Table of Contents

1. INTRODUCTION

This Plan of Operations (PoO) outlines current Pogo Mine activities through Spring 2020 in accordance with current local, state, and federal regulations, permits, and regulatory guidance. Where appropriate, the PoO incorporates and builds upon permitting documents, including the 2002 Water Management Plan and Appendices and the 2018 Reclamation and Closure Plan. This PoO supersedes all prior documents.

2. DEFINITIONS AND ACRONYMS

ACRONYM	NAME
ADEC	Alaska Department of Environmental Conservation
ADNR	Alaska Department of Natural Resources
APDES	Alaska Pollutant Discharge Elimination System
AST	Above ground storage tank
BMP	Best Management Practice
cfm	Cubic feet per minute
CFR	Code of Federal Regulations
cfs	Cubic feet per second
CIP	Carbon-in-Pulp
CPT	Cone penetration test
DSTF	Drystack Tailing Facility
EPA	Environmental Protection Agency
Ft amsl	Feet above mean sea level
Ft bgs	Feet below ground surface
gpm	Gallons per minute
GVEA	Golden Valley Electric Association
HDPE	High-density polyethylene pipe
HDS	High-density sludge
ILR	Intensive leach reactor
hp	Horsepower
kV	Kilovolt
kW	Kilowatt
lb	pound
LCTF	Lower Camp Tank Farm
LG	Low-grade
LHD	Load, haul, dump
LV	Light vehicle
MDRU	Mineral Deposit Research Unit
mg/kg	Milligrams per kilogram
Mgal	Million gallons
mph	Miles per hour
MSHA	Mine Safety and Health Administration
MTon	Million tons
MW	Megawatts
MWTP#3	Mine Water Treatment Plan #3
NP/AP	Neutralization Potential/Acid Potential

ACRONYM	NAME
NSR	Northern Star Resources
ORTW	Off-River Treatment Work
PAX	Potassium amyl xanthate
PoO	Plan of Operations
PSI	Periodic Safety Inspection
PWSID	Public Water System Identification
QAPP	Quality Assurance Project Plan
RTP	Recycle Tailings Pond
SAG	Semi-autogenous grinding
SPCC	Spill Prevention, Control and Countermeasures
SPT	Standard penetration test
SWPPP	Storm Water Pollution Prevention Plan
TAPS	Trans-Alaska Pipeline System
TDS	Total dissolved solids
STpd	Short tons per day
STph	Short tons per hour
SCW	Seepage collection wells
µm	Microns (micrometre)
USGS	United States Geological Survey
UV	ultraviolet
V	volt
VoIP	Voice over IP
W	Watt
WAD	Weak Acid Dissociable

3. SITE ACCESS

3.1 Location

Northern Star (Pogo) LLC (NSR) is the operator of the Pogo Mine, located 38 miles northeast of Delta Junction and 88 miles east-southeast of Fairbanks, Alaska (see Figure 1.1). The site is located within Sections 13, 14, 2-27 and 34-36, T5S, R14E; Sections 18, 19, and 29-34, T5S, R15E; Sections 1-3, 10-15 and 36, T6S, R14E; Sections 3-11, 14-23 and 29-32, T6S, R14E, Fairbanks Meridian.

3.2 Access to Site

A 49-mile-long, all-season road constructed along the Shaw Creek Hillside route provides safe, reliable access to the Pogo Mine. Access is gained from the end of Shaw Creek Road, two miles from the Richardson Highway. The road crosses over the Trans-Alaska Pipeline System (TAPS), 2.5 miles from the Shaw Creek Road. There are four single- span bridges over creeks along the route, and one four span bridge crossing the Goodpaster River. All bridges are single lane with a posted maximum speed of 10 miles per hour (mph). The road and power transmission line routes are shown in Appendix B, Figure 4.1.

The access road is a controlled, restricted access industrial road. A security gate near the departure point at the end of Shaw Creek Road provides access control. A large sign stating the road is "private" and therefore closed to unauthorized traffic is posted at the security gate and at the TAPS crossing.

The design speed limit for the all-season road is 35 to 45 mph. The highest elevation along the road is 3,300 feet above mean sea level (ft amsl); the lowest 970 ft amsl. Roadside berms and guardrails are installed where appropriate. Radio contact is maintained between all vehicles, the security gate and mine security.

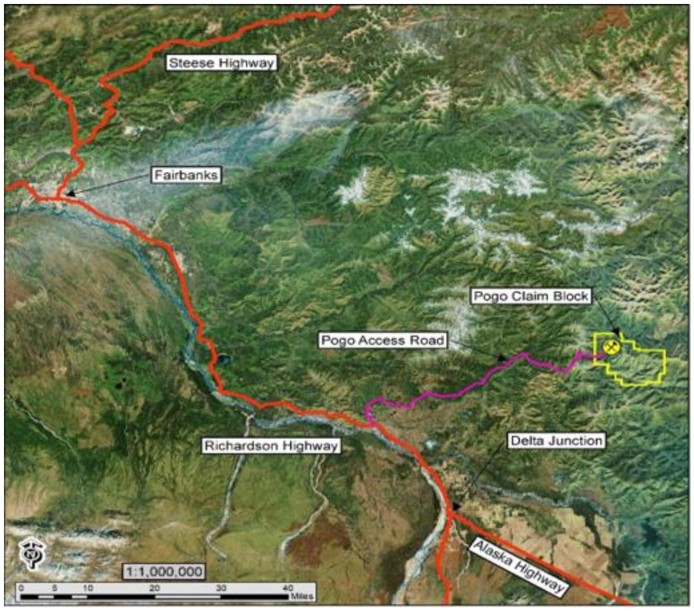

Figure 1.1: General Location Map

All drivers undergo a road safety briefing prior to driving on the Pogo access road, and regular bus drivers are trained in first aid, emergency response. Buses carry emergency response equipment. Properly trained and qualified emergency response personnel will respond to accidents and medical emergencies on the access road. An environmental response team will respond, coordinate and clean up spills as necessary.

Employees are transported onto the mine site by bus or appropriate company vehicles.

Summer and fall road maintenance include grading and repairing of potholes, ruts and washboards, replacing damaged markers and signs, and maintaining drainage and sediment control structures. Winter and spring maintenance include snow removal, road scarifying for improved traction, and drainage maintenance. Emergency maintenance is provided as necessary. Dust is minimized by enforcing low traffic speeds and using water and suppressing agents.

Additional details on construction, operation, and reclamation of the access road is contained in the road easement documents.

3.3 Mine Security

The Pogo Mine security plan includes a combination of measures such as security personnel, police clearance for employees, lockable gates at either end of the mine access road, closed-circuit television surveillance, security lighting, and fencing to ensure personnel, equipment, and product security. Security is provided at the main entrance gate; all traffic on the road is monitored by the gate or site security teams. Emergency travel along the mine access road outside of general access hours is permissible and is supervised by the site security team.

4. OPERATING PLAN / FACILITY DESCRIPTION

4.1 Facility Activity

The mine consists of the six major areas shown on Figure 1.2 in Appendix B and described below. As-built drawings Figures 1.3 – 1.3e are included in Appendix B depicting the project facilities. Figure 1.4 in Appendix B shows the growth media stockpile locations.

1525 Portal Area

- 258-person camp with recreation and catering facilities
- Sewage treatment plant
- Mine water treatment plant
- Mineralized rock and low-grade ore stockpile
- Laydown areas for warehouse and supply

- Warehouses for mine supply
- Growth media stockpiles

Airport Area

- A 3,000-foot airstrip in the Goodpaster River valley just north of Liese Creek
- Site access roads connecting the plant site with the shop/camp facilities, construction camp area, airstrip, tailings site, borrow sites, and other facilities as needed
- Growth media stockpile

Mill / Camp Complex

- Surface gold mill for recovery through gravity concentration, flotation, and Carbon-in-Pulp (CIP) process
- Tailings preparation facilities, including cyanide detoxification and filtration, to produce paste backfill for the underground mine workings and dewatered tailings material suitable for placement in a drystack facility on the surface
- Maintenance shops, office, warehouse complex
- 249-person camp with recreation and catering facility

Tailings Area

- Drystack tailings facility
- Recycle Tailings Pond (RTP) water storage facility
- Diversion ditches
- Growth media stockpiles and connecting roads

Mine

- Underground cut-and-fill mine with adit access and conveyor for transfer of ore to a surface mill
- 1525 portal original exploration adit, ventilation, waste rock haulage, etc.
- 1875 portal primary access for workers, supplies, etc.
- 1690 portal conveyor access and ventilation
- 2150 portal intake ventilation, access for workers, supplies, etc.

Millsite Area

- All utilities, piping and items that connect the respective area
- Items not included in other areas

4.2 General Operating Criteria

Mining and production operations are driven by the mine plan, site conditions, and operational priorities which change daily. General operating criteria for the mine are outlined below.

Milling Rate

- Average operating production..150 STph
- Average eventual production..220 STph

Mining Rate (Ore)..same as milling rate

Current projected mine life………..6 years

Energy requirements for mine operation

- @ 150 STph...30 megawatts (MW)
- @ 220 STph...35 MW

4.3 Environmental Management

4.3.1 Environmental, Health and Safety Policies

NSR's vision "to continue to build a safe, quality mining and exploration company, focused on creating value for Shareholders". To do this, NSR recognizes its Health, Safety, and Environmental Policies as a core competency.

NSR drives a safe and healthy working environment by:

1. Providing information, instruction, training and supervision to enable everyone to work safely.
2. Implementing and maintaining a Safety Management System, which ensures all hazard and risks are identified, evaluated, and managed in order to ensure everyone's safety.
3. Ensuring that managers and supervisors understand their responsibilities and are authorized to take remedial action.
4. Working in conjunction with the total workforce to develop and maintain safe systems of work and related procedures which meet Occupational Safety and Health legislative requirements.

NSR has a duty of care and legal obligation to protect the environment and is committed to managing its activities in an environmentally responsible manner. NSR drives its approach to environmental care by:

1. Implementing and maintaining an Environmental Management System to identify, assess, and minimize environmental risk at all stages of its operations as a fundamental part of its long-term strategy.
2. Monitoring the environmental footprint and setting and measuring annual targets for improved environmental performance.
3. Complying with all applicable legal and statutory requirements as a minimum standard and ensuring prompt and transparent reporting of any non-compliances.
4. Engaging stakeholders on their concerns, aspirations and values regarding the development, operation and closure aspects of projects.
5. Minimizing the environmental impacts of operations through the efficient use of natural resources, the reduction of input materials and waste, and the minimization of dust and emissions of gases.
6. Pursuing biodiversity understanding through baseline assessments and regular monitoring to enhance the ability for biodiversity protection.
7. Providing information, instruction, training and supervision to enable everyone to understand and comply with their environmental obligations and responsibilities.
8. Ensuring managers and supervisors are authorized and accountable for taking remedial action in the event of an environmental non-compliance.
9. No compromising first world standards when exploring, building and operating in developing countries or regions.
10. Communicating this policy and environmental performance in an open, transparent, and accurate manner.

5. ANCILLARY FACILITIES

5.1 Power Supply & Backup

Power is supplied to the mine via a 50-mile-long, 13.8 kilovolt (kV), three phase transmission line constructed along the Shaw Creek Hillside access route (see Figure 4.1 in Appendix B). The transmission line is constructed of wooden H-poles with horizontal conductors. The Pogo transmission line is connected to the Fairbanks to Delta Junction Golden Valley Electric Association (GVEA) transmission line at a substation on the west end of the project near the trans-Alaska pipeline north of Shaw Creek. The terminus substation is located adjacent to the mill building in the Liese Creek Valley.

At the end of mine life, the transmission line will be removed, and the easement reclaimed. Additional details on the power line construction, operation and reclamation are contained in the easement application.

Site backup power is supplied by two 1,000 kilowatt (kW), and one 2000 kW generators at the mill, paste backfill plant and upper/lower camps. This supply is sufficient to power key motors, pumps, water treatment, and lighting both underground and on surface on an emergency basis.

5.2 Maintenance / Warehouse Complex / Administration

5.2.1 Maintenance Facility

The mobile fleet maintenance area contains three maintenance bays, a welding bay and wash bay, as well as a stand-alone light vehicle (LV) workshop adjacent to the 1875 portal. Major repairs and rebuilds are performed at these facilities. Firewall protection between adjoining walls of the main maintenance complex and the remainder of the administration block has been installed. The maintenance facility also has tool storage areas and offices for administrative groups.

5.2.2 Warehouse

A warehouse facility with heated storage inside and cold storage outside is adjoined to the maintenance facility with firewalls between. The warehouse includes offices for the warehouse supervisor, inventory buyer and inventory control, and provides delivery access and unloading points for vendor supplies. Two smaller warehouses located in the lower camp, as well as a number of lower yard locations are utilized for the storage of warehouse inventory items.

5.2.3 Administration Building

The main administration building is a two-story, clad, modular structure containing the following:

- Offices and cubicles for senior staff, administrative, supervisory and technical personnel,
- Reception area,
- Conference rooms,
- Mine personnel line-out and meeting areas,
- Lunch and training room,
- Print and photocopy room,
- Washrooms,
- Clean and dirty locker and shower facilities,
- Communications room; and
- Miscellaneous storage areas.

5.3 Communications System

The two major components of the Pogo communications system are a Hybrid Digital Analog Voice Over IP (VoIP) system telephone system and a local radio repeater system. The systems are described below. The site also utilizes satellite telephones in case of a loss of the microwave-based communication system or other emergency situations.

5.3.1 Hybrid Analog VoIP

The Hybrid Phone system seamlessly combines Analog, Digital and VoIP technologies to provide a geographically diverse and highly redundant telephone infrastructure with the ability to use 2 discrete network links off the property, as well as a tertiary satellite back-up link. Additionally, Emergency Services and senior management have handheld satellite phones at their disposal.

5.3.2 Radio System

The radio system consists of three separate repeater sites, two of which service surface operations - one for Mine site surface operations and the other for radio coverage of the 50-mile access road. The third system services underground operations by way of a leaky-feeder. Approximately 300-400 handheld and mobile radios communicate with one or more of these repeater sites at a given time. By fall of 2020, all radio infrastructure will be converted to digital radio. Two of the three repeater sites are powered by the Pogo electrical grid with 24hrs+ of battery backup. The third site has roughly ten days of battery power available, using a combination of solar and wind-turbines to keep the batteries charged. Its failsafe is a 10kW propane standby generator.

5.4 Potable Water Supply

Water is collected from two 8-inch diameter wells, at depths of 61.5 and 53.3 feet below ground surface (ft bgs). They are located near the Goodpaster River and are in direct influence of surface waters. Two potable water plants (PWSID#) 372643 and 372685 treat and distribute the water respectively to the lower and upper camps, respectively. The water is ozonated, filtered, disinfected with chlorine, and a corrosion inhibitor, orthophosphate, is added prior to distribution.

The potable system for upper camp was designed for an average daily demand of 25,000 gallons (at a maximum filtration rate of 28 gallons per minute (gpm)) and the lower camp was designed for an average daily demand of 16,875 gallon (at a maximum filtration rate of 20 gpm). Both potable water systems are operated within the limitations described in the Pogo Mine Potable Water System Permits for PWSID #372643 and PWSID #372685.

5.5 Firewater

The firewater system utilizes a 192,000-gallon surge tank that is sourced from the drinking water wells.

5.6 Camp Facilities

The upper camp facility is located in the mill and camp bench area. The camp is a pre-engineered modular structure capable of housing approximately 249 people. The camp, shown on Figure 1.3c in Appendix B, includes the following:

- Single status housing units,
- Washroom and shower facilities,
- Kitchen facilities,
- Dining area,
- Recreation area,
- Entertainment area; and
- Laundry facilities.

The lower camp is used to lodge employees and contractors. “D wing” was commissioned in January 2010 (79 beds) and expanded in 2012 for a total of 154 beds. An additional expansion occurred in January 2020, adding 56 beds to lower camp. The remaining single “E wing” from the original construction camp is utilized for year-round contractor accommodations (48 beds); however, all personnel use the dining facilities at lower camp. Total lower camp capacity is 258 beds. Refer to Figure 1.3a in Appendix B. These facilities include the following:

- Double or single housing units
- Washroom and shower facilities,
- Kitchen facilities,
- Dining area,
- Recreation area,
- Entertainment area; and
- Laundry facilities.

5.7 Sewage Treatment

An Alaska Department of Environmental Conservation (ADEC)-approved 72,000 gpd sewage treatment plant is located near the 1525 portal as shown on Figure 1.3a in Appendix B. This treatment plant services both the upper and lower camps.

The sewage treatment plant is connected to the lower camp and upper camp with heat traced gravity flow lines and lift stations. The sewage plant uses ultraviolet (UV) effluent disinfection for final treatment. The effluent limits are provided in Pogo Mine Alaska Pollutant Discharge Elimination System (APDES) Permit No. AK0053341.

5.8 Site Roads

Site roads consist of maintained gravel roads and are shown on Figures 1.3 to 1.3e in Appendix B.

5.9 Airstrip

A 3,000 ft long by 75 ft wide gravel airstrip was built to support construction and mining operations. The airstrip is maintained for the life of the operation and is available until Phase IV Water treatment and post-closure reclamation (refer to Figure 1.3b in Appendix B).

5.10 Meteorological Stations

Meteorological Stations are located on Pogo Ridge (refer to Figure 1.3 in Appendix B) and Pogo Airstrip (refer to Figure 1.3b in Appendix B). Their purpose is to collect data to support air quality and meteorological modeling. Each station has a ten- meter guyed tower with a two foot by two- foot concrete base pad. The Datalogger™ system is housed in a weatherproof enclosure at the base of each tower. Each station measures the following parameters:

- (2) Wind Speed (m/s) (at 10-meters)
- (2) Wind Direction (degrees) (at 10-meters)
- (2) Sigma Theta (degrees)
- (2) Air Temperature and vertical temperature difference (degree C) (at 2 meters and 10 meters elevation)
- (2) Solar Radiation (W/m2)
- Heated Precipitation gauge with wind shield (inches)
- Evaporation Pan (Airstrip only)

Each of the monitoring stations is powered by electrical service with a backup battery and solar power system. Both sites are readily accessible by vehicle.

5.11 Incinerator

Pogo has operated an ACS Model CA-400 incinerator with an auto ash removal system and DUALL wet scrubber air pollution control device. This unit was taken offline January 24, 2019 due to operational changes. Should it be restarted, appropriate notification will be provided to regulatory agencies. Refer to Figure 1.3a in Appendix B for the incinerator building location.

6. GEOLOGY AND MINING

6.1 Geology & Ore Resources

The Pogo Mine lies within approximately 87 square miles of State of Alaska controlled land north of Delta Junction, Alaska. Figure 5.1.1 shows the location and infrastructure of the Pogo Project.

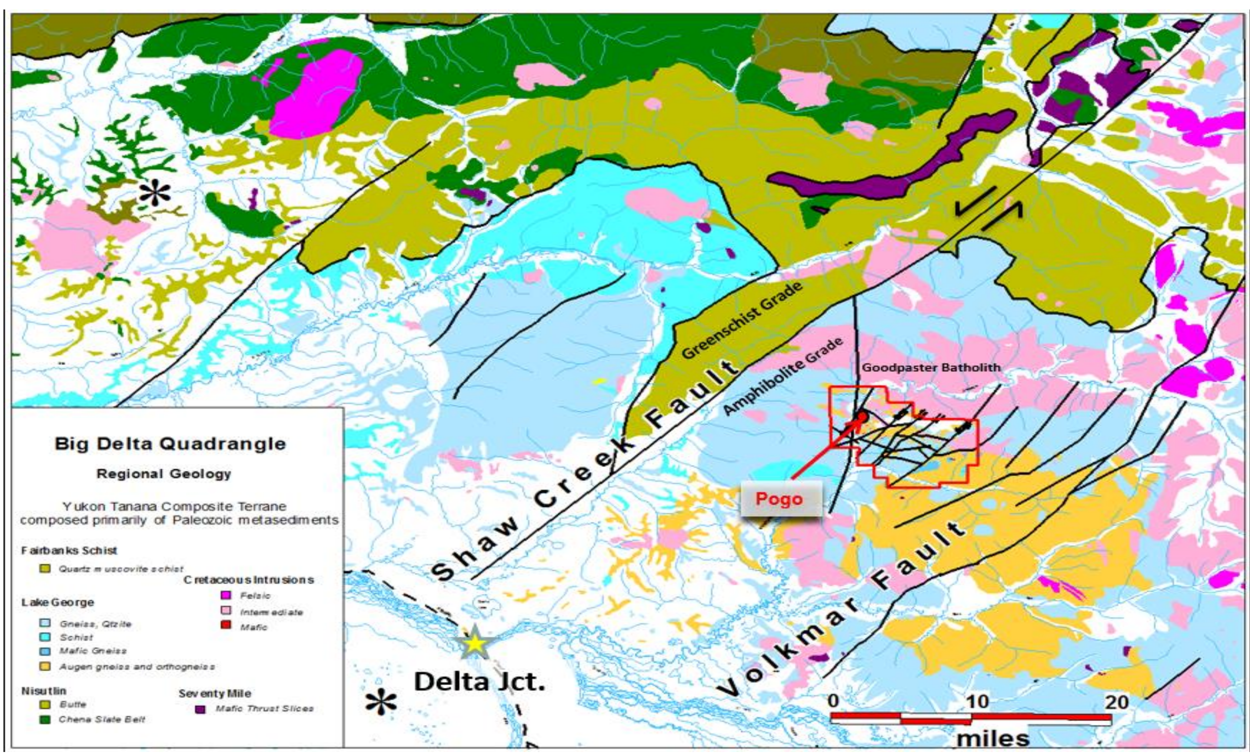

Figure 5.1.1 General Geology of the Pogo Project Area

Gold-bearing quartz veins are hosted in in a sequence of amphibolite-grade gneiss of probable Proterozoic to Mesozoic age. Mid-Cretaceous-aged granitic plutons and dikes intrude the gneisses. Paleozoic gneiss and Cretaceous granite terrain is interpreted to form part of the Yukon-Tanana terrain, a gold belt which extends from Fairbanks eastwards into historic Yukon Territory. During retro-grade metamorphism, ductile deformation of the metamorphic fabric changed to brittle (semi-ductile to brittle) deformation. Low-angle shear zones deformed the rock mass across the region. Fluid inclusion analysis from the Mineral Deposit Research Unit (MDRU) suggest initial formation of the Pogo deposit at depths of roughly 8-10 km.

Mining of the Pogo Mine deposit is carried out in several zones close to each other; the Liese Zone, North Zone, Fun Zone, and East Deep Zone. Vein thickness varies from 1 foot up to 20+ ft thick. A post-mineral tonalite pluton (95 Ma, U-Pb Zircon age date) later intruded and deformed the mineral system.

Frequent post-mineral basalt dykes intrude the mineral system. Late-stage, post-mineral (Paleocene-aged) Faults with pronounced left-lateral offset break the Pogo District stratigraphy into discrete blocks. Pleistocene glaciation scraped some areas clean and deposited thick loess and sand dunes in other places. Surface erosion has shed gold nuggets into local streams to form small placer deposits adjacent to major rivers.

Proposed exploration work activities are conducted primarily from established road disturbance but may include helicopter supported remote drilling operations. Road extensions, pads and trenches are proposed annually in the approved APMA supporting exploration activities. Annual exploration activities are planned for each unique claim block. New expenditures are projected to exceed the annual labour requirements in each case (see Figure 5.1.2 below).

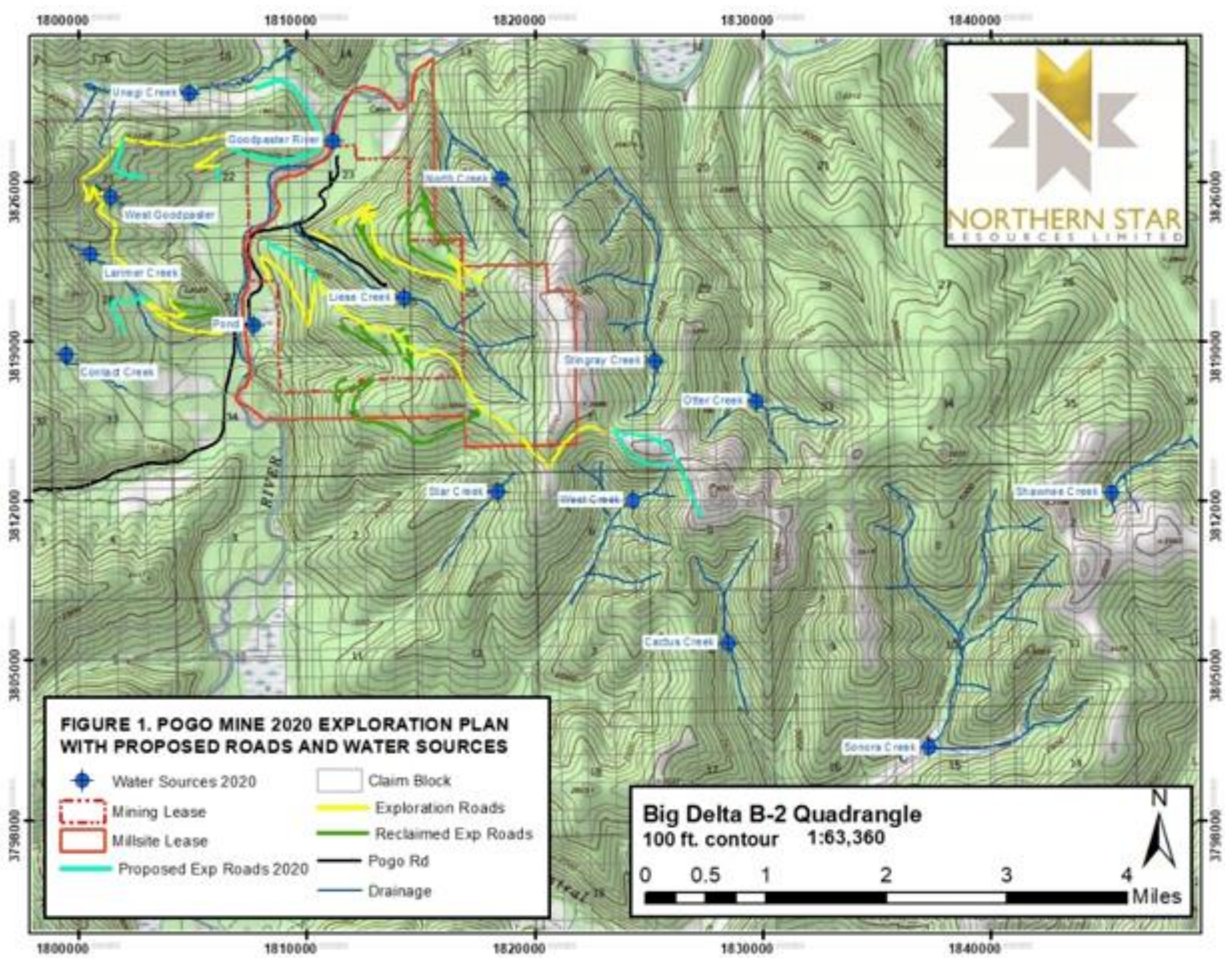

Figure 5.1.2: Pogo Proposed Work Area

6.2 Mine Plan

6.2.1 Mine Access

The 1525 and 1875 portals provide access for workers, supplies, equipment and provide intake ventilation. The 1690 portal is used primarily for conveyor access to the mine and for exhaust ventilation. The 2150 portal is used primarily for intake ventilation and it also provides access for workers, supplies, and equipment. In addition, the 2150 raise is used for ventilation exhaust.

6.2.2 Development

Underground development consists primarily of lateral ramp development, with some raise development for ventilation and emergency egress.

The ore body is accessed via a series of ramps and stope access drifts. Ramps have nominal dimensions of 17 ft wide by 18 ft high and a maximum grade of 15%. The ramps are located on either the footwall or hanging wall of the orebody depending on drilling requirements for the area. Ramp standoffs from the orebody are a minimum of 160' to allow for tele-remote load, haul, dump (LHD) operation on the level to be isolated from the ramp system.

Stope access drifts are developed from the haulage ramps at vertical intervals of 35 - 50 ft depending on vein geometry and driven perpendicular to both the ramp and the strike of the ore it accesses. Levels are mined in both directions from the stope access drift intersection to the lateral extents of the ore zone. The access drifts are designed to intercept the center of the ore zone to maintain two active faces for most of the level development. Figure 5.2.1 shows a 3D rendering of current mine development.

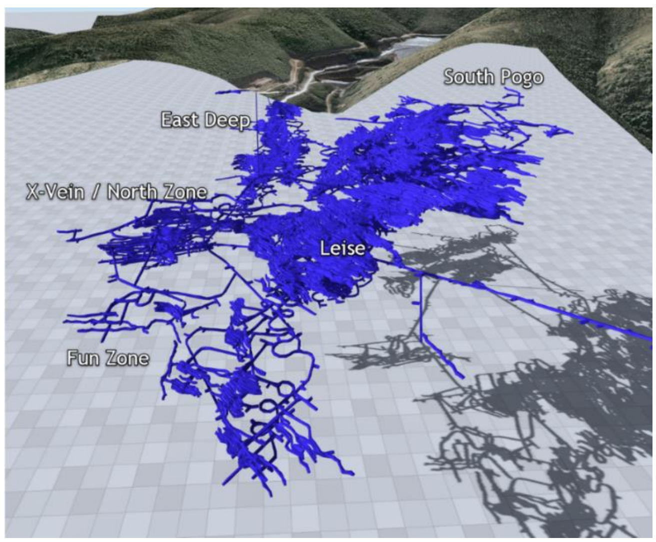

Figure 5.2.1: 3D View of Orebodies and Underground Development

6.2.3 Mining Method

Longhole open stoping is the primary mining method used at Pogo Mine. This method reduces required development footage compared to previous mining methods resulting in lower cost per ton and allowing lower grade material to be mined economically. Lateral development is mined across the ore zone by rubber-tired drilling jumbos. Following completion of development, blastholes are drilled up the vein to the level above by longhole drill rigs and the stope is blasted. Blasted ore is extracted with tele-remote LHD units which safely remove the operator from the unsupported open stope. Depending on rock conditions, grouted cable bolts will be installed prior to stoping to support the hanging wall and minimize unplanned dilution. After the stope is mined, mining voids are filled with mainly paste backfill and some mined waste rock. A simplified cross-section of longhole open stoping is shown in Figure 5.2.2.

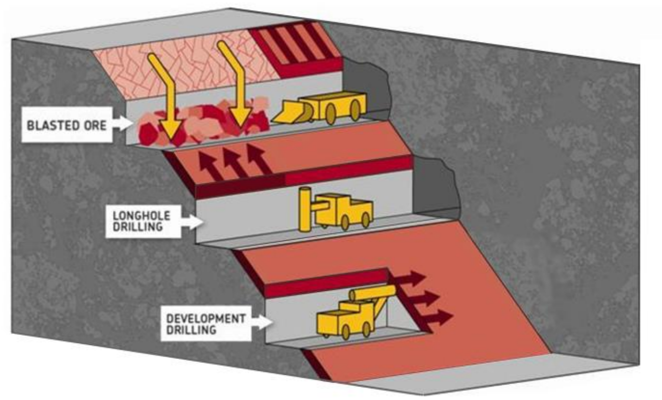

Figure 5.2.2: Longhole Open Stoping Cross-Section

6.2.4 Ore Haulage

Ore is hauled from the stopes to the underground ore storage bin using 9 yd^3 LHD units and 50- or 60-ton haul trucks. The ore bin is fitted with a screen and a hydraulic rock breaker to reduce oversize material. Ore from the bin is fed onto a conveyor with a pan feeder and transported to the surface coarse ore bin for feed into the mill.

6.2.5 Development Rock Haulage

Development rock is trucked to the surface via the 1525, 1875, and 2150 portals and placed according to the rock segregation plan described in Section 5.4.

6.3 Temporary Ore Storage

As a normal part of mining, ore is produced at different rates in comparison to the steady operations of the mill. Mining operations store excess ore underground to the maximum extent possible. Excess ore is also stored at a temporary surface stockpile (1525 lined mineralized ore pad) and temporarily outside each portal. Ore from this temporary stockpile is hauled to the mill feeder to provide steady mill feed.

6.4 Development Rock Segregation & Storage

Development rock is mined, brought to surface, segregated by individual blasted rounds, and held for assay. When the assays are complete, the material is classified as "mineralized" or "non-mineralized" based on the standard operating procedure for rock segregation summarized below.

To classify the rock, drill cuttings from blast holes representing each development blast are sampled and assayed on site. If the material is above either 0.5% sulfur or 600 milligrams per kilogram (mg/kg) arsenic, the blasted rock is classified as "mineralized." If the assay does not exceed these thresholds, the material is classified as "non-mineralized."

The mineralized development rock is stored at the temporary development rock placement area near the portals until it can be trucked to the dry stack tailings facility (DSTF) and encapsulated in the tailings. Non-mineralized rock is used to construct the shell and flow through drains on the DSTF and for road maintenance, construction, and site development.

Optimization of the mine plan and layout forecasts the development rock quantities shown in Table 5.1.

Forecasted	2019	2020	2021	2022	2023	2024	2025	2026	Total
Mineralized Rock to Surface	503,470	1,006,940	1,006,940	1,006,940	1,006,940	1,006,940	915,400	273,435	6,727,004
Non-mineralized Rock to Surface	458,684	1,107,634	855,899	654,511	402,776	402,776	366,160	54,687	4,303,126
Total Development Rock	962,154	2,114,574	1,862,839	1,661,451	1,409,716	1,409,716	1,281,560	328,121	11,030,130

Table 5.1: Development Rock Quantities (tons)

Non-mineralized development rock may be sent to the DSTF but is more commonly used as bulk fill on roads and pads.

6.5 Backfill Distribution

To provide ground support and stabilize the underground areas, mined areas are backfilled with mill tailings mixed with cement. This paste backfill provides part of the necessary ground support for mined-out areas adjacent to another ore panel being mined. Figure 5.5.1 depicts the backfill cycle.

Paste is made in the paste backfill plant, located on the surface near the mill. At the backfill plant, on an average approximately 7.5-13% cement is added to the mixture to ensure strength after curing. A typical designed paste unconfined compressive strength is 20 pounds per square inch (psi) after 2 weeks, and 30 psi at a full cure time of 28 days.

For Liese zone, the paste is pumped from the paste plant via a steel pipeline (Paste Line 1 or PL1) installed in the surface conveyor structure called the 'blue tube' and 1690 decline. For the East Deep zone, a new 2,700 ft long steel surface paste pipeline (PL2) was constructed in an elevated containment trough between the paste plant and 2150 portal. PL2 became operational in October 2015. Figure 1.3c in Appendix B depicts the location of PL2.

To prepare the stopes for fill, all services are removed, including the air and water pipelines and electrical cable. High density polyethylene pipe (HDPE) and breather lines are installed in the highest areas of the stope and extended to the back end of the stope, where filling begins. The HDPE pipe is left in the stope as part of the fill process.

Shotcrete paste barricades are constructed near the access area to contain the cemented paste fill in the stope. During pouring, the paste builds up and pushes out towards the barricade, completely filling the mined void. As the stope fills, small explosive charges are blasted with detonating cord to break the pipe (at couplers) and retreat the active pipe outlet back to the barricade.

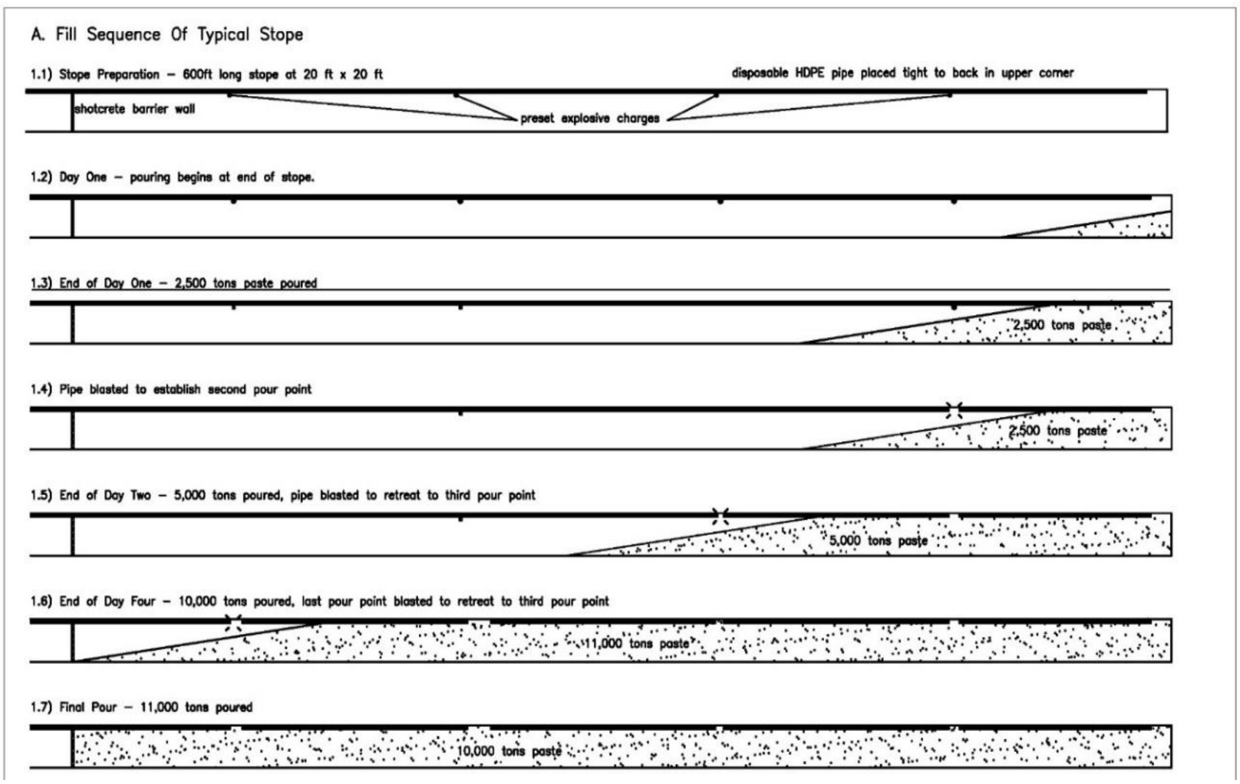

Figure 5.5.1: Backfill Cycle

6.6 Mine Equipment

6.6.1 Mobile Equipment

Underground equipment use is summarized in Table 5.2.

Equipment	Purpose
Two-boom electric-hydraulic drilling jumbos	Face drilling and installation of primary ground support for lateral development mining
Floating boom longhole drill rigs	Drilling stope blastholes and non-accessible vertical development
10 yd^3 load, haul, dump units with tele-remote capabilities	Load material into haul trucks from either development faces or production stopes
Diesel haul trucks ranging in size from 50-ton to 60-ton	Haul ore to the ore bin and development waste rock to surface
Bulk pumpable emulsion	Primary explosive used for both development and production stoping
Packaged emulsion explosives	Used in small stopes where the pump units cannot access or as a backup if a unit is down for repair
Service units with man baskets	Load emulsion into drill holes
Integrated tool carriers	Install mine services and transport supplies
Shotcrete spray tractors	Shotcrete application
Pick-up trucks	Underground personnel transportation
Grader	Road maintenance

Table 5.2: Underground Mobile Equipment

6.6.2 Fixed Equipment

Major pieces of underground fixed equipment used include the following:

- Main and auxiliary fans,
- Propane mine air heaters and storage tanks,
- Ventilation doors and regulators,
- Main and auxiliary pumps,
- Air compressors,
- Portable refuge stations,
- Grizzly screen,
- Hydraulic rock breaker,
- Conveyor belt feeder,
- Conveyor belt; and
- Equipment for furnishing the underground preventative maintenance facilities, refuge stations, latrines, storage areas, and explosive and cap magazines.

6.7 Mine Facilities

6.7.1 Ventilation

Due to the ventilation requirements of the underground diesel equipment, equipment service bays, and other miscellaneous demands, the mine requires a total airflow of 930,000 cubic feet per minute (cfm).

Three fresh air intakes are used: the 1525 portal, 1875 portal, and 2150 portal. Each portal is equipped with two propane burners to heat the incoming cold air in winter to prevent temperatures from dropping below freezing inside the mine.

Exhaust air exits the mine from the 1690 portal and the 2150 ventilation raise. To ensure proper airflow, two 400 horsepower (hp) fans are installed in bulkheads along the 1690 conveyor / exhaust drift in conjunction with two 200 hp fans located in the 2150 ventilation raise access at the bottom of the raise. Ventilation doors, auxiliary fans, ventilation tubing, and regulators are installed as the mine is developed to direct appropriate air quantities to the various work areas.

6.7.2 Conveyor

A 42-inch wide by 2,500-ft long conveyor, approximately 1,200 ft of which is located underground in the 1690 conveyor ramp, conveys ore from the underground ore bin to the mill. The surface portion of the conveyor transports the ore to a 1000-ton (live capacity) storage bin located adjacent to the mill.

The conveyor's drive head pulley is in an enclosure at the top of the 1,000-ton storage bin, while the conveyor's vertical gravity take-up is located in the mine. The conveyor is suspended from metal hangers for its entire underground length to facilitate clean-up.

The conveyor is anchored at intervals along one side of the drift wall and vehicle access is provided along the length of the conveyor drift. Above ground, the conveyor is elevated and housed in a prefabricated tubular gallery that also carries mine services.

A self-cleaning magnet is located near the ore bin apron feeder and is designed to remove any ferrous metal that may harm the conveyor or downstream process equipment. A second conveyor transfers ore from the storage bin to the mill.

6.7.3 Underground Equipment Maintenance

Mine equipment maintenance is performed both underground and at the surface. Two underground preventative service bays have been developed in the mine for minor repairs. All major equipment repairs are performed in the surface shop.

6.7.4 Electrical Distribution System

Electrical power is delivered to the mine from the surface substation at 13.8 kV. The 13.8 kV power cable is fed into the mine through the 1525, 1690, and 2150 portals. Distribution centers are located throughout the mine to convert the power to 480 volt (V) for mine equipment and auxiliary ventilation.

6.7.5 Underground Communications

The mine is served by a leaky feeder system that enables communication via vehicle mounted radios in all mobile fleet and portable hand-held radios. All refuge chambers contain hand-held radios. By fall of 2020, extended runtime battery backups will be added to the leaky feeder system, which will keep it fully operational up to 24 hours after a power failure.

A fixed telephone system is installed in the mine as a backup system, with telephones located at each refuge station and electrical transformer.

The mine is equipped with a stench gas emergency warning system, which can be initiated at any of the main ventilation intake portals (i.e.1525, 1875 & 2150 portals).

6.7.6 Compressed Air

Compressed air for drilling, pumps and the maintenance shops is supplied by electric air compressors installed at the 1525 & 2150 portals. Compressed air is distributed to the primary development drives primarily through 4-inch diameter pipes and to the stopes through 2-inch pipes. When the stopping lift is complete, compressed air lines installed in the stope access drifts and stopping areas are recovered and re-used for subsequent stope lifts.

6.7.7 Service Water

Mine service water is distributed throughout the mine in 4-inch pipelines suspended in the upper corner of the ramps. The pipelines are reduced to a 2-inch diameter in the stope accesses and stopes. When a stopping lift is completed, water lines installed in the stope accesses and stopping areas are recovered and reused in subsequent stope lifts.

A mine service water recycling system is located near 1230 mine sumps underground. It filters the sump water to reuse again as mine service water.

6.7.8 Refuge Stations

Mine Safety and Health Administration (MSHA) requires refuge chambers in areas with limited egress during an emergency. There are currently two distinct styles of emergency escape chambers in use:

- Semi-permanent refuge chambers are installed at key locations throughout the underground workings and are equipped as per MSHA and 30 Code of Federal Regulations (CFR). First aid equipment and other necessities are provided. There are currently twelve semi-permanent refuge chambers positioned underground with an additional three semi-permanent refuge chambers slated for installation by the end of 2020.
- Portable entrapment chambers are located underground at locations where an entrapment hazard is present (i.e. a dead-end heading where the only way out is potentially blocked by working equipment). These entrapment chambers are designed to be highly mobile and change locations on a shift by shift basis due to the needs of the operation. There are currently six portable entrapment chambers supporting underground operations.

6.7.9 Emergency Egress

Personnel typically exit the mine through the 1875, 1525 & 2150 portals. In an emergency, the 1690 portal may also be used. Underground there are numerous ventilation raises with manway ladders to facilitate egress from specific locations.

6.7.10 Fueling

Surface storage near the 1875 and 1525 portals supplies the trucking and light vehicle fleet. Fuel is also delivered to mining equipment via an underground mobile fuel truck for machinery that does not travel regularly to the surface.

6.7.11 Diamond Drilling

Diamond drilling is used to define the orebody and assist in access development placement, reserve estimation and short and long-range planning.

7. MILLING

7.1 Milling Facilities

Gold is recovered from the mined ore using a series of processes consisting of:

1. Grinding the ore to a fine particle size to liberate the gold contained in the ore.
2. Recovering a portion of the gold using gravity methods.
3. Floating the remaining gold and sulfide minerals using froth flotation.
4. Recovering the gold from the flotation concentrate using cyanide leach.

See Figure 6.1 in Appendix B for the Mill Process Flow Diagram.

The mill facilities are located in the Liese Creek Valley at the northwest end of the mill bench. The general layout of the plant site facilities, including the mill and paste backfill plant, is shown in Figure 6.2 in Appendix B. The mill facilities consist of two main buildings: one houses the grinding, gravity, flotation, cyanide leach and carbon in pulp (CIP) processes and the second building contains the tailings dewatering and paste backfill processes. Pogo also has an onsite assay lab to analyse samples. By-products from the assay lab are reused in the mill to maximize recycling and reuse for minimal disposal.

Operation of the Pogo mill proved that the ore is amenable to gravity recovery and approximately one third of the gold may be recovered in this manner. The use of gravity recovery and flotation allows for a smaller cyanide leach, cyanide detoxification, and carbon recovery. Reducing the size of the cyanide leach circuit in turn reduces the amount of cyanide required for ore processing.

The Pogo mill produces two types of tailings:

Tailings from the flotation circuit: Approximately 85% of the total tailings mass consists of finely ground sand and traces of sulfide mineralization. Flotation circuit tailings are added as needed to paste backfill. On average, the volume of flotation tailings in the paste is approximately 8% The remaining tailings are filtered and trucked to the DSTF. Filtered tailings are reduced to 15% to 20% moisture prior to placement. The filtrate water is recycled back into the mill process.

Tailings from the cyanide leach circuit: Tailings from the cyanide leach circuit comprise the remaining 15% of the total tailings mass. All CIP tails are used to make paste backfill after going through the cyanide detoxification circuit, ensuring that most of the sulfide minerals contained in the ore are returned to their original location.

In summary, the Pogo mill process accomplishes the following critical objectives:

- Minimizes the amount of sulfide and arsenic mineralization in the DSTF,
- Ensures that cyanide contacts the minimum amount of ore possible and that all material that contacts cyanide is isolated underground as cemented paste backfill; and
- Ensures that all cyanide-bearing solutions are treated to detoxify cyanide to the lowest practical level.

The milling unit operations are described in Sections 6.1.1 to 6.1.6 below.

7.1.1 Grinding

Ore is conveyed from the surface storage bin to a grinding circuit consisting of a Semi- Autogenous Grinding (SAG) mill and a ball mill. The ore is mixed with recycled water and is ground by the tumbling action of steel balls to produce a target particle size of 80% less than 65 microns (μm), at a slurry density of 35% solids by weight.

7.1.2 Gravity Circuit

All of the ground slurry is directed to a trash screen and then to a centrifugal gravity concentrator that separates the particles according to differences in specific gravity and recovers any "free" gold. Between 15-40% of the gold is currently being recovered in this fashion. Concentrates from the gravity circuit are leached in an Intensive Leach Reactor (ILR), and the residue is reground in a dedicated regrind mill to avoid mixing the cyanide contacted solutions with fresh material in the main grind circuit. The reground residue is then pumped as slurry to the head of the conventional cyanide leach circuit. Gold bearing solution from the ILR is pumped to the gold electrowinning circuit located in the refinery.

7.1.3 Flotation & Concentrate Regrind

After grinding and gravity concentration, the slurry reports to the flotation circuit. In this circuit, finely ground minerals are recovered according to mineral type and surface chemistry to a froth phase; this is created by frother and collector reagents in agitated and aerated tanks. The flotation process recovers the gold not collected in the gravity circuit into a sulfide rich concentrate representing about 15% (by weight) of the mill feed. This flotation concentrate is reground to a powder like consistency (target 80% passing 20 μm) to allow fine gold to be liberated from the sulfide minerals.

7.1.4 Cyanide Leach & Carbon-in-Pulp

Before entering the leach circuit, the reground concentrate is pre-aerated with oxygen from the onsite oxygen plant. The onsite oxygen plant became operational in December 2016, see Figure 6.2 in Appendix B for the oxygen plant location.

Cyanide is introduced to dissolve the gold in the flotation concentrate material. The cyanide process and streams are isolated from contact with the environment. The leached slurry is then directed to CIP tanks, where the dissolved gold is adsorbed onto activated carbon granules suspended in the pulp.

The leach and CIP circuits have two thickeners that permit cyanide solution from the CIP tailings to be recycled to the beginning of the leaching circuit. Pre-aeration and solution recycling minimize the requirement for cyanide in the process.

7.1.5 Carbon Stripping, Electrowinning, Refining

The gold-loaded carbon from the CIP circuit is periodically stripped of its gold in a carbon elution pressure vessel. Loaded solution passes through electrowinning cells and the gold is collected as sludge in the bottom of the cells as well as plated onto stainless steel wool cathodes. The gold is then removed from the cathodes by pressure washing and melted to produce gold dore. The stripped carbon is reactivated by acid washing, followed by thermal regeneration in a horizontal kiln, and recycled back to the CIP circuit.

7.1.6 Cyanide Detoxification

Residual cyanide in the CIP tailings from the cyanide leach circuit undergoes detoxification by means of a sulfur dioxide / air cyanide detoxification process. The sulfur dioxide / air process uses a mixture of sodium metabisulfite solution and air sparged in agitated tanks to oxidize the cyanide. Lime is added to maintain a slurry pH of 8.0 to 9.5, and copper sulfate is added as a catalyst. Following this process, the CIP tailings are used to make paste backfill to fill underground mine headings.

ADEC Waste Disposal Permit 2018DB0001 limits the Weak Acid Dissociable (WAD) Cyanide in the CIP tailings to be used for paste backfilling as follows: "Prior to disposal as paste backfill tailings, the CIP tailings shall be subjected to cyanide detoxification using the SO2 /air process or other suitable cyanide detoxification process approved by the department. The interstitial water samples from detoxified CIP tailings shall contain fewer than 10 milligrams per liter (mg/L) of weak acid dissociable (WAD) cyanide as a monthly average and none of the samples shall contain more than 20 mg/L of WAD cyanide".

8. POGO MINE WASTE MANAGEMENT

Pogo Mine produces a variety of wastes the majority being tailings and mine rock with lesser amounts of general construction debris and other solid waste. All CIP tailings and flotation tailings as needed are placed underground as paste backfill. The remaining flotation tailings are dewatered by pressure filtration and placed in the DSTF. At the end of 2019, an estimated 14.9 million tons of tailings and waste rock have been placed in the DSTF. It is 74% full based on a maximum design height of 350 feet and the permitted capacity of 20 million tons. Pogo is authorized under Waste Management Permit No. 2018DB0001 to dispose of waste in the DSTF, underground mine workings, waste rock, ore stockpiles, and RTP.

8.1 Paste Backfill

As described in Section 6.1, the Pogo Mine produces two tailings products: flotation tailings and CIP. CIP tailings represent approximately 15% of the total volume of milled waste material, contain most of the sulfides, and are the only waste material that contacted cyanide.

After detoxification of the cyanide leach tailings, the cyanide leach tailings are mixed together with cement and flotation tailings as required, producing "paste backfill" and placed in the mined-out stope areas underground for ground support. Placement of all the cyanide leach tailings in the paste backfill ensures safe and permanent disposal underground.

Cyanide leach tailings are temporarily stored in a tank at the mill, allowing for milling operations to continue between paste pours. If the temporary storage approaches 95% full, the mill is shut down to prevent spillage of cyanide contacted material.

8.2 Surface Tailings Treatment Facility

The surface tailings treatment facility has two separate components, the DSTF and the RTP. These components are described below.

8.2.1 DSTF

The DSTF has been in operation since February 2006. The DSTF has two distinct zones: the "shell" areas, which provide structural stability for the facility; and the "general placement area," which is used for general tailings and mineralized rock placement and which is not required to contribute strength. DSTF plan view and cross section drawings are located in the Pogo DSTF Construction and Maintenance Plan (Document Control No. PGO-ENV-005-PLA). The shell is comprised of non-mineralized development rock and compacted tailings. Through 2019 about 14.9 MTon of material has been placed at the Drystack Tailings Facility (DSTF), which includes approximately 9.4 MTon of compacted tailings and 5.5 MTon of waste rock.

The capacity of the DSTF is 20 million tons. The final DSTF diversion ditch and haul road design was prepared by SRK. In September 2013 construction was completed in three phases: Phase I: Construct new North Diversion Ditch and Haul Road; Phase II: Construct new South Diversion Ditch: and Phase III: Close Existing Diversion Ditch. The new diversion ditch channels were designed to intercept non-contact runoff from undisturbed areas upgradient of the DSTF. They were sized to convey the 1 in 200-year, 24-hour precipitation event of 4.6 inches. This design storm event is consistent with the one used to design the segments of the existing diversion system prepared by AMEC in 2004.

Shell Area

The first shell (rock fill shell) was constructed using non-mineralized rock to a width of 100 feet. Non-mineralized rock is placed in three foot lifts on the design 3:1 (horizontal: vertical) slope to construct a shell for the tailings general placement. The second shell (composite Shell 1), which has been constructed since 2009, is constructed using non- mineralized rock and compacted tailings. Non-mineralized rock is placed at the face slope in three feet lifts on the 3:1 slope to a width of 20 feet, then the tailings are placed in one foot lifts and compacted. The width of the second shell is about 150 feet. The construction of the third shell (composite Shell 2) commenced in 2011 using same method as the second shell. DSTF shell construction temporarily ceased at the end of 2012 because elevation of the shells reached the elevation of the existing haul road. Shells 2 and 3 will be completed prior to DSTF closure.

Prior to the shell construction, the toe berm was extended downstream. Approximately one foot of organics and soil was cleared and grubbed from the drystack footprint area and stockpiled for future use as growth media. A 1.5 ft thick layer of non-mineralized rock was placed as an erosion control / drainage blanket over the entire drystack footprint after grubbing is completed. A haul road along the north side of the drystack is used to access the stack. Various access points to the benches are created from the main haul road as the facility rises.

General Placement Area

Tailings and mineralized development rock are co-disposed year-round in the general placement area. The rock is encapsulated in the tailings to minimize the oxidation of any sulfide minerals present. Rock is not placed in the general placement area until there is a two-foot minimum of compacted flotation tailings covering the area. The rock is placed in nine-foot maximum lifts before another two feet of tailings cover is placed over the rock. The mineralized rock may not be placed within 50 feet from the perimeter of DSTF.

The same compaction procedures used in creating the structural shell are used in the general placement area, despite its lower requirement for structural strength. This effort aids trafficability and other operational considerations.

In winter, snow and ice are taken into consideration during construction of the general placement area. Since the performance of the DSTF does not depend on quality compaction in the general placement area, tailings and mineralized rock may be mixed with small amounts of snow and ice prior to placement; however, all reasonable attempts are made to minimize the amount that becomes buried in the stack. Clean snow may be removed from the DSTF after significant snowfall events.

Access to the general placement area is via a haul road between the plant site and DSTF. As construction of the DSTF continues, this haul road is progressively buried.

Perimeter of DSTF

Non-mineralized waste rock is placed at the perimeter of DSTF to allow any runoff from precipitation that bypasses the major diversion ditch above the site is lead to the flow-through drains. All flows or seepage from the drystack passes to the RTP and treated as necessary.

Compaction Requirements

The tailings are placed and compacted in accordance with the Pogo DSTF Construction and Maintenance Plan (PGO-ENV-005-PLA).

Sedimentation Control

Drystack erosion translates into a sediment load in the RTP, thus specific sedimentation control measures are used to keep erosion to a minimum. These control measures have proven effective as very few tailings have reached the RTP. To achieve these results at Pogo, the following measures described below are taken.

<u>Drystack Geometry:</u> The use of two percent slopes to limit erosion on the DSTF. The slope face of the shells is covered with non-mineralized rock to minimize the erosion at the slope face.

<u>Drystack Compaction:</u> Both the shell area and general placement area are compacted, but the shell area is the most erosion resistant.

<u>Equipment Operations:</u> The DSTF shells are developed as a combination of terraces to prevent equipment from causing erosion.

<u>Managing Runoff:</u> Silt fences are used for erosion control as necessary.

Dust Control

Tailings have the potential to create dust, especially when they have been frozen or desiccated by the sun. The DSTF is not overly exposed to sun, and wind velocities are lower than on adjacent ridges.

Best management practices are used to control dust during DSTF operations such as: regular compaction of the tailings to minimize exposed surface area, maintaining minimum moisture content for the tails (also operational benefit), controlling traffic on the drystack, and limiting the use of equipment to active placement area(s) only. Summer moisture from rainfall assists in keeping the surface moisture content within an acceptable range although prolonged periods of warm weather with low humidity may require building silt fences around non- active placement areas.

Surface Water Management

Flow-through Drains

All runoff in and around the DSTF is directed to the RTP by means of a network of ditches and drains. Flow-through drains are constructed in the existing stream valleys within the drystack area to augment the existing drainage courses and allow them to pass residual water from precipitation beneath the DSTF. The capacity of the drains is significantly greater than the previously measured flows in Liese Creek before DSTF construction.

The rockfill used in the flow-through drains is between 12-inch and 36-inch in size and covered with a filter material to prevent fines migrating in from the drystack tailings. The rockfill is placed at about 1H:1V, resulting in a drain base width of 21 ft, crest width of 9 ft and height of 6 ft. The corresponding flow capacity of such a drain is approximately equivalent to a 1:10,000-year/24-hour storm event with no allowance for freeboard and without the benefits of the diversion ditch.

Monitoring

Bi-annual survey records of the DSTF, truck loads, and tonnage data are documented. Visual inspections are recorded and performed daily. Annual surveys to confirm placement rates and current capacity of the DSTF are conducted during the summer and fall.

Geotechnical monitoring is conducted at the shell area in order to confirm that the DSTF is compacted as designed. This monitoring includes geotechnical testing such as Standard Proctor Test, particle size distribution and Atterberg Limits, and in-situ density and moisture content evaluations. Additional information regarding monitoring of the DSTF is found in the Pogo DSTF Construction and Maintenance Plan (PGO-ENV-005-PLA).

8.2.2 Recycle Tailings Pond (RTP) Facility

The RTP is designed to collect and store seepage from the DSTF so that it can be treated before discharge. The RTP also collects all runoff from the DSTF and provides adequate retention time to remove solids.

The RTP dam has a maximum storage capacity of approximately 43.6 million gallons (Mgal) and is permitted for a crest elevation of 2092 ft amsl. The dam is a membrane lined rockfill embankment with a hydraulic height of 67 feet. The dam crest is 35 feet wide and extends over a distance of 550 feet. The sharp crested weir located in the spillway inlet is at elevation 2084 ft amsl. The spillway is engineered to allow a maximum discharge capacity of 440 cubic feet per second (cfs). The spillway intake structure is constructed from reinforced concrete and discharges into a channel lined with a corrugated steel pipe. This channel is approximately 600 feet long and subsequently discharges into a rip rap outfall located in a channel that would return flows to Liese Creek in the event of spillway operation. A grout curtain located beneath the upstream toe of the dam was installed to limit seepage through the foundation bedrock while the use of a composite liner on the upstream face of the dam was installed to limit seepage through the dam embankment in 2012. During normal dam operations, water is pumped from the reservoir via two HDPE pipes emptying into a head tank located north of the dam. The RTP is operated in accordance with the Pogo RTP Operating and Maintenance Manual (PGO-ENV-008-MAN).

The required volume for the RTP Dam is 25 million gallons to accommodate a 10-year, 24-hour precipitation event (corresponding precipitation is 2.8 inches) with a maximum volume of water for mill operation during this event.

Seepage collection wells (SCW) are installed 150 ft downstream of the drystack toe to capture seepage and return it to the RTP. Five wells are currently functional and consist of four deep wells (SCWs 5-8; ranging in depth from 60 to 70 feet) and one shallow well (SCW 9 at 13 feet total depth). Water collected by the SCWs is returned to the RTP via HDPE pipeline. The original four original SCWs 1-4 (never brought online) were plugged and abandoned in 2011.

Four water monitoring wells are installed 330 feet downstream of the seepage collection wells below the RTP dam. For more information on the RTP facility and general site water management, refer to Section 8.

8.3 Food Waste Storage / Burn Pit

Food waste from site is stored across the Goodpaster River Bridge in 40-foot containers surrounded by a chain-link fence during summer months (April through October). The fence isolates a 2,000 square foot area from wildlife to minimize potential human and wildlife interactions. Food waste containers are placed near the incinerator in winter months for easier access potential wildlife interactions are minimal.

A burn pit, near the gravel ponds in the lower camp, is used to dispose combust clean wood and cardboard. The ash is removed and disposed in the drystack. A burn permit is obtained on a yearly basis from ADNR.

8.4 Waste Rock Storage

Underground trucks bring waste rock to the surface for temporary storage near each portal. Surface haul trucks move mineralized rock to the drystack general placement area. Non-mineralized rock is hauled to various areas around the mine site where it is used. Excess non-mineralized material is stored near the airstrip.

8.5 Hazardous Waste / Other Waste

Pogo Mine is large quantity hazardous waste generator. All hazardous waste is temporarily stored in secured covered buildings and shipped off-site for disposal. Pogo Mine generates other solid wastes including empty plastic and glass containers, office supplies, paper, used oil and tires, scrap metal and universal waste. All materials are temporarily stored and shipped off-site for recycling and/or disposal.

9. WATER MANAGEMENT

9.1 Overview

The purpose of the Pogo Mine Water Management Plan is to provide a framework for the collection and treatment of water to achieve the following objectives:

- Ensure the reliability of water supply for all process and potable needs,
- Protect the operations from flooding, erosion, interference from groundwater, precipitation and runoff; and
- Control and treat water that comes into contact with project facilities in an environmentally sound manner before discharge.

For additional background, refer to the Pogo "Water Management Plan" (February 2002 and June 2002).

Pogo is permitted to discharge treated water up to 800 gpm according to APDES Permit No. AK0053341. Mine Water Treatment Plant #3 (MWTP#3) was installed in 2016 and treats all underground and RTP water on site. The groundwater or mine inflow has increased as the mine expands. The current inflow average is 400 gpm; however, an underground seepage flow analysis conducted in 2012 estimated that the inflow rate could increase up to 650 gpm.

An underground recycle system includes a filter and pumping system installed in 2010. This system recycles underground mine water for use in underground operations and reduces the amount of RTP surface water introduced into the mine.

MWTP#3 was constructed in order to accommodate increasing mine inflow water. Pogo's overall water management strategy and various water streams, inflows, and outflows are summarized below.

9.2 Overall Water Collection, Treatment & Discharge Strategy

The major components of the overall water collection, treatment, and discharge strategy for the project are shown in Figure 8.1 in Appendix B. MWTP#3 construction began in 2014. MWTP#3 discharges to the final tank where the water can either be returned to the mill via RTP Head #1 Tank or discharged to the Off-River Treatment Works (ORTW). In case of an emergency, treated water can be pumped to the RTP for storage. Pogo Mine is capable of continuously monitoring the treated effluent for pH, turbidity, and conductivity. Plant performance is monitored using these parameters, allowing for the automatic shutoff of any discharge during process problems.

MWTP#1 has been fully decommissioned and is no longer in operation. MWTP#2 is non- operational, however, can be used in case of emergency and backup purposes.

9.3 Process Water

The mill is designed to maximize the recycling of water (see Figure 8.2 in Appendix B). The only water released from the process is to the tailings as part of the paste backfill or as residual moisture in the surface drystack. Additional water necessary to make paste backfill or flush the paste lines is pulled from the RTP or detoxified process from water in the mill.

The total process water requirement is 147 gpm at 3,000 STpd. Make up water from external sources is used to replace the water entrained in the tailings material. In order of priority, mine drainage water, RTP water and lastly fresh water is used to satisfy this requirement.

9.4 Mine Water

Mine water inflows are highly variable depending on the geology and hydrogeology of active stopes and ramps in the mine. Underground water management is an important component of the operation of the Pogo Mine.

Since underground development commenced in 2004, the mine seepage gradually increased from about 60 gpm in mid-2006 to 150 gpm in mid-2011. It increased significantly from 150 gpm to 275 gpm in July - August 2011 and remained relatively constant from September 2011 to August 2013 with an average flow rate of approximately 290 gpm (varied from 210 gpm to 360 gpm). The increase of mine seepage in mid-2011 was interpreted to be due to the intersection of a highly transmissive water bearing portion of the D3_3 fault zone (Liese Creek and Graphite Faults) and contact with the southern margin of the diorite intrusive.

Pogo began a hydrogeological characterization in 2012 in order to rebuild the groundwater flow model. The original model was established in 2002 and was updated in 2009 (Brown 2009). The current model includes the East Deep zone. The final model was released by SRK in May 2014 (Hydrogeological Characterization Report, Pogo Mine, Alaska). The expected inflows to the mine are summarized in Table 8.1.

Water Management Strategy *	**Average Inflow**	
	Current	**EOY 2022**
Inflow to Mine Under Base Case	420 gpm	400 gpm
Inflow to East Deep	95 gpm	100 gpm
Inflow to North Zone	14 gpm	14 gpm

Table 8.1: Expected Mine Inflows

*SRK 3-D numerical Groundwater Flow Model to Include East Deep Expansion

Pogo began an underground grouting program in 2009 which controlled and minimized underground seepage. As part of the program, grout is applied to the water bearing faults such as Liese Creek ahead of advancing drifts. When water inflow is found in the drift, 60 feet long grout holes are drilled using a drill at the perimeter of drift, followed by a fine ground cement mixed with water pumped into the holes at high pressure using a grout pump through mechanical packers set at the collar of grout holes. Typically, two check holes are drilled after 24-hr curing time. Secondary grouting may be conducted if water inflow still exists. After completing the grouting procedure, the drift is advanced by 40 feet and is progressively grouted. If the water inflow remains uncontrolled by grouting, this excavation may be abandoned and backfilled.

9.5 Surface Water & Runoff

All surface water and runoff from the plant site and DSTF is collected in the RTP immediately downstream of the DSTF. A system of monitoring wells is installed downstream of the RTP to monitor the performance of the RTP seepage collection system.

To minimize the amount of precipitation and runoff that comes into contact with project facilities and then drains to the RTP, a diversion ditch was constructed along both sides of the Liese Creek basin uphill of the DSTF. This ditch will be maintained throughout the life of the Pogo Mine and during decommissioning.

Storm water is controlled in accordance with the Storm Water Pollution Prevention Plan (SWPPP) and Best Management Practices (BMPs) Plan. The stormwater sump collects runoff from the haul roads, the plant site, and the campsite. The mill site and campsite pads are sloped toward the high wall, with drainage directed to the stormwater sump. The mill site and campsite pads were constructed with impervious soil in order to reduce potential infiltration of stormwater and to help direct any spills to the sump. The stormwater pumping system has a large pump capable of accomodating a 5-year/6-hour storm. Both pumps are connected to emergency standby power.

Ice is removed from the ditches before spring breakup as necessary to ensure adequate ditch capacity is available for the freshet. Potentially contaminated ice or snow removed from the mill site pad or other areas is placed so that it drains to the RTP.

9.5.1 DSTF Runoff

The RTP is designed to capture runoff and seepage from the DSTF. The design of the DSTF, placement of materials, operation, and drainage control was described in Section 6.2.1.

Samples of tailings and waste rock were collected from three boreholes within the DSTF during a drilling program initiated in October 2012. Results indicate that that waste rock and tailings are classified as non-potentially acid generating based on neutralization potential to acidification potential. Geochemical analyses of DSTF materials show that acidic drainage from the stack is unlikely (SRK, 2014, Dry Stack Tailings Facility Closure Study).

9.5.2 RTP

Water that accumulates in the RTP is used to fulfil all process makeup water requirements in the mill. RTP water is routed to the mill and the process water tank via the RTP head tanks.

9.6 Excess Water Management, Treatment & Discharge

The storage target at the RTP is 15 million gallons. This water is primarily used at the mill as makeup water. When storage is greater than 15 million gallons the water from the RTP will be treated at MWTP#3 and discharged to the ORTW. Excess water from the underground mine that can't be recycled is treated at MWTP #3 and either recycled to the mill or discharged to the ORTW.

MWTP#3 removes suspended solids, arsenic, and other metals, effluent is mixed and aerated in the ORTW before final discharge to the Goodpaster River. The water treatment process is described in Sections 7.6.1 and 7.6.2.

9.6.1 Mine Water Treatment Plant #3 (MWTP#3)

MWTP#3, commissioned in 2016, operates under a more robust microfiltration membrane system and a fifth reactor that will allow hydrogen peroxide to be added if WAD cyanide levels require more treatment.

The water treatment plants utilize four processes to remove contaminants from the water before discharge. The first process uses high-density sludge (HDS) to achieve enhanced co-precipitation of metals, including arsenic. As necessary, a second process of lime softening and recarbonation remove calcium and magnesium via precipitation and thereby reduce total dissolved solids (TDS). A third process, sulfide precipitation, is available as a contingent measure if additional treatment is necessary to achieve the expected metals concentrations. The treatment system is not sensitive to variations in feed chemistry. The final stage of treatment includes a microfiltration membrane system to polish the treated water for removal of residual suspended solids prior to release to the ORTW. Excess sludge generated by the process is dewatered using a filter press to produce a cake for disposal in the DSTF or with the paste backfill.

MWTP#3 effluent limitations for water discharged to the ORTW are available in Pogo's APDES Permit No. AK0053341 for Outfall 011.

9.6.2 Off-River Treatment Works (ORTW)

The ORTW is an in-area mixing zone and serves as the final step in the water treatment process. Details of the system are shown in Figures 8.4 and 8.5 in Appendix B. The ORTW consists of two ponds. The primary pond is connected to the river by an open channel and water is pumped from the primary to the secondary pond via a shore-based pump station and a buried steel pipe. The pump inlet screen is sized at 0.25-inch, with inlet velocities of less than 0.5 feet per second (ft/s) to prevent fish from moving into the chamber.

Effluent from the water treatment plant is discharged to the mixing chamber of the ORTW pump station, at a maximum rate of 800 gpm. Flow data collected concurrently from the MWTP#3 effluent and a flow meter at the ORTW pump station is used to control the pump output and maintain a maximum 25:1 mix ratio. The United States Geologic Survey (USGS) gauging station located near the Goodpaster bridge monitors the river flows. If winter icing conditions affect the gauging station, manual means of flow measurement are available to guide plant operations.

A mixing well and static inline mixers force the water to mix in the large steel pipe that conveys the water between the ponds. Additional mixing occurs in the secondary pond. An overflow weir in the outlet works of the secondary pond maintains a stable pond elevation and prevents fish from entering the pond from the downstream direction. At a discharge rate of up to 800 gpm from MWTP#3, the secondary pond has up to 72 hours residence time. During potential upset conditions at Outfall 011, Pogo Mine stops discharging until operations return to normal. The outlet of secondary pond provides a consistent and reliable monitoring location. The sampling facilities are located in a heated, weather-protected enclosure. The ORTW effluent limitations are available in Pogo's APDES Permit No. AK0053341 permit for Outfall 001.

9.7 Fresh Water

Fresh water from the gravel pits near the 1525 portal is added to the RTP, MWTP #3, or the 1230 sump when other sources do not adequately meet water requirements.

9.8 Non-Contact Stormwater

Material Site A below the mill was developed into a stormwater sedimentation pond for non-contact runoff. Overflow from the pond is filtered through the alluvial fill of the Road 6 embankment and diffused back into the groundwater in the Goodpaster Valley below the mouth of Liese Creek. An overflow weir controls the pond elevation to allow for storm surge modulation and sediment removal.

Well-defined practices known as "BMPs" (best management practices) are used for stormwater management to control non-contact runoff water quality. The primary parameter controlled is sediment. Refer to Pogo's SWPPP for additional information regarding stormwater.

10. REAGENT MANAGEMENT

10.1 Underground Storage

10.1.1 Supplies

Mining supplies are stored on the surface and in underground drifts. Supplies are regularly moved into the mine for mining activities. The major supplies are; roof bolts, welded wire, pipe, ventilation tubing, drill steel and bits.

10.1.2 Explosives

Explosives are hauled to the Pogo Mine by truck and bulk emulsion is stored underground in two steel tanks. Locked storage magazines are provided for caps, detonating cord, primers and boosters.

10.2 Surface Storage

10.2.1 Mill Reagents

Reagents are purchased in normal commercial bulk containers or packaging, such as tote bins, barrels, palletized sacks, super sacks, etc. These packages are loaded into shipping containers at the point of origin and shipped to the Pogo Mine to provide security and protection against spills and loss throughout the transportation process. Upon delivery to Pogo Mine, reagents are stored in a covered building adjacent to the mill (see Figure 6.2 in Appendix B) or stored in the shipping containers on site until they can be stored within the mill storage area. All covered storage areas have a concrete floor and are bermed or sloped to contain and collect any spillage and aid in clean-up.

Reagents are mixed inside the mill building in appropriate tankage before being pumped into the process. Any spills are contained within the concrete berms of the reagent area and collected in a sump for disposal or return to the process tanks.

Lime – Lime is used for controlling the slurry pH during leaching, water treatment, and cyanide detoxification. Lime is slaked in a ball mill slaker and added where required from a circulating pipe loop of hydrated lime slurry.

Sodium Cyanide – Sodium cyanide is used to dissolve gold. The cyanide is transported as dry briquettes in secure shipping containers and is stored in a reagent storage building that provides adequate secondary containment.

The contents of the cyanide mixing tank are mechanically agitated to enhance dissolution. After the cyanide has dissolved, the solution is transferred to the cyanide storage tank for distribution by centrifugal pumps to the leaching and stripping circuits.

Activated Carbon – Activated carbon is received in 1,000 pounds (lb) bulk bags and used to capture dissolved gold from the leached slurry. Carbon fines are collected and stored on site in tote bins. To recover residual gold values, these tote bins are periodically shipped to an off-site smelter for gold recovery and disposal.

Sodium Hydroxide – This chemical is used to raise the pH in the carbon stripping circuit and neutralize after carbon acid washing. The sodium hydroxide is received as pellets packaged in steel drums containing 500 lb and is mixed with water in batches to form a 20% solution. The solution is prepared in a caustic solution tank between periods of usage thereby eliminating the need for a transfer pump and separate storage tank.

Nitric Acid – Nitric acid is used to acid wash the carbon (after stripping) to remove calcium scale buildup. The acid is delivered in returnable stainless-steel drums containing approximately 100 lbs of concentrated acid solution per drum. Acid washing solution is prepared in a batch mixing tank at strength of 5% by volume. The solution is circulated through a carbon acid wash vessel using a recirculating pump system until the solution pH increases to 7.0. At this point, acid washing is complete, and the spent acid solution is pumped to the mill process. The carbon is rinsed with process water prior to being advanced to the reactivation kiln feed tank. Acid solution is prepared in a single tank between periods of usage, thereby eliminating the need for a transfer pump and separate storage tank. Various storage methods of nitric acid, including bulk totes, are in use to further improve the safety of handling the concentrated acid.

Potassium Amyl Xanthate – PAX is used as a flotation reagent to collect sulfide and gold- bearing minerals.

Clear 215 – This reagent is used as a fines depressant for controlling the flotation of silt-like particles, resulting in improved thickening and flotation performance.

Aero Maxigold 900 Promoter – This reagent is used as a flotation reagent to promote the recovery of gold-bearing minerals.

Aero 5688 Promoter – This reagent is used as a flotation reagent to promote the recovery of gold-bearing minerals.

Aero 6697 Promoter – This reagent is used as a flotation reagent to promote the recovery of gold-bearing minerals.

Aerfroth 549 or MIBC – This reagent is used as a frothing agent in the flotation circuit.

Flocculant – This reagent assists with solids settling in the thickeners of the milling process. Dry flocculant is delivered to the site in 2,000 lb bags and stored in the mill reagent area, where it is mixed using a wet mixing system.

Sodium Metabisulfite – Sodium metabisulfite is delivered in 2,000 lb supersacks for use in the cyanide detoxification circuit. It is mixed and stored in tanks in the reagent mixing area.

Copper Sulfate – Copper sulfate is used as a catalyst in cyanide detoxification. It is received in 2,000 lb supersacks and dissolved in the copper sulfate tank as a 25% solution. The solution is metered from this tank to the SO2/air cyanide destruction tanks.

Fluxes – Fluxes are used in the gold refining process. Anhydrous borax, sodium nitrate, soda ash, manganese dioxide, and graded silica sand are received in 50 to 100 lb bags or drums. These fluxing agents are used directly from their containers to refine gold concentrates into bullion. The containers are stored in the gold refinery.

Water Softening & Anti-scalant Agents – Water softening and anti-scalant agents are used in the mill to treat process water and prevent scaling in pipes. These chemicals are received as prepared concentrated solutions in drums and used as required via liquid metering pumps.

10.2.2 Grinding Media

Grinding balls are delivered in open containers and emptied into ball bunkers situated near the grinding mills. SAG mill grinding balls are loaded to a ball feeder situated over the mill feed conveyor. The ball mill grinding media are loaded through a ball hopper.

10.2.3 Fuel & Propane

Information on fuel storage is found in the Pogo Mine Spill Prevention, Control, and Countermeasures (SPCC) Plan (PGO-ENV-006-PLA). Fuel is trucked to site from various suppliers on an as needed basis. Fuel piping is above ground as much as practical, and all piping is either in lined containment or underground inside secondary piping.

The site has three stationary fueling areas located at the Lower Camp Tank Farm (LCTF), 1525 Portal area and 1875 portal area. Each have all been constructed of earthen berms with impermeable liners providing containment for at least 110% of the volume of the largest tank.

A fuel truck is used to deliver fuel from the main storage tanks to remote equipment and smaller storage tanks on the site. Fuel is pumped for delivery with appropriate automatic shutoff devices.

Smaller tanks with secondary containment are located at the mill building and the camp. These tanks are filled by the fuel truck and are used for fuelling heaters and backup generators. The total above ground diesel fuel storage capacity is 265,340 gallons.

Up to 60,000 gallons of propane storage is provided near both the 1525 Portal and the 1875 Portal. In addition, two 30,000-gallon propane tanks are located at the 2150 portal. These tanks supply the mine air heaters and typically are full only in the winter months. The upper camp has one 2,500-gallon tank for the kitchen facilities. Lower camp has one 15,000-gallon tank which is used to fuel the incinerator when operational. One 750-gallon tank is used to heat the mine dry. A total of 198,250 gallons of propane storage is provided on site.

11. SUPPORTING DOCUMENTS

Supporting documents for monitoring, operation, and maintenance for several key features of the mine are listed in Table 10.1.

Table 10.1: Supporting Documents

Document Name	Document Number	Description
Quality Assurance Project Plan	PGO-ENV-039-PLA	Defines procedures that assure the quality and integrity of collected samples, representativeness of results, precision and accuracy of analyses, and the completeness of data.
Pogo Mine Monitoring Plan	PGO-ENV-011-PLA	Addresses the monitoring requirements of several permits and regulations, and includes a visual monitoring plan, fluid management plan, and water sampling monitoring plan.
Pogo DSTF Construction and Maintenance Plan	PGO-ENV-005-PLA	Provides the steps required to construct and maintain the DSTF as designed.
Pogo RTP Operation and Maintenance Manual	PGO-ENV-008-MAN	Addresses operating and monitoring procedures for the Recycle Tailings Pond Dam and reservoir under normal and usual conditions, and provides guidance and procedures for monitoring, maintenance, and routing inspection for the dam.
Pogo Spill Prevention, Control and Countermeasures Plan	PGO-ENV-006-PLA	Describes facility's oil storage and handling procedures.
Pogo Mine Reclamation and Closure Plan	N/A	Guides operations to ensure objectives for reclamation and closure are achieved

12. TEMPORARY SHUTDOWN

Planning for potential shutdowns is an integral part of good mine management. At some point, the operation may shut down for a short period (less than three months) during the life of the mine. Short-term shutdowns occur due to events such as major equipment breakdowns or weather-related interruptions. Long-term, but still temporary (between three months and three years) shutdowns usually only occur in response to economic changes, such as a prolonged decline in the price of gold. These types of events are much less likely to occur but Pogo has also been designed to accommodate such eventualities. Permanent shutdown occurs at the end of the mine life.

12.1 Short-Term Shutdown Plan

During a short-term shutdown, the following activities are carried out:

- Continue to treat and discharge water,
- Continue all monitoring requirements,
- Continue maintenance of storm water ditches,
- Shut down mill and filter plant and prepare to resume operations as soon as mining recommences; and
- Shape stockpiles to minimize erosion.

These and other maintenance activities keep the facility in good operating order for when the interruption is remedied, and operations are ready to resume.

12.2 Long-Term Shutdown Plan

In the event of a long-term shutdown, a minimum staff continues to maintain and preserve the facility until it can be restarted. The long-term shutdown plan for the Pogo Mine involves the following activities:

- Draw down the RTP to a minimum volume,
- Treat and eliminate all process solutions,
- Shut down the mill and filter plant, draw down all process tanks and vessels, and mothball major equipment to preserve their mechanical condition,
- Flush and clean all process lines and instrumentation, protect all electronics and sensitive equipment,
- Secure the mill, filtration plant and mine and continue to treat water as necessary,
- Continue to maintain storm water system including diversion ditch,
- Implement possible mitigation measures such as grouting and paste backfilling of mining stopes to minimize mine water inflows; and
- Install erosion protection on all stockpiles, dumps, site areas, etc.

Long-term shutdown practices allow the mine and plant to be restarted after a commissioning period, wherein equipment is reassembled and restarted, reagents reintroduced, electrical and control systems re-energized, and production activities resumed. All monitoring and reporting requirements required under the various Pogo Mine permits will be met.

13. RECLAMATION

Reclamation and closure are an integral part of the mining operations plan, providing guidance during the operational life of the mine to ensure that post-mining land use goals are achieved and that the waters of the state are protected. Detailed reclamation plans are provided in Pogo Mine's Reclamation & Closure Plan (Pogo Reclamation and Closure Plan, 2017). The Reclamation and Closure Plan describes a conceptual model for post-mining land use and provides the basis for reclamation and closure activities throughout the life of the project.

There are three critical reclamation and closure issues for the Pogo Mine:

- Successful stabilization and erosion control on steeply dipping slopes,
- Closure of the DSTF; and
- Closure of the underground workings.

Reclamation of the Pogo Mine focuses on establishing post-mining land use in the area. This involves re-grading, surface amendment, re-establishing surface water drainage and re-vegetating. Closure of the Pogo Mine focuses on stabilizing all development rock, tailings and underground workings in order to control or mitigate any seepage and prevent degradation of surface or groundwater.

The reclamation activities are separated into the following five phases:

- Phase I Reclamation of construction disturbance,
- Phase II Reclamation with concurrent mining,
- Phase III Final reclamation and closure of mine site,
- Phase IV Water treatment and post-closure reclamation; and
- Phase V Post-closure monitoring.

14. REFERENCES

- Teck Cominco, Water Management Plan and Appendices, June 2002
- SRK, Sobek Acid-Base Accounting Test Results, November 5, 2008
- SRK, Review of Arsenic Concentrations in Dry Stack Tailings, January 10, 2009
- ADEC Permanent Camp Public Water System Final Operation Approval, PWSID: 372685, February 4, 2009
- Adrian Brown, Pogo Mine Inflow Evaluation and Control Review, April 5, 2009
- Golder Associates, Surface Paste Distribution Containment Pipeline System, May 21, 2013
- SRK, Hydrogeological Characterization Report, Pogo Mine, Alaska, May 2014
- SRK, Pogo Mine Reclamation and Closure Plan, 2017
- ADEC Pogo Lower Camp Approval to Operate, PWSID: 372643, August 16, 2017
- Alaska Department of Environmental Conservation Waste Management Permit 2018DB0001, November 1, 2018
- Alaska Pollutant Discharge Elimination System Individual Permit AK0053341, November 1, 2018

15. APPENDICES

Appendix A – Pogo Mine Claim List

Appendix B – Figures

Figure 1.2 General View of Pogo Development

Figure 1.3 Pogo Mine As-built April 2020 Pogo Plan of Operation

Figure 1.3a: 1525 Portal Area As-built

Figure 1.3b: Airstrip Area As-build

Figure 1.3c: Mill and Camp Bench Area As-built

Figure 1.3d: RTP and Drystack Area As-built

Figure 1.3e: 2150 Portal Area Plan

Figure 1.4: Growth Media Stockpile Locations

Figure 4.1: Pogo Access Road and Transmission Line

Figure 6.1: Mill Process Flow Diagram

Figure 6.2: As-built Mill Plant

Figure 8.1: Conceptual Water Management Flows

Figure 8.2: Process Flow Diagram with Water Use

Figure 8.3: RTP Dam As-built

Figure 8.4: Off-River Treatment Works

Figure 8.5: Off-River Treatment Works Pump Lift Station & Outlet Structure