip alternative concept would rehabilitate and extend an existing but unused airstrip located in Subarctic Valley adjacent to the propose North Route. The existing 1,475-foot (450-m) airstrip is currently overgrown with vegetation and it would need to be rehabilitated and upgraded to provide a 4,500-foot (1,375-m) airstrip for Project use. There is concern about the proximity to the Arctic ridge and potential valley crosswinds. This airstrip alternative concept would meet the Project's purpose and need but given the proximity to the Arctic ridge and planned infrastructure, it was considered not feasible or practicable. Thus, this airstrip alternative was rejected.

Table B.10. Summary of Airstrip Option Impacts

Component Number	Component Considered	Wetland and Waters of the U.S. Impacts (acres)	Stream Impacts (linear feet)
24	Airstrip alternative 3D: Upgrade the existing Dahl Creek airstrip	Wetlands: 0.0 WOUS: 0.0 **Total: 0.0**	0.0
25	Airstrip alternative 3A: Upgrade the existing airstrip near the Bornite Camp	Wetlands: 2.3 WOUS: 0.9 **Total: 3.2**	207.8
26	Airstrip alternative 3B: Construct a new Subarctic Valley airstrip	Wetlands: 12.7 WOUS: 0.1 **Total: 12.8**	1,592.7
27	Airstrip alternative 3C: Rehabilitate and extend abandoned airstrip	Wetlands: 0.1 WOUS: 0.0 **Total: 0.1**	0.0

Note: WOUS (waters of the U.S.).

3.3.6 Fuel Source Options

The Project would be located in an area without existing electrical service and electricity would need to be produced on-site. AMC assessed diesel and liquified natural gas (LNG) as potential fuel sources for meeting the Project's anticipated demand for electricity and thermal power as well as on-site fuel storage requirements (Ausenco 2023). Each system was assessed for a variety of criteria, including the ability to provide continuous electrical and thermal power at a very high level of reliability.

Each of the fuel source options is described in Table B.11.

Table B.11. Fuel Source Options Considered during Alternatives Development

Component Number	Component Considered	Description	Why Considered	Status
28	Diesel for electricity and thermal power	This alternative component would use diesel as a fuel source for meeting the Project's anticipated demand for electricity and thermal power. Each system was assessed for a variety of criteria, including the ability to provide continuous electrical and thermal power at a very high level of reliability.	• Reduce cost • Proven reliability and availability	Carried forward as the preferred alternative
29	LNG for electricity and thermal power	This alternative component would use LNG as a fuel source for meeting the Project's anticipated demand for electricity and thermal power.	• Reduce emissions • Maximize the use of potential in-state infrastructure	Considered and not currently selected as the preferred alternative

Note: LNG (liquified natural gas).

Component Number 28 (Diesel for electricity and thermal power): The use of diesel-fired generators was analyzed in the Project's pre-feasibility study (Ausenco 2023). Ultra-low-sulfur diesel fuel is widely available in Alaska and the transportation and storage infrastructure is commonly used. The use of diesel fuel for power generation would meet the Project's purpose and need and is feasible and practicable. Burning diesel fuel would

have a greater environmental impact on air emissions than LNG but given the uncertain nature of LNG at this time, diesel fuel is the only viable choice. Thus, diesel fuel was selected as the preferred alternative (see EED Section 2.7.2, *Fuel Supply, Storage, and Distribution*, and Section 2.7.3, *Power Generation and Distribution*).

Component Number 29 (LNG for electricity and thermal power): LNG would have lower air emissions than diesel fuel. Should a reliable and cost-effective LNG fuel source become available in the future, the Project would consider modifying the generator fuel source to LNG. This fuel type, if it becomes available, would meet the Project's purpose and need and would likely be feasible and practicable. The relevant environmental effects would be lower than the diesel fuel alternative. Thus, this fuel type was considered and is currently not selected as the preferred alternative due to cost and uncertain availability.

3.3.7 Material Site Options

Potential embankment fill and rock quarry material sites were evaluated in 2018 using desktop analysis and limited field work (DOWL 2019). Based on preliminary design, the Project would require approximately 1.5 million cubic yards of gravel to complete construction of the proposed infrastructure. Potential material sites along the proposed access roads from the existing Bornite Camp to the proposed mine facilities were evaluated for their potential to provide gravel and riprap for construction. Sites were evaluated using published data, data obtained during development of the Ambler Access Project, and data interpreted from aerial imagery. Sixteen undeveloped and two existing material sites were assessed in the field in September 2018 for the quantity and quality of available resources. Six of the undeveloped and two of the existing sites were recommended for further evaluation and potential use.

Material sites will be eliminated from further consideration if they do not have material of sufficient quality and quantity to meet Project needs. In addition to the suitability of materials, location and haul distance to proposed Project facilities would be considered.

Table B.12 summarizes the different types of material site options considered by the Project.

Table B.12. Material Site Options Considered during Alternatives Development

Component Number	Component Considered	Description	Why Considered	Status
30	Use existing material sites	This alternative component would use existing material sites as sources of gravel and rip rap for the Project.	• Maximize the use of existing infrastructure	Carried forward as a preferred alternative
31	Use new material sites	This alternative component would use new material sites as sources of gravel and rip rap for the Project.	• Reduce transport of materials	Carried forward as a preferred alternative

Component Number 30 (Use existing material sites): Use of existing material sites was evaluated in the preliminary engineering report (DOWL 2019) and the pre-feasibility study (Ausenco 2023). The existing material sites would not be able to provide all of the required material to develop the Project but could provide a portion. The existing material sites would meet the Project's purpose and need, are feasible and practicable, and would have the lowest relative environmental effects. Thus, the use of existing material sites was selected as a preferred alternative (see EED Section 2.6, *Material Sites*).

Component Number 31 (Use new material sites): New material site options were analyzed in the preliminary engineering report (DOWL 2019) and the pre-feasibility study (Ausenco 2023). New material sites would be needed to provide some of the necessary borrow material needed to develop the Project. The use of new material sites would meet the Project's purpose and need, are feasible and practicable, and would have low relative environmental effects, given their use would be minimized. Thus, the use of new material sites was selected as a preferred alternative (see EED Section 2.6, *Material Sites*, and Section 3.7.3.2, *Material Sites*).

3.3.8 Wastewater Treatment Options

The Project evaluated multiple technologies to treat the effluent pollutants identified as likely being above Alaska water quality standards (WQS). Over 30 alternatives were identified at the onset of the Project to determine the range of possible options (Brown and Caldwell 2021). Each alternative consisted of a combination of technologies presented above. Each of the alternatives was designed to treat pollutants so effluent discharge would meet Alaska WQS. In the first round of screening, many alternatives were consolidated or improved upon until there were six viable alternatives. Alternatives were further evaluated in a second screening round for feasibility and a recommended alternative was selected during a Project workshop (February 9, 2021 through February 12, 2021). The technologies evaluated included:

- Chemical precipitation/clarification (e.g., traditional chemical precipitation, high-density sludge, ettringite)
- Concentrating (e.g., membranes [nanofiltration or reverse osmosis], ion exchange, evaporation, crystallization)
- Biological (e.g., active, passive)
- Other (e.g., zero-valent iron, accelerated reductive catalysis, liquid/liquid extraction, deep-well injection)

During alternatives screening, the following considerations were made to eliminate or consolidate alternatives:

- Chemical softening pretreatment. Softening reduces the potential for scaling in membrane process, reduces the acidity of water, and improves the operability and reliability of heat exchangers and membrane systems. Alternatives that did not include chemical softening were eliminated in the first round of screening.
- Concentrating. Concentrating reduces the downstream treatment system size (e.g., evaporator/crystallizer or biological treatment systems).
- Heating. Influent temperatures are anticipated to be as low as 41° Fahrenheit (5° Celsius) and heating would be required to bring the water to temperatures suitable for the biological treatment of selenium. Water temperature can also impact the performance of membrane systems (e.g., reverse osmosis, ultrafiltration).
- Recirculation of recovered water. Recirculation of effluent from the biological system was considered because the total dissolved solids is higher in the biological effluent than the reverse osmosis permeate; however, this could lead to a cycling up effect on total dissolved solids and these options were eliminated in the first round of screening.

The screening process reduced over 30 options down to six viable treatment trains for alternatives evaluation. Each of the six treatment train alternatives were evaluated on economic and non-economic factors (e.g., effectiveness at meeting permit limits, reliability, feasibility, adaptability, compatibility, footprint). The selected treatment train received the highest score for both the economic and non-economic factors. The selected alternatives would retain the ability to return reverse osmosis reject to the TMF during the operations phase while providing a proven reverse osmosis reject treatment train during the closure phase to meet Alaska WQS for the discharged water.

Table B.13 summarizes the technologies evaluated.

Table B.13. Water Treatment Options Considered during Alternatives Development

Component Number	Component Considered	Description	Why Considered	Status
32	Chemical precipitation, filtration, and reverse osmosis in operations	This alternative concept would use the following treatment train during Project operations: chemical precipitation, ultrafiltration, and reverse osmosis to generate a permeate that would meet Alaska WQS for discharge, and a brine that would be disposed of in the TMF. Sludge generated would be disposed of in the TMF.	• Can meet Alaska WQS allowing discharge to Subarctic Creek • High reliability rate • Proven technology	Carried forward as the preferred alternative
33	Chemical precipitation, filtration, reverse osmosis, biological, and mechanical dewatering in closure	This alternative concept would use the following treatment train during Project closure: chemical precipitation, ultrafiltration, reverse osmosis, biological treatment, and mechanical dewatering to meet Alaska WQS for discharge. Sludge would be disposed of in the mine pit until it reached capacity, at which time sludge would be deposited in the TMF.	• Can meet Alaska WQS allowing discharge to Subarctic Creek • High reliability rate • Proven technology	Carried forward as the preferred alternative
34	Chemical precipitation and filtration and the use of a mixing zone in the Shungnak River	This alternative concept would use the following treatment train during Project operations: chemical precipitation, filtration, and the use of a mixing zone in the Shungnak River. This alternative concept would not meet Alaska WQS at the discharge location without a mixing zone.	• Mixing zones are permittable in Alaska • Lower cost	Rejected
35	Chemical precipitation, filtration, selenium treatment, and use of a mixing zone in the Shungnak River	This alternative concept would use the following treatment train during Project closure: chemical precipitation, filtration, selenium treatment, and the use of a mixing zone in the Shungnak River. This alternative would not meet Alaska WQS at the discharge location without a mixing zone.	• Mixing zones are permittable in Alaska • Lower cost	Rejected

Note: TMF (tailings management facility); WQS (water quality standards).

Component Number 32 (Chemical precipitation, filtration, and reverse osmosis in operations): The water treatment train for this alternative concept would include the following:

- Chemical precipitation using caustic, soda ash, ferric chloride, and polymer would form solids that would be removed in a ballasted clarifier. This step would remove a significant portion of cationic metals.
- Ultrafiltration would protect the reverse osmosis system by removing suspended solids.
- Reverse osmosis would concentrate the charged contaminants into a brine, which would be disposed of in the TMF. The permeate from the reverse osmosis system would meet Alaska WQS and be discharged to Subarctic Creek.
- Sludge generated during water treatment would be disposed of in the TMF.

The use of this alternative concept during Project operations would mee the Project's purpose and need, is feasible and practicable, and would have the lowest relative environmental effects. Thus, the use of this water treatment strategy was selected as the preferred alternative (see EED Section 2.1.5, *Water Treatment Plan*).

Component Number 33 (Chemical precipitation, filtration, reverse osmosis, biological, and mechanical dewatering in closure): The water treatment train for this alternative concept would include the following during Project closure:

- Chemical precipitation using caustic, soda ash, ferric chloride, and polymer would form solids that would be removed in a ballasted clarifier. This step would remove a significant portion of cationic metals.
- Ultrafiltration would protect the reverse osmosis system by removing suspended solids.
- Reverse osmosis would concentrate the charged contaminants into a brine, which would be disposed of in the TMF. The permeate from the reverse osmosis system would meet Alaska WQS and discharged to Subarctic Creek.
- Biological treatment would remove sulfate, selenium, nitrate, and additional cationic metals.
- Sludge generated during the treatment would be disposed of in the mine pit until it reached capacity, at which time it would then be disposed of in the TMF.

The use of this alternative concept during Project closure would meet the Project's purpose and need, is practicable and feasible, and would have the lowest relative environmental effects. Thus, the use of this water treatment strategy was selected as the preferred alternative (see EED Section 2.1.5, *Water Treatment Plan*).

Component Number 34 (Chemical precipitation and filtration and the use of a mixing zone in the Shungnak River): The water treatment train for this alternative concept would include the following treatment train:

- Chemical precipitation to generate a high-density sludge. The sludge generated during treatment would be disposed of in the TMF.
- Filtration to remove suspended solids.
- Seasonal discharge (May through October) to a mixing zone in the Shungnak River via a pipeline. The mixing zone would need to meet Alaska WQS.

This water treatment strategy would meet the Project's purpose and need and is feasible and practicable, but the permitting risks associated with using a mixing zone and operational challenges associated with it were viewed as a significant Project risk. The relative environmental effects of a mixing zone were considered to be less preferrable if avoidance was possible. Further analysis revealed a treatment train that did not include the need for a mixing zone. Thus, the alternative concept was rejected.

Component Number 35 (Chemical precipitation, filtration, selenium treatment, and use of a mixing zone in the Shungnak River): The water treatment train for this alternative concept would include the following treatment train:

- Chemical precipitation to generate a high-density sludge. The sludge generated during treatment would be disposed of in the mine pit until the capacity was exhausted, at which point the sludge would be disposed of in the TMF.
- Filtration to remove suspended solids.
- Seasonal discharge (May through October) to a mixing zone in the Shungnak River via a pipeline. The mixing zone would need to meet Alaska WQS.

This water treatment strategy would meet the Project's purpose and need and is feasible and practicable, but the permitting risks associated with the mixing zone and operational challenges associated with it were viewed as a significant Project risk. The relative environmental effects of a mixing zone were considered to be less preferable if avoidance was possible. Further analysis revealed a treatment train that did not include the need for a mixing zone. Thus, the alternative concept was rejected.

3.3.9 Liner Options for the Waste Rock Facility

Liner options for the WRF were evaluated to reduce water treatment requirements by minimizing infiltration and oxidation of the waste rock (Klohn Crippen Berger 2021). The options were composed of multiple liner placements and tailings disposal combinations as shown in Table B.14.

Table B.14. Liner Options Considered during Alternatives Development

Component Number	Component Considered	Description	Why Considered	Status
36	Synthetic liner placed on top of the TMF and WRF at closure	A synthetic liner and soil cover would be placed on the top of the TMF and the top and sides of the WRF upon Project closure to minimize water and air infiltration, thus reducing acid generating chemical reactions and transport. This would reduce the amount of water requiring treatment and improve the quality of water that would require treatment at Project closure.	• Reduce the water volume requiring treatment at closure • Improve the quality of influent water at the water treatment plant • Reduce long-term treatment costs	Carried forward as the preferred alternative
37	Synthetic liner on top of the TMF, but only the top portion of the WRF	A synthetic liner and soil cover would be placed on top of the TMF and the top of the WRF upon Project closure to reduce water and air infiltration, and reduce the amount of water, compared to a soil-only cover.	• Reduce some water volume requiring treatment at closure • Provide some improvements to influent water quality • Lower initial liner cost	Rejected
38	Synthetic liner placed under the TMF and WRF during operations and on top of the TMF and WRF at closure	A synthetic liner would be placed under the TMF and WRF during Project operations to minimize groundwater interaction. A synthetic liner and soil cover would be placed on the top of the TMF and the top and sides of the WRF upon Project closure to minimize water and air infiltration, thus reducing acid generating chemical reactions and transport. This would reduce the amount of water requiring treatment and improve the quality of water that would require treatment at Project closure.	• Reduce the water volume requiring treatment at closure • Improve the quality of influent water at the water treatment plant • Reduce long-term treatment costs	Rejected

Note: TMF (tailings management facility); WRF (waste rock facility).

Component Number 36 (Synthetic liner placed on top of the TMF and WRF at closure): The proposed TMF would be designed as a fully lined conventional tailings facility buttressed by the unlined WRF. The Project closure plan would include placing a plastic liner with a soil cap over the TMF and WRF. This liner configuration was analyzed by the Project (Klohn Crippen Berger 2021). The use of this alternative concept during Project closure would meet the Project's purpose and need, is feasible and practicable, and would have relatively low environmental impacts. Thus, the use of this liner alternative concept was selected as the preferred alternative (see EED Section 2.10, *Closure and Reclamation*).

Component Number 37 (Synthetic liner on top of the TMF, but only the top portion of the WRF): This alternative concept is similar to Component Number 36, but the liner would only be placed on the top portion of the WRF and the sides of the WRF would only be covered with soil. Although this would reduce infiltration, it would allow more water infiltration than the alternative described in Component Number 36. The initial costs would be lower given the smaller liner, but the water treatment cost would increase due to the greater amount of water requiring treatment. Due to the presence of the groundwater collection system, the environmental impacts would be similar. This liner configuration was analyzed by the Project (Klohn Crippen Berger 2021). The use of this alternative concept during Project closure would meet the Project's purpose and need and is feasible and practicable, but it would have greater relative environmental impacts. Thus, use of this alternative liner concept was rejected.

Component Number 38 (Synthetic liner placed under the TMF and WRF during operations and on top of the TMF and WRF at closure): This alternative concept is similar to Component Number 36, but the liner would be placed underneath the TMF and WRF during operations. Although groundwater infiltration to the WRF

would be slightly reduced, there would be a significant cost increase by adding the bottom liner. The initial costs would be much higher, and the water treatment costs would be decreased only slightly. There is also concern about the potential failure of the bottom liner and practicability of laying it without puncturing it. Due to the presence of the groundwater collection system, the environmental impacts would be comparable. This liner configuration was analyzed by the Project (Klohn Crippen Berger 2021). The use of this alternative concept during Project closure would meet the Project's purpose and need, but it is not feasible or practicable due to the increased cost and uncertainty associated with potential liner punctures. The bottom liner would have a comparable relative environmental effect. Thus, the use of this liner alternative concept was rejected.

3.4 Alternative Components Considered but Eliminated from Further Analysis

As previously described, AMC considered a number of alternatives for various Project components (mine type, TMF and WRF, pads, access, airstrip, fuel sources, and material sites). A total of 38 alternative components were evaluated to determine whether they were reasonable in light of the Project's purpose and the screening criteria described in Section 3.2, *Alternatives Screening Criteria*. Of these, 22 alternative components were eliminated from further analysis because they did not meet the overall Project purpose; were not considered economically or technically feasible or practicable (as defined by CEQ [1981] guidelines); did not provide benefits over an alternative already being considered; or were not sufficiently unique. After the alternative components were evaluated against the screening criteria, they were either incorporated into AMC's proposed Project as the preferred alternative, eliminated, or considered but not currently selected as the preferred alternative. Alternative components considered but eliminated from further analysis are summarized in Table B.15, along with the rationale for elimination.

Table B.15. Alternative Components Considered but Eliminated from Further Analysis and the Rationale for Elimination

Component Number	Alternative Component Considered	Rationale for Elimination
2	Underground mine	Substantial technical and economic feasibility constraints make this alternative not practicable under the U.S. Army Corps of Engineers Section 404 regulations, because an underground mine: • Would result in safety concerns, less structurally sound and prone to unstable conditions. • Would result in substantially more costs. • Would result in increased time required to extract the targeted resources (increasing the life of the mine and the duration of effects of the mine).
4	WRF located upgradient of the mine pit, with the TMF located downgradient in a separate lined facility	Separated locations for the TMF and WRF were initially considered when it was believed there would not be enough space up valley from the mine pit for both facilities. One WRF site and two TMF sites were evaluated. Both TMF locations proved problematic due to increased water treatment demands resulting from very large freshet events occurring down valley, increased impacts to Subarctic Creek (including fish habitat), and greater impacts to wetlands.
5	Waste rock co-disposed with tailings	To co-dispose materials at Site 3, a larger downstream dam and an upstream wall would be required to accommodate the larger combined volume of tailings and waste rock. A liner would be required under the entire facility and potentially acid generating (PAG) material would be used for construction. This downstream location would require significantly more liner material compared to an upstream location, and it would greatly increase the amount of water requiring capture and treatment. The need for a significantly larger and more expensive water treatment plant would be financially prohibitive. Additionally, this alternative concept would result in greater wetland impacts, total loss of streams, and habitat loss.
6	Waste rock co-disposed with tailings, but with the PAG material placed in a separate lined facility	This alternative concept is a variation of Component Number 5 where the PAG material would be separated from non-acid generating material. Geochemical analysis revealed that approximately 70% of the material would be PAG, so separating the material cannot practically be achieved.

Component Number	Alternative Component Considered	Rationale for Elimination
7	Drystack TMF with a process water pond	In order to dry the tailings material, additional water treatment would be required during Project operations and the Project would not benefit from the water storage capacity the proposed TMF's subaqueous deposition would provide. The mine pit walls would also contribute a significant amount of PAG material and metal leaching potential, so in-perpetuity water treatment would still be required. The additional footprint required for a separate process water pond and greater initial water treatment requirement make this alternative concept not feasible or practicable for economic and technical reasons, as well as having greater relative environmental effects.
8	Liner under the TMF and WRF	Placing a liner under the TMF and WRF would be expensive and present technical challenges to place as there is a high potential for liner failure (i.e., puncture). Water treatment would still be required in perpetuity due to the PAG material and metal leaching potential of the mine pit walls. The placement of an underliner was deemed not feasible or practicable for economic reasons.
10	Operations Pad on top of the Arctic ridge	This location was deemed not feasible or practicable due to the long-haul distances and potentially dangerous road alignment that would be required to connect it to other Project infrastructure.
12	Operations Camp pad site 1	Would not reduce overall impacts: would have more impacts to wetlands and WOUS.
13	Operations Camp pad site 2	Would not reduce overall impacts: would have more impacts to wetlands and WOUS.
14	Operations Camp pad site 3	The site would have required extensive cut and fill to construct a relatively level pad and the location would not reduce overall impacts as it would have more impacts to wetlands and WOUS.
15	Operations Camp pad site 4	The site is not located in the appropriate location for the project, would require additional infrastructure causing greater costs and impacts.
19	Access via Arctic Creek drainage	Would not reduce overall relative environmental impacts: • Would have more impacts to wetlands and WOUS • Would cross the Arctic Creek drainage, an anadromous stream and tributary to the Kogoluktuk River.
20	South Route Alternative 1B	This alignment would require approximately twice as much cut and fill to construct and it would have steep grades that would be used by passenger busses, which would result in additional impacts from the increased emissions generated by vehicle engines and the use of tire chains during inclement conditions. This alternative would also be slightly longer and require more culverts than South Route Alternative 1A.
21	North Route Alternative 2B	Would impact more wetlands and WOUS than North Route Alternative 2A
23	Steel girder bridge crossing of Dahl, Wesley, and Subarctic creeks	This alternative concept would not have greater relative environmental effects than a buried bridge, but it would increase costs.
25	Airstrip Alternative 3A: upgrade the existing airstrip near the Bornite Camp	The surrounding topography is not compatible with the large aircraft anticipated to be used by the Project and the alternative concept would not reduce overall impacts(it would have more impacts to wetlands and WOUS).
26	Airstrip Alternative 3B: construct new Subarctic Valley airstrip	Would not reduce overall impacts: would have more impacts to wetlands and WOUS.
27	Airstrip Alternative 3C: rehabilitate and extend abandoned airstrip	Would not reduce overall impacts: significant earthworks would be required to extend and widen the runway to meet anticipated Project use due to topography and ill-suited native soils. Additionally, there is potential for high valley crosswinds and concerns about the proximity of the Arctic ridge and proposed Project infrastructure.
34	Chemical precipitation and filtration and the use of a mixing zone in the Shungnak River	Use of a mixing zone would have greater relative environmental effects and would create additional permitting risks.

Component Number	Alternative Component Considered	Rationale for Elimination
35	Chemical precipitation, filtration, selenium treatment, and use of a mixing zone in the Shungnak River	Use of a mixing zone would have greater relative environmental effects and would create additional permitting risks.
37	Synthetic liner on top of the TMF, but only the top portion of the WRF	This alternative concept would be similar to the preferred alternative, but it would allow more water infiltration that would then require treatment. The environmental effects would be similar to the preferred alternative due to the groundwater collection system.
38	Synthetic liner placed under the TMF and WRF during operations and on top of the TMF and WRF at closure	The bottom liner would increase Project cost while not providing a substantial benefit. Additionally, placing a liner under the TMF and WRF would be present technical challenges to place as there is a high potential for liner failure (i.e., puncture). Water treatment would still be required in perpetuity due to the PAG material and metal leaching potential of the mine pit walls.

Note: LNG (liquified natural gas); PAG (potentially acid generating); TMF (tailings management facility); WOUS (Waters of the U.S.); WRF (waste rock facility).

4.0 REFERENCES

Ausenco. 2017. *Trilogy Metals Inc. Arctic Pre-Feasibility Study; Trade Off Study; Diesel & LNG Power Generation.* December 8, 2017.

Ausenco Engineering Canada Inc. (2020). *Arctic Project Pre-feasibility Study Update, Alaska, USA.* 105664-05-MS-0000-18172-001 Revision Number C. January 6, 2023

Ausenco Engineering Canada Inc. (2023). *Arctic Project Pre-Feasibility Study Update, Alaska, USA.*

Brown and Caldwell. 2021. *DRAFT Water Treatment Strategy for the Arctic Deposit. Prepared for Ambler Metals, LLC.* June 11, 2021.

CEQ. 1981. *NEPA's 40 Most Asked Questions*. Washington, D.C.

DOWL. 2019. *Trilogy Metals Arctic Access Road Design, Preliminary Engineering Report.* September 2019.

Klohn Crippen Berger. 2021. *DRAFT Alternatives Assessment*. Prepared for Ambler Metals, LLC.

SRK. 2012. NI 43-101 Preliminary Economic Assessment Ambler Project Kobuk, AK. Report Prepared for NovaCopper. March 9, 2012

SRK. 2015. Arctic Project – August 2015 Site Inspection Related to Civil Infrastructure – DRAFT. Prepared for NovaCopper Inc. October 7, 2015

Tetra Tech. 2013. Preliminary Economic Assessment Report on the Arctic Project, Ambler Mining District, Northwest Alaska. Report for NovaCopper. September 12, 2013

USACE. 2012. *Point Thomson Project Final Environmental Impact Statement*. Anchorage, AK.

This page intentionally left blank.