Golder Associates Ltd.

1011 6th Avenue S.W.
Calgary, Alberta, Canada T2P 0W1
Telephone (403) 299-5600
Fax (403) 299-5606

REPORT ON

DETAILED CONSERVATION AND RECLAMATION PLAN FOR SUNCOR'S INTEGRATED MINE PLAN

LEASE 86/17 STEEPBANK MINE AND ATHABASCA RIVER VALLEY

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EXECUTIVE SUMMARY

This report provides further details regarding Suncor's reclamation program, especially in the area of the Steepbank Mine encompassing the Athabasca River Valley. In the Integrated Resource Plan, the Athabasca River Valley is identified as the Athabasca-Clearwater Resource Management Area. This nationally important river valley is considered to be one of the most diverse and productive ecosystems for both vegetation and wildlife within northeastern Alberta.

This report was prepared in accordance with Conservation and Reclamation Application guidelines. It also addresses resource management objectives provided in the Integrated Resource Plan for the Athabasca River Valley.

Reclamation planning details are provided for the Athabasca River Valley within the context of Suncor's integrated mine plan (i.e., both Lease 86/17 and the Steepbank Mine). Site-specific planning (i.e., precise locations for soil/terrain modifications) was not possible earlier in the project development since this level of detail was contingent on an evolving mine plan.

Utilizing the current mine plan, the authors of this report prepared a "mass balance" for soil stripping and detailed reclamation activities. Subsequently, the anticipated post-reclamation environment is described using this mass balance and soil capability classes as the basis for predictions of vegetation and wildlife characteristics on reclaimed areas. The reclamation plan includes both macro- and micro-scale terrain and soil modification protocols to ensure that an equivalent or better capability will be established in the post-reclamation time period.

The balance between mine development and reclamation has been summarized on a series of maps at a scale of 1:50,000 (maps at a scale of 1:20,000 are available on request). Twelve maps are provided for the years 1997 to 2020. Supporting tables document the progression of soil stripping, soil storage and sequential reclamation of various post-disturbance surfaces (e.g., overburden waste dumps, dykes, consolidated tailings deposits). A second series of three maps show the rationale for the integrated revegetation plan for both Lease 86/17 and the Steepbank Mine. The first map shows the type of reclaimed soil and topographic class associated with each of the post-disturbance surfaces. The second map shows the corresponding soil capability class for each reclaimed surface which, in combination with the soil drainage plan, was used to derive the appropriate reclaimed soil

capability. This, in turn, was used to assess revegetation types that will be located on the reclaimed landscape.

Soil losses (i.e., disturbances due to area clearing and stripping activities) of different capability ratings are also "balanced" by comparison to the use of reclaimed soils during the reclamation process. This information is presented, in both figure and table format, for the present time period (1996) and for the year 2020. The report authors have concluded that Suncor's reclamation plan will result in an equivalent or better class of soils for forest productivity on both Lease 86/17 and the Steepbank Mine.

For the terrestrial component, soil capability analysis has been developed for each time period or window of the mine plan and used to assess vegetation and wildlife characteristics of specific reclaimed areas within the mine site. This was done since soil type is a fundamental determinant of productivity and biodiversity. This evaluation indicated that the post-reclamation mine site will have a level of vegetation and wildlife productivity equivalent or better than baseline conditions by virtue of a general increase in soil classes/capability. Within the river valley, Suncor will reclaim the vegetative community to similar types as presently exist, incorporating community diversity and an interspersion of vegetation types. As a result, usage by wildlife such as moose, will be restored to baseline conditions in the post-reclamation period.

Notwithstanding this favourable post-reclamation scenario, there will be some long-term, adverse impacts to wildlife, most notably in a disruption of wildlife corridor qualities of the Athabasca River valley. However, winter tracking count surveys indicate that the river valley in the area of the Steepbank Mine may not be an important wildlife corridor.

For the aquatic component, drainage waters in contact with the mine pit will be diverted to tailings ponds; therefore, there will be minimal impacts on the environment. Surface run-on waters (i.e., from areas outside the footprint of the mine or from areas being cleared for the mine) will be diverted to Shipyard Lake. Since Shipyard Lake is an important ecological resource within the river valley, an overburden waste dump planned for this area will be relocated outside the footprint of this wetlands. Water flows into this wetlands, which will be controlled using a diversion bypass system which will maintain water flows within a range comparable with historical flow rates. Water in excess of these required flows will bypass the lake and will be diverted directly into the outlet channel presently existing between Shipyard Lake and the Athabasca River. Suncor will also enact other measures, described herein, to ensure that there will be minimal impacts to this resource.

ACKNOWLEDGEMENTS

This report was prepared by a working committee with liaison to Suncor provided through Mr. Steve Tuttle. Mr. Peter Nix of Golder Associates Ltd. (Golder) was Project Manager, with technical and editorial input from Mr. John Gulley (Golder). The Suncor Mine Planning Group headed by Mr. Doug Kennedy developed the mine plan for soil stripping and reclamation. Specific environmental issues were addressed by the following personnel: soil, by Mr. Len Leskiw (Can-Ag Enterprises Ltd.); terrestrial/vegetation, by Mr. Dave Kerr and Ms. Sandra Marken (Golder); wildlife, by Mr. Dave Westworth (Westworth, Brusnyk & Assoc. Ltd); aquatic, by Mr. Peter Nix and hydrology, by Mr. Ken Manly (Klohn-Crippen). Map units were produced by Ms. Rowena Punzalan (Golder).

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF MAPS

1.0 INTRODUCTION

1.1 Background

The Suncor reclamation goal is to achieve maintenance-free, self-sustaining ecosystems with capability equivalent to or better than pre-disturbance conditions. Suncor's reclamation strategy and short-term plan for Lease 86/17 were presented in the February 1995 Application for Renewal of the Environmental Operating Approval (Suncor 1995). This strategy was further developed in Suncor's Steepbank Mine Approval Application (Suncor 1996), and is detailed further in this document, in which the focus is on reclamation in the Athabasca River Valley.

"Maintenance-free" reclamation means that human maintenance activities are not required, except for circumstances where future human activities lead to re-disturbance of areas. This does not imply a changeless state, as landforms will experience the normal processes typical of the region leading to gradual reshaping of the landscape. Self-sustaining ecosystems will evolve on revegetated terrains, from new plantings toward mature systems typical of those in the region with little input from man following the initial re-establishment of the ecosystem. "Equivalent land capability" refers to the capability of post-reclamation land to support various uses similar to that which existed prior to an activity being conducted on the land; however, these individual original and post-reclamation land uses will not necessarily be identical (AEPEA 1993).

1.2 Terms of Reference

The Suncor Steepbank Mine Application identified the need for further detailed reclamation planning for the Athabasca River Valley (Suncor 1996). Subsequent to submission of the Application, comments from the regulatory agencies included queries regarding details of Suncor's reclamation program. As a result, Suncor commissioned this study to:

- address regulatory questions relating to Suncor's Conservation and Reclamation (C&R) policy for both Lease 86/17 and the proposed Steepbank Mine; and
- demonstrate how Suncor will achieve the objectives of the Integrated Resource Plan (IRP) for the Athabasca River Valley section of the Suncor Steepbank Mine (AEP 1995).

The mine plan for soil stripping and reclamation was developed by the Suncor Mine Engineering Group. This mine plan was then used as a basis for developing soil volume balance and capability calculations, and subsequent ecological evaluation of the reclaimed areas.

The major focus of this report is the detailed reclamation plan for the river valley component of the Steepbank Mine for the period 1997 to 2005. This period is consistent with the approval period of Suncor's Environmental Operating Approval, issued on June 25, 1996. Subsequent years are included because valley reclamation activities continue through the life of the Steepbank Mine to 2020. The scope of the February 1995 Application included reclamation details for Lease 86/17 to 1999. The Steepbank Mine Application provided reclamation information for both Lease 86/17 and the Steepbank Mine for approval of the integrated operations to 2005 and conceptually to 2020. To assess capabilities of the valley component in a larger geographic context, this report also provides integrated soil capability assessments of Lease 86/17 and the Steepbank Mine for both pre- and post-disturbance periods.

1.3 Objectives

The objectives of the Suncor reclamation program can be summarized as follows:

"Disturbed lands shall be reclaimed with gentle slopes to primarily a forest use compatible with pre-disturbed terrain, providing a range of end uses including wildlife, traditional use and recreation; and dyke slopes shall be revegetated primarily for erosion control providing natural end-use possibilities".

The objectives of this report were to provide a more detailed reclamation plan for Lease 86/17 and the Steepbank Mine, with emphasis on the Athabasca River Valley. This was achieved using annual "snapshots" of the Steepbank Mine plan and concurrent levels of reclamation during the years 1997 through 2005, as well as for future windows of time (2010, 2015 and 2020). Specific reclamation goals are cited in the Suncor Steepbank Mine Application (Suncor 1996) and include geotechnical stability, erosion control, acceptable level of impact to the Athabasca River, and the ultimate provision of self-sustaining, maintenance free landscapes. Specific objectives of this report include:

- detailed, year by year (1997 - 2005, 2010, 2015, 2020) plans for soil removal, capability assessment and replacement, and the development of a yearly soil mass balance;
- detailed revegetation plans for the site;
- description of drainage plans; and in particular, feasibility assessment of the retention of near normal (i.e., baseline) flows of water into Shipyard Lake;
- description of activities which will enhance biodiversity on reclaimed areas including micro-scale terrain modifications in conjunction with soil replacement;
- retention of the wetlands area within Shipyard Lake and, specifically, retention of the fish-habitat potential of the Shipyard Lake area near the Athabasca River; and
- evaluation of expected habitat/wildlife for each reclamation soil/vegetation area.

Suncor plans to meet C&R regulations and Integrated Resource Plan (IRP) objectives through implementation of the enclosed reclamation program.

2.0 RECLAMATION GUIDELINES, DESIGN CRITERIA AND APPROACH

2.1 Integrated Resource Plan (IRP) Guidelines

Recent guidelines produced by the IRP (Alberta Environmental Protection 1995) have been incorporated into this reclamation plan. Specific relevant guidelines are to:

- minimize impacts,
- reclaim to an equivalent capability, optimizing the value of watershed, timber, wildlife, fish, recreation and other resources, and
- develop alternative reclamation approaches where needed.

In view of its distinct character and ecological importance, the Athabasca River Valley is considered a separate Resource Management Area (RMA): the Athabasca-Clearwater. The IRP recognizes that the river valleys in this region provide an important winter range for ungulates, furbearers and bird game. Further, it states that *"cumulative impacts of developments can result in the overall regional degradation of renewable resources"*.

The overall intent of the IRP is to achieve development: 1) in a manner compatible with environmental and social considerations, and 2) to conserve land and natural resources. Specifically, the developer must demonstrate a mitigation of impacts on resources and/or aspects of the river valley as listed below:

- Wildlife: valley vegetation, riparian habitat and habitat diversity.
- Erosion: sensitive soils and drainage patterns.
- Floodplain: setback to at least 1:100 flood level; accommodate natural river evolution.
- Water Quality: for downstream uses; natural surface water and groundwater regimes.
- Recreation and Tourism: visual and acoustic, travel corridor and valley horizon.
- Ecological: unique characteristics, rare flora and fauna, critical functions and processes.
- Traditional Uses: First Nation Peoples.

- Historic Sites: scientific, educational and interpretive purposes.

2.2 Reclamation Design Criteria (Suncor 1996)

Suncor's vision for reclamation includes the construction of stable landforms and re-establishment of productive, self-sustaining ecosystems which will provide land use capabilities equivalent to those of the pre-mining environment. The following general operational and reclamation criteria form the basis for reclamation program design:

- Structures will be geotechnically stable.
- Discharge of earth materials through surface erosion processes will be controlled to rates which are acceptable to the environment.
- Discharge of surface and seepage waters will be managed to ensure an acceptable level of impact on the Athabasca River.
- The ecosystems re-established on disturbed lands will be fully self-sustaining and will mature naturally without presenting significant risk to resident or migratory wildlife species.
- Fully reclaimed lands will be maintenance-free, thereby justifying reclamation certification.

As per the Conservation and Reclamation information presented in the Steepbank Mine Application, criteria used to develop and assess river valley reclamation success can be summarized according to seven key steps:

- Project Goals
- Project Design Considerations
- Approvals
- Operation Phase
- Reclamation Phase
- Reclamation Performance Assessment and Monitoring

2.3 Adaptive Reclamation Management

Adaptive reclamation management involves the initial establishment of end land use objectives according to land use capability, site-specific conditions and stakeholder input. As reclamation proceeds, monitoring of reclamation and revegetation performance over time allows land use objectives to be reviewed and adjustments made to site conditions according to natural revegetation processes. The intent of adaptive reclamation management is to facilitate and respond to the revegetation process to meet specific land capability objectives in the ecologically sensitive and valued Athabasca River Valley. Suncor incorporates adaptive management techniques as routine components of all of its environmental management activities. These techniques have allowed Suncor to further develop and fine-tune its reclamation program during the past 20 years.

Suncor is able to focus adaptive reclamation management techniques as a result of its well established, proven reclamation program. This 20 year history of field and laboratory research provides the basis of knowledge to apply site-specific, adaptive measures to address the special reclamation issue of the Athabasca River Valley. Such issues include the revegetation of dump and dyke structures within the river valley, with the objective of replacing the pre-disturbance vegetation conditions as closely as possible.

The length of time required for development of mature ecosystems within the Boreal Forest Eco-region means that reclamation areas will typically be assessed for certification long before the areas have fully matured. Therefore, Suncor will further establish criteria and monitoring programs (acceptable to all parties) which clearly demonstrate progress toward environmentally-sound and fully-mature ecosystems. Suncor has begun development of a framework to be used for assessment of the performance of its reclamation plan. The Oil Sands Reclamation Performance Assessment Framework was reviewed in the Steepbank Mine Application (Suncor 1996).

Adaptive management may be used at any point throughout the project life cycle, but it will have greatest benefit in the early project planning stages. In these stages the location and compositions of landforms are still to be decided. Later (when landforms are designed or actually constructed), its use will facilitate decision-making on surface contouring measures and corrective initiatives which could improve surface drainage, decrease erosion or enhance vegetation performance.

2.4 Conceptual Reclamation Approach

2.4.1 Terrestrial

Soil capability is a principal determinant for many terrestrial environmental characteristics; including, for example, characteristics of both wildlife and vegetation as well as their sustainability and biodiversity. Therefore, a detailed year-by-year evaluation of soil movement and the classification of reclaimed soils was undertaken on a yearly basis for a nine year period (1997 to 2005), as well as for future periods (2010, 2015, 2020). Subsequently, these soil capability data were evaluated to forecast the post-reclamation terrestrial environment in the river valley (i.e., vegetation, wildlife).

Suncor's objective is to provide equivalent (or better) soil capability (with consequent and equivalent plant and animal ecosystems) as the mine is developed and reclaimed. Annual detailing of soil stripping and reclamation area establishment allows quantification of losses/gains in equivalent capability. This was accomplished through use of the recently developed soil classification system for the oil sands area (Leskiw 1996).

Land use capabilities are not directly addressed in this report. However, the data provided on soil capability and ecological characteristics of the post reclamation period will establish an ecological base from which a number of land use options can be considered.

2.4.2 Aquatic

In terms of aquatic reclamation, planning information has been provided for the mitigation of impacts on Shipyard Lake, a large wetlands within the Steepbank Mine area (cf. Section 5.0). There are no comparable methods to quantify equivalent capability for aquatic resources such as wetlands as was done for soils. Therefore, the reclamation goal was to mitigate any impact to the principal cornerstones of wetlands function (i.e., sediment type, water quality and hydrology) and to protect and enhance valued resources such as fisheries. Suncor's approach was to revise initial designs, as shown in the Steepbank Mine Application (Suncor 1996), and set-back a planned overburden waste dump. As a result, there is now no direct physical impact on Shipyard Lake.

3.0 GENERAL CONSERVATION AND RECLAMATION PLANNING

3.1 Construction of Landforms

The Long-Range Mine Plan defines the intent of, and construction schedule for a particular structure as well as its expected service conditions and service life (Suncor 1996). Prior to reclamation certification Suncor will be present on-site to monitor performance of its structures and to take corrective actions as necessary.

3.1.1 Construction and Monitoring for Landform Security

During construction and operation, Suncor will follow current practices (which are based on the Observational Method) to ensure geotechnical stability of all of its earth structures. Steps followed include:

- A comprehensive site investigation is conducted.
- The most-probable and the worst-case service conditions are identified as potential failure modes.
- Geotechnical design is developed based on the most-probable service condition but monitoring programs and contingency plans are developed to detect and remedy conditions which do not fall within the most-probable conditions.
- The design is prepared through use of a combination of in-house and consultant resources.
- Monitoring of the construction phase is carried out. Geotechnical instrumentation is installed.
- An annual Performance Report is prepared, for all containment structures subjected to external review and submitted to regulatory agencies.

3.1.2 Mine Activities

Details of the integrated Lease 86/17 and Steepbank Mine mine plan (which ultimately supports a dry reclamation landscape) are given in Suncor 1996.

Activities as of 1997 are listed below:

- Clearing has progressed to near the north edge of the property.
- Dyke 8 is under construction using a combination of overburden and tailings sand.
- Preparation for construction of Dykes 8 and 9 abutment is in progress.
- Pond 5 is being infilled with CT as part of the consolidated tailings commercial trial.
- Dyke 7 is under construction as Pond 4 is being infilled. A portion of Pond 4 has been segregated to contain the FGD recycle water pond and store surplus gypsum.
- Pond 2/3 has been constructed to design elevation; fluid is at its design level and will be used as a fine tailings thickener for the foreseeable future. Fine tailings transfer pumps have been installed to provide fine tailings for consolidated tailings (CT) disposal to Pond 5.
- Fine tailings withdrawal from Pond 1 commenced in 1995 with about 2 Mm^2 being transferred to pond 2/3 by the end of the year.
- Other than site investigation, there is no activity on the Steepbank Mine site.

Activities as of 2000 are summarized below:

- Clearing has progressed for Steepbank Mine.
- Mining is essentially complete on Lease 86/17; ore production has begun from Steepbank Mine.
- Dyke 9 is under construction while Dyke 8 is essentially complete.
- Pond 5 is being infilled with CT, with filling to be complete by 2002.
- Pond 4 construction is complete and it is in use as a FGD recycle water pond.
- Pond 2/3 is in use as a fine tails thickener for CT preparation.

Activities as of 2005 include:

- Clearing and mining is progressing at Steepbank Mine.

- Construction of the north overburden waste dump in underway.
- Construction of Dyke 9 is nearly complete.
- Pond 6 is being infilled with CT.
- Pond 5 is completely filled with CT and is in the primary dewatering phase.
- Pond 2/3 contents are in use as a fine tails thickener for CT preparation.

Activities as of 2010 include:

- Mining advance and overburden construction is progressing at Steepbank Mine.
- Primary CT production is directed to Pond 7.
- Ponds 5 and 6 are topped up with CT as dewatering continues.
- Pond 2/3 contents are in use as a fine tailings thickener for CT preparation.

Activities in 2015 include:

- Mining advance and overburden construction is progressing at Steepbank Mine.
- Primary CT disposal is directed to Pond 8.
- Ponds 5, 6 and 7 are periodically topped up with CT as dewatering and consolidation continues.
- Pond 1 has been reclaimed.

Activities in 2020 include:

- Mining completed at Steepbank Mine.
- CT Ponds 5, 6 and 7 have been capped with tailings sand and revegetated.
- CT Pond 8 is topped up with sand from expected extended mining on Lease 25 as dewatering occurs.

Surface stabilization for deposits will be accomplished during the topping up operations described in Suncor (1996). Layers of progressively-higher sand:fines ratio CT will be constructed over the deposit: these layers possess relatively high permeability, thus allowing drainage of the underlying, consolidating deposit. The final deposit layer will be constructed to an elevation above the long-term design elevation to allow for future consolidation. In addition, the deposit surface will be constructed with a hummocky surface to facilitate revegetation.

3.2 Drainage Patterns

3.2.1 Introduction

A reclamation drainage system must re-create the stability, safety and sturdiness of the pre-development natural drainage system. This will be accomplished through development of a surface drainage system patterned after natural models that are characterized by similar climate, topography and soil conditions. Although it will be impossible to fully replicate the original lease drainage system (because of the unique soil and topographic conditions of post-reclamation facilities) , it will be possible to replicate the stability and sturdiness of the original natural systems.

The reclamation drainage plan must include consideration of three objectives, including:

- Provision of a plan for conveyance of surface run-off water following mine closure, ensuring long-term sustainability and without any requirement for continuing maintenance;
- Minimization of the risk of excessive surface erosion (leading to unacceptable releases of CT or tailings sand) through collection and channelling of surface run-off to a receiving water body; and
- Assurance that the quality of water leaving the reclaimed area has an acceptable environmental impact on receiving water bodies.

3.2.2 Design Criteria

Historically, the approach to the design of drainage systems for reclamation has been to supply rigid, erosion resistant drainage facilities configured to handle a specific extreme event. This approach may result in uniformity of design and construction, but does not necessarily achieve the mine closure objectives of minimal erosion and long-term sustainability.

A major deficiency in conventional practice is the absence of a self-healing mechanism for the drainage systems. Often, when man-made channels fail (due to overtopping, washout of erosion protection or channel degradation) the failure leads to accelerated erosion and/or channel relocation. These situations are unacceptable to Suncor. Failures, where underlying materials are highly erosive, result in high sediment yield and loss of aquatic habitat.

The alternative to rigid systems designed for specific extreme events is a dynamic system capable of accommodating evolutionary change without accelerated erosion or unacceptable environmental impacts. Such dynamic facilities must be effective systems with several lines of defence and designed self-healing capability. Therefore, the geomorphic approach to the design of drainage systems and landscape for mine closure will involve development of drainage channels which replicate natural drainage systems. This replication reduces the risk of accelerated erosion and enables provision of self-healing erosion control systems.

Reclamation drainage courses will alter over time and no attempt should be made to resist such change. Instead, every attempt will be made to anticipate and accommodate such shifts by incorporating several lines of defence including boulder-strewn ground and deep riprap trenches within drainage channels.

3.2.3 Erosion Control

Erosion of slopes along the Athabasca River is a natural process which has created the Athabasca Valley and sculpted local topography. Similar processes currently occur on tailings impoundment and other reclamation structures. Small, localized movements of muskeg soil amendment (topsoil) are to be expected, but the movements must be at a sufficiently low rate to allow for self-healing of the vegetative cover. Measures to control erosion are included in the Suncor Application (Suncor 1996).

Suncor's policy is to control surface erosion, thereby enhancing the stability of constructed landforms and controlling loss of soils to the environment. Reconstruction of a soil layer, followed by revegetation is accomplished as soon as practical following construction. Revegetation of lower dyke and dump slopes will proceed while construction continues at higher elevations on the structures. Corrective action will be undertaken where erosion occurs prior to full re-establishment of vegetation.

Once active reclamation is complete and vegetation has been re-established, Suncor will continue to monitor progress toward maturation of landscapes and ecosystems to provide the basis for its submission for reclamation certification. During this phase, Suncor will also carry out any required maintenance activities on its reclamation areas.

3.2.4 Lease 86/17 Drainage System

3.2.4.1 General Routing of Major Drainage Channels

Eventually, Lease 86/17 will comprise a number of reclamation areas (Suncor 1996). The proposed principal drainage scheme for Lease 86/17 routes 60 to 70% of the run-off from reclamation areas westward to Ruth Lake. This lake presently drains southward to Poplar Creek via the Poplar Creek spillway. However, after Syncrude Canada Ltd. commissions its mine closure drainage scheme, Ruth Lake will drain northward (to Beaver Creek Reservoir) and then southward to Poplar Creek via a channel in a deep-cut engineered system which will replicate natural processes.

3.2.4.2 Secondary Drainage Channels

While the major (primary) drainage channels provide surface water outlets from each reclamation area, secondary drainage systems will provide drainage within each of the reclamation areas.

The proposed secondary drainage system will be developed by creating a network of east/west-trending hummocks (ridges) through placement of sand infill. This will force drainage to travel along depressions between the hummocks which will be constructed to form a branched drainage system, similar to many natural drainage basins in the area (Map V2). The advantage of this configuration is it enables earlier planting of upland vegetation on the hummocks. Drainage areas which develop between the hummocks are expected to evolve naturally, creating their own channel pattern and cross-sectional shape. The resulting secondary drainage system is expected to be stable over the long term.

3.2.5 Steepbank Mine Drainage System

The major surface water courses in the vicinity of the Steepbank Mine are the Athabasca and Steepbank rivers. Smaller watercourses in the area include Wood, Leggett, McLean and Unnamed Creeks. Shipyard Lake is a permanent wetlands located on the Athabasca River floodplain. The primary direction of groundwater flow is toward the Athabasca River, but the rate of groundwater flow is very low in comparison to flows in the nearby surface waters (Suncor 1996).

The drainage plan for the Steepbank Mine includes two phases (Suncor 1996):

1) Surface run-on water from undisturbed areas or areas undergoing preparation for clearing, as well as groundwater from shallow aquifers, will be collected in an interception drainage system. The interception channels will discharge to the Shipyard Lake area, with a diversion/overflow system to provide flows comparable to pre-mine flows into this wetlands area. Any flow in excess of the requirements of Shipyard Lake will go directly into the Athabasca River.

2) Mine drainage water is surface run-off from the mined, stripped and developed areas as well as any basal aquifer depressurization waters. These waters, which will be collected through channels into constructed storm water retention basins, and eventually used as process water.

3.3 Soils Management

3.3.1 General Practice

Suncor's current soil reconstruction technique has been used on an operational scale since 1984. Reclamation sites are enhanced with quality soil-building material, using a technique which involves overstripping muskeg (peat) to include 25 to 50% (by volume) of mineral overburden (usually 1 m of peat and 0.4 m of mineral overburden). This material is described as muskeg soil amendment. It is hauled, placed on prepared subsoil and then spread to an average depth of 15 to 25 cm over the underlying materials. The subsoil base materials are either tailings sand, overburden or (in the future) consolidated tailings.

Some materials available for use in construction of reclamation landforms are less desirable as they contain high concentrations of salinity and sodicity. Where these materials are located near the surface of a structure, mitigative measures will be employed to ensure vegetation establishment.

Reconstruction of soil for reclamation areas is a critical component of Suncor's reclamation plan. Since the ultimate capability of the reclaimed area is determined largely by the quality of reconstructed soil. Surfaces of reconstructed landforms are covered with a layer of soil amendment, primarily a muskeg soil that has been stripped from areas to be mined and then either stockpiled or (preferably) transported directly to reclamation areas (i.e., direct placement). Stockpiling is employed where surface disturbance has just begun on a site and where there are no areas yet available for reclamation, as will be the case on the Steepbank Mine until 2004.

Where muskeg is mixed with fine-textured till, clay or silt (fines) the peat/till mixture is designated at Type 1 muskeg soil amendment. Where muskeg is mixed with coarse textured material (sand and gravel), the mixture is designated as Type 2 muskeg soil amendment. Type 1 muskeg soil is primarily used to amend overburden spoil when the Type 1 supply is exhausted or mine logistics dictate Type 2 utilization. This designation has been used for operational planning and is based on the depth of organic material and the texture of underlying mineral overburden. This scheme should not be confused with the soil classification system (cf. Section 3.3.2) used to develop predictions regarding forest productivity in reclaimed areas.

This system of soil salvage is being integrated with the "Land Capability Classification for Forest Ecosystems in the Oil Sand Region" (Leskiw 1996) to ensure that the desired land capabilities are achieved. Thus muskeg soil amendment will be salvaged and directed to the reclamation sites with forest capability development as the primary consideration. This change in focus is not expected to drastically alter Suncor's soil salvage criteria, but will assist in managing the placement of the better-suited reclamation amendments. As a result, muskeg soil amendments having a granular subsoil will be directed to sites with a higher proportion of fines in the pre-reclamation soil mix. Muskeg soil amendment with higher fines ratio will be directed to areas with a tailings sand or CT soil mix. This strategy will result in better water infiltration for the overburden reclamation sites and improved water holding capability for the reclaimed soils on the tailings sand and CT sites.

3.3.2 Soil Classification System

In 1996, Suncor adopted the capability classification approach to designing and rating reclaimed soils. This section provides a pre-mine and post-reclamation soil capability assessment for Lease 86/17 and the proposed Steepbank Mine. Principal soils are identified and rated. Ratings are based on data reported in the "Baseline Soil Survey for the Proposed Suncor Steepbank Mine" (Leskiw 1996), in accordance with "Land Capability Classification for Forest Ecosystems in the Oil Sands Region" (Leskiw 1996). Baseline information for Lease 86/17 is based on aerial photo interpretation and the Soils Inventory of the Alberta Oil Sands Environmental Research Program Study Area. Soil units are correlated with those of the Steepbank Mine survey. Soil stripping at the Steepbank Mine will likely commence by 1997, with placement onto the first available reclamation area by 2001. Detailed annual soil handling plans will be provided in Suncor's annual C&R reporting through the ten-year approval period. Soil capability classes are shown in Table 3.1.

The assigned ratings shown on maps included in this report refer to the soil capability class for each map unit type (Map S3). The convention adopted is that a single number (e.g., 2) means 70% or more of the unit is within Class 2; a range (e.g., 2-3) means 60 to 80% is Class 2 and 20 to 40% is Class 3. It is expected that soils rated better and poorer will also occur within these areas. Landscape classes are discussed in this report, but they are not shown on the map. All level to undulating areas are Class 1 landscape, whereas steep slopes on river banks, and overburden and dyke slopes are Class 2, 3 and 4 landscapes, depending on relative steepness.

Soil capability subclasses are given in letters after the numeric class designation. These describe the kind of limitations responsible for class designation. This information provides a basis for land use planning, soil handling for reclamation and subsequent land management. The subclasses are summarized in Table 3.2.

It is envisaged that final slopes will range from 20 to 40% and that the slopes will have drain ways resembling that of natural gullies. Level reclaimed landscapes will be rated Class 1 landscape whereas reclaimed dyke and overburden slopes will be landscape Class 3.

The relationship between slope steepness, erosion and landscape class is illustrated in Table 3.3.

3.3.3 Pre-disturbance Soils and Forest Capability

The pre-disturbance soils of the integrated study area are shown on Map S1. Brief descriptions of soil type for each terrain type are provided below.

3.3.3.1 River Terraces

River terraces support primarily McMurray and gleyed McMurray soils:

a) McMurray (MMY) Soils

These soils encompass 350 ha (12%) of Lease 86/17 and 42 ha (1%) of the Steepbank Mine. The McMurray soils occur in well to moderately well drained positions on fluvial terraces bordering the Athabasca River. These soils are Orthic Regosols, calcareous, and sandy loam, silt loam and loam textured. Lateral seepage and water tables below 100 cm, together with good soil drainage make these among the most productive soils in the area. These soils are rated as Class 2 for forestry and landscape rating is Class 1.

b) Gleysolic McMurray (GLMMY) Soils

These soils encompass 0 ha (0%) of Lease 86/17 and 120 ha (3%) of the Steepbank Mine. The Gleysolic McMurray soils also occur on the fluvial terraces but in lower positions, usually within meander or channel scars. These soils are poorly drained and medium to fine textured. Water tables occur within 50 cm. As a group, the soils are rated only as Class 4 for forestry, a result of the limitations of wetness on a Class 1 landscape.

3.3.3.2 Lower Valley Gentle Slopes

Lower valley gentle slopes are comprised of Rough Broken (RB2) soils:

a) Rough Broken (RB2) Soils

These soils encompass 215 ha (7%) of Lease 86/17 and 467 ha (13%) of the Steepbank Mine. The RB2 unit is mapped on the lower, gentle slopes of the river valley. A major portion of this unit contains well drained sandy soils over residual material within 100 cm depth. These can be considered as shallow Firebag soils, and they occur on ridges and upper slopes (6 to 15%). On lower slopes positions (6 to 15%) the sandy overlay is deeper so that soils resemble Firebag soils. Inclusions of Kinosis soils also occur. Soil and landscape ratings are given in Table 3.4.

3.3.3.3 Upper Valley Steep Slopes

Upper valley steep slopes are comprised of Rough Broken (RB3) soils:

a) Rough Broken (RB3) Map Unit

These soils encompass 178 ha (6%) of Lease 86/17 and 423 ha (12%) of the Steepbank Mine. The RB3 unit occurs on the upper, steep slopes of the Athabasca River Valley. It includes steep slopes between gullies, (16 to 45%) (for about 60% of the map unit); gullies with extreme slopes (40 to 100% comprising about 20% of the map unit); and wet depressions and gully bottoms occupying about 20% of the map unit.

Soil profiles found on the steep slopes resemble the Kinosis and Firebag soils, but are located on steeper topography. Gullies contain bare eroded banks and Orthic Regosols. The wet areas resemble Algar soils. The range of forest capabilities are summarized in Table 3.5.

3.3.3.4 Upland Plain

Upland plain landscapes are comprised of a variety of mineral and organic soils:

a) Algar (ALG) Soils

These soils encompass 0 ha (0%) of Lease 86/17 and 7 ha (0.2%) of the Steepbank Mine. Algar soils are depressional, poorly drained mineral soils with less than 30 cm of surface peat. The mineral materials are dominantly morainal and loam or finer textured. The Algar soils are soil capability Class 4, limited by wetness. The landscapes are depressional and are rated Class 1.

b) Firebag (FIR) Soils

These soils encompass 262 ha (8%) of Lease 86/17 and 110 ha (3%) of the Steepbank Mine. Firebag soils are rapidly drained Brunisolic soils developed on undulating, sandy fluvial materials. Firebag soils have Class 4 soil capability, limited by low moisture retention. The landscape rating is Class 1.

c) Kinosis (KNS) Soils

These soils encompass 0 ha (0%) of Lease 86/17 and 265 ha (7%) of the Steepbank Mine. Kinosis soils are dominantly Orthic Gray Luvisols on sandy clay loam to clay loam morainal deposits. They range from well to imperfectly drained, from crests to lower slopes, respectively, in a gently undulating landscape. Soil capability classes are dominantly Classes 2 and 3, although there are limited extents of Classes 1 and 4. These variations are largely related to moisture regime. The landscape capability is Class 1.

d) Ruth Lake (RUT) Soils

These soils encompass 623 ha (21%) of Lease 86/17 and 0 ha (0%) of the Steepbank Mine. Ruth Lake soils are sandy to gravelly soils on glaciofluvial deposits. They range from rapidly drained on slight ridges to moderately well drained where they border on organic soils. These soils are dominantly capability Class 5, limited by low moisture retention on Class 1 landscapes.

e) McClelland (MLD) Soils

These soils encompass 0 ha (0%) of Lease 86/17 and 438 ha (12%) of the Steepbank Mine. McClelland soils are very poorly drained organic soils (i.e., fens) associated with drainage courses. Depth of peat ranges from 40 cm to more than 100 cm, and was averaged at 100 cm for volume calculations. Soil capability is Class 5 due to wetness and deep peat. The landscape capability is Class 1.

f) Muskeg (MUS) Soils

These soils encompass 1382 ha (46%) of Lease 86/17 and 1739 ha (48%) of the Steepbank Mine. Muskeg soils are widespread on the upland plain, on both sides of the Athabasca River Valley. They are very poorly drained organic soils also known as bogs. Peat depths exceed 40 cm and are often more than 100 cm. An average depth of 100 cm was used in calculating volumes. Soil capability is Class 5 due to wetness and deep peat. The landscape capability is Class 1.

3.3.4 Reclamation Scenarios and Forest Capability

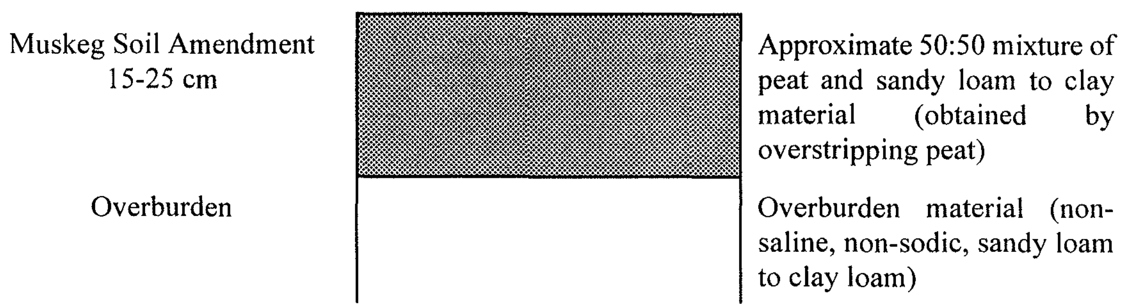
Reclaimed soils include four main types of scenarios occurring on level surfaces and steep slopes:

1. 15-25 cm of muskeg soil amendment over medium to fine textured overburden;
2. 15-25 cm of muskeg soil amendment over sandy loam overburden;
3. 15-25 cm of muskeg soil amendment over tailings sand; and
4. Muskeg soil amendment of varying thicknesses over consolidated tailings and wetlands.

The limitation to these four soil types is a result of mining by-products used as parent materials (e.g., overburden, tailings sand), a key determinant in the development of active soils. The anticipated soil capability of reclaimed areas is shown on Map S3. Reclamation scenarios for the four types of reclamation soils are described in the following section:

3.3.4.1 Reclamation Soil A

A potential reclamation scenario for a moderately productive forest soil (Class 2) includes application of a Reclamation Soil A scenario. Reclamation Soil A, which will be employed on the dyke walls on the Steepbank Mine, has the following profile:



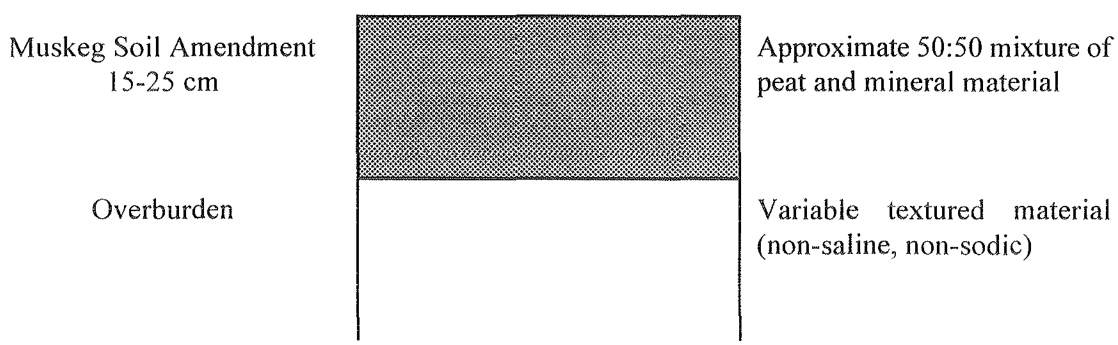
Muskeg soil amendment will be obtained by overstripping peat from Muskeg and McLelland map units (i.e., Class 5 soils), with a placement of 15 to 25 cm onto the underlying material (in this case, overburden). This soil profile, with a sandy loam or finer subsoil texture derived from ALG, KNS, MMY and RB3 units, would result in a Class 2 forest soil on mid slopes. On lower slopes receiving lateral seepage, or level areas with a water table at 1 to 3 m, these soils would be Class 1. If water tables become shallower than 1 m, then the rating will be lowered to Class 3 or 4 depending on degree of wetness.

Soil variation will be produced by creating topographic variation (1-5 m vertical, 10-100 m horizontal) on reclaimed benches, level surfaces and slopes. Inclusions of sandier soils would result in patches of Class 3 soils. Landscape capability is Class 1 on level areas (topographic class 2 and 3) and Class 3 on slopes (topographic classes 5-7).

3.3.4.2 Reclamation Soil B

A potential reclamation scenario for a moderately productive (Class 2) forest soil includes application of a Reclamation Soil B scenario. Reclamation Soil B will be employed on the overburden dumps on the Steepbank Mine.

Moderate capability forest land (Class 2) can be created by placing 15-25 cm of soil amendment over mineral material derived from areas within the ALG, FIR, KNS, RUT, RB3 and RB2 Units. This material is placed on overburden waste dumps and has the following profile:



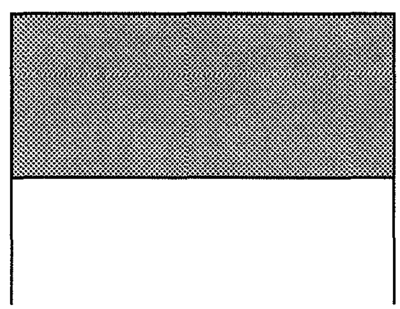
Normally this soil would be Class 2; however, with added moisture through seepage or a water table at 1 to 3 m it would become Class 1. Under excessively wet conditions, it will be rated lower. There may be variations of one class dependent on texture, with finer subsoil materials resulting in a rating of Class 2 and sandy materials resulting in a rating of Class 3. Landscape capability is Class 1 on level areas (topographic class 2) and Class 3 on slopes (topographic classes 5 to 7).

Soil placement and topographic variation would be accomplished as for Soil A; however, there will be more seepage within Soil B, and therefore greater diversity.

3.3.4.3 Reclamation Soil C

A potential reclamation scenario for a low productive forest soil (Class 3) includes application of a Reclamation Soil C scenario. Reclamation Soil C will be employed on the Steepbank Mine on areas capped with tailings sand.

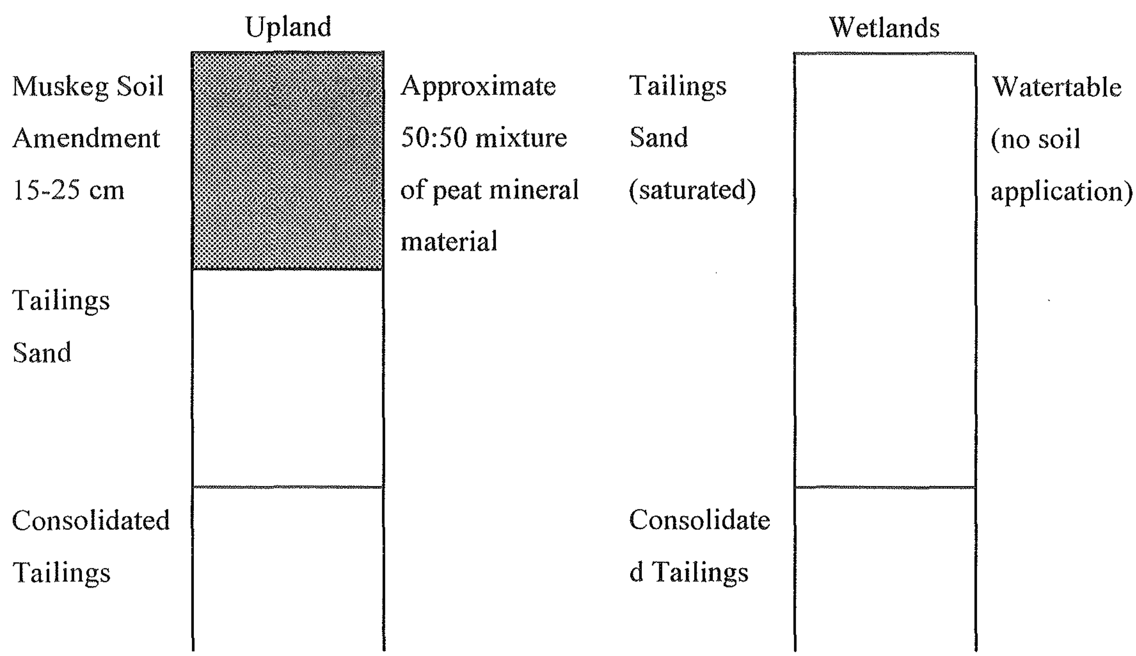
Low capability forest land (Class 3) can be created by placing 15 to 25 cm of muskeg soil amendment over tailings sand. The landscape capability is Class 1 on level areas (topographic class 2) and Class 3 on slopes (topographic classes 5-7). The soil profile would look as follows:



3.3.4.4 Reclamation Soil D

A potential reclamation scenario for a low to non-productive forest soil (Class 3 to 5) includes application of a Reclamation Soil D scenario. Reclamation Soil D will be employed on the Lease 86/17 and Steepbank Mine CT deposit surfaces.

The reclamation of CT deposits is a time related phenomenon. Once the deposits dry sufficiently to permit traffic, then tailings sand or lean CT and a 15 to 25 cm muskeg soil amendment will be placed on 60 to 80% of the surface, creating a type C soil interfingered with wetlands. It is envisaged that there will be a complex of type C soils and wetlands, with possible salinity. At this time, a long-term soil rating of Class 3-5 is assigned. In the short term, these soils are Class 5. Landscape rating will be Class 1 as these lands are nearly level. The soil profiles would look as follows:



3.3.5 Soil Capability Rating from Map Units

Gains and losses of specific soil capability classes for both the Steepbank Mine and Lease 86/17 are shown in Tables 3.6 and 3.7. These data were obtained by plotting land areas and soil classes from the Soil Map Series (MS-1 and MS-3), which show soil conditions for both Lease 86/17 and the Steepbank Mine for predisturbance and long-term (i.e., after mine abandonment) conditions.

3.3.5.1 Lease 86/17

Baseline conditions for soil classes on Lease 86/17 reflect a grouping of soil classes between Class 2-1 (i.e., 60 to 80% is Class 2 and 20 to 40% is Class 1) and Class 5 (Table 3.6). However, the vast majority of soils were within Class 5, the least productive category (2010 ha or 67% of the total). After reclamation (long-term), it is anticipated that there will be only three main groupings, Class 2, Class 3 and Class 3 to 5. The wide range of soil classes in the 3-5 group reflects uncertainties regarding soil moisture conditions on the reclaimed consolidated tailings deposits (cf. Section 3.3.4.4).

Overall, the soil capability in the post reclamation period will be equivalent or better than baseline conditions. There will be a loss of 350 ha of productive soil (Class 2-1), but an increase of 280 ha of moderately productive soils (Class 3). In addition, a large amount of land (1860 ha) will be upgraded from Class 5 to Class 3 to 5.

Finally, note that the total hectares of soil do not balance between the pre-disturbance and post-reclamation conditions. The increase of 220 ha after reclamation can be ascribed to the Tar Island Dyke landform which did not exist before mining activity was initiated.

3.3.5.2 Steepbank Mine

The data in Table 3.7 indicate that 440 ha will remain the same as pre-disturbance conditions since this area (infrastructure) will not be stripped of its soil (Map IMS-2020) and, therefore, was not included in this analysis. Of the remaining 3180 ha, 48% will be reclaimed to a Class 2 (1540 ha) and 52% to a Class 3-5 capability (1640 ha). This rating is substantially higher than the baseline capability which has a lower percentage (8.5%) in the Class 2 or Class 3 condition compared with the 48% for the long-term (i.e., after mine abandonment). In parallel with this observation, the amount of Class 5 soil (i.e., least productive) is anticipated to decrease from 2180 ha at baseline to 0 ha in the long-term.

It is important to recognize the inherent variability of the soil classification system (cf. Section 3.3.3). For example, Lease 86/17 reclaimed soils appear to be less diverse compared with pre-disturbance conditions. However, each single class represents other classes also (i.e., only 70% or more may be within that class). Also, a large area is described as within Class 3 to 5, which encompasses most of the pre-disturbance types of classes. Therefore, it is anticipated that there will be no loss in biodiversity in terms of soil classes. This aspect of the analysis is addressed in the following section.

3.3.6 Assessment and Summary

As discussed in Section 3.3.5, the soil capability classification system appears to show a loss of biodiversity after reclamation. To further evaluate these data, the map units (from which data in Tables 3.6 and 3.7 were generated) were evaluated and adjusted to provide the synopsis given in Table 3.8. This synopsis takes into account variability of soils and their capability in natural and reclaimed landscapes. Field observation and experience provide the basis for this evaluation. An inventory and rating of reclaimed lands on Lease 86/17 is underway in 1996 to confirm this assessment.

3.3.6.1 Lease 86/17

Overall, the soil capability for forest vegetation in the post-reclamation period will be better than baseline conditions. There will be an increase in Class 2 and 3 soils, replacing Class 5 soils. For the total mine area, the combined extent of Class 1, 2, and 3 lands before disturbance was 410 ha or 14%, while the projected extent after reclamation is 1900 ha or 59%.

3.3.6.2 Steepbank Mine

The data in Table 3.8 indicate a substantial increase in Class 2 and 3 soils after reclamation of the Steepbank Mine. Under pre-disturbance conditions, there is 450 ha (13%) of Class 1, 2 and 3 forest soils. Following mining and reclamation, the extensive muskeg areas presently rated Class 5, will be reclaimed to upland forest soils. As a result, there will be a total of 1450 ha (40%) Class 1, 2 and 3 forest soils.

3.3.6.3 Summary

Soil biodiversity will be retained and forest productivity enhanced in the post-reclamation period for both Lease 86/17 and the Steepbank Mine.

3.4 Revegetation

3.4.1 Revegetation Objectives

The primary objectives of Suncor's revegetation program are to:

- provide an erosion-resistant plant cover on tailings dyke slopes and overburden waste dump slopes;
- focus on utilization of woody-stemmed reclamation species common to the region;

- strive to establish a diverse range of plant species to re-create the level of biodiversity common to the pre-disturbed site; and
- establish a permanent, viable plant community capable of developing into a self-sustaining cover of forest species suitable for traditional land uses, wildlife use and with possibilities for recreation and other end uses.

These objectives match those of the Integrated Resource Plan Guidelines for the Athabasca River Valley under the issues of "wildlife", "erosion", "floodplain", "recreation and tourism" and "ecological" resource management (Section 2.1). Suncor's revegetation program is committed to providing a diversity of self-sustaining vegetation communities throughout its reclaimed leases to meet these objectives.

3.4.2 Current Revegetation Practices

The revegetation of reclaimed landform surfaces is dictated by the nature and type of landform structures (dykes, overburden, tailings sand, CT deposit), slope aspect, soil type (capability class) and soil drainage conditions. The type of vegetation community which will successfully establish and develop under various combinations of these factors has been the subject of Suncor research programs over the last 20 years.

Typically, the revegetation process begins with excavation and hauling of undisturbed muskeg soils to the reclamation area. This method (which is completed in the winter whenever possible) enhances site revegetation because dormant, in situ native seed and root fragments are transferred with the soil. Spreading of the muskeg soil amendment on the reclamation site is completed in early spring with the usual result being the emergence of a variety of native, woody-stemmed species, forbs, wildflowers and grasses.

Establishment of woody plants on reclamation areas is integral to the reclamation process. Selection of species and the proportion of each species in the supplemental planting mix are based on the woody-stemmed species common to the ecosites within the Suncor region; existing field conditions; the vegetation type expected to develop on the site (based on landscape terrain features); and the expected growth of woody-stemmed species from seeds and root fragments in the soil amendment layer. The ultimate species composition is designed to accelerate the process of natural succession towards desired vegetation types. The micro-environment modifies as woody cover develops on a reclamation area, providing favourable conditions for later successional and mature species. The planting program ensures these species are present, established and capable of taking advantage of condition changes. Generally, four to six species are planted to supplement the natural processes of woody plant establishment. Details of woody-stemmed species planted by Suncor over the past 20 years are presented in Suncor 1995.

Natural succession to ecosystems similar to others found in this region will result in four primary vegetation types including:

1. Open Mixedwood Forest - Coniferous Dominant (Pine Forest) - This vegetation type will be established on the edges of tailings sand plateaus and slopes.
2. Closed Mixedwood Forest - Deciduous Dominant (Poplar-White Spruce/Shrub) - This vegetation type will be established on the moister areas of tailings sand plateaus and consolidated tailings deposits. It will also be established on overburden dykes used to re-establish Steepbank Mine escarpment areas within the Athabasca River valley.
3. Closed Mixedwood Forest - Coniferous Dominant (White Spruce-Poplar/Shrub) - This vegetation type will be established on the overburden waste dumps, the lower portions of the tailings dyke slopes with northerly aspects and on reclaimed consolidated tailings deposits.
4. Wetlands Closed Shrub Complex - This vegetation type will be established on poorly-drained areas of tailings sand plateaus and consolidated tailings deposits.

3.5 Wildlife

Suncor's current reclamation method produces a diverse herbaceous cover within a year of soil amendment application. This initial cover provides erosion protection along with a source of cover and food for wildlife. Additionally, through Suncor's vegetation program as well as natural revegetation, this cover includes most of the plants required for establishment of a mature forest ecosystem. Wildlife utilization of reclamation areas increases as food and shelter become more available on the reclamation sites (i.e., with maturing vegetation). Monitoring on existing reclaimed areas has been on an observational basis. In the future, Suncor will assess new programs to further monitor and document wildlife usage of newly reclaimed areas.

4.0 RECLAMATION PLAN FOR THE STEEPBANK MINE PORTION OF THE ATHABASCA RIVER VALLEY

4.1 Landforms and Terrain

4.1.1 Proposed Landform Development Within the Athabasca River Valley

The current escarpment will be mined since it is composed mainly of oil sands ore. It will be reconstructed with overburden waste dumps and dykes within the Athabasca River Valley. These are, from north to south, the North Overburden Waste Dump, Dyke 10, the West Overburden Waste Dump and Dyke 11 (Figure 4.1). Each of these structures is constructed of overburden materials stripped from over the oil sands ore body.

The north and west overburden waste dumps will be built primarily with overburden materials which are considered unsuitable for dyke construction. These materials tend to have too high a moisture content to provide the stability required in a containment dyke structure. The dyke structures are designed to provide secure impoundment of the consolidated tailings (CT) which will be held in Ponds 7 and 8.

As a result of these mining features, some of the land areas will be transferred into alternate landforms. Some of the low-lying land within the Athabasca River Valley basin will be reconstructed into areas with 3:1(H:V) slope. These new valley walls will be better drained than the pre-existing landforms and therefore will allow for the development of a productive forest ecosystem. The primary aspect of all the dyke and dump structures will be to the west. Therefore, these constructed structures will effectively replace the existing valley wall slopes on the Steepbank Mine side of the Athabasca River with similar west facing valley walls.

4.1.2 Terrain Modifications Within the Athabasca River Valley

Long-term post-reclamation landform stability (of all retention structures) is evaluated through a combination of current and forecast stability. In more than twenty-five years of operations Suncor has maintained the stability of all tailing dykes and waste dumps. These structures have been designed and operated to accepted Canadian standards. Their design construction and performance have been supported by an extensive monitoring program and reviewed by independent review boards and regulatory agencies.

4.1.2.1 Micro-Scale Modification to Structure Design

The dyke and dump structures are created with stability as the primary objective. This does not preclude the ability to make alterations to the final design of these structures while maintaining the objective of stability. There are possibilities for micro-terrain modifications to all constructed structures. Micro-terrain modifications are defined as a five metre change in elevation or contour over a ten to one hundred metre distance (Figure 4.2). This type of modification can be either vertically aligned, horizontally aligned or both. The result of micro modification to dyke and waste dump structures is the provision for terrain differences that will result in a more diverse ecosystem development. These terrain differences and ecosystem diversities would be more consistent with the pre-disturbance condition.

4.1.2.2 Macro-Scale Modification to Structure Design

Major structure changes or macro-terrain modifications are not as easily achieved. These are defined as major alterations to the design of a waste dump or dyke structure and must be incorporated in the original design of the structure while maintaining the objective of stability. Because of the need for geotechnical stability in dyke structures, the most simple and readily monitored design is considered essential. Therefore macro-terrain modifications are not recommended for dyke structures. However, overburden waste dumps can accommodate major modifications in the design pattern over the length of the structure.

4.2 Drainage Patterns

4.2.1 Existing Drainage

Pre-mine drainage patterns are shown in Figure 4.4. The major watercourses in the mine area are the Steepbank River and the Athabasca River. Smaller watercourses in the area include Unnamed, Leggett and Wood Creeks. Several other smaller watersheds also drain the area. The largest water body in the mine area is Shipyard Lake and its associated wetland/marsh complex. Shipyard Lake is an abandoned oxbow channel of the Athabasca River and is connected hydraulically to the Athabasca River both via surface flow and potentially via groundwater flow. Essentially none of the mine area is drained to the Steepbank River; currently all surface waters drain directly into the Athabasca River or into Shipyard Lake, which drains to the Athabasca River.

4.2.2 Mine Drainage

As discussed in Section 3.2.5, there are two types of surface water streams; surface run-on water from off-lease areas which are intercepted and routed around the active mine areas and mine drainage waters from the disturbed areas of the mine. All mine drainage waters will be contained and used in the extraction process. The only environmental issues surrounding mine drainage waters are the potential for spills from containment facilities. Detailed design of these mine drainage retention basins will minimize the potential for such spills. Interception drainage systems for surface run-on waters are discussed below.

4.2.3 Interception Drainage

Surface run-on waters will be managed during the life of the Steepbank Mine operation to ensure these waters maintain a quality comparable to current surface drainage for the duration of the Steepbank Mine operations.

In the first 4-5 years of the Steepbank Mine operation, interception drainage will be collected in the uplands above the escarpment and routed down to the valley floor through Unnamed Creek to Shipyard Lake. In about 2002, the Unnamed Creek basin near the escarpment will be mined out as part of Pit 1 mining operations. Upland drainage from the north portion of the Steepbank Mine will be maintained through a re-aligned Unnamed Creek channel or pipeline (similar to the current South Mine Drainage system on Lease 86/17) for the duration of mining. As mining progresses southward, run-on drainage from the upland areas will be channelled into Leggett Creek until it is mined out in 2008. This drainage will then be re-routed through the re-aligned Unnamed Creek Channel. This is a change from the drainage plan outlined in the Steepbank Mine Application. The revised plan removes any excess flow from Wood Creek thereby avoiding increased erosion potential or impacts to Wood Creek aquatic habitat.

Shipyard Lake flows will be maintained at baseline levels (about 111 L/s) by interception drainage routed through Unnamed Creek (and the re-aligned Unnamed Creek). After Leggett Creek is mined out, the flow from Leggett Creek will be routed through the re-aligned Unnamed Creek, however, the flow to Shipyard Lake will be split to maintain baseline levels. A sufficient volume to maintain baseline flows in Shipyard lake will be directed to the lake while the remainder will be routed to the outlet of Shipyard Lake at the Athabasca River. Effectively, the Leggett Creek flow will be diverted to the outlet of Shipyard Lake at the Athabasca River. Shipyard Lake is discussed further in Section 5.0 of this report.

4.2.4 Overview of Environmental Impacts

The following summary was included in Suncor's Steepbank Mine Application (Suncor 1996):

- Changes to flows in the Athabasca and Steepbank rivers resulting from development, operation and reclamation of the Steepbank Mine, will be negligible.
- Impacts to surface water are a low concern on a regional basis since there is a low probability of any severe impacts, which (if they were to occur) would only be of short duration.
- Environmental impacts resulting from flooding are expected to be negligible.

4.2.5 Aquatic Habitats

From fisheries surveys conducted in 1995 and spring 1996 there was evidence of minor usage of Leggett or Unnamed Creeks as fish habitat especially at lower reaches during high flow periods.

In 1995, a Spottail Shiner was found in Leggett Creek (Golder, 1996). As these creeks will be totally reconstructed during the reclamation phase of the Steepbank Mine, they will be designed and constructed to provide fish habitat.

4.2.6 Groundwater Impacts and Mitigation

Three principal factors were considered in investigating the potential effects of the Steepbank Mine development on groundwater (Suncor 1996):

- changes in direction of groundwater flow;
- changes in the rate of groundwater discharge to surface water bodies; and
- changes in groundwater quality.

Mine operations will not affect groundwater quality in either the surficial or bedrock aquifers (Suncor 1996). In terms of routine operations, spill prevention and containment measures at the Athabasca Bridge, east access corridor and facilities area will prevent contamination of groundwater.

Consolidated tailings (CT) placed in the mine pits will have a pore water quality similar to the groundwater, including naturally-occurring organic compounds (e.g., naphthenic acid). Therefore, the effect of any seepage of this water on groundwater quality is expected to be negligible.

4.3 Soils

4.3.1 Topsoil Placement

Reconstruction of soils within the Athabasca River Valley will be strongly influenced by the nature of the reclaimed dyke and overburden landforms. While the general application and spreading of muskeg soil materials on these landforms will follow these practices previously described in Section 3.0, particular attention will focus on the salvage of thin, river valley soils, prior to disturbance.

Suncor has previously documented the logistical constraints which limit the ability to salvage shallow deposits of topsoil. Organic deposits of less than 0.6 metres are not usually salvaged due to the reduced quality of the topsoil and the problems associated with using large excavating equipment for this task. However, there is a valued component in these shallower soils which Suncor plans to utilize in refining the reclamation plan for the river valley. A demonstration area will be set up on the Steepbank Mine North Overburden Waste Dump to determine the benefits of salvaging shallow deposits of topsoil. This topsoil would be selectively removed from specific pre-disturbance stands that are projected to develop on the reclaimed landforms. Thus, areas where aspen stands are dominant will be stripped of the shallow soil. This soil will be placed on the reclamation sites in conjunction with the standard salvaged muskeg soil amendment to cover approximately 20% of the total reclamation area. The change in native plant emergence will be documented and compared with normal reclamation practices to assess the benefit of this approach. Should there be a significant improvement, this modification of Suncor's reclamation approach will be incorporated as part of future reclamation activities.

4.3.2 Schedule of Stripping Soil and Reclamation Activities

Soil capability provides the basis to prescribe land use options for site-specific conditions on both pre- and post-disturbance landscapes. Based on the soil capability classes described previously, a detailed soil mass balance was completed to document the progressive development and reclamation of landscapes within the Steepbank Mine.

Soil movement and reconstruction for the Steepbank Mine is an integrated process; therefore, the Athabasca River Valley portion of the mine cannot be isolated from the uplands area. However, river valley soils can be examined within the overall mine plan by extracting that portion of the information base delineated by the Athabasca River escarpment.

Soil stripping and reclamation activities for the Steepbank Mine are shown on Integrated Map Series (IMS-1997 to IMS-2020). These maps show the extent of soil stripping and reclamation as the mine plan is advanced through to the year 2020. The loss of soil classes due to stripping were calculated directly; that is, baseline (i.e., pre-disturbance) soil types were plotted on each map and these soil types then transferred to Class 1 to 5 using Leskiw (1996) and as summarized in this report (cf. Section 3.2.3). The area and class of reclaimed soils were calculated indirectly; that is, reclaimed areas in the IMS map series were extrapolated to the Soil Map (Map S3) which shows soil types after reclamation.

4.3.2.1 Soil Stripping

Soil stripping starts in 1997 with the development of a gravel pit and various infrastructure components. In 1998, the location of the North Overburden Waste Dump is cleared and stripped. Thereafter, stripping will proceed to the south as the mine pit is developed. Between the years 2005 and 2010, large areas of the southern mine area will be stripped, until completion at 2020. The total area cleared and stripped to the year 2020 will be 2690 ha (Table 4.2). The total amount of muskeg soil amendment available by 2020 will be 2138 x 10^4 m^3, based on multiplying the area of Class 5 soils (1527 ha) by a factor of 1.4, as discussed in Section 3.3.1.

The total area cleared and stripped does not match the post-reclamation area of 3775 ha shown in Table 3.7 (cf. Section 3.3.5) since the areas stripped do not include: 1) infrastructure areas (439 ha); 2) the unmined area described as the selectively cleared area (163 ha); and 3) other miscellaneous areas such as soil stockpiles (483 ha).

4.3.2.2 Soil Capability Classes

Soil volume balances (i.e., stripping and soils to stockpiles and/or reclamation areas) via the direct placement of soils are shown in Table 4.3. Stripped volumes used for reclamation are calculated from areas of Muskeg and Mildred soils (i.e., Class 5). These soils are overstripped to an average depth of 1.4 m (i.e., 1 m peat; 0.4 m mineral overburden). Volumes required for reclamation are based on spreading an average of 20 cm of this muskeg soil amendment on each hectare reclaimed. The soil volume balances shown in Table 4.3 indicate that a total soil volume of 2138 x 10^4 m^3 will be stripped by the year 2020. From this total, 325 x 10^4 m^3 (15%) will have been put onto reclaimed land with 200 x 10^4 m^3 (9%) put back using direct placement. The final soil volume in stockpiles by the year 2020 will be 1813 x 10^4 m^3 (85% of the total amount stripped). This volume of muskeg soil amendment will be used to reclaimed large areas of the mine after the year 2020.

4.4 Revegetation/Reclamation Plan

4.4.1 Objectives

The objectives for the Athabasca River Valley revegetation plan are based on replacing, where possible, the pre-disturbance vegetation communities which were identified and described in detail in the Steepbank Mine Application (Suncor 1996) and summarized in this report on Map V1. Revegetation of the reclaimed river valley landscape is essential in meeting IRP guidelines for the Athabasca River Valley, particularly with respect to erosion control, ecological function and processes and wildlife habitat.

The following premises underlie the overall objectives of the revegetation program:

- The composition and structure of the existing river valley vegetation varies with terrain conditions including elevation, slope, aspect and drainage patterns.
- The terrain of the reclaimed landforms (dykes, overburden dumps and CT deposits) will provide variation in elevation, slope, aspect and drainage patterns, which will in turn produce variation in revegetation types.
- Soil capability will influence the types of vegetation which can be established on various reclamation landscapes.
- Soil capability classes are a function of the type of reclaimed landscape, the nature of the subsoil materials and depth of muskeg soil amendment.
- Soil drainage conditions are a prime consideration in planning the revegetation program.
- Vegetation community diversity can be provided for in the reclamation plan, recognizing that increased diversity will occur over time, as other native species invade reclaimed sites.
- Vegetation community species diversity will be enhanced through direct placement of muskeg soil amendment from the river valley escarpment slope to reclaimed dykes and overburden waste dump sites.
- Vegetation patch size and habitat interspersion are important components of the existing vegetation cover, and can be re-established to some extent through site specific planning which may include the use of transplant "islands" (incorporating live shrub/tree saplings and plantings) to create a "mosaic" of revegetation types.

Based on field observations of the existing vegetation community composition, a number of vegetation types were recognized within the Athabasca River Valley. These vegetation types will serve as benchmarks to be used in the subsequent comparison of revegetation success. Reclamation and revegetation of the west-facing overburden waste dumps, for example, will be directed at establishing a vegetation cover that is as similar as possible to the pre-disturbance cover in terms of vegetation community types, patch size, interspersion and community composition.

4.4.2 Existing River Valley Landscapes

The Steepbank Mine will affect the Floodplain, Riparian Escarpment and Upland landforms previously described in the Application (Suncor 1996). Each of these landforms support a variety of vegetation types (ecosites), as shown in Figure 4.6.

The Riparian Floodplain and Riparian Terrace landforms of the Athabasca River Valley support a vegetation cover that is dominated by Closed Deciduous forest (balsam poplar dominant) (Figure 4.7). These stands are typically successional to Closed Mixedwood. Closed White Spruce is also common on the Floodplain in specific locations. In addition, flooding and backwater ponding has allowed for the development of Riparian Wetlands, which were classified within the Wetland Shrub Complex (willow dominated) and the Wetland Open Water/Emergent Vegetation zone. Shipyard Lake and its associated wetlands is an example of this type.

The Riparian Escarpment of both the Athabasca and Steepbank Rivers support a high cover of the Closed Deciduous Forest type, dominated by aspen. The variation in stand age, fire history and succession has resulted in the establishment of other forest cover types including Closed White Spruce (common in gullies) and Closed Jack Pine (common on well-drained knolls and slope crests).

The Upland landform is a broad upland plain which directs drainage from east to west. Large scale pooling and restricted drainage has resulted in the establishment of bogs and fens, which dominate the vegetation cover along the margins of the river valley and upland plain landforms. The relationships between terrain, soils and vegetation of the existing river valley condition are illustrated in Figure 4.8.

The community types identified during the 1995 field program, together with their species composition, was used in formulating the revegetation community types to be used in the revegetation program. These revegetation community types also incorporated input from Suncor's twenty years of on-site reclamation experience.

4.4.3 River Valley Revegetation Model

The revegetation plan for the Athabasca River Valley is based on the relationships between the nature and condition of the reclaimed landscapes, the soil capability class, soil drainage conditions and vegetation establishment and development over time. These relationships are derived from field investigations prior to mine development and from on-going reclamation research at the existing Suncor operations on Lease 86/17. The data collected to date provides a basis for ecological restoration which will be further developed as research and monitoring continue. The river valley revegetation model is summarized in Figure 4.6.

Within the Athabasca River Valley there are four main components of the Steepbank project which must be revegetated. These include (from north to south):

1. The North Overburden Waste Dump
2. Dyke 10 (supporting Pond 7)
3. The West Overburden Waste Dump
4. Dyke 11 (supporting pond 8)

In addition, surfaces of CT deposits are also included because portions of these components occur along the river valley escarpment-upland margins. These structures (as shown on Figure 4.6) present a variety of landform conditions which can support various classes of soil capability for forestry, depending on slope and drainage conditions.

The revegetation model provides the basis from which to design an appropriate revegetation type for site-specific conditions. Table 4.4 provides further details on site conditions including consideration of the type and soil capability class of reclaimed soil, its moisture regime and the types of vegetation it may support. Figure 4.6 provides site-specific information on revegetation communities which can be expected within the broader revegetation types identified for dykes, overburden dumps and CT deposit surfaces. Soil moisture condition is strongly influenced by slope position in both natural and reclaimed terrain within the river valley.

To re-establish vegetation communities as close as possible to the pre-disturbance conditions, species mixes have been prepared on a site-specific basis. The relative proportion of plant mixes is indicated in Table 4.4, along with the anticipated vegetation community type following vegetation maturation. Species composition and structure details of each revegetation type are summarized in Tables 4.5 to 4.12. These species mixes and planting regimes are based on experience from on-site reclamation research combined with analogs of existing ecosite descriptions for the river valley as described in the Application (Suncor 1996).

Variations in revegetation community types reflect adaptations to site conditions within the reclaimed structures. These are reflected in the vegetation types shown on Figure 4.9. The anticipated detailed revegetation plan for the integrated study area is shown on Vegetation Map V2. Further description of the diversity of revegetation types is provided in the following section.

4.4.4 Revegetation of Reclaimed River Valley Landscapes

4.4.4.1 Overburden Dumps and Dyke Walls

Reclamation Soil A (dyke walls) and Soil B (overburden dumps) will be used on these areas as discussed in Section3.4.4. Table 4.5 to 4.12 show the main species component of each of the revegetation community types planned for the Athabasca River Valley, Steepbank Mine. A complex of Closed Mixedwood is planned for the crests and midslope positions of the overburden waste dumps and dyke walls (Figure 4.9, 2020 revegetation plan). This complex is composed of two main community types: jack pine forests and aspen/rose-snowberry (Tables 4.5 and 4.6). On the existing, west-facing upper slopes and slope crests of the Athabasca River, relatively open Jack Pine Forests of 50 to 100 m in diameter are interspersed on better drained crests. The dominant vegetation cover surrounding these jack pine stands consists of well to moderately-drained aspen forests. In the revegetation plan, following terrain recontouring, blueberry/bearberry-reindeer lichen communities are expected to colonize on sites which resemble their natural site conditions (Table 4.6, Map V2). The remaining upper slope areas will become colonized by the aspen/rose-snowberry/hairy wild rye community type (Table 4.1).

The species mix in Table 4.6 will also be used for revegetation on selected south-facing slopes, where the insolation factor is high, resulting in drier conditions (Map V2).

A community type of Closed Mixedwood, White Spruce Dominant is planned for revegetation on northerly aspects of overburden waste dumps and dyke walls, where insolation is less, resulting in more mesic conditions which favour a higher white spruce component in the mature forest canopy (Map V2). Table 4.7 shows the species mix for the community type, based on the dominant tree, shrub and herb species observed in the existing environment. Tree and shrub species will be hand planted, using local and nursery grown individuals while the herb and grass species have been found to emerge from the muskeg soils amendment or through natural invasion. Two different types of Closed Mixedwood White Spruce Dominant forests were observed during the 1995 field program: one type has white spruce overtopping the aspen forest due to successional changes; the other type is a mix of relatively pure white spruce and pure aspen stands. In this later type, white spruce stands were located within inter-ridge (gully) depressions which were moisture receiving and mesic to sub-hygric. Aspen stands were located on the ridge tops and uplands, which were better drained and mesic to sub-mesic moisture regime.

This type of interspersion will be simulated in the revegetation plan: where the terrain is relatively uniform, white spruce and aspen will be intermixed, with a high diversity of understorey species. However, where there is terrain variability, resulting in an undulating topography, white spruce dominant stands will be planted in the depressions (Table 4.7), and aspen-dominant stands will be planted on the ridge tops and upper slopes (Table 4.6). This plan will help to re-establish the habitat diversity which presently exists along the escarpment slopes of the Athabasca River.

A number of aspen community types were observed in the existing, undisturbed environment of the Athabasca River escarpment, with variations attributed to slope and aspect, which, in turn, result in differences in soil nutrient and moisture regimes. West-facing aspects typically supported a mesic aspen forest, with a species composition indicated in Table 4.8. This mix of trees, shrubs, herbs and grasses will be re-established through plantings and natural revegetation from surface soil amendments on the west-facing slopes of the overburden waste dumps and dyke walls (Map V2).

Lower slope positions were also found to support an aspen-dominated community. However, due to a higher moisture regime resulting from downslope run-off, the shrub cover was higher and more diverse, and the understorey supported a number of species which reflected the increase in water availability (Table 4.9). This combination of species will be planted at lower slope positions of dyke walls and overburden waste dumps (Map V2).

Mesic sites, such as those found on the floodplain and in depressional areas and bottom slope positions, supported a deciduous dominant forest of balsam poplar, with a very high shrub cover and diversity. Bottom slope, depressional and level floodplain areas will be revegetated with a species mix which is representative of this community (Table 4.10, Map V2).

4.4.4.2 Tailings Sand

Coarse-textured sand deposits which have been amended with muskeg soil can be expected to be rapidly drained. On analogous sites within the Steepbank Study Area, open jack pine communities typify these site conditions. The revegetation type for this site condition is an Open Mixedwood type with jack pine and poplar anticipated to occupy slope crests and upper slope positions. A detailed description of the vegetation types is shown on Figure 4.6 and in Table 4.5.

4.4.4.3 CT Deposits

The expected successional development of vegetation on CT deposits has been previously outlined in the C&R Section of the Application (Suncor 1996). The sequence of vegetation includes a series of small wetlands, around which will develop a Wetland Closed Shrub Complex, a Deciduous Forest (mesic sites) and eventually a Closed Mixedwood, poplar dominant type (Figure 4.6). Overall, a mosaic of different vegetation types is anticipated in response to the micro-topographic conditions of hummock and swales on these surfaces.

The Wetland Closed Shrub Complex is dominated by willows, sedges, bluejoint and emergent species, representative of the existing wetland shrub zones (Table 4.11). These species have proven to quickly emerge from the muskeg soil amendment. Where possible, wetlands substrate will be directly moved to these sites, providing an abundance of native seeds, roots, stolons and tubers. This is particularly useful for species replacement in the Wetland Open Water/Emergent Vegetation Zone (Table 4.12).

4.4.5 Vegetation Balance

4.4.5.1 Steepbank Mine Footprint

The revegetation plan utilizes the information on vegetation associations or ecosites which occur within the Athabasca River Valley to balance vegetation losses with reclamation replacements. Existing vegetation types include Closed Deciduous, Aspen Dominant; Closed White Spruce; Closed Jack Pine; Closed Mixedwood; and, Closed Mixedwood, White Spruce Dominant. The overall vegetation "balance" for the Steepbank Mine is presented in Table 4.13.

Table 4.4 identifies the general vegetation community types which will be planted to reclaim the overburden waste dumps, dykes and CT deposits. Prior to seeding and planting, terrain, drainage and soil conditions will be documented, and the appropriate community for each micro-terrain site will be identified. This process will provide the basis for revegetation planning which will link the terrain, soil and vegetation parameters to provide for reclamation that is based on the Ecological Land Classification of the existing, pre-disturbance conditions.

The revegetation plan for the footprint of the Steepbank Mine will result in some substantial changes in the overall balance of vegetation communities (Table 4.13). As an overview to this discussion, the following factors are relevant:

- Shipyard Lake is no longer in the footprint of the mine. Therefore the total number of hectares for the wetland open water area at baseline is negligible.
- This apparent discrepancy is the result of the exclusion of the "selectively cleared" area in the soil capability analysis since this area is not scheduled for soil shipping or reclamation.
- The ELC classification system has been expanded in terms of forest cover since the EIA (Suncor 1996) to include more forest types; for example, there are now four different types of Deciduous forests (West Aspect, Lower Slope, South Aspects and Mesic Site). This has been done to achieve greater diversity, especially within the sensitive and valued river valley where wildlife habitat enhancement is an important consideration.
- This comparison includes the entire area of the Steepbank Mine footprint rather than just the river valley position. This was done to conform with the soil classification analysis.

The most significant changes include a substantial increase in the area of Wetland Open Water/Emergent Vegetation Zone and Wetland Closed Shrub Complex. These ecosites are presently uncommon on the escarpment slope and Upland terrain types of the Steepbank Mine footprint. Revegetation of these types is planned to occur in association with the tailings ponds and surrounding sub-hygric area. Another significant difference is the reduction in bog and fen vegetation types (Table 4.13). These vegetation types are very common within the Suncor Local Study Area and therefore reclamation to these types is not considered a benefit to the escarpment slope area. In addition, reclamation to bog and fen vegetation types is largely contingent on the appropriate drainage conditions and may eventually become re-instated, given drainage/moisture conditions.

There is also a planned increase in the area of deciduous dominated vegetation types, as bog and fen and white spruce vegetation types are replaced with aspen dominated types. This is a function of the terrain changes in the reclamation plan, where Upland bog and fen ecosites will be replaced with raised, and better drained terrain and substrate materials, which are better suited to support aspen and white spruce dominated communities. In addition, the successional changes which result in Closed White Spruce Forest, will not be realized for many decades following revegetation. However, the present vegetation plan, does provide white spruce cover in the Closed Mixedwood, White Spruce Dominant ecosite, which eventually outgrow and replaces aspen, resulting in a Closed White Spruce Forest, in the future. During successional changes, and due to variations in tree plantings (as dictated by terrain), the Closed Mixedwood, White Spruce Dominant revegetation type will also provide for areas of Closed White Spruce and relatively even Mixedwood, such as in the existing environment.

An additional change in vegetation balance is associated with jack pine forest cover. This type will be present in the revegetation type of Mixedwood (Crests and Mid-Slopes), which will be a mosaic of aspen dominated and jack pine dominated communities. The overall balance of jack pine stands within the planned revegetation of Mixedwood will likely be similar to the existing cover of 238 ha, with the remaining cover being Aspen (South Slopes).

4.4.5.2 Athabasca River Valley Footprint

A comparison of pre-disturbance and post-reclamation vegetation types for the Athabasca River Valley is detailed in Table 4.14. The total land area involved (approximately 3400 ha) includes both that area of the river valley within, as well as outside of the footprint of the Steepbank Mine. This area is all the land to the west of the river valley boundary shown on Map V2.

The largest vegetation type is Deciduous Forests both for pre-disturbance (48%) and post-reclamation (53%) conditions.

Vegetation types that will increase in area after reclamation include: Closed Mixedwood (from 1 to 16%); Open Mixedwood (from 0 to 13%); and, Closed Mixedwood, White Spruce Dominant (from 5 to 10%). Vegetation types decreasing in area include: Closed Jack Pine (from 6 to 1%); Closed White Spruce (from 13 to 0%); and Peatland (from 13 to ~0%). The Wetlands Shrub Complex ecotype remained substantially the same decreasing from 251 to 214 ha, a result of relocation of the West Overburden Waste Dump away from Shipyard Lake.

4.5 Wildlife

In assessing the impacts of the proposed Steepbank Mine development on wildlife particular concern was expressed about the possible impacts of the project on the Athabasca River Valley (Westworth, Brusnyk and Associates Ltd., 1990 a,b). The valley was identified as the most important wildlife habitat feature in the region, supporting a higher diversity of wildlife than the adjacent uplands. The Athabasca River Valley was also identified as an important wintering area for moose, important breeding habitat for terrestrial birds and high quality denning habitat for furbearers and large carnivores. However, there is no evidence that the valley in the Steepbank Mine area is an important movement corridor (Suncor 1996).

4.5.1 Importance of the Athabasca River Valley for Wildlife

Baseline studies conducted in the Steepbank Mine area in 1995 and 1996 indicated that the Athabasca River Valley and escarpment provides some of the most important wildlife habitat in the area (Suncor 1996). These studies indicate that nine of the 11 mammal species recorded in the Steepbank Mine Study Area were associated with these landscape features and that habitat associated with the river valley such as riparian balsam poplar forest and shrub complexes, supported the highest abundance and diversity of breeding birds.

The importance of the river valley for wildlife is related, at least in part, to the diversity, complexity and productivity of riparian forests (Forsythe and Roelle 1990). Natural zonation in the valley provides habitat for a variety of wildlife species as well as a favourable microclimate during severe weather conditions. Hauge and Keith (1981) reported that moose (*Alces alces*) in the Fort McMurray area frequently moved into the Athabasca River Valley in late winter in response to severe weather and accumulating snow. South and west-facing slopes are important to deer (*Odocoileus* spp.) and moose because they usually have less snow and a greater abundance of deciduous browse than other areas. Browse production and utilization studies conducted in the study area indicated that deciduous forests on the Athabasca River escarpment were heavily used by browsing ungulates (Westworth, Brusnyk and Associates Ltd. 1996a). Moreover, south and west-facing slopes are usually the first to green-up in the spring and thus, provide the first succulent forage of the year.

Typically, river valleys are also considered important as corridors for wildlife moving between seasonal ranges and for dispersing individuals.

Field assessments conducted in 1995 and 1996 to determine baseline wildlife conditions in the Steepbank Mine area showed that habitats in the valley are used by many wildlife species. Track count surveys conducted during the late winter period indicated that moose move into favourable wintering habitat in the valley from the adjacent upland but that movement up and down the valley is minimal. Movements of forest carnivores, such as coyote and fox also appeared to be localized within the valley. Frequencies of tracks crossing transects that extended across the valley were generally similar to track frequencies recorded on transects that paralleled the river. These surveys suggest that, although the Athabasca River Valley provides important habitat for moose and furbearing animals, its importance as a north-south movement corridor for these species may be minimal, during winter at least. However, there is a possibility that the valley functions as a dispersal corridor or travel route during other seasons.

River valley and escarpment areas also typically provide nesting and denning opportunities for a variety of wildlife species. Riparian balsam poplar forest contains numerous deadfalls and standing dead trees, which provide opportunities for cavity nesting birds, such as woodpeckers and some species of waterfowl, and denning opportunities for mammals, such as the black bear (*Ursus americanus*), lynx (*Lynx lynx*) and fisher (*Martes pennanti*). In contrast, the escarpment provides important habitat for mammals such as wolves (*Canis lupus*) and coyotes (*C. Lastrans*) who utilize subterranean dens in well-drained sites.

The Athabasca River Valley also contribute to the biodiversity of the area. Within the study area, mature riparian balsam poplar forests and riparian wetlands, such as Shipyard Lake, are largely restricted to the valley. Riparian balsam poplar (*Populus balsamifera*) forest also provides important breeding habitat for at least 28 species of birds, including six species that were recorded only in this habitat type during breeding bird surveys conducted on the Steepbank Mine area in 1995 (Westworth, Brusnyk and Associates Ltd. 1996b).

4.5.2 Wildlife Reclamation Strategies

4.5.2.1 Habitat Diversity

The Athabasca River Valley is characterized by a high diversity of wildlife habitats. Habitat diversity can be achieved by creating a similar degree of landform diversity and reestablishing plant communities similar to those that presently exist in the valley.

Reclaimed landscapes often exhibit a loss of the topographic variability that characterizes natural landscapes. Recontouring of overburden waste dumps and dyke slopes as described in Section 4.1 will result in the creation of a greater diversity of micro-sites. Differences in aspect, soil moisture regime and water or snow accumulation between micro-sites will result in improved vegetation diversity. This will in turn benefit wildlife by providing a greater diversity of browse and forage species.

Plant species used on reclaimed areas will be selected from communities having similar soil moisture conditions to the area being reclaimed. A variety of trees, shrubs and herbaceous ground plants will be used to provide a more structurally complex habitat and to help promote community diversity during the period of successional development (cf. Section 4.4.4). Selected species will also include some of the more important wildlife food plants.

Examples of upland and wetlands habitat which can be expected to develop over time on reclaimed surfaces are shown on Figure 4.10 and 4.11 along with their anticipated utilization by wildlife species.

4.5.2.2 Spatial Heterogeneity

Wildlife species that exist in forest ecosystems vary widely in their requirements for space. Territory or home range sizes vary from less than one hectare for small animals such as red-backed voles and many songbird species to hundreds of square kilometres for wide ranging species such as wolves and wolverines. A forest must be spatially diverse to support a high diversity of wildlife, although the degree of diversity required varies from species to species. Generally, most species that occupy extensive ranges tend to be habitat generalists; that is, they use a diversity of preferred habitat types. The most difficult species to manage in a reclamation plan are habitat specialists, those species requiring relatively uniform environments or specific habitat conditions. Most habitat specialists have relatively small home ranges, although some forest interior species require larger blocks of habitat. Reclamation planning will reflect habitat requirements of species identified for the Steepbank Mine area during wildlife surveys conducted as components of the environmental impact assessment.

During breeding bird surveys conducted in the Steepbank study area in 1995, a number of bird species were recorded that were restricted to a single habitat type. These species can be considered habitat specialists. The highest number of unique species were associated with Closed Shrub Complexes (9 species) and Riparian Deciduous Forests (6 species). No unique species were recorded in Aspen-dominated Deciduous Forest, suggesting a lower degree of habitat specificity within this habitat type. The Closed Shrub Complex is a habitat associated primarily with wetlands and riparian zones, including the margins of Shipyard Lake. Most of the unique species associated with this habitat (including Great Blue Heron, Sandhill Crane, Spotted Sandpiper, Swamp Sparrow, Red-winged Blackbird and Rusty Blackbird) nest and feed along the margins of marshes and open-water wetlands. The Riparian Deciduous Forest provided habitat for a number of neotropical and North American migrants that were not recorded in other habitat types on the Steepbank Mine area.

These included the Black-throated Green Warbler, Warbling Vireo, American Redstart, Cedar Waxwing, Song Sparrow and Brown-headed Cowbird. This group of birds includes species that nest in the canopy and shrub layers, reflecting the structural diversity of these old riparian forests. The proposed reclamation plan is intended to meet the requirements of each of these unique or specialist species.

4.5.2.3 Refugia

Establishment of productive wildlife habitats on reclaimed areas will be assisted by planting a diverse mixture of native plant species of different life forms (e.g., grasses, forbs, shrubs and trees). The structure and composition of the initially established communities will be simplistic in comparison with the natural undisturbed ecosystems. The newly reclaimed communities will lack the "within habitat" (alpha) diversity that characterises natural ecosystems. Over the long term however, other native species are expected to recolonize reclaimed areas, resulting in an increase in plant and animal diversity. For relatively complex ecosystems it may take hundreds of years before recolonization is complete and the full complement of native species are restored.

Suncor will increase the rate of recolonization of reclaimed landscapes by establishing refugia or "islands" of intact natural ecosystems within the larger development area. These refugia will serve as sources of seed for native plant establishment and will assist in speeding recolonization of reclaimed areas by amphibians, birds, small mammals and the hundreds of species of invertebrates that exist in forest soils.

This practice will be achieved by leaving intact, areas within the general mine footprint that are not required for excavation or facilities construction. Where possible, native habitat corridors will be maintained to connect extensive reclaimed areas with undisturbed habitat. These connections would accelerate recolonization of reclaimed areas by wildlife and would enhance habitat interspersion.

4.5.2.4 Ecosystem Implants

Another method of increasing the rate of recolonization is to transplant patches of soil and vegetation from natural ecosystems to reclamation areas. As described in Section 3.3.1, a mixture of muskeg and underlying surficial materials will be spread over reclamation areas as a muskeg soil amendment. Previous research carried out on Lease 86/17 has shown that this material contains seeds and roots of many native plant species, some of which become established on the reclaimed site. This practice benefits natural regeneration on level sites with moist soil conditions; however, it is not likely to provide the same benefits on the slopes of overburden waste dumps and dykes along the escarpment, where rapid drainage and south and west exposures will result in drier site conditions. On these sites, soil material (i.e., topsoil and vegetation) will be transplanted from equivalent ecotypes to determine the effectiveness of this method. It is not feasible to completely cover reclamation area slopes in this way, however, placing this material in small patches or "islands" across extensive reclamation areas is expected to facilitate the recovery of natural biodiversity. This would be achieved through sequencing of mine stripping and reclamation, with material moved as direct placement; that is, from new working areas to reclamation sites as the mine advances. Stockpiling the muskeg soils results in some mortality of seeds and roots of vegetation as well as loss of mycorrhizal inoculum.

The same approach will be used to develop diverse, productive wetlands habitats on reclamation areas. Transplanting topsoil or sediments from marshes into constructed wetlands will greatly accelerate wetlands development. Existing wetlands sediments contain seeds, roots and other plant propagules, which result in rapid vegetation colonization, as well as introducing a wide range of invertebrates and microorganisms that will promote the establishment of a typical wetlands detrital food chain.

4.5.2.5 Slash and Deadfall

Habitat in boreal forests is provided not just by living vegetation but also by the dead and decaying vegetation components. Many species depend on snags and fallen logs for cover, as nesting or denning sites, and as feeding substrates. Some of these wildlife benefits will be achieved by distributing logs and slash from newly cleared mine areas across areas undergoing reclamation. This practice will also result in nutrient enrichment of these reclamation areas. A disproportionately large amount of the nutrients in a tree are contained in the branches, twigs and leaves (Hunter 1990). Slash, when distributed across a reclamation area, will slowly decompose and recycle nutrients. Decomposing logs provide a moist, fertile seedbed, thus facilitating natural regeneration of trees and other native vegetation. Decomposing logs also serve as sources of mycorrhizal fungi, which form symbiotic relationships with plants by assisting with nutrient resorption. This mycorrhizal relationship is essential for certain tree species. Deadfall is also an important habitat element for small mammals, such as red-backed voles, which consume the fruiting bodies of the fungi and serve as agents of dispersion for spores. On slopes, slash can also aid in erosion control. As a consequence of the above benefits, slash/deadfalls will be incorporated into soil test plots and subsequently, if successful, incorporated into Suncor's reclamation program.

4.5.2.6 Movement Corridors

Winter track count surveys conducted in 1996 did not indicate a well-defined pattern of movement along the valley by moose and forest carnivores (Westworth, Brusnyk & Associates Ltd. 1996a). However, there is concern that the Steepbank Mine Project, which will occupy an extensive area along the east side of the valley, could interfere with some wildlife movements and thus affect processes important for population regulation. A strategy for mitigating those concerns during the operation of the mine will be to maintain the native forested corridor between the mine area and the Athabasca River. The corridor will be limited to 90m (just south of the bridge) and 200 m between the West Overburden Waste Dump and the Athabasca River. It will include provisions to allow wildlife movements past the Steepbank Mine access corridor and the Athabasca River bridge. Vegetation will be planted in the bridge shoreline area to improve the corridor aspects through this area.

a) Overview

The Steepbank Mine will completely disrupt some areas east of the escarpment, as well as some of the escarpment areas. Therefore, the use of the east-west corridor on the Steepbank Mine area will be eliminated. This in turn will further reduce the usage of the north-south corridor because animals which use the Athabasca River Valley may gain access to this corridor via these east-west corridors. The net result is that the expected demand for use of the Athabasca River Valley corridor will decrease from the already low levels recorded during the EIA field investigations.

b) Summary of Impacts

The planned mining activities during the initial 20 years of operations on the Steepbank Mine site will effectively eliminate usage of the area as a corridor for wildlife. However, the potential impact of this removal may be minimal because there was little evidence of pre-development usage of the area as a corridor.

c) Planned Mitigative Activities

1. Suncor will provide a modified corridor area (with the exception of the time when the barge landing site is in use). The modified corridor will include approximately 1350 m of shoreline area where the corridor width is less than 100 m. Table 4.15 details these sections and provides the earliest date when each area will be reclaimed to at least a minimum 100 m width.

2. The return of the area to use by wildlife is an integral component of the planned reclamation activities as detailed in other sections of this report. Suncor will make the following commitments regarding river valley reclamation to re-establish the north-south movement corridor:

   - Immediate reclamation of the decommissioned barge landing site once the new bridge is constructed. Reclamation of this area will include planting of large trees (i.e., >5 m in height) in the reclaimed barge landing area to re-establish the treed shoreline corridor; and
   - Decommissioning and reclamation of all areas located within 100 m of the shoreline area as quickly as possible throughout the 20 years following the start of activities on the Steepbank Mine.

5.0 SHIPYARD LAKE

Wetlands are complex ecosystems which can be unproductive (e.g., bogs) or very productive (e.g., swamps, marshes). They provide a number of key ecological functions such as biogeochemical cycling, nutrient cycling and fish habitat (Hamilton et al. 1992). Suncor has an extensive database on wetlands as a result of past Suncor research regarding the use of wetlands to treat mine release waters (e.g., Nix et al. 1993). In the area of the river valley impacted by the Steepbank Mine, the principal wetlands area is Shipyard Lake. The predominant type of wetlands in northern Alberta is peatlands; however, Shipyard Lake more closely approximates a marsh wetlands. As a result, it is productive biologically (Hamilton 1992) and can support fish production when there is access to the Athabasca River as a result of high water levels. Shipyard Lake is fed by three small catchment basins with an approximate area of 41 km^2.

5.1 Alberta Wetlands Policy

One of the IRP objectives is to minimize impacts and, where necessary, mitigate any adverse impacts through the development of a plan which would provide equivalent capability. Specific draft policy principles developed by the Alberta Water Resources Commission (AWRC 1994) state that wetlands are an integral and important part of the environment, providing many environmental, economic and social benefits. Further, it is recognized that wetlands are dynamic ecosystems and that their management should be a shared responsibility between developers, regulatory agencies and the public. With respect to slough/marshes, the primary objective of AWRC is to conserve these wetlands where possible, to minimize any negative impacts and to mitigate any degradation or loss of wetlands function; perhaps, to the extent of restoring existing wetlands, or creating new wetlands.

5.2 Suncor Wetlands Management Strategy

A standardized protocol similar to the forest soil capability system is not available for assessment of wetlands ecological capability and productivity. Therefore, Suncor's policy will be to preserve fundamental factors which are the principal determinants of wetlands characteristics, such as sediment type, hydrological regime and water quality (Kadlec and Knight 1996). As a result, Suncor relocated the West Overburden Waste Dump away from Shipyard Lake such that this dump now does not intrude into the wetlands, as was originally shown in Suncor's Steepbank Mine Application (Suncor 1996). Suncor's objectives to manage this wetlands are as follows:

- minimize environmental impacts to Shipyard Lake; most notably, by maintaining approximately equivalent water flows and quality compared with pre-mine conditions, and
- enhance, if necessary, nutrient levels in the water column within Shipyard Lake.

The management of Shipyard Lake and other wetlands within the mine development area will consider input from stakeholders through a process yet to be established.

5.3 Wetlands Management and Reclamation Plan

As a result of the relocation of the West Overburden Waste Dump, the following general consequences are likely:

- the physical integrity of Shipyard Lake will be maintained;
- a narrow (200 m) wildlife corridor will exist between this overburden waste dump and the Athabasca River south of Shipyard Lake;
- a larger area of riparian wildlife habitat (i.e., Shipyard Lake and its immediate surrounding land) will be available south of the major concentration of Steepbank Mine support facilities; and
- any impact on fish habitat within Shipyard Lake will be minimized.

5.3.1 Erosion and Channelization

Soil movement will be minimized through the use of upstream retention basins. Further, erosion from the slopes of overburden waste dumps will be minimized through effective and rapid revegetation (Suncor 1996). Changes in the hydrological regime will be minimized through the use of a number of discharge points into the wetlands via the diversion system (cf. Section 4.2.4), thereby minimizing changes to current wetlands channelization.

5.3.2 Hydrology

Original estimates for water flows into Shipyard Lake were a reduction of about 48% after mining (i.e., from 111 to 53 L/s; Klohn-Crippen 1996). As discussed in Section 4.2.4, baseline flows into Shipyard Lake will now be maintained (current hydrological studies are underway to better define baseline or pre-disturbance flows) using a water diversion system (Figure 4.12). Other than minor changes in flows within the mine drainage system resulting from waste dump reconfiguration, relocating the West Overburden Waste Dump out of Shipyard Lake will not affect the overall mine drainage component of the site run-off since this component of the flow will still be used as process water as required.

5.3.3 Water Quality and Nutrient Balance

The chemistry of water flows into Shipyard Lake will likely not change substantially during and after mining since:

- water impacted by mining processes (i.e., depressurization, surface run-off) will be diverted into the mine drainage system for use as process waters;
- groundwater inputs will be very minor (Suncor 1996); and
- inputs of suspended solids will be minimized by decreasing flow velocities in the interception channels, constructing basins to trap sediment, lining the channels with erosion resistant material and/or revegetating disturbed areas adjacent to the channels (Klohn-Crippen 1996).

Water flows lost to Shipyard Lake as a result of mine drainage will be replaced by water from upstream portions of Leggett Creek (i.e., outside the mine footprint). However, the quality of water from Leggett Creek is not substantially different from water within Shipyard Lake (Table 4.16). For example, levels of nutrients are comparable: average total phosphorus is 0.07 mg/L in Shipyard Lake and 0.08 mg/L in Leggett Creek; average nitrate and nitrite nitrogen is 0.02 mg/L in both systems. The only exception is substantially higher levels of non-filterable residue in Leggett Creek (10 to 211 mg/L) compared with Shipyard Lake (2 to 79 mg/L). However, these values likely reflect the sample source; that is, at the mouth of the creek rather than upstream where water diverted to

Shipyard Lake will originate. Also, the removal of suspended soils will be enhanced by retention ponds.

5.3.4 Vegetation and Wildlife

Vegetation and wildlife aspects of the reclaimed Steepbank Mine have been covered in Sections 4.4 and 4.5. However, the following are relevant to these issues in terms of the retention of Shipyard Lake as a viable ecosystem:

- This wetlands complex (which includes both terrestrial and aquatic vegetation) will provide an important natural colonization area for plants adjacent to newly reclaimed areas.
- There will now be no habitat loss as previously predicted (Suncor 1996). In fact, increased flows into the channel draining to the Athabasca River may enhance the fishery.
- The wetlands and adjacent undisturbed dry land will constitute a valuable wildlife refuge area in the river valley.

6.0 MONITORING AND RESEARCH STRATEGIES

Once active reclamation is complete and vegetation has been re-established, Suncor monitors progress toward maturation of landscapes and ecosystems to allow evaluation of the reclamation program, as well as to provide the basis for future submissions for reclamation certification. Monitoring is the foundation of adaptive management, providing on-going feedback to adjust future plans and methods. During this phase, Suncor will carry out any required maintenance activities on its reclamation areas.

Suncor will establish practical criteria which can serve as milestones in the maturation process (to determine whether long-term goals are likely to be achieved). This will include continued refinement and application of the Oil Sands Reclamation Performance Assessment Framework as one method for evaluation of the success of Suncor's reclamation plan and process. Routine reclamation performance assessment and monitoring is described in detail in the Suncor Steepbank Mine Application (Suncor 1996).

The proposed reclamation plan provides considerable flexibility and opportunities to address specific future land uses including wildlife habitat, traditional land use, recreation and possibilities for commercial forest production. It is anticipated that future large-scale demonstrations followed by monitoring of fully-reclaimed areas will establish the basis to determine the final end use of the reclaimed land.

Suncor, has identified a need for a regional, multi-stakeholder approach to end use planning for reclaimed oil sand lands. This process includes participation by all parties with critical interests on end use of the reclaimed oil sands leases. This process may result in the provision of inputs necessary to implement modification to the routine reclamation plan such that certain reclamation areas are available for specific end uses.

6.1 Landforms

Suncor evaluates the performance of tailings structures and deposits through an extensive monitoring program which includes visual inspections; analysis of data from instrumentation; annual structural performance reports; and surveys of pond contents and behaviour. These monitoring and assessment activities will continue until reclamation certification is received. The frequency and level of monitoring will be optimized to meet the requirements for an effective program.

6.2 Reclamation Release Water Quality

Suncor has a well-documented program which monitors regional and on-site surface water and groundwater qualities. Analytical models required to predict future process water quality, (including the impact of conversion to consolidated tailings) have been developed. Comprehensive modelling of surface water and groundwater flow rates from reclaimed lands has been completed for Lease 86/17. Also the distribution, fate and environmental risks of specific chemical species within reclamation streams have been detailed, incorporating extensive field pilot-scale test programs.

6.3 Soils

Vegetation and soil characteristics in reclaimed areas are monitored each year on the Suncor leases. The monitoring program consists of annual vegetation cover assessment and soil sampling on areas reclaimed within the past three to four years, followed by detailed assessment and sampling of all reclaimed areas every fifth year.

Performance of topsoils and subsoils is a key parameter for erosion control and ecosystem sustainability. Suncor has monitored and assessed its reclaimed soils by comparing trends of key parameters to reference soils. Soil samples are analysed for pH, salt content (as indicated by electrical conductivity or EC), macronutrient levels, organic carbon content, nitrate-nitrogen, phosphorus, potassium and sulphate-sulphur. This monitoring program will be extended into newly reclaimed areas, as a routine part of Suncor's reclamation program. Suncor is currently conducting a soil inventory and forest capacility assessment of reclaimed lands on Lease 86/17, to be completed in 1996. This work is evaluating and demonstrating the application of the "Land Capability Classification for Forest Ecosystems in the Oil Sands Region" (Leskiw 1996). It will also provide supporting scientific data for the capability rating system assigned to the four reclamation soil types (A, B, C, and D) as discussed in Section 3.3.4.

6.4 Vegetation

Suncor's reclamation monitoring program also includes assessment of the achievement of its reclamation objective for the river valley of "replacing, where possible, pre-disturbance vegetation communities". Suncor has conducted programs since 1976 to monitor ecological development on its reclaimed sites. These programs include an annual program specifically to assess herbaceous vegetation growth as well as physical and chemical properties of soil. The reclamation program includes a routine maintenance component involving fertilization of revegetated areas, erosion repair and control, and planting of areas with poor performance. Annual assessments of tree and shrub survival and growth have been conducted in areas where known numbers of seedlings were planted. Results of these programs are reported to AEP in Suncor's annual Conservation and Reclamation Report. These monitoring programs will also be extended into newly reclaimed areas.

A revegetation study is planned for 1997 whereby forest floor material will be stripped and direct placed onto reclaimed areas in "islands" or "strips". This will be done in conjunction with tree planting. Monitoring will continue until the year 2002 and results compared with current reclamation practices. If successful, this technique will be incorporated into the Steepbank Mine reclamation program.

6.5 Wildlife

Assessment of the sustainability of re-established ecosystems requires consideration of soil and vegetation development, forecasts on the evolution of revegetated areas to mature systems and re-entry of wildlife.

Monitoring is an integral component of Suncor's adaptive reclamation management approach. Monitoring of wildlife use of reclaimed landscapes is required to provide feedback on the success of reclamation and revegetation techniques. Previous experience has shown that wildlife will begin using reclaimed areas as soon as a herbaceous vegetation cover is established. The diversity of wildlife using the reclamation sites will increase over time as more food and cover become available. Monitoring of wildlife species representative of the various successional stages (Figures 4.8 and 4.9) will indicate the degree to which reclaimed areas are developing into productive sustainable ecosystems. Suncor will monitor wildlife use of special habitat features (refugia, ecosystem implants, riparian buffers, movement corridors and these will include bridge bypass facilities.

6.6 Current Studies

The following monitoring and research activities have been or will be initiated to respond to the ecological sensitivity of the river valley:

- hydrological study of Shipyard Lake;
- ecological characterization of Shipyard Lake;
- shallow soil study strips;
- spring fisheries survey; and
- re-assessment of the EIA based on recent modifications to the project design.

7.0 SUMMARY

This report provides detailed objectives and a commitment to special management and reclamation practices for the Athabasca River Valley section of the Steepbank Mine, in recognition of its sensitive and valued ecology. The river valley reclamation plan will meet specific guidelines established by the Integrated Resource Plan (IRP).

Suncor's reclamation program for both Lease 86/17 and the Steepbank Mine will result in reclamation of the area soils, vegetation and wildlife communities to a state at least equivalent to pre-disturbance conditions. For the Athabasca River Valley component of the Steepbank Mine it is anticipated that overall soil, vegetation and wildlife conditions in this area will also be at least equivalent to pre-disturbance conditions.

This proposed reclamation program will produce the same general pre-disturbance vegetation and wildlife habitat conditions following completion of reclamation as exists in the pre-development condition. All new valley landforms will be reconstructed from overburden. Similar structures on Lease 86/17 are demonstrating the vitality of Suncor's reclamation methods. In addition, because of the sensitive nature of the river valley ecology, Suncor will implement a series of enhanced surface reclamation techniques, thereby ensuring that a similar and sustainable ecosystems will be created in this valued ecological area. Under Suncor's process of adaptive management, this program will include those measures listed below as well as the application of future novel techniques as validated by ongoing research and general improvements in reclamation science.

As a consequence of the above policies, Suncor will achieve IRP guidelines for mitigating adverse environmental impacts in the river valley after mine abandonment, and will minimize adverse impacts during the period of mining operations. The IRP guidelines for the protection of specific biophysical impacts of the river valley are listed below, with a brief summary of Suncor's specific approach to achieving the objectives of each guideline.

Wildlife: valley vegetation, riparian habitat, and habitat diversity

Suncor will establish an equivalent or better soil capability during reclamation. In conjunction with soil replacement, a revegetation program will place a wide diversity of native plants over a terrain configured by both macro and micro-scale modifications. Specific adaptive management procedures will be as follows:

- direct placement of the muskeg soil amendment whenever possible;
- minimize the storage of soils in stockpiles;
- use of transplant islands;
- replant similar aspects (i.e., west facing slopes) with plants typically found on those existing aspects;
- plant appropriate species that conform with conditions of micro-scale sites;
- place logs and slash in reclaimed areas to provide nutrient enrichment and to enhance biodiversity; and
- retain areas of intact native habitat within the general mine footprint to serve as "refugia" and thereby increase the rate of reclamation of reclaimed areas.

The result of these programs will provide a diverse habitat for both plants and animals.

Erosion: sensitive soils and drainage patterns

Suncor will construct stable terrain structures (i.e., retention ponds, diversion channels). Specific reclamation procedures will include:

- maintain historical flows in Wood Creek;
- replace Leggett Creek with a drainage channel after mine abandonment;
- no alteration of flows to Wood Creek; and
- rapid revegetation of all areas associated with drainage-ways.

Floodplain: setback to at least 1:100 flood level; accommodate natural evolution

Suncor will place all permanent structures outside the 1:100 flood level where feasible. Structures within this flood zone will include the bridge abutments and barge landing; however, neither pose any environmental impact issues.

Water Quality: for downstream uses; natural surface water and groundwater regimes

Suncor will avoid any environmentally significant impacts on water quality. Specific plans will:

- direct mine pit and facilities drainage waters to process;
- use retention ponds to minimize inputs of suspended solids into receiving waters;
- use controlled discharge of treated sewage to mitigate any loss of nutrients in Shipyard Lake; and,
- use a water diversion system to maintain flows to Shipyard Lake.

Groundwater impacts have been assessed as negligible. These measures will ensure that there will be no substantial impact of surface water on water quality.

Recreation and Tourism: visual and acoustic, travel corridor, valley horizon

New reclamation technology has increased end use potentials. Recreation and tourism are options that must fit into the overall regional end use plan.

Ecological: unique characteristics, rare flora and fauna, critical functions and processes

Suncor will retain ecological biodiversity as much as possible. This will be achieved by:

- implementing macro-scale structural modifications, where practical;
- implementing micro-scale terrain modifications;
- employing direct placement of topsoil from the escarpment slope to dyke and waste dump slopes to enhance colonization by a diverse variety of native species;
- setting back of some facilities south of the bridge, to provide a 95 m corridor for wildlife; and,
- relocating the West Overburden Waste Dump to avoid direct impacts to Shipyard Lake.

Traditional Uses: First Nation Peoples

Traditional uses for the Steepbank Mine have been assessed (Suncor 1996). Pre-disturbance potentials will be restored through the proposed valley reclamation plan. Suncor will continue its relationship with traditional land users to ensure their input to the planning process.

Historic Sites: scientific, educational and interpretive purposes

Historical resources have been assessed as a low potential (Suncor 1996). Therefore, this reclamation plan has not specifically included any initiatives to preserve such sites. Suncor will continue its current practice of identifying and referral to authorities any findings of historical or archeological value in the course of the mine development.

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Table 3.1 Relationship of Soils Capability Class to Index Points and Forest Productivity

Soil Capability Class	Index Points	Forest Productivity: Limitations
1	81-100	High; none to slight
2	61-80	Moderate; moderate
3	41-60	Low; moderately severe
4	21-40	Currently non-productive; very severe
5	0-20	Permanently non-productive; extreme

Table 3.2 Soil Capability and Landscape Subclasses

Soils (S)	Subclass Letter
<u>Physical Parameters</u>	
· available water holding capacity	M
· structure/consistence	D
· organic carbon	F
· surface peat	O
<u>Chemical Parameters</u>	
· acidity/alkalinity	V
· salinity	N
· sodicity/saturation percentage	Y
· nutrient retention capacity	K
<u>Edaphic Regime</u>	
· soil moisture regime	R
· soil nutrient regime	R
Landscape (L)	
· slope	T
· exposure - configuration of slope, aspect, wind	X
· stoniness	P
· erosion - visible gully erosion	E

Table 3.3 Relationship Between Topographic Classes, Slopes and Landscape Capability Classes

		Landscape Class		
		Severity of Erosion		
Topographic Class	% Slope	Slight-Moderate	Severe-Very Severe	Extreme
1	0-0.5	1	2	3
2	0.6-2	1[1]	2	3
3	3-5	1[1]	2	3
4	6-9	1	2	3
5	10-15	1	2	3
6	16-30	2	3[2]	4
7	31-45	3	3[2]	4
8	46-70	4	4	5

1 Expected reclaimed level surfaces.
2 Expected reclaimed steep slopes.

Table 3.4 RB2 Forest Capability Assessment

Soil	Slope	Extent Percentage	Soil Capability[1]	Landscape Capability[1]
Shallow Firebag	6-15%	20%	5S	2
Firebag	6-15%	60%	4MR	2
Algar	<5%	20%	4R	2
Assigned Overall Rating			4-5	2

[1] Described in Table 3.2.

Table 3.5 RB3 Forest Capability Assessment

Soil	Slope	Extent Percentage	Soil Capability[1]	Landscape Capability[1]
Kinosis	40%	40%	2-3DR	4TE
Firebag	40%	20%	4MR	4TE
Regosols	80%	20%	5FD	5TE
Algar	5-15%	20%	4R	3ET
Assigned Overall Rating			4-3	4TE

[1] Described in Table 3.2.

Table 3.6 Pre-Disturbance and Post-Reclamation Soil Capability Classification for Lease 86/17

Soil Class[1]	Pre-disturbance Area (ha)	Post -Reclamation (ha)
2-1	350	0
2	0	1090
3	0	280
4	260	0
4-3	180	0
3-5	0	1860
4-5	210	0
5	2010	0
TOTAL	3010	3230

[1] Soil class ratings for forest productivity range from Class 1 (most productive) to Class 5 (least productive);see Section 3.3.2.

Table 3.7 Pre-Disturbance and Post-Reclamation Soil Capability Classification for the Steepbank Mine

Soil Class[1]	Pre-disturbance Area (ha)	Post-Reclamation Area (ha)
2-1	40	0
2	0	1540
2-3	270	0
4	120	0
4-3	420	0
3-5	0	1640
4-5	590	0
5	2180	0
Infrastructure Area	0	440
TOTAL	3620	3620

[1] Soil class ratings for forest productivity range from Class 1 (most productive) to Class 5 (least productive); see Section 3.3.2.

Table 3.8 Synopsis of Pre-Disturbance and Post-Reclamation Soil Capability

Soil Class	Lease 86/17 (ha)		Steepbank Mine (ha)	
	Pre-Disturbance	Post-Reclamation	Pre-Disturbance	Post-Reclamation
1	100	100	50	50
2	250	800	200	900
3	60	1000	200	500
4	550	500	800	1250
5	2050	600	2370	500
Infrastructure		230		420
TOTAL	3010	3230	3620	3620

Table 4.1 Average Annual Flows for Drainage Basins in the Steepbank Mine Footprint Before, During, and After Mining Operations

Drainage Basin	Average Annual Flow (L/s)
1995	
Shipyard Lake at Athabasca River	121
Shipyard Lake Outlet	111
Leggett Creek	91
Wood Creek	102
Athabasca River (1)[1]	22
Athabasca River (2)[1]	3
Athabasca River (3)[1]	22
2001	
Shipyard Lake at Athabasca River	126
Shipyard Lake Outlet	111
Leggett Creek	91
Wood Creek	101
Athabasca River (1)[1]	11
Athabasca River (2)[1]	3
Athabasca River (3)[1]	22
2009	
Shipyard Lake at Athabasca River	91
Shipyard Lake Outlet	88
Leggett Creek	92
Wood Creek	101
Athabasca River (1)[1]	9
Athabasca River (2)[1]	3
Athabasca River (3)[1]	22

Table 4.1 Average Annual Flows for Drainage Basins in the Steepbank Mine Footprint Before, During, and After Mining Operations

Drainage Basin	Average Annual Flow (L/s)
2020	
Shipyard Lake at Athabasca River	23
Shipyard Lake Outlet	121
Leggett Creek	0
Wood Creek	101
Athabasca River (1)[1]	9
Athabasca River (2)[1]	3
Athabasca River (3)[1]	9
Post Closure	
Shipyard Lake at Athabasca River	144
Shipyard Lake Outlet	111
Leggett Creek	0
Wood Creek	101
Athabasca River (1)[1]	11
Athabasca River (2)[1]	3
Athabasca River (3)[1]	9

[1] Drainage areas as shown on Figure 4.4.

Notes:
1. Drainage in years 2001 and 2020, inclusive, does not include runoff from the mine area. Runoff from the mine area is collected by an internal drainage system for use in the oil sands extraction process.
2. Long run includes rehabilitated mine areas.
3. Lowland runoff (from muskeg and fen) is assumed to be 50% of the upland unit runoff.
4. The Athabasca River drainage basins represent contribution to flow in the Athabasca River and not the discharge in the river.

Table 4.2 Schedule of Steepbank Mine Soil Stripping for Each Soil Class

Year	Soil Classes							Totals for all Classes	
	Class 2-1[1]	Class 2-3[1]	Class 4[1]	Class 4-3[1]	Class 4-5[1]	Class 5[1]		Total	Total
	Area[2]	Area[2]	Area[2]	Area[2]	Area[2]	Area[2]	Volume	Area[2]	Area[2]
1997	0	0	33	0	17	0	0	50	0
1998	0	21	0	41	107	27	38	196	38
1999	0	5	0	3	0	11	15	19	15
2000	0	12	0	3	1	15	21	31	21
2001	0	22	10	83	43	56	79	214	79
2002	0	4	20	37	9	118	166	188	166
2003	0	1	47	5	0	84	117	137	117
2004	0	0	8	0	0	58	81	66	81
2005	33	145	34	211	191	391	548	1005	548
2010 [4]	2	0	0	15	0	400	560	417	560
2015 [4]	0	0	0	0	0	367	513	367	513
2020 [4]	0	0	0	0	0	0	0	0	0
Total	35	210	152	398	368	1527	2138	2690	2138

1 Soil classes represent the average class capability for each area stripped.
2 Areas in hectares.
3 Volumes in m^3 x 10,000 - Muskeg soil volumes determined by applying a factor of 1.4 to the area stripped (includes MUS and MLD soil units).
4 Values represent five year sub-totals.

Table 4.3 Soil Volume Balance for Stripping and Reclamation Activities for the Steepbank Mine

Year	Volume Stripped (m^3 X 10,000)	Area (ha)	Volume Reclaimed (m^3 X 10,000)	Stockpile Storage Volume (m^3 X 10,000)	Direct Placement Volume (m^3 X 10,000)
1997	0	0	0	0	0
1998	38	0	0	38	0
1999	15	0	0	15	0
2000	21	0	0	21	0
2001	79	0	0	79	0
2002	166	0	0	166	0
2003	117	0	0	117	0
2004	81	114	35	46	35
2005	548	0	0	548	0
2010[1]	560	239	72	488	72
2015[1]	513	308	93	420	93
2020[1]	0	417	125	-125	0
Total	2138	1078	325	1813	200

1 Values represent five year sub-totals.

2 Class 5 soils, from Table 4.2.

3 Calculated by multiplying ha * 0.3 (i.e., 20 cm of muskeg soil amendment X 1.5 to account for soil compression and over-construction in certain areas.

Table 4.4 Revegetation Types Proposed for Various Reclaimed Soils Within Lease 86/17 and the Steepbank Mine

RECLAIMED SOIL TYPE AND CAPABILTY CLASS	DRY slope crests	MESIC mid to upper slopes		MOIST mid to lower slopes	WET lower slopes/ depressions
A-2	**OPEN MIXEDWOOD**	**DECIDUOUS FOREST Westerly aspects**	**CLOSED MIXEDWOOD (White Spruce dominant) Northerly aspects**	**DECIDUOUS FOREST**	**WETLANDS /EMERGENT**
Muskeg/fine textures	Poplar 30%	Poplar 60%	Poplar 20%	Poplar 50%	Muskeg transplant
DYKES	Pine 30%	Spruce 20%	Spruce 60%	Spruce 30%	
	Spruce 10%	Pine 10%	Pine 10%	Willow 10%	
	Shrubs 30%	Shrubs 10%	Shrubs 10%	Shrubs 10%	
B-2	**CLOSED MIXEDWOOD**	**DECIDUOUS FOREST Westerly aspects**	**CLOSED MIXEDWOOD (White Spruce dominant) Northerly aspects**	**DECIDUOUS FOREST**	**WETLANDS /EMERGENT**
Muskeg/coarse textures	Poplar 40%	Poplar 60%	Poplar 20%	Poplar 50%	Muskeg transplant
OVERBURDEN	Pine 40%	Spruce 20%	Spruce 10%	Spruce 30%	
	Spruce 10%	Pine 10%	Pine 60%	Willow 10%	
	Shrubs 10%	Shrubs 10%	Shrubs 10%	Shrubs 10%	
C-3	**OPEN MIXEDWOOD**	**CLOSED MIXEDWOOD Westerly aspects**	**CLOSED WHITE SPRUCE Northerly aspects**	**DECIDUOUS FOREST**	**WETLANDS /EMERGENT**
Muskeg/Tailings Sand	Poplar 30%	Poplar 50%	Poplar 20%	Poplar 40%	Muskeg transplant
TAILINGS SAND	Pine 30%	Pine 10%	Pine 20%	Spruce --%	
	Spruce 10%	Spruce 30%	Spruce 50%	Willow 50%	
	Shrubs 30%	Shrubs 10%	Shrubs 10%	Shrubs 10%	
D-5	**N/A**	**CLOSED MIXEDWOOD (White Spruce dominant) on dry margins**	**DECIDUOUS FOREST on mesic margins**	**WETLAND CLOSED SHRUB COMPLEX**	**WETLANDS /EMERGENT**
Reclaimed CT Deposit	---	Poplar 20%	Poplar 40%	Selected muskeg	Selected muskeg
SURFACES	---	Pine 10%	Pine 40%	transplant within	transplant within
	---	Spruce 60%	Spruce 10%	wetlands/upland	wetlands/upland
	---	Shrubs 10%	Shrubs 10%	mosaic	mosaic

Table 4.5 Open Mixedwood - Coniferous Component Crests/Mid-Slope Positions

JACK PINE - (ASPEN)/ROSE/BLUEBERRY/BEARBERRY - REINDEER LICHEN					
Species	**Common Name**	**Strata**	**% Cover (at maturity)**	**Stem Spacing* (at planting)**	**Notes**
Pinus banksianna	jack pine	A1	40	10m	
Populus tremuloides	trembling aspen	A1	0-5	30m	optional
Picea glauca	white spruce	A2,B,C	0-5	40m	could plant later in program
Betula Papyrifera	paper birch	B2	0-5	40m	
Amelanchier alnifolia	Saskatoon	B1,B2	0-5	40m	more common in microsite depressions
Alnus crispa	green alder	B1	0-10	patches of 5 m diam.	Patchy, in mesic depressions
Rosa acicularis	prickly rose	B2	0-5	40m	ubiquitous
Vaccinium myrtilloides	common blueberry	B2	20	5m	ubiquitous
Arctostaphylos uvaursi	bearberry	C1	30	seed	patchy on sandy substrate
Cladina mitis	reindeer lichen	C1	40-60	with soil transfer	patchy - in older stands
Epilobium angustifolium	fireweed	C2	5	seed	
Campanula rotundifolia	harebell	C2	0-5	seed	
Oryzopsis pungens	northern rice grass	C1	0-5	seed	
Vaccinium vitisidaea	bog cranberry	C2	0-10	seed	
Comandra umbulata	bastard toadflax	C2	0-5	seed	

* This refers to the density of plants at initial revegetation which would be established by use of nursery stock and natural sources from soil amendments.

Table 4.6 Closed Mixedwood - Deciduous Component Crests/Mid-Slope Positions; and Deciduous Forest, South Aspects

ASPEN/WHITE SPRUCE/ROSE-SNOWBERRY/LOW BUSH CRANBERRY/WILD SARSAPARILLA/HAIRY WILD RYE					
Species	Common Name	Strata	% Cover (at maturity)	Stem Spacing * (at planting)	Notes
Populus tremuloides	trembling aspen	A1	50-70	5m	
Picea glauca	white spruce	A2,B,C	0-20	20m	could plant later in program
Amelanchier alnifolia	Saskatoon	B1,B2	5	10m	more common in microsite depressions
Cornus stolonifera	red-osier dogwood	B1,B2	5-10	20m	more common in microsite depressions
Alnus crispa	green alder	B1	0-5	30m	patchy
Symphoricarpos albus	snowberry	B2	20	10m	ubiquitous
Rosa acicularis	prickly rose	B2	30-40	10m	ubiquitous
Vibernum edule	low bush cranberry	B2	20	5m	
Aralia nudicaulis	wild sarsaparilla	C1	30	seed	
Aster conspicuous	showy aster	C1	10	seed	
Epilobium angustifolium	fireweed	C2	20	seed	
Lathyrus ochroelucus	cream-colored vetchling	C2	10	seed	
Petasites palmatus	palmate-leaved colt's foot	C1	10	seed	
Rubus pubescens	dewberry	C2	10-20	seed	
Fragaria virginianna	wild strawberry	C2	5	seed	
Vicia americana	wild vetch	C2	5-10	seed	
Elymus innovatus	hairy wild rye	C	20-30	seed	

* This refers to the density of plants at initial revegetation which would be established by use of nursery stock and natural sources from soil amendments.

Table 4.7 Closed Mixedwood, White Spruce Dominant

WHITE SPRUCE-ASPEN/BALSAM FIR/CANADA BUFFALOBERRY/FEATHER MOSS					
Species	**Common Name**	**Strata**	**% Cover (at maturity)**	**Stem Spacing* (at planting)**	**Notes**
Picea glauca	white spruce	A1, A2, B1, B2	60-70	10m	could stager plantings to simulate structural diversity
Abies balsamea	balsam fir	A2	0-30	30m	plant later (20 yrs)
Populus tremuloides	trembling aspen	A1	10	30m	could plant first (10 yrs)
Populus balsamifera	balsam poplar	A1	0-5	40m	only on lower slope, and/or mesic areas (moisture receiving)
Cornus stolonifera	red-osier dogwood	B1,B2	10	10m	
Shepherdia canadensis	Canada buffaloberry	B2	5-10	10m	in patches of pure white spruce
Vibernum edule	low bush cranberry	B2	5	40m	
Salix bebbianna	beaked willow	B1,B2	0-5	40m	only in depressional submesics sites - patchy
Salix scouleriana	Scouler's willow	B2	0-5	10m	more common in patches of high aspen cover
Rosa acicularis	prickly rose	B2	0-10	10m	
Ribes hudsonianum	wild black currant	B2	0-5	seed	
Linnaea borealis	twinflower	C1	5-10	seed	

Table 4.7 Closed Mixedwood, White Spruce Dominant

WHITE SPRUCE-ASPEN/BALSAM FIR/CANADA BUFFALOBERRY/FEATHER MOSS					
Species	**Common Name**	**Strata**	**% Cover (at maturity)**	**Stem Spacing* (at planting)**	**Notes**
Aralia nudicaulis	wild sarsaparilla	C1	0-10	seed	
Cornus canadensis	bunchberry	C1	5-10	seed	
Epilobium angustifolium	fireweed	C1	10	seed	
Petasites palmatus	palmate-leaved colt's foot	C2	0-10	seed	
Rubus pubescens	dewberry	C2	0-10	seed	
Mitella nuda	bishop's cap	C1	5	seed	
Equisetum arvense	common horsetail	C1	0-20	seed	
Calamagrostis canadensis	bluejoint	C1	20	seed	
Pleurozium schreberi	Schreber's moss	C1	0-80	soil transplant	high cover in pure white spruce stands
Hylocomnium splendens	stair-step moss	C1	0-30	soil transplant	high cover in pure white spruce stands

* This refers to the density of plants at initial revegetation which would be established by use of nursery stock and natural sources from soil amendments.

Table 4.8 **Closed Deciduous Forest - West Aspects**

ASPEN/DOGWOOD-CHOKECHERRY-SASKATOON/ROSE/WILD SARSAPARILLA/BLUEJOINT				
Species	**Common Name**	**Strata**	**% Cover (at maturity)**	**Stem Spacing* (at planting)**
Populus tremuloides	trembling aspen	A1	50-70	5m
Picea glauca	white spruce	A2,B	0-20	20m
Amelanchier alnifolia	Saskatoon	B1,B2	20	10m
Cornus stolonifera	red-osier dogwood	B1,B2	10	20m
Prunus spp.	pin and choke cherry	B1,B2	20	10m
Rosa acicularis	prickly rose	B2	10	10m
Vibernum edule	low bush cranberry	B2	10	5m
Aralia nudicaulis	wild sarsaparilla	C1	20	seed
Aster conspicuous	showy aster	C1	10	seed
Linnaea borealis	twinflower	C2	20	seed
Lathyrus ochroelucus	cream-colored vetchling	C2	10	seed
Calamagrostis canadensis	bluejoint	C1	20	seed

* This refers to the density of plants at initial revegetation which would be established by use of nursery stock and natural sources from soil amendments.

Table 4.9 Closed Deciduous Forest - Lower Slopes

ASPEN/WHITE SPRUCE/ROSE-LOW BUSH CRANBERRY/WILD SARSAPARILLA				
Species	Common Name	Strata	% Cover (at maturity)	Stem Spacing* (at planting)
Populus tremuloides	trembling aspen	A1	50-70	5m
Picea glauca	white spruce	A2	0-20	20m
Populus balsamifera	balsam poplar	B1	5	40m
Cornus stolonifera	red-osier dogwood	B1,B2	5	20m
Salix bebbianna	beaked willow	B1,B2	5	20m
Salix serissima	willow	B2	5	20m
Shepherdia canadensis	Canada buffaloberry	B2	0-20	5m
Rosa acicularis	prickly rose	B2	10	10m
Vibernum edule	low bush cranberry	B2	30	5m
Aralia nudicaulis	wild sarsaparilla	C1	20	seed
Aster ciliolatus	Lindley's aster	C1	10	seed
Epilobium angustifolium	fireweed	C1	10	seed
Aster conspicuous	showy aster	C1	10	seed
Equisteum arvense	common horsetail	C1	20	seed
Linnaea borealis	twinflower	C2	20	seed
Petasites palmatus	palmate-leaved colt's foot	C2	10	seed
Rubus pubescens	dewberry	C2	10	seed
Fragaria virginianna	wild strawberry	C2	5	seed
Calamagrostis canadensis	bluejoint	C1	20	seed

* This refers to the density of plants at initial revegetation which would be established by use of nursery stock and natural sources from soil amendments.

Table 4.10 Closed Deciduous Forest - Mesic Sites - Bottom of Slope, Floodplain

BALSAM POPLAR/WHITE SPRUCE-BALSAM POPLAR/DOGWOOD-WILLOW-CHOKEBERRY/HORSETAIL-BLUEJOINT					
Species	**Common Name**	**Strata**	**% Cover (at maturity)**	**Stem Spacing* (at planting)**	**Notes**
Populus basamifera	balsam poplar	A1,A2,B1,B2	30-75	5m	
Populus tremuloides	trembling aspen	A1	0.10	20m	on better drained terraces
Picea glauca	white spruce	A1,A2,B1,B2	10	20m	
Cornus stolonifera	red-osier dogwood	B1,B2	20-60	5m	
Ribes hudsonianum	wild black currant	B2	5-10	20m	
Salix bebbianna	beaked willow	B1,B2	10-30	10m	
Alix scoulerianna	Scouler's willow	B1,B2	5	20m	
Prunus virginianna	chokecherry	B1	0-40	20m	
Rubus idaeas	wild red raspberry	B2	5-10	10m	
Rosa acicularis	prickly rose	B2	5-10	10m	
Vibernum edule	low bush cranberry	B2	10-30	5m	
Symphoricarpos albus	snowberry	B2	0-5	10m	
Ribes oxycanthoides	wild gooseberry	B2	0-5	10m	
Alnus tenufolia	river alder	B1	0-20	10m	at upper creek edges only
Actea rubra	baneberry	C1	0-5	10m	
Aralia nudicaulis	wild sarsaparilla	C1	5-30	seed	

Table 4.10 Closed Deciduous Forest - Mesic Sites - Bottom of Slope, Floodplain

BALSAM POPLAR/WHITE SPRUCE-BALSAM POPLAR/DOGWOOD-WILLOW-CHOKEBERRY/HORSETAIL-BLUEJOINT					
Species	**Common Name**	**Strata**	**% Cover (at maturity)**	**Stem Spacing* (at planting)**	**Notes**
Aster ciliolatus	Lindley's aster	C1	10	seed	
Rubus pubescens	dewberry	C2	5-30	seed	
Cornus canadensis	snowberry	C2	0-30	seed	
Galium triflorum	sweet-scented bedstraw	C2	0-5	seed	
Mitella nuda	bishop's cap	C2	0-5	seed	
Vicia americana	American vetch	C1	0-5	seed	
Fragaria virginianna	wild strawberry	C2	5	seed	
Equisetum arvense	common horsetail	C1	5-40	seed/soil	depressional seepage sites - common
Calamagrostis canadensis	bluejoint	C1	5-10	seed	
* This refers to the density of plants at initial revegetation which would be established by use of nursery stock and natural sources from soil amendments.					

Table 4.11 Wetland Closed Shrub Complex

GREEN ALDER-WILLOW/BLUEJOINT-SEDGE					
Species	**Common Name**	**Strata**	**% Cover (at maturity)**	**Stem Spacing* (at planting)**	**Notes**
Alnus crispa	green alder	B1,B2	20-30	5m	
Salix bebbianna/Salix spp	beaked willow/willow	B1,B2	5-50	1-5m	
Cornus stolonifera	red-osier dogwood	B1,B2	0-5	10m	
Ribes oxycanthoides	wild gooseberry	B2	0-5	10m	
Picea glauca	white spruce	A1,A2,B1,B2	0-5	20m	
Rosa acicularis	prickly rose	B2	0-5	20m	on drier hummocks
Rubus idaeas	wild red raspberry	B2	5-10	10m	
Calamagrostis canadensis	bluejoint	C1	20	seed	
Caltha palustris	marsh marigold	C2	5	seed	
Carex palustris, C. Lasiocarpa, C. Disperma	sedges	C1	0-80	seed	high cover on very wet sites
Ciculta bulbifera	bulb-bearing hemlock	C1	0-5	seed	
Glyceria grandis	common tall manna grass	C1	0-5	seed	
Potentilla norvegica, P. Palustris	rough cinquefoil marsh cinquefoil	C2	5	seed	

* This refers to the density of plants at initial revegetation which would be established by use of nursery stock and natural sources from soil amendments.

Table 4.12 **Wetland Open Water/Emergent Vegetation Zone**

GREEN ALDER-WILLOW/BLUEJOINT-SEDGE				
Species	**Common Name**	**Strata**	**% Cover (at maturity)**	**Stem Spacing* (at planting)**
Alnus crispa	green alder	B1, B2	0-2	10m
Salix bebbianna	beaked willow	B1, B2	0-2	10m
Calamagrostis canadensis	bluejoint	C1	0-80	seed/soil
Caltha palustris	marsh marigold	C2	0-80	seed/soil
Carex aquatalis	water sedge	C1	50-80	seed/soil
Carex rostrata	beaked sedge	C1	0-40	seed/soil
Lemna minor	duckweed		5-60	seed/soil
Nuphar variegatum	yellow pond lilly		10-20	seed/soil
Typha latifolia	cattail	C1	10-50	seed/soil
Scutellaria galericulata	marsh skullcap	C2	0-10	seed/soil
Polygonum amphibium	water smartweed		0-5	seed/soil
Sparganium eurycarpum	giant bur-reed	C1	0-5	seed/soil
Glyceria striata	fowl manna grass	C1	0-30	seed/soil
Elocharis palustris	creeping spike rush	C1	0-10	seed/soil

* This refers to the density of plants at initial revegetation which would be established by use of nursery stock and natural sources from soil amendments.

Table 4.13 Vegetation Balance for Pre-Disturbance (Baseline) and Post-Reclamation Condition for the Steepbank Mine Footprint

ELC VEGETATION CLASS	BASELINE OR PRE-DISTURBANCE CONDITION		POST RECLAMATION CONDITION		POST RECLAMATION PLAN AS % OF BASELINE
	AREA (ha)	%	AREA (ha)	%	
Closed Mixedwood	32	1	1411	37	4551
Open Mixedwood (Pine Dominated)	0	0	430	11	>100[1]
Closed Jack Pine	238	6	0	0	0
Closed Mixedwood Coniferous (Black Spruce D	110	3	0	0	0
Closed Mixedwood (White Spruce Dominant)	66	2	128	3	194
Closed White Spruce	252	7	0	0	0
Deciduous Forest	903	24	1545 (see below)		178
West Aspect			408	11	
Lower Slopes			385	10	
South Aspect			76	2	
Mesic Sites			676	18	
Disturbed/Herb-Grass	57	2	0	0	0
Peatland			0	0	0
Black Spruce Bog	280	7			
Black Spruce Tamarack Fen	946	25			
Open Black Spruce Bog	811	21			
Tamarack Fen	6	0.2			
Wetland Shrub Complex	74	2	170	5	236
Wetland Open Emergent	0.1	0	91	3	>100[1]
TOTALS	3775	100	3775	100	

[1] Not calculable since the baseline area was zero.

Table 4.14 Vegetation Balance for Pre-Disturbance (Baseline) and Post-Reclamation Condition for the Athabasca River Valley[1]

ELC VEGETATION CLASS	BASELINE OR PRE-C6 DISTURBANCE CONDITION		POST RECLAMATION CONDITION		POST RECLAMATION PLAN AS % OF BASELINE
	AREA (ha)	%	AREA (ha)	%	
Closed Mixedwood	26	1	542	16	2080
Open Mixedwood (Pine Dominated)	0	0	429	13	>100[2]
Closed Jack Pine	214	6	20	1	9
Closed Mixedwood Coniferous (Black Spruce D	131	4	36	1	27
Closed Mixedwood (White Spruce Dominant)	168	5	324	10	193
Closed White Spruce	441	13	0	0	0
Deciduous Forest	1635	48	1789 (see below)	53	109
West Aspect			316		
Lower Slopes			1175		
South Aspect			0		
Mesic Sites			298		
Disturbed/Herb-Grass	71	2	23	0.1	32
Peatland	448 (see below)	13	8	<0.1	2
Black Spruce Bog	112		0		
Black Spruce Tamarack Fen	334		8		
Open Black Spruce Bog	0		0		
Tamarack Fen	2		0		
Wetland Shrub Complex	251	7	214	6	85
Wetland Open Water/Emergent	13	0	13	<0.1	100
Industrial/Sparsely Vegetated	2	<0.1	2	<0.1	100
TOTALS	3400	100	3408	100	

1 Includes both the land within and outside of the footprint of the Steepbank Mine.

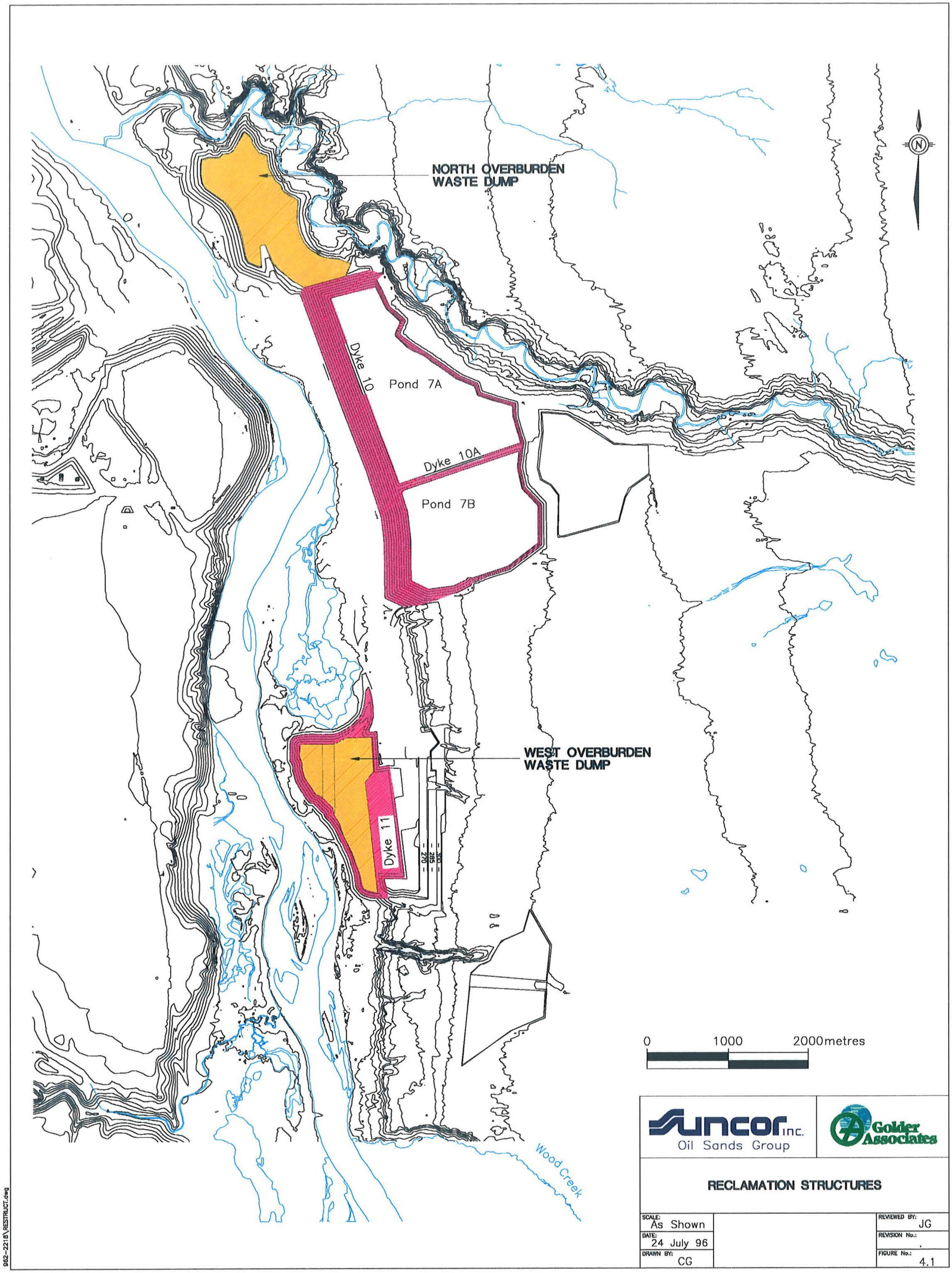
2 Not calculable since the baseline area was zero.

Table 4.15 Modified Wildlife Corridor Areas of the Steepbank Mine

Shoreline Section	Shoreline Length	Corridor Width	Reclaimed to 100 m or Greater By
East Bridge abutment	150 m	7 m	Indefinite
Drainage Basin Area	300 m	90 m	2020
Barge Landing Area	200 m	0 m	1998
Hydrotransport Line Section	700 m	70 m	2020
Total Shoreline Area	1350 m		

Table 4.16 Water Quality Comparison Between Shipyard Lake and Leggett Creek

Parameter	Units	Shipyard Lake at Outlet			Leggett Cr. at Mouth	
		Spring	Summer	Fall	Summer	Fall
Conventional Parameters and Major Ions						
pH		7.59	7.8	7.56	7.6	7.4
Specific Conductance	µS/cm	446	338	353	293	336
Total Dissolved Solids	mg/L	268	190	196	167	188
Non-Filterable Residue (TSS)	mg/L	30	2	79	10	211
Dissolved Organic Carbon	mg/L	25.5	25.4	25.6	25.7	26.2
Calcium - Dissolved	mg/L	58.1	48.2	47.2	50.1	49.5
Magnesium - Dissolved	mg/L	11.8	11.4	11.8	11.3	12.4
Sodium - Dissolved	mg/L	32.3	16.2	15	8.6	10.5
Potassium - Dissolved	mg/L	3.5	1.47	1.8	0.68	1.3
Chloride - Dissolved	mg/L	26.6	8	8.5	1.2	3.7
Sulphate - Dissolved	mg/L	18.2	6.6	7.8	5.3	8.4
Total Alkalinity (as CaCO3)	mg/L	192	161	170	148	168
Bicarbonate	mg/L	234	196	207	180	205
Total Hardness (as CaCO3)	mg/L	194	167	167	172	175
Fluoride	mg/L	0.2	---	---	---	---
Total Cyanide	mg/L	< 0	0.004	0.003	0.003	< 0.001
Sulphur - Total	mg/L	5.2	---	---	---	---
Total Phenolics	mg/L	0.01	0.003	< 0.001	0.004	< 0.001
Hydrocarbons, Recoverable	mg/L	< 1	1	< 1	< 1	< 1
Nutrients						
Nitrite plus Nitrate Nitrogen	mg/L	0.01	< 0.03	0.021	< 0.03	< 0.003
Total Ammonia Nitrogen	mg/L	0.06	0.06	0.03	0.03	0.03
Total Phosphorus	mg/L	0.08	0.03	0.102	0.019	0.196
Metals (Total)						
Aluminum	mg/L	0.3	0.03	1.09	0.14	1.89
Antimony	mg/L	< 0	2E-04	< 0.0002	0.0003	< 0.0002
Arsenic	mg/L	0	8E-04	0.001	0.0005	0.0012
Barium	mg/L	0.09	0.04	0.06	0.04	0.07
Beryllium	mg/L	< 0	0.001	< 0.001	0.002	< 0.001
Boron	mg/L	0.1	0.1	0.08	0.05	0.1
Cadmium	mg/L	0	< 0.003	< 0.003	< 0.003	< 0.003
Chromium	mg/L	0.01	0.007	< 0.002	< 0.002	< 0.002
Cobalt	mg/L	< 0	< 0.003	< 0.003	< 0.003	0.004
Copper	mg/L	0.05	---	---	---	---
Iron	mg/L	3.28	1.16	3.29	0.76	4.81
Lead	mg/L	0.03	< 0.02	< 0.02	< 0.02	< 0.02
Lithium	mg/L	0.01	0.01	0.011	0.011	0.016
Manganese	mg/L	0.32	0.054	0.212	0.088	0.21
Mercury	µg/L	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Molybdenum	mg/L	0	< 0.003	< 0.003	< 0.003	0.004
Nickel	mg/L	0.01	< 0.005	< 0.005	< 0.005	0.012
Selenium	mg/L	< 0	< 2E-04	< 0.0002	< 0.0002	< 0.0002
Silicon	mg/L	1.28	---	---	---	---
Silver	mg/L	< 0	< 0.002	< 0.002	< 0.002	< 0.002
Strontium	mg/L	0.16	0.137	0.14	0.15	0.163
Titanium	mg/L	0.01	< 0.002	0.027	< 0.003	0.046
Uranium	mg/L	< 0.5	---	---	---	---
Vanadium	mg/L	0	0.002	< 0.002	0.006	0.008
Zinc	mg/L	0.05	0.051	0.039	0.038	0.035
Naphthenic Acids	mg/L	< 1	< 1	< 1	< 1	< 1
---No data available						


NORTH OVERBURDEN WASTE DUMP
Dyke 10
Pond 7A
Dyke 10A
Pond 7B
WEST OVERBURDEN WASTE DUMP
Dyke 11
Wood Creek
0
1000
2000metres
Suncor inc.
Oil Sands Group
Golder Associates
RECLAMATION STRUCTURES
SCALE:
As Shown
DATE:
24 July 96
DRAWN BY:
CG
REVIEWED BY:
JG
REVISION No.:
FIGURE No.:
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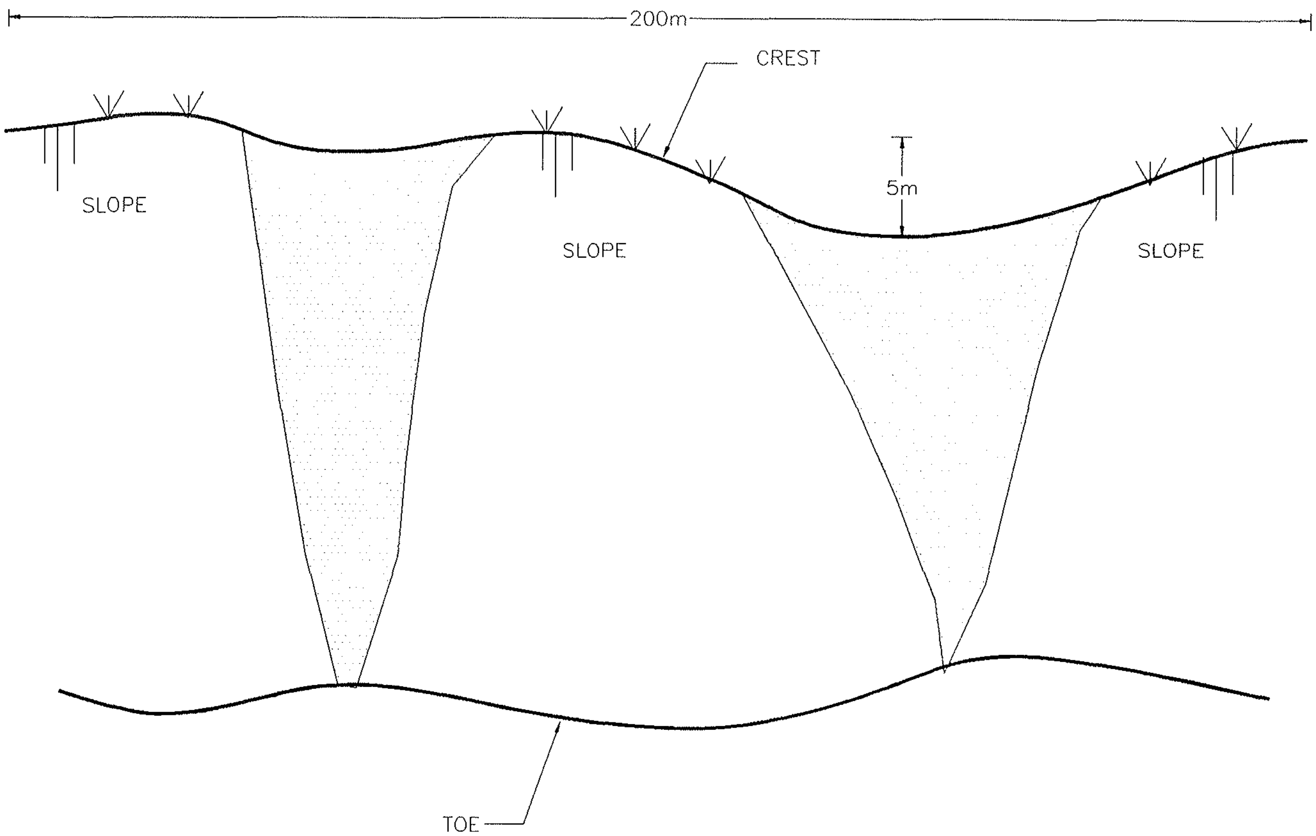
MICRO-TERRAIN MODIFICATION
(e.g., OVERBURDEN WASTE DUMP)

Figure 4.2



NOT TO SCALE
SCHEMATIC ONLY

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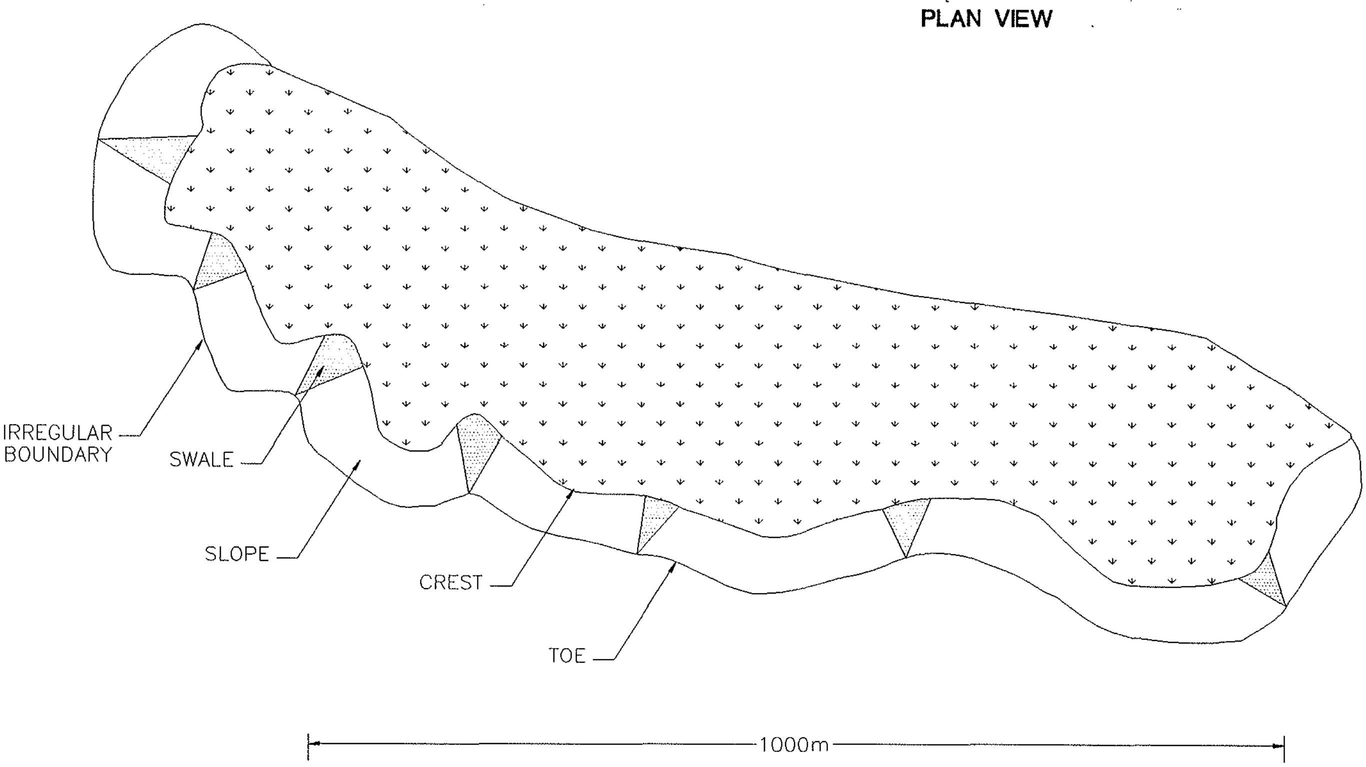
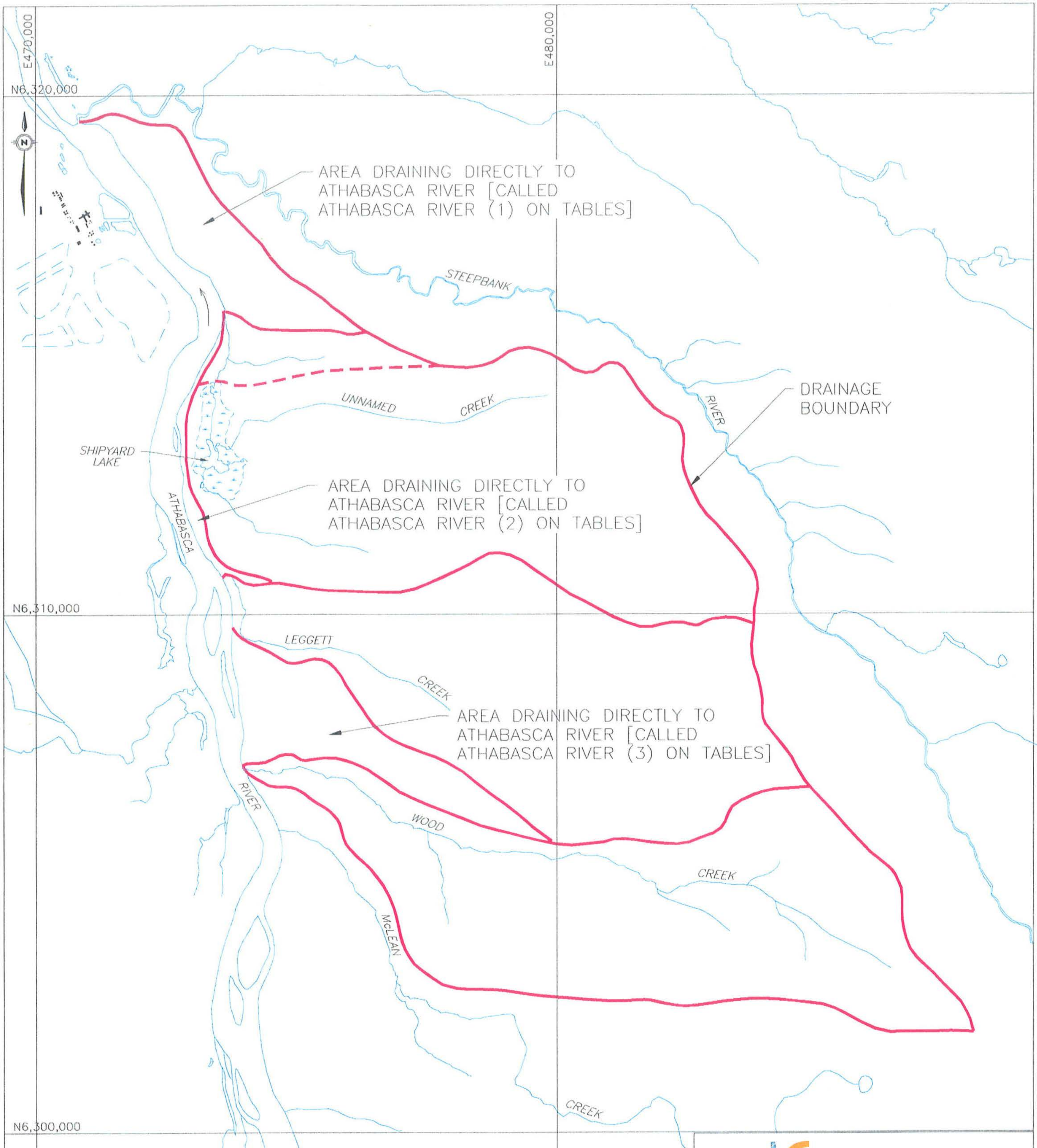
MACRO-TERRAIN MODIFICATION
(e.g., OVERBURDEN WASTE DUMP)

Figure 4.3



NOT TO SCALE
SCHEMATIC ONLY

PROJECT 962-2218 DRAWN CG REVIEWED DATE 10 JULY 96 MACROPLN.dwg



KLOHN-CRIPPEN

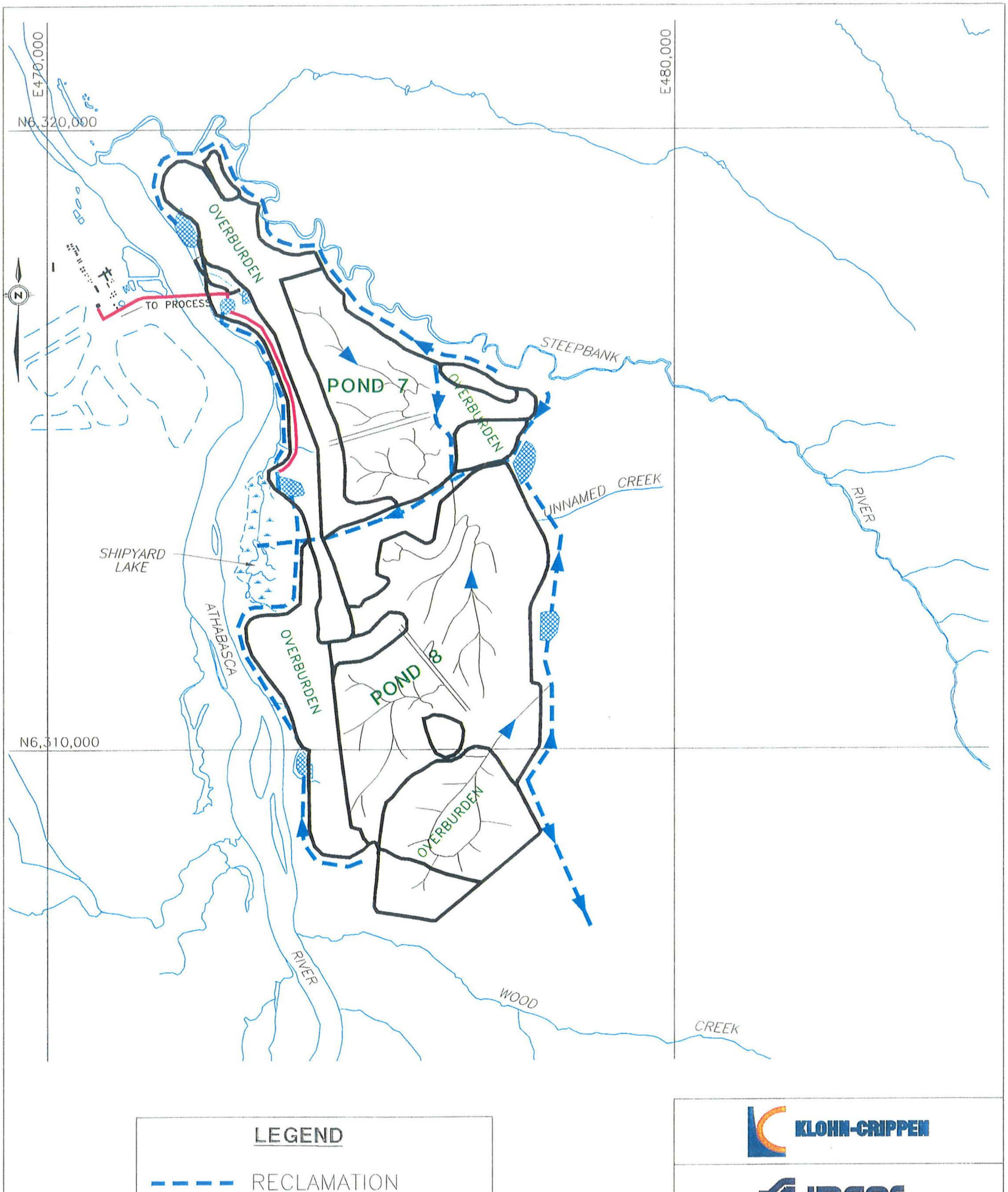
Suncor inc. Oil Sands Group

Golder Associates

(PRE-MINE)
EXISTING DRAINAGE AREAS

SCALE: N.T.S.	Steepbank Mine Application	REVIEWED BY: J.K.M.
DATE: 18 07 96		REVISION No.: 1
DRAWN BY: C.P.B.		FIGURE No.: 4.4

PREDRAIN.dwg



KLOHN-CRIPPEN

Suncor Inc.
Oil Sands Group

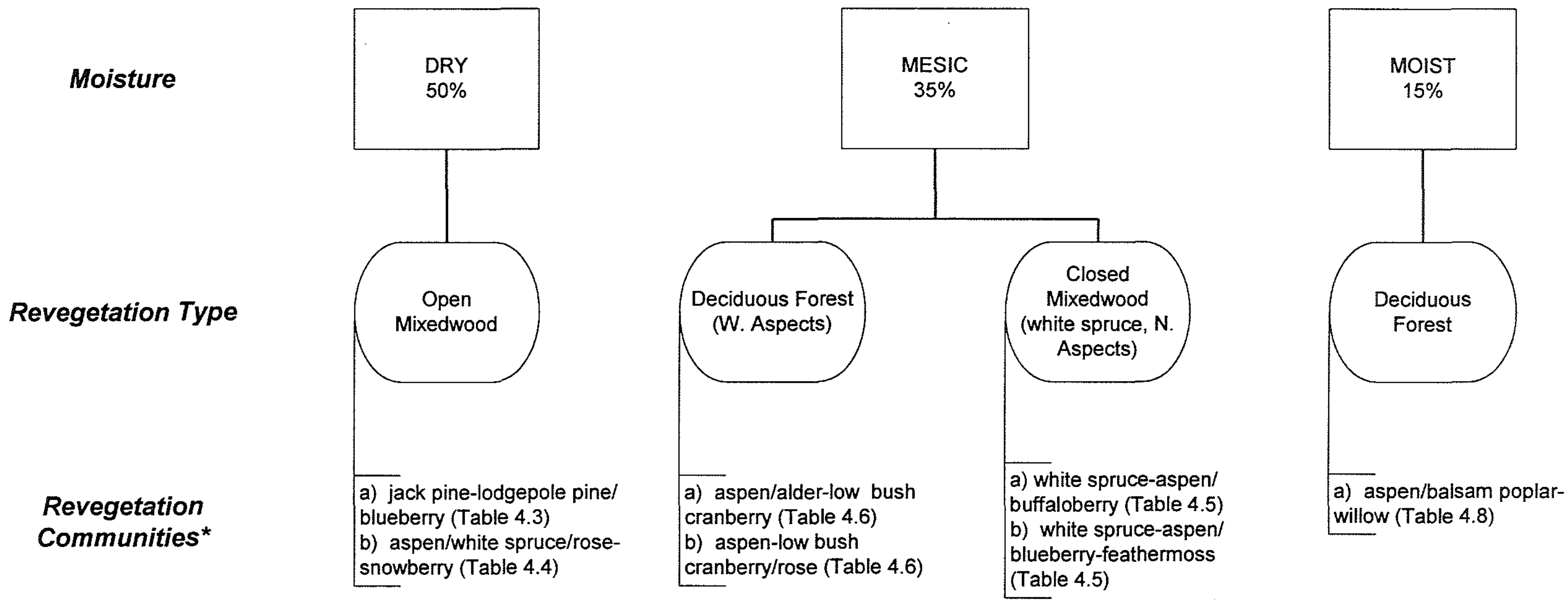
POST RECLAMATION DRAINAGE AREAS

SCALE: N.T.S.	Steepbank Mine EIA		REVIEWED BY: J.K.M.
DATE: JULY 96			REVISION No.: 1
DRAWN BY: L.G.H.			FIGURE No.: 4.5

2705w101.dwg

Figure 4.6 Revegetation types associated with reclamation structures and soil capability classes

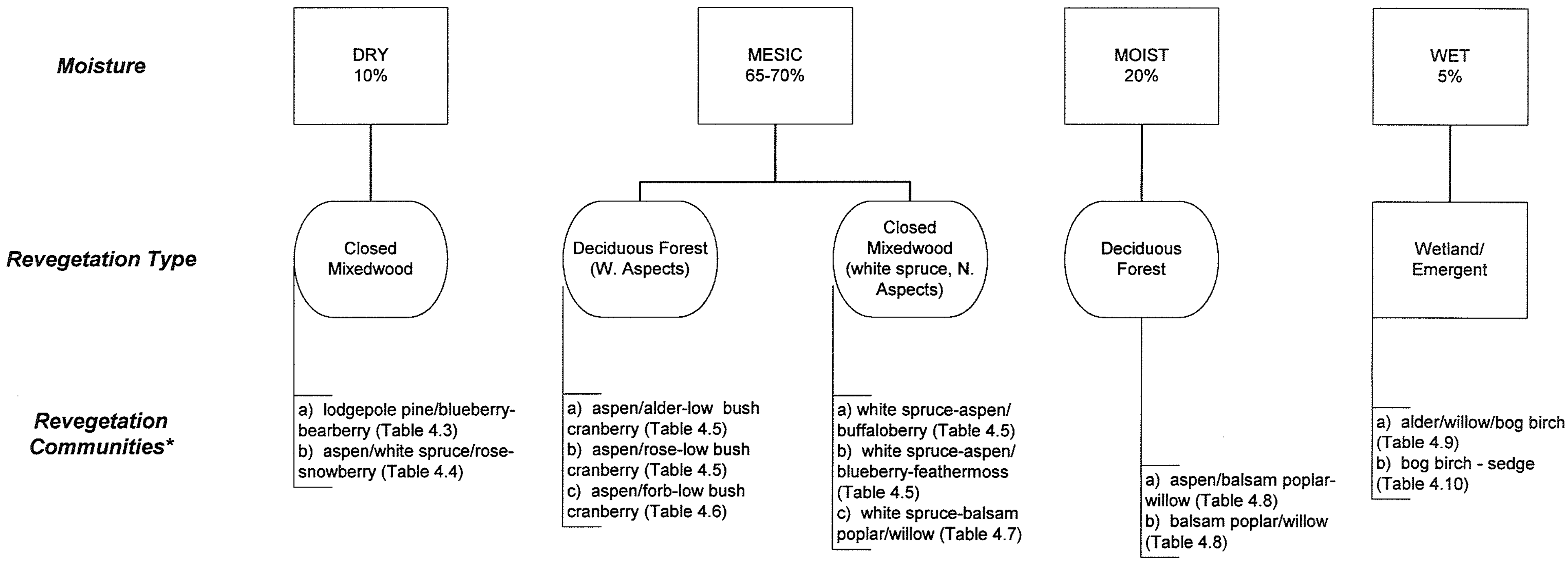
DYKE STRUCTURES, SOIL CLASS A2



* Anticipated plant community composition is presented in Tables 4.3 to 4.10 for each revegetation community
% Refer to the relative proportion of the reclamation landscape affected by the particular moisture regime.
NOTE: Soil class designation refers to reclamation soil type scenario and soil class capability.

Figure 4.6 Revegetation types associated with reclamation structures and soil capability classes (continued)

OVERBURDEN STRUCTURES, SOIL CLASS B2

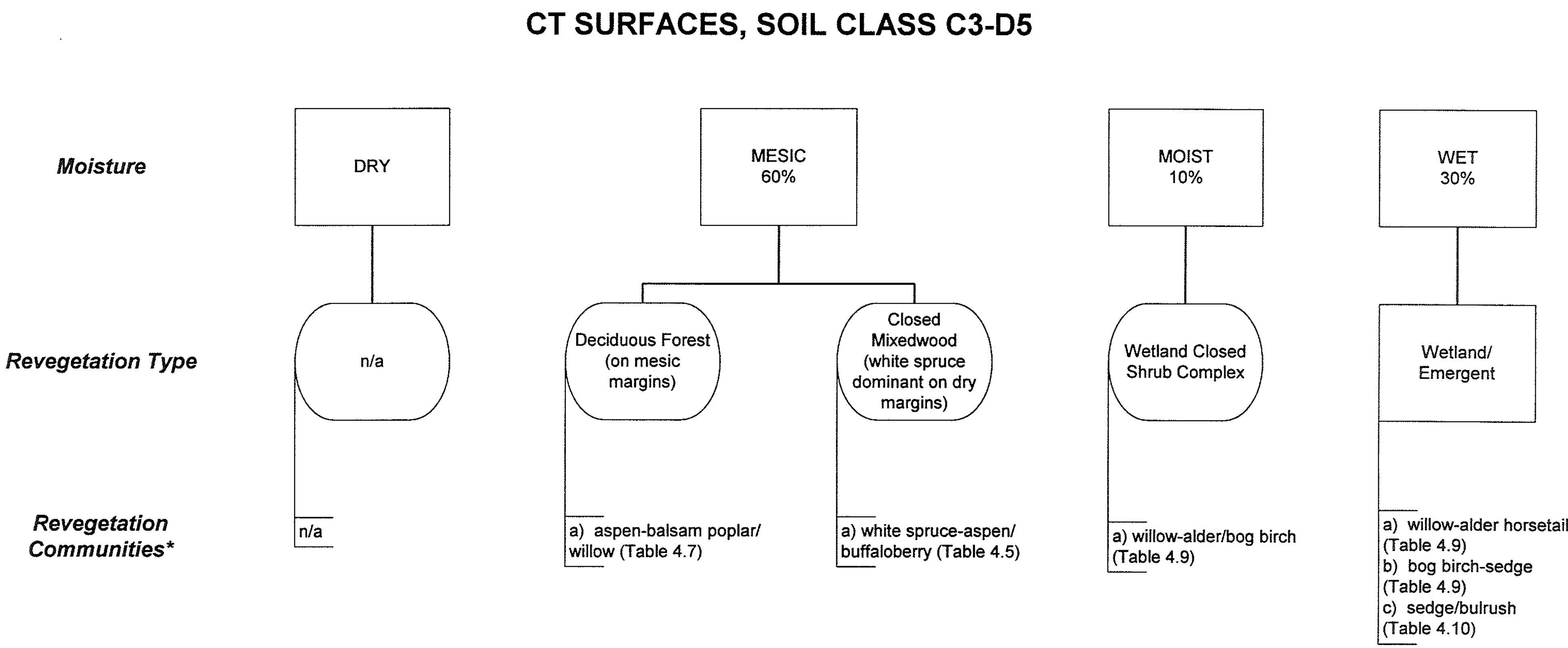


* Anticipated plant community composition is presented in Tables 4.3 to 4.10 for each revegetation community

% Refer to the relative proportion of the reclamation landscape affected by the particular moisture regime.

NOTE: Soil class designation refers to reclamation soil type scenario and soil class capability.

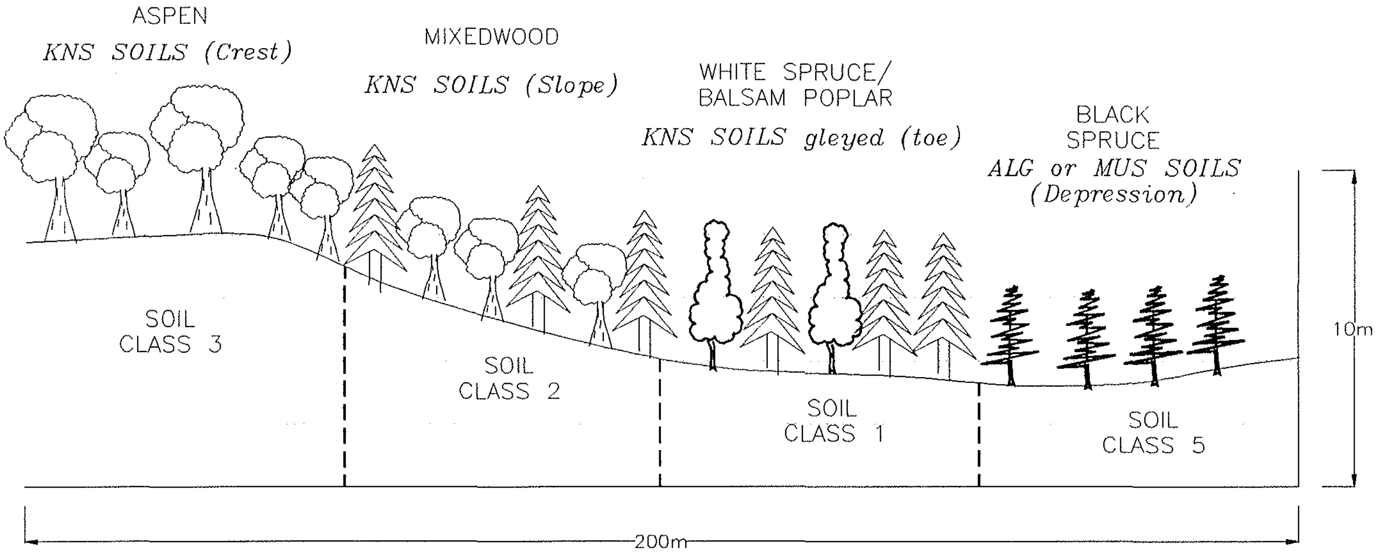
Figure 4.6 Revegetation types associated with reclamation structures and soil capability classes (concluded)



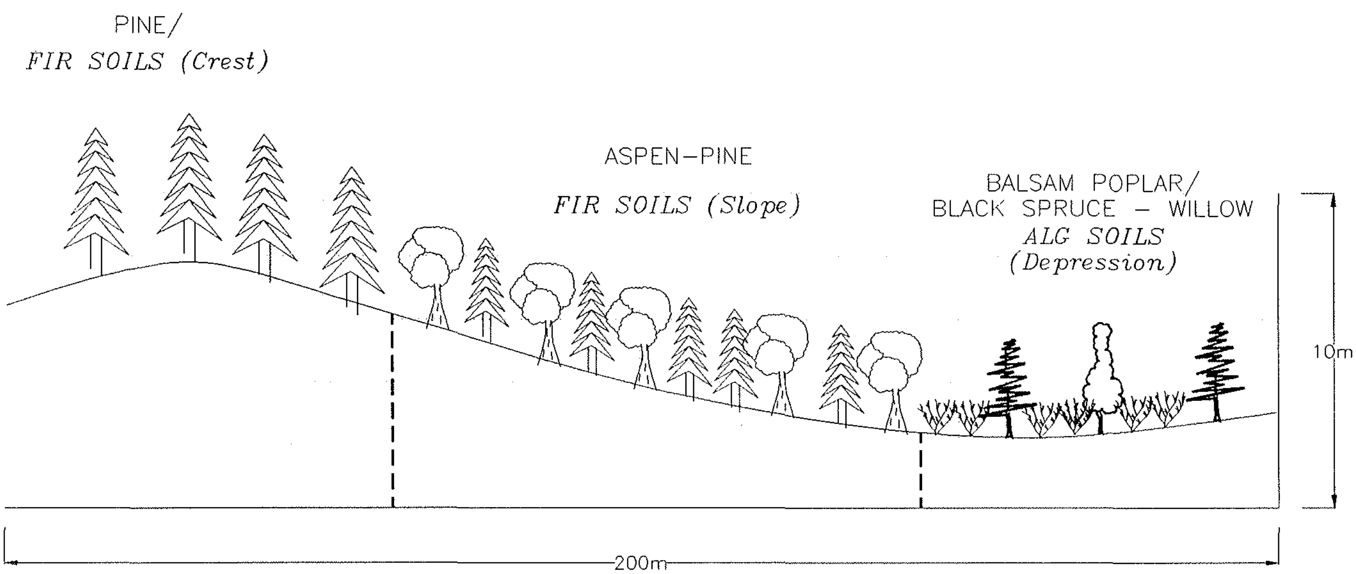
* Anticipated plant community composition is presented in Tables 4.3 to 4.10 for each revegetation community
% Refer to the relative proportion of the reclamation landscape affected by the particular moisture regime.
NOTE: Soil class designation refers to reclamation soil type scenario and soil class capability.

UPLAND LANDFORM VARIATION IN
Kinosis (KNS), Firebag (FIR), Algar (ALG) AND
Muskeg (MUS) SOIL UNITS

Figure 4.7



UPLAND NATURAL VARIATION IN KNS UNIT



UPLAND NATURAL VARIATION IN FIR UNIT

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SCHEMATIC ONLY

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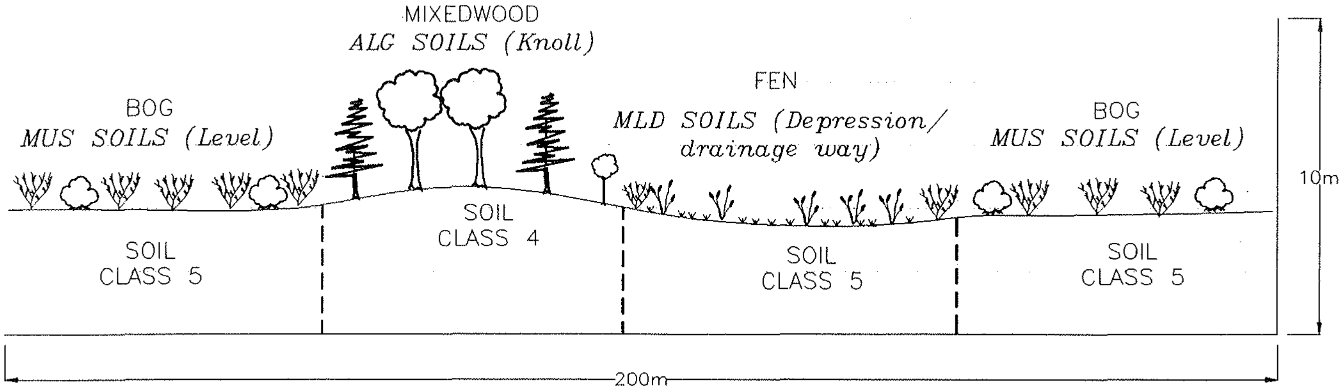
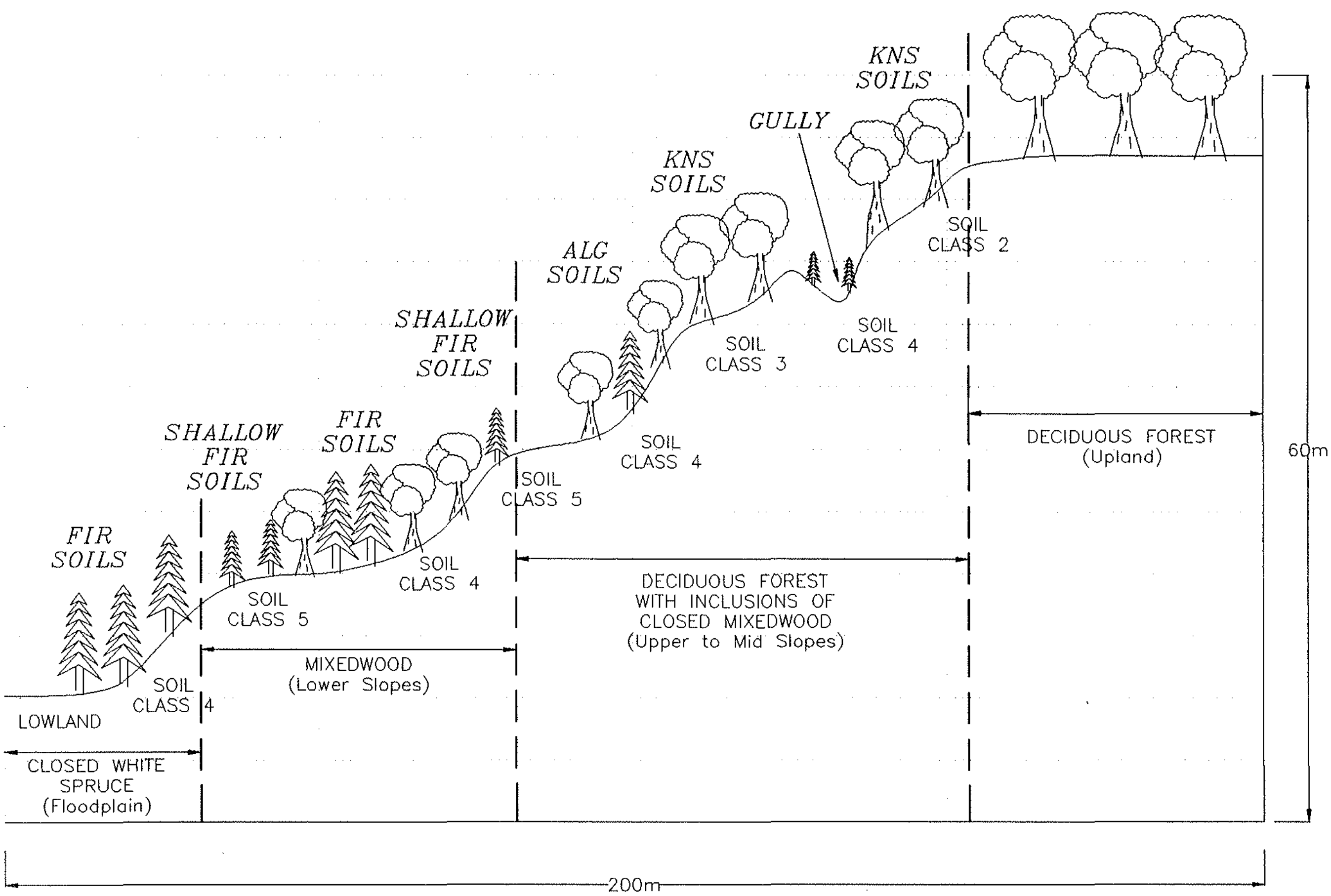
LOWLAND LANDFORM VARIATION IN Muskeg (MUS), Algar (ALG), McLelland (MLD), Firebag (FIR), Kinosis (KNS) and Rough Broken (RB2, RB3) SOIL UNITS

Figure 4.8



LOWLAND NATURAL VARIATION IN MUS UNIT



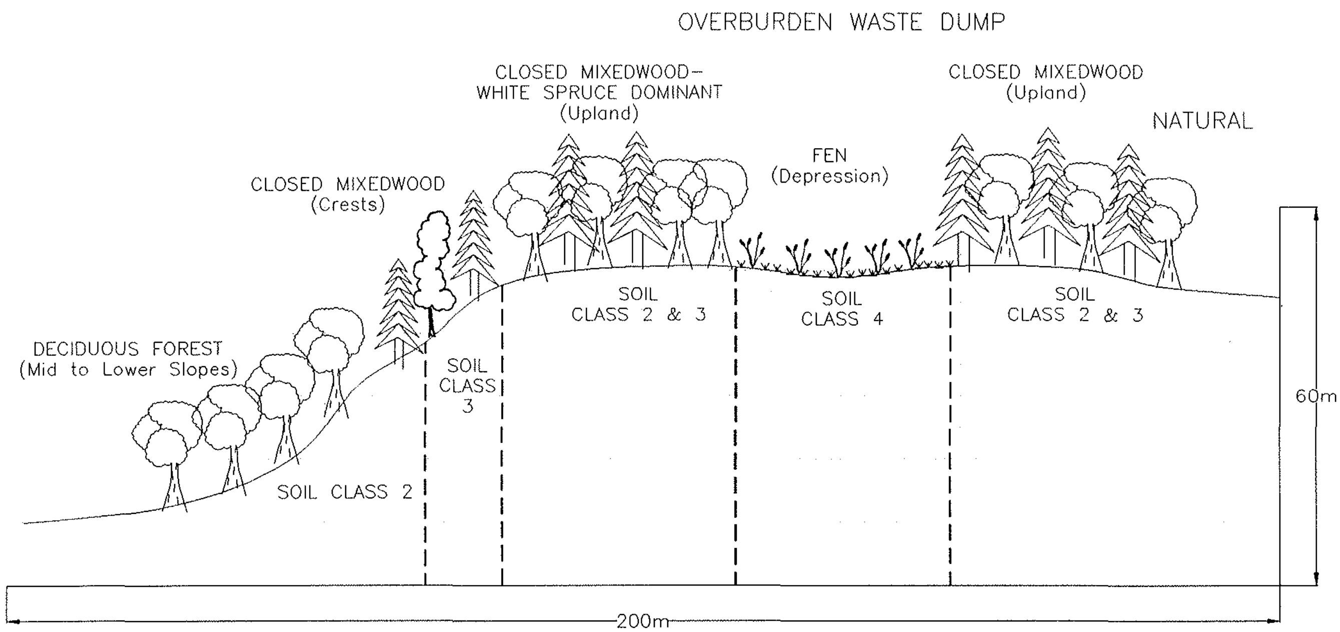
RIVER VALLEY NATURAL VARIATION IN RB2 and RB3 UNITS

NOT TO SCALE
SCHEMATIC ONLY

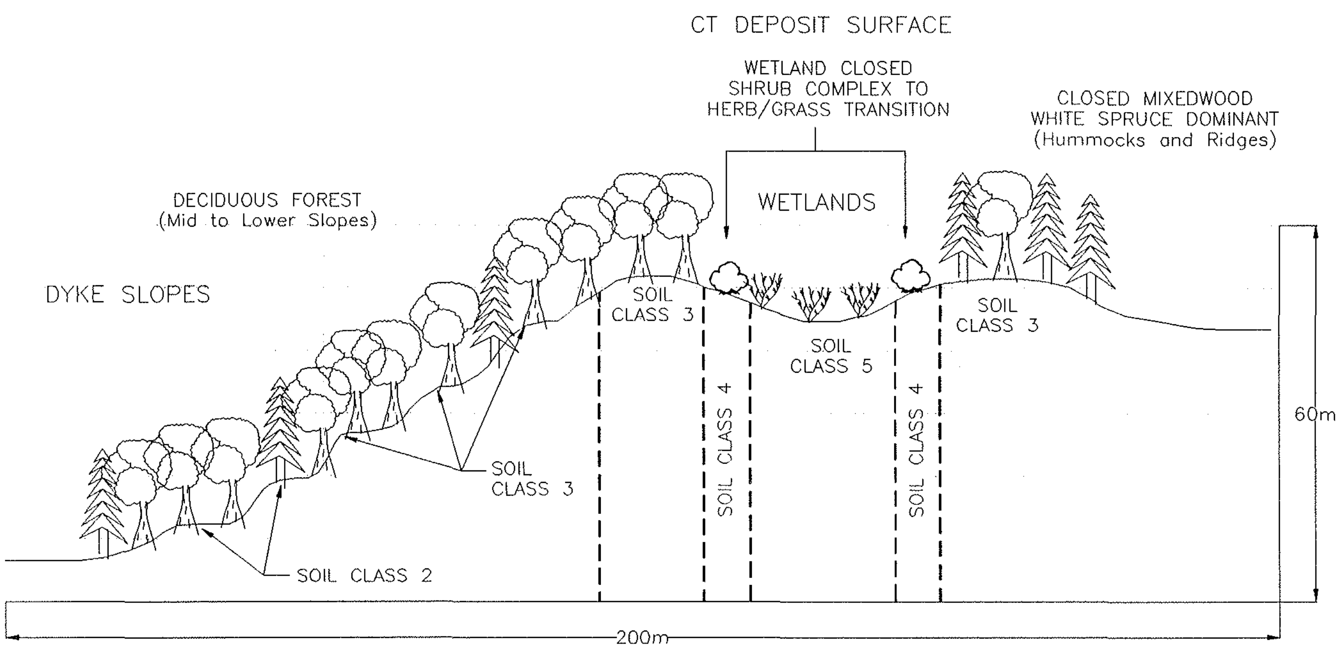
PROJECT 962-2218 DRAWN CG REVIEWED DATE 26 July 96 LOWLAND.dwg

VARIATION IN SOIL CLASSES AND VEGETATION TYPES ON RECLAIMED SURFACES

Figure 4.9



VARIATION IN SOIL CLASS AND VEGETATION TYPE ON "B" RECLAIMED SURFACES



VARIATION IN SOIL CLASS AND VEGETATION TYPE ON "A" and "C" RECLAIMED SURFACES

NOT TO SCALE
SCHEMATIC ONLY

PROJECT 962-2218 DRAWN CG REVIEWED DATE 18 JULY 96 RECLAIM.dwg

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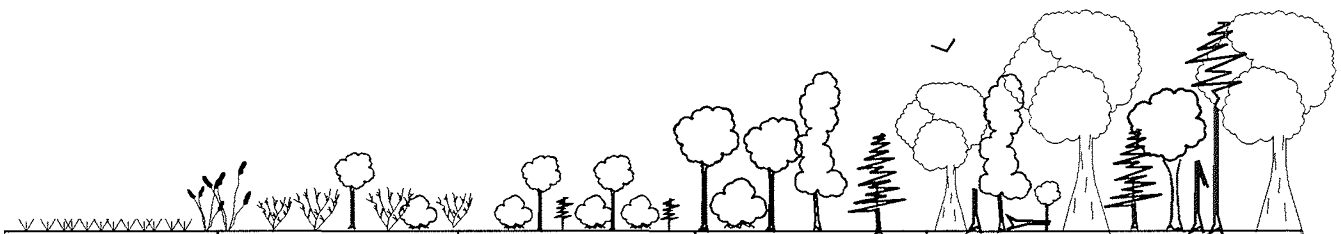
PROJECT 962-2218 DRAWN CG REVIEWED ______ DATE 18 JULY 96 WILDLIFE.dwg

WILDLIFE UTILIZATION OF RECLAIMED TERRESTRIAL HABITAT TYPES OVER TIME

Figure 4.10

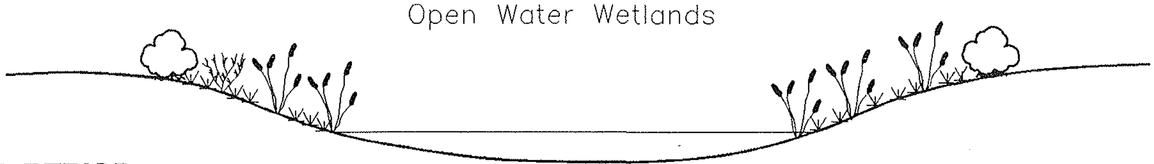


	Herb–Grass	Shrub–Sapling	Young Forest	Mature Forest	Old Forest
TIME PERIOD: (Approximate)	0–10 years	10–20 years	20–40 years	50–70 years	100+ years
SPECIES DIVERSITY	Very Low (10–20 Species)	Low (20–30 Species)	Medium (30–50 Species)	Medium (30–50 Species)	High (50–70 Species)
CHARACTERISTIC SPECIES: Birds	Savannah sparrow LeConte's sparrow	Common yellowthroat Clay–colored sparrow Alder flycatcher Lincoln's sparrow	Tree swallow Ruffed grouse Cedar waxwing	Red–eyed vireo Ovenbird Yellow–bellied sapsucker	Black–throated green warbler Red–breasted nuthatch Black–capped chickadee Pileated woodpecker
Mammals	Meadow vole Arctic shrew White–tailed deer	Deer mouse Snowshoe hare Moose	Snowshoe hare Moose Red–backed vole	Deer mouse Black bear Moose	Red–backed vole Northern flying squirrel Big brown bat

WILDLIFE UTILIZATION OF RECLAIMED WETLANDS HABITAT TYPES OVER TIME

Figure 4.11

MARSH
Open Water Wetlands

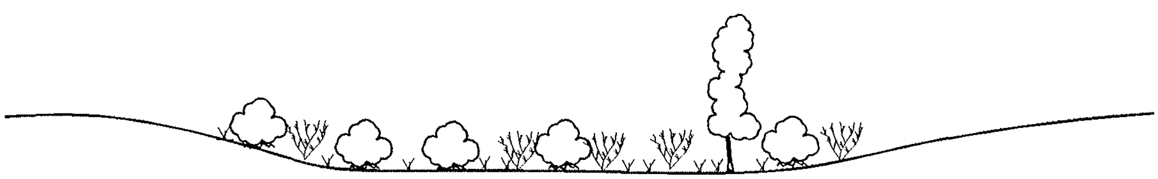


TIME PERIOD: (Approximate) 0–20 years

CHARACTERISTIC SPECIES

Mallard
Blue–winged teal
Great Blue Heron
Marsh Wren
Red–winged Blackbird
Muskrat
Beaver
Chorus Frog

ALDER/WILLOW
Bogbirch – fen



TIME PERIOD: (Approximate) 20–80 years

CHARACTERISTIC SPECIES

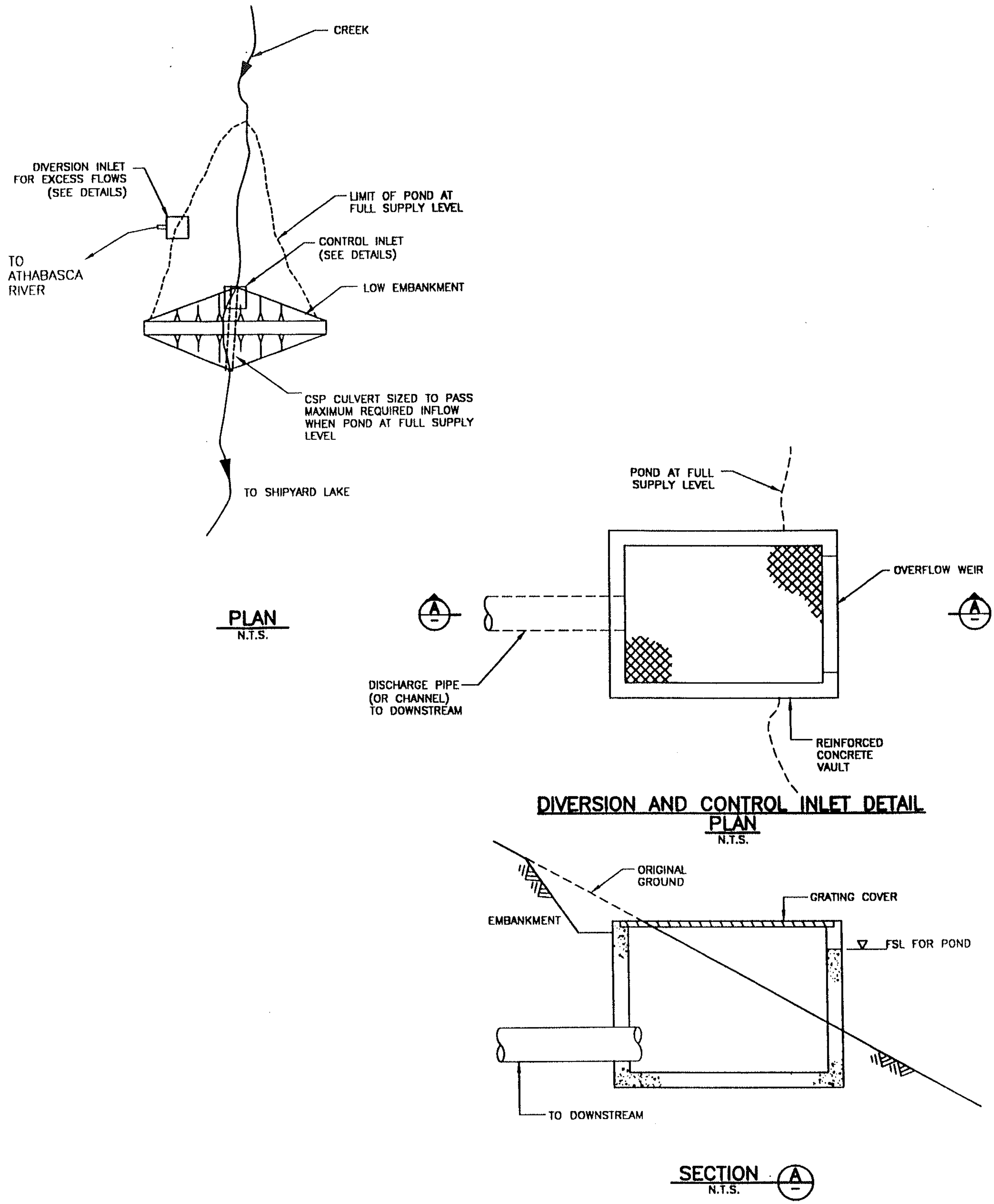
LeConte's Sparrow
Northern Waterthrush
Yellow Warbler
Common Snipe
Swamp Sparrow
Meadow Vole
Arctic Shrew
Moose

NOT TO SCALE
SCHEMATIC ONLY

PROJECT 962–2218 DRAWN CG REVIEWED DATE 18 JULY 96 WETLAND.dwg

DIVERSION BYPASS FOR SHIPYARD LAKE

Figure 4.12



REFERENCE

DRAWING TAKEN FROM REPORT BY KLOHN-CRIPPEN, PROJECT No. PA 2705, DATED JUNE 1996

NOT TO SCALE
SCHEMATIC ONLY

PROJECT 962-2218 DRAWN CG REVIEWED DATE 18 JULY 96 diversion.dwg

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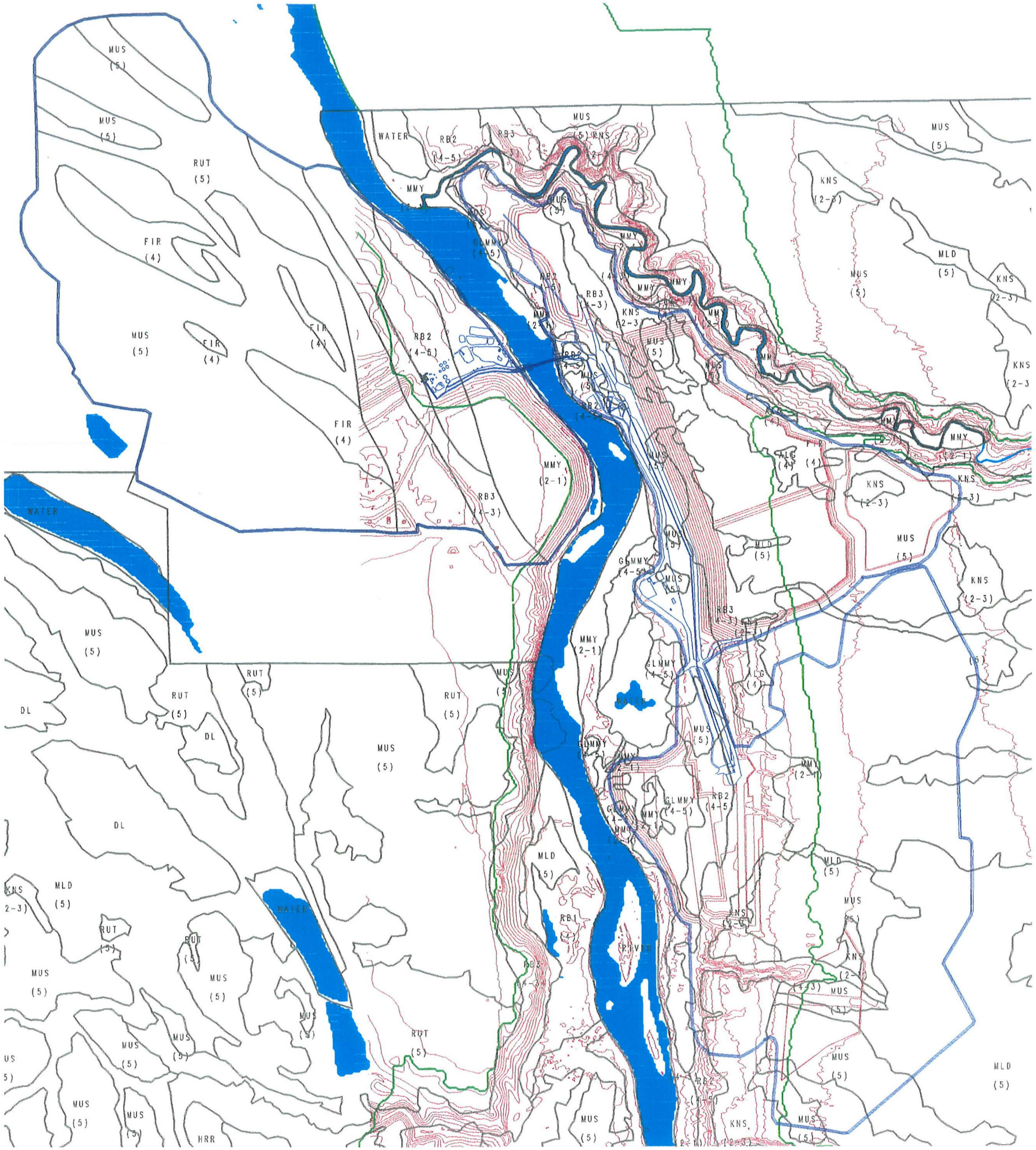


Map S1

LEASE 86/17 AND STEEPBANK MINE

PREDISTURBANCE SOIL CONDITION

LEGEND

SERIES		SOIL CAPABILITY
Algar	- ALG	4
Firebag	- FIR	4
Kinosis	- KNS	2-3
McClelland	- MLD	5
McMurray	- MMY	2-1
Gleyed McMurray	- GLMMY	4-5
Muskeg	- MUS	5
RB2		4-5
RB3		4-3
RB1		4
Ruth Lake	- RUT	5
Horse River	- HRR	2-3

Explanation:
4 = min. 70% class 4, 30% other
2-3 = min. 60% class 2, min. 20% class 3, remaining other

N

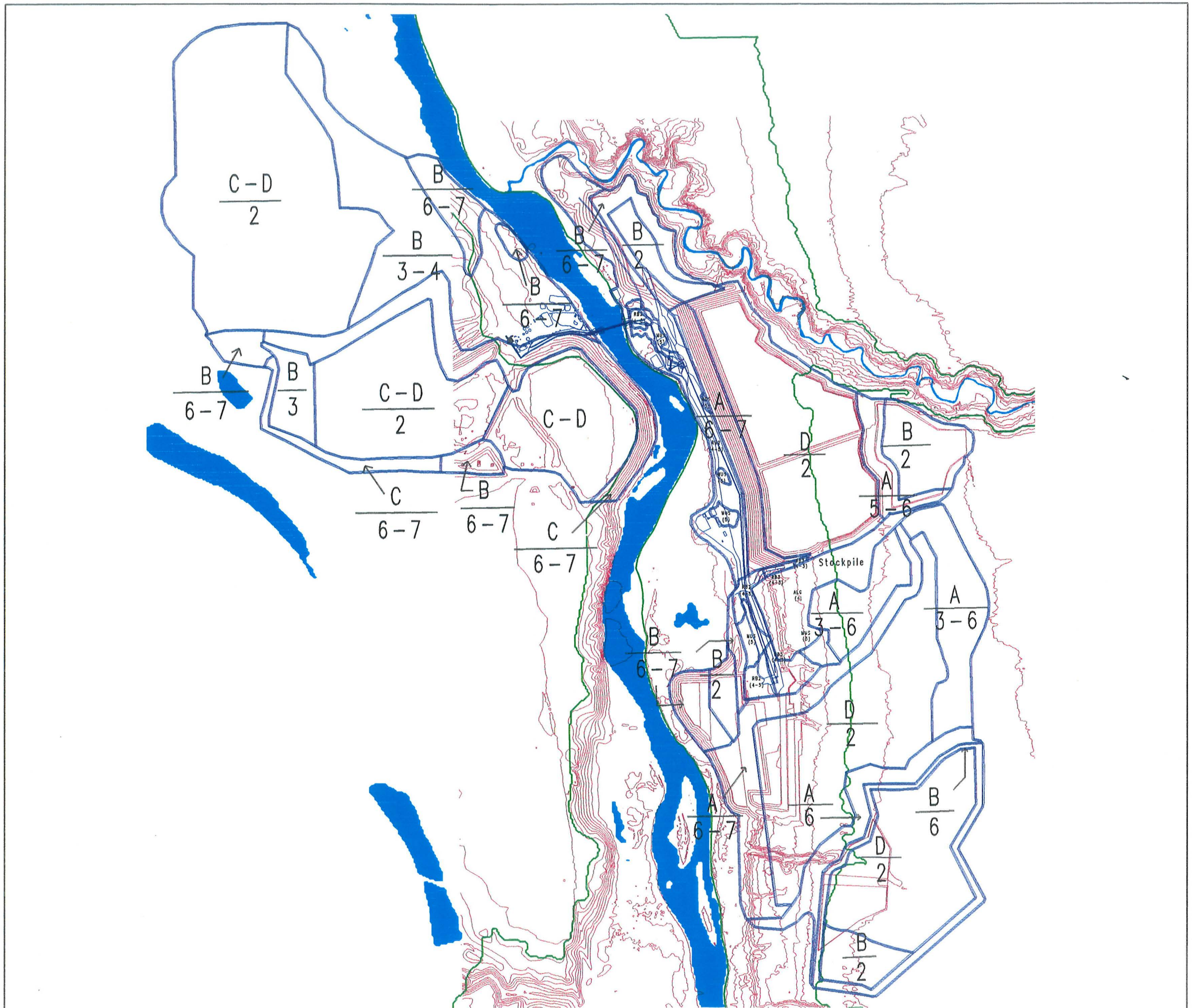
Scale = 1:100,000

0 2 4 6

KILOMETRES

Project No. 962-2218.5020 12 July 1996

Suncor Inc.   Golder Associates



Map S2

LEASE 86/17 AND STEEPBANK MINE
RECLAIMED SOIL TYPES AND TOPOGRAPHY: LONGTERM

LEGEND

RECLAMATION SOILS

A – Peatmix over loam to clayloam materials
B – Peatmix over randomly placed sandy and finer materials
C – Peatmix over tailings sand
D – Pond capping complex (wetlands, tailings sand, peat mix over tailings sand)

TOPOGRAPHIC CLASS	SLOPE
2	< 2%
3	2-5%
4	6-9%
5	9-15%
6	16-30%
7	31-45%

EXAMPLE:

B	=	Reclamation Soil Type
6		Topographic Class

N

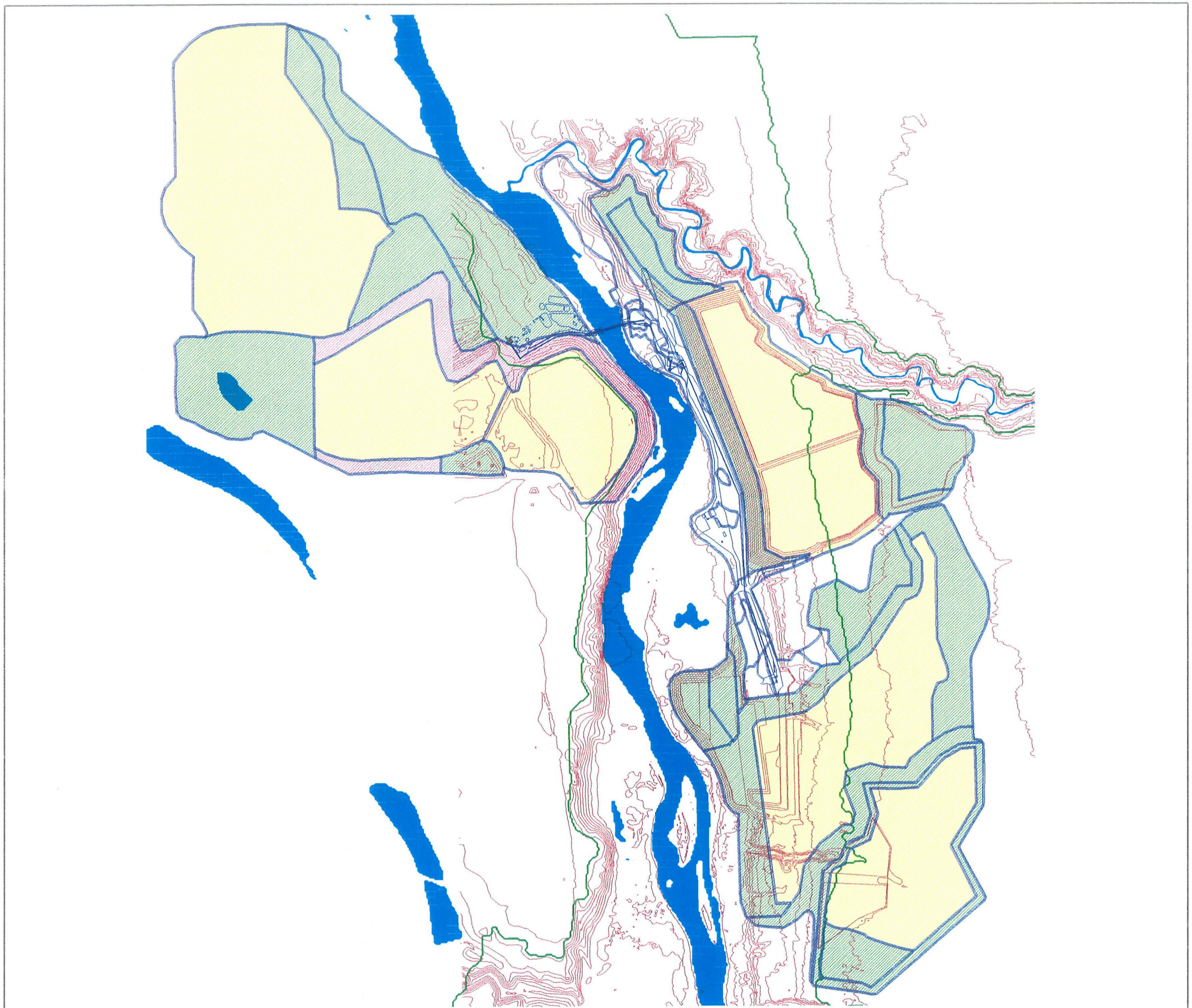
Scale = 1:60,000

0 2 4

KILOMETRES

Project No. 962-2218.5020 12 July 1996

Suncor Inc. Golder Associates



Map S3

LEASE 86/17 AND STEEPBANK MINE RECLAIMED SOILS AND CAPABILITY: LONGTERM

LEGEND

- Soil capability 2
- Soil capability 3
- Soil capability 3 - 5

SOIL CAPABILITY	RELATIVE FOREST PRODUCTIVITY
1	High productivity
2	Moderate productivity
3	Low productivity
4	Currently non-productive
5	Permanently non-productive

N

Scale = 1:60,000

0 2 4

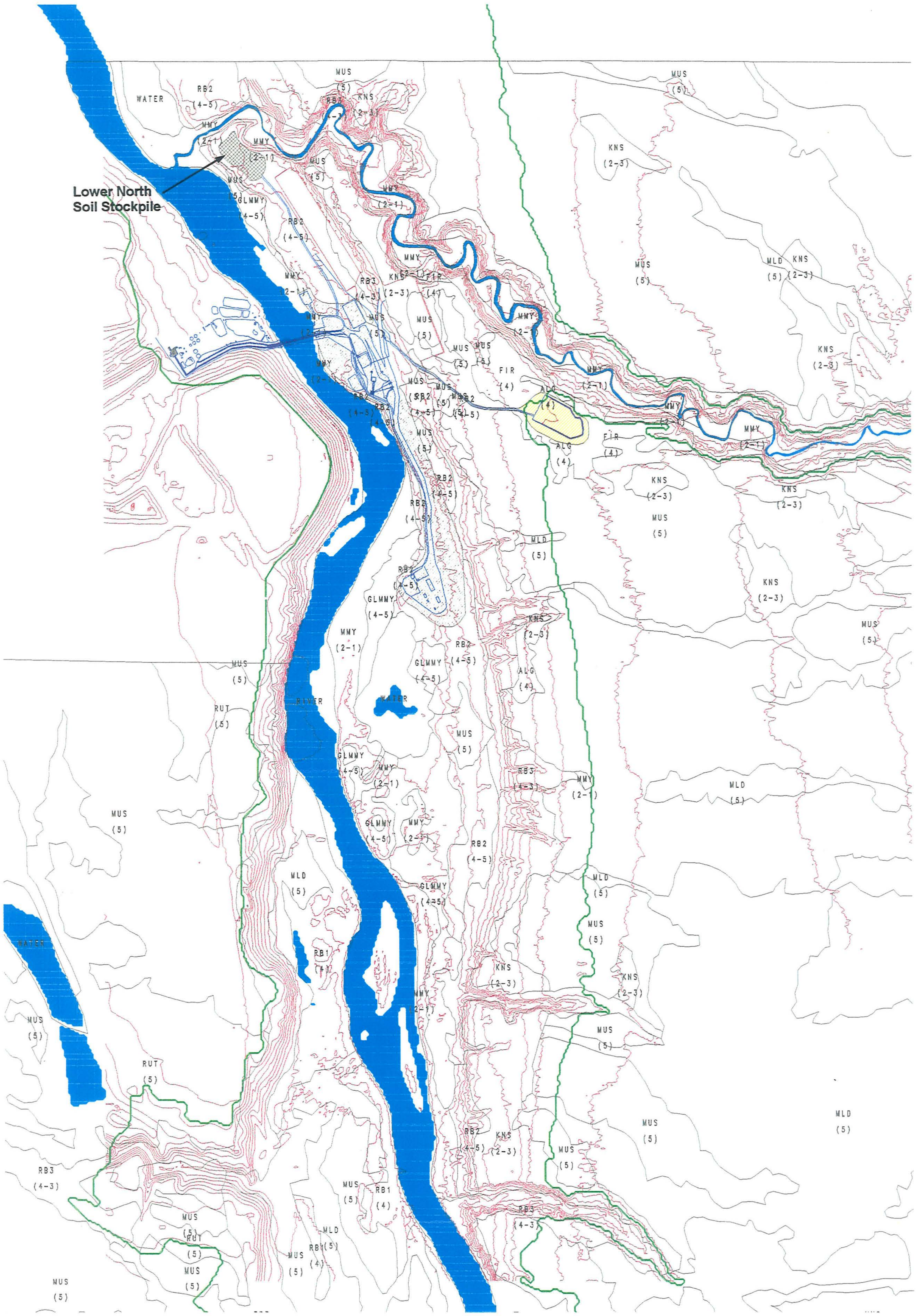
KILOMETRES

Project No. 962-2218.5020

12 July 1996

Suncor Inc.

Golder Associates



LEGEND

- Planned Infrastructure
- Mining Activity
- Muskeg Soil Stockpile
- River valley boundary
- Infrastructure/Transportation

Soil Types and Capability:

Classes shown as:

MUS / 5 = Muskeg Soil / Capability Class 5

NOTE: Mine Plan based on Feasibility 2000 contour

Map IMS - 1997

STEEPBANK MINE: SOIL SALVAGE AND RECLAMATION PLAN YEAR 1997

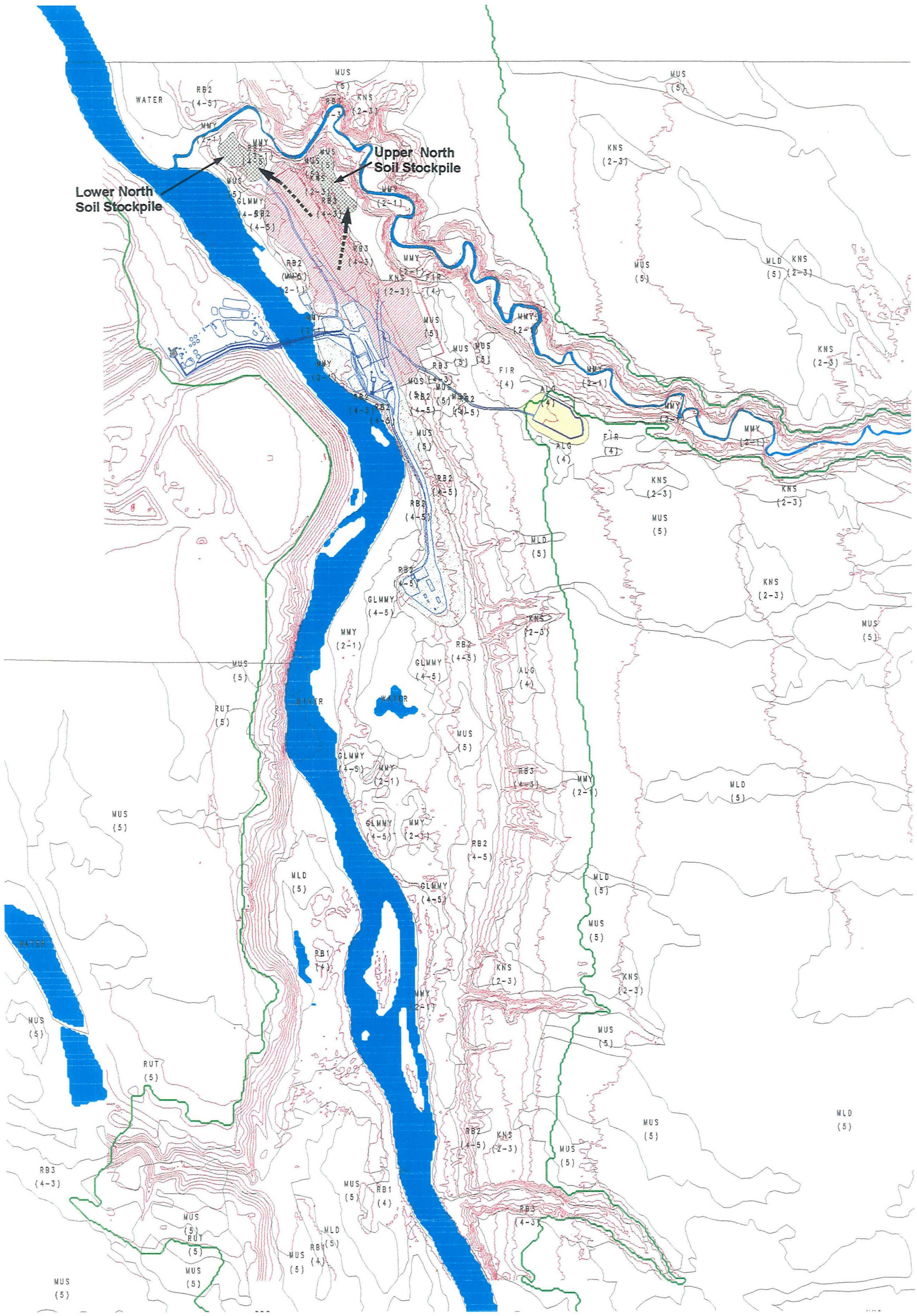
Scale = 1:50,000

0 1 2 km

Project No: 962-2218.5020 By: RP Date: 12 July 1996

Suncor Inc.

Golder Associates



LEGEND

- Planned Infrastructure
- Mining Activity
- Cleared/stripped
- Muskeg Soil stockpile
- River valley boundary
- Infrastructure/Transportation

Soil Types and Capability:
Classes shown as:

MUS / 5 = Muskeg Soil / Capability Class 5

NOTE: Mine Plan based on Feasibility 2000 contour

Map IMS - 1998

STEEPBANK MINE: SOIL SALVAGE AND RECLAMATION PLAN YEAR 1998

Scale = 1:50,000

0 1 2 km

Project No: 962-2218.5020 By: RP Date: 12 July 1998

Suncor Inc.

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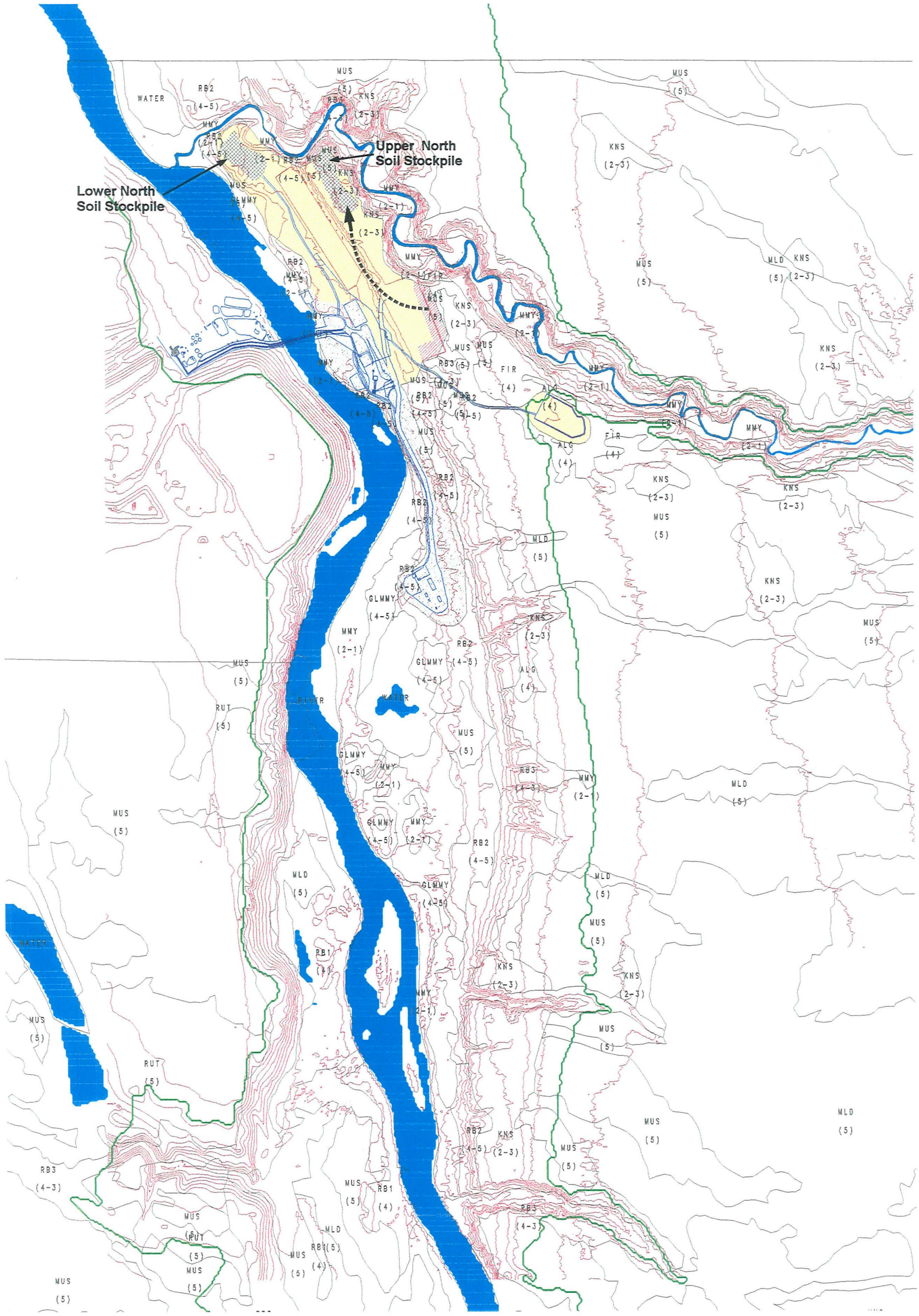

LEGEND

- Planned Infrastructure
- Mining Activity
- Cleared/stripped
- Muskeg Soil stockpile
- River valley boundary
- Infrastructure/Transportation
- Muskeg Soil Storage

Soil Types and Capability:
Classes shown as:

MUS / 5 = Muskeg Soil / Capability Class 5

NOTE: Mine Plan based on Feasibility 2000 contour

Map IMS - 1999
STEEPBANK MINE: SOIL SALVAGE AND RECLAMATION PLAN YEAR 1999

Scale = 1:50,000
0 1 2 km

Project No: 962-2218.5020 By: SP Date: 12 July 1996

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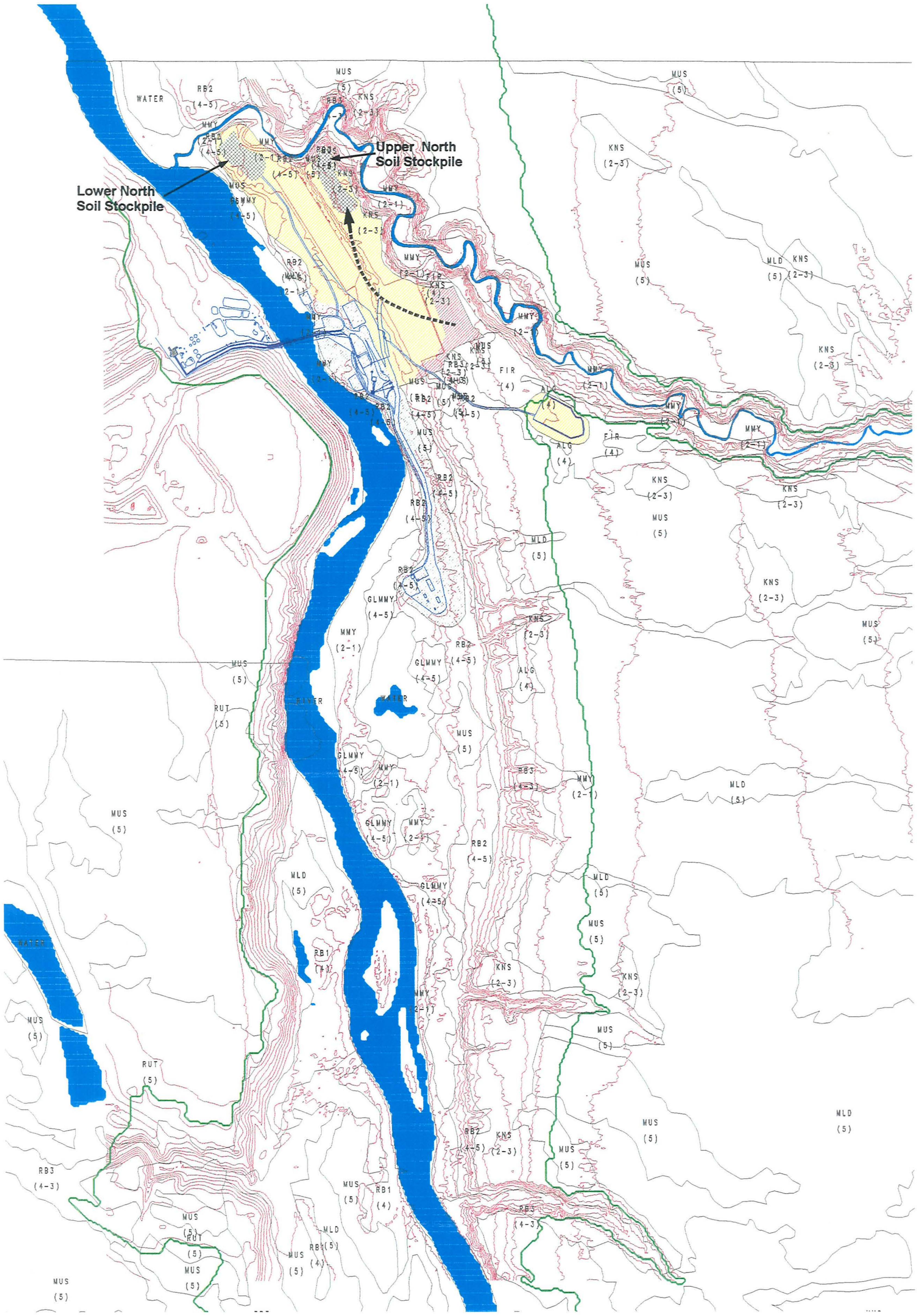

LEGEND

- Planned Infrastructure
- Mining Activity
- Cleared/stripped
- Muskeg Soil stockpile
- River valley boundary
- Infrastructure/Transportation
- Muskeg Soil Storage

Soil Types and Capability:

Classes shown as:

$\frac{\text{MUS}}{5} = \frac{\text{Muskeg Soil}}{\text{Capability Class 5}}$

NOTE: Mine Plan based on Feasibility 2000 contour

Map IMS - 2000

STEEPBANK MINE: SOIL SALVAGE AND RECLAMATION PLAN YEAR 2000

Scale = 1:50,000

0 1 2 km

Project No: 962-2218.5020 By: RP Date: 12 July 1996

Suncor Inc.

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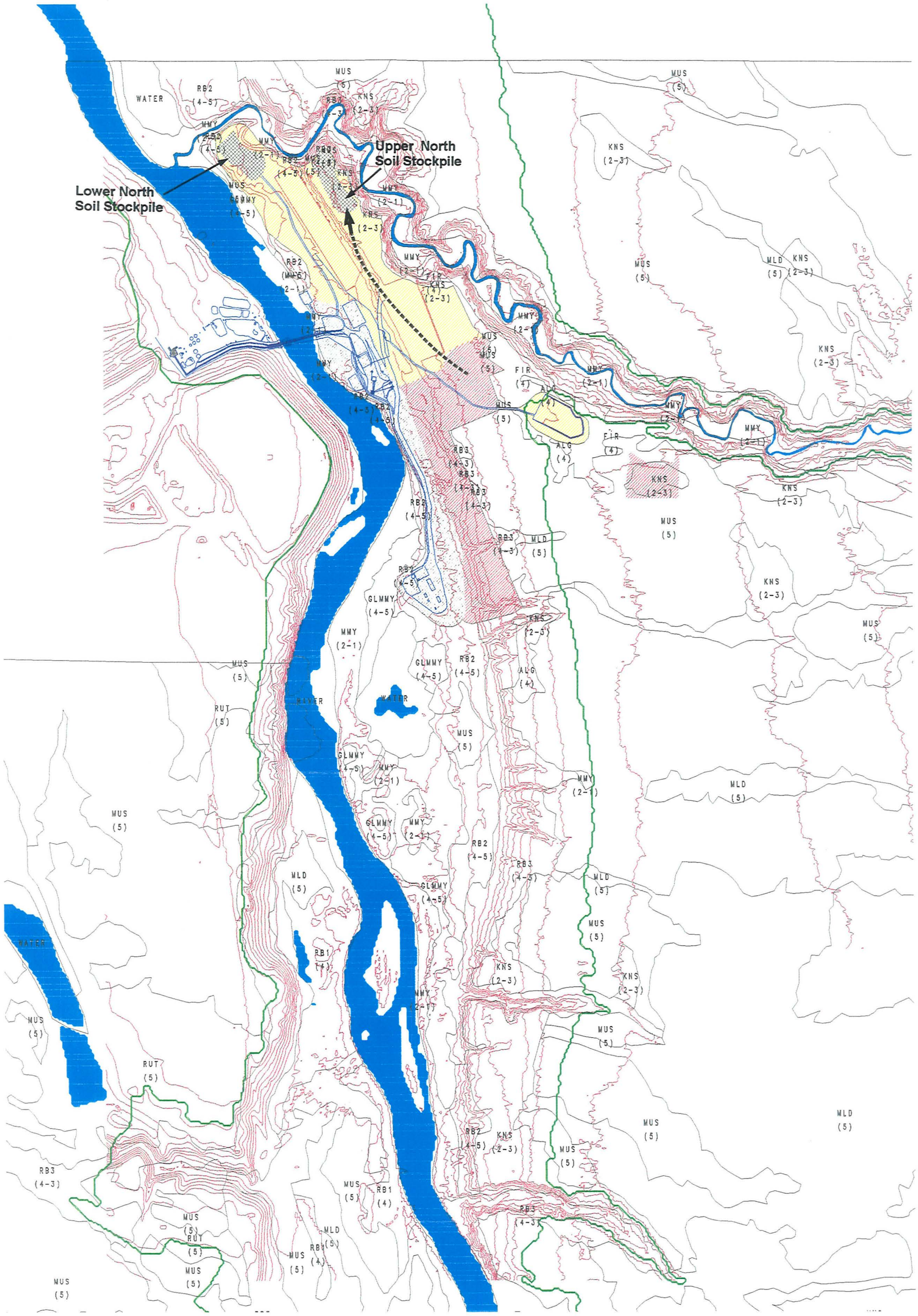

LEGEND

- Planned Infrastructure
- Mining Activity
- Cleared/stripped
- Muskeg Soil stockpile
- River valley boundary
- Infrastructure/Transportation
- Muskeg Soil Storage

Soil Types and Capability:

Classes shown as:

MUS / 5 = Muskeg Soil / Capability Class 5

NOTE: Mine Plan based on Feasibility 2000 contour

Map IMS - 2001

STEEPBANK MINE: SOIL SALVAGE AND RECLAMATION PLAN YEAR 2001

Scale = 1:50,000

0 1 2 km

Project No: 962-2218.5020 By: RP Date: 12 July 1996

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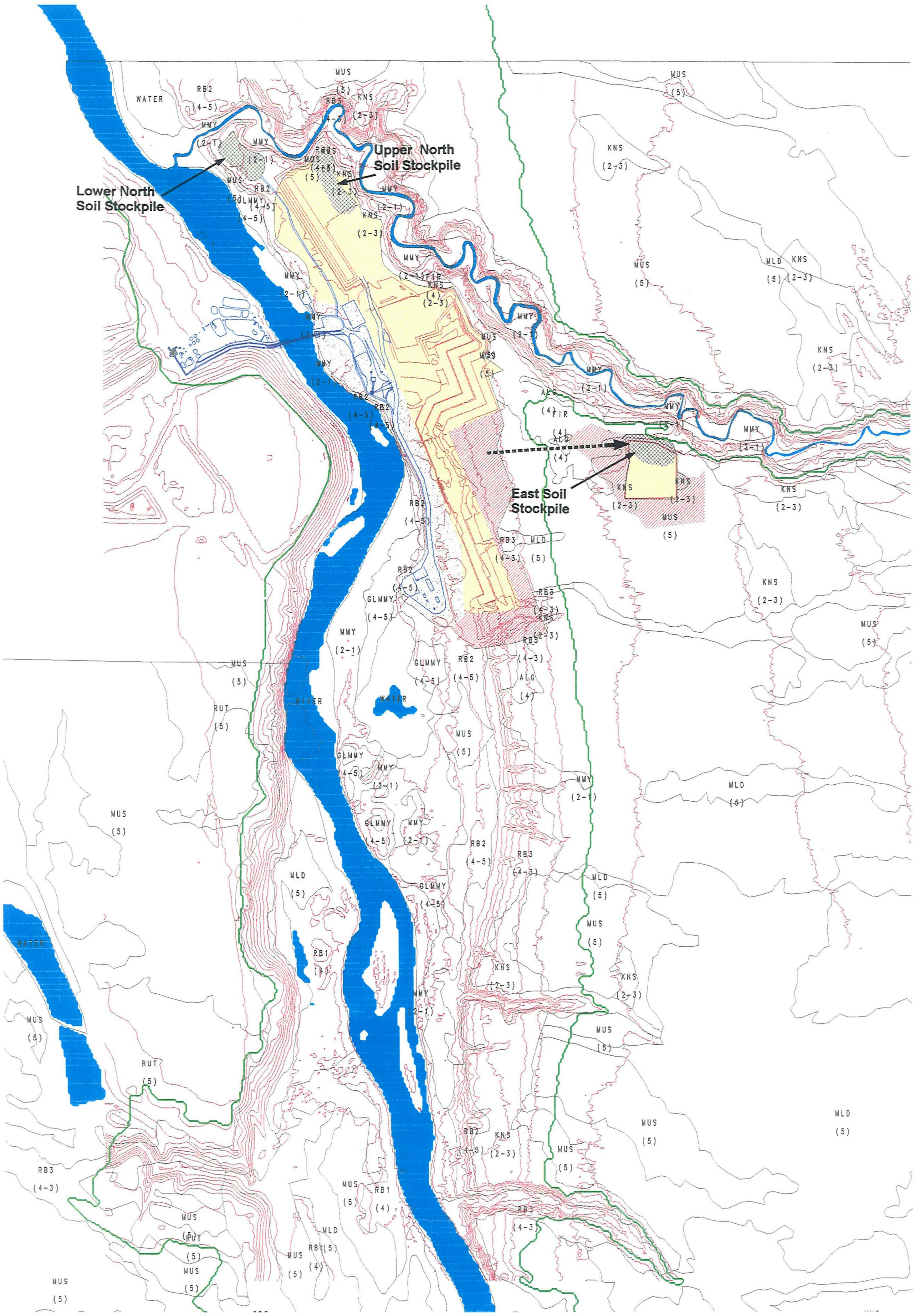

LEGEND

Planned Infrastructure	River valley boundary
Mining Activity	Infrastructure/Transportation
Cleared/stripped	Soil Types and Capability: Classes shown as:
Muskeg Soil stockpile	MUS / 5 = Muskeg Soil / Capability Class 5

Muskeg Soil Storage

NOTE: Mine Plan based on Feasibility 2003 contour

Map IMS - 2002

STEEPBANK MINE: SOIL SALVAGE AND RECLAMATION PLAN YEAR 2002

Scale = 1:50,000

0 1 2 km

Project No: 962-2218.5020 By: RP Date: 12 July 1996

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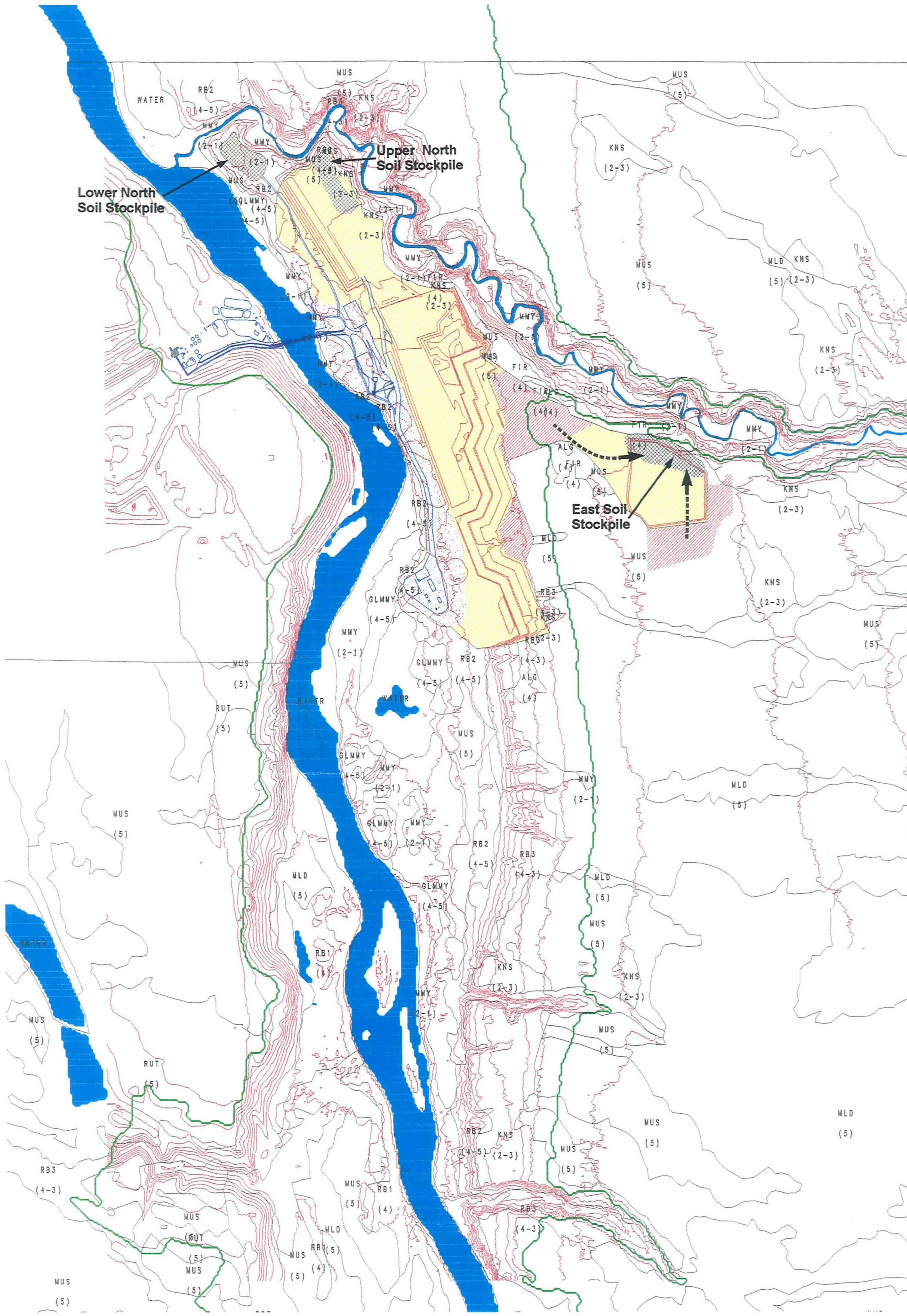

LEGEND

- Planned Infrastructure
- Mining Activity
- Cleared/stripped
- Muskeg Soil stockpile
- River valley boundary
- Infrastructure/Transportation
- Muskeg Soil Storage

Soil Types and Capability:
Classes shown as:

MUS / 5 = Muskeg Soil / Capability Class 5

NOTE: Mine Plan based on Feasibility 2004 contour

Map IMS - 2003
STEEPBANK MINE: SOIL SALVAGE
AND RECLAMATION PLAN YEAR 2003

Scale = 1:50,000
0 1 2 km

N

Project No: 962-2218.5020 By: RP Date: 12 July 1996

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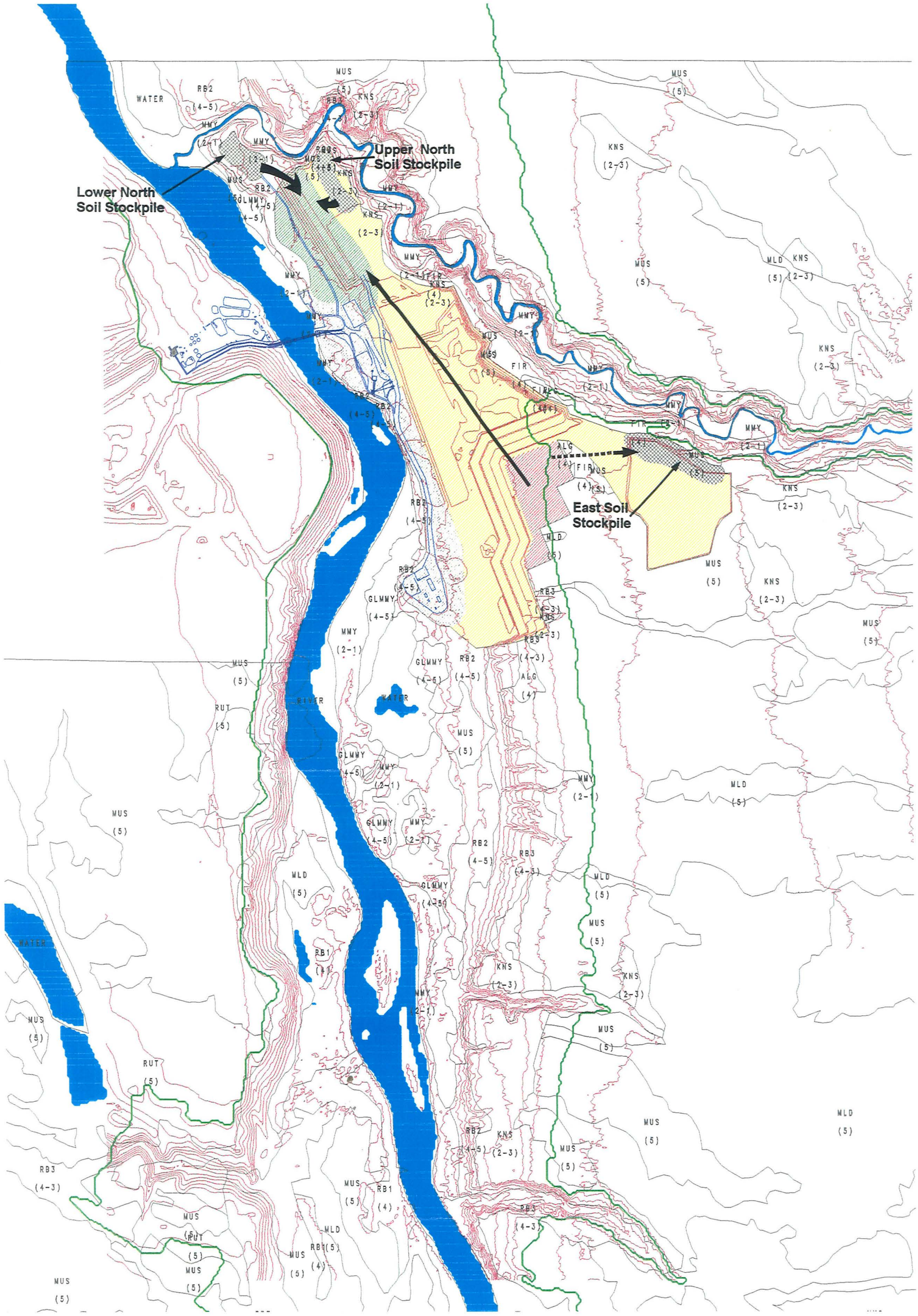

LEGEND

- Planned Infrastructure
- Mining Activity
- Cleared/stripped
- Muskeg Soil stockpile
- New reclamation
- River valley boundary
- Infrastructure/Transportation

Soil Types and Capability:
Classes shown as:

MUS = Muskeg Soil
5 = Capability Class 5

Muskeg Soil Storage

Direct Muskeg Soil Placement

Soil Stockpile Placement

NOTE: Mine Plan based on Feasibility 2005 contour

Map IMS - 2004
STEEPBANK MINE: SOIL SALVAGE AND RECLAMATION PLAN YEAR 2004

Scale = 1:50,000
0 1 2 km

Project No: 962-2218.5020 By: RP Date: 12 July 1996

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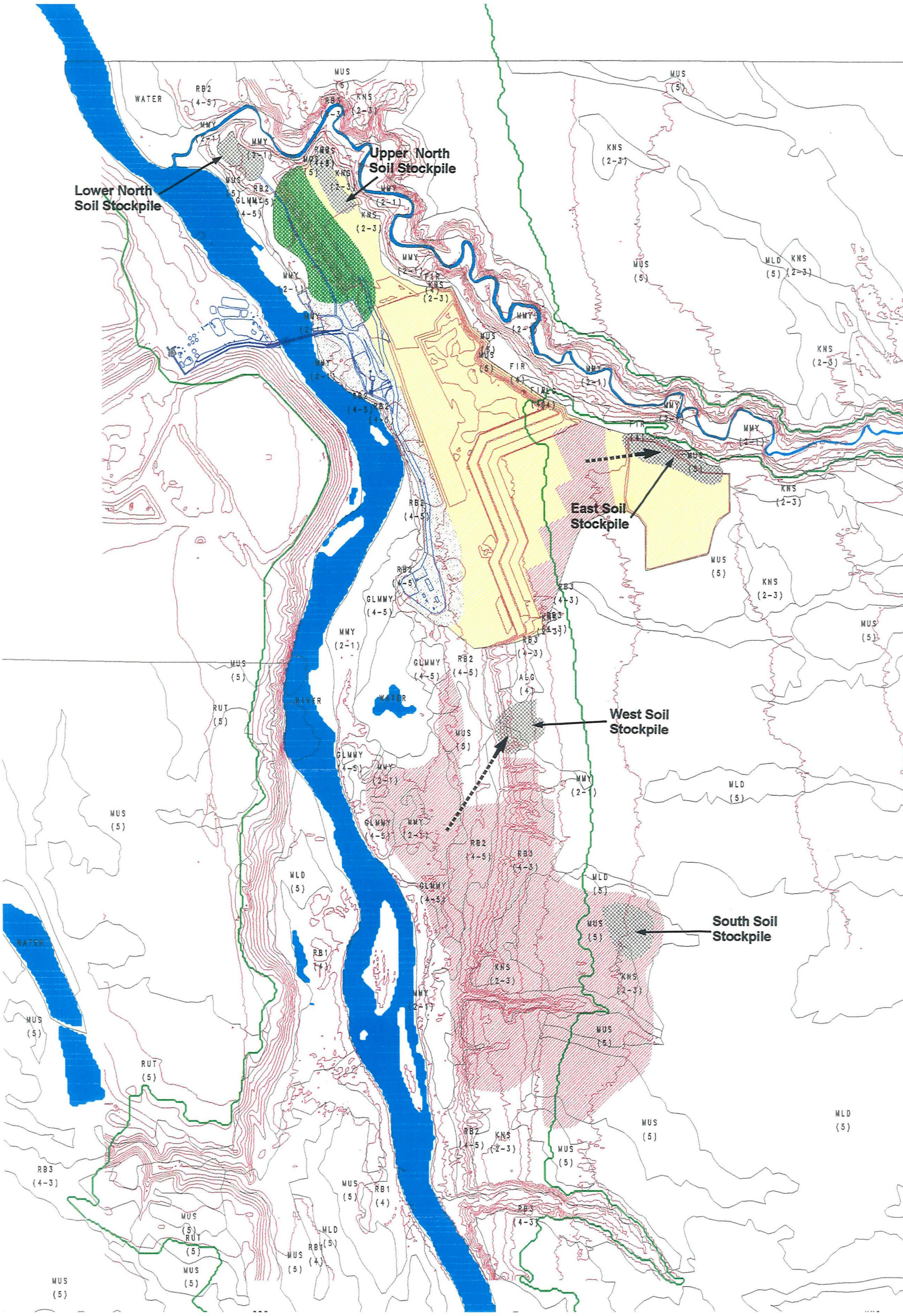


LEGEND

- Planned Infrastructure
- Mining Activity
- Cleared/stripped
- Muskeg Soil stockpile
- Previously reclaimed
- River valley boundary
- Infrastructure/Transportation
- Muskeg Soil Storage

Soil Types and Capability:
Classes shown as:

MUS = Muskeg Soil
--- = ---
5 = Capability Class 5

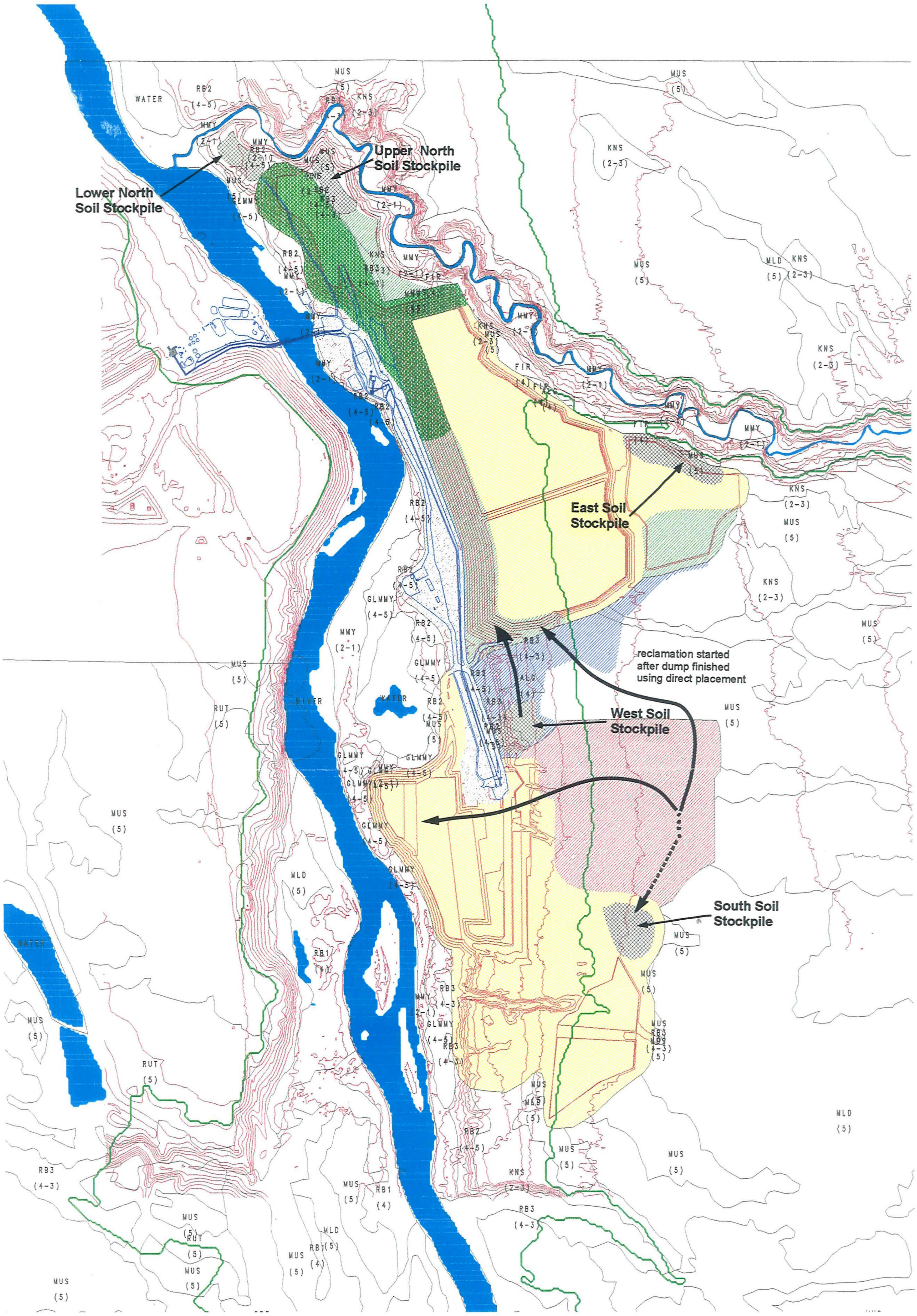
NOTE: Mine Plan based on Feasibility 2005 contour

Map IMS - 2005
STEEPBANK MINE: SOIL SALVAGE AND RECLAMATION PLAN YEAR 2005

Scale = 1:50,000
0 1 2 km

Project No: 962-2218.5020 By: RP Date: 12 July 1996

Suncor Inc.
Golder Associates



LEGEND

- Planned Infrastructure
- Mining Activity
- Cleared/stripped
- Muskeg Soil stockpile
- New reclamation
- Previously reclaimed
- Selectively cleared/stripped (roads, utilities, drainages)
- River valley boundary
- Infrastructure/Transportation

Soil Types and Capability:

Classes shown as:

MUS = Muskeg Soil
5 = Capability Class 5

- Muskeg Soil Storage
- Direct Muskeg Soil Placement
- Soil Stockpile Placement

NOTE: Mine Plan based on Feasibility 2009 contour

Map IMS - 2010

STEEPBANK MINE: SOIL SALVAGE AND RECLAMATION PLAN YEAR 2010

Scale = 1:50,000

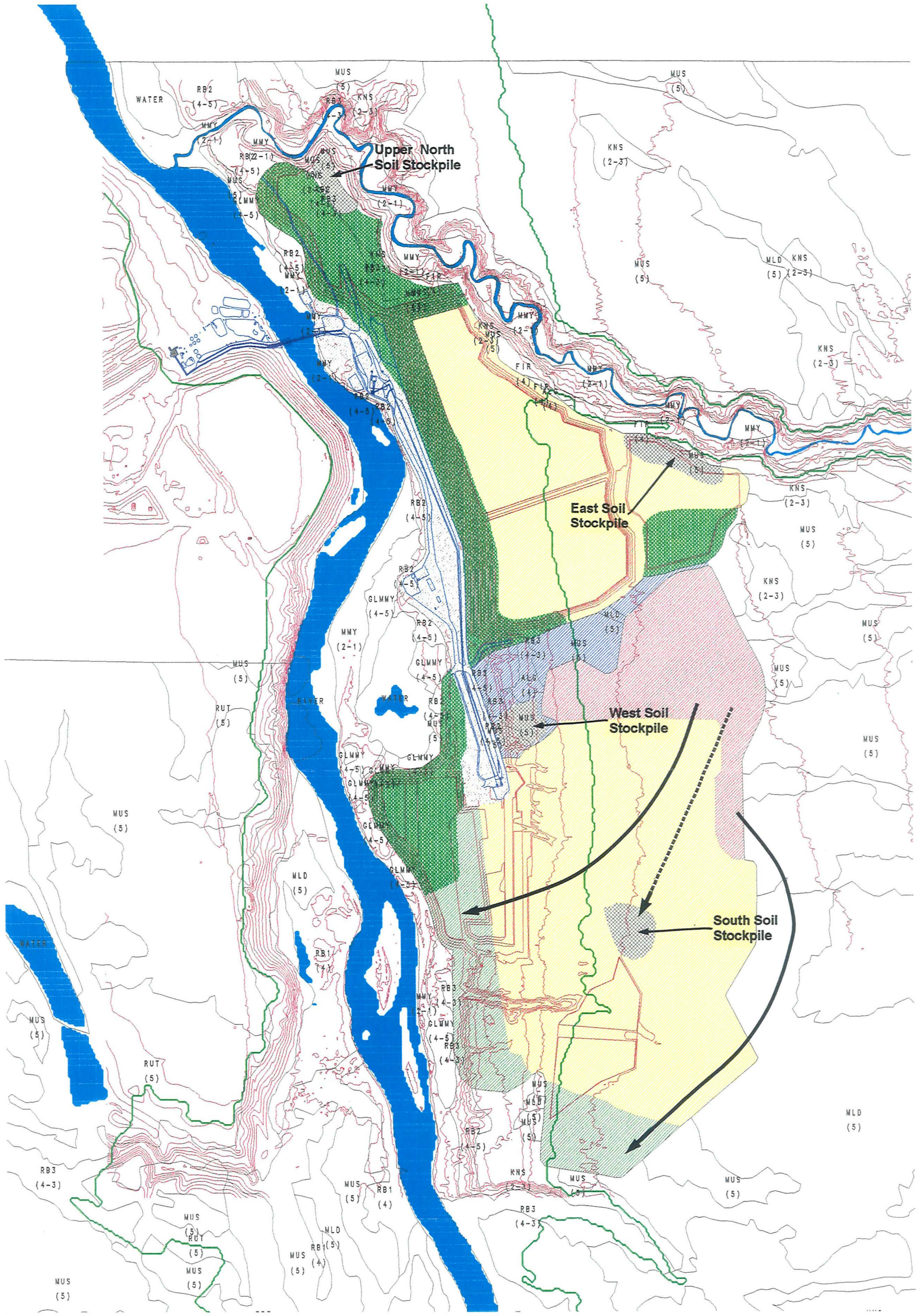
0 1 2 km

N

Project No: 962-2218.5020 By: RP Date: 12 July 1995

Suncor inc.

Golder Associates



LEGEND

- Planned Infrastructure
- Mining Activity
- Cleared/stripped
- Muskeg Soil stockpile
- New reclamation
- Previously reclaimed
- Selectively cleared/stripped (roads, utilities, drainages)
- River valley boundary
- Infrastructure/Transportation

Soil Types and Capability:

Classes shown as:

MUS = Muskeg Soil
5 = Capability Class 5

Muskeg Soil Storage

Direct Muskeg Soil Placement

NOTE: Mine Plan based on Feasibility 2009 contour

Map IMS - 2015

STEEPBANK MINE: SOIL SALVAGE AND RECLAMATION PLAN YEAR 2015

Scale = 1:50,000

0 1 2 km

Project No: 962-2218.5020 By: RP Date: 12 July 1996

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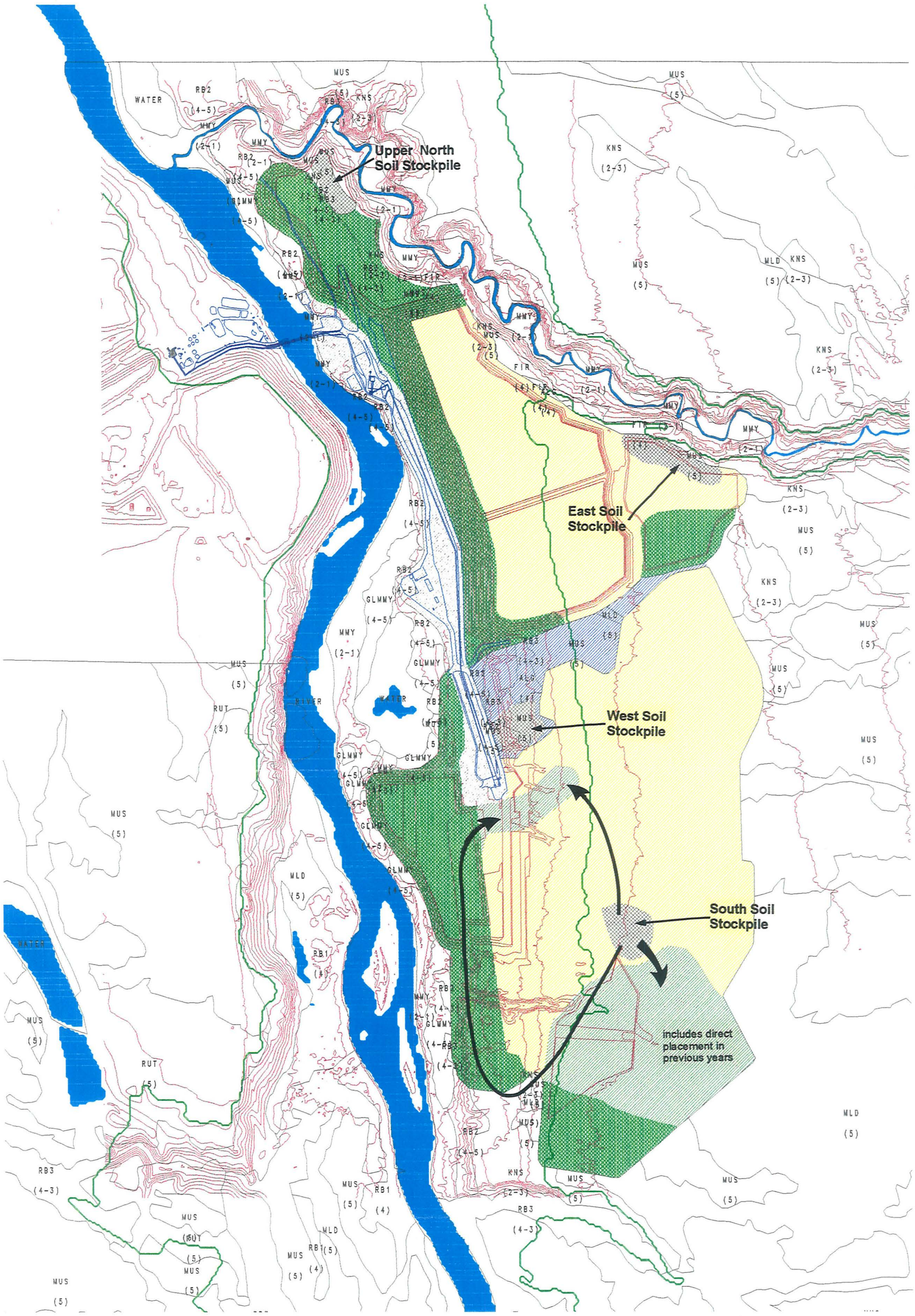


LEGEND

- Planned Infrastructure
- Mining Activity
- Cleared/stripped
- Muskeg Soil stockpile
- New reclamation
- Previously reclaimed
- Selectively cleared/stripped (roads, utilities, drainages)

- River valley boundary
- Infrastructure/Transportation

Soil Types and Capability:

Classes shown as:

MUS = Muskeg Soil
5 = Capability Class 5

Soil Stockpile Placement

NOTE: Mine Plan based on Feasibility 2009 contour

Map IMS - 2020
STEEPBANK MINE: SOIL SALVAGE AND RECLAMATION PLAN YEAR 2020

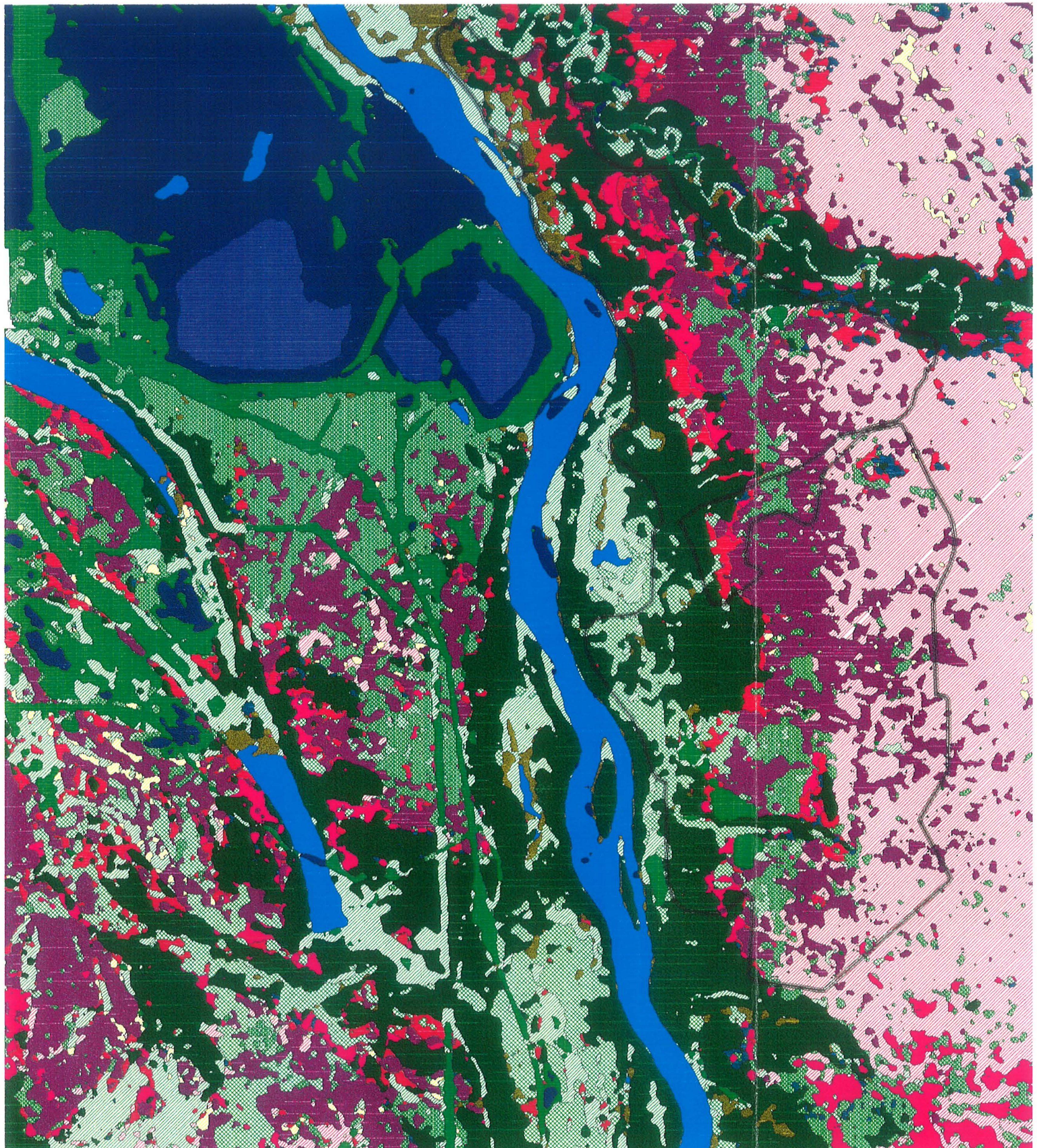
Scale = 1:50,000

0 1 2 km

N

Project No: 962-2218.5020 By: RP Date: 12 July 1996

Suncor Inc. Golder Associates



Map V1

VEGETATION CLASSIFICATION (ECOSITES) WITHIN THE LOCAL STUDY AREA

LEGEND

- Closed Jack Pine (compares to Open Mixedwood)
- Closed White Spruce (compares to Closed Mixedwood, W.Spruce Dom.)
- Deciduous forest (compares to all Deciduous Forest types, aspects)
- Closed Mixedwood (compares to Closed Mixedwood, Poplar Dom.)
- Closed Mixed Coniferous, Black Spruce Dominant (no equivalent)
- Peatland: Closed Black Spruce Bog (no equivalent)
- Peatland: Black Spruce-Tamarack Fen (no equivalent)
- Closed Mixedwood, White Spruce Dominant (compares to Closed Mixedwood, W.Spruce Dom.)
- Peatland: Open Black Spruce Bog (no equivalent)
- Peatland: Open Tamarack Fen (no equivalent)
- Wetland Closed Shrub Complex (compares to Wetland Closed Shrube Complex)
- Disturbed/Herb, Grasses (compares to Disturbed/Herb, Grasses)
- Industrial/Sparsely Vegetated (no equivalent)
- Industrial Open Water (no equivalent)
- Wetland Open Water-Emergent Vegetation Zone (compares to Wetland Open Water)

NOTE: ( ) means compare areas to Revegetation Map V2

N

Scale = 1:60,000

0 2 4

KILOMETRES

Project No. 962-2218.5020 12 July 1996

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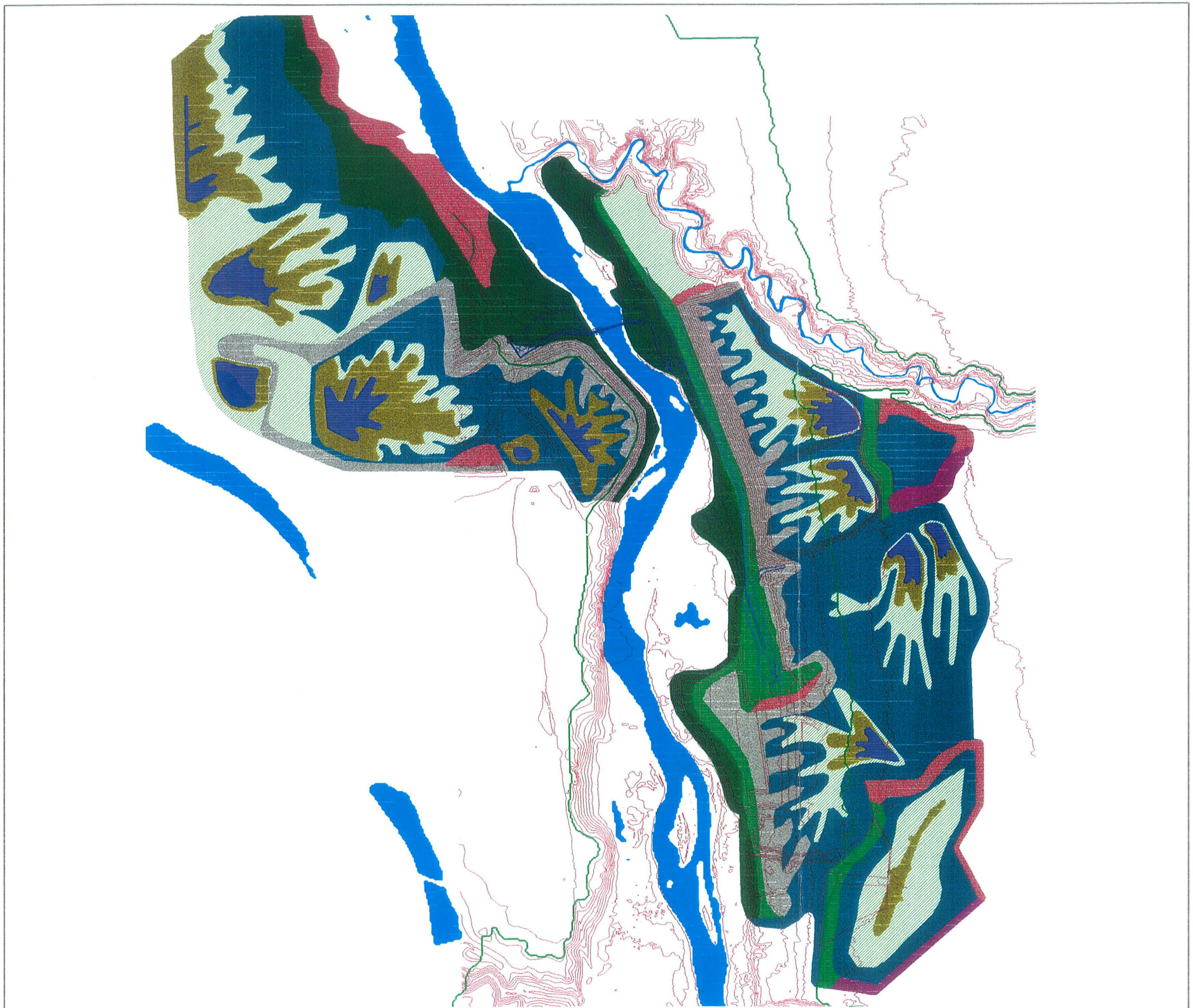
Golder Associates



Map V2

DETAILED REVEGETATION TYPES ASSOCIATED WITH RECLAMATION STRUCTURES IN THE INTEGRATED STUDY AREA: LONG-TERM

LEGEND

- Closed Mixedwood Poplar Dominant (Mesic Sites)
- Closed Mixedwood, White Spruce Dominant (North Aspects)
- Open Mixedwood Pine Dominant (Crests/Upper slopes)
- Deciduous Forest (West Aspects)
- Deciduous Forest (Lower Slopes)
- Deciduos Forest (South Aspects)
- Deciduous Forest (Mesic Sites)
- Wetland Closed Shrub Complex
- Wetland Open Water-Emergent Vegetation

- River Valley boundary

N

Scale = 1:60,000

0 2 4

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