5.2 Soil Disposal Facility

5.2.1 Design Considerations

It is understood that there are soils on site that are contaminated with PCB's and heavy metals. Non-hazardous contaminated soils could be landfilled on site. Hazardous contaminated soil must be shipped off site. It is recommended that a lined containment system be used to encapsulate the contaminated soil and the soil should be covered with sufficient fill to ensure that it freezes back and remains in a frozen condition, thereby further reducing the risk of migration.

A leachate collection and monitoring system is not generally incorporated into high arctic landfills, as they do not function well in a permafrost environment. A combination of freezeback of the landfilled material and a geomembrane cover and liner will result in little to no moisture migration into or out of the landfill.

5.2.2 Design Parameters

Preliminary thermal analyses were carried out to determine the required cover thickness and freezeback time and are presented in the 1996 report (EBA 1996). It was estimated that the active layer thickness would be 1.6 m during an average year and 2.1 m during a warm (1:100) year. It was recommended that the total cover on the landfill be 2.4 m thick (including bedding material). This was estimated to maintain the active layer within the cover material during mean and warm years and provide a safety factor for uncertainties in the thermal model.

The 1996 thermal analyses did not include a climate study for the CAM-F DEW Line site nor did it consider global warming; therefore, it is felt that these original calculations and recommendations are not valid for final design of a soil disposal facility at the CAM-F site. These issues should be addressed in final design.

5.2.3 Potential Contaminated Soil Disposal

Potential Soil Disposal Facility Location 1

Potential Soil Disposal Facility Location 1 is located in a relatively flat area southwest of the station, as shown on Figure 4 and Photos 23 through 25. The area has also been identified as Borrow Area 2. The west portion of the proposed area has some relief towards the west. Most of the proposed landfill area appears to be undisturbed; however, minimal disturbance is evident on the aerial photos. The proposed landfill location slopes towards Sarcpa Lake to the west, which is approximately 1.5 km from the proposed area.

Eleven testpits were excavated in the area (TP-04-04, TP-04-05 and TP-04-21 through TP-04-29). All testpits terminated in permafrost with the exception of TP-04-22, TP-04-23, TP-04-24 and TP-04-28, each of which met refusal on a boulder. Testpit depths were between 1.0 and 1.15 m. The surficial soils comprise silty gravel and sand till with trace to some clay. Measured moisture contents were 9.0%, 9.4%, 8.0% and 9.7%. Testpit logs and laboratory results are found in Appendix B and C, respectively.

Potential Soil Disposal Facility Location 1 is considered an acceptable location for construction of a new landfill; however, constructability issues may arise because of the high natural moisture content of the material. Excavation of the subgrade should be minimized. The reuse of the sand till for berm construction, Type 4 material, would be acceptable with the removal of any boulders (> 200 mm) during placement and recompaction. This material is sensitive to slight changes in moisture content and it may be necessary to air dry the material or blend it with other material if it is, or becomes too wet. Refer to Section 6.2.2 for further information for the area.

Potential Soil Disposal Facility Location 2

Potential Soil Disposal Facility Location 2 is a large relatively flat area immediately southeast of the airstrip and south of the east access road leading to the old construction camp area, as shown on Figure 5 and Photo 26. This area is also considered as a possible landfarm location because of its size, flat topography, and proximity to the station. A freshwater lake is located approximately 40 m to the north of the area; across the access road; however, the surface water from the area flows south towards Sarcpa Lake, 1.3 km

away. Some ground disturbance is evident on the 1964 aerial photos; however, the area is now partially revegetated.

Ten testpits were excavated in the area (TP-04-08 through TP-04-13 and TP-04-30 through TP-04-33). All testpits terminated in frozen ground with the exception of TP-04-11, which met refusal on a boulder. Testpit depths ranged between 1.0 and 1.2 m. The surficial soils comprise of silty, gravel and sand till with trace to some clay. Measured moisture contents were 7.5%, 7.3%, 6.6%, and 7.6%. Testpit logs are presented in Appendix B and laboratory results are presented in Appendix C.

Potential Soil Disposal Facility Location 2 is considered an acceptable location for construction of a new landfill. This proposed area is also considered a suitable location for a landfarm given its size and flat topography. The sand till present would be an acceptable source of Type 4 material upon removal of any material greater than 200 mm. This material is sensitive to slight changes in moisture content and it may be necessary to air dry the material or blend it with other material if it is, or becomes too wet. Refer to Section 6.24 for more information on the area.

Location 2 is considered to be a more suitable location for a soil disposal facility than Location 1 or 3 due to the lower natural moisture contents present. A lower natural moisture content of the material reduces concerns of construction issues with wet soils.

Potential Soil Disposal Facility Location 3

Potential Soil Disposal Facility Location 3 is a large relatively flat area on both sides of the access road leading to the old construction camp area, as shown on Figure 6 and Photos 27 and 28. This area is also considered as a possible landfarm location because of its size, flat topography, and distance from water bodies. The northeast portion drains into a lake approximately 150 m to the northeast that runs east to Sarcpa Lake. The south portion of the area south of the access road drains south towards Sarcpa Lake, which is approximately 650 m away. Most of the proposed landfill area is undisturbed; however, minimal disturbance is evident on the 1964 aerial photos.

Twelve testpits were excavated in the area (TP-04-14 through TP-04-20 and TP-04-34 through TP-04-38). All testpits terminated in frozen ground with the exception of TP-04-17, TP-04-34, TP-04-35, and TP-04-36, each of which met refusal on cobbles or a

boulder. Testpit depths were between 0.9 and 1.25 m. The surficial soils comprise silty,gravel and sand till with trace to some clay. Measured moisture contents were 8.4%, 8.1%, 7.4%, 8.7%, and 9.3%. Testpit logs are presented in Appendix B and laboratory results are presented in Appendix C.

Potential Soil Disposal Facility Location 3 is considered an acceptable location for construction of a new landfill; however, constructability issues may arise because of the high natural moisture content of the material. Excavation in the area should be minimized. Excavated sand till could be used for berm construction, Type 4 material, provided any boulders (> 200 mm) are removed. This material is sensitive to slight changes in moisture content and it may be necessary to air dry the material or blend it with other material if it is, or becomes too wet.

This proposed area is also considered a suitable location for a landfarm given its size and flat topography.

5.3 Landfarms

5.3.1 Potential Landfarm Locations

One additional location was investigated for a landfarm location in addition to the Potential Soil Disposal Facility Locations 2 and 3.

Potential Landfarm Location 1

Potential Landfarm Location 1 is a large relatively flat area located in the vicinity of the station area, west of the garage as shown on Figure 2 and Photo 29. The location is close to POL tanks where hydrocarbon contaminated soil may be present. The proposed landfarm area is disturbed as the area was used as a borrow source in the past.

No testpits were excavated during the 2004 investigation; however, two testpits (TP 13 and TP 14) were excavated in the area during the 1996 investigation. The soils in the area comprise silty sand and gravel till. Boulders and bedrock outcrops are present in the area and Testpit TP 14 terminated on bedrock. Testpit logs are presented in Appendix B.

The area drains northwest towards small pond located adjacent the airstrip 250 m northwest of the area. The ponds eventually drain to Sarcpa Lake, located 1.5 km to the west.

Potential Landfarm Location 1 is a suitable location for construction of a landfarm and is preferred over the two other potential sites. This area is also considered as a possible debris landfill location.

6.0 GRANULAR BORROW MATERIAL

Granular fill is required for the construction of new landfills, remediation of existing landfills and debris areas and backfill of excavation areas. The granular material types and their typical uses have been defined as follows:

- Type 1 Granular Fill – coarse gravel, cobbles and boulders for erosion protection;
- Type 2 Granular Fill – gravel and sand for landfill cover;
- Type 3 Granular Fill – general fill for excavation backfill;
- Type 4 Granular Fill – silty sand and gravel for landfill berms;
- Type 5 Granular Fill – sand for geomembrane bedding; and
- Type 6 Granular Fill – sand and gravel for intermediate landfill debris cover.

6.1 Granular Material Specifications

Type 1 Granular Fill is generally a graded gravel and cobble material with trace sand. Type 1 Granular Fill is typically used for erosion protection and as riprap for small drainage courses. The gradation requirements for Type 1 Granular Fill may vary significantly depending on the specific application. The gradation requirements should be evaluated once the specific application of Type 1 fill is known.

Type 2 Granular Fill is generally used for construction of landfill berms and covers and regrading requirements. It is recommended that Type 2 Granular Fill should have a particle size distribution within the limits presented on Table 1.

TABLE 1
TYPE 2 GRANULAR FILL
PARTICLE SIZE DISTRIBUTION LIMITS

Particle Size (mm)	% Passing
200	100
50	80 to 100
5	45 to 65
0.425	35 to 45
0.08	10 - 40

Type 3 Granular Fill is select material obtained from excavations or other approved sources with a maximum particle size not exceeding 200 mm, which is generally used for regrading low areas, backfill of contaminated soil excavations and general site grading requirements. Type 2 Granular Fill is an acceptable alternative for Type 3 Granular Fill.

Type 4 Granular Fill is a non-saline, well-graded silty gravel and sand used for construction of containment berms for soil disposal facilities or leachate containment systems. The material is placed in a near saturated condition, which will have low permeability upon freezing. The water content of the Type 4 Granular Fill must be adjusted to achieve a minimum degree of saturation of 90%. The Type 4 Granular Fill may be wet and soft at the time of construction due to weather conditions and it may be necessary to air-dry the material so that it can be placed and compacted according to the specifications. Type 4 Granular fill should have a particle size distribution within the limits presented on Table 2.

TABLE 2
TYPE 4 GRANULAR FILL
PARTICLE SIZE DISTRIBUTION LIMITS

Particle Size (mm)	% Passing
200	100
50	80 to 100
5	50 to 60
0.425	35 to 45
0.08	15 to 40

Type 5 Granular Fill is used as an embedment material for geosynthetic liners and should be composed of rounded particles. Type 5 Granular Fill should be free from angular particles, stones larger than 25 mm in diameter, waste or other deleterious materials.

Type 5 Granular Fill should have a particle size distribution within the limits presented on Table 3.

TABLE 3
TYPE 5 GRANULAR FILL
PARTICLE SIZE DISTRIBUTION LIMITS

Particle Size (mm)	% Passing
25	100
12.5	75 to 100
5	50 to 100
2	30 to 60
0.425	10 to 40
0.08	0 to 20

Type 6 Granular Fill is generally used as an intermediate cover within landfills and is obtained from excavations or other sources generally consisting of gravel or sand in an unfrozen state and free of deleterious material. The maximum particle size of the material should be less than 150 mm with less than 8% of the material, by weight, passing the 0.08 mm sieve.

6.2 Granular Borrow Areas

Three borrow areas that would be sources of suitable granular construction materials were identified at the CAM-F DEW Line site during the 1996 site investigation (EBA, 1996). Four additional borrow areas were identified in 2004. Three of these new areas, Borrow Areas 1, 4 and 5, were also identified as possible sites for soil disposal landfills. No borrow should be extracted closer than 50 m to a new landfill site. Potential borrow areas are shown on Figure 1.

Testpits were either hand-excavated or excavated utilizing a small Kubota mini-tractor. Soil samples were collected for laboratory index testing. Testpit logs are presented in Appendix B and laboratory test results are presented in Appendix C. Testpit logs and laboratory test results for the 1996 investigation are found in Appendix B and C, respectively.

Individual borrow areas are discussed in the follow subsections and summarized in Section 6.3. Testpit logs are presented in Appendix B and laboratory results are presented in Appendix C.

6.2.1 Borrow Area 1

Borrow Area 1 is located on the north side of the airstrip as shown on Figure 2A and contains predominately silty gravel and sand till with trace to some clay and varying amounts of cobbles and boulders. Proposed Landfarm Location 1 is located on a section of this borrow area. The area has been disturbed during the construction of the site with some areas being excavated down to bedrock; however, there is a thin veneer of till over the bedrock remaining in much of the area. A total of seven shallow testpits were excavated in the material in 1996 (TP3, TP7, TP8, TP11, TP12, TP13, TP14). Samples of the till contained an average of 11% clay, 21% silt, 32% sand, and 36% gravel. (Note: cobbles and boulders were not included in the particle size analyses.)

The granular materials in Borrow Area 1 are considered suitable for Type 2, Type 3 and Type 4 Granular Fill, excluding the boulders. The identified area shown on Figure 2A is approximately 83,000 m^2 in size. Assuming an average excavation thickness of 0.3 m, an estimated volume of 24,900 m^3 may be available. Additional material may be available at greater depth, but the undulating bedrock surface makes it difficult to estimate quantities.

Development of this borrow area will be subject to the moisture content of the material and the area will be difficult to work in if the material becomes wet. Boulders will require removal.

6.2.2 Proposed Borrow Area 2

Borrow Area 2 is located west of the northwest end of the airstrip along the access road to Borrow Area 3, as shown on Figure 4 and Photos 23 through 25. The area has also been identified as a potential location for a soil disposal facility. Most of the proposed area is undisturbed; however, some disturbance is evident from the aerial photos.

Borrow Area 2 contains predominately silty gravel and sand till with trace to some clay and varying amounts of cobbles and boulders. Eleven testpits were excavated in the area

(TP-04-04, TP-04-05 and TP-04-21 through TP-04-29). All testpits terminated in permafrost with the exception of TP-04-22, 04-23, 04-24 and 04-28, each of which met refusal on a boulder. Testpit depths were between 1.0 and 1.15 m. Moisture contents were 9.0%, 9.4%, 8.0% and 9.7%.

The granular materials in Borrow Area 2 are considered suitable for Type 2, Type 3 and Type 4 Granular Fill, excluding the boulders. The identified area shown on Figure 4 is approximately 106,000 m^2 in size. Assuming an average excavation thickness of 0.5 m, an estimated volume of 53,000 m^3 may be available. Additional material may be available at greater depth, but the moisture content will make the material difficult to extract and work with.

6.2.3 Proposed Borrow Area 3

Borrow Area 3 (West Borrow) is an old borrow area located at the west end of Sarcpa Lake as shown in Figure 7 and Photo 30. The area contains silty gravel and sand till and sand and gravel with some silt. Varying amounts of cobbles and boulders are present in both materials. A total of four testpits were excavated in the area in 2004 and two in 1996 (TP-04-51 through TP-04-54 and TP 1, TP 2). A sample of material from an existing stockpile located in the southeast portion of the borrow area contained 46% sand, 39% gravel and 15% silt/clay. (Note: cobbles and boulders were not included in the particle size analyses.)

Portions of Borrow Area 3 are considered suitable for Type 1, Type 2, Type 3 and Type 4 Granular Fill, excluding the boulders and are shown on Figure 7. The area identified as containing Type 1 Granular Fill is approximately 7,500 m^2 in size. Assuming an average excavation thickness of 0.4 m, an estimated volume of 3,000 m^3 may be available. The areas containing Type 2 and 3 Granular Fill combine to approximately 22,000 m^2 in size. Assuming an average excavation thickness of 0.5 m, an estimated volume of 11,000 m^3 may be available. Additional material may be available at a greater depth. Type 5 Granular Material could be screened from certain portions of the Type 2 and 3 areas.

The area identified as containing Type 2, 3, and 4 Granular Material is approximately 13,500 m^2 in size. Assuming an average excavation thickness of 0.5 m, an estimated volume of 6,750 m^3 may be available. Development of this borrow will be subject to the

moisture content of the material. The material will be difficult to work with if it becomes wet.

The removal of boulders will be required throughout the entire borrow area.

6.2.4 Proposed Borrow Area 4

Borrow Area 4 is located east of the southeast end of the airstrip along the east access road to the Old Camp Area, as shown on Figure 5 and Photo 26. Potential Soil Disposal Facility 2 is located within the proposed borrow area. Most of the proposed area appears to have little disturbance, however, some disturbance is evident on the 1964 aerial photos.

Ten testpits were excavated in the area (TP-04-08 through TP-04-13 and TP-04-30 through TP-04-33). All testpits terminated in frozen ground with the exception of TP-04-11 which had refusal on a boulder. Testpit depths ranged between 1.0 and 1.2 m. The surficial soils comprise silty gravel and sand till with trace to some clay. Measured moisture contents were 7.5%, 7.3%, 6.6% and 7.6%. Testpit logs are presented in Appendix B and laboratory results are presented in Appendix C.

The granular materials in Borrow Area 4 are considered suitable for Type 2, Type 3 and Type 4 Granular Fill, excluding the boulders. The identified area shown on Figure 5 is approximately 84,000 m^2 in size. Assuming an average excavation thickness of 0.5 m, an estimated volume of 42,000 m^3 would be available. Additional material may be available at greater depth.

Development of this borrow will be subject to the moisture content of the material and will be difficult to develop when the material becomes wet. Boulders would require removal for the material to be suitable for Type 2 or Type 4 granular fill.

6.2.5 Proposed Borrow Area 5

Borrow Area 5 is a large relatively flat area on both sides of the access road leading to the old construction camp area, as shown on Figure 6 and Photos 27 and 28. Potential Soil Disposal Facility 3 is located within the area. Most of the proposed area is undisturbed, however, some disturbance is apparent on the aerial photos.

Twelve testpits were excavated in the area (TP-04-14 through TP-04-20 and TP-04-34 through TP-04-38). All testpits terminated in permafrost with the exception of TP-04-17, TP-04-34, TP-04-35, and TP-04-36, each of which met refusal on cobbles or boulders. Testpit depths were between 0.9 and 1.25 m. The surficial soils comprise silty, gravel and sand till with trace to some clay. Moisture contents were 8.4%, 8.1%, 7.4%, 8.7%, and 9.3%.

The granular materials in Borrow Area 5 are considered suitable for Type 2, Type 3 and Type 4 Granular Fill, excluding the boulders. The identified area shown on Figure 6 is approximately 128,000 m^2 in size. Assuming an average excavation thickness of 0.5 m, an estimated volume of 64,000 m^3 would be available. Additional material may be available at greater depth; however, constructability issues may arise due to the high natural moisture content of the material.

Development of this borrow area will be subject to the moisture content of the material. The area will be difficult to work in if the material becomes wet. Boulders will have to be removed to be suitable for Type 2 and Type 4 granular fill.

6.2.6 Proposed Borrow Area 6

Borrow Area 6 consists of a stockpile of sand and gravel at the old camp area, approximately 3.5 km from the station area, as shown in Figure 3. The material likely originated from Borrow Area 7 located across the lake. Samples of the material averaged 53% gravel, 46% sand, and 1% silt. The sample contained 50 mm maximum particle sizes; however, occasional 100 mm maximum particles are present in the stockpile. The stockpile contains approximately 1000 m^3 of material.

The material is frost stable and therefore suitable for Type 6 Granular Fill. The material could be screened to produce Type 5 Granular Fill.

6.2.7 Proposed Borrow Area 7

Borrow Area 7 is located on the east side of the Sarcpa Lake as shown on Figure 8 and contains predominately gravel and sand with trace silt. The area has been disturbed during previous borrow development. A sample of the material contained 61% gravel, 37% sand and 2% silt. The particle size distribution curve is presented in Appendix C.

The granular materials in Borrow Area 7 are considered suitable for Type 3 and Type 6 Granular Fill. If the material was screened, a Type 5 Granular Fill could be produced. The identified area shown on Figure 8 is approximately 100,000 m^2 in size. Assuming an average excavation thickness of 1.0 m, an estimated volume of 100,000 m^3 may be available. Additional material is available at greater depth, but the material may be frozen and extraction would require a thaw and strip operation.

Development of this borrow area is hampered by its location on the east side of Sarcpa Lake. A winter construction haul would be required to move the material to the main site.

6.3 Summary of Granular Borrow Resources

The majority of borrow materials at the CAM-F DEW Line Site are silty gravel and sand till with varying amounts of cobbles and boulders. This material is suitable for Type 2, Type 3 and Type 4 Granular Fill. There is a limited quantity of Type 1, Type 5 and Type 6 material on the main site; however, there is an abundance of Type 6 and source material to produce Type 5 material at Borrow Area 7 on the east side of Sarcpa Lake. Limited amounts of Type 1 Granular Fill are present in Borrow Area 3.

Granular material is prevalent throughout the site and is specifically found at Borrow Area 1, 2, 3, 4 and 5. The material becomes very soft when it is wet. Rubber tired equipment may not be able to access the majority of the borrow areas, limiting development to tracked vehicles and loading from the access roads. Should wet conditions be encountered, whether due to the natural moisture content or weather conditions, the material may require air drying before it can be used. Stockpiling the borrow material may be an option, if there is time, to allow it to drain prior to use.

Silty gravel and sand till suitable for Type 4 Granular Fill is available throughout the site.

Sandy material, suitable for production of Type 5 Granular Fill, is available at the Borrow Area 3, 6, and 7. Type 5 Granular Fill will require screening to satisfy the gradation requirements presented in Section 6.1.

Boulders are present throughout the site and borrow areas. Development of the borrow areas will require sorting of the borrow material to remove the boulders from the fill material prior to placement.

Table 4 summarizes estimated borrow materials available at the CAM-F DEW Line Site.

TABLE 4
SUMMARY OF CAM-F DEW LINE SITE GRANULAR BORROW SOURCES

Borrow Area	Available Granular Fill Type	Quantity Estimate			Comments
		Area (m^2)	Excavation Depth (m)	Volume (m^3)	
Borrow Area 1	Types 2, 3 and 4	83,000	0.3	24,900	Developed area.
Borrow Area 2	Types 2, 3 and 4	106,000	0.5	53,000	Undeveloped area
Borrow Area 3	Type 1	7,500	0.4	3,000	Developed area and
	Types 2 and 3	22,000	0.5	11,000	Undeveloped area.
	Types 2, 3, and 4	13,500	0.5	6,750	
Borrow Area 4	Types 2, 3 and 4	84,000	0.5	42,000	Developed area.
Borrow Area 5	Types 2, 3 and 4	128,000	0.5	64,000	Undeveloped area
Borrow Area 6	Types 5 and 6	Stockpile		1,000	Developed area.
Borrow Area 7	Types 3, 4, 5, and 6	100,000	1.0	100,000	Developed area.

7.0 AIRSTRIP EVALUATION

The CAM-F airstrip is in poor condition. The airstrip is relatively soft and portions are covered with loose gravel. The First Air chief pilot inspected the runway in the mid 1990's and concluded it was only suitable for small aircraft.

Three test pits (TP-04-01 to 04-03) were excavated along the runway length to evaluate the surfacing structure at the CAM-F airstrip. A sand and gravel layer of 600 mm thickness was encountered over a silty gravel and sand till with a high percentage of sand and gravel in Testpits TP-04-01 and TP-04-02. Silty gravel and sand till was encountered

at the surface in the third testpit TP-04-03; no sand and gravel was noted overlying the till. Testpit logs and laboratory results are found in Appendix B and C, respectively.

The west portion of the airstrip has erosion channels along the south side. These channels have been created by water flowing across the airstrip. The ponded water along the north side of the airstrip overtops the airstrip and discharges into the overlying area southwest of the airstrip. Subsurface water was present in TP-04-01 at a depth of 0.6 m.

CBR tests were conducted on samples from TP-04-01 and TP-04-03. The test indicated unsoaked CBR's of approximately 60 for the sand and gravel and approximately 20 for the sand till. Soaked values were somewhat lower at 30 and 10, respectively.

The load capacity of the airstrip is largely a function of the strength of the subgrade material. If the subgrade material is strong, aircraft can land directly on a prepared subgrade. However if the subgrade is not strong enough to support the aircraft that wish to use the airstrip, a layer of compacted gravel is placed over the subgrade to distribute the load of the aircraft so the subgrade is not overstressed.

In 'dry' conditions, the sand till subgrade material would have the capacity to support aircraft with an Aircraft Loading Rating (ALR) of approximately 7.0. However, during 'wet' conditions, the capacity of the runway would drop significantly to only support aircraft with ALR of 4 to 5. The airstrip will usually be in a 'wet' condition due to the natural moisture content and poor drainage.

Table 5 shows typical aircraft for various ALR classifications

TABLE 5
TYPICAL AIRCRAFT FOR AIRCRAFT LOAD RATING (ALR) CLASSIFICATIONS

ALR	Design Tire Pressure (MPa)	Typical Aircraft
1	<0.40	Apache/Aztec/Dove/Beach 18
2	<0.40	King Air
3	<0.40	Lockheed 18
4	0.4 - 0.7	DH125/DC3
5	0.4 - 0.7	Gulfstream/G159/Dash7/F27/HS748/DartHerald/Convair Canso
6	0.4 - 0.7	Convair 440/640
7	0.4 - 0.7	DC-4-M2
8	0.7 - 1.0	Viscount/DC-9-15/DC-6B Super/Argosy 650
9	>1.0	BAC-1-11-500/B737/DC-9-32/Hercules C-130E
10	>1.0	Convair 990/880/B-707-120B/DC-9-51/ElectraP3/Vanguard/ DC-7-7C/Super Constellation/B-767
11	>1.0	B-747-100/DC-10-10/DC-8/B-707-320-420/Super Hercules /Airbus A-300B4/Super VC-10
12	>1.0	Concorde/B-747-200/DC-10-20/30/L1011/DC-8-63/B-727

Note: Obtained from ASG-19 'Manual of Pavement Structural Design'

While the above table provides an indication of the type of aircraft in each ALR classification, each aircraft has a specific ALR that is a function of the total load and gear configuration (and to a lessor extent subgrade strength). The Twin Otter and Skyvan that currently use the airstrip have loaded ALRs of 1.1 and 1.7, respectively. Other aircraft that may desire to use the runway include the DC-3, DC-4, Hercules, and Otter.

It is assumed that the airstrip has a subgrade strength of approximately 130 kN based on the CBR values and soil types. The ALRs for these planes for loaded and unloaded conditions for an assumed subgrade strength of 130 kN (subgrade support B) are listed in Table 6.

TABLE 6
AIRCRAFT LOAD RATINGS FOR SUBGRADE STRENGTH OF 130 kN

Aircraft	ALR Loaded	ALR Unloaded
DC-3	3.5	2.3
DC-4	5.4	3.9
Hercules C130	8.6	6.3
Otter	1.0	1.0
Twin Otter DHC6	1.1	0.2
Shorts Skyvan	1.7	0.4

Based on the design calculations, the subgrade material with a surfacing layer could support a DC-3; however, based on the conditions of the existing airstrip, it is recommended that the airstrip surface be regraded and recompacted prior to use by a DC-3. The loose gravel surface material and silty sandy till should be blended during regrading to create a well-graded and compacted surface material. The erosion channels currently present along the southwest edge of the airstrip in the northwest portion of the airstrip will have to be filled. It is recommended that the airstrip be inspected by a chief pilot prior to landing aircraft.

The DC-4 and Hercules C-130 should not land on this airstrip during 'wet' conditions at full load (ALR >4). Approximately 500 mm of a granular material surfacing layer should be placed over the sand till to increase the capacity of the airstrip for the Hercules. Gravel surface coarse was present in TP-04-01 and TP-02; therefore, at least half the airstrip appears to have the 500 mm of granular material in place. All testpits were excavated along the southwest edge of the airstrip. These locations correspond to areas that required the most amount of fill during the original construction. Additional testpits should be excavated on the northeast edge of the airstrip to verify the fill thickness where the amount of fill above existing ground could be less.

The use of wide tires by the aircrafts that are currently utilizing the airstrip (Twin Otter and Shorts Skyvan) provides some information about the quality of the sand and gravel surfacing. This surface layer is composed of a rounded granular pit run material that has little internal stability. Under these circumstances, a wide tire may be required because of the quality of the granular material. In order to provide confinement for the rounded granular material, a layer of well graded crushed rock can be placed over the existing granular material after grading, shaping and compacting the existing granular material. It may be possible to regrade the existing granular material so that all of the subgrade materials are covered with at least 300 mm of pit run sand and gravel. A new layer of well graded crushed rock of 200 mm thickness could then be added to the runway to provide the 500 mm granular structure required for the Hercules.

Sourcing a well graded crushed rock will be difficult at the CAM-F site. None of the proposed borrow areas would be suitable to facilitate a crushing operation for this type of product. In order to manufacture this material. a quarry would have to be developed to provide a blast rock to feed a crusher to produce the desired surfacing material.

Reconstructing the airstrip for a short term construction season is a considerable expense. It may be more feasible to grade the airstrip prior to freeze up and use it only during the late fall and winter. It may also be possible to use Sarpca Lake for an airstrip during winter months.

8.0 ACCESS ROAD EVALUATION

There are two main access roads present on site and are referenced as the West Access Road and the East Access Road. The West Access Road connects the northwest end of the airstrip to Proposed Borrow Area 3 while the East Access Road connects the station to the old camp area. There are also several access roads around the station to access the airstrip, the Station Northwest Debris Area, the POL tanks, Dump A and Dump B.

For the most part, the access roads are still well defined and in satisfactory condition for heavy equipment traffic; however, regular grading will be required to maintain the roadway surface. The access roads were predominantly constructed out of the silty gravel and sand from along the roadway right-of-way. The access roads are constructed on bedrock exposures along isolated sections.

Random locations were surveyed on the West Access Road and the East Access Road to determine the width of the existing road surface (shoulder to shoulder) and the distance between the toe on each side of the roadway embankment. The West Access Road road surface width ranged from 2.0 to 5.0 m and averaged 3.5 m. The East Access Road road surface width ranged from 3.3 to 6.4 m and averaged 5.2 m. The widths of the access roads are satisfactory for single lane traffic; however pull out sections will be required to facilitate haul traffic.

Presently, there are several rough sections on each access road. Depending on site development and the type of hauling equipment being used, these sections may require regrading prior to any significant vehicle travel.

9.0 QUALITY ASSURANCE

Construction monitoring and quality control are essential for satisfactory performance of the concepts presented in this report. Inspection by a geotechnical engineer with arctic experience is recommended during construction to ensure that the required density and moisture conditioning critical to the design are achieved. It is imperative that the condition of the permafrost in key trenches be inspected and the presence of sound, ice saturated permafrost be verified.

Liner installation should be monitored by qualified construction quality assurance personnel. Supplied materials should be inspected to ensure conformance to specifications.

10.0 POST CONSTRUCTION MONITORING

A post-construction monitoring program is recommended for the new and closure landfills. New landfills and closure landfills should be monitored visually for any signs of settlement, erosion, and ponded water. It is recommended that they be inspected three years after construction is complete. The monitoring program for the Soil Disposal Facility landfill should be carried out during the period required for the facility to achieve thermal equilibrium. Three to five years duration is suggested initially, with the program suspended or substantially downgraded as acceptable performance is confirmed.

The monitoring program for landfills should consist of: visual monitoring; thermal monitoring; surface water or active layer water monitoring.

Suggested monitoring requirements are described in the following sections.

10.1 Visual Monitoring Program

A visual monitoring program should be carried out on an annual basis, by a Professional Engineer registered in NT/NU who is familiar with the requirements of the landfill remediation design. The inspector should look for any signs of distress, including:

- signs of damage or potential damage from settlement, ponding, thermal instability, frost action, or erosion. The visual observations should be supported by simple elevation surveys and photography; and

- damage to the above-ground portions of groundwater monitoring devices or thermistors.

10.2 Thermal Monitoring

A thermal monitoring system should be implemented to allow verification of predicted ground temperatures within the landfill structure if the landfill is designed to remain frozen. It is recommended that two thermistor strings be installed within the central area of the landfill and two thermistor strings be installed in the containment berms around the landfill. Thermistor strings should be installed in drill holes, inside a 25 mm diameter PVC casing, and backfilled with dry sand to eliminate air voids.

10.3 Ground Water or Surface Water Monitoring

Water quality should be monitored within 30 m of the facility. Monitoring should be carried out in existing surface waters or by using monitoring wells installed through the active layer. Samples of water should be obtained from the base of the active layer for testing at the end of the summer season. Baseline water quality data should be determined before any waste is placed in the facility. Representative background conditions should be measured approximately 200 m from the facility.

The results of monitoring during subsequent years should be analyzed and compared to the baseline data and monitoring data from previous years to identify any changes in water quality.

11.0 LIMITATIONS

This report pertains to the specific site and development described in Section 1.0. Isolated information should not be reproduced, transferred, or used outside the context of this report unless clearly referenced to the source. EBA Engineering Consultants Ltd. will not be responsible for unauthorized reuse or interpretation of information presented herein.

This report summarizes the data collected by EBA during the 2004 Geotechnical Investigation. It is recommended that EBA be given the opportunity to review or develop the details of the final design. It is also recommended that geotechnical, materials and environmental engineering field services, such as backfill and drainage measures and testing of soil density and gradation, be performed as construction proceeds to ensure that the design intent is met.

The design concepts presented in this report are based on analyses that demonstrate their feasibility. Certain assumptions pertaining to soil properties, active layer thickness and ground temperatures have been made based on regional knowledge of the terrain and engineering judgement. Engineering inspection during construction must be planned to observe and report site conditions such as active layer depth, soil texture and water content and groundwater conditions encountered during excavation. This data must be reviewed by the geotechnical engineer to confirm that the design intent will be met.

It should be noted that geological conditions are innately variable and are seldom spatially uniform. Stratigraphic information has been based on shallow testpits and surface exposures. In order to develop recommendations from this information, it is necessary to make assumptions concerning the stratigraphy. Adequate monitoring should be provided during construction to check that these assumptions are reasonable. Further conditions are presented in Appendix D, "Geotechnical Report – General Conditions."

12.0 CLOSURE

This report has been prepared in accordance with generally accepted engineering practices and judgement has been used in developing recommendations. No other warrant is made, either expressed or implied.

Respectfully submitted,
EBA Engineering Consultants Ltd.

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