SOIL TREATMENT FACILITY MANAGEMENT PLAN

Ulu Gold Project

Kitikmeot Region, Nunavut

March 2020

BLUE STAR GOLD CORP.

PLAIN LANGUAGE SUMMARY

This plan describes operation and maintenance required for the facility designed to treat soil contaminated with petroleum hydrocarbons (petroleum, oils etc.) at the Ulu Gold Project area, near Kugluktuk, Nunavut.

REVISION HISTORY

Revision #	Date	Section	Summary of Changes	Author	Approver
1	March 2020	-	New document	SRK	P. Kuhn

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1.0 INTRODUCTION

The Plan is intended exclusively for use by Blue Star Gold Corp. (Blue Star) and its contractors to ensure that best practices for minimizing potential environmental impacts and potential environmental liabilities during the remediation of hydrocarbon contaminated (PHC) soils are followed, and that the conditions of the water licences are met, and should be read in conjunction with the documents listed in Table 1.

Table 1 Related project documents, permits and licences.

Document	Authors
Engagement Plan (2020b)	Blue Star Gold Corp.
Spill Response Plan (2020c)	Blue Star Gold Corp.
Wildlife Protection Plan (2020)	Environmental Dynamics Inc.
Interim Closure and Reclamation Plan (2020a)	Blue Star Gold Corp.
Waste Management Plan (2020b)	Blue Star Gold Corp.
Interim Water Management Plan (2006)	Gartner Lee Ltd.
Mineral Claim	Government of Canada
Screening Decision Report	Nunavut Impact Review Board
Water License	Nunavut Water Board
Land Use License	Kitikmeot Inuit Association

1.1 SCOPE

The Soil Treatment Facility (STF) Management Plan (the Plan) provides information on how contaminated soil will be handled in a safe and environmentally sound manner at the Ulu Gold Project, Nunavut (the Site). The purpose of this Plan is to provide a consolidated summary on the operations and closure of the soil treatment facility to be used to treat PHC contaminated soil generated by previous operators. The Plan allows for the aggressive treatment of the PHC contaminated soil when the site is occupied and a more passive approach to treatment during periods of inactivity at the Site.

1.2 OBJECTIVES

The objectives of this Plan are to:

- Ensure employees and contractors are aware of their responsibilities regarding operations and maintenance of the soil treatment facility;
- Outline appropriate operation and maintenance requirements of the facility from initiation to closure; and
- Support safe and compliant waste facility operations and maintenance.

1.3 SITE DESCRIPTION

The Ulu Gold Project is located on Inuit-owned land in the Kitikmeot Region, Nunavut, within the Hood River watershed. It is located 126 km north of the Lupin Mine (Figure 1).

The mineral claims holding the Ulu deposit were initially staked in 1988. Portal excavation at the Ulu site commenced in 1996 to confirm resource calculations and mining design for mill feed to the Lupin Mine. Equipment to construct the camp and develop the mine was mobilized to site via a winter road from the Lupin mine in 1996. Camp 3 was built at the esker sand quarry to facilitate construction of the airstrip, road and underground exploration site. It included tent accommodations, a garage and a fuel tank farm.

Camp 3 was reclaimed in 2018/2019. Underground development of the ramp ceased in August 1997 at the 155m level. The existing facilities at the Ulu underground exploration site consist of a 20-person camp with sleeping and dining quarters, a 22 m by 37 m vehicle repair shop, fuel containment areas (tanks removed in 2018) for bulk diesel and day tank storage, core storage area, core shack, and fuel staging area. An upset estimate of 6,700 m^3 of PHC contaminated soil was identified in the vicinity of former fuel tank farms and the repair shop based on a 2019 contaminated soil site assessment (SRK 2020). It is estimated that 4,000 m^3 of the material identified as PHC-contaminated will require treatment within the STF; with the remainder meeting subsoil remediation guidelines being managed by burial and the soil with oil and grease impacts being packaged for backhaul and transported off-site for treatment.

The Project is located within the Southern Arctic Ecozone and the Takijuq Lake Upland Ecoregion. Much of this region is composed of unvegetated rock outcrops. Vegetative cover is characterized by shrub tundra, consisting of dwarf birch, willow, northern Labrador tea, avens species and blueberry species. Organic Cryosols are the dominant soils in the lowlands and permafrost is deep and continuous (ECCC 2019).

Based on regional normals from Lupin A station between 1980 and 2010 (ECCC, 2020a), average yearly rainfall in the region is 160 mm, mostly occurring during July and August, and average yearly snowfall is equivalent to 138 mm of water, most of which falls during autumn and spring. The average temperature in a year is -10.9 ° Celsius.

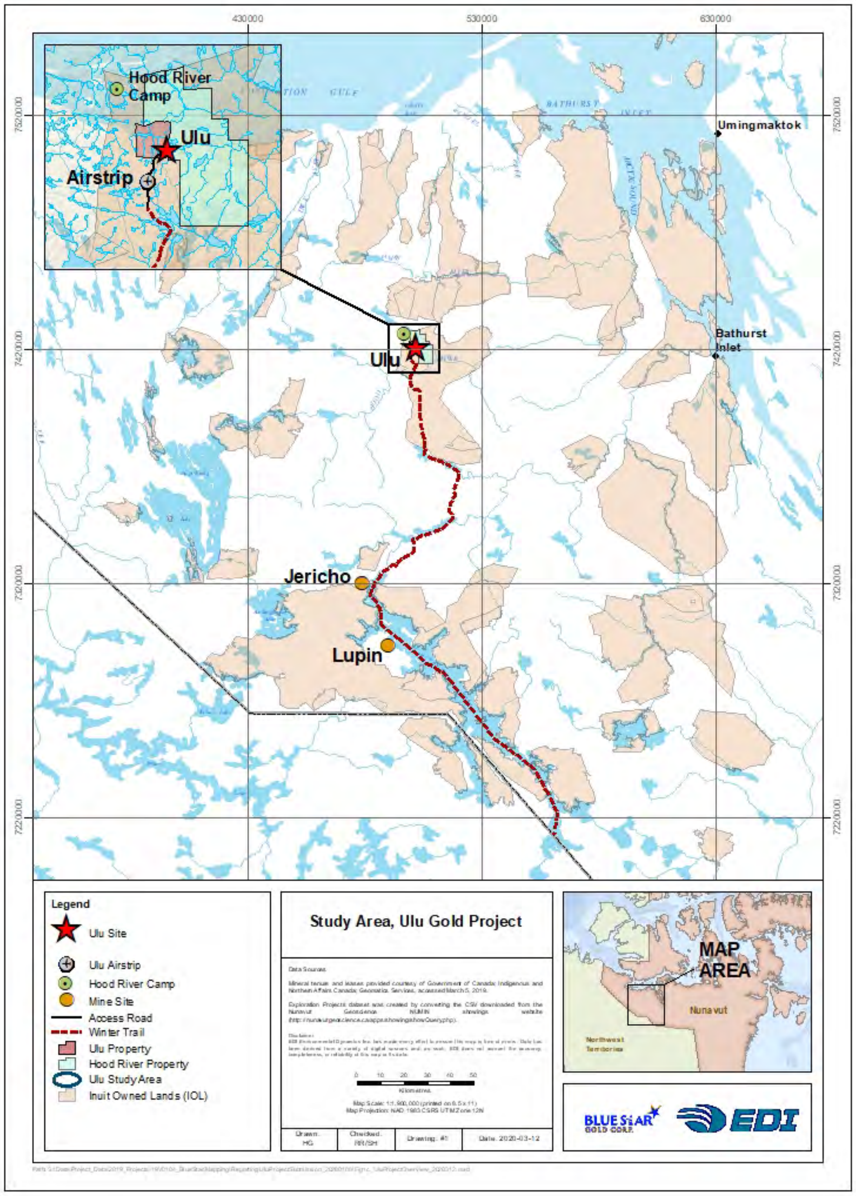

Figure 1 Ulu Gold Project Location Map

1.4 OVERVIEW

Soil treatment (also known as landfarming) is a form of bioremediation that uses naturally occurring micro-organisms contained in the soil (yeast, fungi or bacteria) to metabolize or break down PHCs. Natural processes include volatilization, aeration, biodegradation and photolysis. End products are micro-organism protein, carbon dioxide and water. Stimulation of microbial growth and activity for hydrocarbon removal is accomplished primarily through the addition of air and nutrients (metabolism of hydrocarbons is mediated predominantly through aerobic microbes). The treatment of contaminated soil is restricted to the warmer months when the soil is not frozen or covered with snow. Piles of soil being actively stimulated are referred to as biopiles.

The location for the STF is identified as illustrated in Figure 2. The STF location is favorable due to the level platform on the ore pad, which minimized the quantity of preparation work and natural ground disturbance required for the facility as well as meeting the criteria outlined in the design memorandum in Appendix A. Figure 2 also shows the proximity to access roads, the nearest water body and remediation works.

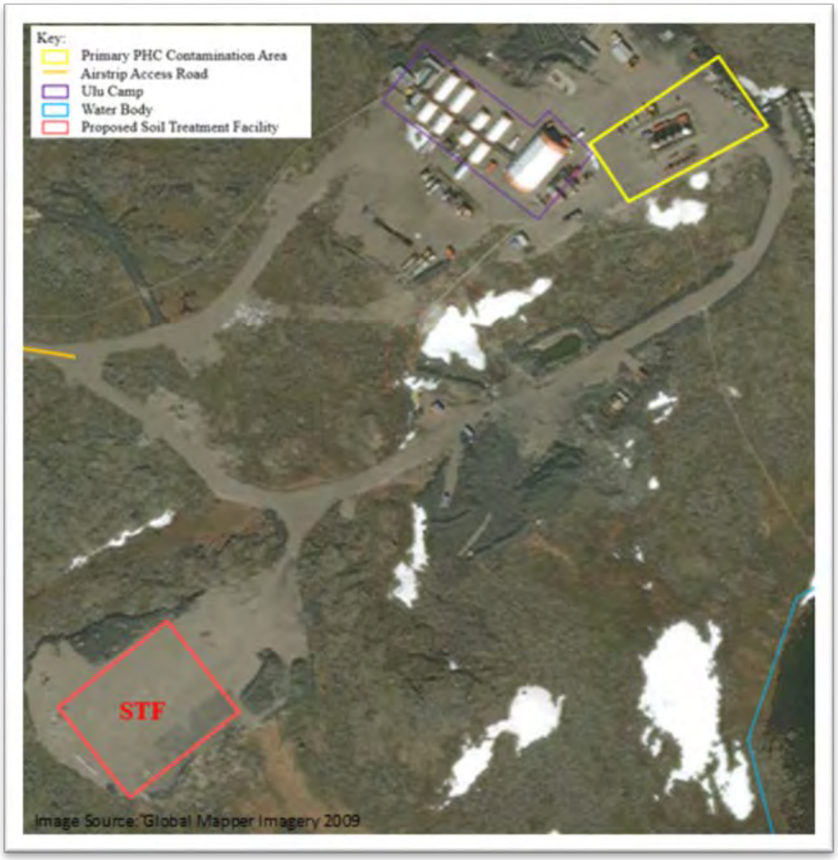

Figure 2 Soil Treatment Facility Overview

1.5 Plan Management

The Plan is reviewed annually by Blue Star's General Manager and updated as needed following receipt of or amendments to licences and permits, to ensure alignment with relevant terms and conditions. When material changes occur, the updated document will be provided to parties in accordance with the *Engagement Plan* (Blue Star 2020b).

1.6 Plan Implementation

This Plan is effective upon approval and is valid throughout all phases of the Project.

The General Manager or Remediation Project Manager is responsible for Plan implementation.

A copy of this Plan is maintained on site in the Office, while the camp is open.

2.0 ROLES AND RESPONSIBILITIES

Blue Star is responsible for activities associated with the Ulu Gold Project, including implementation and management of this Plan. Blue Star's contact information is provided below.

Blue Star Gold Corp.
Suite 1125-595 Howe Street
Vancouver BC V6C 2T5
Contact: Peter Kuhn, General Manager
Phone: 1 604 347 6999
Email: kjgold2010@gmail.com

2.1 STAFF, CONTRACTORS, SUPPLIERS AND VISITORS

All personnel conducting activities on site, including staff, contractors, suppliers and visitors, are required to be guided by this Plan as it pertains to their activities on site. Specifically, these responsibilities include:

- Take all necessary steps to minimize negative effects to water, land and air;
- Cooperate fully with your supervisor and/or Blue Star management to implement an environmental protection program in your work area;
- Only carry out duties and tasks that you are experienced at and trained to perform;
- Where there is uncertainty, ask questions and bring concerns to the attention of your supervisor when working with products or conducting tasks that may pose potential environmental risks;
- Report wildlife observations, archaeological finds, spills and emergency situations in accordance with relevant management plans.

2.2 MANAGERS AND SUPERVISORS

Managers and supervisors have a responsibility to ensure that staff, contractors, consultants and visitors have been trained in Blue Star environmental and heritage resource protection expectations and procedures. Additional supervisor and manager responsibilities include:

- Maintain a no blame work environment in implementing mitigation measures and follow-up actions;
- Ensure site-, task- and material-specific training is provided to all departments and staff;
- Ensure there are appropriate and sufficient supplies on site to support implementing mitigation measures and follow-up actions;
- Provide assistance in responding to environmental hazards;
- Maintain records regarding inspections, personnel training, equipment testing and maintenance; and
- Engage with relevant parties in a timely and transparent manner, where appropriate.

2.3 REMEDIATION PROJECT MANAGER

In addition to the responsibilities listed above the Remediation Project Manager is responsible for:

- Overseeing soil handling, transport, sampling and management in accordance with this Plan;
- Day to day oversight of all related remediation efforts;
- Coordination with other managers and supervisors to ensure safe and appropriate allocation of resources on site; and
- Maintaining the remediation schedule, and where schedule changes occur, advising the General Manager in a timely manner.

3.0 Soil Treatment Facility Operating Procedure

3.1 BASELINE SAMPLING

Prior to construction of the STF, soil samples must be taken from the foundation to establish baseline soil conditions. A minimum of 5 samples must be taken in a grid pattern across the facility footprint by a Qualified Professional and analyzed for PHC fractions F1 to F4, benzene, ethylbenzene, toluene, xylenes (BETX), styrene and polycyclic aromatic hydrocarbons (PAH). Samples will then be taken post closure to assess and confirm contaminants have not leached from the soil storage cells during operations.

Prior to loading the STF with PHC contaminated soil, water samples are to be collected and tested for BETX, styrene, F1, F2, PAH, dissolved metals, pH, alkalinity, chloride, sulphate, turbidity, conductivity, total suspended solids, ammonia, nitrite and nitrate from the monitoring wells and any seeps identified in the vicinity of the facility. Groundwater monitoring and monitoring well locations are presented in Section 1.21.

3.2 MATERIAL SELECTION AND SOIL SAMPLING

The facility operators must know the material being placed within the facility in order to optimize the treatment protocol. Soil containing untreatable contaminants must not be placed within the facility; accordingly, sampling must be undertaken throughout all phases of soil management, as summarized below in Table 3, to ensure all material allocated for the treatment facility are confirmed acceptable prior to placement within and removal from the facility. For further detail, refer to the soil excavation and sampling methodology found in Appendix B for details. The Waste Management Plan (Blue Star 2020d) provides details for the management of soil impacted with oils and lubricants.

Table 2 Material sampling summary:

	Frequency	Notes
During placement in STF	1 discrete sample per 50m³ of soil being placed in the STF	All samples to be field screened. 5 samples per biopile are to be selected for laboratory analysis. 10% of the samples from any stockpile in the STF are to be submitted for laboratory analysis.
Operations monitoring	1 discrete sample per 50m³ of soil in a biopile	All samples to be field screened. A minimum of 5 samples per biopile are to be submitted for laboratory analysis at: • the start of each field season, • mid-way through the season (when the biopiles are being actively aerated), • at the end of the season.
Prior to removal from STF	1 discrete sample per 50m³ to 100m3 of soil in a biopile	Refer to Appendix B Table 2: Biopile confirmatory sampling frequency for laboratory submission per biopile size. 5 samples are to be collected from any stockpile in the STF, field screened and submitted for laboratory analysis when biopile confirmatory samples are collected.

It is not acceptable to blend materials to dilute the concentrations of contaminants below the levels which require treatment (British Columbia Ministry of Environment 1999)

3.3 STOCKPILING

Following sampling and excavation, soil is end dumped from the haul truck outside of the STF in a temporary stockpile. Soil is then transferred into the cells with the excavator or loader, ideally immediately after it is delivered by the haul truck. Temporary stockpiles are intended allow the lighter excavator or loader to enter the STF and thus protect the liner from damage by the heavy haul trucks. Further details on temporary stockpile management can be found in Appendix B.

3.4 MATERIAL PLACEMENT WITHIN FACILITY

The facility comprises of two lined cells; cell 1 (40 m x 40 m) and cell 2 (30 m x 30 m). The STF design is included as Appendix A. An indicator layer will be placed above the liner cover material to assist in preventing the operators from damaging the liner when the soil is being aerated or off loaded; efforts should be made to minimize damage to the indicator layer. As outlined in the design report (Appendix A), the indicator layer can be a variety of available non-hazardous materials found on site, such a spent liner from another facility or wood sheeting. The indicator layer is to be refreshed as functionally necessary prior to the cells being reloaded. The PHC contaminated soil will be placed in the cells an average of 1.5 m thick for treatment above the indicator layer. All soil placed in the STF will be sampled in accordance with the sampling procedure provided in Appendix B.

In the event where the material volumes exceed the estimated quantity and additional storage is required, the material will be stockpiled in the cell 2. Nutrients may be added to the stockpile in cell 2, but the soil will not be actively aerated until its average height is 1.5 m or less. Any stockpile of soil in cell 2 must be fully contained within the cell and the side slopes of the stockpile must not exceed 45°. Material from cell 2 will be transferred into the cell 1 for treatment as the operations progress until all excess material is treated.

3.5 FACILITY SCHEDULE AND VOLUME ESTIMATES

The duration of facility operations is estimated to extend over a 4 to 5-year period. This may vary based on various factors both external and operational.

The schedule outlined in Table 2 below is considered a conservative operational approach. The 2020 work season will include the placement of the majority of the PHC contaminated soils into the facility, and aerations 2 to 3 times per week as outlined in Section 3.6. To ensure a conservative approach, it is assumed there will not be continuous aeration in the following years and the remediation will be affective in the surface 0.5 m of the larger 40 m x 40 m cell; see Section 3.4 for more details on material placement.

Table 3 Soil Treatment Facility Schedule and Quantity Estimates

Year	Volume	Comments
2020	4,000m^3	Placement of estimated volume for treatment within the soil treatment facility. Active season of material aeration.
2021	2,500m^3	Remediated for removal.
2022	800m^3	Remediated for removal.
2023	800m^3	Remediated for removal.
2024	TBC	Repeated process based on the yearly remediated quantities and remaining PHC contaminated material.

Notes: Volumes based on investigation conducted in 2019 (SRK 2020).
Assumes 1/3 PHC contaminated soil will be acceptable for subsoil management

3.6 AERATION

Gas transfer in the contaminated soil is important for two reasons: (a) the bioremediation process requires oxygen to occur and (b) gas transfer promotes volatilization of the PHC from the soil. To achieve the gas transfer, the contaminated soil is turned and aerated up to three times a week during the field season, as equipment availability and weather conditions allow. Under the same climatic conditions, a wet soil will volatilize less mass of hydrocarbons than will a dryer soil and therefore soil aeration is primarily performed on fair days (days with sun) under dry conditions.

The biopiles are formed to an average height of 1.5 m above the indicator layer. The biopiles are typically aerated to a depth of 1.0 m to 1.2 m using an excavator or backhoe. Each full bucket is lifted to the vertical extent of the bucket arm and then let to fall from elevation to achieve an air exchange. A rotating scalper bucket attachment on the excavator or loader can also be used. A rototiller also may be used to aerate the upper 0.5 m of the biopile. During the field season the surface of the biopiles are to be left undulating; windrows up to 2.5 m high may be established (preferably parallel to the prevailing wind direction). The bottom 0.3 to 0.5 m of the biopiles is not aerated or removed during off-loading in order to reduce the risk of damaging the liner at the base of the biopiles.

3.7 MANAGEMENT OF MOISTURE CONTENT

Water is required for microbial respiration and therefore PHC remediation. Hydrocarbon-degrading microbes (hydrocarbonoclastes) need to come into contact with solubilized nutrients in order for PHC bioremediation to occur; this contact is largely governed by the soil moisture content. According to the *Canadian Federal Guidelines for Landfarming Petroleum Hydrocarbon Contaminated Soils* (FCSAP 2006, updated 2013) the soil must be moist, not dry and dusty or dripping wet to support the microbes.

The soil moisture of each biopile is to be managed by obtaining a minimum of 1 reading per 50m^3 from each biopile with a handheld soil moisture meter. During periods when the site is active additional water may be added to the biopiles to maintain an average above 10%. Water that collects in the STF sump and water storage pond can be applied to the biopiles to increase moisture content. Should addition water be required to increase and maintain the soil moisture content water is to be withdrawn from a nearby source, in accordance with water licence limits. During periods when the site is inactive and a site inspection is underway, water is to be applied to the biopiles from the holding pond, as long as the biopiles are not dripping wet.

3.8 NUTRIENT AMENDMENT

The nutrients needed for accelerating bioremediation are added to the soil based on the level of total PHC concentration for the microbial cells to replicate and survive. In cold region soils, nitrogen and phosphorus are the nutrients that typically limit microbial activity. Nitrogen and phosphorus are to be added to the constructed biopiles in the form of granular agricultural fertilizers urea and diammonium phosphate. The amount of urea and diammonium phosphate applied is based on the volume of soil being treated and the concentrations of PHC. While the cells are loaded samples are to be collected and tested for total kjeldahl nitrogen, total phosphorus, pH, hydrocarbonoclastes and PHC fractions F1 to F4 to enable a Qualified Professional to recommend the dosage ratio. The optimal range of carbon: nitrogen: phosphorus (C:N:P) in southern Canada is 100:10:1 to 100:1:0.5 (FCSAP 2006, updated 2013). In the cold regions, the ratio of 100:7.5:0.5 has been successful (Paudyn et al, 2008).

3.9 REMEDIATION PERFORMANCE MONITORING

Monitored bioremediation performance indicators include PHC fractions F2 and F3, moisture content, nutrient concentrations and the number of hydrocarbon degrading bacteria, in sampled soils. Performance monitoring is conducted biweekly throughout the field season using a portable gas detector and soil moisture meter when the site is active; otherwise during periods of inactivity during every site inspection. Laboratory results are to be are obtained for PHCs at the start of each field season, mid-way through the season and then again at the end of the season or annually when the site is inactive. Soil samples are also analyzed for total kjeldahl nitrogen, total phosphorus, pH, and hydrocarbonoclastes at the start of each field season. PAH and PHC fraction F1 are also to be tested for annually, until those parameters meet the soil quality remediation objectives in a given biopile.

3.10 REMEDIATION CONFIRMATORY SAMPLING

To confirm the performance of the bioremediation progress, representative soil samples are collected from the biopiles before the soil is classified as meeting the soil quality remediation objectives and removed from the area where it is being treated. The confirmatory soil sampling methodology is included as Appendix B.

Soil quality remediation objectives for the treatment of contaminated soil at the Site are listed in Table 4. The objectives were derived from site-specific parkland land use guidelines established by the Canadian Council of Ministers of the Environment (CCME) in *Canadian Environmental Quality Guidelines* (CCME 1999) and *Canada-Wide Standards for Petroleum Hydrocarbons in Soil* (CCME 2008) for coarse grained soil. The parameters of concern were determined in the 2019 PHC soil contaminated soil investigation (SRK 2020).

Table 4 Soil quality remediation objectives for the Ulu Gold Project

Parameter	Surface Soil (mg/kg)	Subsurface Soil (mg/kg)
PHC Fraction 1 (F1)	210	700
PHC Fraction 2 (F2)	150	1,000
PHC Fraction 3 (F3)	300	2,500
PAH Naphthalene	0.6	0.6
PAH Phenanthene	0.1	0.1

Source: CCME 2018, 2008

4.0 Water Management

4.1 SURFACE WATER STORAGE

The run-off water within the facility must be controlled to prevent migration of contaminants. In order to facilitate drainage and collection of water, the base of the individual soil storage cells will be sloped at a minimum slope of 1% grade to sumps located in the corner of each cell. The sumps consist of a vertical perforated standpipe/drum from which water can be pulled as required.

Circulation of the water within the facility, and the application of additional water as required, will ensure the moisture content of the material is sufficiently high for dust control and PHC treatment. Circulation will be done manually by means of a water pump, hose and spray nozzle in the warmer months, when the freezing of waterlines is not a concern. Water is to be applied to the biopiles as described in Section 3.7.

Should water accumulation in the sumps increase to a level where it rises near the allowable freeboard, the water storage pond must be sampled and analyzed for PHC constituents listed in the water licence prior to discharge. No water will be discharged to the environment from the STF until the results of the sample analysis confirm that the water is suitable for release and notifications in accordance with the water licence have been made. The results of this analysis will be retained on-site, while the camp is open and will be available for review upon request. The water is to be discharged into areas of existing groundwater seeps to reduce erosion of the tundra.

4.2 GROUNDWATER MONITORING

Should it be present, groundwater monitoring will entail sampling at three new monitoring wells, MW1-MW3, as indicated in Figure 3 below.

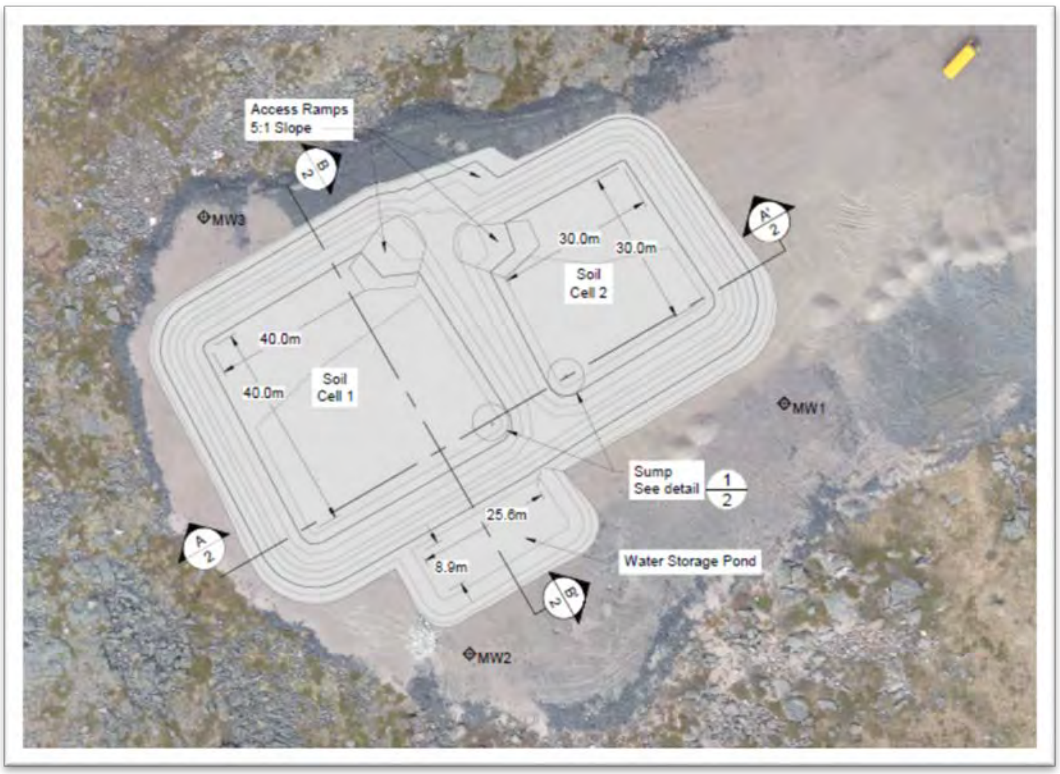

Figure 3 Monitoring Well Locations

Groundwater samples will be taken minimum twice a year during operations, preferably at the beginning and end of the summer/“open-water” season. Additional sampling may be required based on the monitoring results and/or as specified in the water license.

All sampling data must be documented. The absence of water in a monitoring well is to be recorded if applicable. Surface water samples are to be collected from the seeps identified in the vicinity of the facility if no groundwater is available for testing. The samples are to be tested for the parameters of concern being remediated in the STF.

5.0 Inspection and Maintenance

5.1 General

Remediation performance monitoring results are included in an annual remediation progress report submitted to the NWB.

5.2 Visual Inspections

Visual inspections are periodically undertaken in order to prevent contaminate migration into the surrounding area. Visual inspections of the facility must include, but not limited, identifying the following:

- Erosion or sloughing of the facility berms;
- Assess for evidence of deterioration, malfunction, leaks or improper operations of the surface water retention systems
- Exposed or damaged liner;
- Contaminated material breaching the cells area;
- Water accumulation levels.

All observation should be noted, and findings repaired as soon as possible to maintain the integrity of the facility.

Table 5 Visual Inspection Frequencies

	Frequency
During operations (aeration, material placement and removal etc.)	• Biweekly
General/Annual Monitoring	• Annual geotechnical inspection

5.3 Seasonal Closure

Prior to demobilization for winter the biopile will be leveled off to inhibit accumulation of snow in gullies and the condition of the ditches and berms are to be inspected and, if needed, reinforced in an effort to accommodate the spring runoff. In the unlikely event of the facility overtopping or a berm failing, soil samples will be collected to determine if the contamination has spread. Contaminated soil will be directed to the treatment facilities and remediation confirmation samples collected; refer to the Spill Contingency Plan (Blue Star 2020c) for additional details.

5.4 Post-Precipitation Inspection

During periods of rainfall, a visual inspection of the STF will be conducted once per day to verify water levels in cells and holding pond. The objective of the inspection will be to ensure that sufficient freeboard exists and to ensure that no hydrocarbon contaminated water exits the facility.

6.0 Closure

Decommissioning can commence once the PHC levels of all material is found to meet the acceptable levels outlined in this Management Plan. The liner will be removed and disposed with the landfill. All berms leveled and graded to promote positive drainage across the site. Soil samples to be taken and compared to baseline soil samples to confirm no migration of contaminants into the foundation or surrounding area, see Section 3.1.

7.0 REFERENCES

Blue Star Gold Corp. 2020a. Interim Closure and Reclamation Plan, Ulu Gold Project, Kitikmeot Region, Nunavut.

Blue Star Gold Corp. 2020b. Engagement Plan, Ulu Gold Project, Kitikmeot Region, Nunavut.

Blue Star Gold Corp. 2020c. Spill Response Plan, Ulu Gold Project, Kitikmeot Region, Nunavut.

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SRK Consulting (Canada) Inc. 2020. Memo: Results of 2019 Contaminated Soil Investigation at Ulu Gold Project. March 2020.

Appendix A – Soil Treatment Design Memorandum (Incl. Appendices)

SRK Consulting (Canada) Inc.
2200–1066 West Hastings Street
Vancouver, BC V6E 3X2

T: +1.604.681.4196
F: +1.604.687.5532

vancouver@srk.com
www.srk.com

Memo

To:	Peter Kuhn	**Client:**	Blue Star Gold Corp.
From:	Darryl Godley	**Project No:**	1CB041.000
Cc:	Arlene Stearman, Michel Noel	**Date:**	March 13, 2020
Subject:	Ulu Gold Project Soil Treatment Facility Design		

1 Introduction

The Ulu Gold project (the Project) is located on Inuit-owned land in the Kitikmeot Region, Nunavut, within the Hood River watershed. It is located 126 km north of the Lupin mine.

The mineral claims holding the Ulu deposit were initially staked in 1988. Portal excavation at the Ulu site commenced in 1996 to confirm resource calculations and mining design for mill feed to the Lupin Mine. Equipment to construct the camp and develop the mine was mobilized to site via a winter road from the Lupin mine in 1996. Camp 3 was built at the esker sand quarry to facilitate construction of the airstrip, road and underground exploration site. It included tent accommodations, a garage and a fuel tank farm. Camp 3 was reclaimed in 2018/2019. Underground development of the ramp ceased in August 1997 at the 155m level. The existing facilities at the Ulu underground exploration site consist of a 20-person camp with sleeping and dining quarters, a 22 m by 37 m vehicle repair shop, fuel containment areas (tanks removed in 2018) for bulk diesel and day tank storage, core storage area, core shack, and fuel staging area.

In support of the renewal and amendment of the site water licence application submitted by Blue Star Gold Corporation (Blue Star), SRK Consulting (Canada) Inc. (SRK) presents the design and closure for a petroleum hydrocarbon contaminated soil treatment facility (STF). The design is intended to ensure that best practices are followed to minimize potential environmental impacts/environmental liabilities with respect to hydrocarbon contaminated soils.

This memo provides details of the STF design and should be read in conjunction with the attached engineering drawings (Appendix A).

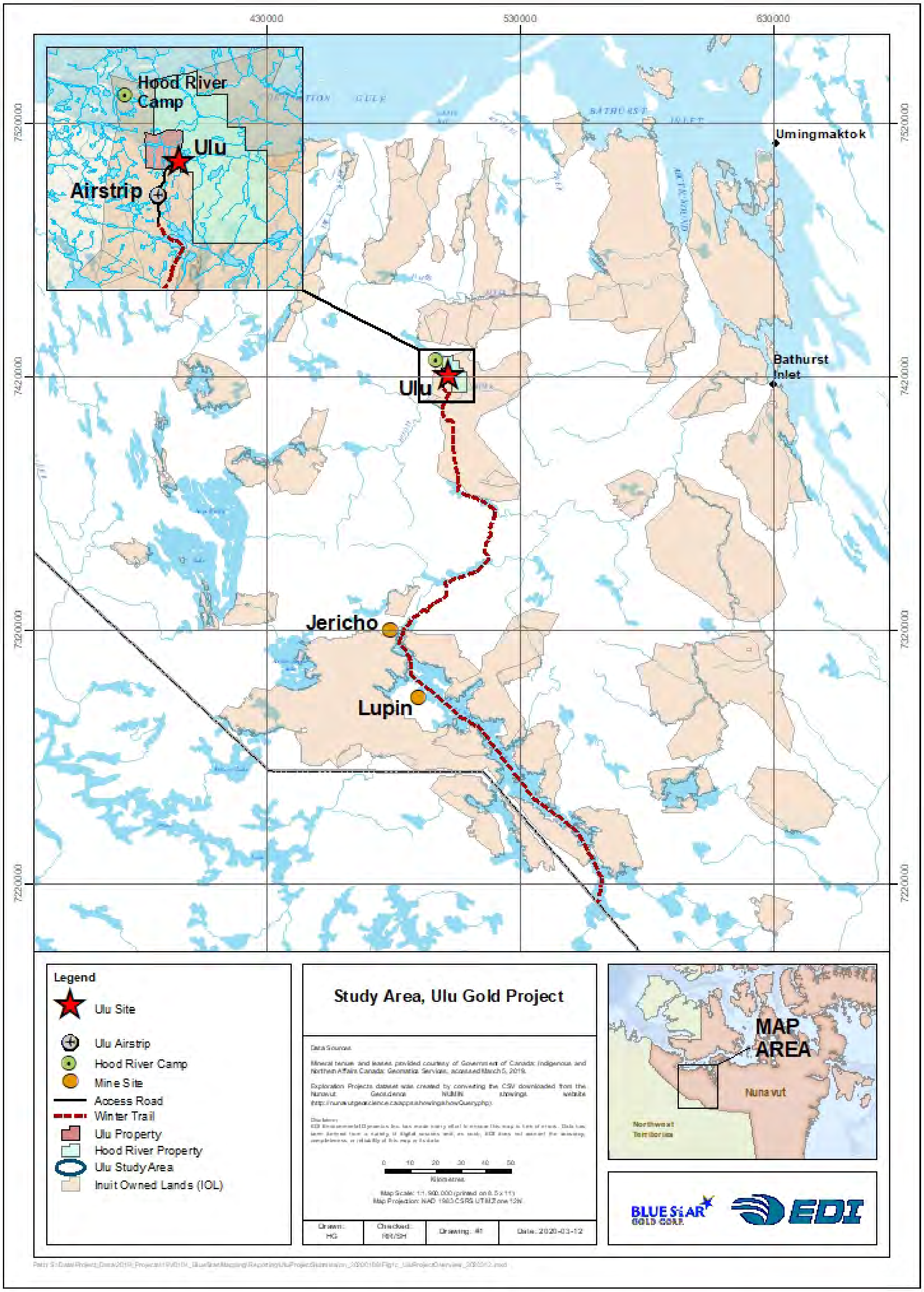


Figure 1.1 Ulu Gold Project Location

2 Existing conditions

2.1 Petroleum Hydrocarbon-Contaminated Material

The previous operators investigated the PHC contamination at the Camp 3 fuel tank farm and collected remediation confirmation samples across the base of the area that was excavated (Stantec 2018). Approximately 1,220 m^3 of PHC impacted soil was transported to the Ulu tank farm and deposited into the area that had previously held the fuel tanks.

Further investigations were conducted by SRK Consulting in 2019. The investigations areas included Camp 3 Tank Farm, Camp 3 Stockpile, Main Tank Farm, Day Tank Farm, Shop Floor and the Parking Areas. The investigation identified about 5525 m^3 of contaminated soil in situ. Soil recovered from Camp 3 that met the Federal subsoil remediation guidelines is to be buried 1.5 m or more below surface (i.e. designated for the non-hazardous waste landfill). It is anticipated that 20 to 30% of the in-situ contamination at surface will meet the subsoil remediation guidelines (SRK 2020).

2.2 Site Description

SRK conducted a site inspection of the Project camp and surrounding facilities in July 2019. The proposed STF location was subsequently identified as illustrated in Figure 1.2. This location is favorable due to the level platform of the existing waste rock pad which will minimize the preparation work and disturbance of natural ground required for the facility, as well as meeting the criteria outlined in Section 2.3. Figure 1.2 site plan shows the proposed STF location, the proximity to access roads, water courses, and remediation works.

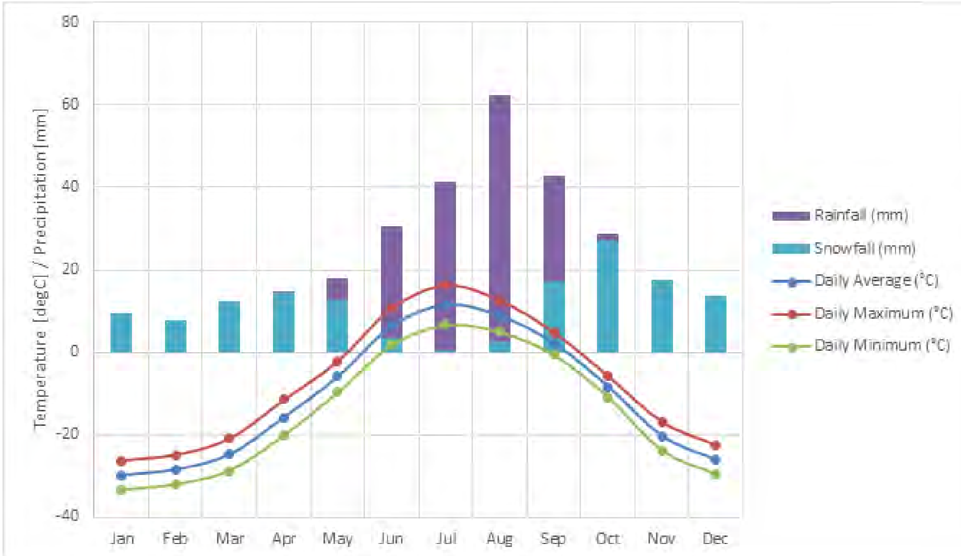
A topographic drone survey was conducted during the 2019 site investigation to capture the detailed topographic surface which implicitly includes the elevation of slope transitions and the general site profile. A 3D model of the Ulu Camp area was utilized for the design of the STF.

Figure 1.2 Soil Treatment Facility Site Plan

2.3 Climate

The proposed STF for the former Ulu Mine exploration camp is located within the Southern Arctic Ecozone and the Takijuq Lake Upland Ecoregion. Much of this region is composed of unvegetated rock outcrops. Vegetative cover is characterized by shrub tundra which includes dwarf birch, willow, northern Labrador tea, avens species, and blueberry species. Organic Cryosols are the dominant soils in the lowlands and permafrost is deep and continuous (ECCC 2019).

Regional annual normals from Lupin A station between 1980 and 2010 (ECCC, 2020a) indicate a mean annual rainfall of 160 mm, mostly occurring during July and August. The annual snowfall is equivalent to 138 mm of water, most of which falls during autumn and spring. The mean annual air temperature is -10.9 °Celsius. Monthly precipitation and temperature normals are illustrated in Figure 1.3.



Source: \\srk.ad\dfs\na\van\Projects\01_SITES\Ulu\1CB041.000_Landfill_Design\Task1020_WaterManagement\Ulu_Hydrology_20200120_COG_V01.xlsx

Figure 1.3 Monthly Temperature and Precipitation Normals

2.4 Hydrology

Long term climate records are not available on site but the Meteorological Service of Canada (MSC), a division of Environment and Climate Change Canada (ECCC), provides historical meteorological data and information in the region. The Lupin A regional station is the nearest MSC station to the site and is located inland, approximately 130 km south of the Project at a similar elevation. The following climate analysis was based on Lupin A meteorological data collected between 1982 and 2006, as this station is expected to be the most representative of the site's climate among MSC stations in the region.

Daily precipitation records from Lupin A station (ECCC, 2020b) were compiled and frequency analyses were carried out for 24h rainfall and yearly precipitation. In addition, climate change in the region is expected to affect precipitation patterns. The degree of uncertainty with the climate expected in the region over the next decades (Government of Nunavut, 2006) has assigned a climate change safety coefficient of 15% to the frequency analysis results. Table 2.1 presents the results of these analyses for several return periods.

Table 2.1 Precipitation frequency analysis results

Return Period [years]	24h Rainfall [mm]	Yearly Precipitation [mm]
Wet 200	68	526
Wet 100	64	505
Wet 50	60	484
Wet 20	55	461
Wet 10	54	453
Wet 5	48	427
Median 2	43	397

Note: best fit distributions for 24h Rainfall, Yearly Precipitation, and Winter Snow + May Rainfall were Pearson type III, Log Normal, and Normal respectively.
Source: compiled in text from R code
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Monthly soil evaporation for an average climatological year at the STF was estimated using the Penman-Monteith methodology (Howell & Evett, 2004). Reference evapotranspiration (ETo) was calculated with the Food and Agriculture Organization of the United Nations ETo calculator and multiplied by a crop coefficient K_c of 1.15 which corresponds to bare soil that is frequently wetted (Allen, Pereira, Raes, & Smith, 1998). Temperature inputs for the calculation were obtained from Lupin A 1980-2010 climate normals (ECCC, 2020a). Table 2.2 displays soil evaporation estimates for the summer months at the Ulu site.

Table 2.2 Monthly soil evaporation estimates

Month	ETo (mm/day)	Soil Evaporation (mm/day)	Soil Evaporation (mm/month)
May	1.3	1.5	46
Jun	2.8	3.2	97
Jul	3.2	3.7	114
Aug	2.1	2.4	75
Summer [mm]			332

Source: \\srk.ad\dfs\na\van\Projects\01_SITES\Ulu\1CB041.000_Landfill_Design\Task1020_WaterManagement\Ulu_Hydrology_20200120_COG_V01.xlsx

Climate change is expected to increase the temperatures in the Canadian arctic over the next decades (Pörtner et al, 2019) and the on-site evaporation is expected to also increase, provided that the other parameters such as humidity, solar radiation, and wind don't vary significantly.

3 Design and Construction

3.1 Overview

Petroleum hydrocarbon (PHC) contaminated material will be treated within the STF. The STF will consist of two soil storage cells and a water storage pond. The cells will be used for soil sorting and treatment. The water storage pond will store contact water accumulated during the summer freshet and rain periods. The treatment process will consist of soil aeration through mechanical turning and, if required, the addition of nutrients for acceleration of bioremediation.

Only material containing the following hydrocarbons will be treated at the STF:

- Diesel fuel;
- Aviation gasoline;
- Gasoline; and
- Equipment oil (not all equipment oil is acceptable within the facility, see Soil Treatment Facility Management Plan for specific details on acceptable hydrocarbons).

All other materials will be deemed inappropriate for the STF. The contaminated material not suitable for the STF will be shipped off-site.

3.2 Design criteria

The design criteria for the STF includes the following:

- Minimum total contaminated soil storage volume of 4,000 m^3;
- An average stockpile height of no greater than 1.5 m during treatment;
- The floor of each cell will be sloped at a minimum slope of 1% towards a sump;
- Each cell will be accessed via access ramps sloped at 5H:1V;
- Each cell shall be lined with a low permeable liner with a hydraulic conductivity of less than $1x10^{-7}$ cm/s (Land and Water Boards of Mackenzie Valley 2020);
- Minimum 0.5 m freeboard.
- Berms will have a minimum height of 1.5 m, 1 m crest width;
- 2H:1V inner and 1.5H:1V outer berm slopes;
- Location >100 m from 25-year return period floodplain;
- Location >500 m from extraction point of potable water source;
- Location >500 m from sensitive area (example national parks boundaries, habitat identified for sensitive species, etc.);
- Site slope <5%; and
- Groundwater table >1 m from base of facility.

3.3 Facility Construction

The STF berms and floor will be constructed of suitable bulk fill and bedding material approved by the site engineer.

The cells will be lined with a liner system that will consist of a linear low-density polyethylene (LLDPE) liner that will be covered with a non-woven geotextile. Liner specification will be confirmed by the site engineer based on availability at time of construction; Appendix D contains specifications utilized for the design based on current availability. The installation of the liner will be done in accordance with the manufacturer's specifications. An alternative option of using a geosynthetic clay liner was considered but was rejected due to the increase cost of transporting the heaver liner option to the Project location.

A minimum 0.15 m thick layer of suitable bedding material will be placed below the liner system, 0.4 m thick cover will be placed above and 0.10 m along the berm side wall of the liner system. Prior to liner installation, the site engineer responsible for construction oversight will approve the placing and compacting of the bedding material. An indicator layer of recycled wood, geotextile etc. will be placed above the cover material to prevent over excavation and damage to the liner system when turning soils during treatment operations.

Equipment must not operate directly on the liner system during the placement of the cover material. Material must be placed/pushed to ensure there is a minimum 0.4 m cover over the liner when traversing above the lined area. The type and size of the mobile equipment will be approved by the site engineer before initiating the work.

The berms for the treatment cells will be constructed to a minimum height of 1.5 m above the indicator layer and will be compacted to a final crest width of 1 m. The site engineer may adjust the berm width based on the available compaction equipment and techniques. A minimum 1.5H:1V outer and 2H:1V inner berm slope will be maintained. The berm width will accommodate the liner system tie-in as per the manufacturer's specifications.

An access ramp for the placement and removal of soil will be constructed in the centre of the cells. Appropriate cover material must be placed to prevent damage to the liner system. The slope of the access ramps must not exceed 5H:1V.

3.4 Soil Sampling

Prior to facility construction, soil samples will be taken from the STF footprint area to establish baseline conditions. Following facility decommissioning, soil samples will be again taken within the facility footprint and compared to baseline conditions to determine the presence and, if any, the extent of contamination arising from facility operation. Refer to Soil Remediation Sampling Methodology (SRK2020a).

3.5 Water Management

The run-off water within the facility must be controlled to prevent migration of contaminants. In order to facilitate drainage and collection of water, the base of the individual soil storage cells will be constructed at a minimum slope of 1% grade to sumps located in the corner of each cell.

Water accumulating within the soil treatment cells can be collected and recirculated for beneficial reuse within the cell to promote treatment and manage dust. The soil treatment cells have the capacity to store a 24 hour, 10-year frequency storm event and the average annual snow accumulation using a 10:1 ratio of snow to water; based on a minimum freeboard of 0.5 m (Land

and Water Boards of Mackenzie Valley 2020). Excess water will be pumped to the water storage pond for testing, treatment (if needed) and discharge.

Water within the facility will be recirculated at a rate sufficient to maintain the moisture content of the material as required for dust control and PHC treatment. The recirculation will be done with a water pump in the summer months. Should water accumulation increase to a level where it rises above the allowable freeboard, the water storage pond will have to be utilized. Water samples will be analyzed for PHC constituents prior to discharge. See the Soil Treatment Facility Management Plan for details.

3.6 Monitoring Wells

Groundwater monitoring is required during operation of the facility to identify possible PHC leachate from the facility. Three monitoring wells will be installed along the periphery of the STF to enable monitoring of the groundwater below the STF. The proposed locations of the monitoring wells are shown in the design drawing package in Appendix A. Details on water monitoring can be found in the Soil Treatment Facility Management Plan.

3.7 Schedule

It is anticipated that the facility construction and subsequent placement of PHC contaminated soils will take place within one summer work season. The design and schedule are based on the availability of the following equipment:

- 1 x excavator (CAT 311)
- 1 x front end loader (CAT 966D)
- 1 x dump truck (CAT 769C)
- 1 x bulldozer (CAT D8N)
- 1 x grader (CAT 14G)

It is understood that the above equipment includes all available resources on site.

3.8 Construction QA/QC

All STF construction activities will be supervised by a qualified site engineer who is responsible for ensuring appropriate quality assurance and quality control (QA/QC) of construction materials and activities. Construction QA/QC monitoring will consist of, but is not limited to, the following:

- Foundation preparation;
- Berm construction;
- Bedding and liner installation; and
- Initial PHC contaminated material placement.

3.9 As-built Survey

On completion of the STF facility construction (prior to placement of PHC contaminated soil), a survey will be performed for the purpose of an as-built report to confirm its size, shape, and location. An as-built report will be presented that contains photo documentation of the construction process and the as-built drawings. The report will include:

- As-built report including drawings from site survey;
- Contaminated soil relocation map (area not necessarily surveyed accurately); and
- Photolog of construction progress.

3.9.1 Survey Control

Surveys to be completed at the following stages of construction:

- Prior to construction;
- All material transitions (example top of bedding/liner); and
- Prior to placement of contaminated soil.

4 Operations and Maintenance

The Soil Treatment Facility Management Plan can be used in conjunction with this design memo. The plan will provide the types of hydrocarbon contaminants accepted, guidance on excavation and placement of soil within the facility, operating method, engineering controls, closure details, and monitoring procedures to be followed during the operation and closure of the facility.

5 Closure

Decommissioning can commence once the PHC levels of all material in the STF is found to meet the acceptable levels outlined in the Management Plan. The liner will be removed and disposed of with the landfill. All berms will be leveled and graded to promote positive drainage across the site.

Soil samples will be taken and compared to baseline soil samples to confirm no migration of contaminants into the foundation, see section 2.3.2 Soil Sampling.

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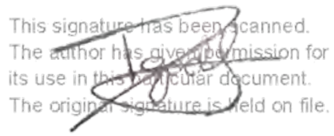

Darryl Godley, EIT (BC)
Consultant

Michel Noel, PEng (BC, NWT/NU)
Principal Consultant

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The opinions expressed in this report have been based on the information available to SRK at the time of preparation. SRK has exercised all due care in reviewing information supplied by others for use on this project. Whilst SRK has compared key supplied data with expected values, the accuracy of the results and conclusions from the review are entirely reliant on the accuracy and completeness of the supplied data. SRK does not accept responsibility for any errors or omissions in the supplied information, except to the extent that SRK was hired to verify the data.SRK Consulting (Canada) Inc.

6 References

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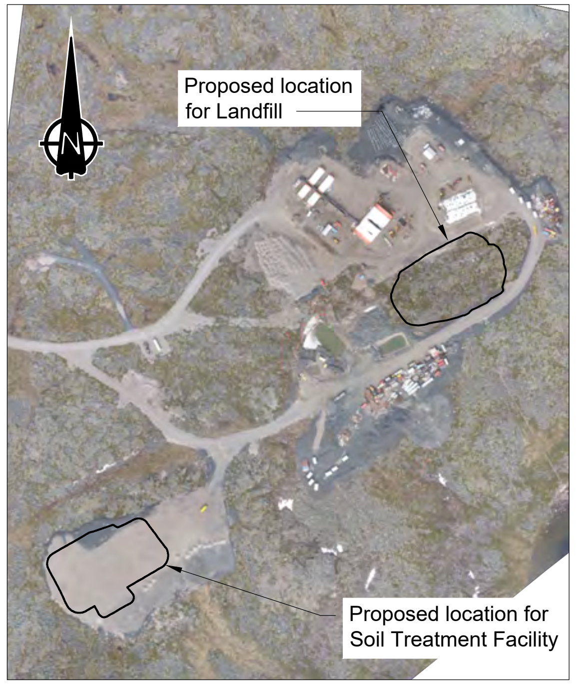
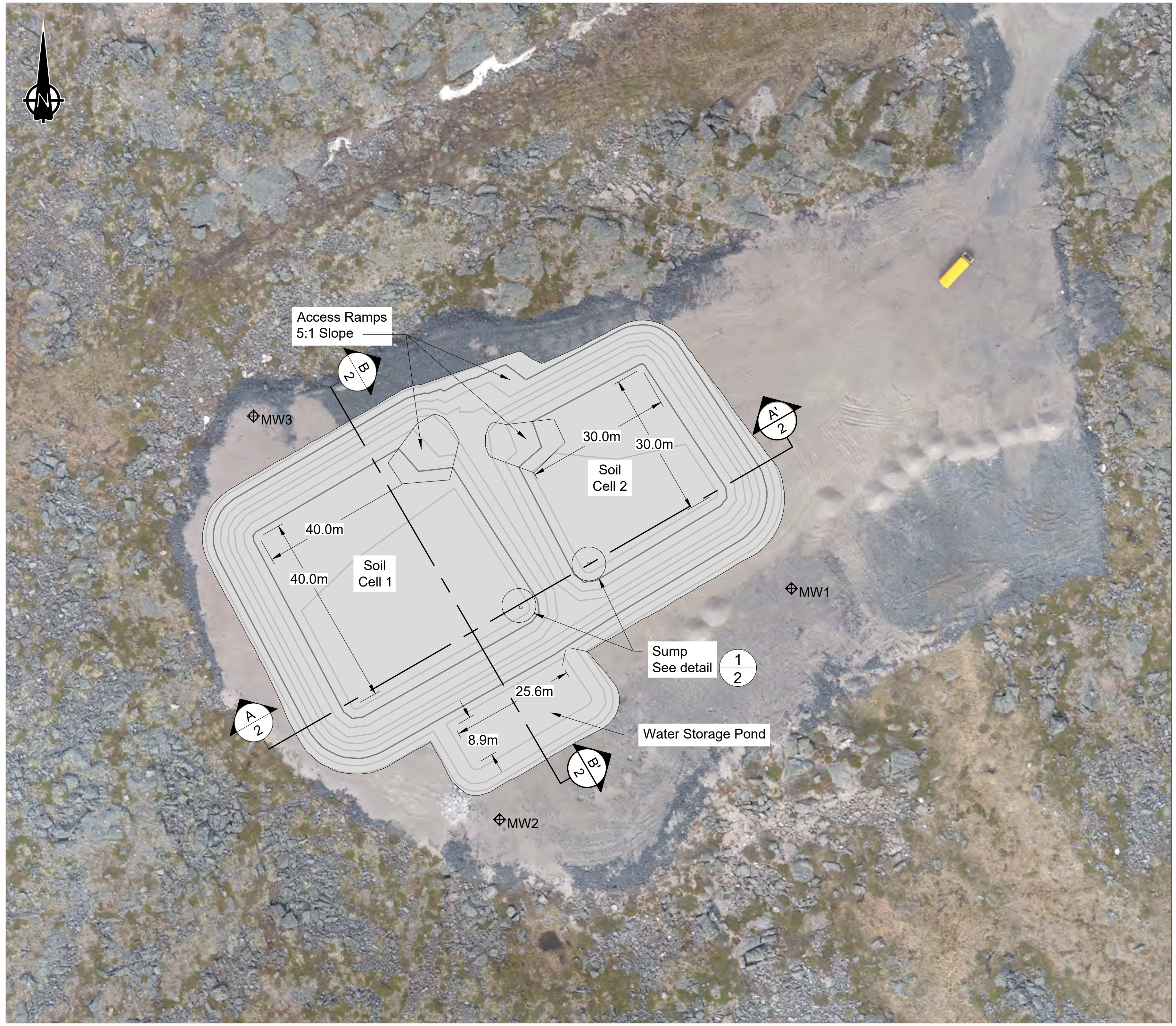
Appendix A: Landfill Design Drawings



Key Plan

0m 50 100 150 200 250 300



Soil Treatment Facility - Plan

0m 10 20 30 40

LEGEND

⌖ Monitoring Well Location

NOTES

1. Contours shown at 1.0m intervals.
2. All dimensions are in meters unless otherwise noted.
3. Limits of existing roadway surfaces are approximate.
4. Construction material to be approved by the Design Engineer.
5. All construction to be completed in accordance with the technical specifications in the design memorandum, Ulu Gold Project Soil Treatment facility Design. March 2020. Project No. 1CB041.000

REFERENCE

1. Coordinate System is WGS84 UTM Zone 12N.
2. Background Image from drone survey completed 07/17/2019.

Material Volumes	
Liner (m^2)	5,630
Liner Cover (m^3)	804
Bedding (m^3)	5,633
Bulk Fill (Base & Berm) (m^3)	10,500

(See Note 4)

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SRK JOB NO.: 1CB041.000
FILE NAME: 1CB041.000 Contaminated Soil Treatment Facility.dwg

Blue Star Gold Corp.

Ulu Gold Project

Soils Treatment Facility Plan

DATE: March 2020 | APPROVED: | FIGURE: 1

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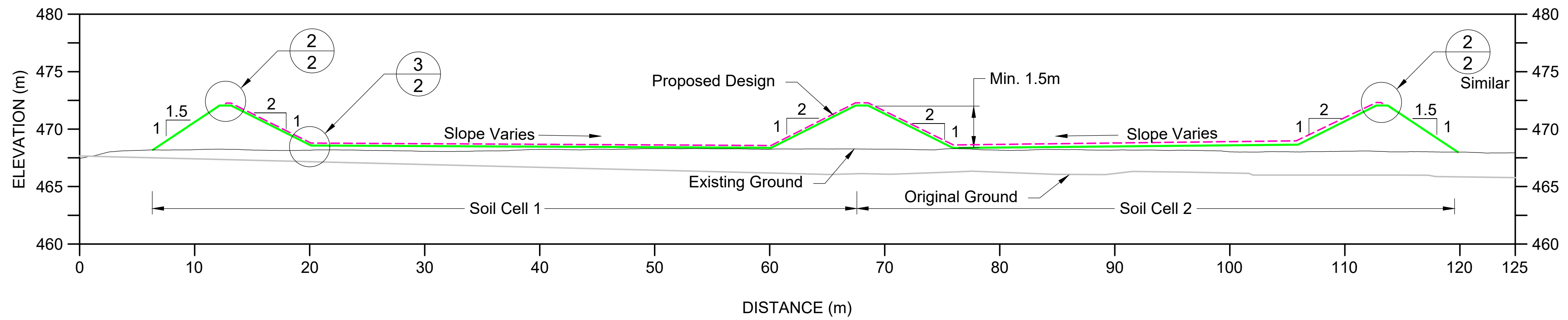
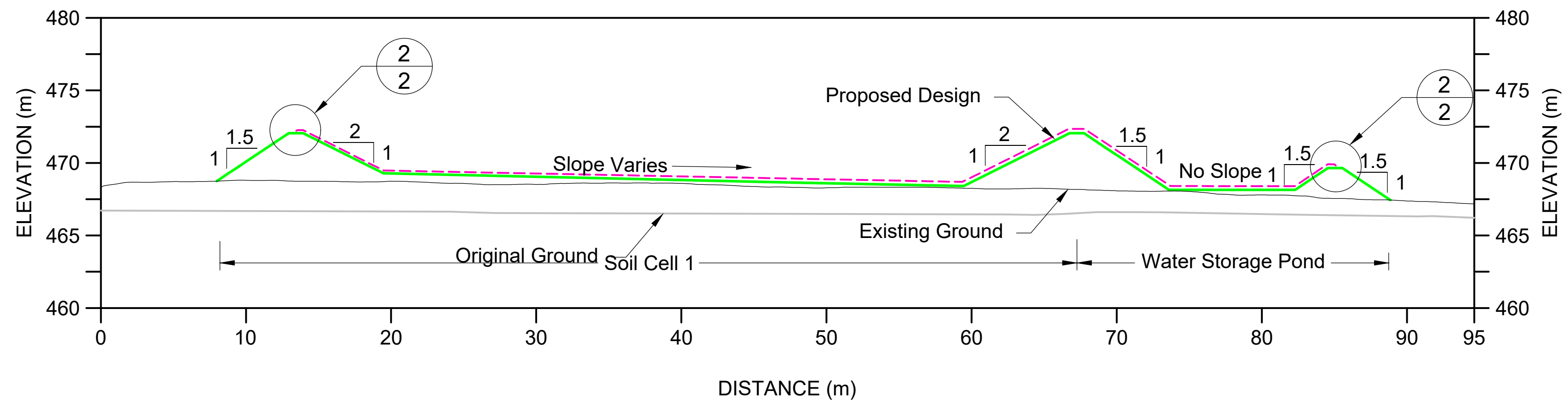
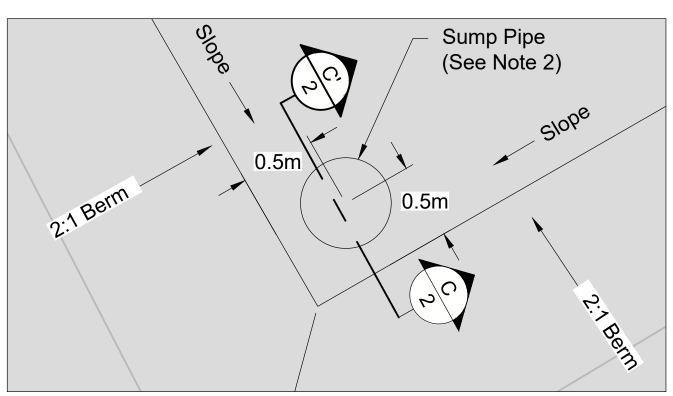


A
1
Cross Section A-A'



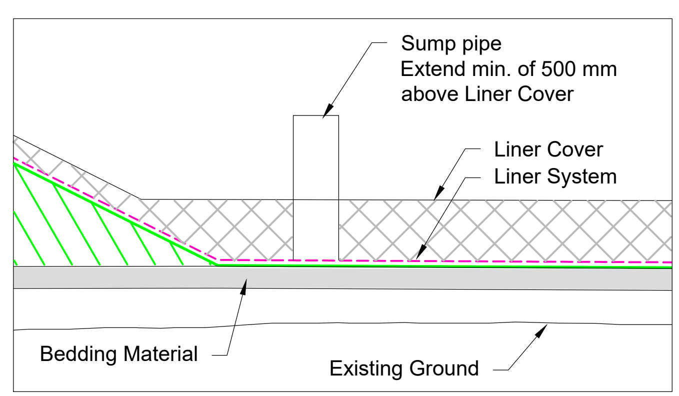
B
1
Cross Section B-B'

0m 5 10 15 20



1
1
Detail 1 - Typical Sump

0m 0.5 1.0 1.5 2.0



C
2
Cross Section C-C'

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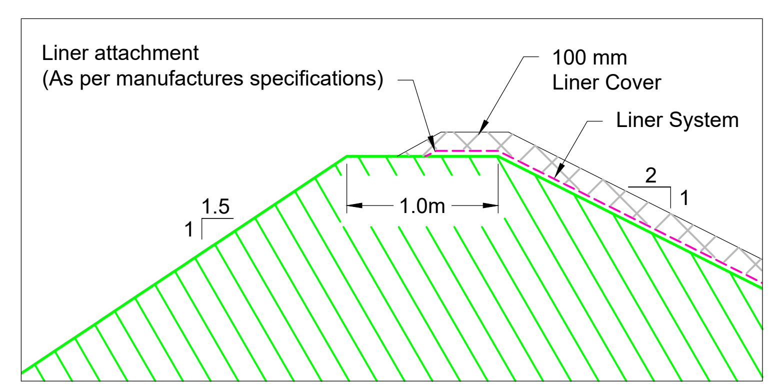

2
2
Detail 2 - Liner Tie-In

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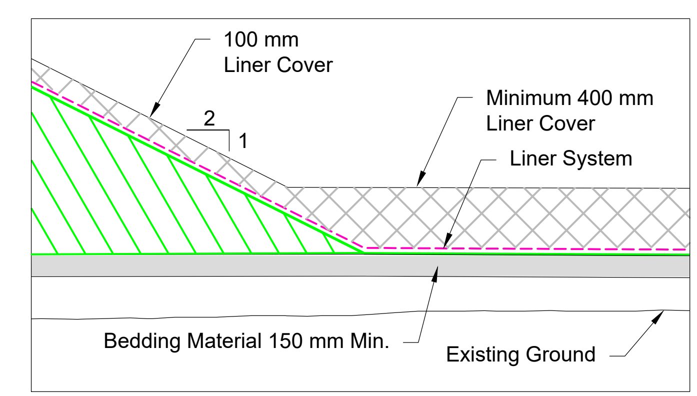

3
2
Detail 3 - Liner Cover
(See Note 3)

0m 0.5 1.0 1.5 2.0

LEGEND

- General Fill Material
- Liner Cover Material
- Liner System
- Bedding Material

NOTES

1. All dimensions are in meters unless otherwise noted.
2. Minimum 300 mm diameter perforated HDPE pipe covered with woven geotextile or approved equivalent. Pipe to be sealed to Liner System in accordance with manufactures specifications.
3. Water Storage Pond cover to be 100 mm thick over whole area.

REFERENCE

1. Coordinate System is WGS84 UTM Zone 12N.
2. Existing Ground surface created from drone survey completed 07/17/2019. Survey data raised by 77.3 m
3. Original ground surface is created from historic data contours in drawing ULUTOPO.DWG.

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Ulu Gold Project

Soil Treatment Facility
Sections

SRK JOB NO.: 1CB041.000
FILE NAME: 1CB041.000 Contaminated Soil Treatment Facility.dwg

Blue Star Gold Corp.

DATE: March 2020
APPROVED:
FIGURE: 2

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Appendix B: Hydrology

Table 1 Precipitation and Temperature normals based on Lupin A records

Parameter	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Rainfall (mm)	0	0	0	0.4	5.3	26.8	41.1	59.8	25.5	1.6	0	0	160.5
Snowfall (mm)	9.4	7.8	12.2	14.3	12.5	3.6	0.4	2.6	17.1	27.1	17.4	13.7	138
Precipitation (mm)	9.4	7.8	12.2	14.6	17.8	30.4	41.5	62.5	42.6	28.7	17.4	13.7	298.5
Daily Average Temperature (°C)	-29.9	-28.5	-24.8	-15.8	-5.9	6.4	11.5	8.8	2.1	-8.4	-20.4	-26.2	-10.9
Daily Maximum Temperature (°C)	-26.3	-24.9	-20.9	-11.5	-2.1	10.8	16.3	12.6	4.8	-5.8	-16.9	-22.6	-7.2
Daily Minimum Temperature (°C)	-33.4	-32.1	-28.7	-20.1	-9.6	1.9	6.7	5	-0.6	-10.9	-23.9	-29.7	-14.6

Source: Compiled into text from ECCC 2020a
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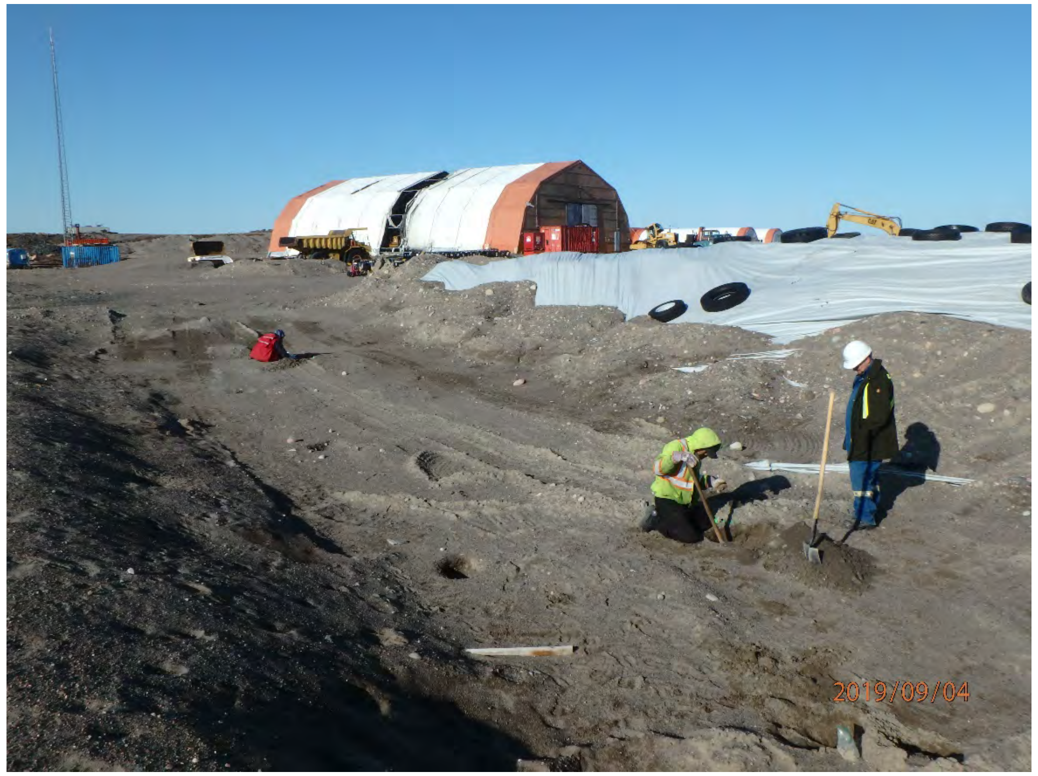
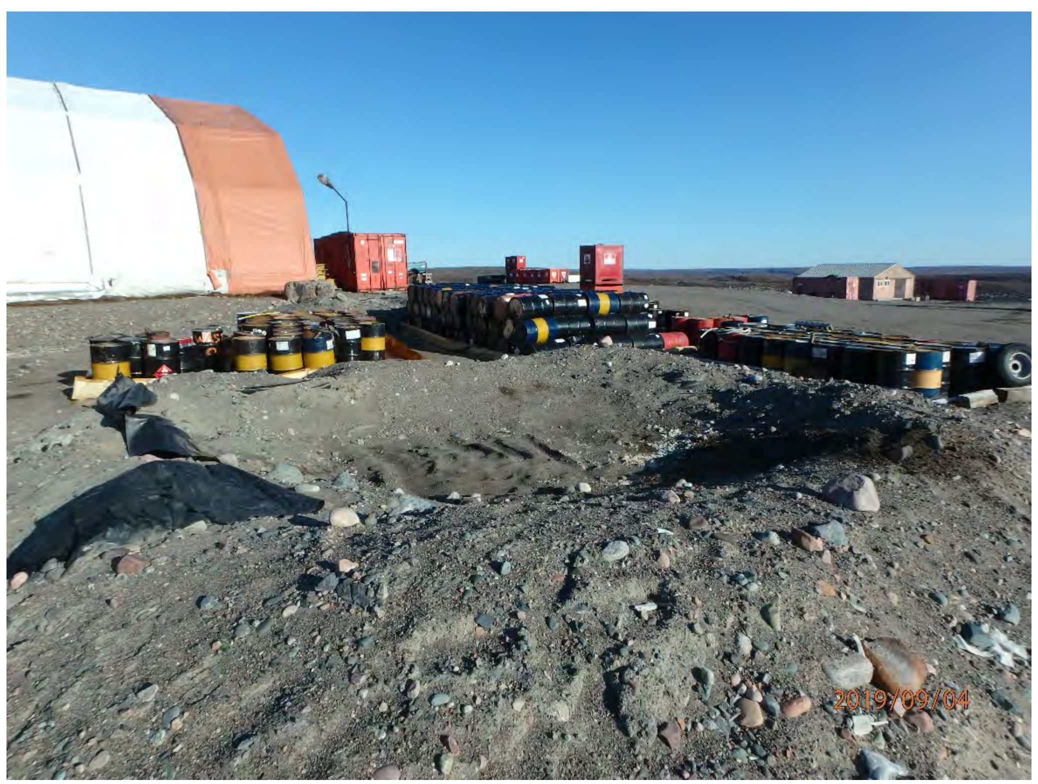
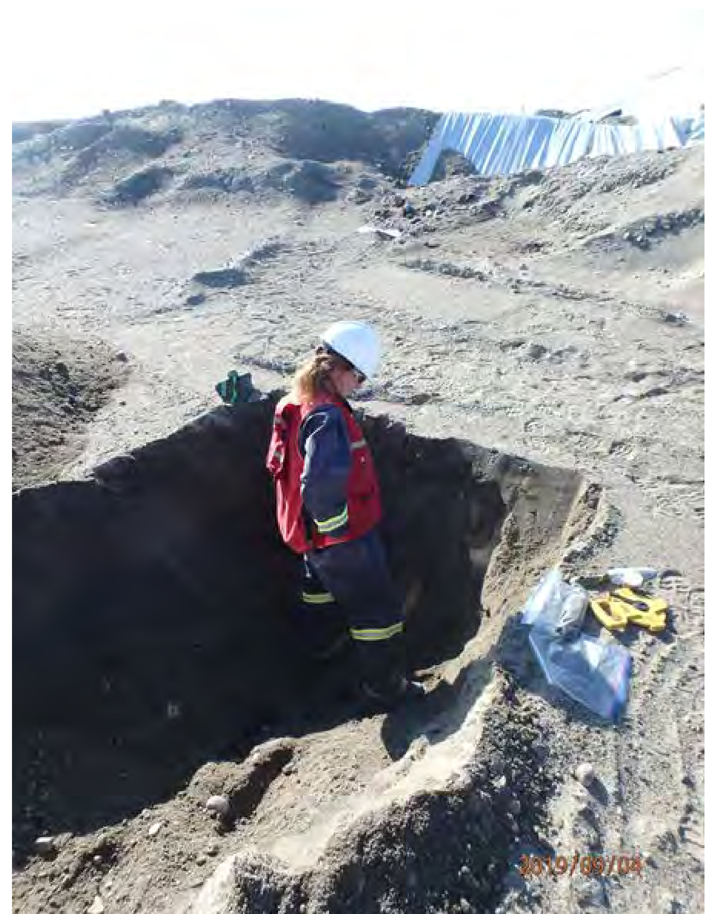
Appendix C: Site Photos





srk consulting	BLUE STAR GOLD CORP.	STF Design
		Site Images 1/2
Job No: 1CB041.00 Filename: STF_Figures.pptx	ULU Gold Project	Date: March 2020 | Approved: DG | Figure: 1



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		Site Images 2/2
Job No: 1CB041.00 Filename: STF_Figures.pptx	ULU Gold Project	Date: March 202 | Approved: DG | Figure: **2**

Appendix D: Liner System Specifications

Marketing, Technical, and Sale Services in Latin America by:

Civil-Tex

Geosynthetics & Engineering

SKAPS

GT-116

Nonwoven Geotextile

SKAPS GT-116 is a needle-punched nonwoven geotextile made of 100% polypropylene staple fibers, which are formed into a random network for dimensional stability. SKAPS GT-116 resists ultraviolet deterioration, rotting, biological degradation, naturally encountered basics and acids. Polypropylene is stable within a ph range of 2 to 13. SKAPS GT-116 conforms to the physical property values listed below:

PROPERTY	TEST METHOD	UNIT	M.A.R.V. (Minimum Average Roll Value)	TYPICAL VALUE** (Average Roll Value)
Nominal Weight*	ASTM D 5261	oz/sy (g/sm)	-	16.0 (542)
Nominal Thickness*	ASTM D 5199	mils (mm)	-	165 (4.2)
Grab Tensile	ASTM D 4632	lbs (kN)	380 (1.690)	400 (1.78)
Grab Elongation	ASTM D 4632	%	50	> 60
Trapezoid Tear Strength	ASTM D 4533	lbs (kN)	145 (0.644)	150 (.670)
Puncture Resistance	ASTM D 4833	lbs (kN)	240 (1.07)	250 (1.11)
Puncture Resistance - CBR	ASTM D 6241	lbs (kN)	1080 (4.820)	1260 (5.600)
Mullen Burst Strength	ASTM D 3786	psi (kPa)	750 (5171)	800 (5517)
Permittivity*	ASTM D 4491	l/sec	0.70	0.75
Permeability*	ASTM D 4491	cm/sec	0.25	0.35
Water Flow*	ASTM D 4491	gpm/sf (l/s/sm)	50 (34)	60 (41)
AOS*	ASTM D 4751	US Sieve (mm)	100 (.150)	140 – 100 (0.11-0.150)
UV Resistance	ASTM D 4355	%/hrs	70/500	80/500

* At the time of manufacturing. Handling, storage, and shipping may change these properties.
** Typical values are given for comparison purpose only.

This information is provided for reference purposes only and is not intended as a warranty or guarantee. SKAPS assumes no liability in connection with the use of this information.

PACKAGING	
Roll Dimensions (W x L) – Meters	4.57 / 3.81 x 45.73 / 54.88
Square Meters Per Roll	209.03
Estimated Roll Weight – Kg	134

Date Issued: 01/04/2010 **MADE IN U.S.A.**

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TECHNICAL DATA SHEET

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PROPERTY	TEST METHOD	FREQUENCY(1)	UNIT Metric	1012112
SPECIFICATIONS				
Thickness (min. avg.)	ASTM D5199	Every roll	mm	1.00
Thickness (min.)	ASTM D5199	Every roll	mm	0.90
Melt Index - 190/2.16 (max.)	ASTM D1238	1/Batch	g/10 min	1.0
Sheet Density (8)	ASTM D792	Every 10 rolls	g/cc	≤ 0.939
Carbon Black Content (9)	ASTM D4218	Every 2 rolls	%	2.0 - 3.0
Carbon Black Dispersion	ASTM D5596	Every 10 rolls	Category	Cat. 1 / Cat. 2
OIT - standard (avg.)	ASTM D3895	1/Batch	min	100
Tensile Properties (min. avg) (2)	ASTM D6693	Every 2 rolls		
Strength at Break			kN/m	29
Elongation at Break			%	800
2% Modulus (max.)	ASTM D5323	Per formulation	kN/m	420
Tear Resistance (min. avg.)	ASTM D1004	Every 5 rolls	N	100
Puncture Resistance (min. avg.)	ASTM D4833	Every 5 rolls	N	275
Dimensional Stability	ASTM D1204	Certified	%	± 2
Multi-Axial Tensile (min.)	ASTM D5617	Per formulation	%	30
Oven Aging - % retained after 90 days	ASTM D5721	Per formulation		
STD OIT (min. avg.)	ASTM D3895		%	35
HP OIT (min. avg.)	ASTM D5885		%	60
UV Res. - % retained after 1600 hr	ASTM D7238	Per formulation		
HP-OIT (min. avg.)	ASTM D5885		%	35
Low Temperature Brittleness	ASTM D746	Certified	°C	- 77
SUPPLY SPECIFICATIONS (Roll dimensions may vary ±1%)				
Roll Dimension - Width			m	6.80
Roll Dimension - Length			m	237.7
Area (Surface/Roll)			m^2	1616.4

NOTES

1. Testing frequency based on standard roll dimension and one batch is approximately 180,000 lbs (or one railcar).
2. Machine Direction (MD) and Cross Machine Direction (XMD or TD) average values should be on the basis of 5 specimens each direction.
8. Correlation table is available for ASTM D792 vs ASTM D1505. Both methods give the same results.
9. Correlation table is available for ASTM D1603 vs ASTM D4218. Both methods give the same results.

* All values are nominal test results, except when specified as minimum or maximum.
* The information contained herein is provided for reference purposes only and is not intended as a warranty of guarantee. Final determination of suitability for use contemplated is the sole responsability of the user. SOLMAX assumes no liability in connection with the use of this information.

Solmax is not a design professional and has not performed any design services to determine if Solmax's goods comply with any project plans or specifications, or with the application or use of Solmax's goods to any particular system, project, purpose, installation or specification.

Appendix B – Soil Sampling Methodology

SRK Consulting (Canada) Inc.
2200–1066 West Hastings Street
Vancouver, BC V6E 3X2

T: +1.604.681.4196
F: +1.604.687.5532
vancouver@srk.com
www.srk.com

Memo

To:	Peter Kuhn	**Client:**	Blue Star Gold Corp.
From:	Arlene Stearman, PGeo	**Project No:**	1CB041.000
Cc:		**Date:**	March 13, 2020
Subject:	Soil Remediation Sampling Methodology, Ulu Gold Project		

1 Objectives

This memo provides information pertaining to the methodology used for characterization and confirmatory soil sampling/analysis during the remediation of the petroleum hydrocarbon (PHC) contaminated soil at the Ulu Gold Project. The rationale for the types and frequency of parameters being analyzed for are presented.

2 Characterization and Confirmation Sampling

Confirmatory sampling is undertaken to ensure that contaminated material is properly remediated. To confirm that contaminated soil has been removed from an excavation, samples are collected *in situ* (in the ground) from the walls and floor of the excavation. To confirm that the contaminated soil removed from the excavation has been remediated to the established remediation objectives, samples are collected *ex situ* from the stockpiles or biopiles of soil being treated. All remediation confirmatory soil samples are analyzed at a laboratory accredited by the Canadian Association for Laboratory Accreditation (CALA) for the parameters analyzed.

Soil characterization sampling is to be undertaken to determine the presence or absence of PHC contamination and assess the level of the contamination. Characterizing the biopiles in the soil treatment facility is required to determine the amount of nutrients and water to amend the soil with and to track progress of the treatment program.

All samples are to have unique sample numbers and the sample location recorded in the field sample logbook.

2.1 In Situ Sampling Procedure

This section describes the procedure to be followed to confirm that the contaminated soil was removed from excavations within the former fuel tank facility, the shop and day tank area.

On-site screening of soil samples for PHC vapours is to be conducted to provide an indication of remedial progress prior to the collection of remediation confirmatory samples, as described in Section 3. This approach prevents delays and increased costs that would be encountered by the exclusive use of an off-site laboratory for on-site control. The soil vapour measurements provide an indication of the presence or absence of PHC contamination.

During the excavation of PHC contaminated soil, discrete field screening samples are to be collected across the base of the excavation in a 10 m by 10 m grid pattern. A tighter sample interval is required at the boundaries of suspected PHC contamination to delineate the area requiring excavation. To establish the depth of the contamination the walls of the excavation are to be profiled at 0.5 m vertical intervals. Discrete wall samples are to be collected at 5 m horizontal intervals within 0.25 m of the base of the horizon determined to be contaminated. A single aliquot of soil from a specific point is a discrete sample. The excavation is to advance until results from the gas detector, combined with the visual appearance of the soil and olfactory indicators suggest that PHC contamination is no longer present in the floor or sidewalls of the excavation. Remediation confirmatory soil samples are to then be collected and analysed at an off-site laboratory. If the results exceed the soil quality remediation objectives (SQROs) listed in Table 3 the excavation is to advance in the areas with elevated laboratory test results.

The confirmatory soil sampling procedure requires each excavation area at the site to be subdivided into individual sampling areas of approximately 10 m by 10 m (or less) as required to cover the floor of the excavation and at 10 m increments along the side wall of the excavation. Samples are to be collected within 0.25 m of the surface of the excavation. Table 1 provides guidance on the number of remediation samples required relative to the size of the excavation.

Table 1 Confirmation sampling requirements for excavation

Floor Area (m^2)	Floor Samples	Sidewall Samples
<25	2	2
>25 to 50	2	3
>50 to 100	3	3
>100 to 250	3	5
>250 to 500	4	6
>500 to 750	4	7
>750 to 1,000	5	8

Source: APGO 2011

All *in situ* sample locations are to be temporarily identified in the field with a labeled piece of flagging tape placed at the sample site. A field sketch is to be produced for all remediation confirmatory samples.

2.2 Ex Situ Sampling Procedure

Remediation confirmatory soil samples are to be collected based on the volume of soil in a given stockpile or biopile and the homogeneity of the soil in the pile. In accordance with the *Federal Guidelines for Landfarming Petroleum Hydrocarbon Contaminated Soils* (FCSAP 2006, updated 2013) the sampling plan includes the methods (grid, composite) and frequency (number of samples per surface area). The samples are to be analyzed for contaminants of interest and compared with the remediation guidelines presented in the Canadian Council of Ministers of the

Environment (CCME) in *Canadian Environmental Quality Guidelines* (CCME 1999) and *Canada-Wide Standards for Petroleum Hydrocarbons in Soil* (CCME 2008).

A composite sample to characterize a stockpile or biopile of soil is to be created by combining up to five discrete samples. Discrete remediation confirmatory samples are to be collected following the turning (aeration) of soil or during the placement of soil into a stockpile. Whenever practical discrete stockpile samples should be collected regularly as the stockpile is being built, i.e. from every second or third load deposited by the front end loader. Equal aliquots of soil from the discrete samples from the same stockpile or biopile are to be combined to create a composite sample. The volume of soil represented by each composite sample is to range from 50 m^3 to 150 m^3, with no discrete sample representing more than 50 m^3. Discrete samples are to be analyzed by the laboratory as part of QA/QC measures (see Section 3). All discrete and composite samples are to have unique sample numbers and the sample numbers of the discrete samples used to create the composite are to be recorded in the field logbook. The stockpiles and biopioles from which the samples were collected are to be identified in the logbook.

Table 2 Stockpile sampling frequency

Pile volume (m^3)	Field Screening Samples	Samples for Laboratory Analysis
Less than 50 m^3	A minimum of 5 samples	A minimum of 1 sample
>50 m^3 to 150 m^3	A minimum of 15 samples	A minimum of 3 samples
>150 m^3 to 500 m^3	A minimum of 30 samples	A minimum of 5 samples
>500 m^3 to 1,500 m^3	A minimum of 50 samples	A minimum of 10 samples
>1,500 m^3	A minimum of 75 samples	A minimum of 15 samples

Source: APGO 2011

2.3 Quality Assurance and Control

Quality assurance and control (QA/QC) measures associated with the collection and analysis of the soil samples include the comparison of field screening results with laboratory data and laboratory analysis of blind duplicates and discrete QA/QC samples. Blind field duplicate samples monitor a combination of the precision of the laboratory analyses, sample preparation errors, sample collection errors and genuine short scale variations in soil geochemistry. Discrete samples monitor the homogeneity of stockpiles and biopiles.

The QA/QC sampling plan requires that one QA/QC sample be submitted for laboratory analysis for every ten samples analyzed. For every ten *in situ* remediation confirmation samples collected one blind duplicate is to be collected in the field and numbered with a unique sample number and the numbers of the duplicate discrete samples noted in the field logbook. For every ten composite samples prepared for the stockpiles and biopiles one duplicate and three discrete samples from the same composite sample are to be prepared for analysis and the numbers of the duplicate composite sample noted in the field logbook. Upon determining which *ex situ* samples will be submitted for laboratory testing preference will be given to the QA/QC samples to ensure that 10% of the samples analyzed are QA/QC samples.

3 Field Screening Method

Soil samples are to be screened on site for PHC vapours using a bag-headspace method and a portable gas detector.

The concentration of organic vapour in soil impacted by hydrocarbons is to be measured on-site using the bag-headspace method. This method involves placing soil in a sealable polyethylene bag (extra large Ziploc®), sealing the bag, disaggregating the soil in the bag and allowing organic vapours to accumulate in the bag's headspace in a warm environment (+10°C) for at least one hour. The concentration of organic vapour is then measured using a portable gas detector such as an RKI Eagle II® calibrated to a hexane and isobutylene standard. Hexane (HEX) results greater than 100 ppm and isobutylene (IBL) results greater than 10 ppm generally indicate that the soil is contaminated with PHC fractions F1 and/or F2.

The results of the gas detector measurements are to be combined with the visual appearance of the soil and olfactory indicators to select which samples were to be submitted for analytical testing at a CALA – accredited laboratory.

A handheld soil moisture meter will be used to monitor the biopiles during periods of little precipitation. Optimal moisture levels are between 20% and 85% to support the microbes (FCSAP 2006, updated 2013). During field seasons when the biopiles are being actively managed, water is to be applied to the biopiles should the moisture content fall below 5%.

4 Parameters for Analysis

Soil samples are to be analyzed for parameters of concern as identified by a series of samples collected to characterize and verify the suspected contaminants. The parameters of concern are listed in Table 3 along with the CCME soil quality remediation objective based on future land use and site-specific exposure pathways.

The types of parameters analyzed for are based on the origin of the soil being treated and the types of PHC contamination present as determined during the 2019 contaminated soil investigation (SRK 2020). PHC F1 and benzene, ethylbenzene, toluene, xylenes (BETX) and PHC F4 impacts were not detected at the Main Tank Farm or shop area during the 2019 soil characterization program. Given that PHC F1, F4 and BETX are not parameters of concern in these areas, these parameters need not be included in the remediation confirmatory and remediation performance monitoring testing conducted on soils originating from these areas. During the 2019 soil characterization program select samples were tested for the presence of polycyclic aromatic hydrocarbons (PAHs). PAH impacts were detected at the main tank farm and therefore PAH analyses will be included in the remediation confirmation testing conducted on soils originating from this area. PHC F1 was detected inside the former day tank farm berm and therefore PHC F1 analysis will be included for remediation confirmatory testing conducted on soils originating from this area.

Table 3 Soil quality remediation objectives

Parameter	Surface Soil (mg/g)	Subsoil (mg/kg)
PHC Fraction 1 (F1)	210	700
PHC Fraction 2 (F2)	150	1,000
PHC Fraction 3 (F3)	300	2,500
PHC Fraction 4 (F4)	2,800	10,000
PAH Naphthalene	0.6	0.6
PAH Phenanthene	0.1	0.1

Source: CCME 2018, 2008

5 Temporary stockpile management

During soil excavation at the periphery of identified contamination it is recommended that temporary stockpiles of soil be established adjacent the excavations and the soil tested as described in Section 2.2. No single stockpile should be greater than 150 m^3, with 25 m^3 the optimal size should space be available adjacent the excavation for multiple stockpiles of this size.

The temporary stockpiles are to be placed on areas covered with esker sand, and not onto undisturbed ground or uncovered development waste rock. *In situ* remediation confirmatory samples are to be collected, as described in Section 2.1, upon the removal of temporary stockpiles. Any esker sand found to have contaminants of concern above the SQROs is to be removed and treated in the STF and *in situ* samples collected from the resulting base of the excavation.

Stockpiles should be segregated by field screening and laboratory results, along with visual indications of PHC impacts during excavation into temporary stockpiles with comparable levels of contamination. Soil that is previously confirmed as contaminated above CCME PL subsoil guidelines (i.e. day tank and main tank farm drive thru) can be loaded directly into the haul truck and transferred to the STF. Soil that excavated from areas at the edge of known contamination should be stockpiled separately. Soil from areas with solely oil and grease impacts should not be blended into temporary stockpiles with diesel or gasoline impacted soil. Soil with oil and grease impacts should be packaged for backhaul and transported off-site for treatment.

All temporary stockpiles are to be assigned a unique number (i.e. TSP1, TSP2) and the location recorded on a field sketch.

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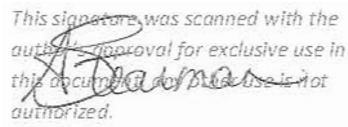

Arlene Stearman, PGeo, FGC
Principal Consultant

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6 References

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