APPENDIX J  REVEGETATION PLAN

Appendix J.1  Snap Lake Mine Revegetation Reclamation Design

Appendix J.2  Revegetation Summary Report
EXECUTIVE SUMMARY

Revegetation at the Snap Lake Mine (Mine) has been identified as a closure activity related to the restoration of native habitat and aesthetics. The objective of this report is to present the final Revegetation Reclamation Design (Revegetation Plan) of Upland areas for the Mine within the Local Study Area. In general, Upland areas are the dry disturbed areas of the Mine. This Revegetation Plan details the locations of revegetation at the Mine, and the methodologies applied to revegetate select Mine components at closure.

The Revegetation Plan was developed to achieve the MVLWB approved site wide (SW) closure objectives (ARKTIS, 2013a):

- SW5 – Landscape features (shape and vegetation) match aesthetics of the surrounding natural area; and,
- SW7 – Revegetation targeted to priority areas.

Closure criteria for the above objectives will provide the measure for revegetation success, as follows:

- Revegetation of priority areas;
- Use of native species; and,
- Mean plant cover of a specified percentage over the LSA.

The following is proposed for mean plant cover (ARKTIS, 2018) and revegetation effort:

- A 5% mean plant coverage on the Upland (dry) revegetation areas is targeted within 5 years, resulting in a mean plant coverage over the LSA of 29.0%. Thus, the criterion is 29.0% plant coverage over the LSA.

To achieve the closure criteria, revegetation of disturbed land will occur according to one of the following methods:

i. Passive - Leave as constructed and natural encroachment of vegetation could occur.
ii. Active-FS - Scarification with native seed and fertilizer applied to the disturbed surface.
iii. Active-OFS - Scarification with overburden placement and native seed and fertilizer applied to the disturbed surface.

The North Pile will be left to naturally revegetate in addition to areas already reclaimed or with limited access or disturbance, as well as other select areas. The Mine building area is identified as the priority area for revegetation and will have overburden placement, along with native seed and fertilizer applied. Site roads, the airstrip and other remaining Upland areas (i.e., laydowns, crusher area, emulsion plant, etc.) will have native seed and fertilizer applied.

The following select areas are outside the scope of this Revegetation Plan:

- North Pile water control structures reclamation is addressed within the North Pile final design.
- Water management pond is addressed within the North Pile final design.
- The winter access spur road, which is primarily located outside the Local Study Area for the Mine is not addressed but is understood to naturally revegetate if disturbed.

Approximately 29,911 m$^3$ of salvaged overburden from the Organics Pile will be spread across the Active-OFS areas in a layer 0.2 m thick. Fertilizer and a grass seed mix consisting of native species will be applied in the spring by broadcast spreader to the designated areas. An appropriate commercial fertilizer mix and application rate will be selected based on soil chemistry and supplier availability. Harrowing of the top 5 to 15 cm of material will occur concurrently with broadcast spreading to incorporate the seed and fertilizer into the soil.

Following completion of reclamation activities, reclamation monitoring will measure the success of the proposed revegetation methods in meeting the closure objectives and criteria. Adaptive management measures will be triggered if monitoring indicates vegetation is stressed, stunted, dying or receding, and/or if revegetation performance indicates that the revegetation criteria will not be achieved.
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1.0 INTRODUCTION

1.1 Project Background

The De Beers Canada Inc. (De Beers) Snap Lake Mine (Mine) is located approximately 220 kilometres (km) northeast of Yellowknife, 30 km south of Mackay Lake, and 100 km south of Lac De Gras, Northwest Territories (see Figure 1). Final regulatory approvals for construction and operation of the Mine were granted in May 2004, and construction began in April 2005. Operation of the Mine commenced in 2007. On December 4, 2015 De Beers announced that it would be suspending operations and that the Mine would be placed under temporary closure termed “care and maintenance” and subsequently into Extended Care and Maintenance. In December 2017 De Beers announced that the Mine will begin preparations for final closure.

During the Environmental Assessment (EA) process (De Beers, 2002), revegetation of disturbed surface materials at the Mine at closure was identified as a topic of interest. Stakeholders expressed a desire for the aesthetics of the site to be similar to the surroundings at closure. In response, the Mine’s Interim Closure and Reclamation Plan (ICRP) (ARKTIS, 2013a) was developed to include the targeted revegetation of select components of the Mine at final closure, as well as, included revegetation as a reclamation research item.

ARKTIS Solutions Inc. (ARKTIS) has been retained by De Beers to develop the final Revegetation Reclamation Design of Upland areas (Revegetation Plan) for the Mine. This Revegetation Plan details the locations of revegetation at the Mine, and the methodologies applied to revegetate select Mine components at closure. The outcomes of revegetation research completed to date for Snap Lake Mine, as well as, at other northern and applicable mine sites (ARKTIS, 2018) have been considered in the development of this Revegetation Plan.

1.2 Purpose, Objectives and Scope

The purpose of the Revegetation Plan is to describe how De Beers will revegetate the Upland (dry), disturbed areas of the Mine within the Local Study Area, which represent the majority of the disturbed areas to be reclaimed at the end of operations. The scope of the Revegetation Plan excludes the following areas:

- North Pile water control structures reclamation which is addressed within the North Pile final design.
- Water management pond which is addressed within the North Pile final design.
- The winter access spur road, which is primarily located outside the Local Study Area for the Mine is not addressed herein but will undergo natural revegetation if disturbed.

The Revegetation Plan was developed to achieve the MVLWB approved site wide (SW) closure objectives (ARKTIS, 2013a) pertaining to revegetation, which include:

- SW5 – Landscape features (shape and vegetation) match aesthetics of the surrounding natural area; and,
- SW7 – Revegetation targeted to priority areas.

The technical content of this report is organized as follows:

- Section 1 presents the purpose and scope of work;
- Section 2 provides an overview of the environmental setting for the Mine;
- Section 3 describes the revegetation methodology;
- Section 4 provides a description of the materials used in the revegetation activities;
- Section 5 summarizes the monitoring program; and,
- Section 6 outlines the adaptive management strategy.
2.0 SITE BACKGROUND

2.1 Project Description

The Mine includes the following key features: underground Mine workings, a processed kimberlite storage facility (the North Pile), Mine facilities and accommodations, an airstrip, water treatment facilities, fuel and ammonium nitrate storage facilities, and during operations an annual seasonal winter access road spur off the Tibbitt-to-Contwoyo winter road. An aerial view of the Mine which depicts the locations for the majority of the mine components is provided in Figure 2. A map of the surface infrastructure is also provided in Figure 1.

Figure 1. Location of Snap Lake Mine, NWT (De Beers, 2015).
2.2 Topography and Surficial Geology

The overall topography of the site can be described as gently sloping with occasional knolls. The elevation of the site varies from approximately 445 m at Snap Lake to approximately 482 m on a knoll located southwest of the Water Management Pond (WMP) (see Figure 3). The natural topography of the North Pile area slopes gently to moderately down from south to north, towards the northwest arm of Snap Lake; however, there are isolated areas of steep slopes, knolls, rugged terrain and local depressions.

Surface drainage in the North Pile area generally flows northwards towards Snap Lake. Surface water and seepage from the Starter Cell and East Cell is collected by perimeter water control structures and
transferred to the WMP and subsequently the water treatment plant for treatment and ultimate discharge to Snap Lake. Construction of West Cell berms and perimeter water control structures began in 2015, however, further construction was postponed with the entry of the mine into care and maintenance.

Surficial geology of the mine site consists of a veneer of Quaternary morainal deposits (till) that contains cobbles and boulders mixed with matrix of sand and silt. The till is generally thin but can be thicker in topographic depressions. Fields of boulders, felsenmeer, and shattered rock debris could also be found in topographic depressions. Bedrock outcrops are common (De Beers, 2002).
Figure 3. Snap Lake Mine layout (Golder, 2016).
2.3 Baseline Vegetation and Ecological Land Classification

The Mine is located in an ecoregion transitional zone between the northern boreal forest to the south and arctic tundra to the north (De Beers, 2002). Vegetation communities consist of open, stunted tree canopies of black spruce (*Picea mariana*) and tamarack (*Larix laricina*) with occasional white spruce (*Picea glauca*). Ground cover is composed of dwarf birch (*Betula pumila var. glandulifera*), willow (*Salix* spp.), ericaceous shrubs, cotton-grass (*Eriophorum* spp.), lichen, and moss species. The dominant soils of this ecoregion are dystric brunisols with some turbic, static, and organic cryosols. Bare rock outcrops are also common. The Snap Lake Mine is within the continuous to discontinuous zones of permafrost.

The impacts of the Snap Lake Mine on the native vegetation communities are assessed at two scales. There is the regional study area (RSA) and the local study area (LSA). The RSA is 301,889 hectares (ha) in size and defined by a circle with a radius of 31 km centred on the Mine site. For the purpose of the Revegetation Plan, the focus will be on the LSA. Note, the historical esker quarry, located south of the Mine and within the RSA, was reclaimed during the construction phase of the Mine and is no longer part of the Mine lease area (Bartlett, 2007); thus, not addressed herein. The LSA is 1,435 ha and includes the land altered by the Mine plus a 500 metre (m) buffer. The LSA includes the site infrastructure, including the airstrip and area surrounding the North Pile. Six Ecological Land Classification (ELC) types are mapped within the LSA: heath boulder, boulder, open spruce forest, riparian tall shrub, tussock-hummock, and water (see Figure 4) (Golder, 2014). The dominant ELC type is the heath boulder complex, followed by tussock-tundra. In addition, smaller units of spruce forest and several shrub units have also been identified.

As of 2018, the total land disturbance associated with the Project within the LSA is 188 ha based on revised estimates from the current site plan (see Section 3.1).
Figure 4. Local Study Area for the Snap Lake Mine (De Beers, 2018).
2.4 Climate

The Mine is located within the Coppermine River Upland Ecoregion of the Taiga Shield Ecozone in the High Subarctic Ecoclimatic Region (Ecological Framework Canada, n.d.). This area is characterized by short, cool summers and long cold winters. The average monthly temperature at the Mine remains below freezing from October through April. Average minimum monthly temperatures at the Mine remain above freezing from June through September, while average maximum temperatures are above freezing from May through October. The air temperature peaks in July with an average value of 13.4°C. The average annual temperature at the Mine is -5.9°C (De Beers, 2002).

Spring freshet occurs in May when high volumes of water is released from the melting snow and freezup occurs in October when average temperatures drop below 0°C and precipitation turns from rain to snow. Based on the derived precipitation data series for Snap Lake, 67% of precipitation occurs as snowfall and 33% as rainfall in an average year (De Beers, 2002). The mean annual rainfall, snowfall and total precipitation at the Mine are 149 mm, 207 mm, and 356 mm, respectively. Monthly rainfall peaks in August.

3.0 REVEGETATION DESIGN & CONCEPT

3.1 Revegetation Methods

Revegetation of disturbed areas can follow one of two general methods: passive revegetation or active revegetation. Passive revegetation refers to the natural colonization and succession of disturbed sites by local native plant species. Active revegetation refers to initiating plant establishment by means of seeding, transplanting or related activities. Various surface treatments can be employed for either approach to support the establishment of vegetation, including but not limited to, scarification (i.e. loosening of surface materials to facilitate encroachment of local plant species), overburden placement, and fertilizer application.

To facilitate the revegetation of disturbed areas, three revegetation approaches have been applied. They consist of both passive and active approaches and include:

i. Passive – Leave as constructed and natural encroachment of vegetation could occur.

ii. Active-FS – Scarification with native seed and fertilizer applied to the disturbed surface.

iii. Active-OFS – Scarification with overburden placement and native seed and fertilizer applied to the disturbed surface.

The revegetation design is focused on the Upland (dry) disturbed areas of the Mine, as depicted in Drawing 1 (see Appendix B). The revegetation approaches applied to the dry disturbed areas is presented in Drawing 2. The Lowland (wet) disturbed areas of the Mine nearly exclusively consist of the North Pile water control structures and water management pond, including proposed constructed wetlands, spillways and ditches that are not yet constructed. As noted, these areas of the Mine are outside the scope of this report. Reclamation of these areas are addressed within the North Pile final design.

The Passive approach is applied to locations where reclamation activities have already been conducted (e.g. former ammonium nitrate storage pad), where disturbance is relatively light and natural recovery is already well underway, or where equipment access may be limited by uneven or sloped terrain (e.g. quarry, laydown slopes, etc.). Additionally, the Passive area includes the North Pile which will be left to naturally revegetate, which was the approach selected in the EA (De Beers, 2002) and is consistent with approaches at other northern diamond mine sites. Additional select areas will also be passively reclaimed.

The Active-OFS approach is applied to the Mine building area, which is identified as the priority area for revegetation and will have overburden placement, along with native seed and fertilizer applied.

The Active-FS approach is applied to site roads, the airstrip and other remaining dry areas (i.e., laydowns, crusher area, emulsion plant, etc.) and will have native seed and fertilizer applied.
Table 1 provides a summary of the areas for each revegetation approach.

Table 1. Revegetation approach for disturbed areas.

<table>
<thead>
<tr>
<th>Revegetation Approach</th>
<th>Revegetation Method</th>
<th>Area Size (m²)</th>
<th>Percentage of Disturbed Area</th>
</tr>
</thead>
<tbody>
<tr>
<td>Active-FS</td>
<td>Scarify, fertilize, and seed</td>
<td>477,778</td>
<td>47.8 24.1</td>
</tr>
<tr>
<td>Active-OFS</td>
<td>Scarify, overburden, fertilize, and seed</td>
<td>149,554</td>
<td>15.0 7.5</td>
</tr>
<tr>
<td>Passive</td>
<td>Natural revegetation</td>
<td>955,362</td>
<td>95.5 48.1</td>
</tr>
<tr>
<td>n/a</td>
<td>Out of project scope</td>
<td>401,925</td>
<td>40.2 20.3</td>
</tr>
<tr>
<td><strong>Total Disturbed Area within LSA</strong></td>
<td></td>
<td><strong>1,984,619</strong></td>
<td><strong>198.5 100.0 (14% of total LSA)</strong></td>
</tr>
</tbody>
</table>

Note:

- Represents the percentage of the total disturbed area and not of the total LSA.
- Includes future area of proposed constructed wetlands, ditches and spillways.
- n/a = not applicable

### 3.2 Revegetation Techniques

All active revegetation areas will be scarified, followed by the addition of seed and fertilizer. Scarification will be completed using toothed rippers (subsoilers) affixed to bulldozers or excavators. Surface materials will be loosened to a minimum depth of 20 cm to improve substrate conditions and encourage vegetation establishment and growth. The roughened and decompacted surface provides for aeration, water absorption, root penetration and shelter from the elements, as well as captures runoff, seed and snow for soil insulation.

Overburden will be placed at the Active-OFS area. Overburden from the Organics Pile on site will be spread to a nominal depth of 20 cm. Overburden will be placed over any cover material that is placed above concrete foundations. Prior to overburden placement, boulders greater than 600 mm that would restrict the ability to spread the salvaged soil at reclamation sites will be removed during the material handling process.

Fertilizer and seed will be applied by broadcast spreader or carried by hand for difficult terrain. Fertilizer will be applied first, as additional passes by equipment will help to work it deeper into the soil. Spreading fertilizer and seed concurrently is not recommended for the two materials will disassociate within the spreader container and would result in non-uniform application (Matheus and Omtzigt, 2013). Fertilizer will not be applied to areas less than 30 m from any water body to reduce potential impacts from runoff. Once fertilizer and seeds have both been applied to an area, the top 5 cm of material will be lightly harrowed (i.e., tilled) to incorporate the seed and fertilizer into the soil. This activity aims to improve germination rates and reduce volatilization of the fertilizer (Matheus and Omtzigt, 2013). Harrowing can be completed at the same time as seeding/fertilizing by pulling a tine harrow behind the broadcast spreader. If relatively light equipment is used to pull the broadcast spreader (e.g., ATV), a minimum of two passes of harrowing should be completed to increase soil contact since ATV pulled harrows typically have limited penetration depth, especially within coarser materials. For rough terrain, harrowing can be conducted by hand with a rake.

For slopes along the edges of roads, pads and laydowns where equipment cannot safely access or is difficult, no scarification, fertilizing, seeding, or overburden placement will occur. These areas will be left to naturally revegetate.

Fertilizer mixes and application rates will be based on soil chemistry and is described in Section 4.2. Seeds will be applied at the following rates:

- 1,500 seeds/m² at Active-FS areas that will require scarifying, fertilizing, and seeding; and,
- 750 seeds/m² at Active-OFS areas that will require scarifying, overburden placement, fertilizing, and seeding.
To achieve the correct application rates, seed/fertilizer are to be weighed to the appropriate amount for the size of the area to be treated, and uniformly applied across the location. Seeding of areas is to take place in the spring to allow seeds maximum amount of time to take root prior to winter and provide a higher chance of surviving until the following year. Seed species and mixes are described in Section 4.1.

### 3.3 Revegetation Closure Criteria

Closure criteria associated with the closure objectives listed in Section 1.2 will provide the measure for revegetation success. The criteria presented by De Beers in 2017 (MVLWB, 2017) and used as the design basis for the Revegetation Plan are as follows:

- Revegetation of priority areas;
- Use of native species; and,
- Mean plant cover of a specified percentage over the LSA.

Native plant species will be used in revegetation and are addressed in Section 4.3. The priority areas for revegetation were selected to be the Mine building area, and as such, will be subject to additional revegetation effort relative to other areas as discussed in Section 3.1. Based on research completed at the Mine, and other northern mines, the following is proposed for mean plant cover (ARKTIS, 2018):

- A 5% mean plant coverage on the Upland (dry) revegetation areas is targeted within 5 years, resulting in a mean plant coverage over the LSA of 29.0%. Thus, the criterion is 29.0% mean plant coverage over the LSA.

Table 2 presents the calculated plant coverage over the LSA for the assumed levels of recovery that develops on the disturbed mine areas after 5 years post-closure. Given the slow growth rate and life cycle of vegetation within the LSA, the criteria for plant coverage set at 5 years post-closure is considered a practicably achievable level of growth within a reasonable timeframe. The measurement methods proposed for evaluating reclamation performance is addressed in Section 5.0 with post-closure monitoring.

Table 2. Mean plant coverage of the LSA resulting from the mean plant cover of the disturbed and undisturbed areas of the Mine over time.

<table>
<thead>
<tr>
<th>Area</th>
<th>Size (ha)</th>
<th>Assumed Plant Cover 5-years Post-Closure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Active-FS</td>
<td>47.8</td>
<td>5%</td>
</tr>
<tr>
<td>Active-OFS</td>
<td>15.0</td>
<td>5%</td>
</tr>
<tr>
<td>Passive</td>
<td>95.5</td>
<td>0%</td>
</tr>
<tr>
<td>Out of project scope</td>
<td>40.2</td>
<td>0%</td>
</tr>
<tr>
<td>Undisturbed area</td>
<td>815.4</td>
<td>35.7%</td>
</tr>
<tr>
<td><strong>Total LSA</strong></td>
<td><strong>1013.9</strong></td>
<td><strong>29.0%</strong></td>
</tr>
</tbody>
</table>

a Areas left to naturally revegetate and disturbed areas outside the Plan’s scope are assumed to have 0% cover at 5-years post-closure.

b Based on the remaining area of the LSA’s constituent ELC units and their baseline mean plant cover as presented in the EAR (De Beers, 2002).

c Excludes water.
4.0 REVEGETATION MATERIALS

4.1 Overburden

Salvaged overburden is currently stockpiled at the Organics Pile on site (Figure 2). Based on survey data collected in 2013 (ARKTIS, 2013b), approximately 130,100 m$^3$ of salvaged overburden is available. This volume is not expected to have significantly changed, since the only notable construction activities to occur on site since that time were the initial construction of West Cell access roads and a containment dyke, neither of which are expected to have contributed significant quantities of salvaged surface material to the Organics Pile. Of the total salvaged materials, roughly 30% is assumed to be made up of boulders and shattered bedrock which was collected along with the adjacent soils during removal (ARKTIS, 2013b).

The Organics Pile is approximately 2 ha in area with mean depth of 6.5 m (ARKTIS, 2013b). Due to the size and length of time the stockpile has been in place, permafrost aggradation into the pile may have occurred. Measures may be taken during execution of the Revegetation Plan to minimize effort to load and spread material from the Organics Pile. This may include stripping the active layer to permit the underlying soils to thaw prior to stripping another layer. This practice could be completed several times over a season. Alternatively, if frozen material in the Organics Pile can be loaded onto a truck, the material once dumped at the designated areas identified in Drawing 2 could remain until thawed to facilitate spreading. A combination of both approaches may be required and will be assessed at time of construction.

Salvaged overburden will be applied to the Mine building area at the east end of the Mine site. Based on the size of this area (Table 1) and a planned overburden layer of 0.2 m thickness, approximately 29,911 m$^3$ of overburden is required. Assuming 70% of the total Organics Pile volume is available for use after removal of boulders (91,070 m$^3$), it is estimated there is sufficient quantity for use at the Active-OFS area. Any excess overburden will be left in place and revegetated per the approach specified in Drawing 2.

4.2 Fertilizer

The fertilizer mix and application rate for the disturbed areas will be based on the soil chemistry. The nutrient range for salvaged overburden material, based on past soil analysis conducted at the Organics Pile (ARKTIS, 2013b) and former ammonium nitrate (AN) storage pad revegetation test plots (ARKTIS, 2016a), are presented in Table 3. Soil classification and the recommended fertilizer application rates from the Yukon Revegetation Manual (Matheus and Omtzigt, 2013) are also provided in Table 3. The construction gravel composing the majority of disturbed site surfaces is assumed to be low in all nutrients.

Table 3. Nutrient classification and recommended fertilizer application rates for disturbed surface materials and salvaged overburden at the Mine.

<table>
<thead>
<tr>
<th>Soil Type</th>
<th>Nutrient</th>
<th>Range (ppm)</th>
<th>Average (ppm)</th>
<th>Classification</th>
<th>Fertilizer Application Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Site surface material $^a$</td>
<td>Available Nitrate-N</td>
<td>n/a</td>
<td>n/a</td>
<td>Low</td>
<td>90 – 60 kg/ha N</td>
</tr>
<tr>
<td></td>
<td>Available Phosphate-P</td>
<td>n/a</td>
<td>n/a</td>
<td>Low</td>
<td>70 – 50 kg/ha P$_2$O$_5$</td>
</tr>
<tr>
<td></td>
<td>Available Potassium-K</td>
<td>n/a</td>
<td>n/a</td>
<td>Low</td>
<td>60 – 40 kg/ha K$_2$O</td>
</tr>
<tr>
<td></td>
<td>Available Sulfate-S</td>
<td>n/a</td>
<td>n/a</td>
<td>Low</td>
<td>17 kg/ha S</td>
</tr>
<tr>
<td></td>
<td>Organic Matter</td>
<td>n/a</td>
<td>n/a</td>
<td>Low</td>
<td>No adjustment required</td>
</tr>
<tr>
<td>Salvaged overburden $^b$</td>
<td>Available Nitrate-N</td>
<td>6.7 - 79</td>
<td>26.9</td>
<td>Moderate – High</td>
<td>40 – 0 kg/ha N</td>
</tr>
<tr>
<td></td>
<td>Available Phosphate-P</td>
<td>3.1 - 12.5</td>
<td>5.5</td>
<td>Low</td>
<td>70 – 50 kg/ha P$_2$O$_5$</td>
</tr>
</tbody>
</table>
### Soil Type and Nutrient Classification

<table>
<thead>
<tr>
<th>Soil Type</th>
<th>Nutrient</th>
<th>Range (ppm)</th>
<th>Average (ppm)</th>
<th>Classification</th>
<th>Fertilizer Application Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Available Potassium-K</td>
<td>47 - 96</td>
<td>63.5</td>
<td>Low</td>
<td>60 – 40 kg/ha K₂O</td>
<td></td>
</tr>
<tr>
<td>Available Sulfate-S</td>
<td>8.3 - 64</td>
<td>33.6</td>
<td>Moderate – High</td>
<td>0 kg/ha S</td>
<td></td>
</tr>
<tr>
<td>Organic Matter</td>
<td>5.3% - 15.6%</td>
<td>9.1%</td>
<td>Moderate</td>
<td>Decrease N-P-K-S by 10 kg/ha each</td>
<td></td>
</tr>
</tbody>
</table>

- **a** Assumed low in nutrients based on a composition of primarily granite construction gravel and crush.

Commercial fertilizers will indicate their formulation as a weight percentage of the nutrients they contain. For example, a formula of 16-20-10 (14) indicates a fertilizer mix of 16% nitrogen (N), 20% phosphorus (measured as P₂O₅ equivalent), 10% potassium (measured as K₂O equivalent) and 14% sulphur (S). To calculate the total amount of fertilizer that will deliver a particular amount of each nutrient, multiply the desired amount of nutrient by 100 and divide by the percent of nutrient present in the fertilizer. Example:

- **desired amount of nitrogen:** 90 kg/ha (site surface material from Table 3)
- **fertilizer blend being used:** 20-24-15
- **rate of fertilizer application:** \( \frac{90 \times 100}{20} = 450 \text{ kg/ha} \)
- **450 kg/ha of 20-24-15 would also supply:** \( \frac{24 \times 450}{100} = 108 \text{ kg/ha of P}_2\text{O}_5 \) (70-50 kg/ha desired)
- **and:** \( \frac{15 \times 450}{100} = 68 \text{ kg/ha of K}_2\text{O} \) (60-40 kg/ha desired)

Using the above example, the total quantity of fertilizer required for all active revegetation areas not receiving overburden (52.77 ha) would be 23,747 kg for a single application. Depending on revegetation performance, additional applications may be required at different application rates based on updated soil chemistry.

Based on the recommended nutrient application rates in Table 3, potentially suitable fertilizer blends as well as the resultant quantities required for the reclamation areas are provided in Table 4.

### Table 4. Potential fertilizer blends and quantities for revegetation areas.

<table>
<thead>
<tr>
<th>Fertilizer Blend N-P-K (S)</th>
<th>Application Rate (kg/ha)</th>
<th>Area (ha)</th>
<th>Fertilizer Quantity (kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Active-FS</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>30-25-20 (7)</td>
<td>250</td>
<td>47.8</td>
<td>11,950</td>
</tr>
<tr>
<td><strong>Active-OFS</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10-30-25 (0)</td>
<td>200</td>
<td>15.0</td>
<td>3,000</td>
</tr>
</tbody>
</table>

An appropriate commercial fertilizer mix will be selected during reclamation based on supplier availability. At that time, the recommended nutrient application rates and fertilizer blends will potentially be revised based on updated soil chemistry data for disturbed areas and salvaged overburden. The selected mix will deliver at least the minimum required amount for each nutrient (especially nitrogen), even if it means two or more nutrients are supplied in excess. Where possible, the use of slow release fertilizers (1 to 2 year release) should be used instead of quick release fertilizers.
4.3 Seeds

Active revegetation areas will be treated with species native to the region. The candidate species selected have a demonstrated track record at other revegetation projects and are tolerant to drought and low nutrient conditions (ARKTIS, 2014). A subset have also demonstrated success in the on-site revegetation test plots research (ARKTIS, 2017).

Table 5 provides the list of native species selected for active revegetation areas.

All selected species are graminoids (i.e., grasses). Grasses were chosen for four primary reasons:

- They are commercially available and economically practicable.
- They can produce a large amount of biomass and thus ground coverage that will aid in meeting revegetation criteria.
- They grow rapidly.
- They are the only plant strata with clear on-site success at the revegetation test plots, with other species having only limited or variable success to date or insufficient data to adequately evaluate.

In addition, other species such as forbs and shrubs have proven to be prohibitive in terms of cost and/or timing to develop sufficient seed stock for site wide reclamation (ARKTIS, 2016b).

The quantity of seed required, based on the areas to be treated and application rates as described in Section 3.1 and 3.2 respectively, is provided in Table 5.

Table 5. Native species selected for revegetation and quantity of seeds required.

<table>
<thead>
<tr>
<th>Common Name</th>
<th>Scientific Name</th>
<th>Reason to Use</th>
<th>No Overburden</th>
<th>Overburden</th>
<th>Total kg</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alpine bluegrass</td>
<td>Poa alpina</td>
<td>Strongly tufted perennial bunchgrass. Good colonizer. Tolerant to moderately acidic soils, low nutrients and drought. Grows best in well-drained areas with coarse sediments, including rock.</td>
<td>375</td>
<td>187.5</td>
<td>176.1</td>
</tr>
<tr>
<td>Rocky mountain fescue</td>
<td>Festuca saximontana</td>
<td>Tolerant to dry alkaline soils, low nutrients and permafrost. Bunchgrass with rapid emergence in early spring. Do not use on wet or acidic sites.</td>
<td>375</td>
<td>187.5</td>
<td>289.8</td>
</tr>
<tr>
<td>Spiked trisetum</td>
<td>Trisetum spicatum</td>
<td>Erect bunchgrass. Tolerant to drought, low nutrient conditions. Grows best on coarse, well-drained sediments and will perform well on poorly developed shallow soils. Works well for erosion control.</td>
<td>375</td>
<td>187.5</td>
<td>75.4</td>
</tr>
<tr>
<td>Tickle grass</td>
<td>Agrostis scabra</td>
<td>Tolerant to acidic soils, drought and low nutrients, and permafrost. Short-lived bunchgrass with early emergence. A common pioneering plant on dry flat ground.</td>
<td>375</td>
<td>187.5</td>
<td>37.7</td>
</tr>
</tbody>
</table>

Seed Mix Total: 1,500 kg/PLS/m² 750 kg/PLS/m² 578.9 kg

Note – Total kg of seed required was estimated assuming 47.8 ha of Active-FS, and 15.0 ha of Active-OFS. Assumes 50% pure live seed (PLS), total application rates of 1,500 PLS/m² for Active-FS and 750 PLS/m² for Active-OFS with all graminoid species making up equal proportions of the seed mix. Based on seed densities from the Yukon Revegetation Manual (Matheus and Omtzigt, 2013).
5.0 MONITORING

5.1 Execution Monitoring and Reporting

During execution of the revegetation program, soil sampling will occur to assess as-constructed conditions, including:

- soil nutrients including nitrogen, phosphorous, potassium and sulphur;
- pH;
- electrical conductivity;
- cation exchange capacity;
- salinity;
- particle size;
- total carbon;
- total nitrogen;
- organic matter;
- major ions; and,
- metals analysis (CCME, 1999).

A target of one soil sample per two hectares will be applied.

Field measurements will be collected for every hectare and will include:

- soil texture;
- soil bulk density;
- overburden thickness;
- scarification depth; and,
- estimate of microtopography.

Additionally, as-constructed documentation will be developed to demonstrate conformance with the design, including areas scarified, fertilized and/or overburden placed, as well as, rates of fertilizer and seed application, and overburden soil thickness.

5.2 Post-Construction Monitoring

After execution of the revegetation program, the following monitoring program will be implemented.

5.2.1 Reclamation Monitoring Locations

The focus of the reclamation monitoring is to measure the success of revegetation methods in meeting the closure objectives and associated closure criteria. The results of the reclamation monitoring will also be used to inform the adaptive management strategies, as presented in Section 6.0.

Reclamation sample plots will be established to measure plant cover within each of the following reclamation areas:

- Active-FS - Areas scarified, fertilized and seeded;
- Active-OFS - Areas scarified, overburden applied, fertilized and seeded; and,
- Passive - Natural revegetation areas.

For active revegetation areas, a target of one sample plot per 5 ha was applied. For passive revegetation areas, a target of one sample plot per 10 ha was applied, for a total of twenty-four sample plots. Prior to execution of the first monitoring program, an initial assessment of the site will be made to evaluate whether the number of sample plots is sufficient to capture the variability in revegetation performance. Based on the
assessment, monitoring plots may be eliminated or additional plots established to ensure a representative mean is achieved.

5.2.2 Reclamation Monitoring Methods

5.2.2.1 Vegetation Sampling

Vegetation data will be collected from the reclamation sampling plots using standardized 5 m by 5 m plots. This is considered an adequate size to capture trees, shrubs, low growing ground cover, boulders, and other terrain features. Twenty-four reclamation sample plots will be established as shown in Drawing 3. As noted in Section 5.2.1 the quantity of sample plots will be assessed at time of monitoring. Each plot will be divided into four quadrants. A 1 m by 1 m quadrat will be placed within the centre of each quadrant for 4 sample locations. The location of each plot will be marked on a map and the Universal Transverse Mercator (UTM) coordinates recorded using a hand-held GPS device. Plots will be marked with a stake in the southwest corner of the plot, and the plot photographed looking northeast from this corner.

5.2.2.2 Soil Sampling

Soil sampling will be conducted to compare the soil character at the time of collection to previous conditions. The results from the soil analysis will evaluate the impact of fertilizer application, plant growth and soil chemistry over time. Soil samples will be collected adjacent to the reclamation plot for analysis. Samples will be taken from 0 to 15 cm depth. One out of every two revegetation plots will have a soil sample collected, for a total of twelve soil samples. If there are indications of vegetation stress, poor vigour, or plant die-back, soil sampling at affected locations will be implemented as required to assess if changes in the growth media are influencing plant vigour and/or establishment.

5.2.3 Reclamation Monitoring Frequency

Once reclamation is complete, the reclamation sample plots will be monitored annually for the first five years. If after five years the closure criteria are not achieved, the reclamation plots will be monitored on a five-year period until the closure criteria are achieved. The frequency of reclamation monitoring is subject to change pending results, trends, and regulatory requirements.

5.2.4 Reclamation Monitoring Parameters

For years 1, 3 and 4, the reclamation plots will be assessed for the following:

- Percent plant cover by vegetation layer (i.e. low shrub layer, graminoid, forb, bryophyte, and terrestrial and epiphyte lichen)
- Total percent cover

For years 2 and 5, and every subsequent 5 year event, the reclamation plots will be assessed for the following:

- Percent plant cover by vegetation layer
- Percent plant cover by species
- Total percent cover

Additionally, at each reclamation plot the following information will be recorded:

- Species vigour (health);
- Presence of weed species (i.e. non-endemic);
- Wildlife sign (e.g. tracks, fecal pellets/droppings, burrows and nests) or species observation;
- Landscape features, aspect, and slope angle or profile;
Soil analysis of collected samples will be completed for years 2 and 5 and then additional sampling based on revegetation performance. Soils will be evaluated for the following:

- Soil nutrients including nitrogen, phosphorous, potassium and sulphur;
- pH;
- electrical conductivity;
- cation exchange capacity;
- salinity;
- particle size;
- total carbon;
- total nitrogen;
- organic matter;
- major ions;
- metals analysis (CCME, 1999);
- soil texture;
- soil bulk density;
- overburden thickness; and,
- estimate of microtopography.

These proposed parameters are subject to change as findings from the post-reclamation monitoring become available.

### 5.2.5 Reclamation Monitoring Data Analysis and Reporting

The monitoring data will be used to evaluate if closure criteria are achieved, and if adaptive management triggers are exceeded which may trigger additional reclamation efforts. The results of the revegetation monitoring program will be documented annually as part of the mine’s post-reclamation program. A summary of the closure criteria and method of evaluation is provided in Table 6.
Table 6. Summary of revegetation criteria monitoring and method of assessing success.

<table>
<thead>
<tr>
<th>Closure Criterion</th>
<th>Method of Evaluation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Revegetation of priority areas</td>
<td>As-constructed survey of active reclamation areas and comparison to areas and locations in Drawing 1.</td>
</tr>
<tr>
<td>Native plant species used</td>
<td>As-constructed documentation that includes purchase of designed seed mix.</td>
</tr>
<tr>
<td>29.5% plant coverage over the LSA</td>
<td>Plant coverage for each of the following revealation areas will be calculated based on the average measurements from the revegetation plots.</td>
</tr>
<tr>
<td></td>
<td>• Areas scarified, fertilized and seeded</td>
</tr>
<tr>
<td></td>
<td>• Areas scarified, overburden applied, fertilized and seeded</td>
</tr>
<tr>
<td></td>
<td>• Natural revegetation areas</td>
</tr>
</tbody>
</table>

\[
\text{Mean plant coverage over LSA} = \frac{\sum C_X S_X}{S_{total}}
\]

<table>
<thead>
<tr>
<th>Area</th>
<th>Size (ha)</th>
<th>Plant Coverage (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scarify, fertilize, and seed(^1)</td>
<td>S(_1) – 47.8</td>
<td>C(_1) – average from revegetation plots</td>
</tr>
<tr>
<td>Scarify, overburden, fertilize, and seed(^1)</td>
<td>S(_2) – 15.0</td>
<td>C(_2) – average from revegetation plots</td>
</tr>
<tr>
<td>Natural revegetation</td>
<td>S(_3) – 95.5</td>
<td>C(_3) – average from revegetation plots</td>
</tr>
<tr>
<td>Out of project scope</td>
<td>S(_4) – 40.2</td>
<td>C(_4) – 0 or based on on-site measurements</td>
</tr>
<tr>
<td>Undisturbed areas(^2)</td>
<td>S(_5) – 815.4</td>
<td>35.7</td>
</tr>
<tr>
<td>Total LSA(^2)</td>
<td>S(_{total}) – 1013.9</td>
<td>-</td>
</tr>
</tbody>
</table>

\(^1\) Size of area to be updated based on as-constructed documentation.  
\(^2\) Excludes water.

6.0 ADAPTIVE MANAGEMENT STRATEGIES

Monitoring will indicate if vegetation is stressed, stunted, dying or receding, and/or if the level of recovery has met or is on track to meet the revegetation criteria for a mean percent cover for the LSA within the first five years post-closure. The action levels for implementing additional revegetation efforts will be as follows:

- **Action Level I** – mean percent cover for the active revegetation areas less than 2.5% after 3 years post-reclamation.
- **Action Level II** – mean percent cover for the active revegetation areas less than 3.75% after 4 years post-reclamation.
- **Action Level III** – mean percent cover for the active revegetation areas less than 5% after 4 years post-reclamation.

The management action that will be implemented for each of the action levels is as follows:

- **Action Level I** – continue monitoring, no mitigation necessary.
- **Action Level II** – internal review and development and implementation of action plan for additional revegetation efforts.
- **Action Level III** – external review and development and implementation of action plan for additional revegetation efforts.
Internal review is completed by De Beers and external review would be completed by qualified consultant. Additional revegetation efforts may include, but not limited to: watering, additional seeding, fertilizing, scarification or some combination thereof. It is likely that success between treatments and areas in meeting criteria will vary. The selection and application of additional reclamation efforts will be based on professional judgement and informed by the monitoring.

Within the first five years it is possible for revegetation growth to be slow or become compromised due to the short growing season as well as the harsh winter conditions. Therefore, it is not unusual for one or two re-seeding events to be required the first few years following the first seeding event. Due to the challenging conditions, revegetation efforts may not be successful in some areas, despite the use of best management practices.

7.0 CLOSING

This report has been prepared exclusively for the use of De Beers Canada Inc. for the specific application described within this report. The details provided in this report are for general information purposes only. The information and recommendations contained in this report should not be used for any other purpose, at another location, or by any other parties. Any use of, or reliance on this report by any third party is at that party’s sole risk. ARKTIS assumes no responsibility for inappropriate use of the contents of this report, and disclaims all liability arising from negligence or otherwise. General terms and conditions are provided in Appendix A.

ARKTIS SOLUTIONS INC.

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Environmental Geoscientist

Jamie Van Gulck, Ph.D., P.Eng. 
Principal
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APPENDIX A: GENERAL TERMS AND CONDITIONS
USE OF REPORT

This report pertains to a specific site, a specific development, and a specific scope of work. It is not applicable to any other sites, nor should it be relied upon for types of development other than those to which it refers. Any variation from the site or proposed development would necessitate a supplementary investigation and assessment.

This report and the assessments and recommendations contained in it are intended for the sole use of ARKTIS Solutions Inc.’s (ARKTIS) client. ARKTIS does not accept any responsibility for the accuracy of any of the data, the analysis or the recommendations contained or referenced in the report when the report is used or relied upon by any party other than ARKTIS’ client unless otherwise authorized in writing by ARKTIS. Any unauthorized use of the report is at the sole risk of the user.

LIMITATIONS OF REPORT

This report is based solely on the conditions which existed on site at the time of ARKTIS’ investigation. The client, and any other parties using this report with the express written consent of the client and ARKTIS, acknowledge that conditions affecting the environmental assessment of the site can vary with time and that the conclusions and recommendations set out in this report are time sensitive.

The client, and any other party using this report with the express written consent of the client and ARKTIS, also acknowledge that the conclusions and recommendations set out in this report are based on limited observations and testing on the subject site and that conditions may vary across the site which, in turn, could affect the conclusions and recommendations made.

The client acknowledges that ARKTIS is neither qualified to, nor is it making, any recommendations with respect to the purchase, sale, investment or development of the property, the decisions on which are the sole responsibility of the client.

During the performance of the work and the preparation of this report, ARKTIS may have relied on the information provided by persons other than the client. While ARKTIS endeavors to verify the accuracy of such information when instructed to do so by the client, ARKTIS accepts no responsibility for the accuracy or the reliability of such information which may affect the report.

STANDARD OF CARE

Services performed by ARKTIS for this report have been conducted in a manner consistent with the level of skill ordinarily exercised by members of the profession currently practicing under similar conditions in the jurisdiction in which the services are provided, subject to the time limits and financial and physical constraints applicable to the services. Professional judgment has been applied in developing the conclusions and/or recommendations provided in this report. No warranty or guarantee, express or implied, is made concerning the test results, comments, recommendations, or any other portion of this report.

ALTERNATE REPORT FORMAT

Where ARKTIS submits both electronic file and hard copy versions of reports, drawings and other project related documents and deliverables (collectively termed instruments of professional service), the Client agrees that only the signed and sealed hard copy versions shall be considered final and legally binding. The hard copy versions submitted by ARKTIS shall be the original documents for record and working purposes, and, in the event of a dispute or discrepancies, the hard copy versions shall govern over the electronic versions. Furthermore, the Client agrees and waives all future right of dispute that the original hard copy signed version archived by ARKTIS shall be deemed to be the overall original for the Project.

The Client agrees that both electronic file and hard copy versions of instruments of professional services shall not, under any circumstances, no matter who owns or uses them, be altered by any party except ARKTIS. The Client warrants that instruments of professional services will be used only and exactly as submitted by ARKTIS.
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1. THIS DRAWING IS NOT TO BE SCALLED.
2. CONTRACTOR IS TO VERIFY ALL DIMENSIONS ON SITE.
3. ALL PARTIES USING THESE DRAWINGS SHALL REVIEW THEM PRIOR TO QUOTING AND CONSTRUCTION OF ANY AND ALL ASPECTS OF THE WORK AND REPORT ANY ERRORS, OMISSIONS AND/OR DEFICIENCIES IMMEDIATELY TO ARKTIS SOLUTIONS INC.
1. THIS DRAWING IS NOT TO BE SCALABLE.
2. CONTRACTOR IS TO VERIFY ALL DIMENSIONS ON SITE.
3. ALL PARTIES USING THESE DRAWINGS SHALL REVIEW THEM PRIOR TO QUOTING AND CONSTRUCTION OF ANY AND ALL ASPECTS OF THE WORK AND REPORT ANY ERRORS, OMISSIONS AND/OR DEFICIENCIES IMMEDIATELY TO ARKTIS SOLUTIONS INC.

AREAS
- 639,819 m²
- 245,395 m²
- 809,818 m²
- 401,925 m²

Snap Lake Mine Final Revegetation Plan Design

Arktis solutions

March 2018

Active-IS
Active-OFS
Passive
Out of Project Scope
1. This drawing is not to be scaled.
2. Contractor is to verify all dimensions on site.
3. All parties using these drawings shall review them prior to quoting and construction of any and all aspects of the work and report any errors, omissions and/or deficiencies immediately to Arktis Solutions Inc.
DE BEERS CANADA INC., SNAP LAKE MINE - REVEGETATION SUMMARY REPORT

March 04, 2018

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APPENDIX B: GENERAL TERMS AND CONDITIONS
1.0 INTRODUCTION

ARKTIS Solutions Inc. (ARKTIS) was retained by De Beers Canada Inc. (De Beers) to complete closure and reclamation services for the Snap Lake Mine (Mine). During the Environmental Assessment (EA) process, revegetation of disturbed surface materials at the Mine at closure was identified as a topic of interest (De Beers, 2002b). Thus, the Interim Closure and Reclamation Plan Version 4 (ICRP v4) (ARKTIS, 2017b) describes the closure activities, objectives, criteria and research plans on this subject. A summary of the revegetation research completed each year is presented in the Annual Closure and Reclamation Plan Progress Report, which is submitted annually to the Mackenzie Valley Land and Water Board, as per Part I, Item 2 of the Water Licence (MV2011L2-0004).

This report presents an overview of select components of the revegetation research completed at De Beers’ Snap Lake Mine (Mine), as well as, at other northern and applicable mine sites. The purpose of this report is to summarize the following research topics identified in the ICRP v4 Reclamation Research Plan:

- Best management practices with regards to revegetation of dry disturbed areas as documented through successful revegetation practices at comparable mine sites.
- Options for surface preparation (e.g. re-contouring, roughening, erosion control, salvaged soil spreading, etc.) to promote natural growth in dry upland areas.
- Metrics applied to measure revegetation success.
- Potential for metals uptake in vegetation at processed kimberlite (PK) areas post closure.

The research findings will be used to support the preparation of a Final Revegetation Plan for the Mine and inform the Mine’s closure and reclamation plan.

2.0 BEST MANAGEMENT PRACTICES FOR REVEGETATION AT NORTHERN MINE SITES

A summary of the main revegetation research projects and the outcomes considered applicable for consideration in the development of a Final Revegetation Plan for the Mine is provided in this section. Discussion is focused on research related to the revegetation of dry upland areas, since these areas will represent the primary component of the disturbed area to be reclaimed at the end of operations at the Mine. Only limited wet lowland areas exist at the Mine that necessitate revegetation and are therefore not the focus of the research herein. In addition, discussion is limited to general research outcomes related to surface preparation options and management practices. For more specific research findings, such as best performing plant species, levels of percent ground coverage, and seed or fertilizer application rates, the referenced research reports should be consulted.

Revegetation research completed at Snap Lake is summarized below. A summary of relevant research completed at the Ekati and Diavik diamond mines, as well as the Colomac mine are provided in the following sub-sections as well. These sites represent reasonable comparable northern locations to the Snap Lake Mine, with potentially similar substrate compositions and environmental characteristics for revegetation. They also provide the most complete and publicly available documentation of revegetation research available in a similar northern climate as the Snap Lake Mine. A brief review of the Yukon Revegetation Manual as a source of revegetation methods and approaches is also provided. Following this, a general summary of the surface preparation options and recommended best management practices, as observed from the research, is provided.

2.1 Snap Lake Mine

The revegetation goal at the Mine is to achieve the re-establishment of native vegetation at priority areas. Research conducted to identify effective methods to revegetate disturbed areas are described in further detail within the sub-sections that follow, which have been divided between natural/passive and active approaches.

2.1.1 Natural/Passive Revegetation

Passive revegetation refers to the natural colonization and succession of disturbed sites by local native plant species. In 2004/05, eleven natural recovery sample plots were established in off-site areas outside
the Mine footprint prior to commencement of mining activities as part of the Vegetation Monitoring Program (VMP) at the Mine (Golder, 2014). The plots provide a measure of the rate and effectiveness of passive recovery as a revegetation method, including percent cover and species diversity. These plots were last surveyed in 2013 and a total of 74 plant species had naturally colonized the disturbed sites (Golder, 2014). Results are presented within the Annual VMP reports to fulfill a requirement of the Environmental Agreement (INAC et al., 2004), and are available on the Snap Lake Environmental Monitoring Agency (SLEMA) website at the link below.


With regards to surface preparation in a revegetation program, main outcomes from this research include:

- Passive recovery is effective at small disturbed sites consisting of reclaimed overburden and esker material and located directly adjacent to undisturbed areas;
- Plant coverage of between 9% and 22% and species diversity of 26 to 40 was achieved after approximately 8 to 14 years; and,
- Percent cover and species diversity can be effective measures of revegetation success, as discussed further in Section 3.0 below.

In addition to the natural recovery sample plots, a visual preliminary evaluation of plant type and species growing naturally on disturbed surfaces around the Mine site was completed in spring and fall of 2017 (ARKTIS, 2017a). The goal of the natural vegetation recovery survey was to assess vegetation growth in on-site areas that have been previously disturbed by site activities. Between 3 to 12 years of natural recovery is represented by the areas surveyed. A summary of the natural recovery assessment and outcomes is documented in the 2017 field summary report provided in Appendix A.

The main outcomes from this research that inform best management practices or surface preparations include:

- Localized areas of natural recovery achieved up to 30% plant coverage in dry, rocky soil composed of boulders and cobbles with finer gravel, sand and silt filling the void species between the larger rocks;
- Moist areas with high organics content were observed to achieve up to 100% coverage; and,
- Species most found included: Dwarf Birch (Betula glandulosa), Fireweed (Chamaenerion angustifolium), Crowberry (Empetrum nigrum) and various species of moss and grasses.

### 2.1.2 Active Revegetation

Active revegetation refers to manually initiating plant establishment by means of seeding, transplanting or related activities. Active revegetation has been a focus of research at Snap Lake as a means for accelerating the revegetation process relative to passive techniques. A desktop review was completed to identify a list of candidate species to be used in revegetation, as well as, examine the potential methods for developing seed stock for these species to support revegetation research, progressive reclamation, and for final revegetation of Mine components at closure (ARKTIS, 2014a).

The desktop review identified an initial list of forty five candidate species for use in revegetation, which was refined down to sixteen species considered to be the most suitable for use at the Mine. The species were selected if they were considered native species to the Northwest Territories, and met one of the following criteria (ARKTIS, 2014a):

- Species is recognized as important for local Traditional Knowledge applications as reported in the Snap Lake EA report (De Beers, 2002b); or,
- Species has demonstrated success in revegetation research or progressive reclamation at Ekati or Diavik Mines.

Recommendations were also developed for sourcing and developing the required seed stock for the candidate species, including using commercial sources for graminoids and forbs, local collection for shrubs, and propagation of shrubs to seedlings at an offsite nursery rather than on-site propagation or direct
A nursery assessment further identified preferred options for sourcing commercial seed and seedling propagation.

A summary of the research and its outcomes is provided in the Snap Lake Mine 2014 Annual Closure and Reclamation Plan Progress Report (ACRPPR) and its appendices (ARKTIS, 2015), available on the Mackenzie Valley Land and Water Board (MVLWB) public registry at the link below.


The main outcomes from this research considered applicable for consideration of best management practices in the development of a Final Revegetation Plan for the Mine include:

- Species should be native to the Northwest Territories;
- Species should have Traditional Knowledge applications and/or demonstrated success;
- Species identified for use in revegetation should be applied to disturbed sites based on their tolerance for dry or wet conditions;
- Of the 16 species considered most suitable for use at the Mine, eight species are potentially suitable for use in revegetation at dry or sloped areas, and eight species are potentially suitable for use at wet areas. Further discussion as well as a list of the candidate species is provided in Section 3.4.1;
- Commercial sources should be used when possible for any candidate species; and,
- Shrub growth was more successful as seedling plugs, with propagation undertaken by an off-site nursery, compared to seeding.

The Mine has advanced the above research to the revegetation field trial level, which aims to test the application of the candidate species above to a field site representative of disturbed infrastructure areas (e.g., roads, laydown areas, airstrip, etc.) and thus inform the revegetation methods. Revegetation test plots were established at a dry, upland site formerly used as the Ammonium Nitrate Storage Pad in 2015 to assess vegetation performance under various growing conditions (ARKTIS, 2017a), including:

- Influence of planting season;
- Influence of shrub growth from seedling plugs and seeds;
- Addition of topsoil as topdressing;
- Application of fertilizer as an amendment;
- Plant species; and,
- Soil characteristics on plant growth and health.

Graminoid and forb seeds were acquired from commercial sources, and local seed collection programs were completed to provide shrub propagules. Species used were based on the candidate species list identified during the desktop review described above. Seeds and seedlings were applied to the test plots in 2016 and 2017.

Test plot research and monitoring has been ongoing to evaluate the success of growth using the different revegetation methods. A summary of the seed collection and test plots research and outcomes is provided in the 2015 and 2016 ACRPPR reports (see links below) and their appendices (ARKTIS, 2016, 2017). The most recent revegetation field summary report summarizing test plots research is provided in Appendix A.


The main outcomes from this research that inform best management practices or surface preparations include:
• Mid-August to mid-September collection is a suitable period for harvesting most candidate shrub species;
• Initial results indicate there is better vegetative performance with topsoil and fertilizer amendments;
• Vegetation performance is greater in soils that are finer, organic-rich, moist, loosely compacted and sheltered;
• Grasses have the greatest success with regards to percent coverage relative to other candidate species planted; and,
• Natural succession by surrounding endemic vegetation can achieve similar levels of growth and/or initially outperform species applied through active revegetation techniques.

2.2 Other Sites

2.2.1 Ekati and Diavik Mines

Revegetation research and progressive reclamation programs have been ongoing at the Ekati (Ecosense, 2014, 2015, 2016) and Diavik (Diavik, 2017; Naeth et al., 2016) diamond mine sites for the past several years or more. Revegetation results at Ekati and Diavik were considered during the identification of candidate species for use at the Snap Lake Mine, as discussed in Section 2.1.2.

The main outcomes from the Ekati and Diavik research that inform best management practices or surface preparations that may be considered applicable to the Snap Lake Mine include:

• Identified the best performing species for use in revegetation. Section 3.4.1 provides a list of the species with demonstrated past performance;
• Organic soil and treated sewage sludge was effective substrate for vegetative cover development;
• Fertilizer aided growth early on, but difference was negligible after two years.
• Gravel is an effective substrate in the short-term, but not as good over time relative to till, topsoil, lake sediment or sewage without the addition of another substrate (e.g. topsoil) or amendment (e.g. fertilizer, scarification);
• Scarification, surface roughening and microsites are important to facilitate vegetation establishment and erosion control;
• Erosion control techniques, such as erosion control blankets, can help to slightly increase plant growth;
• Spring and fall seeding efforts yield similar success, with spring potentially more favourable due to lighter winds and warmer weather;
• Grass dominated seed mixes and species typically perform best, but forb inclusion is important for longer-term plant community diversity and nitrogen fixation;
• Difficulties may persist in establishing shrubs from seed or cuttings, but shrub seedlings can be established successfully in a variety of substrates, including but not limited to PK, gravel and sediment substrates.
• Plant species that are collected as seed locally or purchased from commercial seed suppliers perform similarly when used in revegetation; and,
• Regrowth at actively reclaimed sites is faster than for natural recovery, but still takes upwards of 2 to 3 years for soil and plant development.

2.2.2 Colomac Mine

Revegetation efforts were carried out at the former Colomac Mine site in Fall 2010 (Flat River Consulting, 2016). Much of the reclaimed areas consisted of dry gravel pads, similar to what is expected for Snap Lake Mine at closure. The best management practices learned from Colomac that may be considered applicable to the Snap Lake Mine include:

• Identified successful species, including willow (Salix sp.), alder (Alnus sp.), fireweed (Chamaenerion angustifolium), gooseberry (Ribes uva-crispa) and strawberry-bliete (Blitum capitatum);
• Plant growth is better in soils prepared with the rough and loose method;
• Plant diversity is better in areas prepared with the rough and loose method; and,
• Planting locally collected pioneer species ensures that the revegetation species are adapted to local growing conditions.

2.2.3 Yukon Revegetation Manual

The Yukon Revegetation Manual (Manual) provides a comprehensive summary of methods for planning and implementing revegetation projects in the Yukon, and is based on experience with various methodologies and plant species that have demonstrated success in the territory over the past three decades (Matheus & Omtzigt, 2013). Although focused on the Yukon, much of the Manual’s content can be applicable to the Mine since experience has shown that the geographic location of a revegetation project is less critical than other aspects of the site, such as slope, elevation, soil fertility, soil moisture, soil organic content, and level of disturbance. The methods, strategies and equipment recommended in the Manual were developed specifically to increase the chances of revegetation success in light of the specific challenges northern sites can face, and thus can be considered best management practices to support the development the Mines’ Final Revegetation Plan.

From the Manual, best management practices for a site such as the Snap Lake Mine, which includes a combination of low slope to high slope areas and permafrost, include various recommendations for site preparation, fertilizer and organic amendments, planting regimes and seed mixes, depending on site characteristics. Common recommendations include:

• Surface contouring to limit slopes and control erosion;
• Soil decompaction through scarification and ripping, except for permafrost areas;
• Application of organic materials, with priority areas being erosion-prone areas, clay-rich areas, and slopes;
• Application of fertilizer based on soil chemistry; and,
• Lower seeding rates for flat, organic rich areas and higher rates for bare mineral soils or steep slopes.

2.3 Summary

A summary of the best management practices including options for surface preparations to promote revegetation of dry disturbed sites at the Mine is provided below. A literature review of revegetation in the north developed for the Diavik mine provides a more thorough summary of the available information on revegetation practices with relevance to diamond mines (Naeth et al., 2014). This information, in conjunction with the ongoing research results from the sites discussed above, was used to identify the main options and practices presented below.

Surface preparation options include:

• Addition of organic topsoil, where salvaged overburden at the Mine site is spread across and/or mixed in with the existing substrate at disturbed areas.
• Surface loosening/scarification, where the substrates at disturbed areas are decompacted and roughened to provide for aeration, water absorption and root penetration by plants, as well as, create microsites to shelter soil and plants from erosion and the elements.
• Surface roughening, where a site is roughened to create microsites to shelter soil and plants from erosion and the elements. This can be achieved through the loosening/scarification method described above, as well as through other activities such as the placement of scattered boulders across a disturbed site.
• Addition of fertilizer amendment, where a specific fertilizer composition is applied at a specific rate based on the soil chemistry of the disturbed site to be amended. The option to incorporate fertilizer into the soil through additional harrowing or scarification is often beneficial.

Table 1 summarizes the recommendations for active and passive revegetation best management practices, as well as a combined “hybrid” approach between the two. The recommended best management practices will be considered in the development of the Final Site Revegetation Plan for the Snap Lake Mine. Table 1 should not be considered all inclusive, and the source research studies and reports should be consulted for more specific details on recommended practices for site specific conditions, such as plant species and seed mix ratios, fertilizer applications rates, topdressing thickness, etc.
Table 1. Comparison of revegetation best management practices and surface preparation methods for potential application to the Mine.

<table>
<thead>
<tr>
<th>Best Management Practice</th>
<th>Recommended for Active Revegetation</th>
<th>Recommended for Hybrid Revegetation</th>
<th>Recommended for Passive Revegetation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Topdressing</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Incorporate organic topsoil as a surface amendment.</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Surface Treatment</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Loosen and roughen surface material through scarification, deep ripping, rough dumping and/or boulder placement.</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Decrease slopes where possible.</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Apply fertilizer based on soil chemistry and application guidelines, with multiple applications if possible.</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Plant Species and Seeding</td>
<td>Use native species, locally collected if practical.</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Use species with demonstrated success and/or TK value.</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Utilize seed mixes of grasses and forbs.</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Plant shrubs as seedlings in spring.</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Seed in spring.</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
</tr>
</tbody>
</table>

3.0 REVEGETATION METRICS

3.1 Introduction

Revegetation of disturbed areas at mine closure was identified as a topic of interest by stakeholders during the EA process (De Beers, 2002a) and has remained a focus of closure and reclamation discussions during operations. The approved site wide (SW) closure objectives (ARKTIS, 2017b) pertaining to revegetation at the mine site includes “landscape features (shape and vegetation) match aesthetics of the surrounding natural area” and “revegetation targeted to priority areas”.

There is uncertainty regarding the revegetation metrics (e.g. % coverage, biomass per unit area, biodiversity, etc.) to adopt as criteria, due in part by:

- Field trials to assess revegetation methods and their performance at Snap Lake Mine have been operating for only a short duration;
- Limited examples of revegetation success (proven establishment of self-sustaining plant communities) at comparable sites to Snap Lake; and,
- No comparable mines have approval of closure criteria for revegetation aspects by the Land and Water Boards in the Mackenzie Valley.

The objective of this section of the report is to:

- Summarize the revegetation objectives, proposed criteria and monitoring from comparable mines in the Northwest Territories (NWT) to the Snap Lake Mine;
- Describe the baseline and predicted vegetation characteristics for the Mine as evaluated during the EA (De Beers, 2002b) and further updated in 2006 (Golder, 2007);
• Review revegetation results from comparable mines and Snap Lake Mine to assess the measurable characteristics and their values in setting revegetation criteria; and,
• Propose revegetation criteria for the Snap Lake Mine.

3.2 Summary of NWT Mines Revegetation Objectives, Proposed Criteria and Monitoring

Revegetation closure planning from the Con Mine, and Ekati and Diavik diamond mines in the NWT were reviewed to summarize their proposed closure criteria. Table 2 summarizes the revegetation objectives and associated criteria for each of these mines. The proposed monitoring indicators/measures/methods used to measure criteria are also listed.

Although the closure objectives and criteria for a mine may be site specific and not directly applicable to the Snap Lake Mine, the value from the following summary comes from the identification of any measurable vegetation metrics that may be considered for use as criteria or monitoring indicators/measures for the Snap Lake Mine.

Criteria and/or monitoring indicators/measures that include a measurable metric with applicability to Snap Lake Mine are highlighted in Table 2. Common vegetative metrics that have been used for criteria and/or their monitoring indicators/measures at more than one mine site include:

• Vegetation/plant/ground cover; and,
• Native species.

Other less common metrics identified include:

• Biodiversity (richness and diversity);
• Productivity (biomass);
• Plant height; and,
• Foliar elements.

In the following sections, the common metrics will be considered with regards to available baseline information and research results from comparable mines and Snap Lake Mine to help identify appropriate metrics for use as revegetation criteria.
Table 2. Summary of revegetation closure objectives, current proposed criteria and monitoring indicators, measures or methods.

<table>
<thead>
<tr>
<th>Mine</th>
<th>Closure Objective</th>
<th>Proposed Closure Criteria</th>
<th>Monitoring Indicators/Measures/Methods</th>
</tr>
</thead>
<tbody>
<tr>
<td>Snap Lake Mine¹</td>
<td>SW5 – Landscape features (shape and vegetation) match aesthetics of the surrounding natural area.</td>
<td>No visible buildings, equipment or non-local materials.</td>
<td>Final landscape inspected by a qualified professional and representatives of affected Aboriginal Parties.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Construction of physically stable drainage pathways addressed under other objectives.</td>
<td>Submission of as-built conditions in a summary report completed by a qualified person.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Final grading will reflect surrounding topography (i.e. steep edges of pits and trenches flattened or backfilled) and natural drainage pathways will be re-established, where possible.</td>
<td>Vegetation monitoring detailed in Closure Objective SW7.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Revegetation targets for the various mine areas are met (SW7).</td>
<td></td>
</tr>
<tr>
<td>SW7 – Revegetation targeted to priority areas.</td>
<td></td>
<td>Revegetation activities shall be successfully completed at priority areas to promote natural recovery.</td>
<td>Final landscape inspected by a qualified professional and representatives of affected Aboriginal Parties.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Submission of as-constructed site survey completed by a qualified person.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Vegetation monitoring will be completed to evaluate the establishment of vegetation at reclaimed surfaces across the site and provide a documented case study for future projects.</td>
</tr>
<tr>
<td>Con Mine²</td>
<td>Establish a self-sustaining, native vegetation cover.</td>
<td>Criteria 1: Self-sustaining vegetation cover minimizes fugitive dust generation from tailings through wind erosion.</td>
<td>Total plant cover - Percent of the ground covered by living plants.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Productivity - Total plant biomass (kg/ha).</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Plant height - Average height of plants by vegetation layer (if any) in cm.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Criteria 2: Self-sustaining vegetation cover minimizes the amount of precipitation infiltrating the tailing(s).</td>
<td>Total plant cover - Percent of the ground covered by living plants.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Productivity - Total plant biomass (kg/ha).</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Plant height - Average height of plants by vegetation layer (if any) in cm.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Criteria 3: Country rock capping and vegetative islands will provide a physical barrier to minimize contact between both people and wildlife with the underlying tailing.</td>
<td>Total plant cover - Percent of the ground covered by living plants.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Productivity - Total plant biomass (kg/ha).</td>
<td></td>
</tr>
<tr>
<td>Mine</td>
<td>Closure Objective</td>
<td>Proposed Closure Criteria</td>
<td>Monitoring Indicators/Measures/Methods</td>
</tr>
<tr>
<td>-------------------------------------</td>
<td>-----------------------------------------------------------------------------------</td>
<td>------------------------------------------------------------------------------------------</td>
<td>-------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Ekati Diamond Mine</td>
<td>Native vegetation used for rehabilitation work.</td>
<td>Criteria 4:5</td>
<td>Species composition - Record species presence and % cover by vegetation layer.</td>
</tr>
<tr>
<td></td>
<td>Sites rehabilitated with plant cover have sufficient plant cover to stabilize land</td>
<td>Vegetation is dominated by native species.</td>
<td>Foliar elements - Nutrients and trace element concentrations in plants.</td>
</tr>
<tr>
<td></td>
<td>surfaces.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Diavik Diamond Mine</td>
<td>SW5 – Re-vegetation efforts targeted to priority areas.</td>
<td>Record of species types used for re-vegetation work.</td>
<td>Sampling and inspection.</td>
</tr>
<tr>
<td></td>
<td>SW9 – Landscape features (topography and vegetation) that match aesthetics and</td>
<td>Vegetation cover (%).</td>
<td>Routine monitoring and sampling.</td>
</tr>
<tr>
<td></td>
<td>natural conditions of the surrounding natural area.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Change in biodiversity (richness and diversity units) of Regional Study Area less than 1%.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Surface of scarified native material (rock or till).</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Mine footprint area less than 13 km² post-closure.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Final re-vegetation procedures applied to priority areas.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Change in biodiversity (richness and diversity units) of Regional Study Area less than 1%.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>No surface visible buildings, equipment or non-local materials.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Notes:
- Shaded cells indicate measurable criteria or monitoring indicators/measures with potential applicability to Snap Lake Mine.
- 1 Snap Lake Mine Interim Closure and Reclamation Plan v4 (ARKTIS, 2017b).
- 2 Vegetation Establishment Monitoring Program Report (Stantec Consulting Ltd., 2016).
- 3 Ekati Diamond Mine Interim Closure and Reclamation Plan (BHP, 2011).
- 4 Closure and Reclamation Plan – Version 4.0 (Diavik, 2017).
- 5 Applies to direct vegetation areas; assumes the country rock cover will minimize fugitive dust generation from wind erosion in the recently active tailings.
- 6 Applies to direct vegetation areas.
- 7 Applies to vegetative islands.
- SW – Site Wide
3.3 Baseline, Mine Closure and Far Future Vegetative Characteristics for Snap Lake Mine

The vegetative characteristics of the undisturbed Mine site prior to construction and operations, as well as the predicted characteristics at mine closure and in the far future (i.e. 100 years post closure) provide an understanding on how vegetation metrics within the LSA were predicted to change due to mine operations. The baseline data can be used to help calculate the impact the selected revegetation options will have on vegetation metrics across the LSA, and subsequently how that impact compares to the mine closure and far future conditions as predicted in the EA (De Beers, 2002a). Reasonable and achievable revegetation metrics can then be identified that may be used as closure criteria. A discussion on the baseline, mine closure and far future vegetative characteristics within the Mine’s LSA is provided in the sections below.

3.3.1 Ecological Land Classification Units within the Local Study Area

An assessment of the ecological land classification (ELC) units in the local study area (LSA) was completed at the time of the 2002 EA (De Beers, 2002a) and updated in 2006 (Golder, 2007) using newer satellite imagery (see Table 3 and Table 4 respectively). Within the LSA for each ELC, the baseline area, the predicted area at end of active closure, and the predicted area in the far future (i.e. 100 years post closure) is presented. The LSA with ELC units is shown in Figure 1.

Each ELC unit has their own documented vegetative characteristics, including:

- Plant cover (i.e. percent of surface area covered by vegetation);
- Plant species and richness (i.e. total number of species);
- Species diversity (i.e. distribution of plants); and,
- Plant communities (i.e. total number of communities).

Of these characteristics, the first three are consistent with the vegetation metrics identified as being used for criteria and/or monitoring indicators/measures at other comparable mine sites (see Section 3.2). Two of these metrics, plant cover and species/richness, are considered in the following sections. Because interest in revegetation is focused primarily on ensuring species and cover are representative of the characteristics of site, other vegetation metrics are useful for monitoring but not considered further for revegetation criteria.

The area predictions provided in Table 3 and Table 4 are based on an end of mine life scenario with the West Cell of the North Pile fully developed. Currently, the West Cell perimeter embankments commenced construction prior to the Mine entering care and maintenance in 2015; however, the West Cell remains largely undeveloped. Given that the Mine will enter final closure prior to the West Cell being constructed, the predicted areas at mine closure and far future will no longer be representative of site conditions. An updated satellite image is scheduled to be taken summer of 2018 which will update the ELC units and associated areas. This information will be presented in the 2018 Vegetation Monitoring Report.
Table 3. Baseline 2002 EA (De Beers, 2002a) ELC and predicted mine closure and far future area sizes within the LSA.

<table>
<thead>
<tr>
<th>ELC</th>
<th>Baseline</th>
<th>Loss</th>
<th>At Mine Closure</th>
<th>Far Future†</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>ha</td>
<td>% of LSA</td>
<td>ha</td>
<td>% of LSA</td>
</tr>
<tr>
<td>Dry Areas</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Heath/boulder</td>
<td>784.8</td>
<td>54.7</td>
<td>414.6</td>
<td>52.8</td>
</tr>
<tr>
<td>Heath tundra</td>
<td>2.0</td>
<td>0.1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Open spruce forest</td>
<td>69.3</td>
<td>4.8</td>
<td>44.5</td>
<td>64.2</td>
</tr>
<tr>
<td>Wet Areas</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Riparian tall shrub</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Birch seep</td>
<td>6.2</td>
<td>0.4</td>
<td>5.1</td>
<td>82.8</td>
</tr>
<tr>
<td>Tussock-hummock</td>
<td>108.3</td>
<td>7.5</td>
<td>53.9</td>
<td>49.8</td>
</tr>
<tr>
<td>Sedge Wetland</td>
<td>21.2</td>
<td>1.5</td>
<td>8.9</td>
<td>42.1</td>
</tr>
<tr>
<td>Water</td>
<td>443.5</td>
<td>30.9</td>
<td>32.5</td>
<td>7.3</td>
</tr>
<tr>
<td>Total LSA</td>
<td>1435.3</td>
<td>100</td>
<td>559.5</td>
<td>39</td>
</tr>
</tbody>
</table>

† Far Future was considered 100 years following Mine closure.

Table 4. Updated 2006 (Golder, 2007) ELC baseline and predicted mine closure and far future area sizes within the LSA.

<table>
<thead>
<tr>
<th>ELC</th>
<th>Baseline</th>
<th>Loss</th>
<th>At Mine Closure</th>
<th>Far Future‡</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>ha</td>
<td>% of LSA</td>
<td>ha</td>
<td>% of LSA</td>
</tr>
<tr>
<td>Dry Areas</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Heath/boulder</td>
<td>784.1</td>
<td>54.6</td>
<td>189.7</td>
<td>24</td>
</tr>
<tr>
<td>Heath tundra</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Open spruce forest</td>
<td>101.8</td>
<td>7.1</td>
<td>10.7</td>
<td>11</td>
</tr>
<tr>
<td>Wet Areas</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Riparian tall shrub</td>
<td>1.3</td>
<td>0.1</td>
<td>0.7</td>
<td>54</td>
</tr>
<tr>
<td>Birch seep</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Tussock-hummock</td>
<td>116.3</td>
<td>8.1</td>
<td>8.5</td>
<td>7.3</td>
</tr>
<tr>
<td>Sedge Wetland</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Water</td>
<td>431.5</td>
<td>30.1</td>
<td>8.7</td>
<td>2</td>
</tr>
<tr>
<td>Total LSA</td>
<td>1435</td>
<td>100</td>
<td>218.3</td>
<td>15.2</td>
</tr>
</tbody>
</table>

‡ Far Future was considered 100 years following Mine closure.

It has been assumed riparian tall shrub will not re-establish in the far future, similar to sedge wetlands and open spruce forests (De Beers, 2002a).
Figure 1. Local study area and ELC units for the Snap Lake Mine (De Beers, 2016).
3.3.2 Percent Ground Cover of Vegetation

Percent ground cover is the amount of living plant material that covers the soil surface, where 100% ground cover means that the soil cannot be seen and 0% ground cover is bare soil. The 2002 EA included percent ground cover for the original ELC units (De Beers, 2002a), as shown in Table 5 and Table 6.

The mean percent ground cover calculated over the total LSA for the baseline, mine closure and far future is presented in Table 5 and Table 6 using the 2002 EA and 2006 updated cases respectively. The following observations are noted:

- The percent ground cover at mine closure is less than baseline which reflects the land disturbance at the Mine and that limited time has passed for revegetation to occur.
- The far future predictions of ground coverage are less than baseline, which reflects a change in ELC areas at the Mine after mine operations compared to pre-operations.
- The far future predictions of ground coverage are larger than at end of mine operations since additional time has passed to allow for revegetation to occur.
Table 5: Baseline, post-closure and far future plant coverage for the LSA using the 2002 EA ELC areas (De Beers, 2002a).

<table>
<thead>
<tr>
<th>ELC</th>
<th>Undisturbed Area at Mine Closure as % of Total LSA</th>
<th>Baseline Mean Cover</th>
<th>Baseline Mean Cover for Total LSA</th>
<th>Mean Cover at Mine Closure</th>
<th>Mean Cover at Far Future</th>
<th>% Change from Baseline to Mine Closure</th>
<th>% Change from Baseline to Far Future</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heath/boulder</td>
<td>25.8%</td>
<td>26%</td>
<td>24.1%</td>
<td>11.5%</td>
<td>21.1%</td>
<td>-52.3%</td>
<td>-12.5%</td>
</tr>
<tr>
<td>Heath tundra</td>
<td>0.1%</td>
<td>70%</td>
<td>24.1%</td>
<td>11.5%</td>
<td>21.1%</td>
<td>-52.3%</td>
<td>-12.5%</td>
</tr>
<tr>
<td>Open spruce forest</td>
<td>1.7%</td>
<td>41%</td>
<td>24.1%</td>
<td>11.5%</td>
<td>21.1%</td>
<td>-52.3%</td>
<td>-12.5%</td>
</tr>
<tr>
<td>Riparian tall shrub</td>
<td>0%</td>
<td>75%</td>
<td>24.1%</td>
<td>11.5%</td>
<td>21.1%</td>
<td>-52.3%</td>
<td>-12.5%</td>
</tr>
<tr>
<td>Birch seep</td>
<td>0.1%</td>
<td>40%</td>
<td>24.1%</td>
<td>11.5%</td>
<td>21.1%</td>
<td>-52.3%</td>
<td>-12.5%</td>
</tr>
<tr>
<td>Tussock-hummock</td>
<td>3.8%</td>
<td>85%</td>
<td>24.1%</td>
<td>11.5%</td>
<td>21.1%</td>
<td>-52.3%</td>
<td>-12.5%</td>
</tr>
<tr>
<td>Sedge wetland</td>
<td>0.9%</td>
<td>80%</td>
<td>24.1%</td>
<td>11.5%</td>
<td>21.1%</td>
<td>-52.3%</td>
<td>-12.5%</td>
</tr>
<tr>
<td>Water</td>
<td>28.6%</td>
<td>0%</td>
<td>24.1%</td>
<td>11.5%</td>
<td>21.1%</td>
<td>-52.3%</td>
<td>-12.5%</td>
</tr>
</tbody>
</table>

Notes:
Water ELC areas are considered to have no ground cover.
Disturbed areas are assumed to have no ground cover at mine closure.
Weighted means are used based on area proportions.

Table 6: Baseline, post-closure and far future plant coverage for the LSA using the 2006 Updated ELC areas (Golder, 2007).

<table>
<thead>
<tr>
<th>ELC</th>
<th>Undisturbed Area at Mine Closure as % of Total LSA</th>
<th>Baseline Mean Cover</th>
<th>Baseline Mean Cover for Total LSA</th>
<th>Mean Cover at Mine Closure</th>
<th>Mean Cover at Far Future</th>
<th>% Change from Baseline to Mine Closure</th>
<th>% Change from Baseline to Far Future</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heath/boulder</td>
<td>41.4%</td>
<td>26%</td>
<td>24.1%</td>
<td>19.8%</td>
<td>23.6%</td>
<td>-17.8%</td>
<td>-2.1%</td>
</tr>
<tr>
<td>Heath tundra</td>
<td>0%</td>
<td>70%</td>
<td>24.1%</td>
<td>19.8%</td>
<td>23.6%</td>
<td>-17.8%</td>
<td>-2.1%</td>
</tr>
<tr>
<td>Open spruce forest</td>
<td>6.3%</td>
<td>41%</td>
<td>24.1%</td>
<td>19.8%</td>
<td>23.6%</td>
<td>-17.8%</td>
<td>-2.1%</td>
</tr>
<tr>
<td>Riparian tall shrub</td>
<td>0.04%</td>
<td>75%</td>
<td>24.1%</td>
<td>19.8%</td>
<td>23.6%</td>
<td>-17.8%</td>
<td>-2.1%</td>
</tr>
<tr>
<td>Birch seep</td>
<td>0%</td>
<td>40%</td>
<td>24.1%</td>
<td>19.8%</td>
<td>23.6%</td>
<td>-17.8%</td>
<td>-2.1%</td>
</tr>
<tr>
<td>Tussock-hummock</td>
<td>7.5%</td>
<td>85%</td>
<td>24.1%</td>
<td>19.8%</td>
<td>23.6%</td>
<td>-17.8%</td>
<td>-2.1%</td>
</tr>
<tr>
<td>Sedge wetland</td>
<td>0%</td>
<td>80%</td>
<td>24.1%</td>
<td>19.8%</td>
<td>23.6%</td>
<td>-17.8%</td>
<td>-2.1%</td>
</tr>
<tr>
<td>Water</td>
<td>29.5%</td>
<td>0%</td>
<td>24.1%</td>
<td>19.8%</td>
<td>23.6%</td>
<td>-17.8%</td>
<td>-2.1%</td>
</tr>
</tbody>
</table>

Notes:
Water ELC areas are considered to have no ground cover.
Disturbed areas are assumed to have no ground cover at mine closure.
Weighted means are used based on area proportions.
3.3.3 Plant Species and Richness

The EA (De Beers, 2002a) catalogued the variety of plant species found on site naturally during the baseline monitoring program. Identified species are discussed further in Section 3.4. The species richness, or the number of distinct plant species occurring within an area, was also developed for each ELC unit (De Beers, 2002a), as shown in Table 7 and Table 8.

A comparison of the baseline, mine closure and far future species richness calculated over the total LSA is provided in Table 7 and Table 8 for the 2002 EA and updated 2006 EA cases respectively. The following observations are noted:

- Species richness for the total LSA at mine closure is lower than the baseline (pre-mining).
- Species richness in the far future is less than baseline (pre-mining).
- Species richness in the far future for the total LSA is greater than at mine closure as a result of vegetation re-establishment on disturbed lands.

Species richness is not one of the commonly used metrics to evaluate revegetation success based on the review of other mines criteria (see Section 3.2). Species richness is a parameter to monitor during post-closure monitoring to understand the recovery and plant types; however, it not considered further as a criterion for the Mine since it is challenging to control the species types that may grow and thrive at various locations at the Mine. It is anticipated that encroachment of native species onto disturbed areas will occur naturally in the post-closure, as has been observed in the vegetation monitoring completed at the Mine (ARKTIS, 2017a).
Table 7. Baseline, post-closure and far future species richness for the LSA using the 2002 EA ELC areas (De Beers, 2002a).

<table>
<thead>
<tr>
<th>ELC</th>
<th>Undisturbed Area at Mine Closure as % of Total LSA</th>
<th>Baseline Mean Richness</th>
<th>Baseline Mean Richness for Total LSA</th>
<th>Mean Richness at Mine Closure</th>
<th>Mean Richness at Far Future</th>
<th>% Change from Baseline to Mine Closure</th>
<th>% Change from Baseline to Far Future</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heath/boulder</td>
<td>25.8%</td>
<td>15</td>
<td></td>
<td>10.9</td>
<td>5.2</td>
<td>-52.3%</td>
<td>-1.8%</td>
</tr>
<tr>
<td>Heath tundra</td>
<td>0.1%</td>
<td>20</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Open spruce forest</td>
<td>1.7%</td>
<td>12</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Riparian tall shrub</td>
<td>0%</td>
<td>26</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Birch seep</td>
<td>0.1%</td>
<td>13</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tussock-hummock</td>
<td>3.8%</td>
<td>22</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sedge wetland</td>
<td>0.9%</td>
<td>23</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Water</td>
<td>28.6%</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Notes:
Water ELC areas are considered to have zero plant richness.
Disturbed areas are assumed to have zero plant richness at mine closure.
Weighted means are used based on area proportions.

Table 8. Baseline, mine closure and far future species richness for the LSA using the 2006 Updated ELC areas (Golder, 2007).

<table>
<thead>
<tr>
<th>ELC</th>
<th>Undisturbed Area at Mine Closure as % of Total LSA</th>
<th>Baseline Mean Richness</th>
<th>Baseline Mean Richness for Total LSA</th>
<th>Mean Richness at Mine Closure</th>
<th>Mean Richness at Far Future</th>
<th>% Change from Baseline to Mine Closure</th>
<th>% Change from Baseline to Far Future</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heath boulder</td>
<td>41.4%</td>
<td>15</td>
<td></td>
<td>10.9</td>
<td>8.6</td>
<td>-21.1%</td>
<td>-0.9%</td>
</tr>
<tr>
<td>Heath tundra</td>
<td>0%</td>
<td>20</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Open spruce forest</td>
<td>6.3%</td>
<td>12</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Riparian tall shrub</td>
<td>0.04 %</td>
<td>26</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Birch seep</td>
<td>0%</td>
<td>13</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tussock-hummock</td>
<td>7.5%</td>
<td>22</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sedge wetland</td>
<td>0%</td>
<td>23</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Water</td>
<td>29.5%</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Notes:
Water ELC areas are considered to have zero plant richness.
Disturbed areas are assumed to have zero plant richness at mine closure.
Weighted means are used based on area proportions.
3.4 Review of Revegetation Results with Applicability for Closure Criteria

3.4.1 Identification of Plant Species for Revegetation

As part of revegetation research, a candidate species list for use during revegetation was developed for the Snap Lake Mine (ARKTIS, 2015). Species considered most suitable for use at the Mine met the following three specific selection criteria:

- Native species;
- Demonstrated track record when used in other revegetation projects; and,
- Traditional Knowledge application.

Plant species native to the Snap Lake site region were compiled by identifying species that were either:

- Recorded within the EA (De Beers, 2002a) as being present when baseline studies were conducted;
- Recorded during the ongoing vegetation monitoring program (Golder, 2007); or,
- Present in the “NWT Native Seed Development Species List” developed by the Aurora Research Institute in Inuvik (Aurora Research Institute, 2014).

Species considered to have met the criteria of having a proven track record were compiled by evaluating revegetation research trials conducted at the Ekati and Diavik diamond mines (BHP, 2012; Diavik, 2011b), and identifying those species that had established and were still present at the end of the monitoring programs.

Species with a known Traditional Knowledge value were identified from the Snap Lake EA (De Beers, 2002a).

Only shrubs, graminoids and forbs were included in the candidate species list, since they are typically used for revegetation at mine sites (Skousen & Zipper, 2010).

Table 9 provides a summary of the overall candidate species analysis. Species that satisfied the native species criteria, as well as, at least one of the other two selection criteria were chosen as candidate species for Snap Lake, and are highlighted in Table 9. The one exception was the native species Showy Locoweed (Oxytropis slendens), which was included due to recommendations from the literature (Smreciu, A., 1993) and for its drought tolerance.

The final candidate species list for revegetation is provided in Table 10. Species are categorized according to their moisture tolerance, which will help dictate how they should be used in revegetation.

Potential revegetation criteria specifying the use of native species in revegetation efforts or dominance as the primary plant type is a common metric proposed by similar mines in the NWT (see Section 3.2). The list of native species compiled through the above research, as well as identified during the EA (De Beers, 2002a), vegetation monitoring (Golder, 2007) or in the Aurora species list (Aurora Research Institute, 2014) can be used to confirm the achievement of any such adopted criteria.
<table>
<thead>
<tr>
<th>Strata</th>
<th>Common Name</th>
<th>Scientific Name</th>
<th>Species Selection Criteria</th>
<th>Native Species</th>
<th>Prior Performance</th>
<th>TK Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shrub</td>
<td>Bearberry</td>
<td>Arctostaphylos uva-ursi</td>
<td>x</td>
<td></td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td></td>
<td>Dwarf Birch</td>
<td>Betula glandulosa</td>
<td>x</td>
<td></td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td></td>
<td>Crowberry</td>
<td>Empetrum nigrum</td>
<td>x</td>
<td></td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td></td>
<td>Blueberry</td>
<td>Vaccinium uliginosum</td>
<td>x</td>
<td></td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td></td>
<td>Lingonberry</td>
<td>Vaccinium vitis-idaea</td>
<td>x</td>
<td></td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td></td>
<td>Rhododendron</td>
<td>Rhododendron ferrugineum</td>
<td>x</td>
<td></td>
<td></td>
<td>x</td>
</tr>
<tr>
<td></td>
<td>Willow</td>
<td>Salix sp.</td>
<td>x</td>
<td></td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td></td>
<td>Green alder</td>
<td>Alnus viridis</td>
<td>x</td>
<td></td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td></td>
<td>Dwarf Labrador Tea</td>
<td>Ledum decumbens</td>
<td>x</td>
<td></td>
<td></td>
<td>x</td>
</tr>
<tr>
<td></td>
<td>Bilberry</td>
<td>Vaccinium myrtillus</td>
<td>x</td>
<td></td>
<td></td>
<td>x</td>
</tr>
<tr>
<td></td>
<td>Bog rosemary</td>
<td>Andromeda polifolia</td>
<td>x</td>
<td></td>
<td></td>
<td>x</td>
</tr>
<tr>
<td></td>
<td>Creeping Azalea</td>
<td>Loiseleuria procumbens</td>
<td>x</td>
<td></td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>Graminoid</td>
<td>Tickle grass</td>
<td>Agrostis scabra</td>
<td>x</td>
<td></td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td></td>
<td>Alpine wheatgrass</td>
<td>Agropyron violaceum</td>
<td>x</td>
<td></td>
<td></td>
<td>x</td>
</tr>
<tr>
<td></td>
<td>Slender wheatgrass</td>
<td>Agropyron pauciflorum</td>
<td>x</td>
<td></td>
<td></td>
<td>x</td>
</tr>
<tr>
<td></td>
<td>Purple reedgrass</td>
<td>Calamagrostis purpureascens</td>
<td>x</td>
<td></td>
<td></td>
<td>x</td>
</tr>
<tr>
<td></td>
<td>Hairy wild rye</td>
<td>Elymus innovates</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Rocky Mountain Fescue</td>
<td>Festuca saximontana</td>
<td>x</td>
<td></td>
<td></td>
<td>x</td>
</tr>
<tr>
<td></td>
<td>Arctared fescue</td>
<td>Festuca rubra</td>
<td></td>
<td></td>
<td></td>
<td>x</td>
</tr>
<tr>
<td></td>
<td>Alpine holygrass</td>
<td>Hierochloe alpine</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Sedge</td>
<td>Carex vaginata</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Sedge</td>
<td>Carex bigelowii</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Sedge</td>
<td>Carex aquatilis</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Arctic cotton/arctic cottongrass</td>
<td>Eriophorum callitrix</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Arctic cotton/arctic cottongrass</td>
<td>Eriophorum angustifolium</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Bluejoint/reedgrass</td>
<td>Calamagrostis canadensis</td>
<td>x</td>
<td></td>
<td></td>
<td>x</td>
</tr>
<tr>
<td></td>
<td>Polar grass</td>
<td>Arctagrostis latifolia</td>
<td>x</td>
<td></td>
<td></td>
<td>x</td>
</tr>
<tr>
<td></td>
<td>Alpine bluegrass</td>
<td>Poa alpina</td>
<td>x</td>
<td></td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>Strata</td>
<td>Common Name</td>
<td>Scientific Name</td>
<td>Species Selection Criteria</td>
<td>Native Species</td>
<td>Prior Performance</td>
<td>TK Value</td>
</tr>
<tr>
<td>-----------------</td>
<td>--------------------------</td>
<td>----------------------------</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Graminoid (cont'd)</td>
<td>Tundra bluegrass</td>
<td>Poa glauca</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Tufted hairgrass</td>
<td>Deschampsia caespitosa</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Nuttall’s alkali grass</td>
<td>Puccinellia nutalliiana</td>
<td></td>
<td></td>
<td></td>
<td>x</td>
</tr>
<tr>
<td></td>
<td>Spiked trisetum</td>
<td>Trisetum spicatum</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Showy locoweed</td>
<td>Oxytropis splendens</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Reflexed locoweed</td>
<td>Oxytropis deflexa</td>
<td></td>
<td></td>
<td></td>
<td>x</td>
</tr>
<tr>
<td></td>
<td>Viscid oxytrope</td>
<td>Oxytropis viscida</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Alpine hedysarum</td>
<td>Hedysarum alpinum</td>
<td></td>
<td></td>
<td></td>
<td>x</td>
</tr>
<tr>
<td></td>
<td>Liquorice root/Northern hedysarum</td>
<td>Hedysarum mackenzii</td>
<td></td>
<td></td>
<td></td>
<td>x</td>
</tr>
<tr>
<td></td>
<td>Fireweed</td>
<td>Epilobium angustifolium</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Epilobium latifolia</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Alpine milk-vetch</td>
<td>Astragalus alpine</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Wormwood</td>
<td>Artemisia arctica</td>
<td></td>
<td></td>
<td></td>
<td>x</td>
</tr>
<tr>
<td></td>
<td>Hairy or small butterwort</td>
<td>Pinguicula villosa</td>
<td></td>
<td></td>
<td></td>
<td>x</td>
</tr>
<tr>
<td></td>
<td>Cloud berry</td>
<td>Rubus chamaemorus</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Scotch false asphodel</td>
<td>Tofieldia pusilla</td>
<td></td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Sticky false asphodel</td>
<td>Tofieldia glutinosa</td>
<td></td>
<td></td>
<td></td>
<td>x</td>
</tr>
<tr>
<td></td>
<td>Prickly saxifrage</td>
<td>Saxifraga tricuspidata</td>
<td></td>
<td></td>
<td></td>
<td>x</td>
</tr>
</tbody>
</table>

Note: Shaded cells indicate selected candidate species identified as being native to the NWT with a demonstrated track record and/or Traditional Knowledge application.
Table 10. Summary of candidate species and their tolerance to soil moisture.

<table>
<thead>
<tr>
<th>Plant Species</th>
<th>Scientific Name</th>
<th>Strata</th>
<th>Soil Moisture Tolerance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bearberry</td>
<td>Arctostaphylos uva-ursi</td>
<td>Shrub</td>
<td>Drought tolerant</td>
</tr>
<tr>
<td>Crowberry</td>
<td>Empetrum nigrum</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tickle grass</td>
<td>Agrostis scabra</td>
<td>Graminoid</td>
<td></td>
</tr>
<tr>
<td>Rocky mountain fescue</td>
<td>Festuca saximontana</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Alpine bluegrass</td>
<td>Poa alpina</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tundra bluegrass</td>
<td>Poa glauca</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Spiked trisetum</td>
<td>Trisetum spicatum</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Showy locoweed</td>
<td>Oxytropis splendens</td>
<td>Forb</td>
<td></td>
</tr>
<tr>
<td>Dwarf birch</td>
<td>Betula glandulosa</td>
<td>Shrub</td>
<td>Moisture tolerant</td>
</tr>
<tr>
<td>Dwarf labrador tea</td>
<td>Ledum decumbens</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bog blueberry</td>
<td>Vaccinium uliginosum</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Willow</td>
<td>Salix sp.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bluejoint/reedgrass</td>
<td>Calamagrostis canadensis</td>
<td>Graminoid</td>
<td></td>
</tr>
<tr>
<td>Polar grass</td>
<td>Arctagrostis latifolia</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tufted hairgrass</td>
<td>Deschampsia caespitosa</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Alpine milk-vetch</td>
<td>Astragalus alpina</td>
<td>Forb</td>
<td></td>
</tr>
</tbody>
</table>

3.4.2 Timeline for Vegetation Re-Establishment

The selection of revegetation criteria needs to be cognizant of the timeframe of plant growth. Without limitation, plant growth is influenced by environmental and ground conditions, which are variable, as well as the revegetation activity or methodology (e.g., active and passive revegetation approaches).

An evaluation of research results from northern mines was undertaken to assess the timeframe to re-establish revegetation using percent ground cover as the metric. Percent ground cover was chosen since it is the most common metric used and therefore was a measured parameter for comparison.

Revegetation performance data was compiled from comparable NWT mines including Diavik and Ekati, as well as from Snap Lake Mine, to evaluate the plant coverage with time. The data consolidated was restricted to dry areas since this is the primary area of revegetation efforts for the Snap Lake Mine, and is summarized in Table 11 and presented in Figure 2. The dataset represents a variety of site specific characteristics and vegetative effort, including:

- Different soil and moisture characteristics;
- Different plant species;
- Varying levels of soil preparation;
- Some studies included seeding and others natural recovery; and,
- Some studies included fertilizer application and seeding and others did not.

As a result, there is scatter in the data and not a strong correlation of plant coverage with time. Regardless, as noted in Figure 2, a general trend of increasing plant coverage with time is apparent. Based on the dataset, it is suggestive that a 10% mean cover may be a reasonable target after five years of growth, and that with time greater plant coverage occurs.
Table 11. Summary of revegetation plant coverage with time at dry sites.

<table>
<thead>
<tr>
<th>Year Post-Vegetative Effort</th>
<th>Site</th>
<th>Location</th>
<th>Total % Coverage</th>
<th>Mean % Cover</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Snap Lake</td>
<td>Test Plots</td>
<td>4.3%</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Vegetation Monitoring Passive Plots (Heath Boulder ELC)</td>
<td>17.3%</td>
<td>10.8%</td>
</tr>
<tr>
<td></td>
<td>Ekati</td>
<td>Fox Topsoil Stockpile</td>
<td>6.4%</td>
<td>11.8%</td>
</tr>
<tr>
<td>2</td>
<td>Snap Lake</td>
<td>Vegetation Monitoring Passive Plots</td>
<td>24%</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>East Cell north ditch (NR-12)</td>
<td>50%</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>East Cell north embankment base (NR-13)</td>
<td>65%</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Ekati</td>
<td>Airstrip Esker</td>
<td>10.7%</td>
<td>10.6%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>10.5%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Snap Lake</td>
<td>Vegetation Monitoring Passive Plots (Heath Boulder ELC)</td>
<td>20.3%</td>
<td>45.1%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Quarry-dry (NR-4)</td>
<td>10%</td>
<td>10.4%</td>
</tr>
<tr>
<td></td>
<td>Diavik</td>
<td>Revegetation Test Plots</td>
<td>2.2%</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Ekati</td>
<td>Beartooth Topsoil Stockpile</td>
<td>12.3%</td>
<td>17.2%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Fox Topsoil Stockpile</td>
<td>10.2%</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>34.5%</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>11.9%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Snap Lake</td>
<td>Accommodations complex south (NR-11)</td>
<td>50%</td>
<td>30%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>BSMRP (NR-14)</td>
<td>10%</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Ekati</td>
<td>Paul Lake Laydown</td>
<td>20.9%</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Tercon Laydown Area</td>
<td>2.5%</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>11.7%</td>
<td></td>
<td>18.5%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>15.95%</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Snap Lake</td>
<td>AN storage (NR-2)</td>
<td>20%</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>North slope organics pile (NR-8)</td>
<td>40%</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Ekati</td>
<td>Airstrip Esker</td>
<td>20.8%</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Emulsion Plant (NR-1)</td>
<td>4.3%</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>South north pile road berm (NR-6)</td>
<td>15%</td>
<td>32.2%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>South slope laydown (NR-7)</td>
<td>65%</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Starter cell, south perimeter ditch (NR-9)</td>
<td>50%</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Starter cell, north PS1 slope (NR-17)</td>
<td>35%</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>Snap Lake</td>
<td>Vegetation Monitoring Passive Plots (Heath Boulder ELC)</td>
<td>9.1%</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Airstrip Side Slope</td>
<td>30.1%</td>
<td>17.6%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Fox Portal Gravel Pad</td>
<td>10.7%</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>28.5%</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>9.4%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Year Post-Vegetative Effort</td>
<td>Site</td>
<td>Location</td>
<td>Total % Coverage</td>
<td>Mean % Coverage</td>
</tr>
<tr>
<td>-----------------------------</td>
<td>--------------</td>
<td>---------------------------------</td>
<td>------------------</td>
<td>----------------</td>
</tr>
<tr>
<td>11</td>
<td>Ekati</td>
<td>Koala Topsoil</td>
<td>55.5%</td>
<td>35.1%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>14.6%</td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>Ekati</td>
<td>Beartooth Topsoil Stockpile</td>
<td>32.2%</td>
<td>21.8%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Fox Topsoil Stockpile</td>
<td>32.5%</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>15.3%</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Snap Lake</td>
<td>FAR embankment (NR-15)</td>
<td>12%</td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>Ekati</td>
<td>Paul Lake Laydown</td>
<td>61.4%</td>
<td>28.4%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Tercon Laydown Area</td>
<td>2.15%</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>24.5%</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>25.5%</td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>Ekati</td>
<td>Koala Topsoil</td>
<td>55.9%</td>
<td>36.9%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>17.9%</td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>Ekati</td>
<td>Airstrip Side Slopes</td>
<td>28.3%</td>
<td>22.7%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Fox Portal Gravel Pad</td>
<td>6.8%</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>35.4%</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>20.1%</td>
<td></td>
</tr>
<tr>
<td>21</td>
<td>Ekati</td>
<td>Fox Portal Gravel Pad</td>
<td>28.5%</td>
<td>25.6%</td>
</tr>
</tbody>
</table>

Sources:
DE BEERS CANADA INC., SNAP LAKE MINE
REVEGETATION SUMMARY REPORT

3.5 Revegetation Activities

3.5.1 Priority Areas for Revegetation

Identification of priority areas for revegetation is a research topic where additional stakeholder interest and engagement is to be completed (see Reclamation Research Plan (ARKTIS, 2017b). The current proposed revegetation strategy for the Mine has identified infrastructure areas (i.e. building pads, camp area, laydown areas, etc.) and site roads and airstrip as locations where revegetation efforts are applied. The revegetation approach could include either active (i.e. seeding) or passive (e.g. scarification, topsoil placement, fertilizer application) methods. These areas are expected to have greater difficulty with natural vegetative recovery without revegetation efforts applied due to the dry environmental setting, compacted materials on surface, and use of construction materials with limited nutrients and/or fines content.

For the remaining disturbed areas, the North Pile will not be covered with salvaged topsoil or actively revegetated, which was the approach selected in the EA (De Beers, 2002a) and is consistent with approaches at other northern diamond mine sites; thus it is not a priority for revegetation efforts. Water control structures (i.e. WMP, sumps) represent wet/moist areas where natural vegetation recovery is less challenging. Select water control structures will continue to be used for water management into the post closure phase (final details to be determined with final engineering design), and when they are no longer needed will be covered/infilled or converted into wetlands. For these reasons, the water control structures and other wet/moist areas are also not a priority for revegetation efforts at this time and will be further considered after final plans for site water management at closure are completed.

A conceptual overview of potential priority areas for revegetation at the Snap Lake Mine, which at this time only includes infrastructure areas and potentially site roads and airstrip, is provided in Figure 3.
Figure 3. Snap Lake Mine revegetation areas.
3.5.2 Revegetation Options for Snap Lake

The following four revegetation options have been considered for the revegetation at the Snap Lake Mine:

1. Leave as constructed. No scarification of areas, no seeding and no fertilizer application.

2. Scarification of areas. This includes scarification of select disturbed areas, including infrastructure areas, site roads and airstrip, and potentially water control structures, as shown in Figure 3.

3. Scarification and seeding/fertilizer application. This scenario involves the scarification of disturbed areas on site (except North Pile) and the application of seeds and fertilizer to disturbed infrastructure areas as identified in Figure 3.

4. Scarification, topsoil placement and seeding/fertilizer application. This scenario involves the scarification of disturbed areas on site (except North Pile). It also includes the application of topsoil and the application of seeds and fertilizer to disturbed infrastructure areas (Figure 3).

One of the above or a combination of these revegetation options will be implemented at closure. Depending on the option selected, the average plant coverage that will develop across the LSA can be predicted. The methodology to calculate a mean cover for the LSA includes using the baseline cover data identified in Section 3.3 to provide an estimate of coverage for undisturbed areas. A conservative estimate for the mean plant coverage that will develop at disturbed areas undergoing one of the above revegetation options can be identified from vegetation performance results as summarized in Section 3.4.2. Estimates for disturbed and undisturbed area sizes can be provided through the site development map as shown in Figure 3.

Following the completion of engagement to further define the preferred priority areas for revegetation efforts (see Reclamation Research Plan (ARKTIS, 2017b)) and subsequent selection of a revegetation option(s), the above calculation can be performed to identify the mean plant coverage for the LSA for adoption as closure criteria.

3.6 Selection of Revegetation Metrics to Use as Closure Criteria

Potential metrics that can be considered for revegetation criteria at the Mine were evaluated and discussed in the following sub-sections.

3.6.1 Re-Establishment of Native Species

Based on review of closure criteria at comparable mine sites in the NWT (Section 3.2), re-establishment and/or dominance of native species is a common metric proposed to evaluate revegetation success. The use of native species in potential revegetation efforts, as well as the encroachment of native endemic vegetation from surrounding areas, makes this criterion achievable following mine closure, and measurable from the readily available comprehensive baseline information detailing the native species in the Snap Lake area. Therefore, this is a recommended metric for adoption as closure criteria.

3.6.2 Plant Ground Coverage and Timeline for Re-Establishment

Average percent plant coverage of vegetation is also a common method of evaluating revegetation success that was proposed for adoption as a closure criteria metric by other similar sites. Various factors can influence the timeline for revegetation, such as revegetation methodology and environmental factors. Given the anticipated long-time span for plants to optimally reestablish at the Mine, the criteria for plant coverage needs to be scaled to assessment at shorter time interval duration post-closure. It is recommended that the criteria for plant coverage be scaled to a practically achievable duration post closure, taking into consideration the slow growth rate and life cycle of vegetation within the LSA.

If monitoring indicates that the target plant coverage may not be achieved within a target period, efforts can be considered to aid in the growth of plants, such as additional seeding and/or application of fertilizer. A summary of the proposed revegetation closure criteria for the Snap Lake Mine is provided in Table 12.
Table 12: Summary of the updated revegetation closure criteria and planned activities.

<table>
<thead>
<tr>
<th>Approved Closure Objective</th>
<th>Proposed Closure Criteria</th>
<th>Primary Closure Activities</th>
<th>Post-Closure Monitoring and Inspection</th>
</tr>
</thead>
<tbody>
<tr>
<td>SW7 – Revegetation targeted to priority areas.</td>
<td>Priority areas revegetated with native species. Mean plant cover of xxx% over the LSA at xxx years post-closure (values to be determined with final design). Where coverage and timeframe are defined based on research findings and final revegetation plan for the Mine.</td>
<td>Revegetation efforts will include some combination of the following activities across the various mine areas: 1) Grading surfaces to promote drainage and limit pooling, surface material loosening (scarification). 2) Placement of salvaged soil from the Organics Pile as a growth amendment to select priority locations. 3) Fertilizer application. 4) Application of native seed species as seeds and/or seedlings.</td>
<td>Revegetation monitoring that includes  • Species density (% plant cover)  • Species richness (record native species present) The monitoring program will be developed with the final design.</td>
</tr>
</tbody>
</table>

4.0 METALS UPTAKE IN PLANTS

Metals uptake by vegetation growing on the North Pile during the post-closure phase was identified as a potential concern to human and wildlife health by stakeholders (MVEIRB, 2003). This section summarizes the research outcomes of metal uptake by plants that has been completed to date for the Mine.

4.1 Snap Lake Mine

In 2014, a desktop review (ARKTIS, 2014b) was completed to provide a summary of the general processes involved in metal uptake by vegetation from substrates, and examined the potential implications to the Mine at closure. Key findings included the following items:

- PK may contain high concentrations of transition metals such as chromium and nickel; however, the neutral to alkaline pH of the porewater can limit the bioavailability of most metals.
- Metal uptake by vegetation is highly species specific, where variations in metal uptake between plant types may vary greatly at the same location.
- Metal uptake by vegetation is highly site specific, where environmental differences between sites often result in variations in metal uptake within the same plant species.
- Certain plant species found at the Snap Lake Mine have demonstrated the ability to uptake and accumulated metals from soil into the shoots and/or fruits of the plant.
- The North Pile cover is anticipated to limit the amount of interaction between vegetation and the underlying PK; however, some native plant species have been recorded with root depths exceeding the thickness of rock cover materials (0.5 m).

4.2 Other Sites

4.2.1 Ekati/Diavik

Evaluation of metals uptake by vegetation growing within PK has been conducted at the Ekati (HMA, 2013; DDEC, 2016) and Diavik (Diavik, 2017) mine sites. To date, the major findings include as follows:

- At Ekati, metals uptake by grasses from PK exceeded natural levels for four metals (HMA, 2013); however, analysis did not indicate any concern for contaminate uptake in grass species as they were generally within the range of literature values for typical metal uptake in agricultural plant species (DDEC, 2016).
• At Diavik, grasses uptake some metals from PK, however there is limited association between substrate and plant tissue metal concentrations, suggesting substrate concentrations are not an effective method for predicting trace metal accumulation in plants. Uptake by grasses was greater when plants were larger and healthier and was dependent on metal species (Diavik, 2017).

4.3 Summary

Research at the Snap Lake, Ekati and Diavik mine sites indicate plants can uptake metals from PK; however, the risk for bioaccumulation and potential for harmful effects in receptors is unclear. The Mackenzie Valley Environmental Impact Review Board (MVEIRB) ruled that the proposed 0.5 m thick granite cover over PK and waste rock at the North Pile would sufficiently mitigate any potential metal uptake by vegetation growing on the North Pile (MVEIRB, 2003). With results from Ekati also suggesting there is little concern from metals uptake from direct growth in PK (DDEC, 2016), no changes to the existing closure design for the North Pile at Snap Lake are considered necessary at this time. Should the future closure risk assessment and/or post closure monitoring identify an unacceptable risk from metals uptake by vegetation on the North Pile, appropriate adaptive measures can be identified and implemented.

5.0 CONCLUSIONS

This report has provided an overview of select components of the revegetation research completed at De Beers’ Snap Lake Mine, as well as, at other northern and applicable mine sites. Topics addressed in this document include best management practices and surface preparation options to promote the reestablishment of natural vegetation, the development of proposed closure criteria to evaluate the success of revegetation activities in achieving closure objectives, and the potential for metals uptake in vegetation. A summary of the main outcomes from the research completed for each topic is as follows:

• Revegetation activities at the Snap Lake Mine should use the topdressing, surface treatments and species and seeding methods recommended in Table 1 for the active and passive reclamation areas.
• Proposed revegetation closure criteria for the Snap Lake Mine include:
  o Native plant species, and,
  o Plant coverage over the LSA at a defined time period based on the final revegetation plan for the Mine.
• Plants can uptake metals from PK; however, the 0.5 m thick granite cover over PK and waste rock at the North Pile should be sufficient to mitigate any potential metal uptake by vegetation growing on the North Pile. A closure risk assessment will further inform this recommendation based on final closure design.

Traditional Knowledge (TK) specific to revegetation is another research topic that will contribute to closure planning. During the EA, TK was used to identify the plant species at site that have traditional value, which was used in assessing residual impacts to the traditional plant potential of the Mine site post closure, among other criteria (De Beers, 2002b). Based on engagement with communities and reaffirmed during a recent closure workshop in May 2017 (MVLWB, 2017), select Aboriginal stakeholders identified the desire that active revegetation of the North Pile should not occur, and that wet/runoff areas should be targeted for revegetation to “treat” water that passes over it. Collection of TK to inform the Final Revegetation Plan is identified as a reclamation research topic in the ICRP v4 (ARKTIS, 2017b).

The information summarized in this report will be used in closure planning for the Snap Lake Mine and for potential incorporation into the closure activities and criteria to be presented in the Final Site Revegetation Plan.
6.0 CLOSING

This report has been prepared exclusively for the use of De Beers Canada Inc. for the specific application described within this report. The details provided in this report are for general information purposes only. The information and recommendations contained in this report should not be used for any other purpose, at another location, or by any other parties. Any use of, or reliance on this report by any third party is at that party’s sole risk. ARKTIS assumes no responsibility for inappropriate use of the contents of this report, and disclaims all liability arising from negligence or otherwise. General terms and conditions are provided in Appendix B.

ARKTIS SOLUTIONS INC.

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7.0 REFERENCES


APPENDIX A: REVEGETATION STUDIES AND REPORTS
DE BEERS CANADA INC., SNAP LAKE MINE - 2017 REVEGETATION FIELD PROGRAM SUMMARY REPORT

September 25, 2017

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1.0 INTRODUCTION

ARKTIS Solutions Inc. (ARKTIS) has been contracted by De Beers Canada Inc. (De Beers) to complete revegetation research for the Snap Lake Mine (Mine). Revegetation of disturbed surface materials at mine closure was identified as a topic of interest by stakeholders during the Environmental Assessment (EA) process (De Beers, 2002), and is a reclamation research item within the Interim Closure and Reclamation Plan (ICRP) (ARKTIS, 2013).

A summary of the revegetation research completed each year is presented in the Annual Closure and Reclamation Plan Progress Report, which is submitted annually to the Mackenzie Valley Land and Water Board, as per Part I, Item 2 of the Water Licence (MV2011L2-0004).

The purpose of this report is to document the following revegetation research completed in 2017.

- Continuation of the revegetation test plots that are designed to evaluate active revegetation methods. Specifically, in 2017 spring and fall seeding events occurred, as well as, monitoring of revegetation growth.
- Preliminary assessment of vegetative natural recovery about the mine site where there has been land disturbance due to operations.

2.0 REVEGETATION TEST PLOTS

2.1 Background

In 2014, desktop reviews were completed to develop candidate revegetation species for dry and wet conditions on site, as well as, preferred sourcing of off-site nursery vendors to support adequate seed/seedling stock development for the reclamation work (ARKTIS, 2014c). A survey of potential collection areas identified candidate species for which seed could be collected locally, confirmed the presence of stands of each species within the expected Ecological Land Classification (ELC) units, and documented general observations regarding the quality of stands for seed production and optimal timelines for future collection efforts. Species were selected if they were considered native species to the Northwest Territories, and met one of the other following criteria (ARKTIS, 2014b):

- Species is recognized as important for local Traditional Knowledge applications; or,
- Species has demonstrated success in revegetation research or progressive reclamation at Ekati or Diavik Mines.

In 2015 and 2016 seed collection on site was completed and the following species yielded sufficient quantities to support the test plot trials (ARKTIS, 2016a, 2016b):

- Bearberry
- Lingonberry
- Crowberry
- Dwarf Birch
- Dwarf Labrador Tea
- Bog Blueberry

Five graminoid species were selected for use in the test plots. The selected grass species include: tickle grass, rocky mountain fescue, alpine bluegrass, tundra bluegrass, and spiked trisetum. These species were chosen due to their availability through commercial suppliers, they are drought tolerant and have been used successfully during revegetation studies at other northern mine sites (ARKTIS, 2014c).
Only one forb species was selected for use in the test plots: showy locoweed. It is a drought tolerant legume, which was included since its availability to fix nitrogen may enhance the establishment and growth of grasses (Matheus and Omtzigt, 2012). Showy locoweed seed is also available commercially.

In 2015, revegetation test plots were constructed at the former AN Storage pad (ARKTIS, 2016b). The goal of the revegetation test plots is to assess vegetation responses to variations in topdressing, seeding and fertilizing methods, and seasonality of seed application on vegetation growth (ARKTIS, 2014a) in dry soil conditions. Test plots were divided into A plots and B plots with subsections numbered 1 through 4. A plots are seeded in the fall while the B plots are seeded in the spring. Plots A and B are then subdivided into four separate rows to assess vegetation growth using the following topdressing and fertilizing methods: fertilizer/topsoil, fertilizer/no topsoil, no fertilizer/topsoil and no fertilizer/no topsoil. Due to limited opportunities for evaluation of revegetation techniques as part of progressive reclamation, field research trials were undertaken to evaluate specific methods and assess the preferred approach for revegetation success at Snap Lake (ARKTIS, 2014a).

In 2016, the experimental design for active revegetation was initiated (ARKTIS, 2016a). Spring application of fertilizer, graminoid and forb seeds to plots B1 through B4 was completed in June. Fall application of fertilizer, graminoid, forb and shrub seeds to plots A1 through A4 was completed in October. Also in 2016, a preliminary assessment of vegetation cover at the test plots during a separate visit in September was completed and reported in ARKTIS (2016a).

As additional time and revegetation performance characteristics are collected, the information will be used to inform the revegetation program for the Mine at closure.

2.2 Activities Completed in 2017

2.2.1 Test Plot Seeding Program

From June 16th to June 17th, 2017, spring application of fertilizer, shrub seeds and shrub seedlings to plots B1 through B4, as defined in Section 4.1 of ARKTIS (2014a), was completed. In 2016, the spring application of fertilizer, graminoid and forb seeds to plots B1 through B4 was completed and the fall application of fertilizer, graminoid, forb and some shrub seeds to plots A1 through A4 was completed and therefore did not need to be repeated in 2017. From September 8th to 9th, 2017, fall application shrub seeds to plots A1 through A4 was completed. The following activities as part of the seed application and root plug planting were completed:

1. Sub-plot boundaries were measured out to approximately 7.5 m x 15 m in size, with planting rows marked at widths of 1.25 m for shrubs.
2. Existing vegetation from sub-plots were removed prior to shrub root plug and seed treatment.
3. A 13/14-16-10 (Nitrogen-Phosphorous-Potassium ratio) fertilizer was applied at a rate of 300 kg/ha to the B3 shrub sub-plots (topsoil) and 500 kg/ha to the B1 shrub sub-plots (no topsoil).
4. Planting of available shrub root plugs (lingonberry and crowberry) that were collected as seed at Snap Lake in 2015 and 2016 and underwent propagation to root plugs at an off-site nursery (NATS Nursery).
   o Four to five shrub root plugs per meter were planted 5 to 8 cm deep, for a total of 32 shrubs for lingonberry and 72 shrubs for crowberry for each shrub species’ planting row, except plot B3 which received 35 lingonberry root plugs.
5. Shrub lingonberry, bearberry and crowberry were directly seeded during the spring program, using the following methods:
   o Four 2.5-5 cm deep holes per meter were dug by hand tool where possible, for a total of approximately 60 holes per row for lingonberry, crowberry and bearberry.
   o Approximately 10-15 lingonberry seeds, 5-10 crowberry seeds and 3-4 bearberry seeds were placed in each hole and covered with soil.
6. Shrub bearberry were directly seeded during the fall program, using the following methods:
   o Four 2.5-5 cm deep holes per meter were dug by hand tool where possible, for a total of approximately 60 holes per row for bearberry.
Approximately 5-8 bearberry seeds were placed in each hole and covered with soil.

Figure 1 depicts the layout of the test plots within the site area. Figure 2 and Figure 3 illustrates the dimensions and seeding pattern within test plots B1 to B4 and A1 to A4 that received fertilizer treatment in spring and fall of 2016 and 2017. A photographic log of the test plot area from the time of the initial seeding in spring 2016 to fall 2017 is provided in Table 3.

2.2.2 Revegetation Monitoring

During the spring 2017 field program, an assessment of vegetation cover at the test plots B1 through B4 was completed. Estimates of the percent cover for candidate species and barren plots are summarized in Table 1, with reference photographs provided in Table 3. Photographs in Table 3 will eventually provide a visual representation of the vegetation growth in each plot over several years. Currently photos are limited to spring 2016 (Plots B1-B4), fall of 2016 (Plots B1-B4), spring 2017 (Plots A1-A4; B1-B4), and fall 2017 (Plots A1-A4; B1-B4).

Photographs in 2017 were taken from the southeast corner of each test plot in order document the change over time and between treatment applications. The methodology applied to assess revegetation included:

- For each species in each sub-plot (refer to Figure 4), the following characteristics were estimated:
  - Percent vegetation cover
  - Plant height
  - Stem count
  - General plant health

- Vegetation growth was assessed as follows:
  - Each planting row was divided into 15 equal sections, numbered from 0 to 14 from south to north.
  - The barren subplots were divided into 9 equal sections.
  - Percent cover was estimated by placing a 50 x 20 cm quadrat at three sections along each species row or within each barren plot; the total percent cover of all vegetation within the quadrat was estimated, as well as, the percent cover of individual species. A stem count of individual candidate species, measures of plant height and observations of plant health was also completed for each quadrat location.

- A photograph of each revegetation sub-plot was taken from the southern edge to record progress.

Observations regarding the revegetation at test plots B1 through B4 in 2017 were similar to that of 2016, as follows:

- Encroaching endemic vegetation from the surrounding area appears to dominate the existing ground cover relative to the candidate species applied through active revegetation.

- Vegetation ground cover was substantially greater in test plot B3 which had fertilizer added and topsoil compared to the test plots that had no fertilizer or topsoil.

- Grasses have the greatest success when looking at percent coverage in all test plots compared to the other candidate species planted. Common reed (Phragmites australis), a species that was not planted, was found in high concentration in the test plots in the fall monitoring assessment.

- Within the topsoil plots, areas with darker, more organic rich soil support more vegetation relative to areas with lighter, finer grained soil.

- For plots with no topsoil, vegetation growth is greater in areas with finer, sandy material, moist ground, and/or in the shelter of depressions and boulders, with Rocky Mountain Fescue being the predominant species.
3.0 NATURAL VEGETATION RECOVERY

3.1 Background

A visual preliminary evaluation of plant type and species growing naturally on disturbed surfaces around the Mine site was completed in spring and fall of 2017. The goal of the natural vegetation recovery survey was to assess vegetation growth in areas that have been previously disturbed by mine site activities.

3.2 Activities completed in 2017

A visual preliminary evaluation of plant type (e.g., grass, shrub) and species name growing naturally on disturbed surfaces around the Mine site was conducted on June 18th and 19th and September 8th and 9th, 2017. A representative sample of wet and dry soil conditions were targeted for this evaluation. Locations evaluated are depicted in Figure 5. Information recorded is presented in Table 2 and photographs in Table 4. The natural recovery assessment was conducted by completing the following steps:

1. Representative locations for wet and dry natural growth with an even geographic distribution across site were identified during a driving tour.
2. Locations identified were marked off with a flag at the south-east corner of each plot.
3. A 4 x 4 m square was marked out.
4. Plant species were identified when possible.
5. The percent coverage was estimated over the 4 x 4 m plot.
6. Soil type was describe based on grain size, dryness, and thickness; the presence or absence of fines and organics was also noted.
7. GPS locations were recorded and a photograph was taken.

Initial observations regarding the natural revegetation disturbed areas were as follows:

- Seventeen locations were assessed. Thirteen of those had at least 30% plant coverage.
- Species most found included: dwarf birch, fireweed, moss, grasses and crowberry.
- NR-10 (WMP shore) and NR-16 (Starter Cell, south ditch) both had areas with 100% plant coverage and NR-3 (Quarry-wet) had 85% plant coverage. These three areas also had the highest percent of organics observed in the soil with 30 to 40%.

4.0 SEED COLLECTION

No seed collection was done in 2017. Information regarding previous seed collection are summarized in the Revegetation Research Program 2015 Annual Report and 2016 Revegetation Field Program Summary Report (ARKTIS Solutions Inc., 2016a, 2016b).

5.0 CLOSING

This report has been prepared exclusively for the use of De Beers Canada Inc. for the specific application described within this report. The details provided in this report are for general information purposes only. The information and recommendations contained in this report should not be used for any other purpose, at another location, or by any other parties. Any use of, or reliance on this report by any third party is at that party’s sole risk. ARKTIS assumes no responsibly for inappropriate use of the contents of this report, and disclaims all liability arising from negligence or otherwise. General terms and conditions are provided in Appendix A.
6.0 REFERENCES

Grasses and grasses + legumes were applied to test plots B1 through B4 in June 2016. Grasses, grasses + legumes, and shrub seed (lingonberry and crowberry) were applied to test plots A1 through A4 in October 2016. Shrub seed (lingonberry, crowberry and bearberry) and seedlings (lingonberry and crowberry) were applied to test plots B1 through B4 in June 2017. Shrub seed (bearberry) was applied to test plots A1 through A4 in September 2017. Photo taken July 2012, facing north.
Figure 2. Dimensions and seeding pattern in test plots B1 to B4 as of June 2017.
Figure 3. Dimensions and seeding pattern in test plots A1 to A4 as of September 2017.
Figure 4. Section divisions for revegetation test plot monitoring. For each subplot, each planting row was subdivided into 15 equal sections (bottom diagram). For barren subplot (top diagram) – entire subplot was divided into 9 sections. For all treatments, 3 sections were surveyed using a 20 x 50 cm quadrant. The choice for what sections to be sampled were randomly selected.
Figure 5. Natural recovery assessment locations. Location names in blue are potential wet test plot locations.
### Table 1. Growth monitoring for revegetation Test Plots at the former AN Storage Pad.

<table>
<thead>
<tr>
<th>Plot</th>
<th>Top Dressing</th>
<th>Amendment</th>
<th>Sub-plot</th>
<th>Species/name</th>
<th>Fall 2016 Assessment</th>
<th>Spring</th>
<th>2017 Assessment</th>
<th>Reference Photograph</th>
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</thead>
<tbody>
<tr>
<td>A1</td>
<td>None</td>
<td>Fertilizer</td>
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<td>Alpine Bluegrass</td>
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<td>Rocky Mountain Fescue</td>
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<td></td>
<td></td>
<td></td>
<td>Spiked Trisetum</td>
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<td></td>
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<td></td>
<td>Tickle Grass</td>
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<td>Legume + Grasses</td>
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<td>Alpine Bluegrass + Showy Locoweed</td>
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<td>Rocky Mountain Fescue + Showy Locoweed</td>
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<td>Spiked Trisetum + Showy Locoweed</td>
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<td>-</td>
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<td>Showy Locoweed</td>
<td>- -</td>
<td>-</td>
<td>3 2</td>
<td>-</td>
</tr>
</tbody>
</table>

### Summary

- **Alpine Bluegrass**
  - Fall 2016: 15% cover, 10% stem count.
  - Spring 2017: 0% cover, 0% stem count.
  - Average: 7.5% cover, 5% stem count.

- **Rocky Mountain Fescue**
  - Fall 2016: 0% cover, 0% stem count.
  - Spring 2017: 5% cover, 0% stem count.
  - Average: 2.5% cover, 0% stem count.

- **Spiked Trisetum**
  - Fall 2016: 0% cover, 0% stem count.
  - Spring 2017: 0% cover, 0% stem count.
  - Average: 0% cover, 0% stem count.

- **Tickle Grass**
  - Fall 2016: 0% cover, 0% stem count.
  - Spring 2017: 0% cover, 0% stem count.
  - Average: 0% cover, 0% stem count.

- **Legume + Grasses**
  - Fall 2016: 0% cover, 0% stem count.
  - Spring 2017: 0% cover, 0% stem count.
  - Average: 0% cover, 0% stem count.

- **Alpine Bluegrass + Showy Locoweed**
  - Fall 2016: 0% cover, 0% stem count.
  - Spring 2017: 0% cover, 0% stem count.
  - Average: 0% cover, 0% stem count.

- **Rocky Mountain Fescue + Showy Locoweed**
  - Fall 2016: 0% cover, 0% stem count.
  - Spring 2017: 0% cover, 0% stem count.
  - Average: 0% cover, 0% stem count.

- **Spiked Trisetum + Showy Locoweed**
  - Fall 2016: 0% cover, 0% stem count.
  - Spring 2017: 0% cover, 0% stem count.
  - Average: 0% cover, 0% stem count.

- **Tickle Grass + Showy Locoweed**
  - Fall 2016: 0% cover, 0% stem count.
  - Spring 2017: 0% cover, 0% stem count.
  - Average: 0% cover, 0% stem count.

- **Showy Locoweed**
  - Fall 2016: 0% cover, 0% stem count.
  - Spring 2017: 0% cover, 0% stem count.
  - Average: 0% cover, 0% stem count.
## DE BEERS CANADA INC., SNAP LAKE MINE
### 2017 REVEGETATION FIELD PROGRAM SUMMARY REPORT

### Plot: DE BEERS CANADA INC., SNAP LAKE MINE
#### SNAP LAKE MINE
- **2017 REVEGETATION FIELD PROGRAM SUMMARY REPORT**

#### Plot and Dressing Summary

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<th>Sub-plot</th>
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<th>Spring</th>
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<th>Fall</th>
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<td>Photograph</td>
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</tbody>
</table>

#### Shrub Species
- **Crowberry (direct seed)**
  - Planted Fall of 2016
  - Total Percent (%) Cover: -
  - Spring: -
  - 2017 Assessment: -
  - Fall: -
- **Lingonberry (direct seed)**
  - Total Percent (%) Cover: -
  - Spring: -
  - 2017 Assessment: -
  - Fall: -
- **Bearberry (direct seed)**
  - Planted Fall of 2017
  - Total Percent (%) Cover: -
  - Spring: -
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  - Fall: -

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- Total Percent (%) Cover: -
- Spring: -
- 2017 Assessment: -
- Fall: -

#### Grass Species
- **Alpine Bluegrass**
  - Planted Fall of 2016
  - Total Percent (%) Cover: -
  - Spring: -
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  - Fall: -
- **Rocky Mountain Fescue**
  - Total Percent (%) Cover: -
  - Spring: -
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  - Fall: -
- **Spiked Trisetum**
  - Total Percent (%) Cover: -
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- **Tickle Grass**
  - Total Percent (%) Cover: -
  - Spring: -
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#### Legume + Grasses Species
- **Alpine Bluegrass + Showy Locoweed**
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  - 2017 Assessment: -
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- **Rocky Mountain Fescue + Showy Locoweed**
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- **Spiked Trisetum + Showy Locoweed**
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- Photograph 6
- Photograph 7
- Photograph 8
- Photograph 9
- Photograph 10
- Photograph 11
- Photograph 12
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### DE BEERS CANADA INC., SNAP LAKE MINE
### 2017 REVEGETATION FIELD PROGRAM SUMMARY REPORT

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<td>Avg: 3.7 grass Avg: 0.5 forb</td>
<td>Avg: 12 grass Avg: 17 forb</td>
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<td>0</td>
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<td>1 grass 0 forb</td>
<td>1 grass 0 forb</td>
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<td>10</td>
<td>11</td>
<td>10 grass 1 forb</td>
<td>30 grass 21 forb</td>
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<td>13</td>
<td>6</td>
<td>5 grass 1 forb</td>
<td>24 grass 13 forb</td>
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<td>Average</td>
<td>7.3</td>
<td>Avg: 5.3 grass Avg: 0.7 forb</td>
<td>Avg: 18 grass Avg: 11 forb</td>
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<td>Showy Locoweed</td>
<td>0 - 1</td>
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<td>Plot</td>
<td>Top Dressing</td>
<td>Amendment</td>
<td>Species</td>
<td>Shrub</td>
<td>Fall 2016 Assessment</td>
<td>2017 Assessment</td>
<td>Reference Photograph</td>
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<td>Total Percent (%) Cover</td>
<td>Spring</td>
<td>Total Percent (%) Cover</td>
<td>Species Stem Count</td>
<td>Fall</td>
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<td>Quadrant meter along planting row</td>
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<td>0.5</td>
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<td>Average</td>
<td>2.2</td>
<td>1</td>
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<td>Shrub</td>
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<td>Crowberry (direct seed)</td>
<td>Planted Spring of 2017</td>
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<td>Lingonberry (direct seed)</td>
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<td>Bearberry (direct seed)</td>
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<td>Crowberry (seedlings)</td>
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<td>Lingonberry (seedlings)</td>
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<td>Average</td>
<td>10</td>
<td>10</td>
<td>10</td>
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</tbody>
</table>

Note: shaded areas indicate areas that were not monitored.

+ Percent cover estimated based on range observed for candidate species throughout the entire area of individual planting rows and for all species present within the entire area of the natural recovery sub-plots.

Test plots A1 through A4 did not commence treatment until October 2016, and thus no monitoring data was available in fall 2016 or spring 2017.
Table 2. Natural vegetation recovery assessment.

<table>
<thead>
<tr>
<th>Location Name</th>
<th>Ecological Land Classification (ELC) unit</th>
<th>GPS Location (UTM)</th>
<th>Plant Species Observed</th>
<th>% Coverag e</th>
<th>Densit y per 16m²</th>
<th>Plant Species</th>
<th>Soil Description</th>
<th>Approximate Soil Thickness (m)</th>
<th>Fines (%)</th>
<th>% Fine s</th>
<th>Organic s (%)</th>
<th>% Organic s</th>
<th>Rock Type</th>
<th>Area Condition</th>
<th>Reference Photograph</th>
</tr>
</thead>
<tbody>
<tr>
<td>NR-1 (Emulsion Plant)</td>
<td>Heath Boulder</td>
<td>503549 7052705</td>
<td>Dwarf birch</td>
<td>15</td>
<td>17</td>
<td>Unknown 1</td>
<td>Unknown 2</td>
<td>Gravel to cobbles; dry</td>
<td>0.1 to 0.8</td>
<td>Y</td>
<td>&lt;5</td>
<td>N</td>
<td>Granite</td>
<td>Work last completed in area in 2008, with the exception of the revegetation plots constructed in 2015 at the AN Storage pad.</td>
<td>Photograph 97</td>
</tr>
<tr>
<td>NR-2 (AN storage)</td>
<td>Heath Boulder</td>
<td>504348 7052295</td>
<td>Fireweed</td>
<td>20</td>
<td>30</td>
<td>Birch shrub</td>
<td>Moss</td>
<td>Gravel to cobbles; dry</td>
<td>0.5 to 1.5</td>
<td>Y</td>
<td>10</td>
<td>N</td>
<td>Granite</td>
<td>Completion of electrical distribution and construction of Ammonium Nitrate (AN) Storage Building in 2009.</td>
<td>Photograph 88</td>
</tr>
<tr>
<td>Location Name</td>
<td>Ecological Land Classification (ELC) unit</td>
<td>GPS Location (UTM)</td>
<td>Plant Species Observed</td>
<td>% Coverag e</td>
<td>Density % per 16m²</td>
<td>Soil Type Description</td>
<td>Approximate Soil Thickness (m)</td>
<td>% Fine s</td>
<td>Organic s (Y/N)</td>
<td>% Organic s</td>
<td>Rock Type</td>
<td>Area Condition</td>
<td>Reference Photograph</td>
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<tr>
<td>NR-3 (Quarry-wet)</td>
<td>Heath Boulder</td>
<td>504920 7052112</td>
<td>Dwarf birch Fireweed Unknowns Moss (2-4)</td>
<td>85 (w. moss) 40 (w/o moss)</td>
<td>-</td>
<td>Silt/sand, gravel some cobbles organic-rich wet/damp</td>
<td>0.05 to 0.1</td>
<td>Y</td>
<td>50</td>
<td>Y</td>
<td>30</td>
<td>Granite</td>
<td>Expansion of Apron Quarry in 2012. Work ongoing in area.</td>
<td></td>
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</tr>
<tr>
<td>NR-5 (IL6 inflow area)</td>
<td>Heath Boulder</td>
<td>505153 7052881</td>
<td>Unknown grasses Moss</td>
<td>30</td>
<td>-</td>
<td>Organic rich Mostly fines and organics Damp soil area</td>
<td>0.3</td>
<td>Y</td>
<td>60</td>
<td>Y</td>
<td>20</td>
<td>Granite</td>
<td>Work last done in 2012 when the construction of the inland lake IL6 diversion ditch catchment was completed.</td>
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<tr>
<td>Location Name</td>
<td>Ecological Land Classification (ELC) unit</td>
<td>Plant Species Observed</td>
<td>Soil Description</td>
<td>Approximate Soil Thickness (m)</td>
<td>% Fine s (Y/N)</td>
<td>% Organic s (Y/N)</td>
<td>% Organic s (Y/N)</td>
<td>Rock Type</td>
<td>Area Condition</td>
<td>Reference Photograph</td>
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<tr>
<td>NR-6 (South north pile Road berm)</td>
<td>Heath Boulder</td>
<td>Dwarf birch</td>
<td>Boulders, cobbles with gravel/sand filling spaces, dry</td>
<td>0.4</td>
<td>Y</td>
<td>&lt;10</td>
<td>Y</td>
<td>&lt;5</td>
<td>Granite</td>
<td>Photograph 101</td>
<td></td>
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<td>Area last disturbed during the construction of the North Pile Starter Cell in 2008.</td>
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<tr>
<td>NR-7 (south slope laydown)</td>
<td>Heath Boulder</td>
<td>Dwarf birch Birch regular Crowberry Unknowns</td>
<td>Gravel/cobbles, boulders; some sand in spaces</td>
<td>&lt;1</td>
<td>N</td>
<td>-</td>
<td>N</td>
<td>Granite</td>
<td>Photograph 102</td>
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<td>Area last disturbed during the construction of the North Pile Starter Cell in 2008.</td>
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<td>Photograph 103</td>
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<td>Location Name</td>
<td>Ecological Land Classification (ELC) unit</td>
<td>GPS Location (UTM)</td>
<td>Plant Species Observed</td>
<td>Plant Species</td>
<td>Soil Type</td>
<td>Soil Description</td>
<td>Approximate Soil Thickness (m)</td>
<td>Fine Description</td>
<td>Fine (%)</td>
<td>Organic (%)</td>
<td>Organic (%)</td>
<td>Rock Type</td>
<td>Area Condition</td>
<td>Reference Photograph</td>
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<tr>
<td>NR-8 (north slope organics pile)</td>
<td>Heath Boulder</td>
<td>505817 7052276</td>
<td>Fireweed</td>
<td>Known grasses</td>
<td>Unknown weed</td>
<td>40</td>
<td>&gt;100</td>
<td>Boulders, cobbles, gravel; good amount of organics and fines</td>
<td>Y</td>
<td>40</td>
<td>Y</td>
<td>20</td>
<td>Granite</td>
<td>Last disturbed is unknown. Grading and construction of the embankment at the organics laydown area occurred in 2009. Organics from pile were used for the construction of the revegetation test pads in 2015.</td>
<td>Photograph 104</td>
</tr>
<tr>
<td>NR-9 (Starter cell, south perimeter ditch)</td>
<td>Heath Boulder</td>
<td>505897 7052575</td>
<td>Dwarf birch</td>
<td>Dwarf labrador tea</td>
<td>Dwarf Labrador tea</td>
<td>35</td>
<td>20 - 40</td>
<td>Boulders, gravel, sand filling spaces, dry, lower areas more damp</td>
<td>1</td>
<td>Y</td>
<td>10</td>
<td>N</td>
<td>Granite</td>
<td>Area last disturbed during the construction of the North Pile Starter Cell in 2008.</td>
<td>Photograph 105</td>
</tr>
<tr>
<td>Location Name</td>
<td>Ecological Land Classification (ELC) unit</td>
<td>GPS Location (UTM)</td>
<td>Plant Species Observed</td>
<td>% Coverag e</td>
<td>% Y per 16m²</td>
<td>Soil Description</td>
<td>Approximate Soil Thickness (m)</td>
<td>% Fine s (Y/N)</td>
<td>% Organic s (Y/N)</td>
<td>% Organic s</td>
<td>Rock Type</td>
<td>Area Condition</td>
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<tr>
<td>NR-10 (WMP shore)</td>
<td>Heath Boulder</td>
<td>506541 7052410</td>
<td>Unknown grasses</td>
<td>100</td>
<td>-</td>
<td>Mud, organics, pk fines, damp</td>
<td>&gt;1</td>
<td>Y</td>
<td>60</td>
<td>Y</td>
<td>40</td>
<td>Granite</td>
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<td>Littoral zone of the WMP. Area damp. Seasonal growth.</td>
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<tr>
<td>NR-11 (accommodation complex south)</td>
<td>Heath Boulder</td>
<td>506670 7052466</td>
<td>Unknown Shrubs Moss</td>
<td>50</td>
<td>15</td>
<td>Boulders, cobbles, gravel, sand</td>
<td>0.2</td>
<td>Y</td>
<td>5</td>
<td>N</td>
<td>-</td>
<td>Granite</td>
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<td>Area last disturbed during camp construction in 2010.</td>
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<tr>
<td>NR-12 (East Cell north ditch)</td>
<td>Heath Boulder</td>
<td>505515 7052934</td>
<td>Crowberry Dwarf birch Unknown grass Unknown shrub</td>
<td>50</td>
<td>&gt;50</td>
<td>Gravel, sand, some fines some boulders, cobbles</td>
<td>0.2 to 1</td>
<td>Y</td>
<td>15</td>
<td>Y</td>
<td>10</td>
<td>Granite</td>
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<td>Area last disturbed in 2014 during East Cell Construction.</td>
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<tr>
<td>Location Name</td>
<td>Ecological Land Classification (ELC) unit</td>
<td>GPS Location (UTM)</td>
<td>Plant Species Observed</td>
<td>% Coverages</td>
<td>% Soil Description</td>
<td>Approximate Soil Thickness (m)</td>
<td>Fine (Y/N)</td>
<td>% Organic (Y/N)</td>
<td>% Organic (Y/N)</td>
<td>Rock Type</td>
<td>Area Condition</td>
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<tr>
<td>NR-13 (East Cell north embankment base)</td>
<td>Heath Boulder</td>
<td>505833 7052883</td>
<td>Dwarf birch Fireweed Unknown grasses and weeds Unknown shrubs</td>
<td>65</td>
<td>Boulders, cobbles, spaces filled with gravel, sand and some fines</td>
<td>0.3</td>
<td>Y</td>
<td>10</td>
<td>Y</td>
<td>Granite</td>
<td>Area last disturbed in 2014 during East Cell Construction</td>
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<tr>
<td>NR-14 (BSMRP)</td>
<td>Heath Boulder</td>
<td>506818 7053149</td>
<td>Fireweed Unknown shrub</td>
<td>10</td>
<td>Boulders, cobbles, gravel, some sand</td>
<td>0.3</td>
<td>N</td>
<td>-</td>
<td>N</td>
<td>Metavolcanic</td>
<td>Area last disturbed during camp construction in 2010.</td>
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<tr>
<td>Location Name</td>
<td>Ecological Land Classification (ELC) unit</td>
<td>GPS Location (UTM)</td>
<td>Plant Species Observed</td>
<td>% Coverag e</td>
<td>Soils Type</td>
<td>Soil Description</td>
<td>Approximate Soil Thickness (m)</td>
<td>Reference Photograph</td>
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<tr>
<td>NR-15 (FAR embankment)</td>
<td>Heath Boulder</td>
<td>507044 7053064</td>
<td>Dwarf birch Crowberry</td>
<td>12</td>
<td>Cobble, gravel, some sand</td>
<td>0.2</td>
<td>N</td>
<td>N</td>
<td>Metavolcanic</td>
<td></td>
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<tr>
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<td>Heath Boulder</td>
<td>505544 7052215</td>
<td>Unknown shrub (willow?) Unknown grasses</td>
<td>100</td>
<td>Mossy, wet, organic rich; fines, sand and gravel</td>
<td>0.1 to 0.3</td>
<td>Y</td>
<td>30</td>
<td>Y</td>
<td>Granite</td>
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<tr>
<td>NR-17 (Stater cell, north PSS1 slope)</td>
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<td>505252 7052240</td>
<td>Crowberry Unknown shrub (willow?) Moss Fireweed</td>
<td>35</td>
<td>Cobble, gravel, sand, boulders, finer naturally infilling spaces</td>
<td>0.1 to 0.3</td>
<td>Y</td>
<td>&lt;5</td>
<td>N</td>
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<td>GPS Location (UTM)</td>
<td>Plant Species Observed</td>
<td>% Coverag e</td>
<td>Densit y per 16m²</td>
<td>Soil Description</td>
<td>Approximate Soil Thickness (m)</td>
<td>Fine s (Y/N)</td>
<td>% Fine s</td>
<td>Organic s (Y/N)</td>
<td>% Organic s</td>
<td>Rock Type</td>
<td>Area Condition</td>
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<td>Photograph 113</td>
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Notes: Plots marked with a flag at SE corner. Plots were 4 x 4m square north to south. Assessment occurred on June 18 and 19, 2017.
Table 3. Photographs of test plots.

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<th>Spring 2017</th>
<th>Fall 2017</th>
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<td>Grasses + Legumes</td>
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<td>Shrubs</td>
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<td>Grasses + Legumes</td>
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<td>Photograph 83. Facing north</td>
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<td>Overview</td>
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<td>Photograph 90. Facing north</td>
<td>Photograph 91. Facing north</td>
<td>Photograph 92. Facing northeast</td>
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<td>Overview</td>
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<td><img src="image4" alt="Photograph 96. Facing northwest" /></td>
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Note: shaded areas indicate areas that were not monitored.
Table 4. Photographs of natural vegetation recovery assessment.

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<tr>
<th>Photograph</th>
<th>Description</th>
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<tr>
<td>97. NR-1</td>
<td>(Emulsion Plant), Facing north.</td>
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<tr>
<td>98. NR-2</td>
<td>(AN Storage area), Facing north.</td>
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<tr>
<td>99. NR-3</td>
<td>(Quarry-wet), Facing north.</td>
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<tr>
<td>100. NR-4</td>
<td>(Quarry-dry), Facing north.</td>
</tr>
<tr>
<td>101. NR-5</td>
<td>(IL6 inflow area), Facing north.</td>
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<tr>
<td>102. NR-6</td>
<td>(North Pile south road berm), Facing north.</td>
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<tr>
<td>103. NR-7</td>
<td>(Laydown south slope), Facing north.</td>
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<tr>
<td>104. NR-8</td>
<td>(Organics Pile north slope), Facing north.</td>
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<tr>
<td>105. NR-9</td>
<td>(Starter Cell south perimeter ditch), Facing north.</td>
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<tr>
<td>106. NR-10</td>
<td>(WMP shore), Facing north.</td>
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</table>

Photograph 108. NR-12 (East Cell north ditch). Facing north.


Photograph 110. NR-14 (BSMRP). Facing north.

Photograph 111. NR-15 (FAR embankment). Facing north.

Photograph 112. NR-16 (Starter Cell south ditch). Facing north.

Photograph 113. NR-17 (Starter Cell north PS1 slope). Facing north.
APPENDIX A: GENERAL TERMS AND CONDITIONS

USE OF REPORT

This report pertains to a specific site, a specific development, and a specific scope of work. It is not applicable to any other sites, nor should it be relied upon for types of development other than those to which it refers. Any variation from the site or proposed development would necessitate a supplementary investigation and assessment.

This report and the assessments and recommendations contained in it are intended for the sole use of ARKTIS Solutions Inc.’s (ARKTIS) client. ARKTIS does not accept any responsibility for the accuracy of any of the data, the analysis or the recommendations contained or referenced in the report when the report is used or relied upon by any party other than ARKTIS’ client unless otherwise authorized in writing by ARKTIS. Any unauthorized use of the report is at the sole risk of the user.

LIMITATIONS OF REPORT

This report is based solely on the conditions which existed on site at the time of ARKTIS’ investigation. The client, and any other parties using this report with the express written consent of the clients and ARKTIS, acknowledge that conditions affecting the environmental assessment of the site can vary with time and that the conclusions and recommendations set out in this report are time sensitive.

The client, and any other party using this report with the express written consent of the client and ARKTIS, also acknowledge that the conclusions and recommendations set out in this report are based on limited observations and testing on the subject site and that conditions may vary across the site which, in turn, could affect the conclusions and recommendations made.

The client acknowledges that ARKTIS is neither qualified to, nor is it making, any recommendations with respect to the purchase, sale, investment or development of the property, the decisions on which are the sole responsibility of the client.

During the performance of the work and the preparation of this report, ARKTIS may have relied on the information provided by persons other than the client. While ARKTIS endeavors to verify the accuracy of such information when instructed to do so by the client, ARKTIS accepts no responsibility for the accuracy or the reliability of such information which may affect the report.

STANDARD OF CARE

Services performed by ARKTIS for this report have been conducted in a manner consistent with the level of skill ordinarily exercised by members of the profession currently practicing under similar conditions in the jurisdiction in which the services are provided, subject to the time limits and financial and physical constraints applicable to the services. Professional judgment has been applied in developing the conclusions and recommendations provided in this report. No warranty or guarantee, express or implied, is made concerning the test results, comments, recommendations, or any other portion of this report.

ALTERNATE REPORT FORMAT

Where ARKTIS submits both electronic file and hard copy versions of reports, drawings and other project related documents and deliverables (collectively termed instruments of professional service), the Client agrees that only the signed and sealed hard copy versions shall be considered final and legally binding. The hard copy versions submitted by ARKTIS shall be the original documents for record and working purposes, and, in the event of a dispute or discrepancies, the hard copy versions shall govern over the electronic versions. Furthermore, the Client agrees and waives all future right of dispute that the original hard copy signed version archived by ARKTIS shall be deemed to be the overall original for the Project.

The Client agrees that both electronic file and hard copy versions of instruments of professional services shall not, under any circumstances, no matter who owns or uses them, be altered by any party except ARKTIS. The Client warrants that instruments of professional services will be used only and exactly as submitted by ARKTIS.
## APPENDIX B: SCIENTIFIC NAMES OF REVEGETATION SPECIES

<table>
<thead>
<tr>
<th>Species Common Name</th>
<th>Species Scientific Name</th>
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<td>Alpine bluegrass</td>
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<td>Bearberry</td>
<td>Arctostaphylos rubra</td>
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<tr>
<td>Bog blueberry</td>
<td>Vaccinium uliginosum</td>
</tr>
<tr>
<td>Crowberry</td>
<td>Empetrum nigrum</td>
</tr>
<tr>
<td>Dwarf birch</td>
<td>Betula glandulosa</td>
</tr>
<tr>
<td>Dwarf Labrador tea</td>
<td>Ledum decumbens</td>
</tr>
<tr>
<td>Lingonberry</td>
<td>Vaccinium vitis-idaea</td>
</tr>
<tr>
<td>Rocky mountain fescue</td>
<td>Festuca saximontana</td>
</tr>
<tr>
<td>Showy locoweed</td>
<td>Oxytropis splendens</td>
</tr>
<tr>
<td>Spiked trisetum</td>
<td>Trisetum spicatum</td>
</tr>
<tr>
<td>Tickle grass</td>
<td>Agrostis scabra</td>
</tr>
<tr>
<td>Tundra bluegrass</td>
<td>Poa glauca</td>
</tr>
</tbody>
</table>
APPENDIX B: GENERAL TERMS AND CONDITIONS
USE OF REPORT

This report pertains to a specific site, a specific development, and a specific scope of work. It is not applicable to any other sites, nor should it be relied upon for types of development other than those to which it refers. Any variation from the site or proposed development would necessitate a supplementary investigation and assessment.

This report and the assessments and recommendations contained in it are intended for the sole use of ARKTIS Solutions Inc.’s (ARKTIS) client. ARKTIS does not accept any responsibility for the accuracy of any of the data, the analysis or the recommendations contained or referenced in the report when the report is used or relied upon by any party other than ARKTIS’ client unless otherwise authorized in writing by ARKTIS. Any unauthorized use of the report is at the sole risk of the user.

LIMITATIONS OF REPORT

This report is based solely on the conditions which existed on site at the time of ARKTIS’ investigation. The client, and any other parties using this report with the express written consent of the clients and ARKTIS, acknowledge that conditions affecting the environmental assessment of the site can vary with time and that the conclusions and recommendations set out in this report are time sensitive.

The client, and any other party using this report with the express written consent of the client and ARKTIS, also acknowledge that the conclusions and recommendations set out in this report are based on limited observations and testing on the subject site and that conditions may vary across the site which, in turn, could affect the conclusions and recommendations made.

The client acknowledges that ARKTIS is neither qualified to, nor is it making, any recommendations with respect to the purchase, sale, investment or development of the property, the decisions on which are the sole responsibility of the client.

During the performance of the work and the preparation of this report, ARKTIS may have relied on the information provided by persons other than the client. While ARKTIS endeavors to verify the accuracy of such information when instructed to do so by the client, ARKTIS accepts no responsibility for the accuracy or the reliability of such information which may affect the report.

STANDARD OF CARE

Services performed by ARKTIS for this report have been conducted in a manner consistent with the level of skill ordinarily exercised by members of the profession currently practicing under similar conditions in the jurisdiction in which the services are provided, subject to the time limits and financial and physical constraints applicable to the services. Professional judgment has been applied in developing the conclusions and/or recommendations provided in this report. No warranty or guarantee, express or implied, is made concerning the test results, comments, recommendations, or any other portion of this report.

ALTERNATE REPORT FORMAT

Where ARKTIS submits both electronic file and hard copy versions of reports, drawings and other project related documents and deliverables (collectively termed instruments of professional service), the Client agrees that only the signed and sealed hard copy versions shall be considered final and legally binding. The hard copy versions submitted by ARKTIS shall be the original documents for record and working purposes, and, in the event of a dispute or discrepancies, the hard copy versions shall govern over the electronic versions. Furthermore, the Client agrees and waives all future right of dispute that the original hard copy signed version archived by ARKTIS shall be deemed to be the overall original for the Project.

The Client agrees that both electronic file and hard copy versions of instruments of professional services shall not, under any circumstances, no matter who owns or uses them, be altered by any party except ARKTIS. The Client warrants that instruments of professional services will be used only and exactly as submitted by ARKTIS.