# SOIL ASSESSMENT

# FOR PORTIONS OF THE PROPOSED

# KITIMAT – SUMMIT LAKE

# NATURAL GAS PIPELINE LOOPING PROJECT

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January 2007

06003.3

# EXECUTIVE SUMMARY

The construction of the Kitimat to Summit Lake Looping Project (the KSL Project) will enable Pacific Northern Gas Ltd. (PNG) to increase the capacity of the existing natural gas transmission pipeline to meet shipper demand as well as to reverse the direction of flow so that the existing pipeline and the new pipeline loop can flow natural gas in both a westerly and an easterly direction. The project involves the construction of approximately 462 km of 914 mm (36-inch) diameter pipe between a location immediately north of the community of Kitimat, BC and a location immediately east of the community of Summit Lake, BC. The project also includes the construction and operation of one new compressor station located at the mid-point of the new pipeline and the installation of associated aboveground facilities including block valves and receiving traps for pipeline inspection tools at specific locations within the designated right-of-way. Construction of the project will require temporary construction camps, stockpile sites and other temporary work yards. No ground disturbing work is required on the existing PNG pipeline where it is not paralleled by the proposed KSL Project. The purpose of the KSL Project is to deliver natural gas that is received at the proposed Kitimat Liquefied Natural Gas (KLNG) facility, located immediately southwest of the City of Kitimat, to the Duke Energy Inc. pipeline facilities located east of the Village of Summit Lake. To accommodate the construction and operation of the KSL Project, PNG and KLNG have jointly formed a new company, Pacific Trail Pipelines Limited Partnership. (PTP) that will own and operate the proposed pipeline loop as well as the existing PNG pipeline.

Mentiga Pedology Consultants Ltd. was commissioned by Westland Resource Group Inc. (Westland) on behalf of PTP to conduct a soil survey along portions of the proposed route. The soil survey was conducted on all the Agricultural Land Reserve (ALR) land as well as other lands that may have potential for agricultural development. The ALR occurs between KP 158.3 and 162.6, KP 272.9 and 278.9, KP 306.6 and 307.9, and KP 326.1 and 352.7. The soil survey was conducted on 61 km of the 468 km proposed route at the following locations.

KP 158.3 to 162.6;

KP 272.9 to 282.2;

KP 289.2 to 291.2;

KP 296.7 to 301.5;

KP 306.2 to 313.7; and

KP 322.2 to 355.3.

Soil investigations and mapping were conducted from August 25 to 29, 2006 at a scale of 1:20,000. The soils and landscapes were described in terms of landform, surficial materials, slope, texture, stoniness, topsoil thickness, drainage conditions, profile morphology and soil chemistry. The distribution and extent of the various soils along the proposed route surveyed are shown on the accompanying Environmental Work Sheets. Average depth of topsoil, topography and present land use are also indicated on the Work Sheets. The soil-landscape units delineated on the Environmental Work Sheets are described briefly in the map legend and in detail in this report. The suitability of the soils for reclamation, according to the guidelines of the Alberta Soils Advisory Committee (1987), have been evaluated. The soils were also evaluated for alternate material handling according to the guidelines of the Alberta Pipeline Environmental Steering Committee (1996). Material handling recommendations are also provided.

Well to moderately well drained, Orthic Gray Luvisols, with little or no topsoil (Ah, Ahe, Aep or Ap horizons) in forested areas and developed on glaciofluvial sandy loams, loam to clay loam textured till, glaciolacustrine loams, silt loams or sandy loams and glaciolacustrine clays are the dominant soils occupying about 69% of the route surveyed. These soils are non-saline and non-sodic, sometimes weakly calcareous and strongly acid to neutral in soil reaction (pH). Topsoil thickness in cleared and developed fields varies from 10-20 cm and is usually brown to dark brown in colour. The topsoil horizon in cleared and developed fields consists mainly of Ae horizon material that has been slightly darkened with cultivation over the years (Aep horizon). Well to rapidly drained Eluviated Dystric Brunisols with no topsoil in forested areas and developed on coarse textured glaciofluvial deposits or till material occupy about 25% of the selected areas investigated along the proposed route. These soils are non-saline, non-sodic, non-calcareous and strongly acid to medium acid in soil reaction. These soils have rarely been cleared and developed for agricultural purposes and are characterized by a thin duff layer (L-H or L-F horizon) overlying a thin pale brown Ae horizon, a yellowish brown Bm horizon and a brown C horizon that usually occurs within 60 cm of the surface. Other soils, but of minor extent, include: Orthic Regosols developed on silt loam to gravelly sand textured recent fluvial material on the floodplains of the major creeks and rivers; very poorly drained Typic or Fibric Mesisols developed on moss peat greater than a metre thick; and rock outcrops which have less than 10 cm of weathered material at the surface.

The majority (approximately 86%) of the selected portions of the proposed route surveyed consists of bush land (B). Bush-pasture (B-P) areas are of minor extent occupying less than 1% of the route surveyed. Pasture land (P) occupies about 5% of the route surveyed while hay fields (H) with a well developed sod layer occupy about 3%. The remaining 6% consists of cultivated land (C). Present land use is shown on the accompanying Environmental Work Sheets.

Topsoil or upper root zone material salvage is intended to ensure that the most desirable existing material is available and used for restoration and revegetation of disturbed areas. The total depth of topsoil, when it exists, up to a maximum depth of 40 cm should be salvaged. The upper 15-20 cm of root zone material should be salvaged from undisturbed bush areas that lack a topsoil horizon. Topsoil or root zone material is a better growth medium than the underlying subsoil because of a higher organic matter content and usually a more favourable texture. Topsoils, when they occur, are not always easily distinguished from subsoils by colour but the average depth of the topsoil is indicated in the Map Unit designation on the Environmental Work Sheets.

In general, a successful reclamation program can be achieved by salvaging the topsoil materials on cultivated fields, pasture lands, bush areas and hay fields. Topsoils should be salvaged over the ditch-line and spoil-side on all cultivated lands. Topsoils only need to be salvaged over the ditch-line area on hay fields and pasture lands with a well-developed sod layer as well as all bush areas. Topsoils only need to be salvaged over the ditch-line area (1 m wider than the proposed ditch-line width) on all lands, if construction of the pipeline occurs when the soils are frozen.

Topsoil or root zone material should be salvaged from all undisturbed bush areas that require grading and from the proposed ditch-line area. It is recommended that the topsoil or root zone material be salvaged from an area at least one metre wider on each side of the proposed ditch width. The area receiving the spoil material should be smoothed out prior to spoil material being placed on the existing upper material so that the spoil material can be easily separated and removed from the in-situ upper material during final clean-up. No topsoil salvage or upper root zone material salvage is required in areas of Rock outcrops (R) or Kenzie (KNZ) soils. Salvaged topsoil or root zone material can be stored over the adjacent existing pipeline where the route follows along an existing pipeline but it is not recommended that the spoil material be stored over the adjacent existing pipeline because of difficulties in removing all of the spoil material from the adjacent pipeline during final clean-up. Leaving some of the spoil material on the adjacent pipeline results in an area over the existing line, which either lacks a vegetative cover or has a high percentage of weeds. Leaving some of the topsoil or root zone material over the adjacent existing line will not result in these environmental concerns.

Fifteen soil types and miscellaneous land units have been identified and described in detail along the selected areas investigated along the proposed route. Their characteristics and implications to pipelining have been discussed. Soils susceptible to trench instability, compaction, rutting and erosion have been identified. Appropriate mitigative measures have been recommended. Soils recommended for alternate soil handling procedures (three-lift and over-stripping) have been identified. Based on mitigative measures presented in this report there should be no significant adverse effects to the soil resource with construction of the pipeline.

It is recommended that where practical, root zone and surface organic material (duff layer) be salvaged on all undisturbed areas requiring grading along the pipeline route beyond the areas surveyed and discussed in this report. Although limited in volume, this material will be of value during the restoration of the right-of-way.

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# 1.0 INTRODUCTION

The construction of the Kitimat to Summit Lake Looping Project (the KSL Project) will enable Pacific Northern Gas Ltd. (PNG) to increase the capacity of the existing natural gas transmission pipeline to meet shipper demand as well as to reverse the direction of flow so that the existing pipeline and the new pipeline loop can flow natural gas in both a westerly and an easterly direction.

The project involves the construction of approximately 462 km of 914 mm (36-inch) diameter pipe between a location immediately north of the community of Kitimat, BC and a location immediately east of the community of Summit Lake, BC (see Figure 1). The project also includes the construction and operation of one new compressor station located at the mid-point of the new pipeline (see Figure 1) and the installation of associated aboveground facilities including block valves and receiving traps for pipeline inspection tools at specific locations within the designated right-of-way. Construction of the project will require temporary construction camps, stockpile sites and other temporary work yards. No ground disturbing work is required on the existing PNG pipeline where it is not paralleled by the proposed KSL Project.

PNG is regulated under the *B.C. Utilities Commission Act* and the proposed KSL Project is subject to review under the *B.C. Environmental Assessment Act* (*BCEA Act*) as well as the *Canadian Environmental Assessment Act* (*CEA Act*). This review and approval process will be conducted under the auspices of the Harmonization Agreement by the B.C. Environmental Assessment Office (BCEAO) and the Canadian Environmental Assessment Agency (CEA Agency). Application will be made to the BCEAO for an Environmental Approval Certificate (EAC) for the purposes of constructing and operating the KSL Project.

The purpose of the KSL Project is to deliver natural gas that is received at the proposed Kitimat Liquefied Natural Gas (KLNG) facility, located immediately southwest of the City of Kitimat, to the Duke Energy Inc. pipeline facilities located east of the Village of Summit Lake. To accommodate the construction and operation of the KSL Project, PNG and KLNG have jointly formed a new company, Pacific Trail Pipelines Limited Partnership. (PTP) that will own and operate the proposed pipeline loop as well as the existing PNG pipeline.

Mentiga Pedology Consultants Ltd. was commissioned by Westland Resource Group Inc. (Westland) on behalf of PTP to conduct a soil survey along portions of the proposed route. The soil survey was conducted on all the Agricultural Land Reserve (ALR) land as well as other lands that may have potential for agricultural development. The soil survey was only conducted on 61 km of the 462 km proposed route.

Soil investigations and mapping were conducted from August 25 to 29, 2006 on Photomosaics at a scale of about 1:15,000. The information was later transferred to Photomosaic Environmental Work Sheets at a scale of 1:20,000. The soils and landscapes were described in terms of landform, surficial materials, slope, texture, stoniness, topsoil thickness, drainage conditions, profile morphology and soil chemistry. The distribution and extent of the various soils along the proposed route surveyed are shown on the accompanying Environmental Work Sheets. Average depth of topsoil, topography and present land use are also indicated on the Work Sheets. The soil-landscape units delineated on the Environmental Work Sheets are described briefly in the map legend and in detail in this report. The suitability of the soils for reclamation, according to the guidelines of the Alberta Soils Advisory Committee (1987), have been evaluated. The soils were also evaluated for alternate material handling according to the guidelines of the Alberta Pipeline Environmental Steering Committee (1996). Material handling recommendations are also provided.

Field investigations were not originally carried out between KP 387.6 to KP 393.2 and KP 441.1 to KP 444.3. Soil investigations were carried out in the two areas from June 5-7, 2007. Details of these investigations are presented in Appendix I of this report.

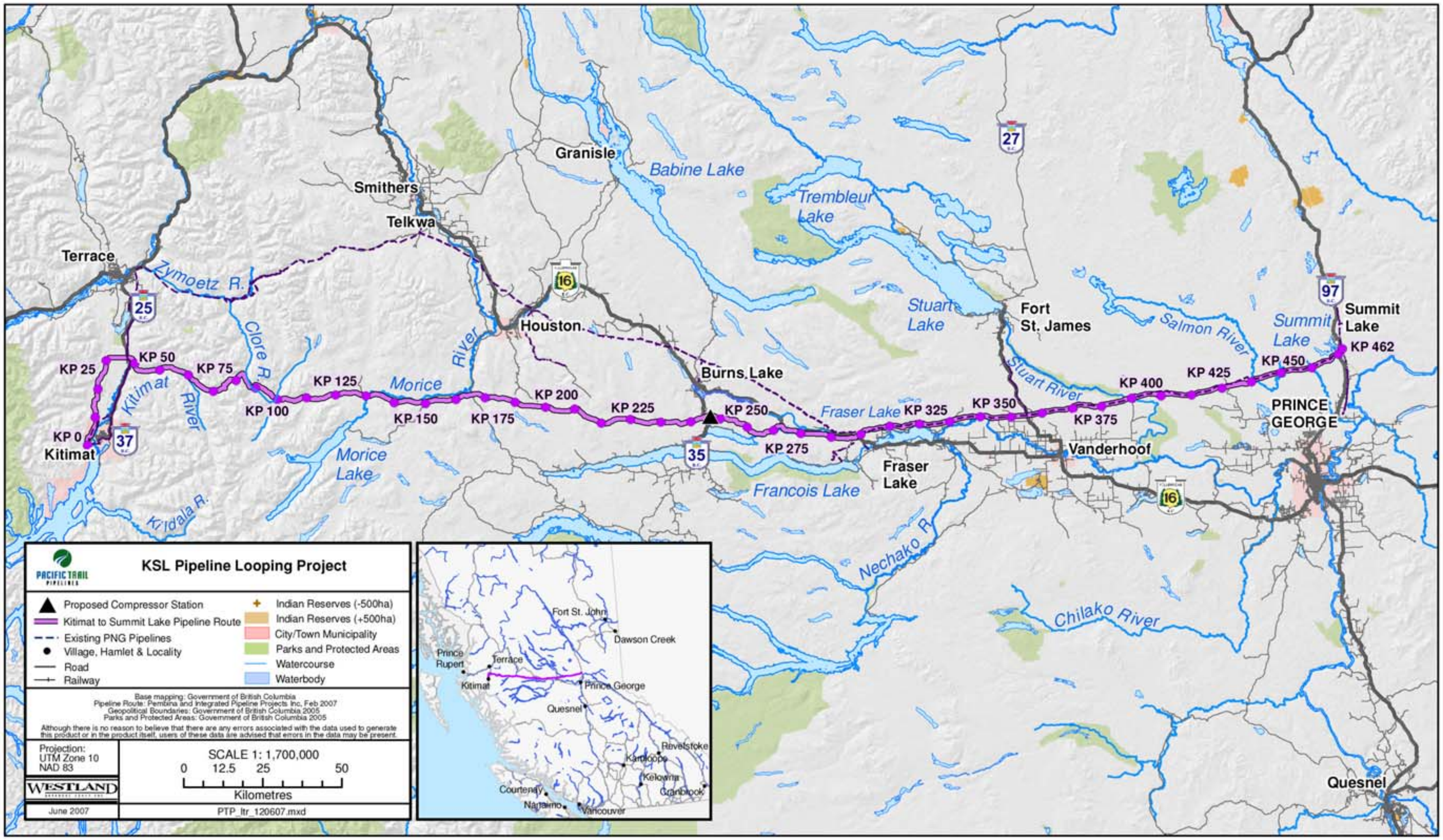


**Figure 1 Regional Overview of the KSL Project.**

# 2.0 THE STUDY AREA

## 2.1 Location and Extent

The project involves the construction of approximately 462 km of 914 mm (36-inch) diameter pipe between a location immediately north of the community of Kitimat, B.C. and a location immediately east of the community of Summit Lake, B.C. (see Figure 1). A soil survey was not conducted along the entire 468 km proposed route. The soil survey was conducted on all the Agricultural Land Reserve (ALR) land as well as other lands that may have some potential for agricultural development. The soil survey was only conducted along about 61 km of the proposed route at the following locations:

KP 158.3 to 162.6;

KP 272.9 to 282.2;

KP 289.2 to 291.2;

KP 296.7 to 301.5;

KP 306.2 to 313.7; and

KP 322.2 to 355.3.

The ALR occurs between KP 158.3 and 162.6, KP 272.9 and 278.9, KP 306.6 and 307.9, and KP 326.1 and 352.7.

## 2.2 Surficial Materials and Landform

A variety of surficial deposits occur along the proposed route surveyed. The route surveyed consist mainly of till, glaciofluvial and glaciolacustrine deposits. Till deposits occupy about 41% of the route surveyed. Two types of till were identified. One is gravelly sandy loam to loam textured and the other is loam to clay loam textured. The gravelly sandy loam to loam textured till is very stony to exceedingly stony and slightly to strongly acid while the loam to clay loam textured till is slightly to moderately stony and neutral to strongly acid. Till deposits generally occur on undulating to moderately rolling landscapes in the areas surveyed.

Stone-free to slightly stony glaciolacustrine deposits occupy about 37% of the areas surveyed. Two types of glaciolacustrine deposits were identified. One is silty clay to clay textured while the other is fine sandy loam, silt loam or silty clay loam textured. Both glaciolacustrine deposits are non-saline, non-sodic, neutral to mildly alkaline at depth and weakly calcareous. Glaciolacustrine deposits usually occur on gently undulating to undulating landscapes.

Glaciofluvial sands and gravels occupy about 17% of the areas investigated. Very coarse textured loamy sands occupy about 2%, sandy loams about 3% and glaciofluvial gravels about 12%. These coarse textured materials are strongly acid to neutral in soil reactions and usually occur on undulating to gently rolling landscapes.

The remaining 5% of the areas investigated consists of thick moss peat deposits (1%), recent fluvial sediments on the major creeks and rivers (1%) and rock outcrops (3%).

### 2.3 General Soil Patterns

Well to moderately well drained, Orthic Gray Luvisols, with little or no topsoil (Ah, Ahe, Aep or Ap horizons) in forested areas and developed on glaciofluvial sandy loams, loam to clay loam textured till, glaciolacustrine loams, silt loams or sandy loams and glaciolacustrine clays are the dominant soils occupying about 69% of the route surveyed. These soils are non-saline and non-sodic, sometimes weakly calcareous and strongly acid to neutral in soil reaction (pH). Topsoil thickness in cleared and developed fields varies from 10-20 cm and is usually brown to dark brown in colour. The topsoil horizon in cleared and developed fields consists mainly of Ae horizon material that has been slightly darkened with cultivation over the years (Aep horizon).

Well to rapidly drained Eluviated Dystric Brunisols with no topsoil in forested areas and developed on coarse textured glaciofluvial deposits or till material occupy about 25% of the selected areas investigated along the proposed route. These soils are non-saline, non-sodic, non-calcareous and strongly acid to medium acid in soil reaction. These soils have rarely been cleared and developed for agricultural purposes and are characterized by a thin duff layer (L-H or L-F horizon) overlying a thin, pale brown Ae horizon, a yellowish brown Bm horizon and a brown C horizon that usually occurs within 60 cm of the surface.

Other soils, but of minor extent, include: Orthic Regosols developed on silt loam to gravelly sand textured recent fluvial material on the floodplains of the major creeks and rivers; very poorly drained Typic or Fibric Mesisols developed on moss peat greater than a metre thick; and rock outcrops which have less than 10 cm of weathered material at the surface.

More detailed descriptions of the soils along the portions surveyed are provided in Section 3.2.

### 2.4 Present Land Use

The majority (approximately 86%) of the selected portions of the proposed route surveyed consists of bush land (B). An indication of the dominant tree species at each inspection site is presented in the Site Inspection List in Appendix A. Some of the bush land has cleared pasture land within the bush land which cannot be separated individually. Such areas are delineated as bush-pasture areas (B-P) on the Environmental Work Sheets. Bush-pasture areas are of minor extent occupying less than 1% of the route surveyed. Pasture land (P) occupies about 5% of the route surveyed while hay fields (H) with a well developed sod layer occupy about 3%. The remaining 6% consists of cultivated land (C).

Present land use is shown on the accompanying Environmental Work Sheets. The following present land use categories are shown on the Sheets:

| | | |
|---|---|---|
| B | - | bush |
| B-P | - | bush-pasture |
| C | - | cultivated |
| H | - | hay |
| P | - | pasture |

The extent of the present land use categories is as follows:

| Land Use Category | Length (km) | % of Route Surveyed |
|---|---|---|
| B | 52.2 | 85.6 |
| B-P | 0.2 | 0.3 |
| C | 3.3 | 5.4 |
| H | 2.0 | 3.3 |
| P | 3.3 | 5.4 |
| Total | 61.0 km | 100.0% |

# 3.0 SOILS

## 3.1 Soil Investigation Methods

The purpose of a soil survey is to identify and delineate soil patterns in the landscape and to present the information to the user.

Soil mapping is based on the philosophy of pedology – that soils are natural bodies that reflect the influence of their environment. Point observations of soils are extrapolated to areas by using principles of geomorphology and surficial geology, combined with vegetation pattern indicators. Since soil is a continuum, and adjacent soils seldom have sharp boundaries, Soil Units are defined as having a certain range of properties. These Soil Units are delineated on the basis of parent geologic material and landform, soil profile and soil moisture conditions. The soil and land attributes recognized in mapping are important for various land uses.

Prior to any field investigations, aerial photographs at a scale of about 1:30,000 were examined and the Agricultural Land Reserve (ALR) was determined and delineated on 1:20,000 scale Strip Maps. A soil survey was conducted on all the delineated ALR as well as other lands that may have some potential for agricultural development. A soil survey was not conducted along the entire 468 km proposed route. The soil survey was only conducted along about 61 km of the proposed route at the following locations:

| | |
|---|---|
| KP 158.3 to 162.6 | (4.3 km); |
| KP 272.9 to 282.2 | (9.3 km); |
| KP 289.2 to 291.2 | (2.0 km); |
| KP 296.7 to 301.5 | (4.8 km); |
| KP 306.2 to 313.7 | (7.5 km); and |
| KP 322.2 to 355.3 | (33.1 km) |
| Total | 61.0 km |

The soils have been classified and described according to the criteria established by the Soil Classification Working Group (1998). This system classifies soils in their natural state, and thus indicates relationships between soils and their environment. During field investigations, soil properties examined include: depth and thickness of horizon; colour; texture; structure; consistence; and any other pertinent details. Site characteristics such as parent materials, landform, topography, drainage and surface stoniness are also described using established procedures. Where available, soil names were correlated with the previous soil surveys carried out in the general areas. For those areas where little or no soils information exists, soil names were derived from local names, and are applicable only to this study. The previous reconnaissance soil surveys in the general area (Farstad and Laird 1954; Cotic, Van Barneveld and Sprout 1976) provided helpful background information. Soil mapping was conducted on Photomosaics at a scale of about 1:15,000. The information was later transferred to Photomosaic Environmental Work Sheets at a scale of 1:20,000.

Selected areas along the proposed route were traversed from August 25 to 29, 2006 and the soils were inspected at 133 locations. The location of the inspections sites are shown on the accompanying Environmental Work Sheets and inspection data are summarized in Appendix A. The usual procedure was to excavate a soils pit to 20-30 cm and hand auger to a depth of 1.2 m, and describe the morphological characteristics of the soils. Very stony conditions sometimes prevented soil investigations beyond the 50 cm depth but road cuts to depths beyond the one metre depth provided valuable additional information. Landscape features and the dominant tree species or present land use were also described at each inspection site.

The soils were sampled for laboratory analyses at 13 sites. Depending on the site, the master horizons (A, B and C), the upper and lower subsoils, or just the upper subsoil were sampled to a depth of up to 2.0 m. Surface horizons from selected hay fields and pasture lands were sampled for nutrient analysis. Soil analyses were carried out by Lakeside Research Laboratories in Brooks, Alberta using standard methods (McKeague 1978) as listed below:

| Analysis | Extraction | Determination | Reference |
|---|---|---|---|
| pH (water) | Saturated Paste | Electrodes | Page 68 |
| Electrical Conductivity | Saturated Extract | Conductivity Bridge | Page 70 |
| %Saturation | Saturated Paste | %$H_2O$ added | Page 69 |
| Organic Matter | Dry Combustion | LECO Furnace | Page 109 |
| $CaCO_3$ Equivalent | Hydrochloric Acid | Gravimetric Method | Page 86 |
| Particle Size Analysis | - | Hydrometer | Page 15 |

Electrical conductivity (EC), saturation percentage (Sat%), soil reaction (pH) and particle size analysis (PSA) were determined on all samples collected. Organic matter (OM) content was analyzed on all topsoil samples. Calcium carbonate content ($CaCO_3$) was determined on all samples with a pH>7.0. Nutrient analyses (N, P, K, $SO_4$) were run on topsoil samples collected from selected hay fields and pasture lands.

The areas delineated on the Environmental Work Sheets are called Map Delineations. The label of a Map Delineation identifies a Soil Unit in the numerator and the Topographic Class in the denominator. Also indicated in the numerator (in parenthesis) is the average depth or range in depth of the topsoil, in cm. For example for the notation:

$$\frac{\text{PVW(15)}}{3}$$

identifies an area of moderately well drained Orthic Gray Luvisols developed on silty clay to clay textured glaciolacustrine material (Pineview (PVW) soils) on Topographic Class 3 (2-5% slopes). The average depth of topsoil (Ah, Ahe, Aep or Ap horizon) in the Map Unit is 15 cm.

Mapping phases are sometimes used to indicate important soil characteristics affecting agricultural ratings or reclamation suitability ratings. For example for notation:

$$\frac{\text{shPVW(10)}}{3}$$

identifies an area of moderately well drained Orthic Gray Luvisols developed on a silty clay to clay textured glaciolacustrine veneer overlying loam to clay loam textured till (shallow Pineview (shPVW) soils). The underlying till is encountered within 1.2 m of the surface. The Topographic Class is Class 3 (2-5% slopes) and the average depth of topsoil in the Map Unit is 10 cm.

Only one mapping phase was used in this study. It is described as follows:

**sh** shallow phase – indicated by the notation "sh" preceding the Soil Unit abbreviation. It indicates areas of soils with an unconforming parent material within 1.2 m of the surface. This phase is only used with Pineview soils to indicate areas of Pineview soils that have till within 1.2 m of the surface (shallow Pineview (shPNW) soils) and with Barrett soils to indicate areas of Barrett soils that have hard consolidated rock within 1.2 m of the surface (shallow Barrett (shBAT) soils).

## 3.2 Soil Units

The Soil Units identified along selected areas of the proposed route are described on the following pages. A key to the soils is presented in Table 1. The extent of the various soils along the selected routes surveyed is shown in Table 2. Laboratory analyses of samples soils are provided in Table 3 and Appendix F.

### *3.2.1 Alix (ALX) Soils*

EXTENT: 7.5 km or 12.3% of routes surveyed

SOIL CLASSIFICATION: Eluviated Dystric Brunisol

PARENT MATERIAL: Gravelly sandy loam to loamy sand textured glaciofluvial

DRAINAGE: Rapidly

SURFACE STONINESS: Very to exceedingly stony (S3-4)

TOPOGRAPHY: Undulating to gently rolling (2-9% slopes)

PROFILE DESCRIPTION: Site 4

| Horizon | Depth (cm) | Colour | Texture | Structure | Consistence |
|---|---|---|---|---|---|
| L-H | 4-0 | dark brown | deciduous and coniferous debris | | |
| Ae | 0-4 | light gray | gvLS-gvS | single grain | loose |
| Bm | 4-30 | yellowish brown | gvLS | single grain | loose |
| C | 30-200 | brown | gvS | single grain | loose |

COMMENTS:

- Alix soils occur from KP 158.3 to 161.8 and are the dominant soils between KP 351.0 and 353.3.
- There is no topsoil (Ah, Ahe or Ap horizons). Instead there is a thin duff layer (L-H or L-F horizon) overlying a light gray leached horizon (Ae horizon) and a yellowish brown, upper subsoil horizon (Bm horizon).
- These coarse textured soils lack cohesion properties and are susceptible to unstable trench walls when vertically ditched.
- Alix soils have not been developed for agricultural purposes.
- These coarse textured soils are non-saline and non-sodic to the 1.2 m depth

### 3.2.2 Alluvium (AV) Soils

EXTENT: 0.4 km or 0.7% of routes surveyed

SOIL CLASSIFICATION: Orthic Regosol

PARENT MATERIAL: Silt loam to gravelly sand textured recent fluvial

DRAINAGE: Well to rapidly

SURFACE STONINESS: Stone-free to exceedingly stony (S0-S4)

TOPOGRAPHY: Gently undulating to undulating (1-5% slopes)

PROFILE DESCRIPTION: Site Inferred

| Horizon | Depth (cm) | Colour | Texture | Structure | Consistence |
|---|---|---|---|---|---|
| C1 | 0-25 | brown | SL-LS | single grain | loose |
| C2 | 25-70 | grayish brown | gvLS | single grain | loose |
| C3 | 70+ | light yellowish brown | SL | single grain | very friable to loose |

COMMENTS:

- These soils are of minor extent. They only occur on the floodplains of Tchesinkut Creek at KP 278.9 and Sam Ross Creek at KP 280.8.
- These soils lack both a topsoil horizon and a B horizon.
- Alluvium soils are usually very coarse textured and lack cohesion properties which will result in unstable trench walls when vertically ditched.

### *3.2.3 Barrett (BAT) Soils*

EXTENT: 19.0 km or 31.2% of routes surveyed

SOIL CLASSIFICATION: Orthic Gray Luvisol

PARENT MATERIAL: Loam to clay loam textured till

DRAINAGE: Well to moderately well

SURFACE STONINESS: Slightly to moderately stony (S1-2)

TOPOGRAPHY: Gently undulating to very strongly rolling (1-45% slopes)

PROFILE DESCRIPTION: Site 19

| Horizon | Depth (cm) | Colour | Texture | Structure | Consistence |
|---|---|---|---|---|---|
| L-H | 4-0 | dark brown | | duff layer | |
| Ae | 0-12 | pale brown | SiL | m.m.plty. | friable |
| Bt | 12-84 | dark yellowish brown | SiCL-CL | m.m.sbk. | firm to very firm |
| C | 84-120 | brown | L-CL | massive | firm to very firm |

COMMENTS:

- Barrett soils are the dominant soils in the areas investigated.
- Topsoil thickness varies from 12-17 cm in cleared and developed fields. No topsoil (Ah, Ahe or Ap horizons) occurs in bush areas. Instead there is a thin duff layer (L-H horizon) overlying a light coloured Ae horizon. The topsoil horizon in cleared and developed fields (Ap horizon) consists mainly of former Ae horizon material that has been darkened with cultivation over the years. Topsoils are not usually easily distinguished from subsoils by colour in cleared and developed fields.
- Barrett soils are non-saline and non-sodic to the 1.2 m depth.
- Barrett soils that have hard consolidated bedrock within 1.2 m of the surface are identified as **shallow Barrett (shBAT) soils**. These soils occupy 0.6 km in the vicinity of KP 325.5 and KP 327.8. Hard consolidated bedrock occurs at about 80 cm below the surface in these areas. These soils have not been developed for agricultural purposes in the areas surveyed.

### *3.2.4 Berman (BMN) Soils*

EXTENT: 6.4 km or 10.5% of routes surveyed

SOIL CLASSIFICATION: Orthic Gray Luvisol

PARENT MATERIAL: Fine sandy loam, silt loam and silty clay loam textured glaciolacustrine

DRAINAGE: Well to moderately well

SURFACE STONINESS: Stone-free to slightly stony (S0-1)

TOPOGRAPHY: Gently undulating to strongly rolling (1-30% slopes)

PROFILE DESCRIPTION: Site 92

| **Horizon** | **Depth (cm)** | **Colour** | **Texture** | **Structure** | **Consistence** |
|---|---|---|---|---|---|
| Aep | 0-15 | brown | SiL | w.f.gran. | friable |
| Ae | 15-30 | pale brown | SiL | m.m.plty. | friable |
| Bt | 30-75 | dark yellowish brown | SiL-L | w.f.sbk. | friable to firm |
| Ckgj | 75-120 | mottled dark yellowish brown to yellowish brown | SiL | massive | friable |

COMMENTS:

- These soils are generally confined to the Nechako River Valley area. Extensive areas of these soils occurs, south and southwest of the community of Endako.
- Extensive areas of Berman soils have been developed for agricultural purposes.
- Topsoil thickness varies from 12-20 cm in cleared and developed fields. No topsoil (Ah, Ahe, Aep or Ap horizons) occur in bush areas. Instead there is a thin duff layer (L-H horizon) overlying a light coloured Ae horizon. The topsoil horizon in cleared and developed fields (Ap or Aep horizon) consists mainly of former Ae horizon material that has been slightly darkened with cultivation over the years. Topsoils are not easily distinguished from subsoils by colour in cleared and developed fields.
- Berman soils are non-saline and non-sodic to the 1.2 m depth.

### 3.2.5 Braeside (BRD) Soils

EXTENT: 0.8 km or 1.3% of routes surveyed

SOIL CLASSIFICATION: Orthic Gray Luvisol

PARENT MATERIAL: Sandy loam textured glaciofluvial

DRAINAGE: Well

SURFACE STONINESS: Stone-free to slightly stony (S0-1)

TOPOGRAPHY: Undulating (2-5% slopes)

PROFILE DESCRIPTION: Site 15

| Horizon | Depth (cm) | Colour | Texture | Structure | Consistence |
|---|---|---|---|---|---|
| L-H | 3-0 | dark brown | | duff material | |
| Ae | 0-5 | pale brown | fSL | w.f.plty. | very friable |
| Bt | 5-48 | dark yellowish brown | fSL-SiL | w.f.sbk. | friable |
| C | 48-120 | brown | fSL | massive | friable |

COMMENTS:

- These soils are of very minor extent. They were only mapped in the vicinity of KP 350.8 and KP 352.0.
- Braeside soils have not been developed for agricultural purposes.
- There is no topsoil (Ah, Ahe, Aep or Ap horizons). Instead there is a thin duff layer (L-H or L-F horizon) overlying a thin, pale brown, leached horizon (Ae horizon) and a dark yellowish brown, upper subsoil horizon (Bt horizon).
- Braeside soils are non-saline and non-sodic to the 1.2 m depth.

### 3.2.6 Crystal (CRY) Soils

EXTENT: 6.1 km or 10.0% of routes surveyed

SOIL CLASSIFICATION: Eluviated Dystric Brunisol

PARENT MATERIAL: Gravelly sandy loam to gravelly loam textured till

DRAINAGE: Well to rapidly

SURFACE STONINESS: Very to exceedingly stony (S3-4)

TOPOGRAPHY: Undulating to strongly rolling (2-30% slopes)

PROFILE DESCRIPTION: Site 89

| Horizon | Depth (cm) | Colour | Texture | Structure | Consistence |
|---|---|---|---|---|---|
| L-H | 4-0 | dark brown | | duff material | |
| Ae | 0-10 | pale brown | gvSL-gvL | vw.f.plty. | friable |
| Bm | 10-55 | brown to dark yellowish brown | gvL | vw.f.sbk. | friable to firm |
| C | 55-120 | brown | gvL | massive | friable to firm |

COMMENTS:

- These soils are generally confined to some of the upland areas. An extensive area of these soils occurs from KP 298.5 to 301.5.
- Crystal soils have not been developed for agricultural purposes in the areas surveyed.
- There is no topsoil (Ah, Ahe, Aep or Ap horizons). Instead there is a thin duff layer (L-H or L-F horizon) overlying a light coloured Ae horizon and a brown to dark yellowish brown Bm horizon.
- These coarse textured soils may lack cohesion properties, which may result in unstable trench walls when vertically ditched.
- Crystal soils are non-saline and non-sodic to the 1.2 m depth.

### *3.2.7 Kenzie (KNZ) Soils*

EXTENT: 0.5 km or 0.8% of routes surveyed

SOIL CLASSIFICATION: Fibric and Typic Mesisols

PARENT MATERIAL: Moss peat greater than a metre thick

DRAINAGE: Very poorly

SURFACE STONINESS: Stone-free (S0)

TOPOGRAPHY: Level to depressional (0-1% slopes)

PROFILE DESCRIPTION: Site 24

| Horizon | Depth (cm) | Colour | Texture | Structure | Consistence |
|---|---|---|---|---|---|
| Of | 0-50 | reddish brown | | fibric moss peat | |
| Om | 50-120+ | yellowish brown to brown | | semi-decomposed moss | |

COMMENTS:

- These soils are of very minor extent, occupying 0.5 km or 0.8% of the routes surveyed. They only occur in the vicinity of KP 306 and KP 347.1.
- Kenzie soils are characterized by semi-decomposed moss peat that exceeds a depth of a metre. The underlying mineral material will rarely be encountered within trench depth. They occur in very poorly drained level to depressional areas.
- Watertables are at or near the surface.
- These soils remain in their native vegetation of dominantly black spruce.
- The moss peat material is susceptible to soil compaction.

### *3.2.8 Mapes (MPS) Soils*

EXTENT: 1.1 km or 1.8% of routes surveyed

SOIL CLASSIFICATION: Eluviated Dystric Brunisol

PARENT MATERIAL: Loamy sand textured glaciofluvial

DRAINAGE: Well to rapidly

SURFACE STONINESS: Stone-free to slightly stony (S0-1)

TOPOGRAPHY: Gently undulating to strongly rolling (1-30% slopes)

PROFILE DESCRIPTION: Site 96

| Horizon | Depth (cm) | Colour | Texture | Structure | Consistence |
|---|---|---|---|---|---|
| Ap | 0-15 | brown to dark brown | LS | single grain | loose |
| Bm | 15-70 | yellowish brown | LS | single grain | loose |
| C | 70-120 | brown | LS | single grain | loose |

COMMENTS:

- An extensive area of these soils occurs southwest of the community of Endako from KP 277.2 to 278.1.
- These soils have sometimes been developed for agricultural purposes (hay fields and pasture land). Topsoil thickness in cleared and developed fields varies from 10-15 cm. Topsoils are not easily distinguished from subsoils by colour in cleared and developed fields.
- These coarse textured soils lack cohesion properties which will result in unstable trench walls when vertically ditched.
- Mapes soils are non-saline and non-sodic to the 1.2 m depth.

### 3.2.9 Nithi (NIT) Soils

EXTENT: 0.8 km or 1.3% of routes surveyed

SOIL CLASSIFICATION: Orthic and Eluviated Dystric Brunisols

PARENT MATERIAL: Fine sandy loam to silt loam textured glaciofluvial veneer overlying loamy sand to sand textured glaciofluvial material

DRAINAGE: Well to rapidly

SURFACE STONINESS: Stone-free (S0)

TOPOGRAPHY: Gently undulating to undulating (1-15% slopes)

PROFILE DESCRIPTION: Site 97

| Horizon | Depth (cm) | Colour | Texture | Structure | Consistence |
|---|---|---|---|---|---|
| Aep | 0-15 | brown | SiL-L | vw.f.gran. | friable |
| Ae | 15-22 | pale brown | SiL | w-m.m.plty. | friable |
| Bm | 22-50 | yellowish brown | SiL-L | w.f.sbk. | friable |
| C | 50-100 | dark yellowish brown | S | single grain | loose |

COMMENTS:

- These soils are confined to an area southwest of the community of Endako from KP 277.1 to 277.3 and from KP 278.1 to 278.7.
- Nithi soils have sometimes been developed for agricultural purposes (pasture and hay fields). Topsoil thickness in cleared and developed fields varies from 10-15 cm. Colour differentiation between topsoils and subsoils in cleared and developed fields is Fair.
- The lower subsoil is considerably coarser textured than the upper subsoil (loamy sand to sand textured in the lower subsoil and fine sandy loam, loam or silt loam textured in the upper subsoil). Coarser textures occur at about the 50 cm depth.
- The lower subsoil material lacks cohesion properties, which will result in unstable trench walls when vertically ditched.
- Nithi soils are non-saline and non-sodic to the 1.2 m depth.
- These soils have been recommended for an alternate soil handling procedure to maintain the upper subsoil textural characteristics. They have been recommended to be over-stripped to a depth of 30 cm in bush areas and have been recommended for the three-lift soil handling procedure in cleared and developed fields (pasture lands and hay fields). The first lift should include the upper 15 cm while the second-lift should be about 30 cm in thickness. The third and final lift will consist mainly of the loamy sand to sand textured material.

### 3.2.10 Pineview (PVW) Soils

EXTENT: 15.6 km or 25.5% of routes surveyed

SOIL CLASSIFICATION: Orthic Gray Luvisol

PARENT MATERIAL: Silty clay to clay textured glaciolacustrine

DRAINAGE: Moderately well

SURFACE STONINESS: Stone-free to slightly stony (S0-1)

TOPOGRAPHY: Gently undulating to moderately rolling (1-15% slopes)

PROFILE DESCRIPTION: Site 31

| Horizon | Depth (cm) | Colour | Texture | Structure | Consistence |
|---|---|---|---|---|---|
| Ap | 0-16 | pale brown | SiL-L | m.m.plty. | friable |
| Bt | 16-75 | dark yellowish brown | C | m.m.sbk. | firm |
| Ck | 75-110 | dark brown to dark yellowish brown | C | massive | firm |

COMMENTS:

- These soils are common northwest of the Town of Vanderhoof. Extensive areas occur from KP 329.5 to 332.0, KP 338.2 to 341.3 and from KP 343.6 to 347.0.
- Topsoil thickness in cleared and developed fields varies from 10-16 cm. No topsoil (Ah, Ahe, Aep or Ap horizons) occurs in bush areas. Instead there is a thin duff layer (L-H horizon) overlying a relatively thick, light coloured Ae horizon. The topsoil horizon in cleared and developed fields (Ap or Aep horizon) consists mainly of former Ae horizon material which frequently is still light coloured. Topsoils are generally lighter coloured than the underlying subsoil.
- Pineview soils are fine textured and therefore susceptible to soil compaction and rutting.
- These fine textured soils are non-saline and non-sodic to the 1.2 m depth.
- Pineview soils which have loam to clay loam textured till within 1.2 m of the surface are identified as **shallow Pineview (shPVW) soils**. These soils occupy 3.2 km or 5.2% of the routes surveyed. An extensive area of these soils occurs north of Fraser Lake from Kp 310.1 to 313.1 where the underlying till is encountered at 30 to 80 cm below the surface. Surface stoniness may be increased with construction of the pipeline. These soils have not been developed for agricultural purposes along the routes surveyed.

#### *3.2.11 Miscellaneous Land Units*

During the course of the soil survey, at selected locations along the proposed route, three miscellaneous land units, namely; **Consolidated Bedrock or Rock Outcrops (R),** R**ough Broken Slopes (RB),** and **Stream Channels (SC)** were identified.

Areas of hard consolidated bedrock are identified by the **Rock (R) Land Unit**. There is usually less than 10 cm of weathered material at the surface. Consolidated bedrock (R) occupies 1.4 km or 2.3% of the routes surveyed. Extensive areas of Rock Outcrops occur between KP 325 and 329. No surface material needs to be salvaged from areas of the Rock (R) Land Unit.

The steep slopes adjacent to deeply incised creeks or rivers are identified by the **Rough Broken Land Unit (RB).** These steep slopes are susceptible to soil erosion and slumping when the protective vegetation is removed. Special procedures for erosion control are required on these steep slopes (diversion berms). It is important that a vegetative cover be established as quickly as practical to prevent soil erosion. The upper 15-20 cm of root zone material should be salvaged from undisturbed areas for replacement to aid in revegetating these areas. Rough Broken Slopes occupy 1.1 km along the portions of the route surveyed.

Undifferentiated Regosolic and Gleysolic soils developed on recent fluvial sediments and gravelly sandy loam to clay textured materials on the narrow gently to moderately rolling slopes adjacent to the channel are identified by the **Stream Channel Land Unit (SC).** These drainage channels vary widely in drainage and texture. Most areas are poorly drained. Stream Channels occupy 0.3 km of the portions of the routes surveyed.

**TABLE 1**

**KEY TO THE SOILS**

| Soil Symbol | Soil Name | Soil Classification | Parent Material | Texture Class | Drainage Class |
|---|---|---|---|---|---|
| ALX | Alix | Eluviated Dystric Brunisol | glaciofluvial | gravelly sandy loam to loamy sand | rapidly |
| AV | Alluvium | Orthic Regosol | recent fluvial | silt loam to gravelly sand | well to rapidly |
| BAT | Barrett | Orthic Gray Luvisol | till | loam to clay loam | well to moderately well |
| BMN | Berman | Orthic Gray Luvisol | glaciolacustrine | fine sandy loam, silt loam and silty clay loam | well to moderately well |
| BRD | Braeside | Orthic Gray Luvisol | glaciofluvial | sandy loam | well |
| CRY | Crystal | Eluviated Dystric Brunisol | till | gravelly sandy loam to loam | well to rapidly |
| KNZ | Kenzie | Fibric Mesisol Typic Mesisol | organic | moss peat | very poorly |
| MPS | Mapes | Eluviated Dystric Brunisol | glaciofluvial | loamy sand | well to rapidly |
| NIT | Nithi | Orthic Dystric Brunisol Eluviated Dystric Brunisol | glaciofluvial | fine sands and silts overlying loamy sand to sand | well to rapidly |
| PVW | Pineview | Orthic Gray Luvisol | glaciolacustrine | silty clay to clay | well to moderately well |
| **Miscellaneous Land Units:** | | | | | |
| R | Rock | Hard consolidated bedrock at or near the surface | | | |
| RB | Rough Broken | Steep slopes along drainage courses | | | |
| SC | Stream Channel | Undifferentiated Regosolic and Gleysolic soils developed on recent fluvial sediments | | | |
| **Soil Phase:** | | | | | |
| sh | shallow | Soils with an unconforming parent material within 1.2 m of the surface | | | |

**TABLE 2**

**EXTENT OF VARIOUS SOILS ALONG THE PROOPOSED ROUTES SURVEYED**

| Soil Symbol | Soil Name | Length (km) | Percent |
|---|---|---|---|
| ALX | Alix | 7.5 | 12.3 |
| AV | Alluvium | 0.4 | 0.7 |
| BAT | Barrett | 18.4 | 30.2 |
| shBAT | shallow Barrett | 0.6 | 1.0 |
| BMN | Berman | 6.4 | 10.5 |
| BRD | Braeside | 0.8 | 1.3 |
| CRY | Crystal | 6.1 | 10.0 |
| KNZ | Kenzie | 0.5 | 0.8 |
| MPS | Mapes | 1.1 | 1.8 |
| NIT | Nithi | 0.8 | 1.3 |
| PVW | Pineview | 12.4 | 20.3 |
| shPVW | shallow Pineview | 3.2 | 5.2 |
| **Miscellaneous Land Units** | | | |
| R | Rock | 1.4 | 2.3 |
| RB | Rough Broken | 1.1 | 1.8 |
| SC | Stream Channel | 0.3 | 0.5 |
| Total | | 61.0 km | 100.0% |

### 3.3 Soil Suitability for Reclamation

The criteria used to rate soil suitability are those proposed by the Soil Quality Criteria Subcommittee of the Alberta Soils Advisory Committee (1987). These guidelines, reproduced in Appendix C, provide a subjective evaluation (Good, Fair, Poor, Unsuitable) of suitability based on interpretation of physical and chemical properties of the soils. The ratings are based on general predictions of soil performance and do not consider varying requirements of individual plant species or special management input. Ratings have been assigned to the soils using their physical characteristics and results from laboratory analyses for those soils sampled while for those soils that were not sampled, ratings are based on field observations. Laboratory results and soil suitability ratings of sampled soils are presented in Table 3. Suitability ratings of the soils for reclamation is presented in Table 4.

Soils with topsoil horizons (Ah, Ahe, Aep and Ap horizons) are generally confined to areas that have been cleared for agricultural purposes (hay fields, pasture lands and cultivated fields). The topsoil in these areas is often low in organic matter content, has a low soil reaction (pH) or is coarse textured. Topsoil horizons occur in some of the Barrett, Berman, Mapes, Nithi and Pineview soils. The topsoil material in Barrett, Berman, Nithi and Pineview soils is generally rated as Fair to Poor (F-P) quality material due mainly to a low soil reaction (pH) and/or a low organic matter content while topsoils of Mapes soils are considered Poor (P) quality material due to a coarse texture limitation. All soils do not have a distinct topsoil horizon (Ah, Ahe, Aep or Ap horizon) in forested areas, but have a root zone mat overlying mineral material in the upper 15-20 cm (L-F, L-H, Ae and Bm or Bt horizons). When textures are favourable (loam, silt loam or sandy loam) and the material is not exceedingly stony or bouldery the upper root zone material is generally more favourable for reclamation than the underlying subsoil material. The upper material in forested areas is generally rated as Fair-Poor quality material for reclamation, however, the surface material in Alix, Alluvium, Crystal, and Mapes soils is considered Poor (P) quality material due to a coarse texture limitation.

Subsoils of Berman and Braeside soils have favourable texture and soil reactions (pH) and are rated as Fair to Good (F-G) quality material for reclamation while subsoils of Barrett soils are considered Fair (F) quality material due to a moderately fine texture and low soil reaction limitations. Subsoils of Alix, Alluvium, Crystal and Mapes soils are rated as Poor (P) quality material due mainly to a coarse texture limitation while subsoils of Pineview soils are rated as Poor to Fair (P-F) quality material due to a fine texture limitation. The upper subsoil of shallow Pineview soils is rated as Poor to Fair quality material while the underlying coarser textured till is considered Fair (F) quality material. The upper subsoil of shallow Barrett soils is rated as Fair quality material while the underlying hard consolidated bedrock is rated as Unsuitable (U). The upper subsoil of Nithi soils is rated as Fair to Good quality material while the underlying sands, at about the 50 cm depth, are considered Poor quality material. Kenzie soils are Organic soils and are not given a suitability rating in Table 4.

**TABLE 3**

**SOIL CHARACTERISTICS OF SAMPLED SOILS**

| Site | Soil Unit | Horizon | Depth (cm) | pH ($H_2O$) | EC (dS/m) | Sat (%) | $CaCO_3$ Equiv. (%) | Organic Carbon (%) | Texture | Reclamation Suitability Rating and Limitations* |
|---|---|---|---|---|---|---|---|---|---|---|
| 4 | Alix | Bm | 4-30 | 5.6 | 0.1 | 37 | - | - | gvLS | P(6) |
| | (ALX) | C | 30-200 | 6.1 | <0.1 | 28 | - | - | gvS | P(6) |
| 19 | Barrett | Bt | 12-84 | 6.0 | 0.2 | 49 | - | - | SiCL | F(1,6) |
| | (BAT) | C | 84-120 | 6.1 | 0.2 | 32 | - | - | L | F(1) |
| 52 | Berman | Aep | 0-15 | 6.5 | 0.4 | 38 | 0.8 | 0.8 | SL | P(8) |
| | (BMN) | Bt | 15-75 | 6.6 | 0.3 | 35 | - | - | SiL | G |
| | | C | 75-120 | 6.4 | 0.3 | 35 | - | - | SiL | F(1) |
| 92 | Berman | Aep | 0-15 | 6.4 | 0.8 | 61 | - | 2.6 | SiL | F(1,4) |
| | (BMN) | Bt | 30-75 | 6.5 | 0.3 | 44 | - | - | SiL | G |
| | | Ckgj | 75-120 | 7.8 | 0.3 | 40 | 0.8 | - | SiL | F(1) |
| 106 | Berman | Aep | 0-15 | 5.2 | 0.4 | 56 | - | 1.2 | SiL | P(1) |
| | (BMN) | Bt | 22-70 | 7.3 | 0.3 | 50 | 0.3 | - | SiL | G |
| 124 | Berman | Aep | 0-15 | 6.1 | 0.3 | 45 | - | 1.0 | SiL | F(1,8) |
| | (BMN) | Bm1 | 15-50 | 6.5 | 0.1 | 35 | - | - | L | G |
| | | Bm2 | 50-90 | 6.5 | 0.2 | 41 | - | - | SiL | G |
| 15 | Braeside | Bt | 5-48 | 6.2 | 0.3 | 37 | - | - | SiL | F(1) |
| | (BRD) | C | 48-120 | 6.4 | 0.1 | 29 | - | - | SL | F(1,4) |
| 89 | Crystal | Bm | 10-55 | 6.4 | 0.3 | 24 | - | - | gvL | P(6) |
| | (CRY) | C | 55-100 | 6.2 | 0.2 | 28 | - | - | gvL | P(6) |
| 97 | Nithi | Aep | 0-15 | 5.3 | 0.4 | 40 | - | 0.9 | L | P(1) |
| | (NIT) | Bm | 22-50 | 5.6 | 0.3 | 42 | - | - | L | F(1) |
| | | C | 50-100 | 6.6 | 0.1 | 31 | - | - | S | P(6) |
| 101 | Nithi (NIT) | Bm | 10-55 | 6.0 | 0.1 | 31 | - | - | SL | F(1) |
| 31 | Pineview | Bt | 16-75 | 6.7 | 0.3 | 58 | - | - | C | P(6) |
| | (PVW) | Ck | 75-110 | 7.5 | 0.2 | 59 | 0.4 | - | C | P(6) |
| 39 | Pineview | Bt | 13-68 | 6.7 | 0.2 | 60 | - | - | C | P(6) |
| | (PVW) | Ck | 68-150 | 8.0 | 0.5 | 50 | 1.8 | - | SiCL | F(1,6) |
| 80 | shallow | Bt | 12-53 | 5.7 | 0.2 | 35 | - | - | SiCL | F(1,6) |
| | Pineview (shPVW) | IIC | 53-200 | 5.9 | 0.2 | 25 | - | - | SL | F(1,4) |

| * Limitations | Ratings (After ASAC, 1987) |
|---|---|
| 1 – pH | |
| 2 – EC | G – Good |
| 3 – SAR | F – Fair |
| 4 – Sat% | P – Poor |
| 5 – Stoniness | U – Unsuitable |
| 6 – Texture | |
| 7 – Consistence | |
| 8 – Organic Carbon | |

**TABLE 4**

**SUITABILITY RATINGS OF THE SOILS FOR RECLAMATION**

| Soil Symbol | Soil Name | Soil Classification | Parent Material | Suitability Ratings Topsoil* | Suitability Ratings Subsoil |
|---|---|---|---|---|---|
| ALX | Alix | Eluviated Dystric Brunisol | glaciofluvial | P(0) | P |
| AV | Alluvium | Orthic Regosol | recent fluvial | P(0) | P |
| BAT | Barrett | Orthic Gray Luvisol | till | F-P(0-17) | F |
| shBAT | shallow Barrett | Orthic Gray Luvisol | till veneer overlying hard rock | F-P(0) | F/U |
| BMW | Berman | Orthic Gray Luvisol | glaciolacustrine | F-P(0-20) | F-G |
| BRD | Braeside | Orthic Gray Luvisol | glaciofluvial | F-P(0) | F-G |
| CRY | Crystal | Eluviated Dystric Brunisol | till | P(0) | P |
| KNZ | Kenzie | Fibric and Typic Mesisols | moss peat | -(0) | - |
| MPS | Mapes | Eluviated Dystric Brunisol | glaciofluvial | P(0-15) | P |
| NIT | Nithi | Orthic and Eluviated Dystric Brunisols | glaciofluvial | F-P(0-15) | F-G/P |
| PVW | Pineview | Orthic Gray Luvisol | glaciolacustrine | F-P(0-16) | P-F |
| shPVW | shallow Pineview | Orthic Gray Luvisol | glaciolacustrine veneer overlying till | F-P(0) | P-F/F |

* Range in depth of topsoil in parentheses (cm)

Suitability Ratings:
- G - Good
- F - Fair
- P - Poor
- U - Unsuitable

### 3.4 Evaluation of the Soils for Alternate Soil Handling

The criteria used to determine if a Soil Unit should be subjected to an alternate soil handling procedure are those proposed by the APESC (1996). These guidelines, reproduced in Appendix D, provide a decision on whether a particular soil type should be subjected to an alternate soil handling procedure to maintain soil capability. An alternate soil handling procedure consists of either over-stripping the topsoil or a three-lift procedure. In a three-lift soil handling procedure the soil is removed and replaced as three separate layers, namely; topsoil, upper subsoil and lower subsoil. Soil characteristics that are important in determining an alternate soil handling procedure include; topsoil thickness, upper subsoil thickness, the presence or absence of a Bnt horizon, stone or gravel content, the presence or absence of sodic bedrock, texture, salinity, sodicity and the map unit length. The minimum map unit length is generally considered 100 m. Evaluation of all the soils encountered along selected portions of the proposed route for an alternate soil handling procedure is presented in Table 5.

Only Nithi soils have been recommended for an alternate soil handling procedure to maintain the upper subsoil textural characteristics. Nithi soils occupy 0.8 km southwest of the community of Endako from KP 277.1 to 277.3 and from KP 278.1 to 278.7. The three-lift soil handling procedure is recommended in areas of hay fields and pasture lands (KP 277.1 to 277.3 and KP 278.4 to 278.7) while over-stripping the upper root zone material to a depth of 30-35 cm is recommended in forested areas (KP 278.1 to 278.4). The first-lift should include the upper 15 cm (Aep or Ap horizon) while the second-lift should be about 30 cm in thickness. The third and final lift will consist mainly of the loamy sand to sand textured lower subsoil material. Extra temporary workspace may be required to accommodate the extra spoil pile in areas of hay fields and pasture lands.

**TABLE 5**

**EVALUATION OF THE SOILS FOR ALTERNATE SOIL HANDLING**

| Soil Symbol | Soil Name | Soil Classification | Parent Material | Topsoil Depth Range (cm) | Alternate Handling |
|---|---|---|---|---|---|
| ALX | Alix | Eluviated Dystric Brunisol | glaciofluvial | 0 | No |
| AV | Alluvium | Orthic Regosol | recent fluvial | 0 | No |
| BAT | Barrett | Orthic Gray Luvisol | till | 0-17 | No |
| shBAT | shallow Barrett | Orthic Gray Luvisol | till veneer overlying hard rock | 0 | No |
| BMW | Berman | Orthic Gray Luvisol | glaciolacustrine | 0-20 | No |
| BRD | Braeside | Orthic Gray Luvisol | glaciofluvial | 0 | No |
| CRY | Crystal | Eluviated Dystric Brunisol | till | 0 | No |
| KNZ | Kenzie | Fibric and Typic Mesisols | moss peat | 0 | No |
| MPS | Mapes | Eluviated Dystric Brunisol | glaciofluvial | 0-15 | No |
| NIT | Nithi | Orthic and Eluviated Dystric Brunisols | glaciofluvial | 0-15 | **Yes** |
| PVW | Pineview | Orthic Gray Luvisol | glaciolacustrine | 0-16 | No |
| shPVW | shallow Pineview | Orthic Gray Luvisol | glaciolacustrine veneer overlying till | 0 | No |

### 3.5 Soil Nutrient Analysis

Surface horizons collected from selected pasture lands and hay fields were analyzed for nutrients. The results are as follows:

| Soil Unit | Present Land Use | Depth (cm) | Available Nutrients (ppm) | | | |
|---|---|---|---|---|---|---|
| | | | $NO_3$ | $PO_4$ | K | $SO_4$ |
| Berman (BMN) | hay | 0-15 | <1.2 | 60 | 310 | <5 |
| Berman (BMN) | hay | 0-15 | <1.2 | 9.3 | 43 | <5 |
| Berman (BMN) | pasture | 0-15 | <1.2 | 2.8 | 44 | <5 |
| Berman (BMN) | pasture | 0-15 | 1.2 | 61 | 202 | <5 |
| Nithi (NIT) | hay | 0-15 | <1.2 | 22 | 48 | <5 |

Laboratory analysis indicates that pasture lands and hay fields are deficient in nitrogen and phosphorous. Adequate amounts of potassium and sulphur occur in the soils sampled. Lakeside Research recommends 115 lbs. of nitrogen and 20 lbs. of phosphorous per acre on pasture lands and hay fields for average yields of new grass (see fertilizer recommendations in Appendix F).

### 3.6 Soil Erosion Hazard

Soil erosion hazard is the expected rapidity and amount of soil loss, by water and/or wind, that may be expected in an area following removal of the protective vegetation cover and failure to implement the proper erosion control measures.

The rate of erosion depends on several factors: the amount, intensity, and seasonal distribution of rainfall; the steepness and length of slopes; the absence or presence of channels of concentration; the type of vegetation cover; and the nature of the soil. Infiltration capacity and structure stability are two significant soil characteristics influencing water erosion while particle size, durability of surface cloddiness, rock fragments, organic matter and lime content are important soil characteristics influencing wind erosion.

The soil Mapping Units along selected portions of the proposed route were rated for wind and water soil erosion hazard according to the guidelines in Appendix E. Ratings of all the Map Units encountered along selected portions of the proposed route are provided in Table 6.

Soils that are sandy textured are rated as having a High (H) wind erosion hazard while soils that are loam, silt loam, clay loam or silty clay loam textured are rated as having a Moderate (M) wind erosion hazard. Alix, Alluvium, Braeside, Crystal and Mapes soils are all rated as having a High wind erosion hazard. These soils occupy 26% of the selected portions of the route surveyed. Berman and Nithi soils are developed on loam, silt loam or sandy loam textured glaciofluvial or glaciolacustrine material and are rated as having a Moderate-High (M-H) wind erosion hazard when the vegetation is disturbed. These soils occupy another 12% of the portions of the route surveyed. Barrett and Pineview soils are rated as having a Moderate (M) wind erosion hazard. Only the Rock outcrops (R) and Kenzie soils are rated as having a Slight (S) wind erosion hazard.

All soils occurring on less than 9% slopes are rated as having a Slight (S) water erosion hazard while those occurring on 10-15% slopes are rated as having a Moderate (M) water erosion hazard. Soils occurring on greater than 15% slopes are rated as having a High (H) water erosion hazard. Some of the Barrett, Berman, Crystal, and Mapes soils occur on slopes, which exceed 15%. Water erosion protective measures may have to be initiated on slopes that exceed 15%. The Rough Broken (RB) Land Unit adjacent to deeply incised creeks or rivers are highly susceptible to soil erosion and slumping when the protective vegetation is removed. Special procedures for erosion control are required on these steep slopes (i.e. diversion berms).

**TABLE 6**

**WIND AND WATER SOIL EROSION HAZARDS RATINGS OF MAP UNITS ALONG THE PROPOSED ROUTES SURVEYED***

| Map Unit | Wind Erosion Hazard** | Water Erosion Hazard** |
|---|---|---|
| ALX(0)/3 | H | S |
| ALX(0)/3-4 | H | S |
| AV(0)/2 | H | S |
| AV(0)/2-3 | H | S |
| BAT(10-15)/2-3 | M | S |
| BAT(0)/3 | M | S |
| BAT(0)/3-4 | M | S |
| BAT(10-15)/3-4 | M | S |
| BAT(15)/3-4 | M | S |
| BAT(0)/4 | M | S |
| BAT(15)/4 | M | S |
| BAT(0)/4-5 | M | S |
| BAT(10-15)/4-5 | M | S |
| BAT(0)/5 | M | M |
| BAT(0)/5-6 | M | M |
| BAT(10-15)/5-6 | M | M |
| BAT(0)/6 | M | H |
| BAT(0)/6-7 | M | H |
| shBAT(0)/3-4 | M | S |
| BMN(15)/2-3 | M-H | S |
| BMN(0)/3 | M-H | S |
| BMN(15)/3 | M-H | S |
| BMN(0)/3-4 | M-H | S |
| BMN(10-15)/3-4 | M-H | S |
| BMN(15)/3-4 | M-H | S |
| BMN(10-15)/4 | M-H | S |
| BMN(0)/4-5 | M-H | M |
| BMN(10-15)/4-5 | M-H | M |
| BMN(0)/5-6 | M-H | H |
| BRD(0)/3 | H | S |
| CRY(0)/3-4 | H | S |
| CRY(0)/4 | H | S |
| CRY(0)/4-5 | H | S |
| CRY(0)/5 | H | M |
| CRY(0)/6 | H | H |
| KNZ(0)/1 | S | S |

* According to guidelines provided in Appendix E

** S – Slight
M – Moderate
H – High

**TABLE 6**

**WIND AND WATER SOIL EROSION HAZARD RATINGS OF MAP UNITS ALONG THE PROPOSED ROUTES SURVEYED* (Concluded)**

| Map Unit | Wind Erosion Hazard** | Water Erosion Hazard** |
|---|---|---|
| MPS(10)/2-3 | H | S |
| MPS(15)/2-3 | H | S |
| MPS(10-15)/3-4 | H | S |
| MPS(0)/5-6 | H | H |
| NIT(0)/2-3 | M-H | S |
| NIT(10-15)/2-3 | M-H | S |
| NIT(15)/2-3 | M-H | S |
| PVW(15)/2 | M | S |
| PVW(0)/2-3 | M | S |
| PVW(0)/3 | M | S |
| PVW(10-15)/3 | M | S |
| PVW(15)/3 | M | S |
| PVW(0)/3-4 | M | S |
| PVW(10-15)/4 | M | S |
| PVW(0)/4-5 | M | M |
| PVW(0)/5 | M | M |
| PVW(10-15)/5 | M | M |
| shPVW(0)/3-4 | M | S |
| shPVW(0)/4 | M | S |
| shPVW(0)/4-5 | M | M |
| Miscellaneous Land Units | | |
| R(0)/3-4 | S | S |
| R(0)/4 | S | S |
| R(0)/4-5 | S | S |
| R(0)/5-6 | S | M |
| RB(0)/5 | M | H |
| RB(0)/5-6 | M | H |
| RB(0)/6-7 | M | H |
| RB(0)/7-8 | M | H |
| SC | M | M |

* According to guidelines provided in Appendix E

** S – Slight
M – Moderate
H – High

## 3.7 Soil Compaction

All soils are susceptible to soil compaction and rutting if unfavourable moisture conditions prevail at the time of construction. However, some soils are more prone to soil compaction than others, because of their physical characteristics (i.e. texture and structure) and drainage.

Only fine textured Pineview and shallow Pineview soils are highly susceptible to soil compaction and rutting. Kenzie soils are also highly susceptible to soil compaction. These soils occupy about 26% of the selected portions of the route surveyed. No construction of the pipeline should take place in these soil areas when wet conditions exist. Soil compaction and rutting will not be a major concern if construction occurs in the winter when the soils are frozen.

## 3.8 Soil Stability

Soils that are coarse textured often lack cohesion properties, which may result in unstable trench walls when vertically ditched. Soils that are coarse textured and excessively wet are highly susceptible to unstable trench walls. Areas of Alix, Alluvium, Crystal, Mapes and Nithi soils are susceptible to trench instability. Soils susceptible to trench instability occupy about 26% of the selected portions of the route surveyed. Salvaged topsoil or root zone material should be stored at a sufficient distance from the trench so that the salvaged material is not lost in the trench, if trench instability occurs.

## 4.0 MATERIAL HANDLING RECOMMENDATIONS

Topsoil or upper root zone material salvage is intended to ensure that the most desirable existing material is available and used for restoration and revegetation of disturbed areas. The total depth of topsoil, when it exists, up to a maximum depth of 40 cm should be salvaged. The upper 15-20 cm of root zone material should be salvaged from undisturbed bush areas that lack a topsoil horizon. Topsoil or root zone material is a better growth medium than the underlying subsoil because of a higher organic matter content and usually a more favourable texture. Topsoils, when they occur, are not always easily distinguished from subsoils by colour but the average depth of the topsoil is indicated in the Map Unit designation on the Environmental Work Sheets.

In general, a successful reclamation program can be achieved by salvaging the topsoil materials on cultivated fields, pasture lands, bush areas and hay fields. Topsoils should be salvaged over the ditch-line and spoil-side on all cultivated lands. Topsoils only need to be salvaged over the ditch-line area on hay fields and pasture lands with a well-developed sod layer as well as all bush areas. Topsoils only need to be salvaged over the ditch-line area (1 m wider than the proposed ditch-line width) on all lands, if construction of the pipeline occurs when the soils are frozen.

Topsoil or root zone material should be salvaged from all undisturbed bush areas that require grading and from the proposed ditch-line area. It is recommended that the topsoil or root zone material be salvaged from an area at least one metre wider on each side of the proposed ditch width (e.g. if the ditch is to be 3 m wide the topsoil or root zone material should be salvaged from an area 5 m wide). The area receiving the spoil material should be smoothed out prior to spoil material being placed on the existing upper material so that the spoil material can be easily separated and removed from the in-situ upper material during final clean-up. No topsoil salvage or upper root zone material salvage is required in areas of Rock outcrops (R) or Kenzie (KNZ) soils.

Salvaged topsoil or root zone material can be stored over the adjacent existing pipeline where the route follows along an existing pipeline but it is not recommended that the spoil material be stored over an adjacent existing pipeline because of difficulties in removing all of the spoil material from the adjacent pipeline during final clean-up. Leaving some of the spoil material on the adjacent pipeline results in an area over the existing line which either lacks a vegetative cover or has a high percentage of weeds. Leaving some of the topsoil or root zone material over the adjacent existing line will not result in these environmental concerns.

Unstable trench walls will be a concern in gravely and sandy textured soil areas because these soils often lack cohesion properties. Sandy and gravely textured soils that are susceptible to trench instability occupy about 26% of the selected portions of the route surveyed. Topsoil or root zone material should be salvaged over a wide enough area to prevent loss of surface material, if trench instability occurs. Stored topsoil or root zone material should be placed far enough away from the trench so that if trench instability occurs the stored material will not be lost in the trench.

Wind erosion of soil particles could be a major concern along portions of the proposed route because of some sandy textured soils. Topsoils or surface root zone material should not be salvaged under extremely windy conditions. It may be necessary to tackify the topsoil or surface root zone material in areas of Alix, Alluvium, Berman, Braeside, Crystal, Mapes and Nithi soils that are particularly vulnerable to wind erosion, especially when the vegetation is disturbed.

Water erosion of soil particles could be a major concern in upland areas where slopes exceed 15%. Water erosion protective measures such as diversion berms may have to be initiated on some of the steeper slopes and should be initiated on all the Rough Broken slopes.

Since many of the soils along the selected portions of the route surveyed are well to rapidly drained, sandy textured and sometimes gravelly, soil compaction and rutting will not be a major concern. Only moderately well drained, fine textured Pineview soils are susceptible to soil compaction and rutting. Construction of the pipelines should not take place on these soils under wet conditions. Poorly drained Kenzie soils (Organic soils) are also susceptible to soil compaction. Compaction of the peat material could restrict future drainage through the peat material. Construction traffic should be kept to a minimum in very poorly drained Kenzie soil areas. Soil compaction and rutting will not be a major concern if the soils are frozen at the time of construction.

Only Nithi soils have been recommended for an alternate soil handling procedure to maintain the upper subsoil textural characteristics. Nithi soils occupy 0.8 km southwest of the community of Endako from KP 277.1 to 277.3 and from KP 278.1 to 278.7. The three-lift soil handling procedure is recommended in areas of hay fields and pasture lands (KP 277.1 to 277.3 and KP 278.4 to 278.7) while over-stripping the upper root zone material to a depth of 30-35 cm is recommended in forested areas (KP 278.1 to 278.4). The first-lift should include the upper 15 cm (Aep or Ap horizon) while the second-lift should be about 30 cm in thickness. The third and final lift will consist mainly of the loamy sand to sand textured lower subsoil material. Extra temporary work space may be required to accommodate the extra spoil pile in areas of hay fields and pasture lands.

Soil characteristics and their implications to pipeline are provided in Table 7.

**TABLE 7**

**SOIL CHARACTERISTICS AND THEIR IMPLICATIONS TO PIPELINING**

| Soil Symbol | Soil Name | Soil Classification[1] | Parent Material[2] | Texture Class[3] | Drainage Class[4] | Topsoil Depth Range (cm) | Colour Differentiation between Topsoil and Subsoil | Erosion Hazards[5] Wind | Erosion Hazards[5] Water | Susceptible to Soil Compaction and Rutting | Susceptible To Trench Instability | Comments or Other Concerns |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ALX | Alix | E.DYB | GF | gvSL-gvLS | R | 0 | - | H | S | - | Yes | - |
| AV | Alluvium | O.R | F | SiL-gvS | W-R | 0 | - | H | S | - | Yes | - may be gravelly at the surface |
| BAT | Barrett | O.GL | T | L-CL | W-MW | 0-17 | Fair-Poor | M | S-H | - | - | - |
| shBAT | shallow Barrett | O.GL | T/R | L-CL/R | W | 0 | - | M | S | - | - | - hard consolidated bedrock will be encountered within trench depth |
| BMN | Berman | O.GL | GL | fSL-SiL-SiCL | W-MW | 0-20 | Fair-Poor | M-H | S-H | - | - | - |
| BRD | Braeside | O.GL | GF | SL | W | 0 | - | H | S | - | - | - |
| CRY | Crystal | E.DYB | T | gvSL-gvL | W-R | 0 | - | H | S-H | - | Yes | - |
| KNZ | Kenzie | FI.M-TY.M | O | O | VP | 0 | - | S | S | Yes | - | - |
| MPS | Mapes | E.DYB | GF | LS | W-R | 0-15 | Fair-Poor | H | S-H | - | Yes | - |
| NIT | Nithi | O.DYB - E.DYB | GF | fSL-SiL/LS-S | W-R | 0-15 | Fair | M-H | S | - | Yes | -much coarser textured below the 50 cm depth |
| PVW | Pineview | O.GL | GL | SiC-C | W-MW | 0-16 | Fair-Poor | M | S-M | Yes | - | - |
| shPVW | shallow Pineview | O.GL | GL/T | SiC-C/L-CL | W-MW | 0 | - | M | S-M | Yes | - | -surface stoniness may be increased due to underlying till |

1. Soil Classification according to the Soil Classification Working Group (Agriculture and Agri-Food Canada 1998).

**2. Parent Material**
- F - fluvial
- GF - glaciofluvial
- GL - glaciolacustrine
- O - organic
- R - hard consolidated bedrock
- T - till

**3. Texture Classes**
- fSL - fine sandy loam
- vfSL - very fine sandy loam
- SL - sandy loam
- LS - loamy sand
- S - sand
- SiL - silt loam
- SiC - silty clay
- SiCL - silty clay loam
- L - loam
- O - organic
- R - rock
- C - clay
- CL - clay loam
- gv - gravelly

**4. Drainage Classes**
- R - rapidly
- W - well
- MW - moderately well
- I - imperfectly
- P - poorly
- VP - very poorly

**5. Erosion Hazards**
- S - slight
- M - moderate
- H - high

## 5.0 REFERENCES

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# APPENDIX A

# SUMMARY OF SOIL INSPECTION SITES

# KEY TO SITE INSPECTION LIST

## SOIL UNITS:

| | | |
|---|---|---|
| ALX | - | Alix |
| AV | - | Alluvium |
| BAT | - | Barrett |
| BMN | - | Berman |
| BRD | - | Braeside |
| DRY | - | Crystal |
| KNZ | - | Kenzie |
| MPS | - | Mapes |
| NIT | - | Nithi |
| PVW | - | Pineview |

## MISCELLANEOUS LAND UNITS:

| | | |
|---|---|---|
| R | - | Rock |
| RB | - | Rough Broken |
| SC | - | Stream Channel |

### Soil Phase:

| | | |
|---|---|---|
| sh | - | shallow |

## SOIL CLASSIFICATION:

| | | |
|---|---|---|
| E.DYB | - | Eluviated Dystric Brunisol |
| FI.M | - | Fibric Mesisol |
| O.DYB | - | Orthic Dystric Brunisol |
| O.GL | - | Orthic Gray Luvisol |

## PARENT MATERIAL:

| | | |
|---|---|---|
| F | - | recent fluvial |
| GF | - | glaciofluvial |
| GL | - | glaciolacustrine |
| O | - | organic |
| R | - | hard rock |
| T | - | till |

**TEXTURE:**

| | | |
|---|---|---|
| C | - | clay |
| CL | - | clay loam |
| L | - | loam |
| LS | - | loamy sand |
| O | - | organic |
| R | - | hard rock |
| S | - | sand |
| SiC | - | silty clay |
| SiCL | - | silty clay loam |
| SiL | - | silt loam |
| fSL | - | fine sandy loam |
| vfSL | - | very fine sandy loam |
| gvSL | - | gravelly sandy loam |
| gvL | - | gravelly loam |

**TOPOGRAPHY CLASSES:**

| | | | |
|---|---|---|---|
| 1 | - | 0 – 0.5% | level |
| 2 | - | 0.5 – 2% | nearly level |
| 3 | - | 2 – 5% | very gentle slopes |
| 4 | - | 6 – 9% | gentle slopes |
| 5 | - | 10 – 15% | moderate slopes |
| 6 | - | 16 – 30% | strong slopes |
| 7 | - | 31 – 45% | very strong slopes |
| 8 | - | 46 – 70% | extreme slopes |

**DRAINAGE CLASSES:**

| | | |
|---|---|---|
| R | - | rapidly |
| W | - | well |
| MW | - | moderately well |
| I | - | imperfectly |
| P | - | poorly |
| VP | - | very poorly |

**SURFACE STONINESS CLASSES:**

| | | |
|---|---|---|
| S0 | - | nonstony |
| S1 | - | slightly stony (stones 10-30 m apart) |
| S2 | - | moderately stony (stones 2-10 m apart) |
| S4 | - | exceedingly stony (stones .01-1 m apart) |
| S5 | - | excessively stony (stones <0.1 m apart) |

## DOMINANT VEGETATION:

| | | |
|---|---|---|
| Aw | - | aspen |
| Bf | - | balsam fir |
| Bi | - | birch |
| B-P | - | bush-pasture |
| C | - | cultivated |
| Df | - | douglas fir |
| H | - | hay field |
| P | - | improved pasture |
| Pl | - | lodgepole pine |
| Sb | - | black spruce |
| Sw | - | white spruce |

# SITE INSPECTION LIST

| Site | Soil Unit | Classification | Parent Material | Depth of Topsoil (cm) | Dominant Texture Topsoil/Subsoil | Topographic Class | Drainage Class | Surface Stoniness Class | Dominant Vegetation | Comments |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | ALX | E.DYB | GF | 0 | -/gvSL | 3-4 | W-R | S3-4 | Pl | |
| 2 | ALX | E.DYB | GF | 0 | -/gvSL | 3-4 | R | S4 | Pl | |
| 3 | ALX | E.DYB | GF | 0 | -/gvSL | 3-4 | R | S4 | Pl-Aw | |
| 4 | ALX | E.DYB | GF | 0 | -/gvSL-LS | 3-4 | R | S4 | Pl-Aw | |
| 5 | BAT | O.GL | T | 0 | -/L-SL | 4-5 | W | S3-4 | Pl | |
| 6 | MPS | E.DYB | GF | 0 | -/LS | 5-6 | R | S0-1 | Pl | |
| 7 | ALX | E.DYB | GF | 0 | -/gvSL-LS | 3 | W-R | S3 | Pl | |
| 8 | ALX | E.DYB | GF | 0 | -/gvSL | 3 | W-R | S3-4 | Pl | |
| 9 | ALX | E.DYB | GF | 0 | -/gvSL | 3 | W-R | S3-4 | Pl | |
| 10 | ALX | E.DYB | GF | 0 | -/gvSL | 3 | R | S3-4 | Pl | |
| 11 | ALX | E.DYB | GF | 0 | -/gvSL | 3 | W-R | S3 | Pl | |
| 12 | ALX | E.DYB | GF | 0 | -/gvSL | 3 | W-R | S3-4 | Pl | |
| 13 | BRD | O.GL | GF | 0 | -/SL | 3 | W-R | S1 | Sw | |
| 14 | ALX | E.DYB | GF | 0 | -/gvSL | 3 | W-R | S2-3 | Pl-Sw | |
| 15 | BRD | O.GL | GF | 0 | -/fSL-SiL | 3 | W | S0 | Aw-Sw | |
| 16 | PVW | O.GL | GL | 5 | SiCL/(C/SiC) | 3 | MW | S0 | Aw | |
| 17 | PVW | O.GL | GL | 0 | -/(SiC/C) | 3 | MW | S0 | Aw | |
| 18 | PVW | O.GL | GL | 0 | -/SiC-C | 3 | MW | S0-1 | Aw-Sw | |
| 19 | BAT | O.GL | T | 0 | -/L-CL | 3-4 | W-MW | S1-2 | Aw | used for pasture |
| 20 | BAT | O.GL | T | 0 | -/L-CL | 3-4 | W-MW | S2 | Aw-Sw | used for pasture |
| 21 | BAT | O.GL | T | 0 | -/L-CL | 3-4 | W-MW | S2 | Aw | used for pasture |
| 22 | BAT | O.GL | T | 0 | -/L-CL | 3-4 | W-MW | S1 | Aw | used for pasture |
| 23 | BAT | O.GL | T | 12 | SiL/CL | 3-4 | MW | S1 | P | |
| 24 | KNZ | FI.M | O | 0 | -/O | 1 | VP | S0 | Sb | |
| 25 | PVW | O.GL | GL | 0 | -/C | 3 | MW | S0-1 | B-P | |
| 26 | PVW | O.GL | GL | 10 | SiL/C | 3 | MW | S0-1 | B-P | |
| 27 | PVW | O.GL | GL | 13 | SiL/C | 3 | MW | S0-1 | C | |
| 28 | PVW | O.GL | GL | 13 | SiL/C | 4 | MW | S0-1 | C | |
| 29 | PVW | O.GL | GL | 15 | SiL/SiC-SiCL | 4 | MW | S0-1 | C | |
| 30 | PVW | O.GL | GL | 16 | SiL/SiC | 3 | MW | S0-1 | P | |
| 31 | PVW | O.GL | GL | 16 | SiL/C | 3 | MW | S0-1 | C | |
| 32 | PVW | O.GL | GL | 12 | SiL/C | 3 | MW | S0-1 | C | |
| 33 | PVW | O.GL | GL | 0 | -/C | 3-4 | MW | S0-1 | Pl-Sw | |
| 34 | BAT | O.GL | T | 0 | -/CL | 3-4 | W-MW | S1 | Aw | |
| 35 | BAT | O.GL | T | 0 | -/CL | 4 | MW-W | S1-2 | Pl-Sw | |
| 36 | shPVW | O.GL | GL/T | 0 | -/(C/CL) | 4-5 | W-MW | S0-1 | Aw-Pl | till at 40 cm |
| 37 | PVW | O.GL | GL | 0 | -/SiC-C | 5 | MW | S0-1 | Aw | |
| 38 | PVW | O.GL | GL | 0 | -/(SiC/C) | 3 | W-MW | S0-1 | Aw-Sw | |
| 39 | PVW | O.GL | GL | 0 | -/(C/SiCL) | 5 | MW | S0-1 | Aw-Sw | |
| 40 | PVW | O.GL | GL | 0 | -/SiC-C | 3 | MW | S0-1 | Pl-Sw-Aw | |
| 41 | PVW | O.GL | GL | 0 | -/SiC-C | 3 | MW | S0-1 | Pl-Sw | |
| 42 | PVW | O.GL | GL | 0 | -/SiC-C | 3 | MW | S0-1 | Aw-Pl-Sw | |
| 43 | BAT | O.GL | T | 0 | -/CL-L | 4-5 | W-MW | S2 | Pl-Sw-Aw | |
| 44 | BAT | O.GL | T | 0 | -/CL-L | 5 | W-MW | S2-3 | Pl | |
| 45 | BAT | O.GL | T | 0 | -/L-CL | 4-5 | W-MW | S2 | Pl-Sw-Aw | |
| 46 | PVW | O.GL | GL | 0 | -/SiC-C | 3 | MW | S0-1 | Sw-Aw | |
| 47 | PVW | O.GL | GL | 0 | -/C | 3 | MW | S0-1 | Sw-Aw | |
| 48 | BAT | O.GL | T | 0 | -/CL | 3-4 | W-MW | S1-2 | Sw-Aw | |
| 49 | PVW | O.GL | GL | 15 | SiL/C-SiC | 3 | W-MW | S0-1 | C | |
| 50 | BAT | O.GL | T | 17 | SiL/CL | 3-4 | W-MW | S1-2 | C | |

# SITE INSPECTION LIST (Continued)

| Site | Soil Unit | Classification | Parent Material | Depth of Topsoil (cm) | Dominant Texture Topsoil/Subsoil | Topographic Class | Drainage Class | Surface Stoniness Class | Dominant Vegetation | Comments |
|---|---|---|---|---|---|---|---|---|---|---|
| 51 | BAT | O.GL | T | 12 | SiL-L/CL-C | 4-5 | W-MW | S1-2 | H | |
| 52 | BMN | O.GL | GL | 15 | vfSL/vfSL-SiL | 3-4 | W | S0 | H | |
| 53 | PVW | O.GL | GL | 0 | -/SiC-C | 4-5 | W-MW | S0-1 | Pl-Aw-Sw | |
| 54 | PVW | O.GL | GL | 0 | -/SiC-C | 3-4 | W-MW | S1 | Pl-Aw-Sw | |
| 55 | PVW | O.GL | GL | 0 | -/SiC-C | 3 | MW | S1 | Pl-Aw | |
| 56 | BAT | O.GL | T | 0 | -/CL | 3-4 | W-MW | S1-2 | Pl-Sw | large boulders in area |
| 57 | PVW | O.GL | GL | 0 | -/C | 3 | MW | S0-1 | Pl | |
| 58 | BAT | O.GL | T | 0 | -/L-CL | 4 | W-MW | S2 | Pl | |
| 59 | BAT | O.GL | T | 0 | -/CL | 4 | W-MW | S2 | Pl | |
| 60 | BAT | O.GL | T | 15 | SiL/CL | 3-4 | W-MW | S1-2 | P | |
| 61 | BAT | O.GL | T | 15 | SiL/CL | 3-4 | MW | S1 | P | |
| 62 | PVW | O.GL | GL | 15 | SiL/CL-C | 2 | W-MW | S1 | H | |
| 63 | PVW | O.GL | GL | 0 | -/SiC-C | 2-3 | W-MW | S0-1 | Aw-Pl | |
| 64 | BAT | O.GL | T | 0 | -/L-CL | 3-4 | W-MW | S1-2 | Sw-Pl | |
| 65 | PVW | O.GL | GL | 0 | -/SiC-C | 3-4 | W-MW | S1 | Pl-Sw | |
| 66 | BAT | O.GL | T | 0 | -/L-CL | 3-4 | W-MW | S1-2 | Pl-Sw | |
| 67 | shBAT | O.GL | T/R | 0 | -/(CL/R) | 3-4 | W-MW | S1-2 | Df-Pl-Sw | hard rock at 80 cm |
| 68 | R | - | R | 0 | -/R | 4-5 | W-R | S4 | Pl-Aw-Sw | |
| 69 | BAT | O.GL | T | 0 | -/L-CL | 4-5 | W-MW | S1 | Df-Aw-Sw | |
| 70 | BAT | O.GL | T | 0 | -/L-CL | 3-4 | W-MW | S2 | Sw-Pl-Df | |
| 71 | BAT | O.GL | T | 0 | -/CL | 3-4 | W-MW | S1 | Df-Sw-Bi | |
| 72 | shBAT | O.GL | T/R | 0 | -/(CL/R) | 3-4 | W-MW | S2-3 | Df-Sw | hard rock at 80 cm |
| 73 | BAT | O.GL | T | 0 | -/L-CL | 5 | W-MW | S1-2 | Pl-Sw-Df | |
| 74 | CRY | E.DYB | T | 0 | -/gvSL-LS | 3-4 | R | S3 | Bf-Sw-Pl | |
| 75 | BAT | O.GL | T | 0 | -/L-CL | 6-7 | W | S2-3 | Df-Sw | |
| 76 | BAT | O.GL | T | 0 | -/L-CL | 3 | W-MW | S1-2 | Pl-Df-Sw | |
| 77 | CRY | E.DYB | T | 0 | -/gvSL | 3-4 | W-R | S3 | Df-Pl-Sw | |
| 78 | CRY | E.DYB | T | 0 | -/gvSL | 3-4 | W-R | S3 | Df-Sw-Pl | |
| 79 | PVW | O.GL | GL | 0 | -/CL-C | 3-4 | MW | S0-1 | Pl-Aw | |
| 80 | shPVW | O.GL | GL/T | 0 | -/(SiCL/SL) | 3-4 | MW | S1-2 | Pl-Aw | till at 53 cm |
| 81 | shPVW | O.GL | GL/T | 0 | --/(SiCL/L) | 3-4 | W-MW | S1-2 | Pl-Aw-Sw | till at 58 cm |
| 82 | shPVW | O.GL | GL/T | 0 | -/(SiC/L-CL) | 4 | W-MW | S1-2 | Pl-Sw | till at 42 cm |
| 83 | shPVW | O.GL | GL/T | 0 | -(C/L-CL) | 4 | W-MW | S1-2 | Pl | till at 30 cm |
| 84 | shPVW | O.GL | GL/T | 0 | -/(C/L-CL) | 3-4 | W-MW | S1-2 | Df-Pl-Sw | till at 80 cm |
| 85 | BAT | O.GL | T | 0 | -/L-CL | 4-5 | W-MW | S2 | Pl-Aw | |
| 86 | CRY | E.DYB | T | 0 | -/gvSL-gvL | 4 | W-R | S3 | Pl | |
| 87 | CRY | E.DYB | T | 0 | -/gvSL-L | 4 | W-R | S3 | Pl | |
| 88 | CRY | E.DYB | T | 0 | -/gvSL-L | 5 | W-R | S3 | Aw | |
| 89 | CRY | E.DYB | T | 0 | -/gvSL-L | 5 | W | S3-4 | Aw-Pl | |
| 90 | CRY | E.DYB | T | 0 | -/gvSL-L | 3-4 | W | S3-4 | Aw-Pl | |
| 91 | BMN | O.GL | GL | 0 | -/SiL-SiCL | 3 | W-MW | S0-1 | Pl-Sw | |
| 92 | BMN | O.GL | GL | 15 | fSL-SiL/fSL-SiL | 3 | I | S0 | H | |
| 93 | BMN | O.GL | GL | 15 | SiL/SiCL | 3 | W-MW | S0 | H | |
| 94 | BMN | O.GL | GL | 0 | -/SiCL | 5-6 | W-MW | S0 | Aw | |
| 95 | BMN | O.GL | GL | 0 | -/SiCL | 3-4 | W-MW | S0 | Aw-Pl-Sw | |
| 96 | MPS | O.DYB | GF | 15 | LS/LS | 2-3 | R | S0 | H | |
| 97 | NIT | E.DYB | GF | 15 | fSL-SiL/(SiL-L/LS-S) | 2-3 | W-R | S0 | H | coarser textured at 50 cm |
| 98 | NIT | E.DYB | GF | 0 | -/(fSL/LS-S) | 2-3 | W-R | S0 | Pl | coarser textured at 48 cm |
| 99 | MPS | O.DYB | GF | 0 | -/LS-S | 2-3 | R | S0 | Pl | |
| 100 | MPS | O.DYB | GF | 10 | LS/LS-S | 3-4 | R | S0 | P | |

## SITE INSPECTION LIST (Concluded)

| Site | Soil Unit | Classification | Parent Material | Depth of Topsoil (cm) | Dominant Texture Topsoil/Subsoil | Topographic Class | Drainage Class | Surface Stoniness Class | Dominant Vegetation | Comments |
|---|---|---|---|---|---|---|---|---|---|---|
| 101 | NIT | O.DYB | GF | 10 | SL/(SL/LS) | 2-3 | W | S0 | P | coarser textured at 50 cm |
| 102 | BMN | O.GL | GL | 0 | -/SiCL | 3-4 | W-MW | S0 | Aw | |
| 103 | BMN | O.GL | GL | 0 | -/SiCL | 3-4 | W-MW | S0 | Aw | |
| 104 | BMN | O.GL | GL | 12 | SiL/SiCL | 3-4 | W-MW | S0 | P | |
| 105 | BAT | O.GL | T | 15 | SiL/L | 4 | W | S2 | P | |
| 106 | BMN | O.GL | T | 15 | SIL/SICL | 3 | W-MW | S0 | P | |
| 107 | BMN | O.GL | GL | 0 | -/SiCL | 3-4 | W-MW | S0 | Aw-Sw | |
| 108 | BAT | O.GL | T | 0 | -/L-CL | 4 | W-MW | S1-2 | Pl-Sw | |
| 109 | BAT | O.GL | T | 0 | -/L-CL | 3 | W-MW | S1-2 | Pl-Sw | |
| 110 | CRY | E.DYB | T | 0 | -/gvSL | 4-5 | W | S2 | Pl-Sw | |
| 111 | CRY | E.DYB | T | 0 | -/gvSL | 4-5 | W | S4 | Pl-Aw | |
| 112 | CRY | E.DYB | T | 0 | -/gvSL | 4-5 | W | S3-4 | Pl-Sw-Aw | |
| 113 | BAT | O.GL | T | 12 | SiL-L/L-CL | 2-3 | W-MW | S1-2 | P | |
| 114 | BAT | O.GL | T | 0 | -/L-CL | 3-4 | W-MW | S1 | Aw-Sw | |
| 115 | BAT | O.GL | T | 0 | -/L | 3-4 | W | S2 | Sw-Pl | |
| 116 | BAT | O.GL | T | 0 | -/L | 3-4 | W | S2 | Pl-Sw | |
| 117 | BAT | O.GL | T | 0 | -/L | 6 | W | S2 | Aw-Sw | |
| 118 | BAT | O.GL | T | 0 | -/L | 3-4 | W | S2-3 | Sw-Pl | |
| 119 | BAT | O.GL | T | 0 | -/L-CL | 3-4 | W-MW | S2 | Pl-Sw | |
| 120 | BAT | O.GL | T | 0 | -/L | 5-6 | W | S2-3 | Sw-Aw | |
| 121 | BMN | O.GL | GL | 20 | fSL-SiL/fSL-SiL | 2-3 | W | S0 | H | |
| 122 | BMN | O.GL | GL | 15 | fSL/(fSL/L-SiCL) | 2-3 | W | S0 | H | |
| 123 | BMN | O.GL | GL | 15 | fSL/(fSL/L) | 2-3 | W | S0 | P | |
| 124 | BMN | O.GL | GL | 15 | fSL/(fSL/L) | 2-3 | W | S0 | P | |
| 125 | BMN | O.GL | GL | 0 | -/(fSL/L) | 3 | W | S0 | Pl-Sw-Aw | |
| 126 | BMN | O.GL | GL | 0 | -/(fSL/L) | 3 | W | S0 | Pl-Sw-Aw | |
| 127 | BAT | O.GL | T | 0 | -/L-CL | 5 | W-MW | S2 | Sw-Df | |
| 128 | CRY | E.DYB | T | 0 | -/gvSL-L | 4-5 | W-R | S3-4 | Aw | |
| 129 | BAT | O.GL | T | 0 | -/L | 5 | W-MW | S1-2 | Aw | |
| 130 | BAT | O.GL | T | 0 | -/L | 6 | W | S1-2 | Pl-Df-Sw | |
| 131 | BAT | O.GL | T | 0 | -/L | 4-5 | W | S2-3 | Sw | |
| 132 | CRY | E.DYB | T | 0 | -/gvSL | 5 | W | S3-4 | Pl | |
| 133 | BAT | O.GL | T | 0 | -/CL-C | 3 | MW | S0-1 | Pl-Sw | |

# APPENDIX B

# PHOTOS

**Photo 1 Area of Alix soils (Eluviated Dystric Brunisols developed on glaciofluvial gravels) at KP 160.8.**

**Photo 2 Area of Pineview soils (Orthic Gray Luvisol developed on glaciolacustrine clays) at site 39 at KP 339.9.**

Mentiga: August, 2006

**Photo 3** **Large rocks in area of Barrett soils (Orthic Gray Luvisols developed on loam to clay loam textured till) at Site 56 at KP 332.3.**

**Photo 4** **Looking west down power line from Site 120 at KP 282.0. Area of Barrett soils.**

Mentiga: August, 2006

**Photo 5** **Consolidated bedrock was encountered at shallow depths during construction of the previous pipeline. Such an area is mapped as Rock (R) soils. Site 68 at KP 327.4.**

Mentiga: August, 2006

# APPENDIX C

# GUIDELINES FOR RECLAMATION RATINGS

## CRITERIA FOR EVALUATING SUITABILITY OF TOPSOIL MATERIAL FOR REVEGETATION IN THE PLAINS REGION

| **Rating/Property** | **Good(G)** | **Fair (F)** | **Poor (P)** | **Unsuitable (U)** |
|---|---|---|---|---|
| Reaction (pH) | 6.5-7.5 | 5.5-6.4 &<br>7.6-8.4 | 4.5-5.4 &<br>8.5-9.0 | <4.5 and >9.0 |
| Salinity (E.C.)<br>(dS/m) | <2 | 2-4 | 4-8 | >8 |
| Sodicity (SAR) | <4 | 4-8 | 8-12 | >12* |
| Saturation (%) | 30-60 | 20-30<br>60-80 | 15-20,<br>80-120 | <15 and >120 |
| Stoniness Class | S0, S1 | S2 | S3, S4 | S5 |
| Texture | FSL, VFSL,<br>L, SL, SiL | CL, SCL,<br>SiCL | LS, SiC,<br>C**, S, HC*** | |
| Moist<br>Consistence | Very friable<br>Friable | Loose | Firm,<br>Very firm | Extremely firm |
| Organic Carbon (%) | >2 | 1-2 | <1 | |
| $CaCO_3$<br>Equivalent (%) | <2 | 2-20 | 20-70 | >70 |

* Materials characterized by an SAR of 12 to 20 may be rated as Poor if texture is sandy loam or coarser and saturation % is less than 100.

** C – may be upgraded to Fair or Good in some arid areas

*** HC – may be upgraded to Fair or Good in some arid areas

Source: Soil Quality Criteria Relative to Disturbance and Reclamation; Alberta Soils Advisory Committee (1987).

## CRITERIA FOR EVALUATING SUITABILITY OF SUBSOIL MATERIAL FOR REVEGETATION IN THE PLAINS REGION

| Rating/Property | Good(G) | Fair (F) | Poor (P) | Unsuitable (U) |
|---|---|---|---|---|
| Reaction (pH) | 6.5-7.5 | 5.5-6.4 & 7.6-8.5 | 4.5-5.4 & 8.6-9.0 | <4.5 and >9.0 |
| Salinity (E.C.) (dS/m) | <3 | 3-5 | 5-10 | >10 |
| Sodicity (SAR) | <4 | 4-8 | 8-12 | >12* |
| Saturation (%) | 30-60 | 20-30, 60-80 | 15-20, 80-120 | <15 and >120 |
| Stone Content (% Volume) | <3 | 3-25 | 25-50 | >50 |
| Texture | FSL, VFSL, L, SiL, SL | CL, SCL, SiCL | S, LS, SiC, C, HC | Bedrock |
| Moist Consistence | Very friable Friable | Loose, Firm | Very firm | Extremely firm |
| Gypsum | The suitability criteria for sodicity (SAR) may be altered by the presence of high levels of either lime ($CaCO_3$) or gypsum ($CaSO_4$) in excess of other soluble salts. | | | |
| $CaCO_3$ Equivalent (%) | | | | |

* Materials characterized by an SAR of 12 to 20 may be rated as Poor if texture is sandy loam or coarser and saturation % is less than 100.

Source: Soil Quality Criteria Relative to Disturbance and Reclamation; Alberta Soils Advisory Committee (1987).

# APPENDIX D

## GUIDELINES FOR ALTERNATIVE SOIL HANDLING PROCEDURES DURING PIPELINE CONSTRUCTION

**(After: APESC, June 1996)**

# CRITERIA FOR ALTERNATIVE SOIL HANDLING PROCEDURES

The criteria in this section are not presented in any order of priority. Also, there is a soil handling procedure decision flow chart at the end of this section which may be helpful in applying the criteria.

Soil Handling Unit

The soil handling unit is the soil map unit. All units identified on a map with a particular symbol (soil map unit delineation) should be handled in the same manner.

Soil Handling Unit Length

A soil handling unit length is equivalent to one soil map unit delineation at a map scale of 1:10,000. Except for situation where there are strongly contrasting soils or topographic features (e.g. bedrock ridge, stream channels, pot holes) the soil handling length would normally be a minimum of 100 m. The minimum soil handling length and the minimum soil map unit size are assumed to be equal.

Soil Sampling Criteria for Problem Soil Management

Sufficient soil sampling (based on professional judgment) should be completed to determine if the map unit delineation should be considered for alternative soil handling. If problem soils are anticipated, there should be at least one sample every 400 m.

Additional soil investigations or sampling may be required at a later time to better define a problem soil area identified by the pedologist in the initial survey. If an alternative soil handling candidate map unit delineation is less than or equal to 400 m in length **and** there are no soil chemistry data for that unit, the entire map unit delineation should be considered for alternative soil handling.

Further soil investigations or sampling is suggested as necessary to reduce the length of alternative handling procedures as requested or suggested by the field pedologist.

Topsoil Thickness Criteria

For topsoil stripping, the average topsoil thickness in a map unit delineation must be between 10 cm and 35 cm, and must be of "better quality" than the upper subsoil. Actual stripping depths can be modified during construction by on-site inspection. Again, special situations might suggest consideration of <10 cm.

Upper Subsoil Thickness Criteria

The average thickness of the upper subsoil of the soil map must be greater than 15 cm before separate subsoil lift handling is considered.

Maximum aggregate thickness of topsoil and upper subsoil to be separately handled is 50 cm. Therefore, the maximum amount of upper subsoil to be separately salvaged is 40 cm. This limit is set to allow for better planning of right-of-way width requirements.

Actual stripping depths can be modified during construction by on-site inspection.

### Stone or Gravel Content (Coarse Fragments) Criteria

Alternate soil handling procedures will be considered when the upper subsoil is non-gravelly or non-stony material and:

the lower subsoil (50 cm to trench depth) has a coarse fragment (>2 mm in diameter) content of >35% if gravelly and >20% if cobbly (See Agriculture Canada 1987 for details).

consolidated bedrock is encountered that would break into hard fragments with trenching.

### Sodic Bedrock Criteria

Alternate soil handling procedures will be considered when the upper subsoil has an electrical conductivity (EC) of less than 8 dS/m and the lower subsoil includes sodic bedrock which, by definition, has a SAR greater than 15.

### Subsoil Salinity

As a general guide for identifying problem areas and to avoid those areas with a minor amount of lower subsoil that meets the chemistry criteria identified in Section 5.9, alternative soil handling procedures should be considered when: lower subsoil with an EC of greater than 10 dS/m occupies 50% or more by depth of the material below 50 cm to trench depth. These numbers should not be taken as definitive but rather to alert the assessor of potential problems. Also, this criterion should not be dealt with in isolation from other characteristics such as the presence of Bn or Bnt horizons.

### Salinity Criteria for Three-Lift

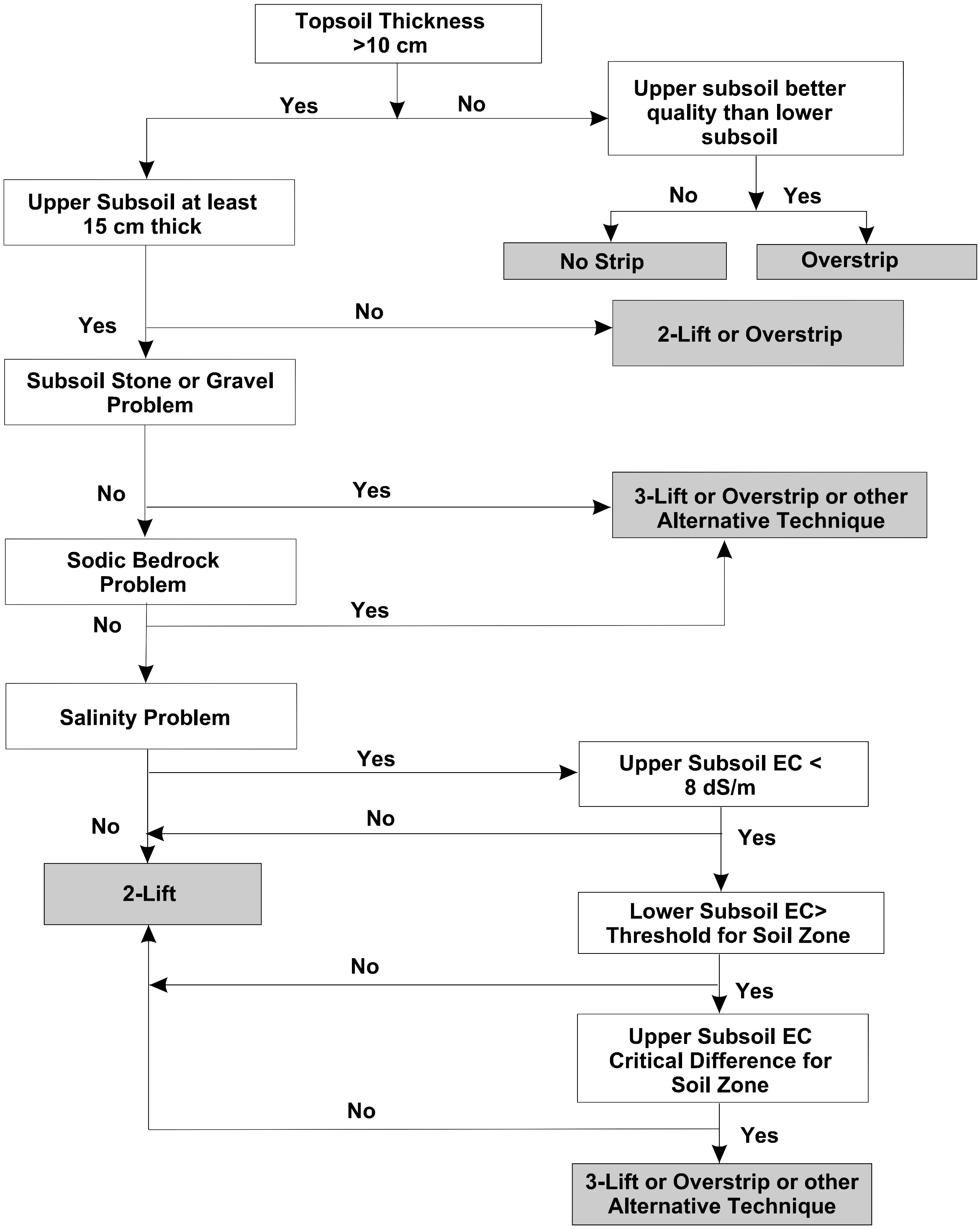
Three-lift procedures should be considered when the upper subsoil has an EC of less than 8 dS/m and the following conditions for salinity are met:

i) pre-construction EC of the upper subsoil must be less than 8dS/m,

ii) Threshold EC of lower subsoil must be exceeded (see table), and

iii) critical difference EC (lower subsoil minus upper subsoil) must be greater than or equal to 4 dS/m

| Soil Zone | Upper Subsoil EC (dS/m) | Lower Subsoil Threshold EC (dS/m) | Critical Difference EC (dS/m) |
|---|---|---|---|
| Brown | <8 | <5 | ≥4 |
| Dark Brown | <8 | >6 | ≥4 |
| Others | <8 | >8 | ≥4 |




**PROBLEM SOIL HANDLING PROCEDURE CHART**

# APPENDIX E

# GUIDELINES FOR WIND AND WATER SOIL EROSION HAZARD RATINGS

## CRITERIA FOR EVALUATING WIND SOIL EROSION HAZARD IN THE HOUSTON TO VANDERHOOF AREA*

| Rating | Characteristics |
|---|---|
| Slightly to None (S) | All soils with SiCL or CL surface textures and containing at least 3 percent organic matter. |
| Moderate (M) | All soils with L or SiL surface textures and containing at least 3 percent organic matter |
| High (H) | All soils with LS, S or SL surface textures and containing at least 3 percent organic matter |

## CRITERIA FOR EVALUATING WATER SOIL EROSION HAZARD IN THE HOUSTON TO VANDERHOOF AREA*

| Rating | Characteristics |
|---|---|
| Slightly to None (S) | All soils with SiL and SiCL surface textures occurring on less than 5 percent slopes. All soils with L and SL surface textures occurring on less than 9 percent slopes. Little erosion can be expected with minimal disturbance. All poorly and very poorly drained soils on level and enclosed depressional positions of the landscape. No erosion can be expected; however, additions will occur if the surrounding upland is disbursed. |
| Moderate (M) | All soils with SiL and SiCL surface textures occurring on 5 to 9 percent slopes. All soils with L and SL surface textures occurring on 9 to 15 percent slopes. Rill erosion and some gullying can be expected. |
| High (H) | All soils with SiL and SiCL surface textures occurring on greater than 9 percent slopes. All soils with L and SL surface textures occurring on greater than 15 percent slopes. Extensive gullying can be expected when the protective vegetation is removed. |

* These guidelines were developed by Al Twardy and are based on review of local literature, review of U.S.A. guidelines and practical experience.

# APPENDIX F

# LABORATORY RESULTS

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Part of the Tyson Foods Family

MENTIGA PEDOLOGY CONSULTANTS LTD.
Al Twardy
#3, 8016 - 47 Avenue
Edmonton, AB
T6E 5P3

TEST REPORT# 060911-11320

SEPTEMBER 11, 2006

PROJECT: PNG PIPELINE
SAMPLES COLLECTED IN THE GRAY SOIL ZONE WEST OF PRINCE GEORGE, BRITISH COLUMBIA
P.O.#: 00003

DATE RECEIVED: AUG 31/06

| LAB # | Site Description | | Horizon | Depth cm | Saturated Paste Basis pH | E.C. mS/cm | SAT % | OM % | ppm N | P | K | SO4 | CaCO3 % | Sand % | Clay % | Silt % | Textural Class |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 11328 | 4 | 1 | Bm | 4-30 | 5.6 | 0.09 | 37 | | | | | | | 81 | 3 | 16 | LS |
| 11329 | | 2 | C | 30-200 | 6.1 | 0.04 | 28 | | | | | | | 93 | 2 | 5 | S |
| 11330 | 15 | 3 | Bt | 5-48 | 6.2 | 0.29 | 37 | | | | | | | 41 | 9 | 50 | SiL |
| 11331 | | 4 | C | 48-120 | 6.4 | 0.12 | 29 | | | | | | | 49 | 7 | 44 | SL |
| 11332 | 19 | 5 | Bt | 12-84 | 6.0 | 0.22 | 49 | | | | | | | 15 | 39 | 46 | SiCL |
| 11333 | | 6 | C | 84-120 | 6.1 | 0.19 | 32 | | | | | | | 34 | 27 | 39 | L |
| 11334 | 31 | 7 | Bt | 16-75 | 6.7 | 0.25 | 68 | | | | | | | 18 | 48 | 34 | C |
| 11335 | | 8 | Bc | 75-110 | 7.5 | 0.20 | 59 | | | | | | 0.37 | 17 | 43 | 40 | C |
| 11336 | 39 | 9 | Bt | 13-68 | 6.7 | 0.24 | 60 | | | | | | | 10 | 53 | 37 | C |
| 11337 | | 10 | C | 68-160 | 8.0 | 0.46 | 50 | | | | | | 1.8 | 19 | 37 | 44 | SiCL |
| 11338 | 62 | 11 | Ap | 0-15 | 6.6 | 0.39 | 38 | 1.3 | <1.2 | 60 | 310 | <5 | | 56 | 5 | 39 | SL |
| 11339 | | 12 | Bt | 15-75 | 6.6 | 0.33 | 36 | | | | | | | 35 | 5 | 60 | SiL |
| 11340 | | 13 | C | 75-120 | 6.4 | 0.30 | 35 | | | | | | | 28 | 18 | 59 | SiL |
| 11341 | 80 | 14 | Bt | 12-53 | 5.7 | 0.19 | 35 | | | | | | | 13 | 38 | 49 | SiCL |
| 11342 | | 15 | IIC | 53-200 | 5.9 | 0.19 | 25 | | | | | | | 50 | 14 | 28 | SL |
| 11343 | 89 | 16 | Bm | 10-55 | 6.4 | 0.30 | 24 | | | | | | | 48 | 13 | 41 | L |
| 11344 | | 17 | C | 55-100 | 6.2 | 0.22 | 28 | | | | | | | 40 | 13 | 39 | L |
| 11345 | 92 | 18 | Ap | 0-15 | 6.4 | 0.78 | 61 | 4.5 | <1.2 | 9.3 | 43 | <5 | | 23 | 14 | 63 | SiL |
| 11346 | | 19 | Bt | 30-75 | 6.6 | 0.32 | 44 | | | | | | | 31 | 18 | 51 | SiL |
| 11347 | | 20 | Cgj | 75-120 | 7.6 | 0.27 | 40 | | | | | | 0.75 | 35 | 11 | 54 | SiL |
| 11348 | 97 | 21 | Ap | 0-15 | 5.3 | 0.41 | 40 | 1.5 | <1.2 | 22 | 48 | <5 | | 35 | 16 | 40 | L |
| 11349 | | 22 | Bt | 22-50 | 5.6 | 0.20 | 42 | | | | | | | 39 | 15 | 46 | L |
| 11350 | | 23 | C | 50-100 | 6.6 | 0.12 | 31 | | | | | | | 91 | 2 | 7 | S |
| 11351 | 101 | 24 | Bm | 10-55 | 6.0 | 0.13 | 31 | | | | | | | 68 | 7 | 25 | SL |

MR

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G.S.T. REGISTRATION #R6344083 RT0001

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**TEST REPORT# 060911-11328**

SEPTEMBER 11, 2006

**PROJECT: PNG PIPELINE**
SAMPLES COLLECTED IN THE GRAY SOIL ZONE WEST OF PRINCE GEORGE, BRITISH COLUMBIA
**P.O.#: 06003**

DATE RECEIVED: AUG 31/06

| LAB # | Site Description | Horizon | Depth cm | Saturated Paste Basis pH | E.C. mS/cm | SAT % | OM % | ppm N | P | K | SO4 | CaCO3 % | Sand % | Clay % | Silt % | Textural Class |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 11352 | 106 25 | Aep | 0-15 | 5.2 | 0.40 | 56 | 2.1 | <1.2 | 2.8 | 44 | <5 | | 13 | 25 | 62 | SiL |
| 11353 | 26 | Bt | 22-70 | 7.3 | 0.31 | 50 | | | | | | 0.27 | 11 | 23 | 66 | SiL |
| 11354 | 124 27 | Aep | 0-15 | 6.1 | 0.34 | 45 | 1.7 | 1.2 | 61 | 202 | <5 | | 35 | 9 | 56 | SiL |
| 11355 | 28 | Bm1 | 15-50 | 6.5 | 0.12 | 35 | | | | | | | 44 | 8 | 48 | L |
| 11356 | 29 | Bm2 | 50-90 | 6.5 | 0.15 | 41 | | | | | | | 31 | 14 | 55 | SiL |

FERTILIZER RECOMMENDATION (LB/ACRE) FOR NEW GRASS

| N | P205 | K20 | SO4-S |
|---|---|---|---|
| 115 | 20 | - | - |

| TEST | METHOD REFERENCE | DATE OF ANALYSIS | TECHNICIAN RESPONSIBLE |
|---|---|---|---|
| pH | SOP 4160 CSSS (Carter) 1993, Method 16.2 | 09/05 | LE |
| E.C. | SOP 4150 CSSS (Carter) 1993, Method 18.3.1 | 09/05 | LE |
| SAT % | SOP 4100 CSSS (Carter) 1993, Method 18.2.2 | 09/08 | SH |
| Organic Matter (O.M.) % | CSSS (McKeague) 1978, Method 4.2.1 | 09/05 | MR |
| Nitrate Nitrogen (NO3-N) lb/acre | CSSS (Carter) 1993, Method 4.2 modified | 09/05 | MS |
| Phosphorus (P) lb/acre | Qian et.al, 1993 (Modified Kelowna Method) | 09/01 | MS |
| Potassium (K) lb/acre | Qian et.al, 1993 (Modified Kelowna Method) | 09/01 | LE |
| Sulfate-Sulfur (SO4-S) lb/acre | CSSS (Carter) 1993, Method 9.2 modified | 09/05 | MS |
| CaCO3 % | CSSS (McKeague) 1978. Method 3.41 | 09/08 | MR |
| Particle Size Analysis | SOP 4000 CSSS (McKeague) 1978. Method 2.12 | 09/06 | BK |

Report Authorized By: [signature]
Manager/Supervisor - Lab Services

Unless otherwise stated, all samples were received in good condition.
Test results are only representative of the samples submitted to the laboratory.
This report should only be reproduced in full.
Liability is limited to the cost of analysis.

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G.S.T. REGISTRATION #853440931RT0001

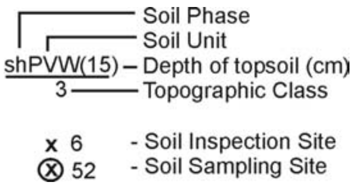
# APPENDIX G

# SOILS LEGEND

## SOILS LEGEND

| Soil Symbol | Soil Name | Soil Classification | Parent Material | Texture Class | Drainage Class |
|---|---|---|---|---|---|
| ALX | Alix | Eluviated Dystric Brunisol | glaciofluvial | gravelly sandy loam to loamy sand | rapidly |
| AV | Alluvium | Orthic Regosol | recent fluvial | silt loam to gravelly sand | well to rapidly |
| BAT | Barrett | Orthic Gray Luvisol | till | loam to clay loam | well to moderately well |
| BMN | Berman | Orthic Gray Luvisol | glaciolacustrine | fine sandy loam, silt loam and silty clay loam | well to moderately well |
| BRD | Braeside | Orthic Gray Luvisol | glaciofluvial | sandy loam | well |
| CRY | Crystal | Eluviated Dystric Brunisol | till | gravelly sandy loam to loam | well to rapidly |
| KNZ | Kenzie | Fibric Mesisol<br>Typic Mesisol | organic | moss peat | very poorly |
| MPS | Mapes | Eluviated Dystric Brunisol | glaciofluvial | loamy sand | well to rapidly |
| NIT | Nithi | Orthic Dystric Brunisol<br>Eluviated Dystric Brunisol | glaciofluvial | fine sands and silts overlying loamy sand to sand | well to rapidly |
| PVW | Pineview | Orthic Gray Luvisol | glaciolacustrine | silty clay to clay | well to moderately well |
| **Miscellaneous Land Units:** | | | | | |
| R | Rock | Hard consolidated bedrock at or near the surface | | | |
| RB | Rough Broken | Steep slopes along drainage courses | | | |
| SC | Stream Channel | Undifferentiated Regosolic and Gleysolic soils developed on recent fluvial sediments | | | |
| **Soil Phase:** | | | | | |
| sh | shallow | Soils with an unconforming parent material within 1.2 m of the surface | | | |

NOTATIONS:




TOPOGRAPHY CLASSES:

| | | | |
|---|---|---|---|
| 1 | - | 0 - 0.5% | level |
| 2 | - | 0.5 - 2% | nearly level |
| 3 | - | 2 - 5% | very gentle slopes |
| 4 | - | 6 - 9% | gentle slopes |
| 5 | - | 10 - 15% | moderate slopes |
| 6 | - | 16 - 30% | strong slopes |
| 7 | - | 31 – 45% | very strong slopes |
| 8 | - | 46 – 70% | extreme slopes |

PRESENT LAND USE:

| | | |
|---|---|---|
| B | - | bush |
| B-P | - | bush-pasture |
| C | - | cultivated |
| H | - | hay |
| P | - | improved pasture |

# APPENDIX H

# SOILS OVERVIEW BETWEEN KP 387.6-393.2 AND KP 444.1-444.3 ALONG THE PROPOSED KSL PROJECT

A soils overview was carried out along the proposed pipeline right-of-way from KP 387.6 to 393.2 and KP 441.1 to 444.3 because these areas where not previously field investigated and are located near or within the Agriculture Land Reserve (ALR) and may have potential for agricultural development. Soils and topography information was obtained by carrying out an aerial photo interpretation of 1:20,000 scale recently flown (August 16, 2006) aerial photographs and using existing reconnaissance soils information (Farstad and Laird 1954; Kelly and Farstad 1946). The soils and landscape information gathered from the photo interpretation and previous existing reconnaissance soil surveys was transferred to the accompanying Photomosaic Environmental Work Sheets (Sheets 64, 65 and 73 of 76). Most of the overview areas consist of bush land. Improved agricultural land appears to be confined to the west side of the Stuart River in the vicinity of KP 388.5. Cleared land which may or may not be agricultural land occurs in the vicinity of KP 391. Field investigation will be carried out at a later date when the soils are not covered with snow or are frozen.

Most of the two overview areas consist of well to moderately well drained Orthic Gray Luvisols developed on stone-free to slightly stony, clay textured glaciolacustrine deposits (Pineview (PVW) or Fort St. James (FSJ) soils) or, to a lesser extent, well to moderately drained Orthic Gray Luvisols developed on slightly to very stony, loam to clay loam textured till (Barrett (BAT) soils). A small area of well to rapidly drained Eluviated Dystric Brunisols developed on very to exceedingly stony, gravelly sandy loam to loam textured till occurs on strongly to very strongly rolling slopes on the west side of the Stuart River (Crystal (CRY) soils). Well to moderately well drained Orthic Regosols or Orthic Humic Regosols developed on loam, silt loam or sandy loam textured recent fluvial material occurs on the floodplain of the Stuart River (Nechako (NCO) soils). These soils may be coarser textured at depth.

Two new soils occur in the two overview areas that do not occur in the previous areas that were field investigated along the proposed route. The two new soils identified in the overview areas which do not occur in the previous field investigated areas include; Fort St. James (FSJ) soils, and Nechako (NCO) soils. Both of these soils only occur in the Stuart River segment between KP 387.6 and 393.2. Typical profile descriptions of the two new soils encountered are included as well as their implications to pipelining. The distribution and extent of the various soils and topography classes occurring along the two overview areas are shown on Environmental Work Sheets 64, 65 and 73 of 76.

### *Fort St. James (FSJ) Soils*

EXTENT: Dominant soils in the Stuart River Segment from KP 389.2 to 393.2

SOIL CLASSIFICATION: Orthic Gray Luvisol

PARENT MATERIAL: Silty clay to clay textured glaciolacustrine

DRAINAGE: Moderately well

SURFACE STONINESS: Stone-free to slightly stony

TOPOGRAPHY: Undulating to strongly rolling (2-30% slopes)

PROFILE DESCRIPTION: Site inferred

| Horizon | Depth (cm) | Colour | Texture | Structure | Consistence |
|---|---|---|---|---|---|
| L-H | 6-0 | very dark brown | | duff layer | |
| Ae | 0-13 | pale brown | SiL-SiCL | m.m.plty. | friable |
| Bt | 13-68 | dark yellowish brown | C | m.m.sbk. | firm |
| Ck | 68-120 | brown to dark brown | C | massive | firm |

COMMENTS:

- These soils are common in the Stuart River segment from KP 389.2-393.2.
- Topsoil thickness in cleared and developed fields varies from 10-15 cm. No topsoil (Ah, Ahe, Aep or Ap horizons) occurs in bush areas. Instead there is a thin duff layer (L-H horizon) overlying a relatively thick, light coloured Ae horizon. The topsoil horizon in cleared and developed fields (Ap or Aep horizon) consists mainly of former Ae horizon material which frequently is still light coloured. Topsoils are generally lighter coloured than the underlying subsoil.
- Fort St. James soils are similar to Pineview (PVW) soils which were previously described in this report. They only differ in that the glaciolacustrine deposit originated from a different laken deposit and is of different lithology.
- Fort St. James soils are fine textured and therefore susceptible to soil compaction and rutting.
- These fine textured soils are non-saline and non-sodic to the 1.2 m depth.

### *Nechako (NCO) Soils*

EXTENT: Occur only on the floodplain of the Stuart River

SOIL CLASSIFICATION: Orthic Regosols and Orthic Humic Regosols

PARENT MATERIAL: Loam, silt loam and sandy loam textured recent fluvial

DRAINAGE: Well to moderately well

SURFACE STONINESS: Stone-free to slightly stony

TOPOGRAPHY: Gently undulating to gently rolling (1-9% slopes)

PROFILE DESCRIPTION: Site inferred

| Horizon | Depth (cm) | Colour | Texture | Structure | Consistence |
|---|---|---|---|---|---|
| Ap | 0-15 | dark brown | L | w.f.gran. | friable |
| C1 | 15-35 | grayish brown | SiL | stratified | friable |
| C2 | 35-100 | olive brown | L-SL | stratified | friable |
| C3 | 100+ | brown | SL | single grain | friable |

COMMENTS:

- These soils are confined to the floodplain of the Stuart River from KP 388.1 - 389.3.
- These soils probably lack a significant topsoil horizon in bush areas. Topsoil thickness in cleared and developed fields is probably in the 10-15 cm depth range.
- Coarser textured materials may occur at depth (gravels or sands).
- Nechako soils may lack cohesion properties at depth which may result in unstable trench walls when vertically ditched.
- These soils may be similar to Alluvium (AV) soils which were previously described in this report.
- It appears that Nechako soils are extensively used for agricultural purposes on the west side of the Stuart River.

Soil Characteristics and their Implications to Pipelining of New Soils Identified in the Overview Areas.

| Soil Symbol | Soil Name | Soil Classification[1] | Parent Material[2] | Texture Class[3] | Drainage Class[4] | Topsoil Depth Range (cm) | Colour Differentiation between Topsoil and Subsoil | Erosion Hazards[5] Wind | Erosion Hazards[5] Water | Susceptible to Soil Compaction and Rutting | Susceptible To Trench Instability | Comments or Other Concerns |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| FSJ | Fort St. James | O.GL | GL | SiC-C | MW | 0-15 | Fair-Poor | M | S-H | Yes | - | - |
| NCO | Nechako | O.R-O.HR | F | L-SiL-SiL | W-MW | 0-15 | Fair-Poor | M-H | S | - | Possible | - may be gravelly at depth |

1. Soil Classification according to the Soil Classification Working Group (1998).

**2. Parent Material**
F - recent fluvial
GL - glaciolacustrine

**3. Texture Classes**
C - clay
CL - clay loam
L - loam
SiL - silt loam
SiCL - silty clay loam
SiC - silty clay
SL - sandy loam

**4. Drainage Classes**
W - well
MW - moderately well
I - imperfectly

**5. Erosion Hazards**
S - slight
M - moderate
H - high

# APPENDIX I

## SOILS INVESTIGATIONS ALONG POTENTIAL AGRICULTURAL LAND BETWEEN KP 387.6 – 393.2 AND KP 441.1 – 444.3 ALONG THE PROPOSED RIGHT-OF-WAY OF THE KSL PROJECT

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E-mail: mentiga@telusplanet.net

**June 29, 2007** **Project No. : 06003B.1**

**Mark Walmsley**
**Westland Resource Group Inc.**
**203 – 830 Shamrock St.**
**Victoria, British Columbia**
**V8X 2V1**

**Re: Soil Investigations Along Potential Agricultural Land Between KP 387.6 – 393.2 and KP 441.1 – 444.3 Along the Proposed Right-of-Way of the KSL Project.**

Field investigations were not originally carried out between KP 387.6 – 393.2 and KP 441.1 – 444.3. Soil investigations were carried out in the two areas from June 5-7, 2007. The soils were inspected at 14 locations. The location of the inspection sites (Sites 134-147, inclusively) are shown on the accompanying KSL Pipeline Looping Project Soils Map Set (Maps 14 and 15 of 15), and inspection data are summarized in the attached Site Inspection List. Soil investigations were carried out with a hand auger to a depth of 1.2 m. The soils were sampled at two sites (Sites 134 and 141) for laboratory analyses. Soil analyses included; soil reaction (pH), electrical conductivity (EC), saturation percentage (Sat%) and sodium adsorption ratio (SAR) on upper and lower subsoils. Soil analyses were carried out by Lakeside Research in Brooks, Alberta. Laboratory results are shown in Table 1. Most of the soils encountered along the proposed route were previously described in detail in the main report (Soil Assessment for Portions of the Proposed Kitimat – Summit Lake Natural Gas Pipeline Looping Project prepared for Pacific Trail Pipelines in January 2007).

Two new soils were encountered along the proposed route investigated that were not previously described in the main soils report. The two new soils are Fort St. James (FSJ) soils and Nechako (NCO) soils. Both of these soils only occur in the Stuart River Segment between KP 388.0 and 393.2. Fort St. James soils are similar to Pineview (PVS) soils and Nechako soils are developed on recent fluvials silts and fine sands on the upper floodplain of the Stuart River. Typical profile descriptions of the two new soils encountered are included as well as a table describing their implications to pipelining (Table 2). The distribution and extent of the various soils and topography classes occurring in the two areas field investigated are shown on the accompanying KSL Pipeline Looping Project Soils Map Set ( Maps 14 and 15 of 15). Both segments field investigated consist mainly of forest. A small area of cultivated land only occurs on the west side of the Stuart River from KP 388.4 – 388.8.

Yours truly,

A. Twardy, M.Sc., P.Ag.
Senior Soil Scientist

AT/ml
Att.

**Nechako (NCO) Soils**

EXTENT: Occur only on the floodplain on the west side of the Stuart River

SOIL CLASSIFICATION: Orthic Regosols and Orthic Humic Regosols

PARENT MATERIAL: Loam, silt loam and sandy loam textured recent fluvial

DRAINAGE: Well

SURFACE STONINESS: Stone-free to slightly stony

TOPOGRAPHY: Undulating to moderately rolling (2-15% slopes)

PROFILE DESCRIPTION: Site 141

| Horizon | Depth (cm) | Colour | Texture | Structure | Consistence |
|---|---|---|---|---|---|
| Ap | 0-14 | dark brown to brown | fSL-L | w.f.gran. | friable |
| C1 | 14-70 | brown | fSL | stratified | friable |
| C2 | 70-120 | olive brown | fSL | stratified | friable |

COMMENTS:

- These soils are confined to the floodplain on the west side of the Stuart River from KP 388.1 – 388.8.
- These soils lack a significant topsoil horizon in bush areas. Topsoil thickness in cleared and developed fields is in the 10-15 cm depth range. Colour differentiation between topsoils and subsoils is poor.
- Coarser textured materials may occur below the 1.2 m depth (gravels or sands).
- Nechako soils may lack cohesion properties at depth which may result in unstable trench walls when vertically ditched.
- These sols are somewhat similar to Alluvium (AV) soils which were previously described in the soils report.

**Fort St. James (FSJ) Soils**

EXTENT: Dominant soils in the Stuart River Segment from KP 389.2 to 393.2

SOIL CLASSIFICATION: Orthic Gray Luvisol

PARENT MATERIAL: Silty clay to clay textured glaciolacustrine

DRAINAGE: Moderately well

SURFACE STONINESS: Stone-free to slightly stony

TOPOGRAPHY: Undulating to moderately rolling (2-15% slopes)

PROFILE DESCRIPTION: Site 144

| Horizon | Depth (cm) | Colour | Texture | Structure | Consistence |
|---|---|---|---|---|---|
| L-H | 6-0 | very dark brown | | duff layer | |
| Ae | 0-11 | pale brown | SiL-SiCL | m.m.plty. | friable |
| Bt | 11-58 | dark yellowish brown | C | m.m.sbk. | firm |
| Ck | 58-120 | brown to dark brown | C | massive | firm |

COMMENTS:

- These soils are common in the Stuart River segment from KP 389.2 – 393.2.
- Topsoil thickness in logged areas varies from 10-15 cm. No topsoil (Ah, Ahe, Aep or Ap horizons) occurs in bush areas. Instead there is a thin duff layer (L-H horizon) overlying a relatively thick, light coloured Ae horizon.
- Fort St. James soils are similar to Pineview (PVW) soils which were previously described in the soils report. They only differ in that the glaciolacustrine deposit originated from a different laken deposit and is of different lithology.
- Fort St. James soils are fine textured and therefore susceptible to soil compaction and rutting.
- These fine textured soils are non-saline and non-sodic to the 1.2 m depth.

Table 1. Soil Characteristics of Sampled Soils.

| Site | Soil Unit | Horizon | Depth (cm) | pH ($H_2O$) | EC (dS/m) | Sat (%) | SAR | Organic Carbon (%) | Field Texture | Reclamation Suitability Rating and Limitations* |
|---|---|---|---|---|---|---|---|---|---|---|
| 141 | Nechako (NCO) | Ap | 0-14 | 6.2 | 0.5 | 56 | - | 2.0 | fSL-L | F(1) |
| | | C1 | 14-70 | 6.7 | 0.1 | 36 | 0.6 | - | fSL | G |
| | | C2 | 70-120 | 6.6 | 0.1 | 38 | 0.8 | - | fSL | G |
| 134 | Pineview (PVW) | Bt | 5-70 | 5.4 | 0.1 | 72 | 0.8 | - | C | P(6) |
| | | BC | 70-120 | 7.1 | 0.2 | 75 | 0.9 | - | C | P(6) |

* Limitations
1 – pH
2 – EC
3 – SAR
4 – Sat%
5 – Stoniness
6 – Texture
7 – Consistence
8 – Organic Carbon

Ratings (After ASAC, 1987)

G – Good
F – Fair
P – Poor
U – Unsuitable

Table 2. Soil Characteristics and their Implications to Pipelining of New Soils Identified in the Segments Recently Field Investigated.

| Soil Symbol | Soil Name | Soil Classification[1] | Parent Material[2] | Texture Class[3] | Drainage Class[4] | Topsoil Depth Range (cm) | Colour Differentiation between Topsoil and Subsoil | Erosion Hazards[5] | | Susceptible to Soil Compaction and Rutting | Susceptible To Trench Instability | Comments or Other Concerns |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | Wind | Water | | | |
| FSJ | Fort St. James | O.GL | GL | SiC-C | MW | 0-15 | Fair-Poor | M | S-M | Yes | - | - |
| NCO | Nechako | O.R-O.HR | F | L-fSL-SiL | W | 8-14 | Fair-Poor | H | S-M | - | Possible | - may be gravely at depth |

1. Soil Classification according to the Soil Classification Working Group (Agriculture and Agri-Food Canada 1998).

**2. Parent Material**
- F - recent fluvial
- GL - glaciolacustrine

**3. Texture Classes**
- C - clay
- CL - clay loam
- L - loam
- SiL - silt loam
- SiCL - silty clay loam
- SiC - silty clay
- SL - sandy loam

**4. Drainage Classes**
- W - well
- MW - moderately well
- I - imperfectly

**5. Erosion Hazards**
- S - slight
- M - moderate
- H - high

## SITE INSPECTION LIST

| Site | Soil Unit | Classification | Parent Material | Depth of Topsoil (cm) | Dominant Texture Topsoil/Subsoil | Topographic Class | Drainage Class | Surface Stoniness Class | Dominant Vegetation | Comments |
|---|---|---|---|---|---|---|---|---|---|---|
| 134 | PVW | O.GL | GL | 0 | -/C | 4 | MW | S0 | P1 | |
| 135 | PVW | O.GL | GL | 0 | -/C | 3-4 | MW | S0 | P1 | |
| 136 | PVW | O.GL | GL | 0 | -/C | 4 | MW | S0 | Pl-Aw | |
| 137 | PVW | O.GL | GL | 0 | -/SiCL | 4 | MW | S0 | Pl-Aw | |
| 138 | PVW | O.GL | GL | 0 | -/SiCL-C | 3-4 | MW | S0 | Pl-Sw-Aw | |
| 139 | PVW | O.GL | GL | 0 | -/SiCL-C | 3-4 | MW | S0 | Sw-Aw-Pl | |
| 140 | NCO | O.R | F | 8 | fSL/fSL | 4 | W | S0 | B-P | |
| 141 | NCO | O.HR | F | 14 | fSL/(fSL/fSL-L) | 3-4 | W | S0 | C | |
| 142 | FSJ | O.GL | GL | 0 | -/SiCL-C | 4 | MW | S0-1 | logged | |
| 143 | FSJ | O.GL | GL | 0 | -/SiCL-C | 3-4 | MW | S0-1 | logged | |
| 144 | FSJ | O.GL | GL | 0 | -/SiCL-C | 3-4 | MW | S0 | Pl-Sw | |
| 145 | FSJ | O.GL | GL | 0 | -/SiCL-C | 3-4 | MW | S0 | logged | |
| 146 | FSJ | O.GL | GL | 0 | -/SiCL-C | 3-4 | MW | S0-1 | logged | |
| 147 | FSJ | O.GL | GL | 0 | -/SiCL-C | 5 | MW | S0 | Pl-Sw | |

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**TEST REPORT# 070614-9249**

JUNE 14, 2007

**PROJECT: PNG PROJECT FOR WESTLAND**
GRAY SOIL NEAR PRINCE GEORGE B.C.
**P.O.#: 06003B**

DATE RECEIVED: JUNE 12/07

| | | | | | Saturated Paste Basis | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | soluble ions | | | | | | | | |
| LAB # | Site Description | | Horizon | Depth cm | pH | E.C. mS/cm | SAT % | Na | Ca mEq/L | Mg | SAR | OM % | N | P | K ppm | SO4 |
| 9249 | 134 | 1 | Bt | 5-70 | 5.4 | 0.08 | 72 | 0.3 | 0.2 | 0.2 | 0.8 | | | | | |
| 9250 | | 2 | Bc | 70-120 | 7.1 | 0.19 | 75 | 0.6 | 0.5 | 0.5 | 0.9 | | | | | |
| 9251 | 141 | 3 | Ap | 0-14 | 6.2 | 0.54 | 56 | | | | | 3.4 | 12 | 77 | 190 | <5 |
| 9252 | | 4 | C1 | 14-70 | 6.7 | 0.14 | 36 | 0.4 | 0.6 | 0.3 | 0.6 | | | | | |
| 9253 | | 5 | C2 | 70-120 | 6.6 | 0.08 | 38 | 0.4 | 0.2 | 0.1 | 0.8 | | | | | |

FERTILIZER RECOMMENDATION (LB/ACRE) FOR NEW GRASS

| N | P205 | K20 | SO4-S |
|---|---|---|---|
| 75 | 0 | - | - |

| TEST | METHOD REFERENCE | DATE OF ANALYSIS | TECHNICIAN RESPONSIBLE |
|---|---|---|---|
| pH | SOP 4160 CSSS (Carter) 1993, Method 16.2 | 06/13 | MS |
| E.C. | SOP 4150 CSSS (Carter) 1993, Method 18.3.1 | 06/13 | BK |
| SAT % | SOP 4100 CSSS (Carter) 1993, Method 18.2.2 | 06/14 | VE |
| Soluble Na, Ca, Mg | SOP 4200 CSSS (Carter) 1993, Method 18.3.2 | 06/14 | LE |
| SAR | SOP 4290 CSSS (Carter) 1993, Method 18.4.3 | 06/14 | VE |
| Organic Matter (O.M.) % | CSSS (McKeague) 1978, Method 4.2.1 | 06/13 | BK |
| Nitrate Nitrogen (NO3-N) lb/acre | CSSS (Carter) 1993, Method 4.2 modified | 06/13 | MS |
| Phosphorus (P) lb/acre | Qian et.al, 1993 (Modified Kelowna Method) | 06/13 | MS |
| Potassium (K) lb/acre | Qian et.al, 1993 (Modified Kelowna Method) | 06/13 | LE |
| Sulfate-Sulfur (SO4-S) lb/acre | CSSS (Carter) 1993, Method 9.2 modified | 06/13 | MS |

Report Authorized By: ______________________
Manager/Supervisor - Lab Services