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Golder Associates

REPORT ON

WILDLIFE
HABITAT SUITABILITY INDICES (HSI)
MODELLING
FOR THE MUSKEG RIVER MINE PROJECT

Submitted to:

Shell Canada Limited
400 - 4 Avenue SW
Calgary, AB T2P 3H2

February 1998 **972-2237**

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February 10, 1998

Proj. No. 972-2237

Judith A. Smith
Manager, Environmental Services
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Shell Canada Limited
400 - 4th Avenue SW
P.O. Box 100, Station M
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RE: Final report - Wildlife Habitat Suitability Indices (HSI) for the Muskeg River Mine Project

Dear Judy

Attached is the final report on the Wildlife HSI for the Muskeg River Mine Project. This report provides details on analysis of wildlife habitat within the Muskeg River Mine Project Local Study Area (LSA) and Regional Study Area (RSA). The report also includes details on: a) Habitat Suitability Indices Modelling; b) baseline and potential changes to the habitat values as a result of mine development; c) analysis of wildlife species biodiversity; and d) analysis of linkage and fracture areas within RSA.

Should you have any questions about this report, please contact me at 299-5640.

Yours very truly,

GOLDER ASSOCIATES LTD.

John R. Gulley, M.Sc., P. Biol.
Oil Sands Project Director

attachment

cc. Doug Mead (Shell)
Ian Mackenzie (EIA Project Manager)

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ACKNOWLEDGEMENTS

This study was conducted for Shell Canada Ltd. under the direction of Doug Mead and Judy Smith.

Models for some species were adapted from models prepared by Axys Environmental Consulting Ltd. and Westworth, Brusnyk and Associates Ltd. Habitat variable data was obtained from Bovar Environmental from Syncrude baseline studies and Golder Associates Ltd. from Shell Canada Limited baseline studies. Modelling was conducted by Wayne Bessie, GIS analyses by Jill Hebb and The Forestry Corp. Report writing was conducted by Michael Raine and Wayne Bessie. The report was edited for content by John Gulley and Rita Ewing. Technical editing was performed by Barbara McCord. Formatting was performed by Megan Brown and Maureen Myers.

EXECUTIVE SUMMARY

This document reports on the analysis of wildlife habitat within Shell Canada Limited's Muskeg River Mine Project Local Study Area (LSA) and Regional Study Area (RSA). Analysis of habitat capability was accomplished through Habitat Suitability Index (HSI) modelling. The goals of this study were to establish baseline habitat capability values for the two study areas, and then assess potential changes to these habitat values as a result of mine developments and other industrial or infrastructure developments. A further goal for the LSA was to determine the long-term changes to wildlife habitat after mine closure and completion of vegetation community reclamation and regrowth.

HSI models were adapted from existing models or were newly developed for each of the Key Indicator Resource (KIR) species, which were selected for the study. These species were: beavers, black bears, cape may warblers, dabbling ducks species group, fishers, great gray owls, moose, pileated woodpeckers, red-backed voles, ruffed grouse, snowshoe hares and western tanagers. In addition, an analysis of wildlife species biodiversity at the habitat level was conducted as was an analysis of moose linkage and fracture areas within the RSA based on habitat areas that allow, and disturbance areas that potentially disrupt, movements for moose.

HSI models allow assessment of the capability of habitats to support any of the ecological requirements of a species. They do this by rating a vegetation community's compositional and structural components (e.g., downed wood cover) on a scale ranging from 0 - 1. These ratings are then combined in an overall index that ranges from 0 - 1 , where 0 indicates the habitat does not meet the species critical needs, and 1 indicates all of the species' needs can be found in that area. These index values are then multiplied by the area of each vegetation community, and the products are summed to determine Habitat Units (HUs). HUs are thus a manner to quantify the total habitat of a species throughout a study area. HUs were compared in this study to demonstrate impacts of development and reclamation on the habitat of each KIR. Likewise, biodiversity HUs were defined and compared to assess changes in wildlife species diversity, while changes to moose linkage habitat areas were used to assess potential fragmentation of moose habitat.

In the LSA, beavers were predicted to have 1,424 HUs at baseline. This value was reduced by 30.5% to 990 HUs due to mine development (clearing, aquifer drawdown, and human disturbances combined). On closure, when all habitats were reclaimed, beaver habitat was predicted to return to 1,339 HUs, which represented a low magnitude decrease of 6% from baseline. In the RSA, beavers were mapped as having 105,408 HUs at baseline. This decrease 0.1% due to the Muskeg River Mine Project

(Project) to 105,325 HUs. The total cumulative impact of all approved developments plus the Project would reduce beavers habitat 1.5% from baseline, and the impact of all planned projects was 2.5%.

Black bears were predicted to have 3,809 HUs at baseline in the LSA. This was predicted to be reduced by 45.1% by the Project to 2,092 HUs. On closure black bear habitat was predicted to increase to 4,880 HUs, an increase of 28.1% from baseline. In the RSA, black bear habitat of 362,016 HUs at baseline was decreased by 0.4% to 360,427 HUs due to the Project. The cumulative decrease of all approved developments was 2.3%, and the impact of all planned developments was 4.8%.

Cape May warblers were predicted to have 1,583 HUs at baseline in the LSA. This was reduced by 48.6% by the Project to 814 HUs, but on closure, warbler habitat was predicted to increase to 2,387 HUs, an increase of 50.8% from baseline. In the RSA, Cape May warbler habitat of 162,454 HUs at baseline decreased by 0.5% due to the Project. The cumulative decrease of all approved developments was 2.1%, and the impact of all planned developments was 4.3%.

Dabbling ducks were predicted to have 1,446 HUs at baseline in the LSA. This was predicted table reduced by 35% by the Project to 940 HUs. On closure, dabbling duck habitat was predicted to increase to 2,070 HUs, an increase of 43.2% from baseline. In the RSA, dabbling ducks habitat of 108,916 HUs at baseline was decreased by 0.2% due to the Project. The cumulative decrease of all approved developments was 1.2%, and the impact of all planned developments was 2.2%.

Fishers were predicted to have 4,789 HUs at baseline in the LSA. This was predicted to be reduced by 54.7% by the Project to 2,173 HUs. On closure, fisher habitat was predicted to increase to 5,135 HUs, an increase of 7.0% from baseline. In the RSA, fisher habitat of 555,957 HUs at baseline was decreased by 0.4% due to the Project. The cumulative decrease of all approved developments was 2.5%, and the impact of all planned developments was 4.9%.

Great gray owls were predicted to have 25,59 HUs at baseline in the LSA. This was predicted to be reduced by 61.1% by the Project to 995 HUs, but post-closure great grey owl habitat was predicted to increase to 2,985 HUs, an increase of 16.6% from baseline. In the RSA, great gray owl habitat of 308,237 HUs at baseline was decreased by 0.7% due to the Project. The cumulative decrease of all approved developments was 2.9%, and the impact of all planned developments was 5.0%.

Moose were predicted to have 4,678 HUs at baseline in the LSA. This was reduced by 54.3% by the Project to 2,136 HUs. On closure, moose habitat was predicted to increase to 5,126 HUs, an increase of 9.6% from baseline. In the RSA, moose habitat of 385,291 HUs at baseline was decreased by 0.6% to 382,860 HUs due to the Project. The cumulative decrease of all approved developments was 2.9%, and the impact of all planned developments was 5.6%. Total moose fracture zone area in the RSA was 4.1% of the RSA or 42,972 ha. This increased to 4.9% of the RSA due to the Project, and then to 7.8% when all approved developments were included or 9.8% when all planned developments were included. Fracture areas represent habitats unusable to moose due to human caused disturbances, whether or not the habitat was suitable.

Pileated woodpeckers were predicted to have 3,403 HUs at baseline in the LSA. This was reduced by 43.7% by the Project to 1,915 HUs. On closure pileated woodpecker habitat was predicted to increase to 5,173 HUs, an increase of 52% from baseline. In the RSA, pileated woodpecker habitat of 324,826 HUs at baseline was decreased by 0.5% to 323,315 HUs due to the Project. The cumulative decrease of all approved developments was 1.9%, and the impact of all planned developments was 4.1%.

Red-backed voles were predicted to have 5,469 HUs at baseline in the LSA. This was reduced by 44.3% by the Project to 3,044 Hus. On closure, vole habitat was predicted to increase to 5,692 HUs, an increase of 4.1% from baseline. In the RSA, red-backed vole habitat of 505,202 HUs at baseline was decreased by 0.4% to 503,176 HUs due to the Project. The cumulative decrease of all approved developments was 2.2%, and the impact of all planned developments was 4.2%.

Ruffed grouse were predicted to have 3,305 HUs at baseline in the LSA. This was predicted to be reduced by 44.8% by the Project to 1,825 HUs. On closure, ruffed grouse habitat was predicted to increase to 3,841 HUs, an increase of 16.2% from baseline. In the RSA, ruffed grouse habitat of 318,183 HUs at baseline was decreased by 0.5% to 316,626 HUs due to the Project. The cumulative decrease of all approved developments was 2.1%, and the impact of all planned developments was 4.2%.

Snowshoe hares were predicted to have 7,319 HUs at baseline in the LSA. This was reduced by 53.5% by the Project to 3,404 HUs. On closure, snowshoe hare habitat was predicted to increase to 7,260 HUs, which remains a decrease of 0.8% from baseline. In the RSA, snowshoe hare habitat of 786,163 HUs at baseline was decreased by 0.5% to 781,907 HUs due to the Project. The cumulative decrease of all approved developments was 2.7%, and the impact of all planned developments was 4.9%.

The final species modelled was the western tanager. This species was predicted to have 1,104 HUs at baseline in the LSA. This was reduced by 34.3% by theProject to 725 HUs. On closure, western tanager habitat was predicted to increase to 3,195 HUs, an increase of 189.4% from baseline. In the RSA, western tanager habitat of 127,278 HUs at baseline was decreased by 0.3% to 126,840 HUs due to the Project. The cumulative decrease of all approved developments was 1.7%, and the impact of all planned developments was 4.2%.

Biodiversity in the LSA was initially predicted to be 7,516 HUs at baseline for mammals, 7,293 HUs for birds and 8,531 HUs for reptiles and amphibians. The Project reduced biodiversity HUs by 39.5% (mammals), 40.4% (birds) and 42.1% (reptiles and amphibians). On closure, habitat for mammals showed an increase over baseline of 5.7%, but both birds, and reptiles and amphibians, were predicted to decrease by 5.5 and 17.2 %, respectively. In the RSA, biodiversity habitat was initially 936,331 HUs for mammals, 874,441 HUs for birds, and 850,641 HUs for reptiles and amphibians. The mammals were decreased by 0.4 % due to the Project, 2.3% by all approved developments, and 6.1% by all planned developments. The birds were similarly decreased by 0.4%, 2.3% and 6.0% (respectively), whereas reptiles and amphibians were decreased 0.4%, 2.4% and 6.0% respectively.

1. INTRODUCTION

Shell Canada Limited (Shell) is planning an oil sands development on the western part of Lease 13. This development is known as the Muskeg River Mine Project (Project). The area is located approximately 75 km north of Fort McMurray and on the east side of the Athabasca River. As part of an Environmental Impact Assessment (EIA) for the project, Shell is required to assess the potential impacts of development on wildlife (i.e., mammals, birds, amphibians and reptiles). Baseline information concerning these wildlife groups is required for impact assessment, mitigation planning, closure design and monitoring recommendations.

In this report, Habitat Suitability Index (HSI) modelling (US Fish and Wildlife Service 1981) is used to assess impacts to wildlife habitat for the Local and Regional Study Areas (LSA and RSA) of the Project. Baseline habitat, impacts due to the Project alone, and regional Cumulative Effects Analyses (CEA) are presented. The regional analysis includes analyses of: 1) the Muskeg River Mine alone (termed Scenario 1); 2) the Project and approved projects (Scenario 2 or CEA) and 3) the Project, approved, and planned developments (Scenario 3 or the Regional Development Review [RDR]). In addition, models of wildlife biodiversity and linkage zones for moose are presented in this report.

Pertinent companion documents to this report include:

- Baseline Wildlife Report (Golder 1997a);
- Wildlife EIA (Golder 1997b, Section E11);
- Wildlife CEA (Golder 1997b, Section F11); and
- Wildlife RDR (Golder 1997b, Section G11).

HSI models are analytical tools for determining the relative potential of an area to support individuals (or populations) of a wildlife species. They are frequently used to quantify potential habitat losses and gains for wildlife species as a result of various land use activities. Today, HSI modelling is used in EIAs to determine potential impacts of project activities on wildlife resources.

The report is organized into the following sections:

Theory and Use of HSI Models

In Section 2, background to the HSI process is provided, including objectives and steps in the modelling process.

Spatial and Temporal Boundaries

The study areas and timeframes for the assessments are defined in Section 3.

Key Indicator Resources

In Section 4, the Key Indicator Resource species (KIRs) selected for the Muskeg River Mine are presented and a rationale for their selection is provided.

Methods

In Section 5, sources for the models and input data are described, as are methods for the impact analyses.

Results and Discussion

Results of the HSI analyses are presented and discussed for each KIR in Section 6, first for the LSA and then for the RSA.

Summary

Finally, in Section 7, the main findings are presented in a series of summary tables and are discussed.

2. THEORY AND USE OF HSI MODELS

HSI models are analytical tools for determining the relative potential of an area to act as habitat for a wildlife species. Habitat is defined in the models according to physical structures within areas and arrangements of physical properties among areas. An implicit assumption is that the total amount of habitat is related to the potential to support individuals or populations of a wildlife species. An explicit assumption is that habitat areas may be summed within an area of interest to determine the total area of habitat available to a species. These sums are then used to quantify habitat losses and gains as a result of changes in land use.

2.1 BACKGROUND

HSI models evaluate the potential of an area to support a wildlife species, based on a number of known or assumed relationships between elements of habitat structure and their capability to support a species' biological needs. These relationships are then combined mathematically in models. They are referred to as index models because the rating they provide is a relative value ranging from 0 to 1, where 0 indicates that an area is unsuitable and 1 indicates it is of optimum suitability. HSI values for each habitat type are then multiplied by the area (ha) of the habitat type to determine the number of habitat units (HUs) for each wildlife species. HSI models cannot provide information about abundance and other demographic characteristics of wildlife populations and cannot be used as a substitute for population data. They are, however, appropriate for:

1. Determining a ranking of the capability of a single habitat area to support various wildlife species, so management plans can reflect the needs of wildlife in the area or so a baseline status of wildlife habitat is known before habitat modifications.

2. Comparing different habitat types or areas to determine where various wildlife species are most likely to be affected by land management activities, or to plan for areas that are highest priority for protection.

3. Comparing the same area at different times by predicting changes to the habitat structure as a result of industrial activity and/or natural succession.

Long experience with HSI models in the United States has led to the development of standard protocols for HSI development and use (U.S. Fish and Wildlife Service 1981). Over the last decade, large forestry companies throughout North America have begun developing habitat models that can be linked to forest harvesting scenarios to assess changes over hundreds of years of management (e.g., Beck and Beck 1995). Mining project EIAs are also using HSI modelling to assess habitat baseline conditions and potential changes associated with mine development or reclamation activities (e.g., Axys 1996).

2.2 OBJECTIVES

Objectives for HSI mapping are normally to determine project-related impacts. In this report, HSI models are used to determine habitat conditions at baseline, impact, and fully reclaimed scenarios in the Project LSA. In the RSA, a progression of developments are assessed: baseline, baseline with Project (Scenario 1), baseline with Muskeg River Mine and all other approved developments (Scenario 2 or CEA), and baseline with all approved and other planned developments (Scenario 3 or RDR). In this manner the cumulative impacts of the Project and other developments on the wildlife habitat resource are assessed.

2.3 STEPS INVOLVED IN HSI MODELLING

The steps in HSI modelling are:

- development of HSI models for wildlife Key Indicator Resources;
- verification of model relationships;
- testing model performance; and
- verification of the model's predictions.

These steps are discussed in more detail in the following sections.

2.3.1 Development of HSI Models

The development of habitat models requires an understanding of the ecology and habitat requirements of wildlife species to be assessed. It usually involves a thorough literature review to identify all the known requirements and habitat relationships, followed by the development of model relationships that determine the species' biological needs. Previously developed HSI models may also be adapted for use in the area of interest. However, model from another area may require significant modifications for local conditions or may not be appropriate given differences in the habitat types, the data used to run the model or the scale of model application. Even models used previously in the same area are subject to these considerations.

Selection of habitat variables is done by assessing each species' needs for living space, nesting/breeding shelter, food/foraging cover, water/minerals, thermal cover, concealment cover and escape terrain. These needs can then be used to determine the attributes that are most required to determine species habitat use. Attributes may include elements of habitat structure such as: height, density, cover or size of living or dead trees or shrubs; species composition of trees, shrubs or other vegetation, presence of dead wood, rocky terrain, or open ground; and availability or distance to food, water or mineral resources, or other resources. Alternatively, the habitat type itself may be used directly in the models.

In developing habitat relationships, it is important to consider that the habitat attributes in the models must be available to perform model predictions. If an identified attribute is not in an existing data-set, it will be necessary to measure this variable in a new inventory (an expensive alternative) or it may be possible to predict the variable from related attributes (for example, tree diameter can be used to predict height). A third option is to make use of existing variables rather than new ones. This option is only valid if the exchange can be made without loss of model performance. The level of precision of the variables used for modelling is important too, since estimated attributes will pass on errors in each stage of the modelling and a well-defined model may be unable to provide precise estimates regardless of the strength of the relationship.

Once variables are selected, a relationship between each variable and habitat suitability is determined. This relationship must reflect real variation in the species biology. For example, if the opportunity for nest construction increases as trees get larger, a linear increase over a range of tree diameters may be appropriate. Two main relationship forms are: 1) continuous curves that show increasing, decreasing, or unchanging suitability over various ranges of the attribute, and 2) histograms that show specific values relative to categorical attributes or over set ranges of a given value. Each individual variable thus defines a suitability index that varies between 0 and 1, where 1 represents the optimum conditions and 0 represents an unsuitable condition. Over the range of some variables, there may never be a condition in which the habitat is unsuitable, in which case, the index should always be greater than 0. For example, if food increases with shrub cover but is still available at approximately 50% of the maximum when there are no shrubs, the index would range from 0.5 to 1.

Finally, the individual variable suitability index values are combined in an equation that reflects the manner in which all the variables interact to determine habitat use. Interactive components are generally multiplied whereas independently acting components are generally summed. In either case, a constraint is placed on the model to limit the overall suitability index to range between 0 and 1. This may involve constraining a sum to a maximum of 1, selecting the highest of several index values or determining the mean (or weighted mean) by either the common arithmetic mean or the geometric mean. The choice of equation types can have significant effects on a model's outcome, so it is important that the method of combination is driven by knowledge about the manner in which the combination of variables influences species habitat use.

2.3.2 Verification of Model Relationships

An important step in HSI modelling is verification of the relationships determined in the above steps. This involves field testing within the range of habitats in which the animals occur. The field testing program must determine:

- whether the habitat variables in the models are the same as the ones present in the habitats the species selects;
- whether the change in habitat performance predicted over the range of each variable holds true;
- whether the combination of variables acts in the manner described in the equation relationships; and
- whether the use of different habitat types is related to the prediction of overall suitability in the model.

The outcome of this process may be a verified model, an amended model or a rejected model (in which case an entirely new model must be developed).

2.3.3 Testing Model Performance

The performance of HSI models is tested by examining outputs in a trial run with existing data and models. This testing step is independent of the verification of the model relationships, and is used mainly to ensure that the model is providing the range of values expected, and is showing as highly suitable areas that the modeller or biologist believes to be the best habitat, and shows as low those areas known not to support the species. This test is not just a test of the models, but also of the GIS software running the models, the geographic database and other habitat data driving the predictions. This step may illustrate model shortcomings, which need to be corrected, or may indicate that the habitat data or geographic data need to be updated or modified before final use.

2.3.4 Verification of Model Predictions

Unlike the previous verification steps that involve examination of parts of the model or of its performance relative to local data, this step involves examination of the predicted HSI values for different areas relative to an independent set of wildlife habitat use or population measurements over a much larger area. This step may require several years of data, collected throughout several seasons, since some species are highly variable in their habitat use among seasons and years. A continuous monitoring program may be required for some species. For other species, a data-set compiled by another source, such as a game management agency, may also be available for testing. It is important, though, that data used to build and test the model earlier are not used to verify it, since that would not be an independent test.

3. SPATIAL AND TEMPORAL BOUNDARIES

3.1 SPATIAL BOUNDARIES

The Local Study Area (LSA) was determined by the outer boundaries of Lease 13 West and a 0.5 km buffer around the project footprint (Golder 1997b). A buffer of 0.5 km was selected for the LSA as it met the maximum zone of disturbance (0.5 km) for wildlife used in the Aurora Mine EIA (BOVAR 1996) and this assessment. This buffer did not extend a full 500 m to the north of Lease 13, however, as Syncrude intends to develop the area to within several hundred metres of the edge of Lease 13.

A Regional Study Area (RSA) for wildlife was selected to correspond with the RSA for vegetation and ELCs (see Golder 1997b and c). The boundaries for the RSA were developed in consultation with Shell Canada Ltd., Syncrude Canada Ltd., Suncor Energy Inc., Oil Sands and other stakeholders. Boundaries were set with consideration of a number of biophysical criteria, including watershed boundaries, ecological boundaries (based on ecological land classification criteria) and the regional airshed (based on existing air emission and deposition data).

3.2 TEMPORAL BOUNDARIES

The temporal boundaries for the EIA were defined as follows:

- Baseline (1997)
- Construction Phase (2000 - 2002)
- Operational Phase (2003 - 2029)
- Closure

These periods were selected because the characteristics of the project's impacts are quite different between the construction and operational phases, and a long-term view of the project at closure is required to assess the likely success of proposed reclamation/mitigation measures. Two main phases of the development were selected for detailed analysis: the Construction and Operation phase and Closure phase.

For the CEA and RDR scenarios, it was assumed that all developments would be built and operating at their maximum extents simultaneously. As this is unlikely to occur, due to the phased nature of the developments, the CEA and RDR scenarios tend to overestimate impacts.

4. KEY INDICATOR RESOURCES (KIRS)

As it is nearly impossible to study all species within an area, species representative of public and scientific values can be chosen for management purposes. Species selected in this manner are known as Management Indicator Species (MIS) (Salwasser and Unkel 1981), Valued Ecosystem Components (VECs) (Sadar 1994), key species and other terms. They will be termed Key Indicator Resources (KIRs) for the purposes of this report, following the terminology of the Aurora EIA (BOVAR 1996). Species chosen as KIRs for the Aurora Mine EIA were selected based on a scoring of species' political importance (endangered status), commercial and subsistence economic importance, non-consumptive importance and ecological importance (BOVAR 1996). Rather than repeat this process, the study team reviewed the selection process and adopted the KIRs of the Aurora Mine EIA for the Muskeg River Mine EIA. Following review of this list by Alberta Environmental Protection (AEP) personnel, two additional KIRs were selected: the western tanager and the pileated woodpecker. In addition to representing their respective species groups, KIRs were chosen for the reasons listed in Table 1.

Table 1 Wildlife Key Indicator Resources and Selection Rationale

moose	economic importance, early successional species
red-backed vole	importance in food chain
snowshoe hare	importance in food chain
black bear	economic importance, carnivore
beaver	economic importance, semi-aquatic habits
fisher	use of late seral stages, economic importance, carnivore
dabbling ducks	importance in food chain, economic and recreational importance
ruffed grouse	economic and recreational importance
Cape May warbler	use of white spruce forests, neotropical migrant
western tanager	use of open forest mixedwood, neotropical migrant
pileated woodpecker	use of late seral stages, large diameter trees and snags
great gray owl	raptor, use of wetlands

5. METHODS

5.1 MODEL SOURCES

HSI models were adapted from models previously used for other oil sands projects (Axys 1996, Westworth 1996) or were created by Golder Associates. Models for the 12 KIRS, biodiversity and linkage zones are presented in Appendix I.

5.2 INPUT DATA

5.2.1 Data Layers

5.2.1.1 Local Study Area

The LSA consists of 10,954 ha of vegetation and wetlands communities. Four important digital habitat features were incorporated to perform HSI modelling and conduct the impact assessment: a hydrology layer, a baseline vegetation layer, a project components layer and a post-reclamation vegetation layer.

Hydrology Layer

The hydrology layer included all the streams, rivers, ponds, and lakes within the LSA. It was used in conjunction with water polygon data that existed in the vegetation layer. Incorporating the hydrology layer with vegetation was accomplished by splitting the vegetation polygons that were bisected by stream and rivers. This was required so that the distance from water buffers applied in the beaver and dabbling duck models could be accomplished from the vegetation layer edge. Additional hydrological features were incorporated into the closure reclamation map (reclaimed ponds and wetlands) and were also used for the modelling. Using these combined layers, at baseline, 177 hectares of open water occur in the LSA. This changes to 139 hectares at the full mine impact, and is reclaimed to 747 hectares at closure.

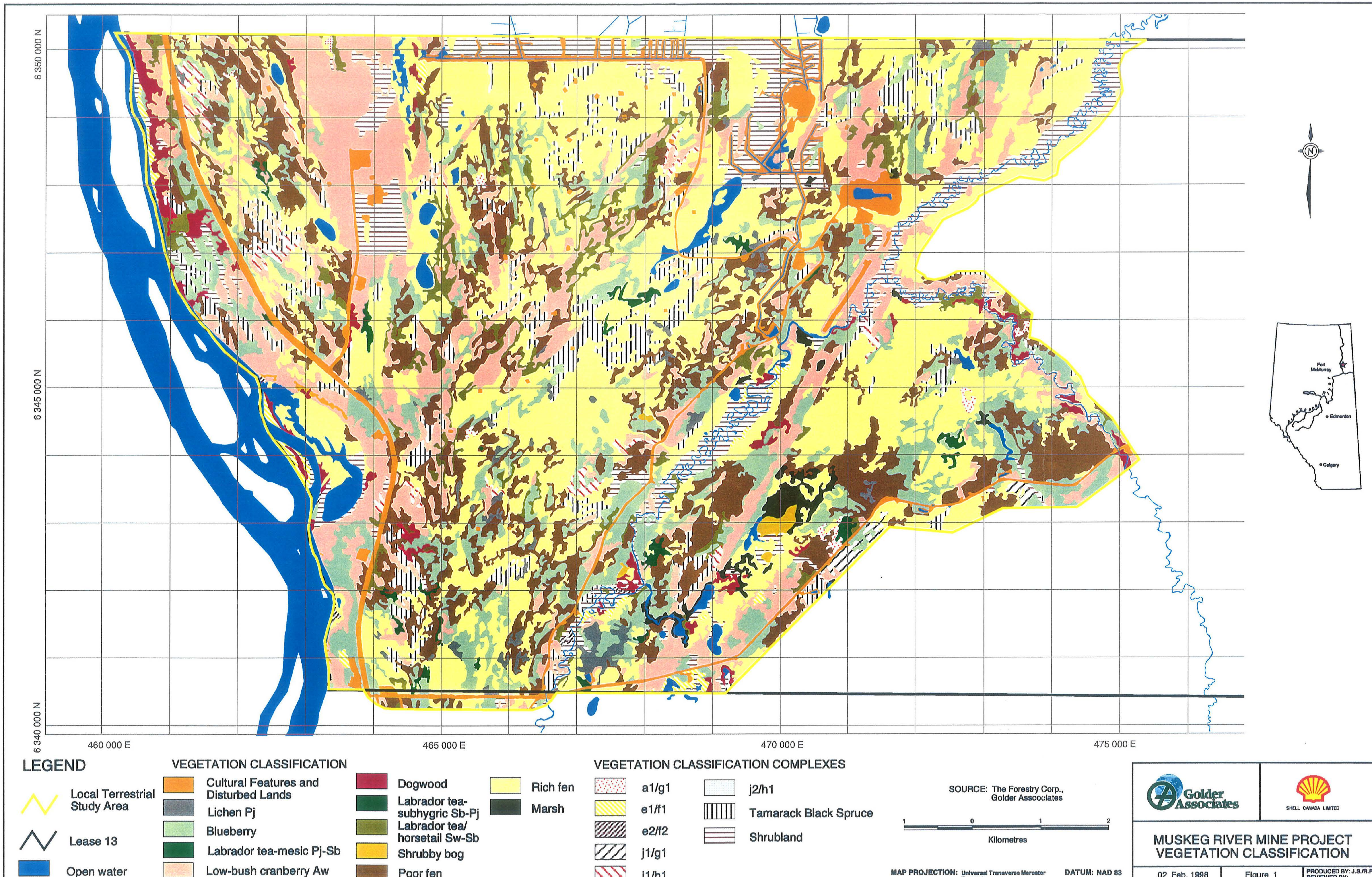
Baseline Vegetation Layer

In this project, all modelling was based on vegetation community classifications. Therefore, all data and habitat areas were calculated based on the digital vegetation maps developed for the vegetation component of the baseline (Golder 1997c). The baseline vegetation layer consists of mapped polygons classified by a combination of ecological phase and Alberta Wetlands Inventory (AWI) classes (Table 2; Figure 1).

Table 2 Vegetation Classification Types in the Local Study Area

Code	Vegetation Class	Code	Vegetation Class
a1	Lichen Pj	j1/g1(FFNN)	Treed Poor Fen Sb-Pj
a1/g1 complex	Pj-Lt	j1/g1(FTNN)	Treed Poor Fen Lt-Sb-Pj
AIG	Gravel Pits	j1/h1(FTNN)	Treed Poor Fen Sb-Sw-Lt
AIH	Roads and Right-of-ways	j2(FFNN)	Treed Poor Fen Sb-Lt
AIM	Surface Mines	j2(FTNN)	Treed Poor Fen Sb-Lt
b1	Blueberry Pj-Aw	j2/h1(FTNN)	Treed Poor Fen Sb/Sw-Lt
b3	Blueberry Aw-Sw	k1(FOPN)	Patterned Open Rich Fen
b4	Blueberry Sw-Pj	k1(FTNN)	Treed Rich Fen
b4(STNN)	Coniferous Swamp Sw-Pj	k2(FONS)	Shrubby Rich Fen
c1	Labrador Tea-mesic Pj-Sb	k2(FTNN)	Shrubby Treed Rich Fen
c1(STNN)	Coniferous Swamp Pj-Sb	k3(FONG)	Graminoid Rich Fen
d1	Low-Bush Cranberry Aw	l1(MONG)	Marsh
d2	Low-Bush Cranberry Aw-Sw	Lt(STNN)	Coniferous Swamp Lt
d2(STNN)	Coniferous Swamp Aw-Sw	Lt-Aw(STNN)	Coniferous Swamp Lt-Aw
d3	Low-Bush Cranberry Sw	Lt-Pb(STNN)	Coniferous Swamp Lt-Pb
d3(STNN)	Coniferous Swamp Sw	Lt-Sb	Upland Lt-Sb
e1	Dogwood Pb-Aw	Lt-Sb(STNN)	Coniferous Swamp Lt-Sb
e1/f1	Pb-Aw	NMC	Cutbanks
e2	Dogwood Pb-Sw	NWF(WONN)	Shallow Open Water
e2/f2	Pb-Sw	NWL	Lakes and Ponds
e3	Dogwood Sw	NWR	Rivers
g1	Labrador Tea-subhygric Sb-Pj	Sb(STNN)	Coniferous Swamp Sb
g1(STNN)	Coniferous Swamp Pj-Sb	Sb-Lt	Upland Sb-Lt
h1	Labrador Tea/Horsetail Sw-Sb	Sb-Lt(SFNN)	Coniferous Swamp Sb-Lt
h1(STNN)	Coniferous Swamp Sw-Sb	(Sb-Lt)SFNN	Coniferous Swamp(Sb-Lt)
i2(BTNN)	Shrubby Bog	Sb-Lt(STNN)	Coniferous Swamp Sb-Lt
j1(FTNN)	Treed Poor Fen Sb-Lt	shrub	Upland Shrubland
j1/g1 (FTNN)	Treed Poor Fen Lt-Sb-Pj	shrub(SONS)	Shrubby Swamp
		blank	Unclassified

Each polygon is described by a set of (selected) attributes (Tables 3 and 4). Areas of each vegetation type were summed for comparison with changes in wildlife HSI results.



/data8/oilsands/972-2237/9700/9701/final/arcview/veg50fin.apr

Table 3 Vegetation Layer Attributes

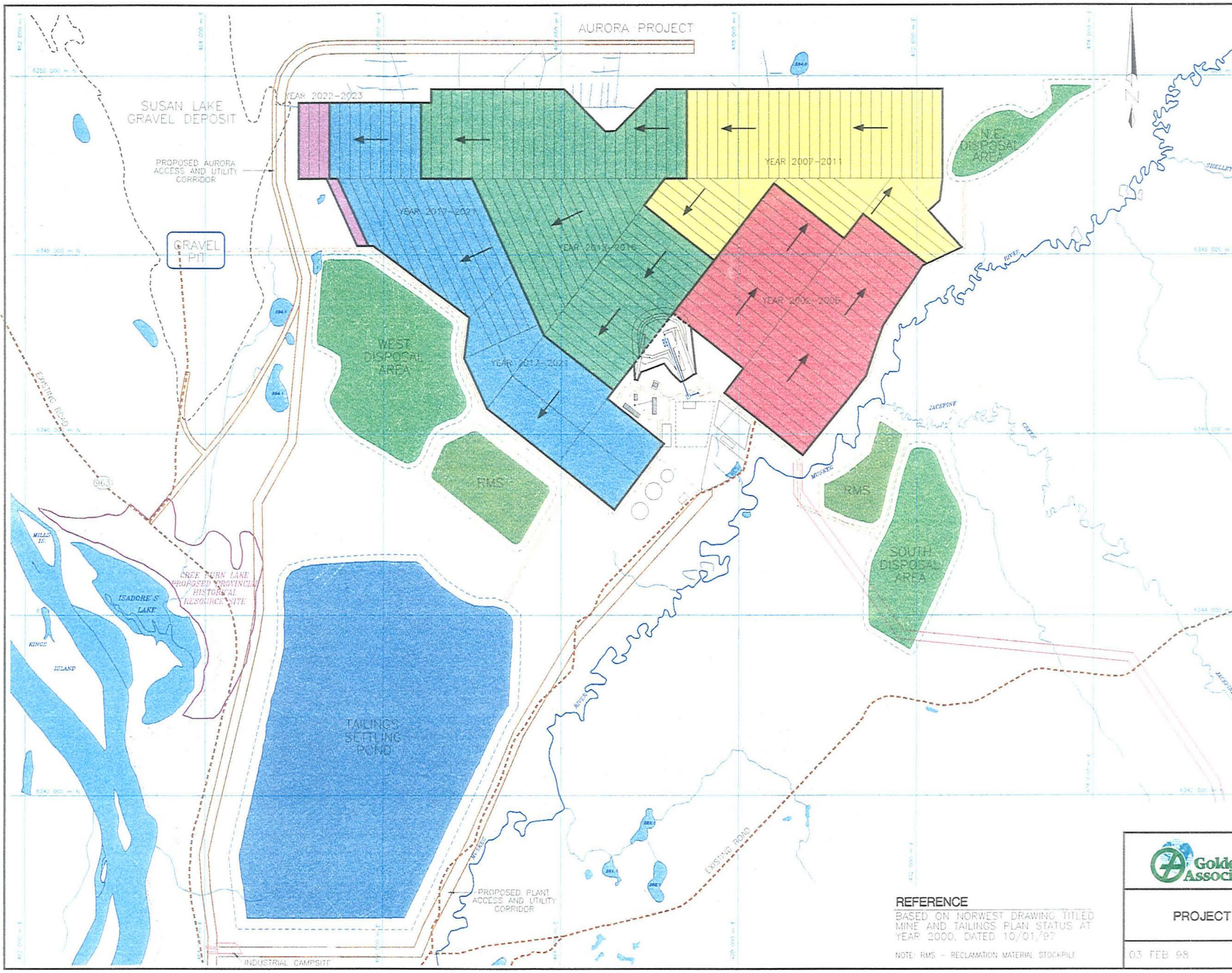
Attribute	Description
Area	Polygon Area in hectares
Perimeter	Polygon Perimeter in metres
Vegetation Classification	Combined Phase/Wetlands Vegetation Class
Moisture Regime	Alberta Vegetation Inventory (AVI) Moisture Regime Class
Canopy Closure	AVI Canopy Closure Class: Open, A, B, C, and D
Height	AVI Height in metres
Sp1	First Tree Species
Sp1pc	First Tree Species 1/10 Proportion
Sp2	Second Tree Species
Sp2pc	Second Tree Species 1/10 Proportion
Sp3	Third Tree Species
Sp3pc	Third Tree Species 1/10 Proportion
Sp4	Fourth Tree Species
Sp4pc	Fourth Tree Species 1/10 Proportion
Sp5	Fifth Tree Species
Sp5pc	Fifth Tree Species 1/10 Proportion
Origin	AVI Year Class Of Stand Origin
Wetlands Type	Alberta Wetlands Inventory Wetland Type

Table 4 Wetlands Attributes

	Wetlands Codes
A	Disturbed Non-Wetland
B	Bogs
F	Fens
L	Lakes/Ponds
R	Rivers
S	Swamps
M	Marshes
W	Shallow Open Water
N	Non-wetlands
Z	Forested Non-Wetlands

Project Components Layer

The project footprint (Figure 2) was used to overlay on the baseline maps to determine impacts for each KIR. A total of 4,313 ha of land is expected to be disturbed.



REFERENCE
BASED ON NORWEST DRAWING TITLED
MINE AND TAILINGS PLAN STATUS AT
YEAR 2000, DATED 10/01/97

NOTE: RMS - RECLAMATION MATERIAL STOCKPILE

Golder Associates

SHELL CANADA LIMITED

PROJECT DEVELOPMENT COMPONENTS

03 FEB 98	Figure 2	DRAWN BY: CG

Reclaimed Vegetation Layer

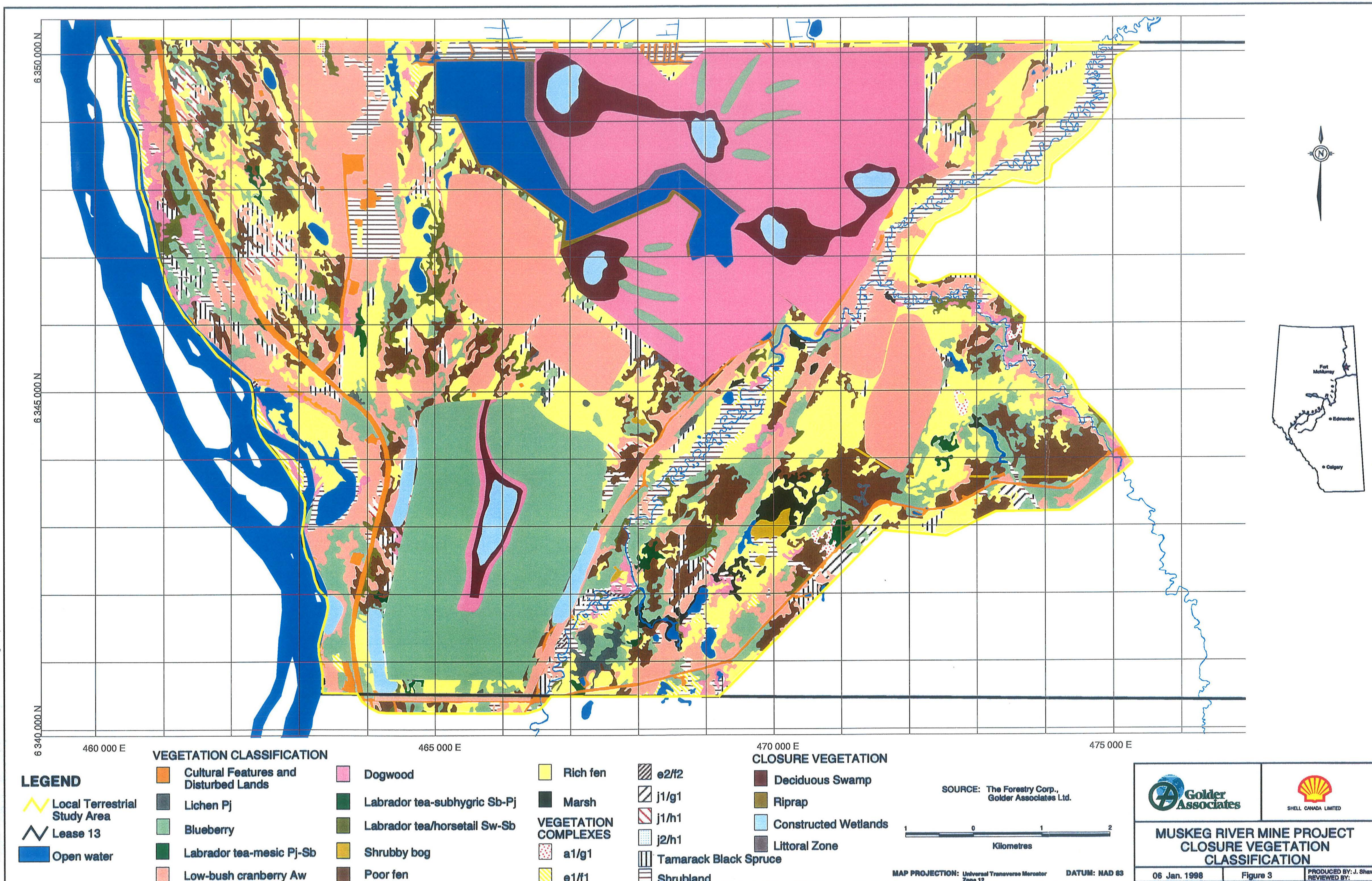
The post-closure vegetation base layer (Figure 3) demonstrates the changes that would occur many years in the future after the mine is closed. The reclaimed vegetation layers are based on presumed soil and terrain attributes, which will exist once pits are no longer operational. Thus, although the vegetation that will occur cannot be specifically verified, a foundation of expertise exists on which to base generalized reclamation types. This point is important because the reclaimed landscape can have many effects on wildlife habitat and tends, in this plan, to create more uniform large forest patches, which will also result in large patches of uniformly suitable wildlife habitat.

The Project closure plan discusses these issues much more fully, but some of the important points, as they could affect wildlife habitat, are summarized below. First, there will be some new vegetation types that will be added to the LSA. These include reclaimed riparian shrubland, which may be similar to the shrubby swamp of the baseline vegetation but with less organic material development (Table 5). There will be reclaimed open water which should eventually be similar to the pond category, reclaimed wetlands, which will eventually become like marshes, and rip rap areas, which will be piles of rocks with very sparse or no vegetation. The reclamation plan also calls for Blueberry - Aspen/Birch forest development on some of the well-drained old pit edges.

Table 5 Additional Reclaimed Vegetation Codes

Code	Vegetation Class
r	reclaimed riparian shrubland
o	reclaimed open water
b2	Blueberry Aw-Bw
w	reclaimed wetlands
rr	rip-rap

The vegetation at reclamation will be substantially different from the baseline conditions according to the current plan, and in large part this relates to a loss of peatlands (swamps and fens) and replacement of those areas with open water/wetlands and upland forests (Table 6). These changes may have large impacts on wildlife, especially species that make use of the much more productive and diverse upland forest habitats.



/data8/oilsands/972-2237/9700/9701/final/arcview/reclvegfin.apr

Table 6 Changes in Reclaimed Vegetation Compared to Baseline Conditions

Vegetation Group	Baseline (ha)	Reclaimed (ha)	Change (ha)	Percent Change
Open Water[a]	177.3	747.0	+569.7	+321.3
Bogs	20.1	20.1	-	-
Cultural Disturbances	327.3	246.9	-80.5	-24.6
Fens	5,183.3	2,697.4	-2,485.9	-48.0
Marshes	84.6	80.5	-4.1	-4.8
Swamps	708.4	334.4	-374.0	-52.8
Shrubby Swamps	793.5	822.7	+29.2	+3.7
Cutbanks	12.1	12.1	-	-
Upland Forests	3,513.1	5,870.7	+2,357.6	+67.1
Upland Shrublands	119.5	107.8	-11.7	-9.8
Unclassified	15.0	14.6	-0.3	-2.3
Total	10,954.3	10,954.3	-	-

(a) Includes reclaimed open water and reclaimed wetland categories. The reclaimed wetlands may eventually become marshes and would add an additional 184.5 ha to the marsh category and subtract the same from the open water category.

5.2.1.2 Regional Study Area (RSA)

Three digital data layers were used in the geographic analyses of habitat suitability in the RSA analysis. These were a hydrology layer, a baseline vegetation layer, and a human disturbances layer where each individual development area could be added separately. Roads and other cultural disturbances were also indicated on the disturbance layer.

Hydrology Layer

The hydrology layer, which was used to obtain all rivers, creeks, ponds and lakes in the RSA was derived from NTS topographic maps and from the regional orthophoto. Incorporating the hydrology layer with vegetation was accomplished by splitting vegetation polygons that were bisected by streams and rivers. This was required so that the distance from water buffers applied in the beaver and dabbling duck models could be accomplished from the vegetation layer edge.

Baseline Vegetation Layer

The vegetation layer for the RSA was determined from interpretation of landsat imagery at a 30 m resolution. The remote sensing technique used similar reflectance spectra to train the GIS softwear to pick out similar vegetation types throughout the region. Vegetation types (Table 7) determined on the 30 m square pixels were then aggregated into polygons. This process also picked up some of the larger rivers and linear disturbances, which were aided development of the impact layer.

Table 7 Baseline Areas of Vegetation Types in the RSA

Regional Class	Vegetation Type	Baseline Area (ha)
0	unclassified	2,314
1	open water	20,971
2	jack pine forest	15,280
3	mixedwood forest	119,425
4	spruce forest	765,89
5	aspen (poplar) forest	821,69
6	graminoid fen	319,13
7	wet shrublands	4,039
8	marsh	3,479
9	disturbances	30,035
10	unclassed (cloud)	5
11	wooded peatland	639,296
12	paper birch forest	901
13/14	burned fen	10,131
15	cutblocks	13,443
	Total	1,049,989

Human Disturbances Layer

The disturbance layer was developed from a variety of sources, including the RSA orthophoto, the vegetation map, and information from approved or planned developments. These were used in conjunction with the other layers to define a baseline condition (all developments up to 1997), and impact condition (baseline plus Muskeg River Mine Project), the CEA condition (baseline, Muskeg and new Approved Projects) and the RDR condition (All planned developments for which public information was attainable; Table 8).

Table 8 List of Cultural Disturbances by Area (hectares) in the Regional Baseline and the Incremental Regional Development Scenarios

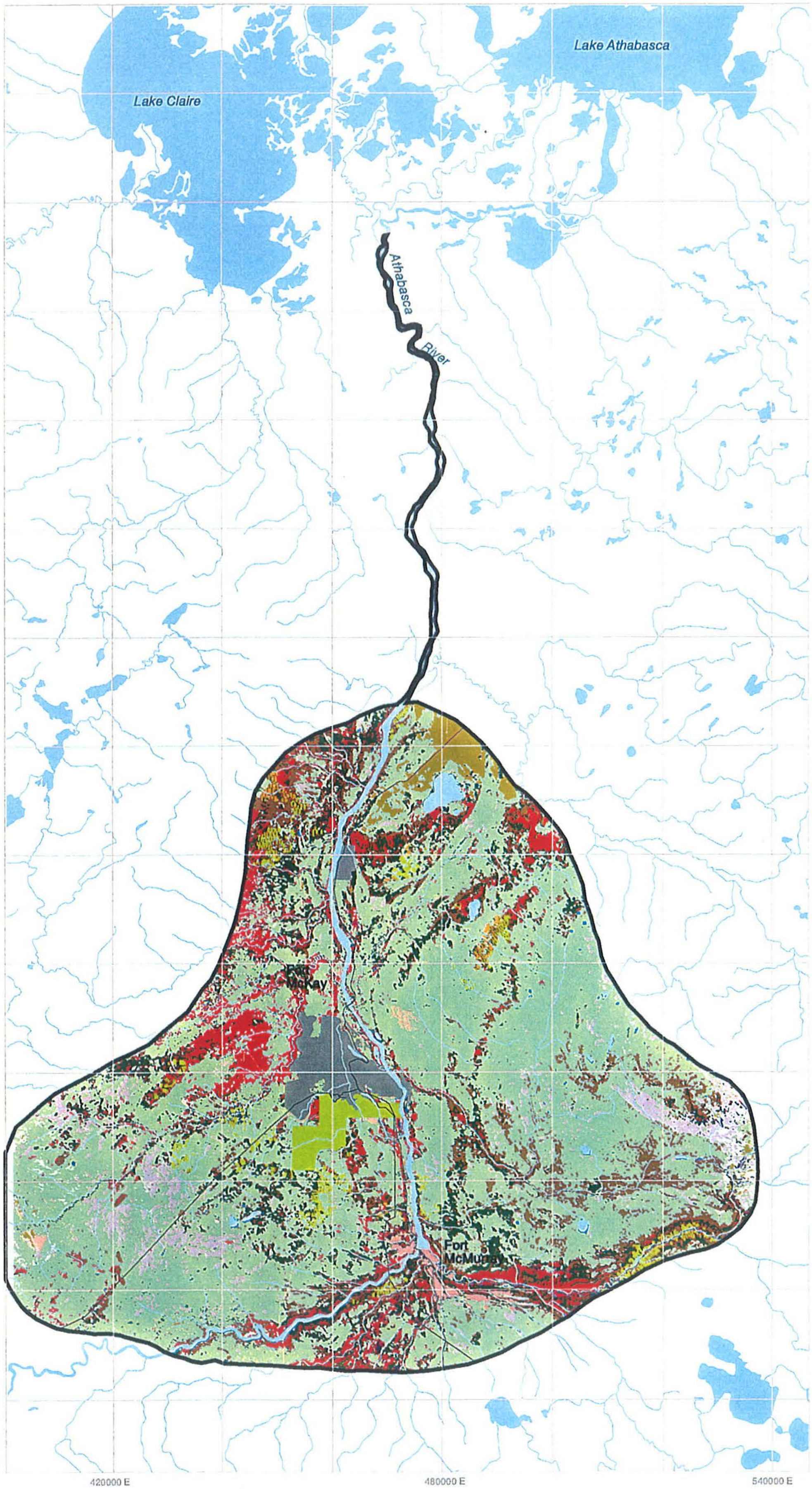
Baseline Disturbances	Cities	4,002 ha
	Cutblocks	13,443
	Roads	428
	Utility Corridors	1,038
	Suncor Lease 86/17	3,369
	Mildred Lake (Syncrude)	23,244
	Gibson's Petroleum	22
	SOLV-EX	2,088
	Steepbank Mine (up to 1997)	150
	Other Developments	200
Added at Scenario 1	Muskeg River Mine Project	4,343
	New Pipeline	265
Added at Scenario 2 (CEA)	Aurora North Mine	7,756
	Aurora South Mine	7,415
	Steepbank Mine (Post 1997)	3,234
Added At Scenario 3 (RDR)	Suncor Millenium	5,437
	Petro-Canada In-situ	33
	Shell Lease 13 East	7,215
	Mobil Kearl Oil Sands Mine	5,350

5.2.2 Habitat Variables

Habitat variables for the models included those for tree and shrub cover, downed wood density, ground cover and tree attribute data. These variables are defined below and are presented in Appendix II.

5.2.2.1 Tree and Shrub Cover, Ground Cover of Herbs, Mosses and Lichens

Tree and shrub cover means and ground cover means were derived from published values in Beckingham and Archibald's (1995) Field Guide to Ecosites of Northern Alberta, using ecophase level classes, the same classes which were used to determine the vegetation classification in the LSA. These tree and shrub values were also used in the ecophase/swamp complexes that were described in the vegetation data layer, although



LEGEND

- Regional Study Boundary
- Linear Disturbances
- Hydrology
- Forestry
- Existing Open Pit Mines
- Other Oil Sands Disturbances
- Municipalities

VEGETATION CLASSIFICATION

- Unclassified
- Jack Pine Forest
- Mixedwood Forest
- Spruce Forest
- Aspen (Poplar) Forest
- Graminoid Fen
- Wet Shrublands
- Marsh
- Natural Disturbances
- Wooded Peatland
- Paper Birch Forest
- Recent Burn Fen
- Forestry Cutblocks

5 0 5 10 15 20 25
Kilometres

N

SOURCE: Golder Associates Ltd., Leskiw (1996), Petro-Canada, RADARSAT International, Soils Department (Alberta Research Council, AOSERP Report 122), Suncor, Syncrude, Norwest

MAP PROJECTION: UTM
Zone 12
NAD 83 (GRS 1980)

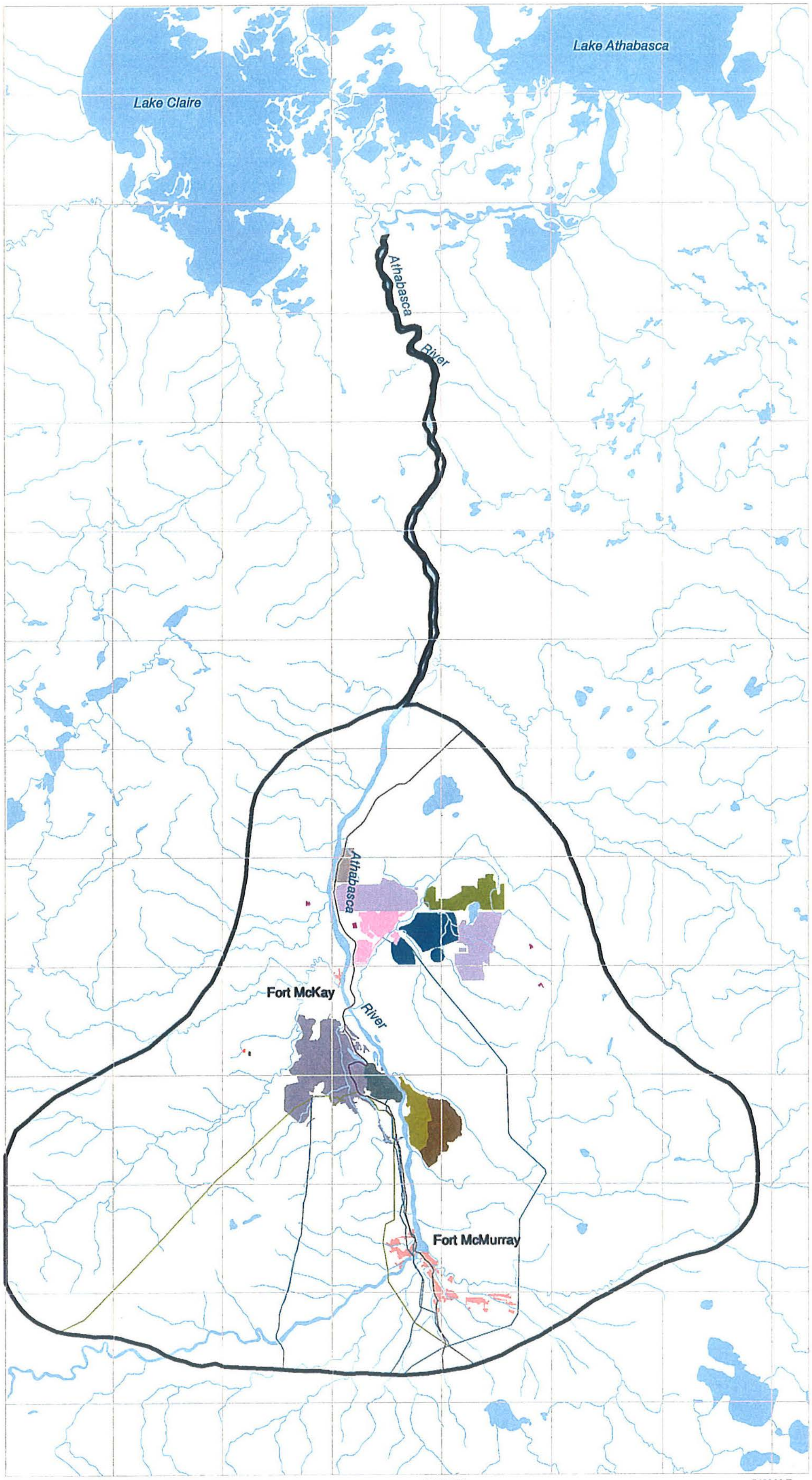
Golder Associates

SHELL CANADA LIMITED

REGIONAL STUDY AREA VEGETATION CLASSIFICATION

28 Jan. 1998	Figure 4	PRODUCED BY: J.Shaw REVIEWED BY:

/data/oilsands/972-2237/9700/9702/final/arcview/rsa_VEG502.apr



LEGEND

- Regional Study Boundary
- Highway
- Pipelines
- Powerlines
- Hydrology
- Suncor Lease 86/17
- Syncrude Mildred Lake
- Other Oil Sands Development
- Gibsons Petroleum
- SOLV-EX
- Shell Lease 13 East
- Muskeg River Mine Project
- Suncor Steepbank Mine
- Suncor Millennium Mine
- Petro-Canada
- Mobil Kearl Mine
- Aurora Mines
- Municipalities

5 0 5 10 15 20 25

Kilometres

N

SOURCE: Conor Pacific, Golder Associates Ltd., Mobil, Petro-Canada, RADARSAT International, Suncor, Syncrude, Norwest

MAP PROJECTION: UTM
Zone 12
NAD 83 (GRS 1980)

Golder Associates

SHELL CANADA LIMITED

REGIONAL STUDY AREA REGIONAL DEVELOPMENTS FOR REGIONAL DEVELOPMENT REVIEW

10 Jan. 1998	Figure 5	PRODUCED BY: J.Shaw REVIEWED BY:

/data8/oilsands/972-2237/9700/9705/final/arcview/RBA_base_cas50.apr professional judgment was used to restrict certain species from the wetter conditions of the swamps. In such cases, only the species were changed and the total shrub or tree cover remained constant. For vegetation complexes of two ecosite phases, the simple arithmetic mean of the two cover values were determined. Shrub and tree values for other classes which were not derived from the ecophase classification were determined using descriptions of the vegetation in those types and professional judgment. Vegetation classes which were determined in this way included all shrublands, open water types and all disturbed types.

5.2.2.2 Tree Composition, Stand Height, Mean Diameter at Breast Height (DBH), Age, Canopy Closure, and Moisture

Tree composition, stand height, mean DBH, age, canopy closure and moisture attributes were determined from the Alberta Vegetation Inventory (AVI) database. Each AVI class was assigned an ecological phase/wetland class. Thus, the above attributes were simply sorted among the phase/wetland classes and means were determined. Note that in the LSA baseline analysis, the actual values for these attributes on a polygon by polygon basis were used, rather than the means. The means were used in the reclaimed vegetation layer and in the regional analysis, after averaging among vegetation classes that made up the regional classes (see Section 5.2.2.4). Tree height was provided directly in the AVI dataset, as was canopy closure class, age and moisture class. Tree composition and DBH were first calculated for each stand in the AVI, and then averaged. Calculation techniques are described below.

Tree Composition

Tree 1/10th proportions were provided in the AVI dataset. These were multiplied by 10 to give percents. These were summed by tree groups: deciduous, coniferous and total trees. Note that tamarack was not added into either deciduous or coniferous categories, but was included in the total tree group. This was done since the value of conifers in most of the HSI models is the shelter effect they provide in winter, which would not be provided by the needleless tamarack trees.

DBH

DBH was predicted from stand height using the equations below. The dominant tree species was the one listed in the species #1 category within the AVI. Height is in metres for all equations. Stands where there were no trees were assigned a dbh of 0 (Table 9).

Table 9 DBH Stand Height

Dominant Tree:	Equation
White Spruce:	DBH (cm) = 10^(0.15+0.95*log10(height))
Jack Pine or Any Deciduous:	DBH (cm) = 10^(0.15+0.90*log10(height))
Black Spruce	DBH (cm) = 10^(0.15+0.85*log10(height))
Tamarack	DBH (cm) = 10^(0.15+0.75*log10(height))

^= raised to power of
*= multiplied
(Equations courtesy W. Bessie, Unpublished Research)

5.2.2.3 Downed Wood Density and Litter Cover

Downed wood density and litter cover were determined from field plot data collected by Golder Associates in 1997 combined with data collected by Bovar in 1996. Each data point was assigned an ecophase class based on existing vegetation information collected at each point. Note that the vegetation data was originally planned to be used to determine the shrub and tree cover and ground cover attributes, but was rejected for this purpose due to poor representation among ecophases and low sample sizes. However, there was no other data source available for litter and downed wood, so it was used knowing that there were severe limitations in the data. The litter and density values were sorted by ecological phase and means were determined. Data gaps were filled in based on professional judgment.

5.2.2.4 Regional Study Area Habitat Attributes

The same ecological data were combined from several classes to determine the RSA values (Table 10). All combinations were determined by the mean among the LSA classes which were deemed to be included in the much broader regional study classes. For example, the aspen forest RSA vegetation type was made up of d1, e1, and e1/f1 types from the LSA. The assumption was made that the proportion of each stand type which made up each class was the same as the proportions present in the LSA. Thus, the mean for the regional area was weighted based on the actual number of polygons of a each type in the LSA. This same averaging technique was applied to all ecological attributes.

Table 10 Derivation of Regional from Local Vegetation Classes

Regional Vegetation Classes	Included Local Study Area Classes
Unclassified	All Vegetation Types
Open Water	NWL, NWR
Jack Pine Forest	a1, a1/g1, b4*, b4(STNN)*, g1*, g1(STNN)*
Mixedwood Forest	b1, b3, d2,d2(STNN), e2, e2/f2
Spruce Forest	(Sb-Lt)SFNN, b4*, b4(STNN)*, c1, c1(STNN), d3, d3(STNN), e3, g1*, g1(STNN)*, h1, h1(STNN), Sb-Lt
Aspen (Poplar) Forest	d1, e1, e1/f1
Graminoid Fen	k3(FONG)
Wet Shrublands	shrub, shrub(SONS)
Marsh	l1(MONG)
Disturbances	AIG, AIH,AIM,NMC
Wooded Peatland	i2(BTNN), j1(FTNN), j1/g1(FFNN), j1/g1(FTNN), j1/h1(FTNN), j2(FFNN), j2(FTNN), j2/h1(FTNN), k1(FOPN), k1(FTNN), k2(FONS)*, k2(FTNN)*, Lt-Aw(STNN), Lt-Pb(STNN), Lt-Sb(STNN), Sb(STNN), Sb-Lt(SFNN), Sb-Lt(STNN),
Paper Birch Forest	b2
Burned Fen	k2(FONS)*, k2(FTNN)*
Cutblocks	All Upland Forest Types

* indicates the type was split between two regional vegetation classes

5.3 MODEL ANALYSES

Impact analyses for the LSA included assessment of habitat losses and/or gains due to site clearing, changes in vegetation due to drawdown and loss of effective habitat due to disturbance.

5.3.1 Site Clearing

Baseline vegetation and changes associated with the Project (Figure 2) result in the following changes to areas by main vegetation groups (Table 11). The actual breakdowns by vegetation classification appear in the vegetation section of the EIA (Golder 1997b). As the table shows, a large loss of vegetation communities is associated with the Project. This is expected to have a large bearing on wildlife HSI changes.

Table 11 Change in Vegetation (ha) due to Muskeg River Mine Project

Vegetation Group	Baseline	Impact	Change	Percent Change
Open Water	177.3	139.4	-37.9	-21.4
Bogs	20.1	20.1	-	-
Cultural Disturbances[a]	327.3	4,524.1	+4,196.7	+1,282.1
Fens	5,183.3	2,685.7	-2,497.7	-48.2
Marshes	84.6	80.5	-4.1	-4.8
Swamps	708.4	334.4	-374.0	-52.8
Shrubby Swamps	793.5	521.0	-272.5	-34.3
Cutbanks	12.1	12.1	-	-
Upland Forests	3,513.1	2,514.4	-998.7	-28.4
Upland Shrublands	119.5	107.8	-11.7	-9.8
Unclassified	15.0	14.8	-0.2	-1.3
Total	10,954.3	10,954.3	-	-

[a] includes mine impacts and previous disturbances.

5.3.2 Drawdown

Effects of drawdown on the local surface and groundwater resources of the LSA will impact vegetation and, hence, wildlife habitat. As it is difficult to predict the effect of changes in hydrology on wildlife habitat, an assumption was made that the value of habitat within the drawdown zone would be one half the HSI value for any given KIR. The drawdown zone was taken from the hydrology section of the EIA (Golder 1997b).

5.3.3 Disturbance

Wildlife species may avoid or reduce their use of habitat adjacent to areas of human activity. Impacts are greater if the adjacent habitat is of high quality and if the total supply of habitat in the area is limiting. One way to estimate the amount of habitat affected by disturbance (i.e., habitat effectiveness) is to assume disturbance Zones of Influence (ZI) and Disturbance Coefficients (DC) for each KIR and each activity type. A ZI is the maximum distance to which a disturbance (e.g., traffic noise) is felt, and a DC is the effectiveness of the habitat within the ZI in fulfilling the requirements of the species (e.g., a DC of 0.9 represents 90% habitat effectiveness). ZIs and DCs can be used with HSI mapping within a Geographic Information System (GIS) to estimate the quantity and quality of habitat (expressed in HUs) that could be affected by a development.

Different species react differently to developments. Most work on this subject has been done for grizzly bears. Numerous studies (e.g., Mattson et al. 1987, McClellan and Shackleton 1988, 1989a, 1989b, Purves et al. 1992, Mace et al. 1996) have measured the displacement of grizzly bears by different levels of human activities.

Horejsi (1979) found that moose were disturbed by active seismic line work to within 1 km, while other researchers have found that moose avoid areas of human activity but did not determine a zone of influence (e.g., Hancock 1976, Rolley and Keith 1980). Still others have found that moose can habituate to human disturbance (e.g., Pauls 1987).

Unfortunately, results of such studies are often highly variable due to the difficulties associated with studying a wide-ranging and reclusive species such as the grizzly bear, and most study designs are based on rather arbitrary buffer distances around disturbance features (e.g., analyze bear locations less than and greater than 500 m from roads: Mace et al. 1996). Therefore, most displacement models have relied on professional judgement, using empirical data as a guide only.

BOVAR (1996) used a ZI of 500 m for moose and 100 m for snowshoe hares for the Aurora Mine EIA. They made a conservative assumption that displacement was complete within the ZI for these species (i.e., DC was zero for all activity types). In contrast, they assumed that all other KIRs were not displaced by the Aurora Mine development.

Westworth (1996) used a ZI of 250 m and a DC of zero for all KIRs for the Suncor EIA, due to sensory disturbance, reduced hiding and thermal cover, reduced forage palatability due to the accumulation of dust, and, for breeding birds, increased risk of nest predation from edge-adapted species.

The ZIs and DCs used for the Project EIA are shown in Table 12. These variables were determined through professional judgement, based on literature review and other oil sands EIAs. Habitat alienation from disturbance was not considered to be a factor for red-backed voles, beavers or western tanagers.

Table 12 Displacement Variables for Wildlife KIRs for the Muskeg River Mine Project

						Zone of Influence (m)						
Activity Code	**Use Level**	**Motorized**	**Use Duration**	**DC (cover)**	**DC (noncover[a])**	**Moose**	**Red-Backed Vole/ Beaver**	**Black Bear**	**Fisher/ Hare**	**Ruffed Grouse/ Duck**	**Breeding Birds**	**Raptor**
main road	high	yes	-	0.25	0.05	500	0	100	200	100	100	500
secondary road	low	yes	-	0.75	0.375	500	0	100	200	100	100	500
utility corridor	incidental	yes	-	0.9	0.8	250	0	50	100	50	50	250
active mine areas, gravel pits, dumps	high	yes	24 h	0.1	0.0	500	0	100	200	100	100	500
plant, camp, urban areas	high	yes	24 h	0.2	0.1	500	0	100	200	100	100	500
tailings pond	low	no	24 h	0.9	0.8	250	0	50	100	50	50	250

[a] noncover Disturbance Coefficients used for moose and black bear only

For moose and black bears, different DCs were established depending on whether or not the vegetation adjacent to the disturbance represented adequate cover or not (USDA Forest Service 1981). Cover for these species was defined by the cover component of the moose or black bear HSI model (Appendix I). The DC for cover was used for habitats that had an HSI for cover of > 0.5.

5.4 IMPACT SCENARIOS

5.4.1 Environmental Impact Assessment

HSI analyses for the EIA included mapping of baseline habitat conditions, determining habitat losses due to project construction, and then determining habitat gains due to reclamation. Losses due to construction were determined by overlaying the maximum exent of the project footprint over baseline habitat maps for each KIR. Losses calculated in this manner represent a conservative approach to impact assessment in that the entire footprint will not be in a disturbed state at any one time. Due to the phased nature of the development, and to progressive reclamation of mined-out areas, the actual amount of habitat at any given time will not be reduced as much as analysis in this report indicates.

5.4.2 Cumulative and Regional Development Review Assessments

The CEA for this study included assessing habitat in the RSA for each KIR for the following scenarios:

- Baseline Scenario: Baseline Conditions;
- Impact Scenario 1: Muskeg River Mine;
- Impact Scenario 2: Muskeg River Mine + approved developments (CEA); and
- Impact Scenario 3: Muskeg River Mine + approved developments + planned developments (RDR).

The developments included in each of the above scenarios are listed in Table 13 (refer also to Figure 5).

Table 13 Muskeg River Mine Project - Impact Assessment and CEA Development List

	Scenario1	Scenario 2	Scenario 3
BASELINE Conditions to the end of 1997	BASELINE + *Muskeg River Mine Project*	BASELINE + Muskeg River Mine Project + *APPROVED DEVELOPMENTS*	BASELINE + Muskeg River Mine Project + Approved Developments + *PUBLICLY DISCLOSED DEVELOPMENTS*
EXISTING (BASELINE)			
Suncor Lease 86/17	Suncor Lease 86/17	Suncor Lease 86/17	Suncor Lease 86/17
Syncrude Mildred Lake	Syncrude Mildred Lake	Syncrude Mildred Lake	Syncrude Mildred Lake
Suncor Steepbank	Suncor Steepbank	Suncor Steepbank	Suncor Steepbank
Gibsons Petroleum	Gibsons Petroleum	Gibsons Petroleum	Gibsons Petroleum
SOLV-EX	SOLV-EX	SOLV-EX	SOLV-EX
Municipalities	Municipalities	Municipalities	Municipalities
Pulp mills for water quality	Pulp mills for water quality	Pulp mills for water quality	Pulp mills for water quality
Forestry	Forestry	Forestry	Forestry
Pipelines/roadways/ others	Pipelines/roadways/ others	Pipelines/roadways/ others	Pipelines/roadways/others
	Muskeg River Mine Project	Muskeg River Mine Project	Muskeg River Mine Project
APPROVED PROJECTS		Syncrude Aurora North and South Mines	Syncrude Aurora North and South Mines
		Suncor Steepbank Mine and Fixed Plant Expansion	Suncor Steepbank Mine and Fixed Plant Expansion
		Forestry	Forestry
DISCLOSED PROJECTS			Suncor Project Millennium - Upgrader and Mine
			Shell Lease 13 East Mine
			Syncrude Project 21 Mildred Lake Upgrader Expansion
			Mobil Kearl Mine and Upgrader
			Petro-Canada MacKay River - In-situ
			JACOS Hangingstone - In-situ
			Gulf Surmont - In-situ
			Major pipelines, utility corridors and roadways

6. RESULTS AND DISCUSSION

In this section, results of the HSI analysis are presented for each of the KIRs in alphabetical order, followed by results of the biodiversity and moose linkage models. Raw HSI results are provided in Appendix III and are summarized in tables in this section. In 6.1, baseline conditions for the LSA are presented along with results of the analysis of the impacts of the Project. In 6.2, baseline conditions for the RSA are presented along with results of the three regional impact scenarios (Project, CEA and RDR). HSI scores for each vegetation type, prior to any spatial considerations, are provided in Appendix IV. For models that use juxtaposition of vegetation types for different life requisites (e.g., moose require the juxtaposition of food and cover), tables for both life requisites are included in Appendix IV.

6.1 LOCAL ANALYSES

6.1.1 Beaver

6.1.1.1 Baseline Conditions

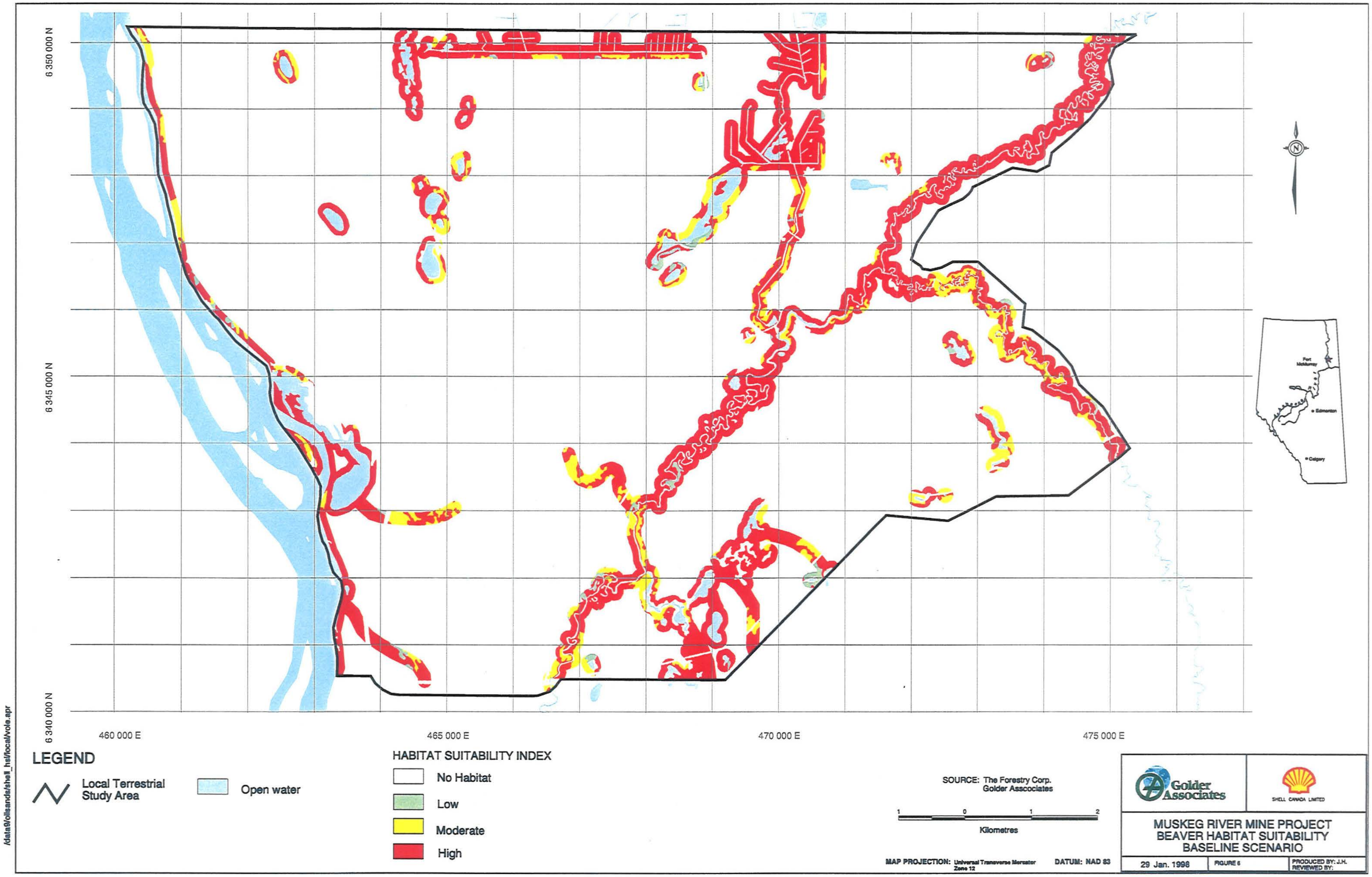
HSI index values calculated for the beaver (Figure 1c, Appendix I; Table 1, Appendix IV) indicate that, if within 30 m of water, many vegetation types (23) can provide high suitability habitat. High suitability habitats included patterned open, treed rich and shrubby fens, as well as aspen-blueberry forest. Unsuitable habitat for food and cover included disturbed sites, marshes and water bodies. While water bodies were considered to offer little in the way of food and cover to beavers, they do provide them with sites to build their lodges and food piles, therefore water bodies should not be regarded as having no value to beavers.

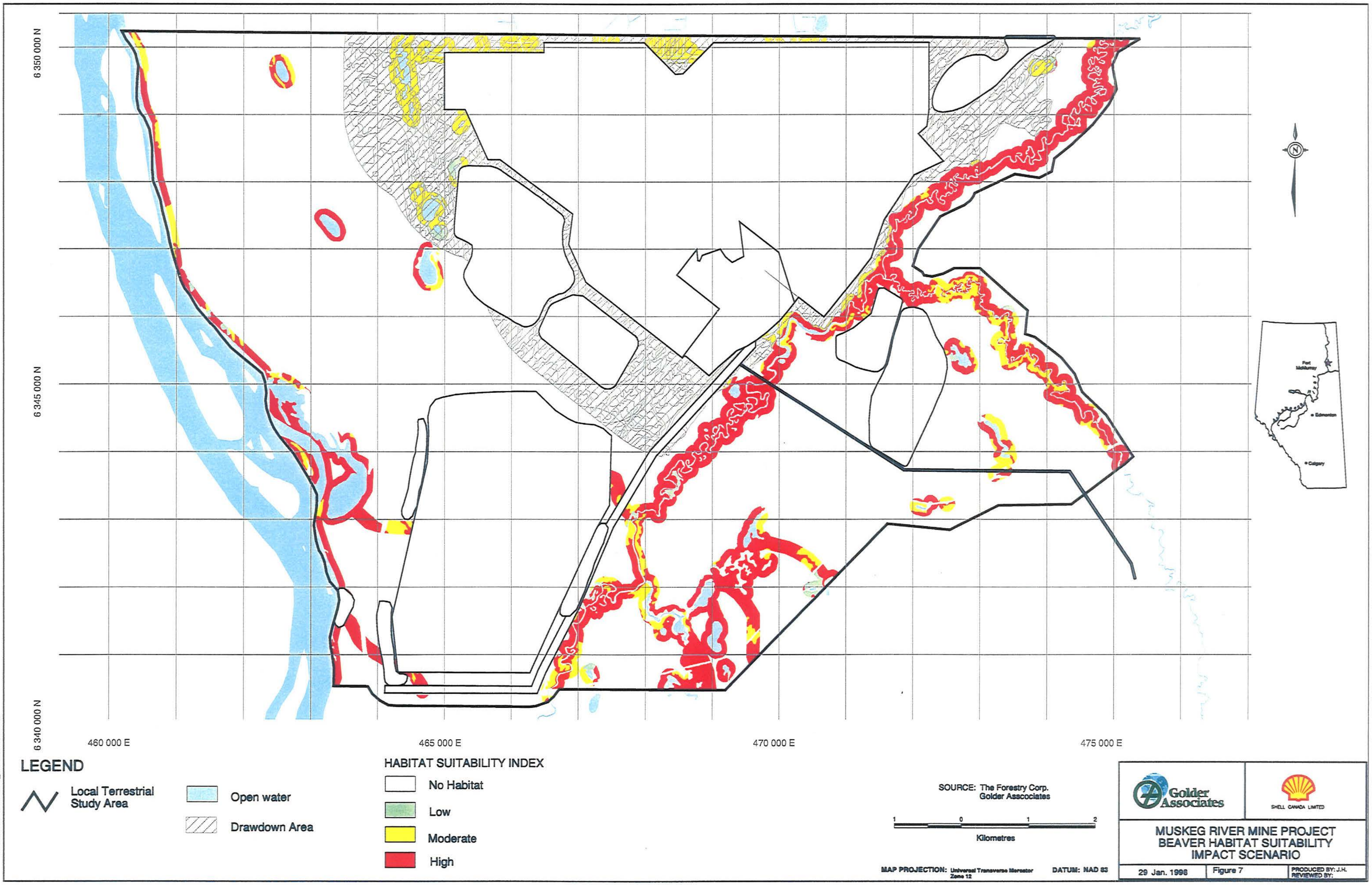
The baseline map of beaver habitat suitability (Figure 6) shows that all beaver habitat is distributed within 100 m of water. A total of 1,424 HUs were mapped for the LSA. 13.4% of the LSA was mapped as high suitability habitat, 2.2% as medium suitability, 0.3% as low suitability and 84.1% as unsuitable.

6.1.1.2 Impact of the Project

Impacts of the Project on beaver habitat (Tables 14-15) include an overall loss of 25.4% due to site clearing, 5.1% due to drawdown and 0% due to disturbance for a total loss of 30.5% of the baseline HUs (Figure 7).

Reclamation is expected to result in an overall loss of 6.0% of HUs over baseline conditions (Table 15, Figure 8).


6 350 000 N
6 345 000 N
6 340 000 N
460 000 E
465 000 E
470 000 E
475 000 E
Fort McMurray
Edmonton
Calgary
LEGEND
Local Terrestrial Study Area
Open water
HABITAT SUITABILITY INDEX
No Habitat
Low
Moderate
High
SOURCE: The Forestry Corp. Golder Associates
1 0 1 2
Kilometres
MAP PROJECTION: Universal Transverse Mercator Zone 12
DATUM: NAD 83
Golder Associates
SHELL CANADA LIMITED
MUSKEG RIVER MINE PROJECT
BEAVER HABITAT SUITABILITY
BASELINE SCENARIO
29 Jan. 1998
FIGURE 6
PRODUCED BY: J.H.
REVIEWED BY:
/data9/oilsands/shell_hsi/local/vole.apr



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6 340 000 N
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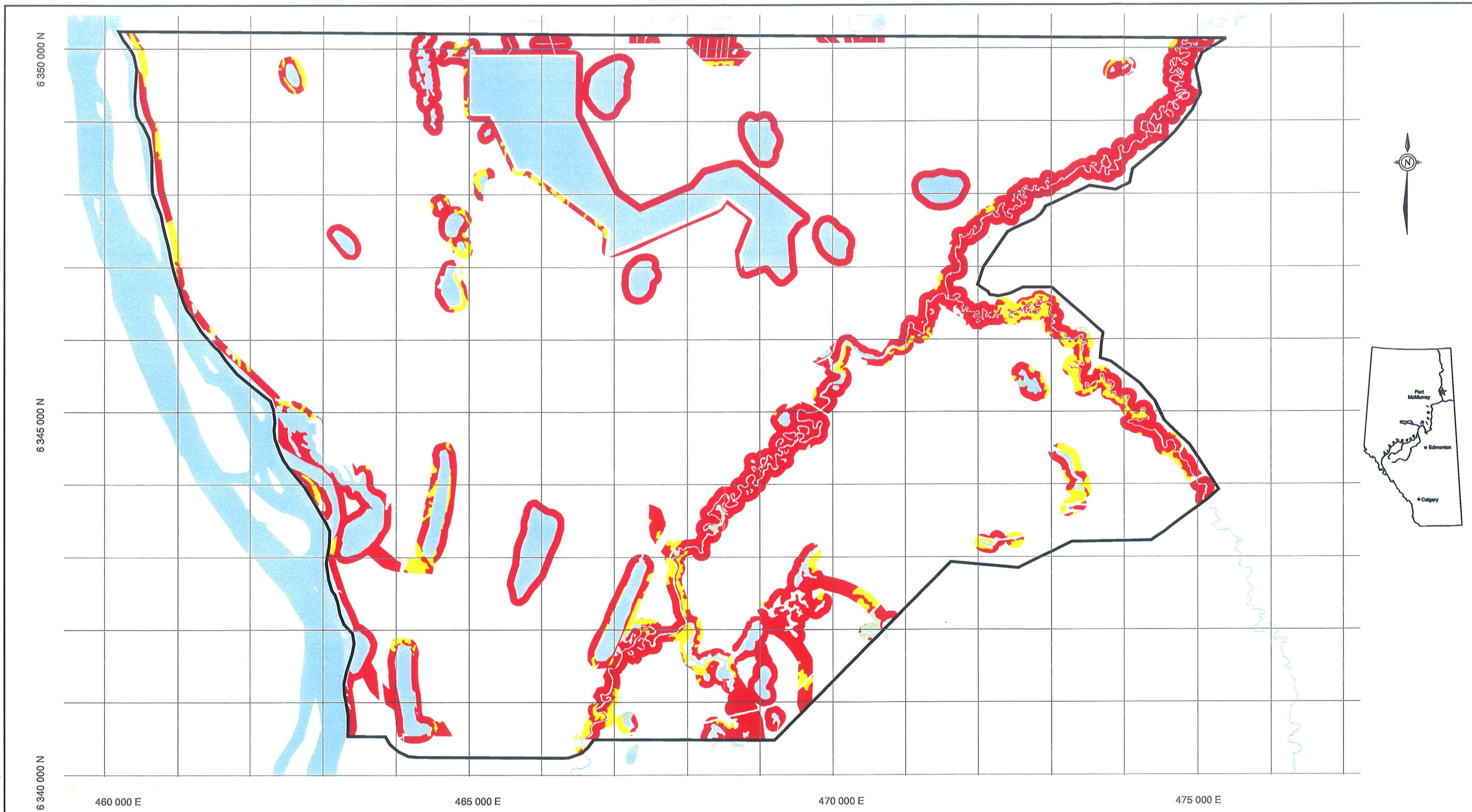
465 000 E
470 000 E
475 000 E
/data9/oilsands/shell_hsi/local/vole.apr
LEGEND
Local Terrestrial Study Area
Open water
Drawdown Area
HABITAT SUITABILITY INDEX
No Habitat
Low
Moderate
High
SOURCE: The Forestry Corp.
Golder Associates
1 0 1 2
Kilometres
MAP PROJECTION: Universal Transverse Mercator Zone 12
DATUM: NAD 83
Golder Associates
SHELL CANADA LIMITED
MUSKEG RIVER MINE PROJECT
BEAVER HABITAT SUITABILITY
IMPACT SCENARIO
29 Jan. 1998
Figure 7
PRODUCED BY: J.H.
REVIEWED BY:



/data9/oilsands/shell_hsi/local/vole.apr

LEGEND

Local Terrestrial Study Area

Open water

HABITAT SUITABILITY INDEX

No Habitat

Low

Moderate

High

SOURCE: The Forestry Corp.
Golder Associates

1 0 1 2

Kilometres

Scale: 1/50,000

MAP PROJECTION: Universal Transverse Mercator Zone 12

DATUM: NAD 83

Golder Associates

SHELL CANADA LIMITED

MUSKEG RIVER MINE PROJECT
BEAVER HABITAT SUITABILITY
CLOSURE SCENARIO

29 Jan. 1998

Figure 8

PRODUCED BY: J.H.
REVIEWED BY:

Table 14 Impact of Clearing, Drawdown, Disturbance and Reclamation on Beaver Habitat Units Within the LSA

Species	Rating	Baseline	Development Impacts			Closure
			Clearing	Drawdown	Disturbance	
Beaver	Low	8	5	9	9	6
	Medium	121	85	149	149	97
	High	1,295	973	832	832	1,236
	Total	1,424	1,063	990	990	1,339

Table 15 Percent Impact of Clearing, Drawdown, Disturbance and Reclamation on Beaver Habitat Units Within the LSA

Species	Rating	Baseline	Develoment Impacts				Reclamation Change From Baseline
			Clearing Change	Drawdown Change	Disturbance Change	Total Change	
Beaver	Low	8	-37.5	+50.0	0.0	+12.5	-25.0
	Medium	121	-29.8	+52.9	0.0	+23.1	-19.8
	High	1,295	-24.9	-10.9	0.0	-35.8	-4.6
	Total	1,424	-25.4	-5.1	0.0	-30.5	-6.0

6.1.2 Black Bear

6.1.2.1 Baseline Conditions

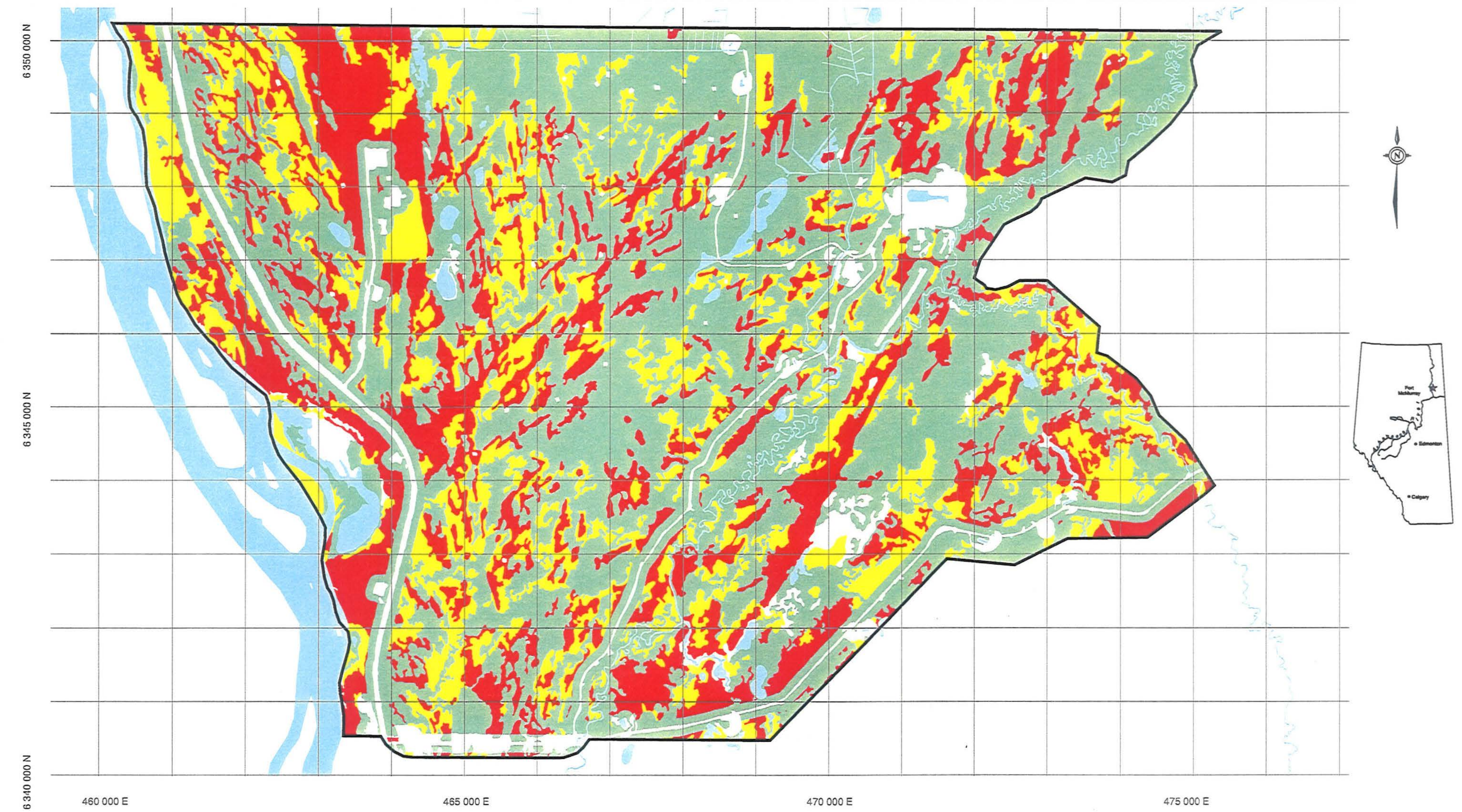
High suitability habitats for the black bear included aspen (n=3), jack pine (2) and white spruce-dominated (1) vegetation types (Table 3, Appendix IV).

A total of 3,809 HUs were mapped for the LSA (Figure 9). 22.3% of the LSA was mapped as high suitability habitat, 18.4% as medium suitability habitat, 52% as low suitability habitat and 7.2% as unsuitable habitat.

6.1.2.2 Impact of the Project

Impacts of the Project on black bear habitat (Tables 16-17) include an overall loss of 27.9% due to site clearing, 6.1% due to drawdown and 11.1% due to disturbance for a total loss of 45.1% of the baseline HUs (Figure 10).

Reclamation is expected to result in an overall increase of 28.1% of HUs over baseline conditions (Table 17, Figure 11).



LEGEND

Local Terrestrial Study Area

Open water

HABITAT SUITABILITY INDEX

No Habitat

Low

Moderate

High

SOURCE: The Forestry Corp.
Golder Associates

1 0 1 2
Kilometres

MAP PROJECTION: Universal Transverse Mercator Zone 12

DATUM: NAD 83

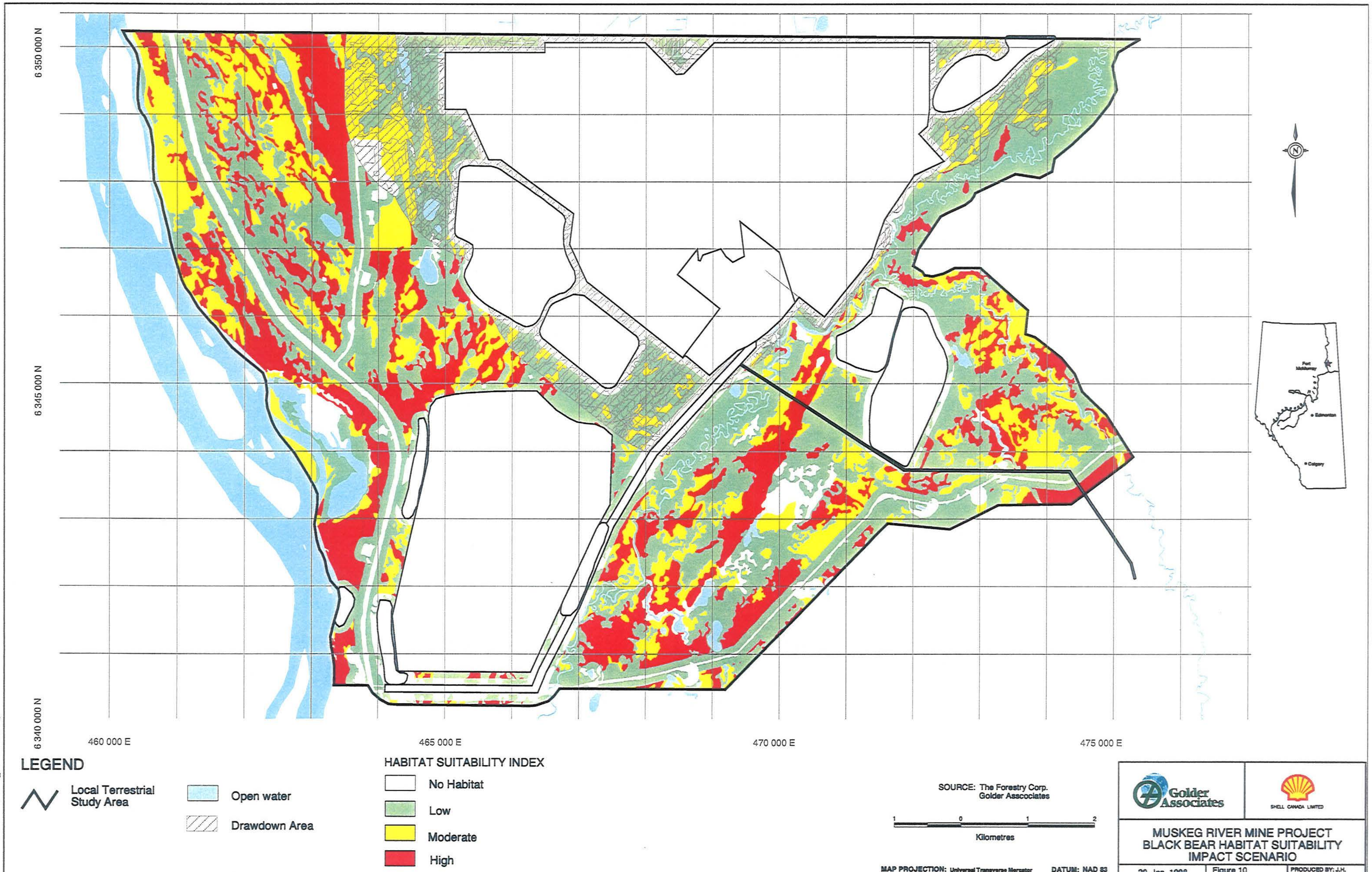
Golder Associates

SHELL CANADA LIMITED

MUSKEG RIVER MINE PROJECT
BLACK BEAR HABITAT SUITABILITY
BASELINE SCENARIO

29 Jan. 1998	FIGURE 9	PRODUCED BY: J.H. REVIEWED BY:

/data9/oilsands/shell_hs/local/vole.apr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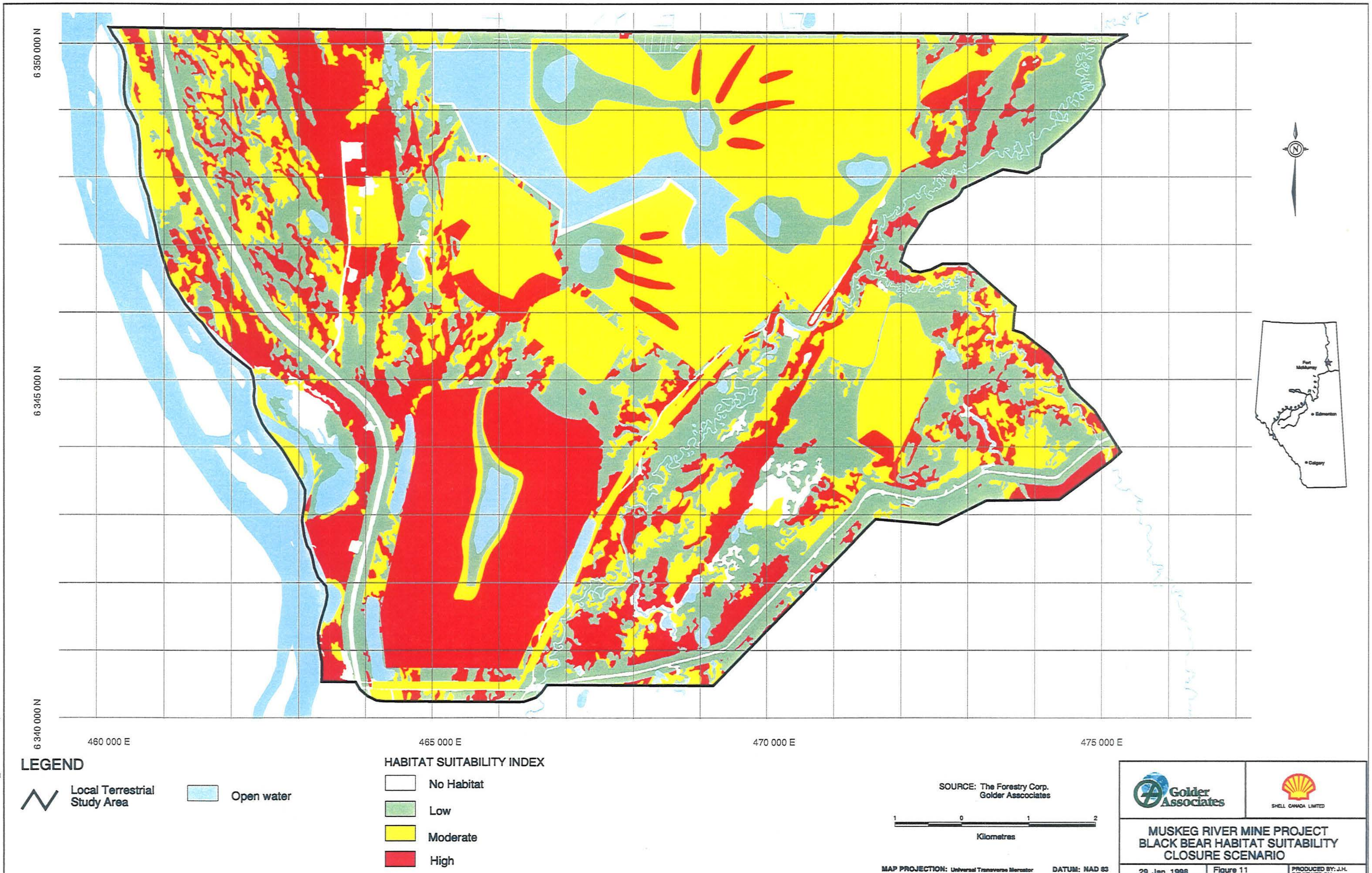
460 000 E
465 000 E
470 000 E
475 000 E
Fort McMurray
Edmonton
Calgary
/data9/oilsands/shell_hsi/local/vole.apr
LEGEND
Local Terrestrial Study Area
Open water
Drawdown Area
HABITAT SUITABILITY INDEX
No Habitat
Low
Moderate
High
SOURCE: The Forestry Corp.
Golder Associates
1 0 1 2
Kilometres
MAP PROJECTION: Universal Transverse Mercator Zone 12
DATUM: NAD 83
Golder Associates
SHELL CANADA LIMITED
MUSKEG RIVER MINE PROJECT
BLACK BEAR HABITAT SUITABILITY
IMPACT SCENARIO
29 Jan. 1998
Figure 10
PRODUCED BY: J.H.
REVIEWED BY:



/data9/oilsands/shell_hsi/local/vole.apr

Table 16 Impact of Clearing, Drawdown, Disturbance and Reclamation on Black Bear Habitat Units Within the LSA

Species	Rating	Baseline	Development Impacts			Closure
			Clearing	Drawdown	Disturbance	
Black Bear	Low	1,079	572	559	528	659
	Medium	791	590	639	508	1,850
	High	1,939	1,584	1,315	1,056	2,371
	Total	3,809	2,746	2,513	2,092	4,880

Table 17 Percent Impact of Clearing, Drawdown, Disturbance and Reclamation on Black Bear Habitat Units Within the LSA

Species	Rating	Baseline	Development Impacts				Reclamation Change From Baseline
			Clearing Change	Drawdown Change	Disturbance Change	Total Change	
Black Bear	Low	1,079	-47.0	-1.2	-2.9	-51.1	-38.9
	Medium	791	-25.4	+6.2	-16.6	-35.8	+133.9
	High	1,939	-18.3	-13.9	-13.4	-45.5	+22.3
	Total	3,809	-27.9	-6.1	-11.1	-45.1	+28.1

6.1.3 Cape May Warbler

6.1.3.1 Baseline Conditions

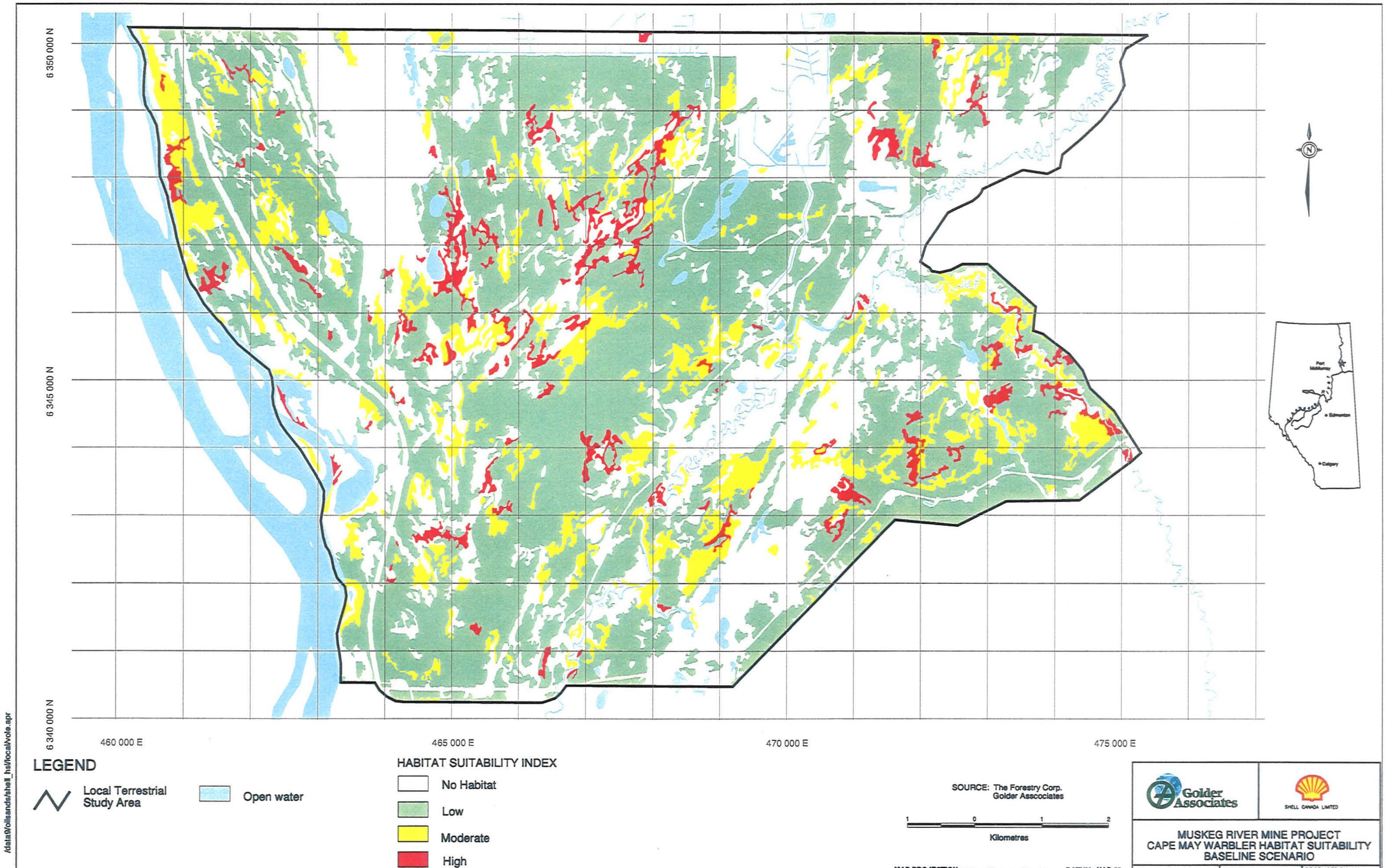
High suitability habitats for the Cape May warbler included four white spruce-dominated vegetation types (Table 5, Appendix IV).

A total of 1,583 HUs were mapped for the LSA (Figure 12). 3.5% of the LSA was mapped as high suitability habitat, 8.9% as medium suitability habitat, 45.6% as low suitability habitat and 41.9% as unsuitable habitat.

6.1.3.2 Impact of Muskeg River Mine Project

Impacts of the Project on Cape May warbler habitat (Tables 18-19) include an overall loss of 35% due to site clearing, 4% due to drawdown and 9.6% due to disturbance for a total loss of 48.6% of the baseline HUs (Figure 13).

Reclamation is expected to result in an overall gain of 50.8% of HUs over baseline conditions (Table 19, Figure 14). However, development of a suitable white spruce-dominated forest will take considerable time (100+ years).

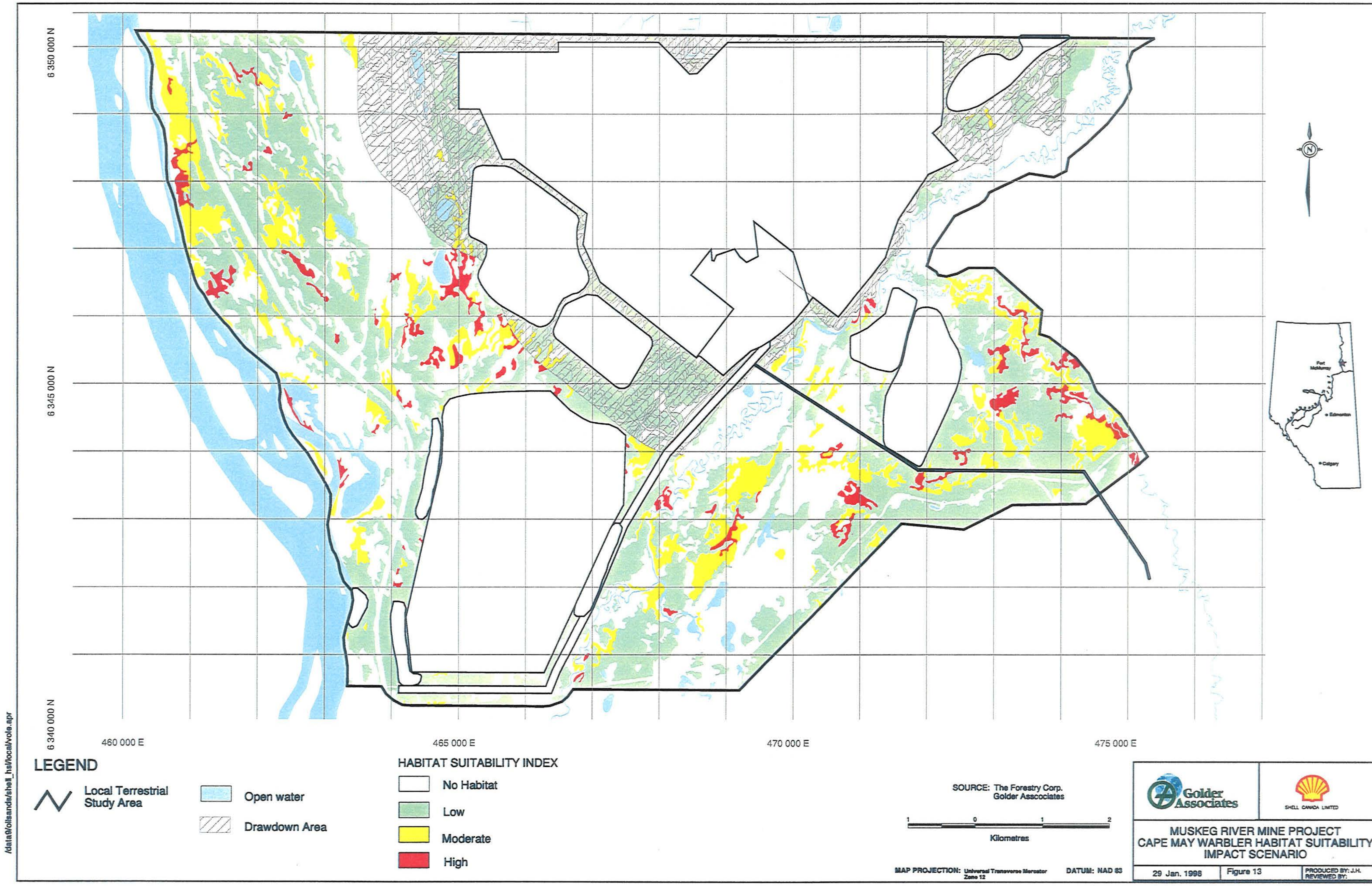


MUSKEG RIVER MINE PROJECT
CAPE MAY WARBLER HABITAT SUITABILITY
BASELINE SCENARIO

29 Jan. 1998	FIGURE 12	PRODUCED BY: J.H. REVIEWED BY:

Golder Associates

SHELL CANADA LIMITED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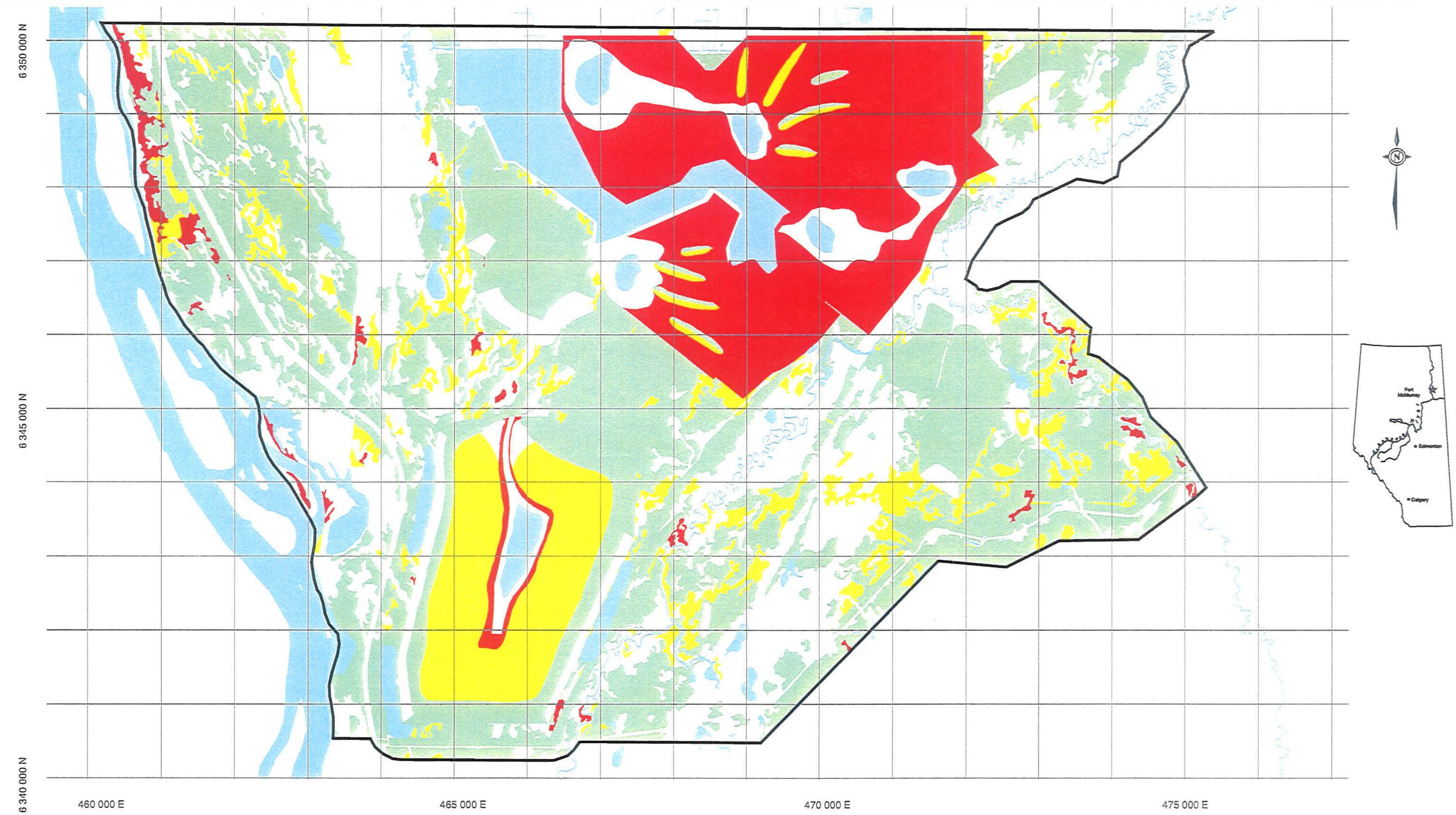
6 340 000 N
460 000 E
465 000 E
470 000 E
475 000 E
Fort McMurray
Edmonton
Calgary
LEGEND
Local Terrestrial Study Area
Open water
Drawdown Area
HABITAT SUITABILITY INDEX
No Habitat
Low
Moderate
High
SOURCE: The Forestry Corp. Golder Asscociates
Kilometres
MAP PROJECTION: Universal Transverse Mercator Zone 12
DATUM: NAD 83
Golder Associates
SHELL CANADA LIMITED
MUSKEG RIVER MINE PROJECT
CAPE MAY WARBLER HABITAT SUITABILITY
IMPACT SCENARIO
29 Jan. 1998
Figure 13
PRODUCED BY: J.H.
REVIEWED BY:
/data9/oilsands/shell_hsi/local/vole.apr



LEGEND

Local Terrestrial Study Area

Open water

HABITAT SUITABILITY INDEX

- No Habitat
- Low
- Moderate
- High

SOURCE: The Forestry Corp.
Golder Associates

1 0 1 2
Kilometres

MAP PROJECTION: Universal Transverse Mercator Zone 12

DATUM: NAD 83

Golder Associates

SHELL CANADA LIMITED

MUSKEG RIVER MINE PROJECT
CAPE MAY WARBLER HABITAT SUITABILITY
CLOSURE SCENARIO

29 Jan. 1998	Figure 14	PRODUCED BY: J.H. REVIEWED BY:

/data9/oilsands/shell_hsi/local/vole.apr

Table 18 Impact of Clearing, Drawdown, Disturbance and Reclamation on Cape May Warbler Habitat Units Within the LSA

Species	Rating	Baseline	Development Impacts			Closure
			Clearing	Drawdown	Disturbance	
Cape May Warbler	Low	711	412	407	341	390
	Medium	534	408	383	320	590
	High	338	209	176	153	1,407
	Total	1,583	1,029	966	814	2,387

Table 19 Percent Impact of Clearing, Drawdown, Disturbance and Reclamation on Cape May Warbler Habitat Units within the LSA

Species	Rating	Baseline	Development Impacts				Reclamation Change From Baseline
			Clearing Change	Drawdown Change	Disturbance Change	Total Change	
Cape May Warbler	Low	711	-42.1	-0.7	-9.3	-52.0	-45.1
	Medium	534	-23.6	-4.7	-11.8	-40.1	+10.5
	High	338	-38.2	-9.8	-6.8	-54.7	+316.3
	Total	1,583	-35.0	-4.0	-9.6	-48.6	+50.8

6.1.4 Dabbling Ducks

6.1.4.1 Baseline Conditions

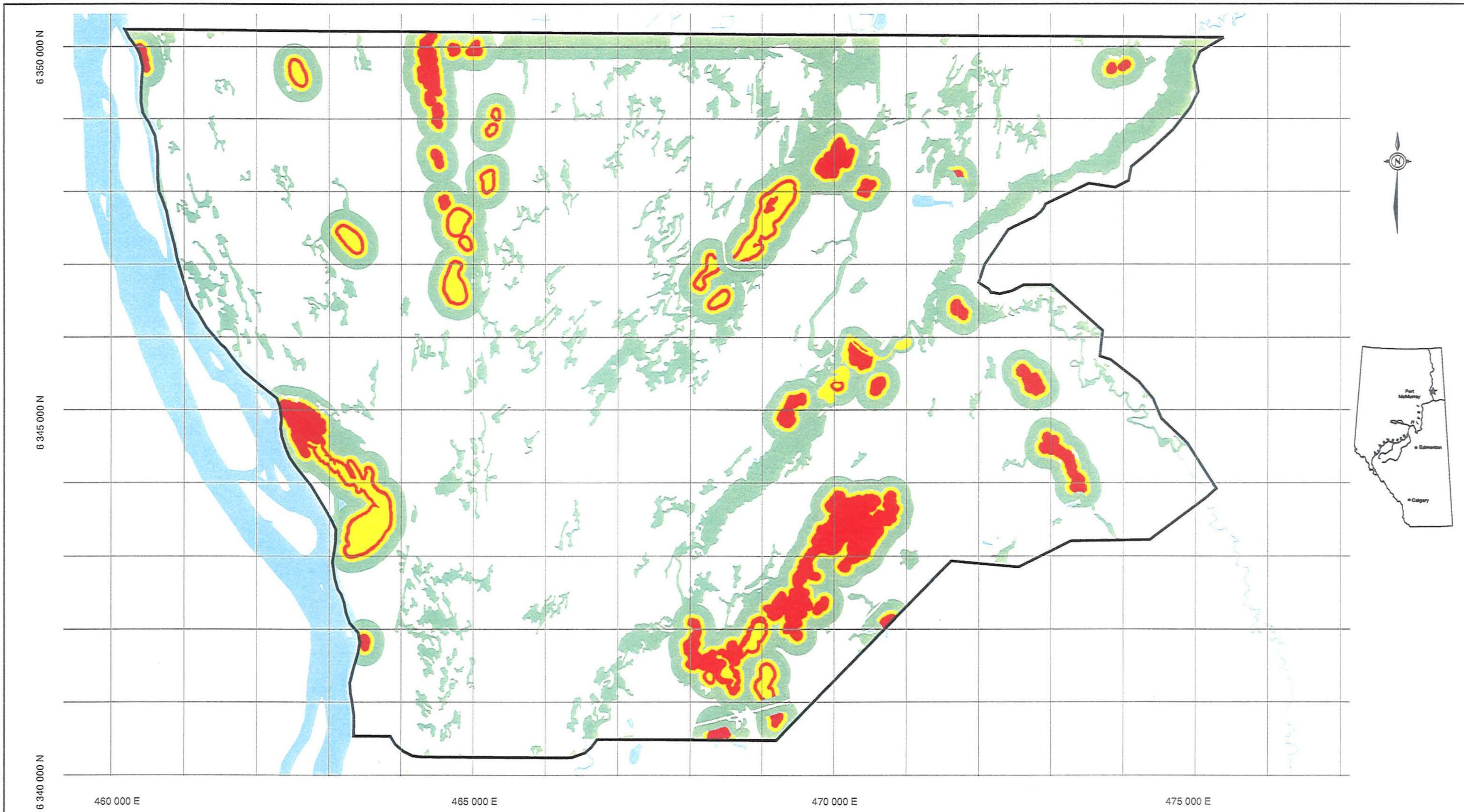
High suitability habitats for dabbling ducks included marsh, shallow open water, reclaimed wetland vegetation types and all habitat within 30 m of ponds and marshes (Table 7, Appendix IV).

A total of 1,446 HUs were mapped for the LSA (Figure 15). 4.1% of the LSA was mapped as high suitability habitat, 3.8% as medium suitability habitat, 21.1% as low suitability habitat and 70.9% as unsuitable habitat.

6.1.4.2 Impact of Muskeg River Mine Project

Impacts of the Project on dabbling duck habitat (Tables 20-21) include an overall loss of 22.7% due to site clearing, 7.3% due to drawdown and 5% due to disturbance for a total loss of 35% of the baseline HUs (Figure 16).

Reclamation is expected to result in an overall gain of 43.2% of HUs over baseline conditions (Table 21, Figure 17).



/data9/oilsands/shell_hsi/local/vole.apr

LEGEND

Local Terrestrial Study Area

Open water

HABITAT SUITABILITY INDEX

- No Habitat
- Low
- Moderate
- High

SOURCE: The Forestry Corp.
Golder Associates

1 0 1 2
Kilometres

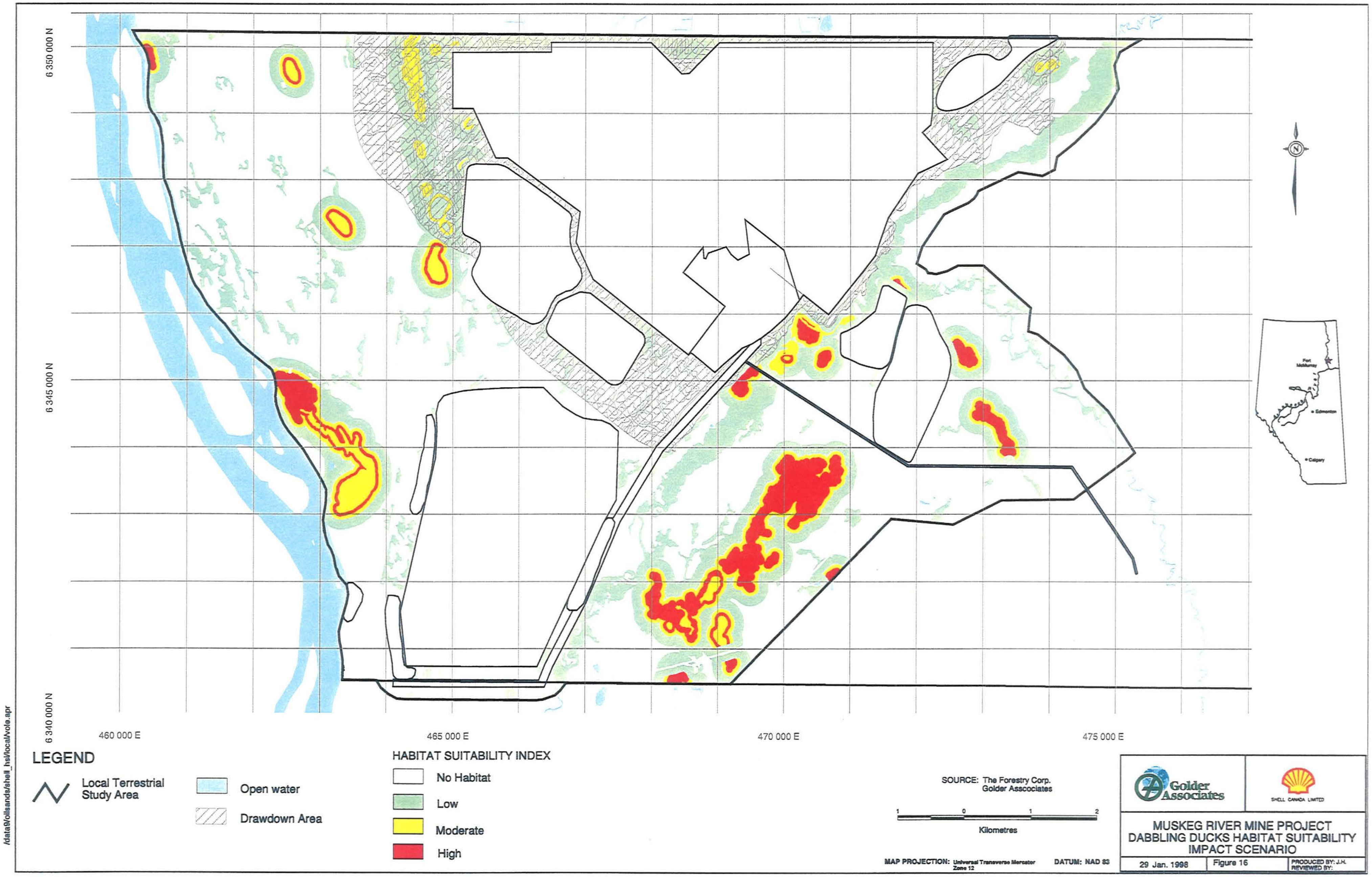
MAP PROJECTION: Universal Transverse Mercator Zone 12 DATUM: NAD 83

Golder Associates

SHELL CANADA LIMITED

**MUSKEG RIVER MINE PROJECT
DABBLING DUCK HABITAT SUITABILITY
BASELINE SCENARIO**

29 Jan. 1998	FIGURE 15	PRODUCED BY: J.H. REVIEWED BY: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6 340 000 N
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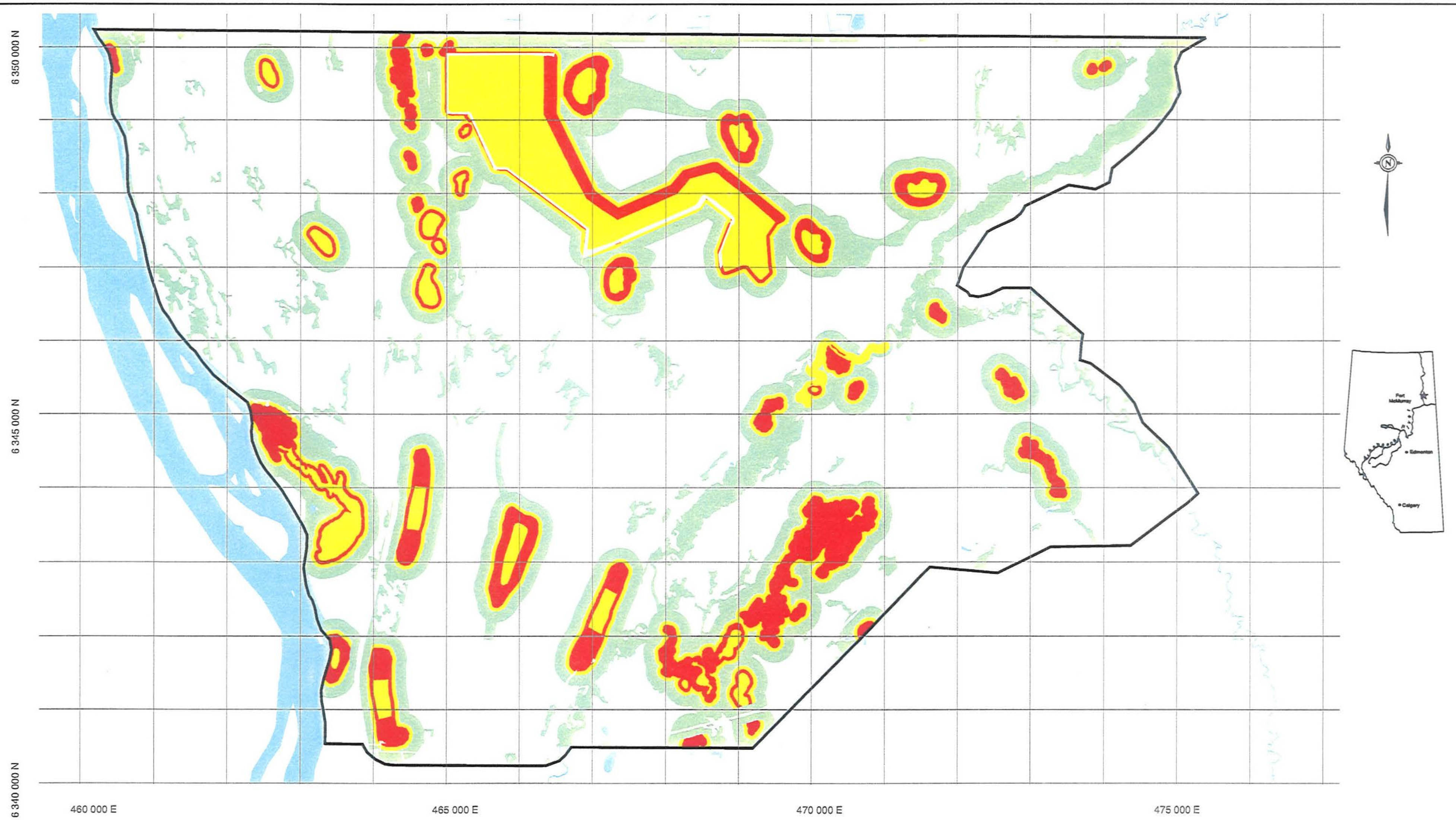
465 000 E
470 000 E
475 000 E
Fort McMurray
Edmonton
Calgary
LEGEND
Local Terrestrial Study Area
Open water
Drawdown Area
HABITAT SUITABILITY INDEX
No Habitat
Low
Moderate
High
SOURCE: The Forestry Corp. Golder Associates
1 0 1 2
Kilometres
MAP PROJECTION: Universal Transverse Mercator Zone 12
DATUM: NAD 83
Golder Associates
SHELL CANADA LIMITED
MUSKEG RIVER MINE PROJECT
DABBLING DUCKS HABITAT SUITABILITY
IMPACT SCENARIO
29 Jan. 1998
Figure 16
PRODUCED BY: J.H.
REVIEWED BY:
/data9/oilsands/shell_hsi/local/vole.apr



/data9/oilsands/shell_hsi/local/vole.apr

LEGEND

Local Terrestrial Study Area

Open water

HABITAT SUITABILITY INDEX

- No Habitat
- Low
- Moderate
- High

SOURCE: The Forestry Corp.
Golder Associates

1 0 1 2
Kilometres

MAP PROJECTION: Universal Transverse Mercator Zone 12

DATUM: NAD 83

Golder Associates

SHELL CANADA LIMITED

MUSKEG RIVER MINE PROJECT
DABBLING DUCKS HABITAT SUITABILITY
CLOSURE SCENARIO

29 Jan. 1998	Figure 17	PRODUCED BY: J.H. REVIEWED BY:

Table 20 Impact of Clearing, Drawdown, Disturbance and Reclamation on Dabbling Duck Habitat Units Within the LSA

Species	Rating	Baseline	Development Impacts			Closure
			Clearing	Drawdown	Disturbance	
Dabbling Ducks	Low	721	494	463	414	701
	Medium	278	233	219	204	638
	High	447	391	330	322	731
	Total	1,446	1,118	1,012	940	2,070

Table 21 Percent Impact of Clearing, Drawdown, Disturbance and Reclamation on Dabbling Duck Habitat Units Within the LSA

Species	Rating	Baseline	Development Impacts				Reclamation Change From Baseline
			Clearing Change	Drawdown Change	Disturbance Change	Total Change	
Dabbling Ducks	Low	721	-31.5	-4.3	-6.8	-42.6	-2.8
	Medium	278	-16.2	-5.0	-5.4	-26.6	+129.5
	High	447	-12.5	-13.6	-1.8	-28.0	+63.5
	Total	1,446	-22.7	-7.3	-5.0	-35.0	+43.2

6.1.5 Fisher

6.1.5.1 Baseline Conditions

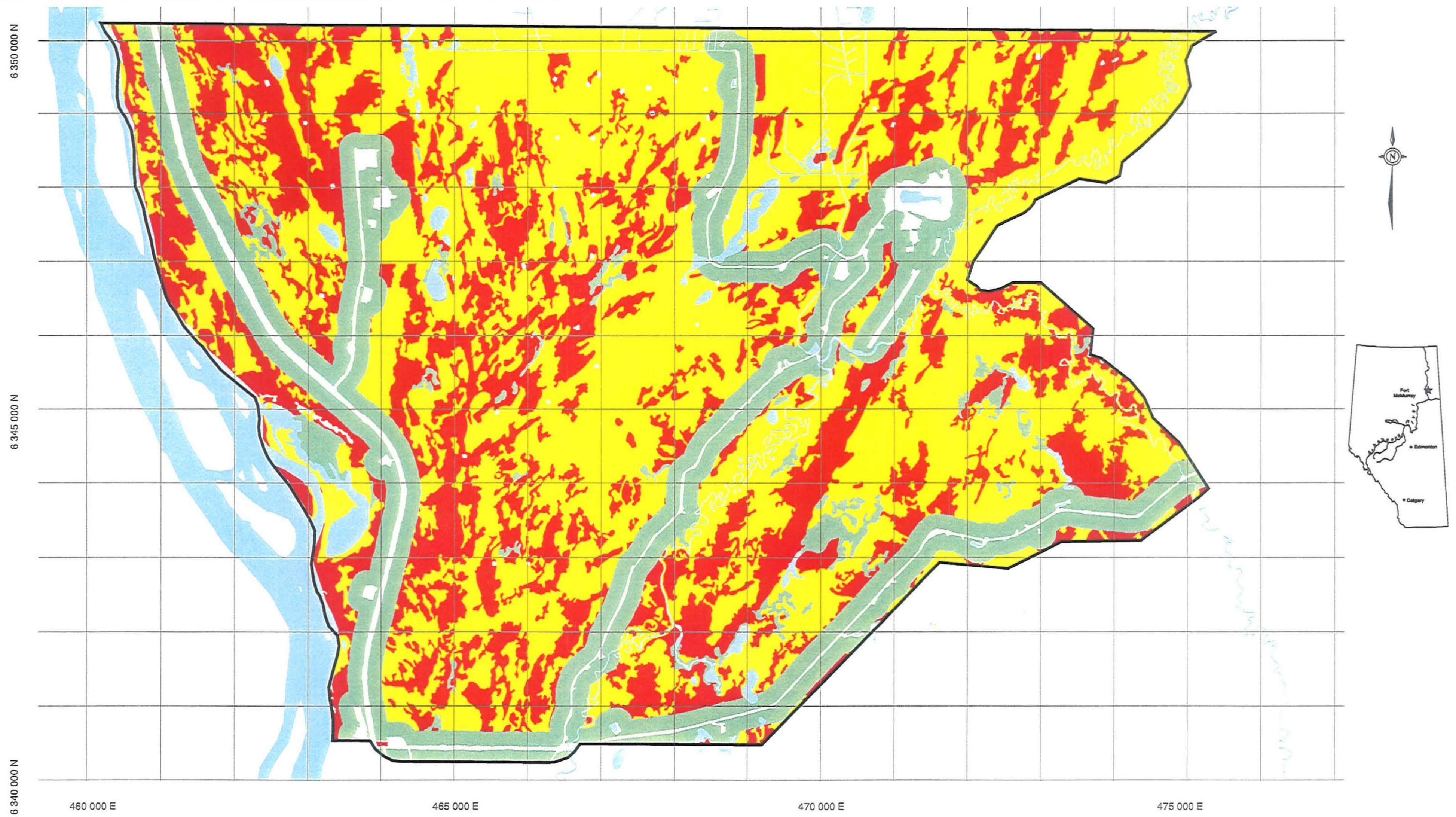
High suitability habitats for the fisher included black spruce (n=9), jack pine (2) and white spruce-dominated (2) vegetation types. (Table 9, Appendix IV). Shrubby bogs (1) and aspen-white spruce mixedwood forest (1) were also ranked high by the model.

A total of 4,978 HUs were mapped for the LSA (Figure 18). 27.8% of the LSA was mapped as high suitability habitat, 48.5% as medium suitability habitat, 18.8% as low suitability habitat and 4.9% as unsuitable habitat.

6.1.5.2 Impact of Muskeg River Mine Project

Impacts of the Muskeg River Mine Project on fisher habitat (Tables 22-23) include an overall loss of 37.2% due to site clearing, 3.4% due to drawdown and 14.1% due to disturbance for a total loss of 54.7% of the baseline HUs (Figure 19).

Reclamation is expected to result in an overall gain of 7% of HUs over baseline conditions (Table 23, Figure 20).



/data9/oilsands/shell_hsi/local/vole.apr

LEGEND

Local Terrestrial Study Area

Open water

HABITAT SUITABILITY INDEX

- No Habitat
- Low
- Moderate
- High

SOURCE: The Forestry Corp. Golder Associates

1 0 1 2

Kilometres

MAP PROJECTION: Universal Transverse Mercator Zone 12

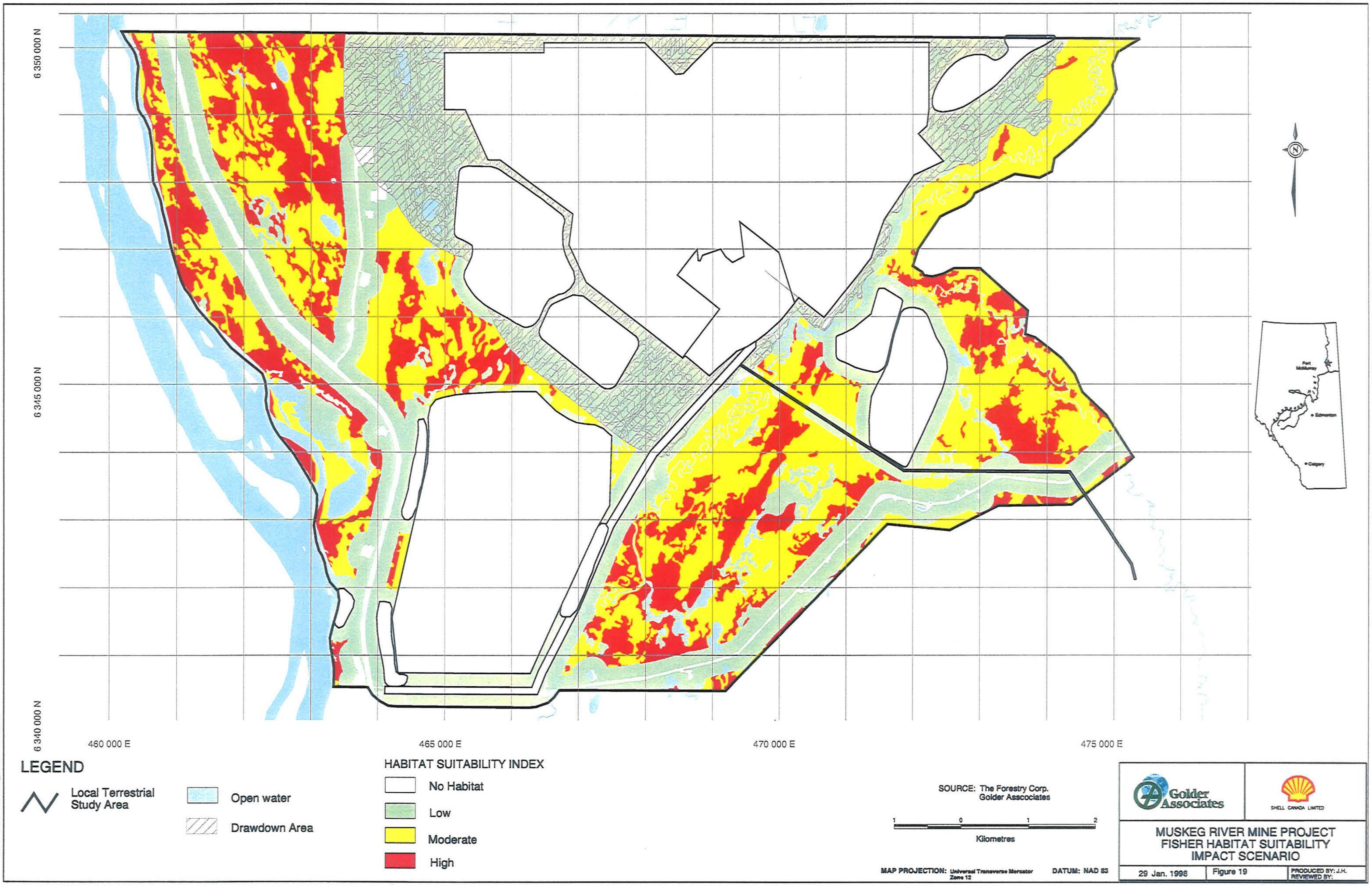
DATUM: NAD 83

Golder Associates

SHELL CANADA LIMITED

MUSKEG RIVER MINE PROJECT
FISHER HABITAT SUITABILITY
BASELINE SCENARIO

29 Jan. 1998	FIGURE 18	PRODUCED BY: J.H. REVIEWED BY:



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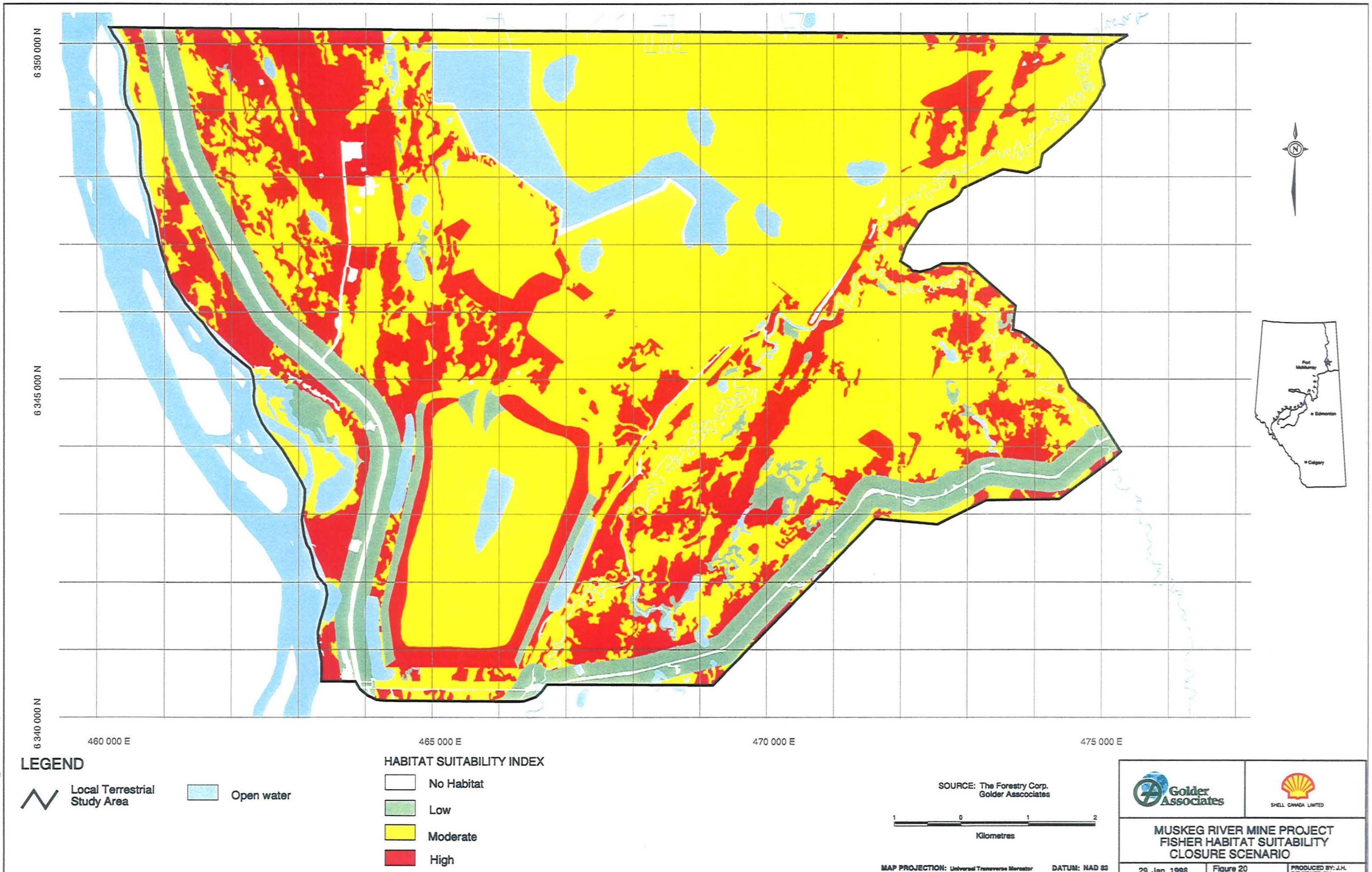
460 000 E
465 000 E
470 000 E
475 000 E
N
LEGEND
Local Terrestrial Study Area
Open water
Drawdown Area
HABITAT SUITABILITY INDEX
No Habitat
Low
Moderate
High
SOURCE: The Forestry Corp. Golder Associates
1 0 1 2
Kilometres
MAP PROJECTION: Universal Transverse Mercator Zone 12
DATUM: NAD 83
Golder Associates
SHELL CANADA LIMITED
MUSKEG RIVER MINE PROJECT
FISHER HABITAT SUITABILITY
IMPACT SCENARIO
29 Jan. 1998
Figure 19
PRODUCED BY: J.H.
REVIEWED BY:
/data9/oilsands/shell_hsi/local/vole.apr



/data9/oilsands/shell_hs/local/vole.apr

Table 22 Impact of Clearing, Drawdown, Disturbance and Reclamation on Fisher Habitat Units Within the LSA

Species	Rating	Baseline	Development Impacts			Closure
			Clearing	Drawdown	Disturbance	
Fisher	Low	237	260	277	268	150
	Medium	2,360	1474	1,293	955	3,198
	High	2,201	1,280	1,279	950	1,787
	Total	4,798	3,014	2,849	2,173	5,135

Table 23 Percent Impact of Clearing, Drawdown, Disturbance and Reclamation on Fisher Habitat Units Within the LSA

Species	Rating	Baseline	Development Impacts				Reclamation Change From Baseline
			Clearing Change	Drawdown Change	Disturbance Change	Total Change	
Fisher	Low	237	+9.7	+7.2	-3.8	+13.1	-36.7
	Medium	2,360	-37.5	-7.7	-14.3	-59.5	+35.5
	High	2,201	-41.8	-0.0	-14.9	-56.8	-18.8
	Total	4,798	-37.2	-3.4	-14.1	-54.7	+7.0

6.1.6 Great Gray Owl

6.1.6.1 Baseline Conditions

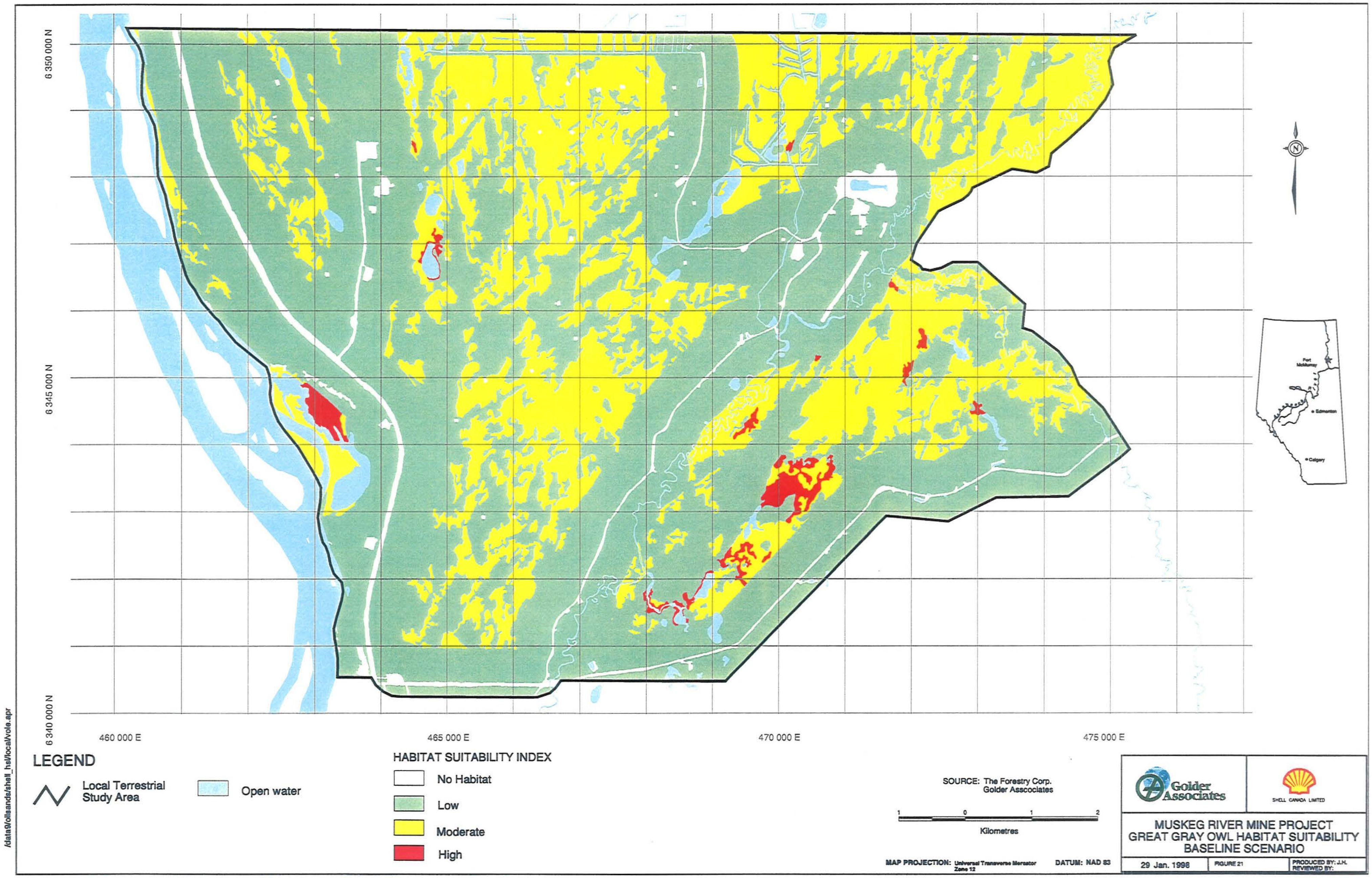
High suitability habitats for great gray owl food included graminoid rich fens, marshes and reclaimed wetlands (Table 11, Appendix IV). High suitability habitats for great gray owl cover included white spruce forest (n=1) and mixedwoods (2) (Table 13, Appendix IV).

A total of 2,558 HUs were mapped for the LSA (Figure 21). 1.1% of the LSA was mapped as high suitability habitat, 29.1% as medium suitability habitat, 65% as low suitability habitat and 4.9% as unsuitable habitat.

6.1.6.2 Impact of Muskeg River Mine Project

Impacts of the Muskeg River Mine Project on great gray owl habitat (Tables 24-25) include an overall loss of 16.5% due to site clearing, 7.2% due to drawdown and 37.5% due to disturbance for a total loss of 61.1% of baseline HUs (Figure 22). It is likely that the projected loss due to disturbance is an overestimate as a disturbance ZI of 500 m for the great gray owl, while perhaps suitable for other raptors, is perhaps too large.

Reclamation is expected to result in an overall gain of 16.6% of HUs over baseline conditions (Table 25, Figure 23). Most of this gain is due to gains in moderate suitability habitat.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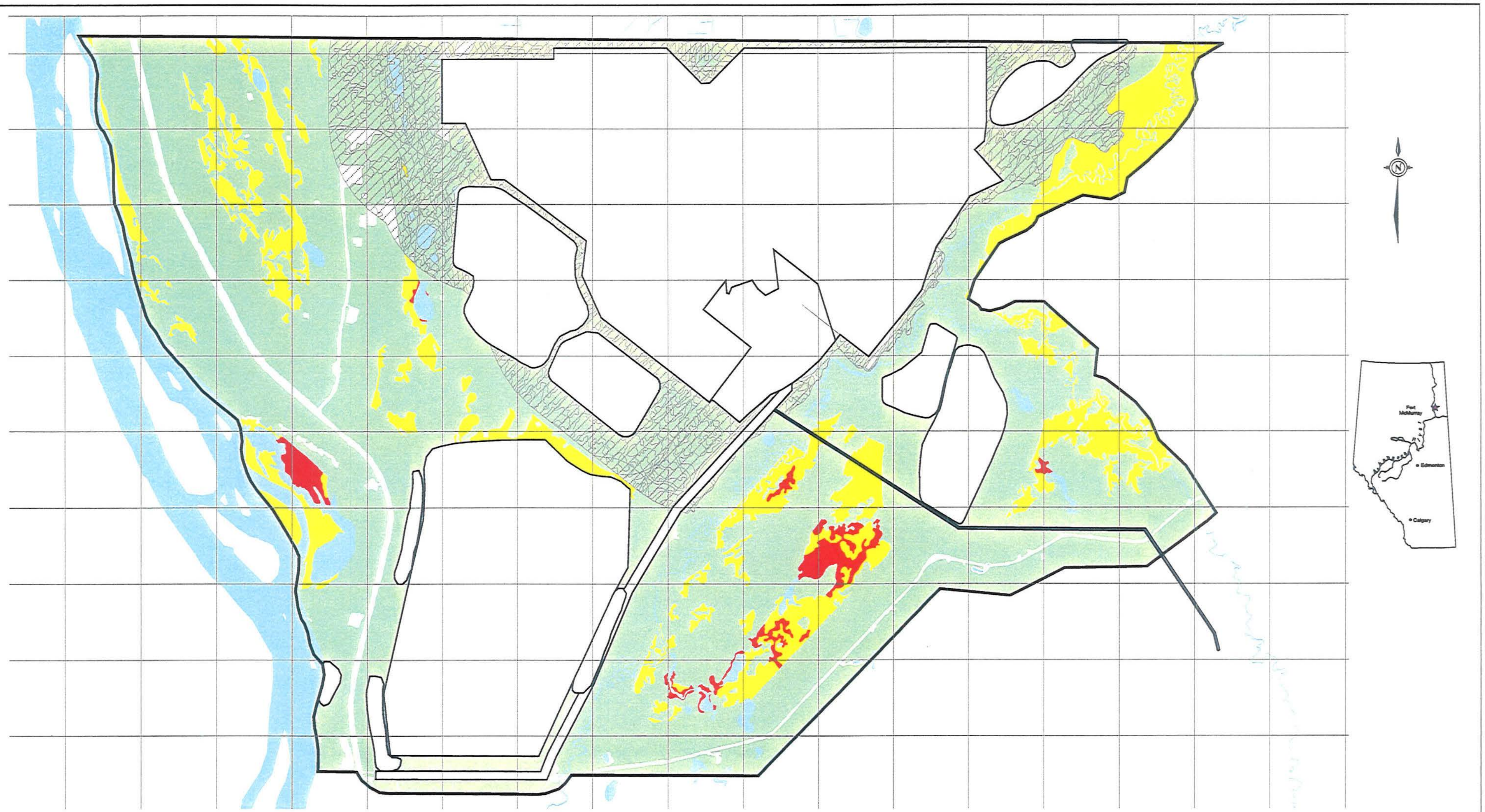
465 000 E
470 000 E
475 000 E
Fort McMurray
Edmonton
Calgary
LEGEND
Local Terrestrial Study Area
Open water
HABITAT SUITABILITY INDEX
No Habitat
Low
Moderate
High
SOURCE: The Forestry Corp.
Golder Associates
1 0 1 2
Kilometres
MAP PROJECTION: Universal Transverse Mercator Zone 12
DATUM: NAD 83
Golder Associates
SHELL CANADA LIMITED
MUSKEG RIVER MINE PROJECT
GREAT GRAY OWL HABITAT SUITABILITY
BASELINE SCENARIO
29 Jan. 1998
FIGURE 21
PRODUCED BY: J.H.
REVIEWED BY:
/data9/oilsands/shell_hsi/local/vole.apr



LEGEND

- Local Terrestrial Study Area
- Open water
- Drawdown Area

HABITAT SUITABILITY INDEX

- No Habitat
- Low
- Moderate
- High

SOURCE: The Forestry Corp.
Golder Associates

1 0 1 2
Kilometres

MAP PROJECTION: Universal Transverse Mercator Zone 12 DATUM: NAD 83

Golder Associates

SHELL CANADA LIMITED

MUSKEG RIVER MINE PROJECT
GREAT GRAY OWL HABITAT SUITABILITY
IMPACT SCENARIO

29 Jan. 1998	Figure 22	PRODUCED BY: J.H. REVIEWED BY:

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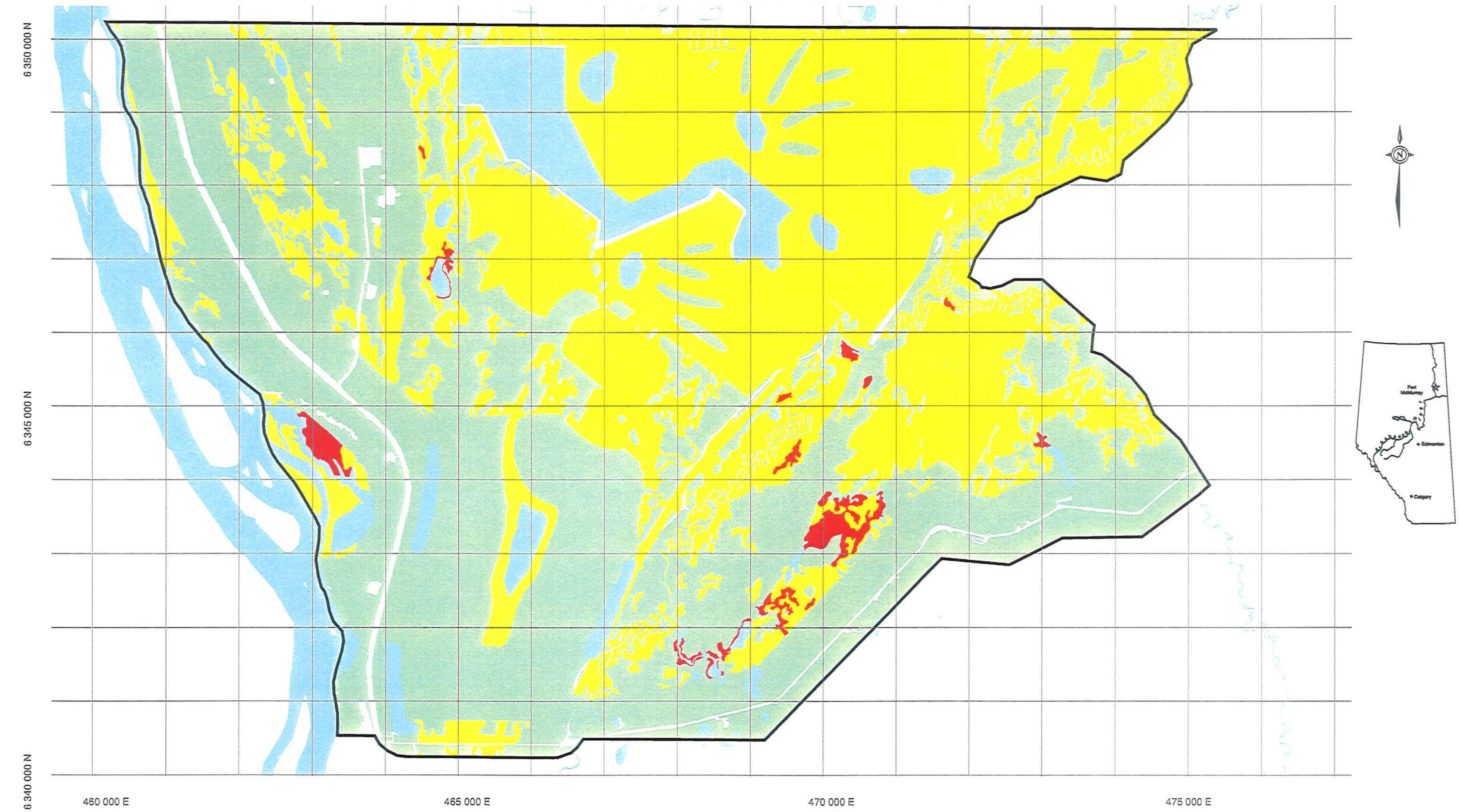


/data0/oilsands/shell_hsi/local/vole.apr

LEGEND

Local Terrestrial Study Area

Open water

HABITAT SUITABILITY INDEX

- No Habitat
- Low
- Moderate
- High

SOURCE: The Forestry Corp. Golder Associates

1 0 1 2

Kilometres

MAP PROJECTION: Universal Transverse Mercator Zone 12

DATUM: NAD 83

Golder Associates

SHELL CANADA LIMITED

MUSKEG RIVER MINE PROJECT
GREAT GRAY OWL HABITAT SUITABILITY
CLOSURE SCENARIO

29 Jan. 1998 | Figure 23 | PRODUCED BY: J.H. REVIEWED BY:

Table 24 Impact of Clearing, Drawdown, Disturbance and Reclamation on Great Gray Owl Habitat Units Within the LSA

Species	Rating	Baseline	Development Impacts			Closure
			Clearing	Drawdown	Disturbance	
Great Gray Owl	Low	1,088	984	1,008	523	1,076
	Medium	1,360	1,034	828	374	1,811
	High	111	120	118	98	98
	Total	2,559	2,138	1,954	995	2,985

Table 25 Percent Impact of Clearing, Drawdown, Disturbance and Reclamation on Great Gray Owl Habitat Units Within the LSA

Species	Rating	Baseline	Development Impacts				Reclamation Change From Baseline
			Clearing Change	Drawdown Change	Disturbance Change	Total Change	
Great Gray Owl	Low	1,088	-9.6	+2.2	-44.6	-51.9	-1.1
	Medium	1,360	-24.0	-15.1	-33.4	-72.5	+33.2
	High	111	+8.1	-1.8	-18.0	-11.7	-11.7
	Total	2,559	-16.5	-7.2	-37.5	-61.1	+16.6

6.1.7 Moose

6.1.7.1 Baseline Conditions

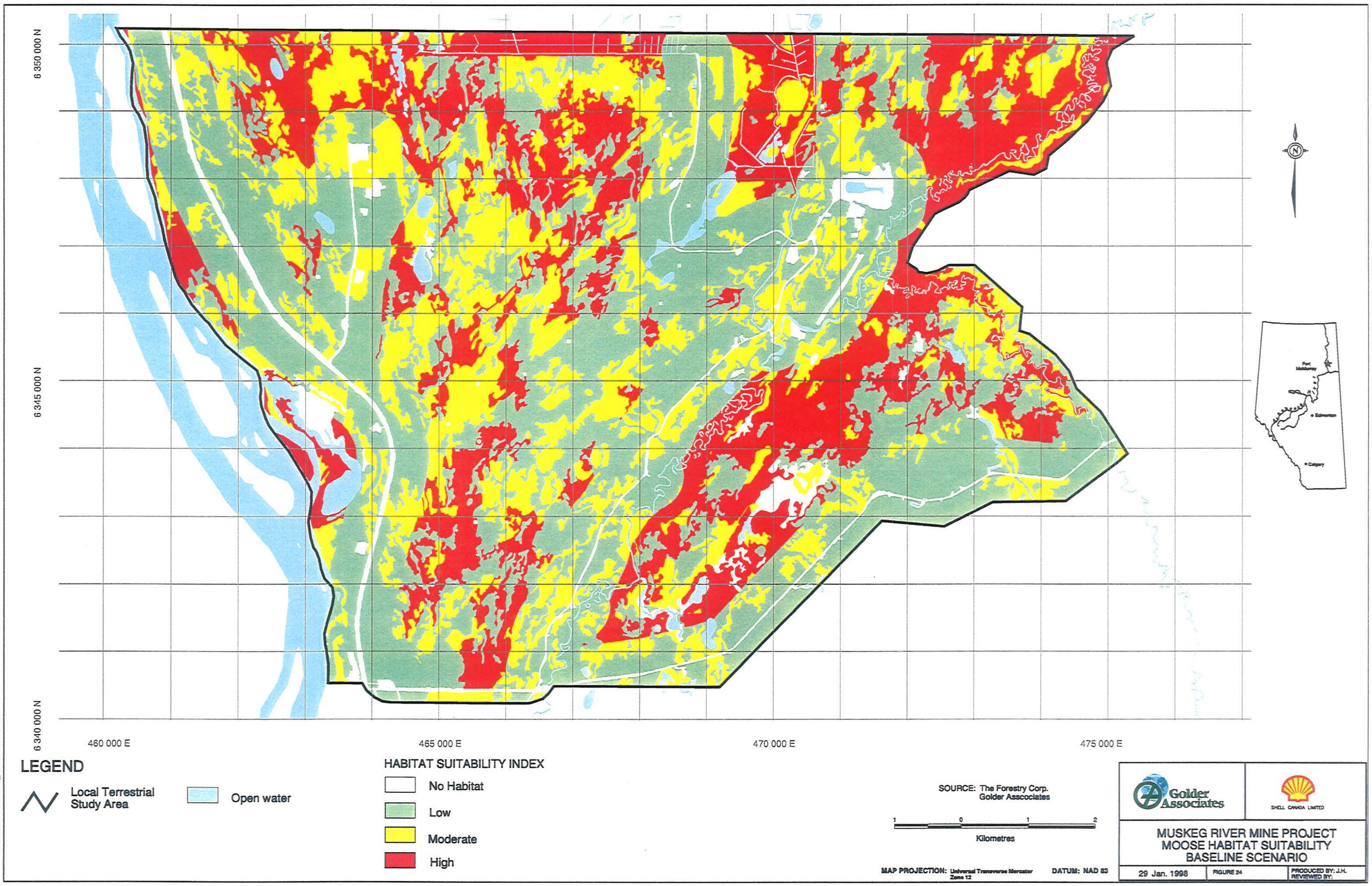
High suitability habitats for moose food included wetlands (n=3), aspen/balsam poplar (3) and white spruce-dominated (1) vegetation types (Table 15, Appendix IV). Other vegetation types that were highly suitable included upland shrubland and reclaimed riparian shrub types. For moose cover, high suitability habitats included jack pine (2), white spruce/black spruce (6) and balsam poplar-white spruce (1) dominated vegetation types (Table 17, Appendix IV).

A total of 4,678 HUs were mapped for the LSA (Figure 24). 25% of the LSA was mapped as high suitability habitat, 26.3% as medium suitability habitat, 42.7% as low suitability habitat and 6.1% as unsuitable habitat.

6.1.7.2 Impact of Muskeg River Mine Project

Impacts of the Project on moose habitat (Tables 26-27) include an overall loss of 21.5% due to site clearing, 7.1% due to drawdown and 25.7% due to disturbance for a total loss of 54.3% of the baseline HUs (Figure 25).

Reclamation is expected to result in an overall gain of 9.6% of HUs over baseline conditions (Table 27, Figure 26).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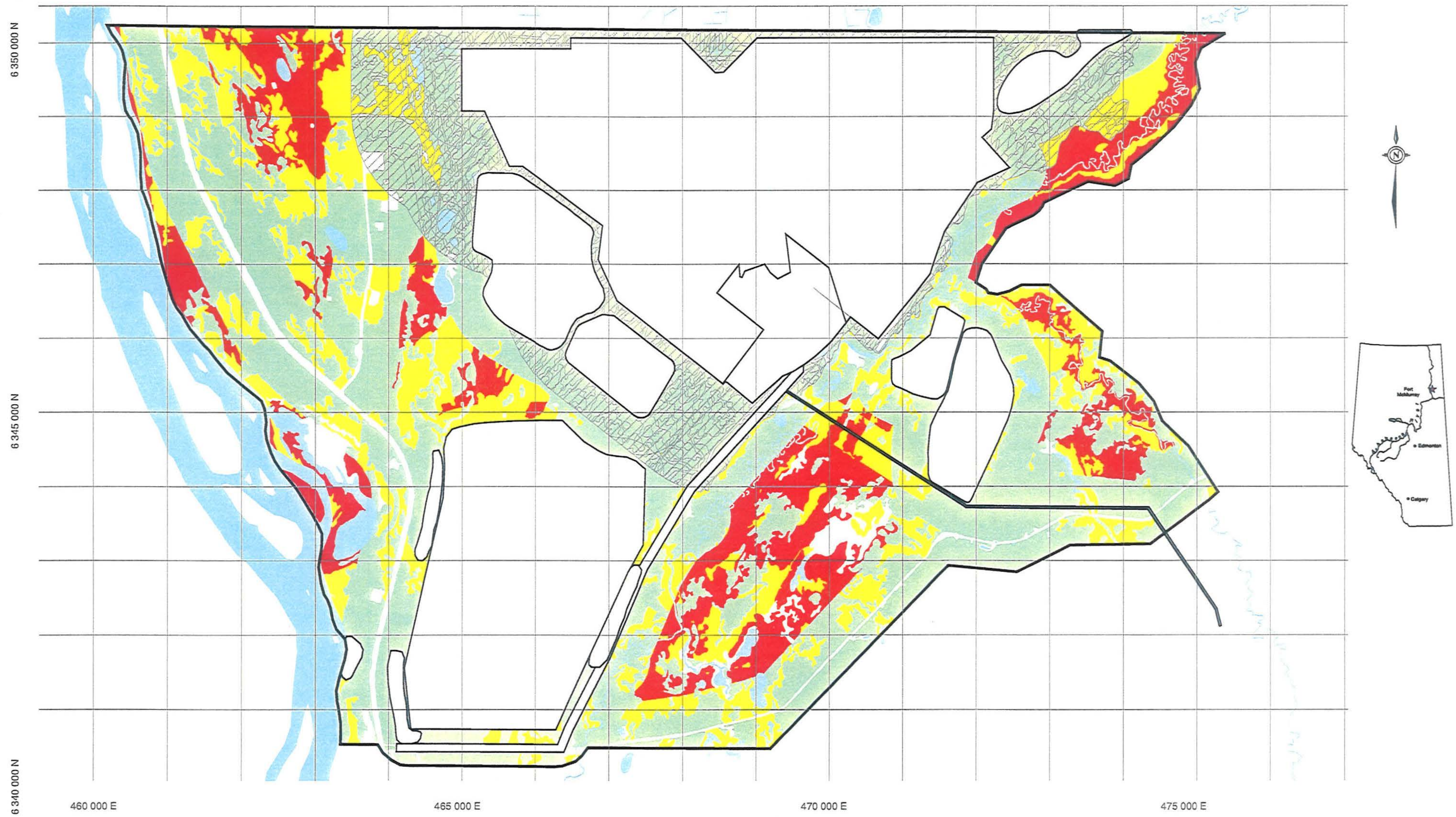
6 345 000 N
6 340 000 N
460 000 E
465 000 E
470 000 E
475 000 E
N
Fort McMurray
Edmonton
Calgary
LEGEND
Local Terrestrial Study Area
Open water
HABITAT SUITABILITY INDEX
No Habitat
Low
Moderate
High
SOURCE: The Forestry Corp. Golder Associates
1 0 1 2
Kilometres
MAP PROJECTION: Universal Transverse Mercator Zone 12
DATUM: NAD 83
Golder Associates
SHELL CANADA LIMITED
MUSKEG RIVER MINE PROJECT
MOOSE HABITAT SUITABILITY
BASELINE SCENARIO
29 Jan. 1998
FIGURE 24
PRODUCED BY: J.H.
REVIEWED BY:
/data9/oilsands/shell_hsi/local/vole.apr



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LEGEND

- Local Terrestrial Study Area
- Open water
- Drawdown Area

HABITAT SUITABILITY INDEX

- No Habitat
- Low
- Moderate
- High

SOURCE: The Forestry Corp.
Golder Associates

1 0 1 2
Kilometres

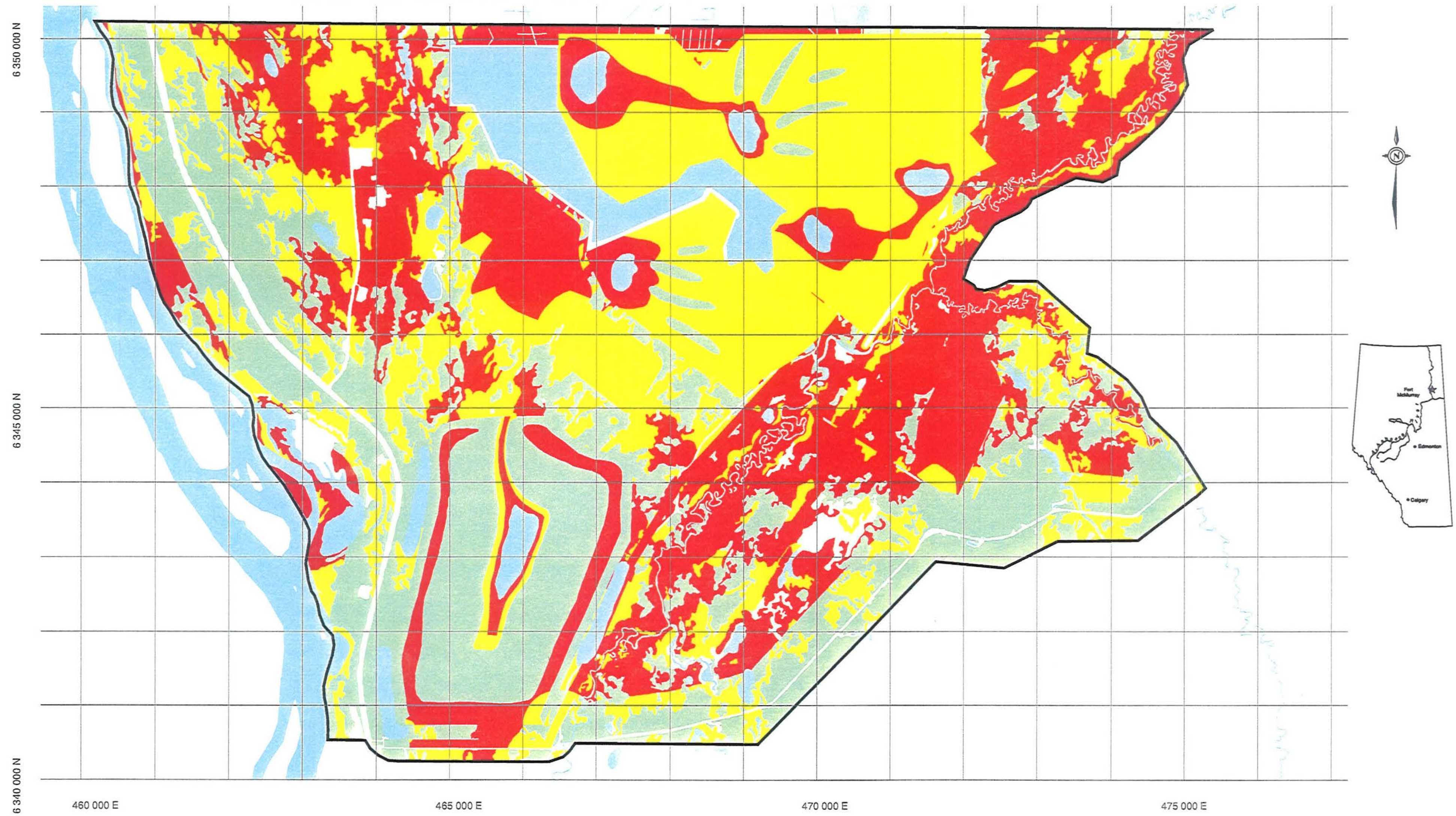
MAP PROJECTION: Universal Transverse Mercator Zone 12 DATUM: NAD 83

Golder Associates

SHELL CANADA LIMITED

MUSKEG RIVER MINE PROJECT
MOOSE HABITAT SUITABILITY
IMPACT SCENARIO

29 Jan. 1998	Figure 25	PRODUCED BY: J.H. REVIEWED BY:



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LEGEND

Local Terrestrial Study Area

Open water

HABITAT SUITABILITY INDEX

No Habitat

Low

Moderate

High

SOURCE: The Forestry Corp.
Golder Associates

1 0 1 2

Kilometres

MAP PROJECTION: Universal Transverse Mercator Zone 12

DATUM: NAD 83

Golder Associates

SHELL CANADA LIMITED

MUSKEG RIVER MINE PROJECT
MOOSE HABITAT SUITABILITY
CLOSURE SCENARIO

29 Jan. 1998	Figure 26	PRODUCED BY: J.H. REVIEWED BY:

Table 26 Impact of Clearing, Drawdown, Disturbance and Reclamation on Moose Habitat Units Within the LSA

Species	Rating	Baseline	Development Impacts			Closure
			Clearing	Drawdown	Disturbance	
Moose	Low	955	375	435	625	632
	Medium	1,483	1,086	1,087	646	1,670
	High	2,240	2,210	1,817	865	2,824
	Total	4,678	3,671	3,339	2,136	5,126

Table 27 Percent Impact of Clearing, Drawdown, Disturbance and Reclamation on Moose Habitat Units Within the LSA

Species	Rating	Baseline	Development Impacts				Reclamation Change From Baseline
			Clearing Change	Drawdown Change	Disturbance Change	Total Change	
Moose	Low	955	-60.7	+6.3	+19.9	-34.6	-33.8
	Medium	1,483	-26.8	+0.1	-29.7	-56.4	+12.6
	High	2,240	-1.3	-17.5	-42.5	-61.4	+26.1
	Total	4,678	-21.5	-7.1	-25.7	-54.3	+9.6

6.1.8 Pileated Woodpecker

6.1.8.1 Baseline Conditions

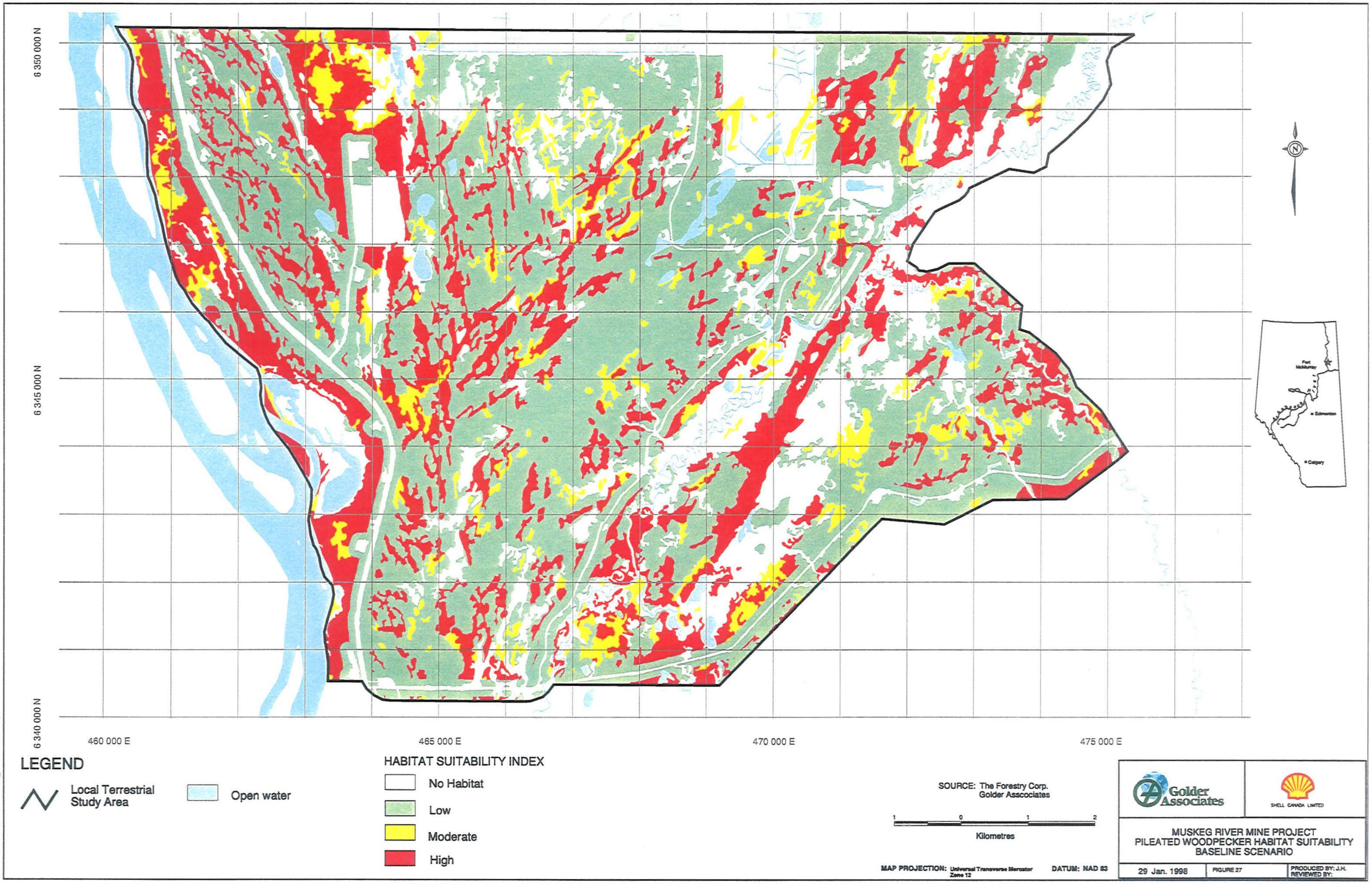
High suitability habitats for the pileated woodpecker included balsam poplar (n=4), jack pine (1), aspen (2), white spruce (1) and white spruce-aspen dominated (3) vegetation types (Table 19, Appendix IV). The abundance of large trees dictated the suitability of vegetation types for this species.

A total of 3403 HUs were mapped for the LSA (Figure 27). 21.7% of the LSA was mapped as high suitability habitat, 6% as medium suitability habitat, 45.6% as low suitability habitat and 26.7% as unsuitable habitat.

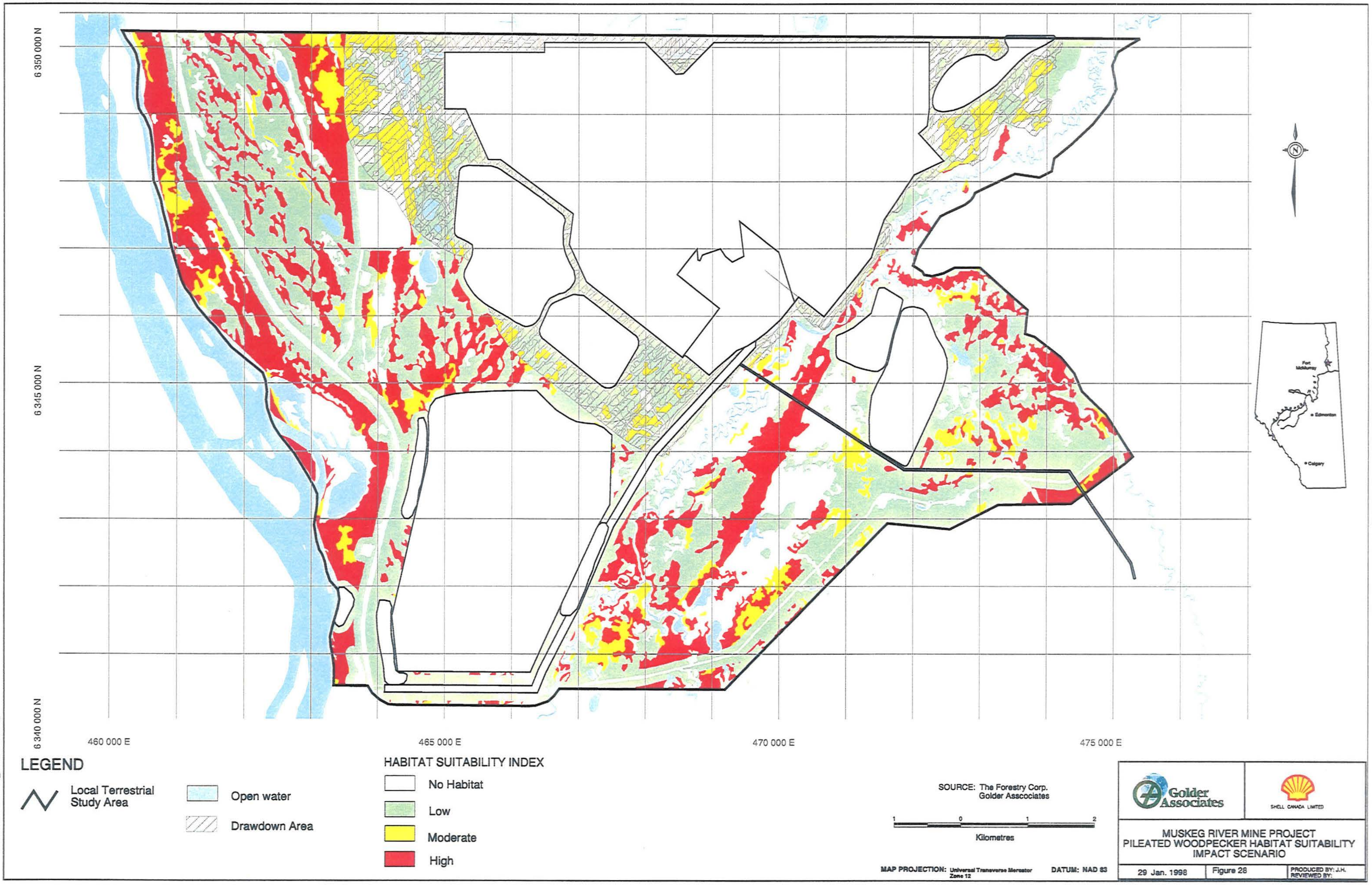
6.1.8.2 Impact of Muskeg River Mine Project

Impacts of the Project on pileated woodpecker habitat (Tables 28-29) include an overall loss of 26.4% due to site clearing, 6.3% due to drawdown and 11% due to disturbance for a total loss of 43.7% of the baseline HUs (Figure 28).

Reclamation is expected to result in an overall gain of 52% of HUs over baseline conditions (Table 29, Figure 29).



/data9/oilsands/shell_hsi/local/vole.apr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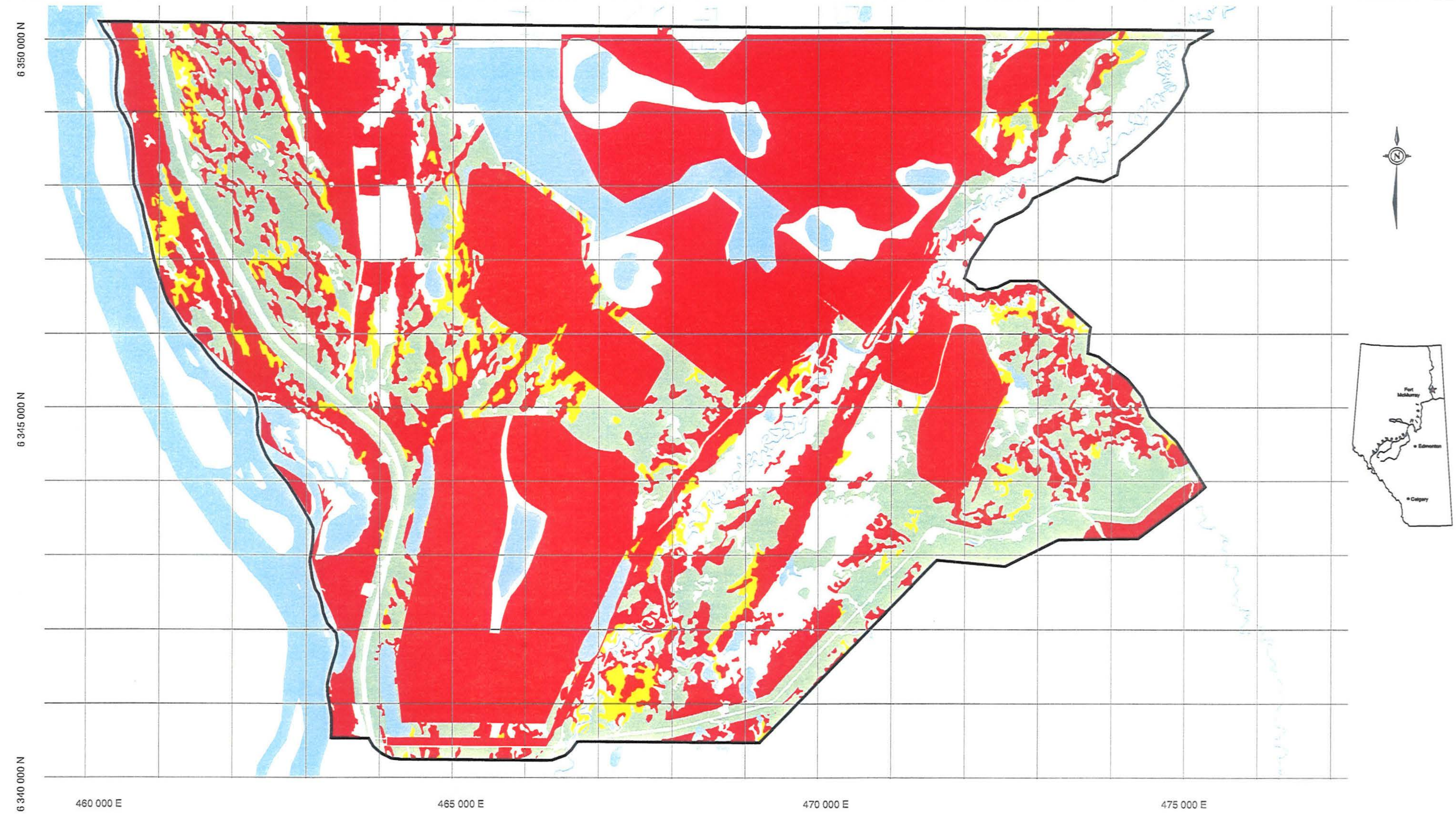
465 000 E
470 000 E
475 000 E
Fort McMurray
Edmonton
Calgary
LEGEND
Local Terrestrial Study Area
Open water
Drawdown Area
HABITAT SUITABILITY INDEX
No Habitat
Low
Moderate
High
SOURCE: The Forestry Corp.
Golder Associates
1 0 1 2
Kilometres
MAP PROJECTION: Universal Transverse Mercator Zone 12
DATUM: NAD 83
Golder Associates
SHELL CANADA LIMITED
MUSKEG RIVER MINE PROJECT
PILEATED WOODPECKER HABITAT SUITABILITY
IMPACT SCENARIO
29 Jan. 1998
Figure 28
PRODUCED BY: J.H.
REVIEWED BY:
/data9/oilsands/shell_hsi/local/vole.apr



/data9/oilsands/shell_hsi/local/vole.apr

LEGEND

Local Terrestrial Study Area

Open water

HABITAT SUITABILITY INDEX

- No Habitat
- Low
- Moderate
- High

SOURCE: The Forestry Corp.
Golder Asscociates

1 0 1 2
Kilometres

MAP PROJECTION: Universal Transverse Mercator Zone 12

DATUM: NAD 83

Golder Associates

SHELL CANADA LIMITED

MUSKEG RIVER MINE PROJECT
PILEATED WOODPECKER HABITAT SUITABILITY
CLOSURE SCENARIO

29 Jan. 1998	Figure 29	PRODUCED BY: J.H. REVIEWED BY:

Table 28 Impact of Clearing, Drawdown, Disturbance and Reclamation on Pileated Woodpecker Habitat Units Within the LSA

Species	Rating	Baseline	Development Impacts			Closure
			Clearing	Drawdown	Disturbance	
Pileated Woodpecker	Low	1,016	487	464	453	474
	Medium	283	200	312	240	166
	High	2,104	1,816	1,514	1,222	4,533
	Total	3,403	2,503	2,290	1,915	5,173

Table 29 Percent Impact of Clearing, Drawdown, Disturbance and Reclamation on Pileated Woodpecker Habitat Units Within the LSA

Species	Rating	Baseline	Development Impacts				Reclamation Change From Baseline
			Clearing Change	Drawdown Change	Disturbance Change	Total Change	
Pileated Woodpecker	Low	1,016	-52.1	-2.3	-1.1	-55.4	-53.3
	Medium	283	-29.3	+39.6	-25.4	-15.2	-41.3
	High	2,104	-13.7	-14.4	-13.9	-41.9	+115.4
	Total	3,403	-26.4	-6.3	-11.0	-43.7	+52.0

6.1.9 Red-backed Vole

6.1.9.1 Baseline Conditions

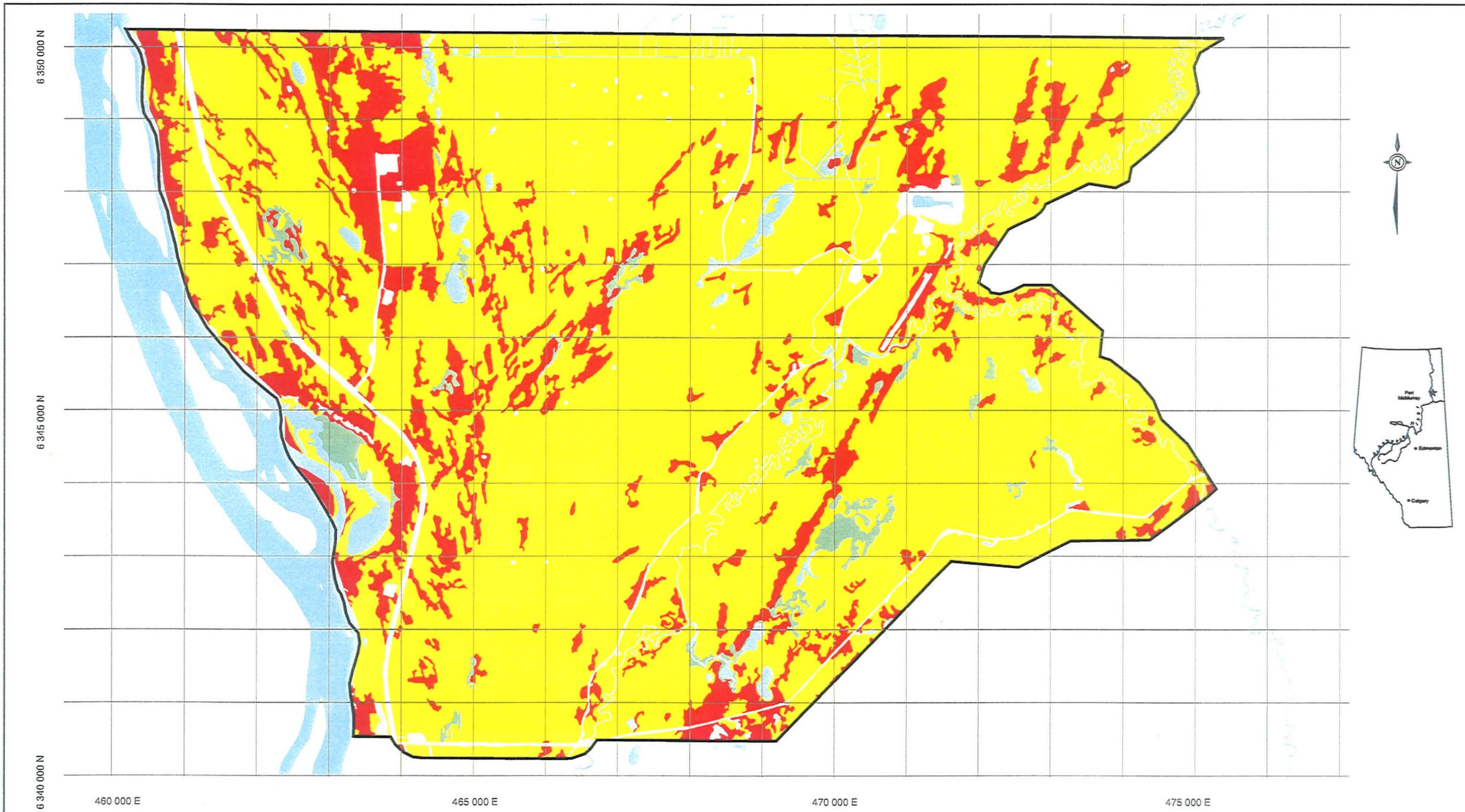
High suitability habitats for the red-backed vole included aspen (n=1), balsam poplar (3) and white spruce-dominated (1) vegetation types (Table 21, Appendix IV).

A total of 5,469 HUs were mapped for the LSA (Figure 30). 15% of the LSA was mapped as high suitability habitat, 78.4% as medium suitability habitat, 1.7% as low suitability habitat and 4.9% as unsuitable habitat.

6.1.9.2 Impact of Muskeg River Mine Project

Impacts of the Project on red-backed vole habitat (Tables 30-31) include an overall loss of 38.8% due to site clearing, 5.6% due to drawdown and 0% due to disturbance for a total loss of 44.3% of the baseline HUs (Figure 31).

Reclamation is expected to result in an overall gain of 4.1% of HUs over baseline conditions (Table 31, Figure 32).



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LEGEND

Local Terrestrial Study Area

Open water

HABITAT SUITABILITY INDEX

No Habitat

Low

Moderate

High

SOURCE: The Forestry Corp.
Golder Associates

1 0 1 2

Kilometres

MAP PROJECTION: Universal Transverse Mercator Zone 12

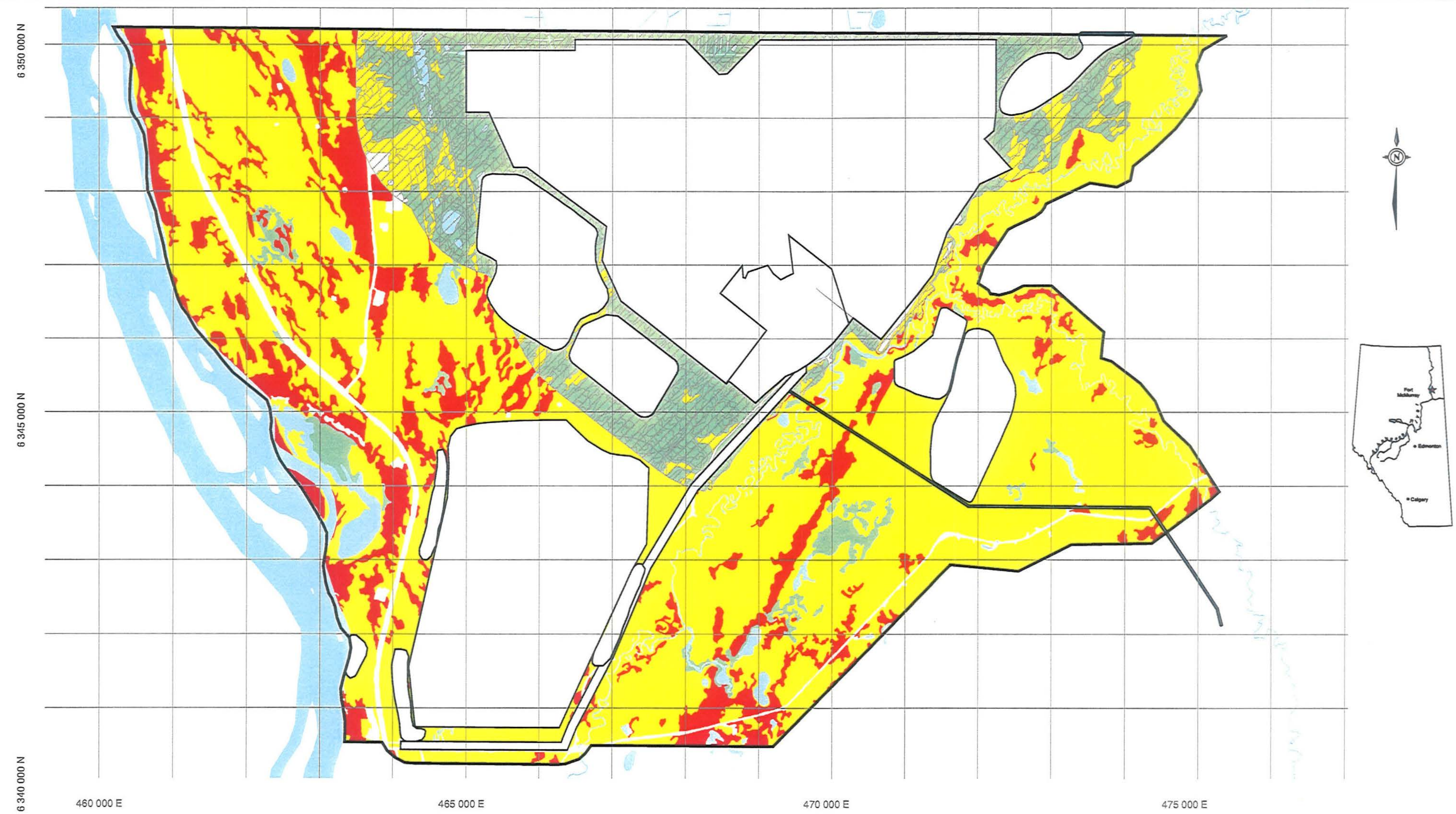
DATUM: NAD 83

Golder Associates

SHELL CANADA LIMITED

MUSKEG RIVER MINE PROJECT
RED-BACKED VOLE HABITAT SUITABILITY
BASELINE SCENARIO

29 Jan. 1998 | FIGURE 30 | PRODUCED BY: J.H. REVIEWED BY:



LEGEND

Local Terrestrial Study Area

Open water

Drawdown Area

HABITAT SUITABILITY INDEX

No Habitat

Low

Moderate

High

SOURCE: The Forestry Corp. Golder Associates

1 0 1 2

Kilometres

MAP PROJECTION: Universal Transverse Mercator Zone 12

DATUM: NAD 83

Golder Associates

SHELL CANADA LIMITED

MUSKEG RIVER MINE PROJECT
RED-BACKED VOLE HABITAT SUITABILITY
IMPACT SCENARIO

29 Jan. 1998 | Figure 31 | PRODUCED BY: J.H. REVIEWED BY:

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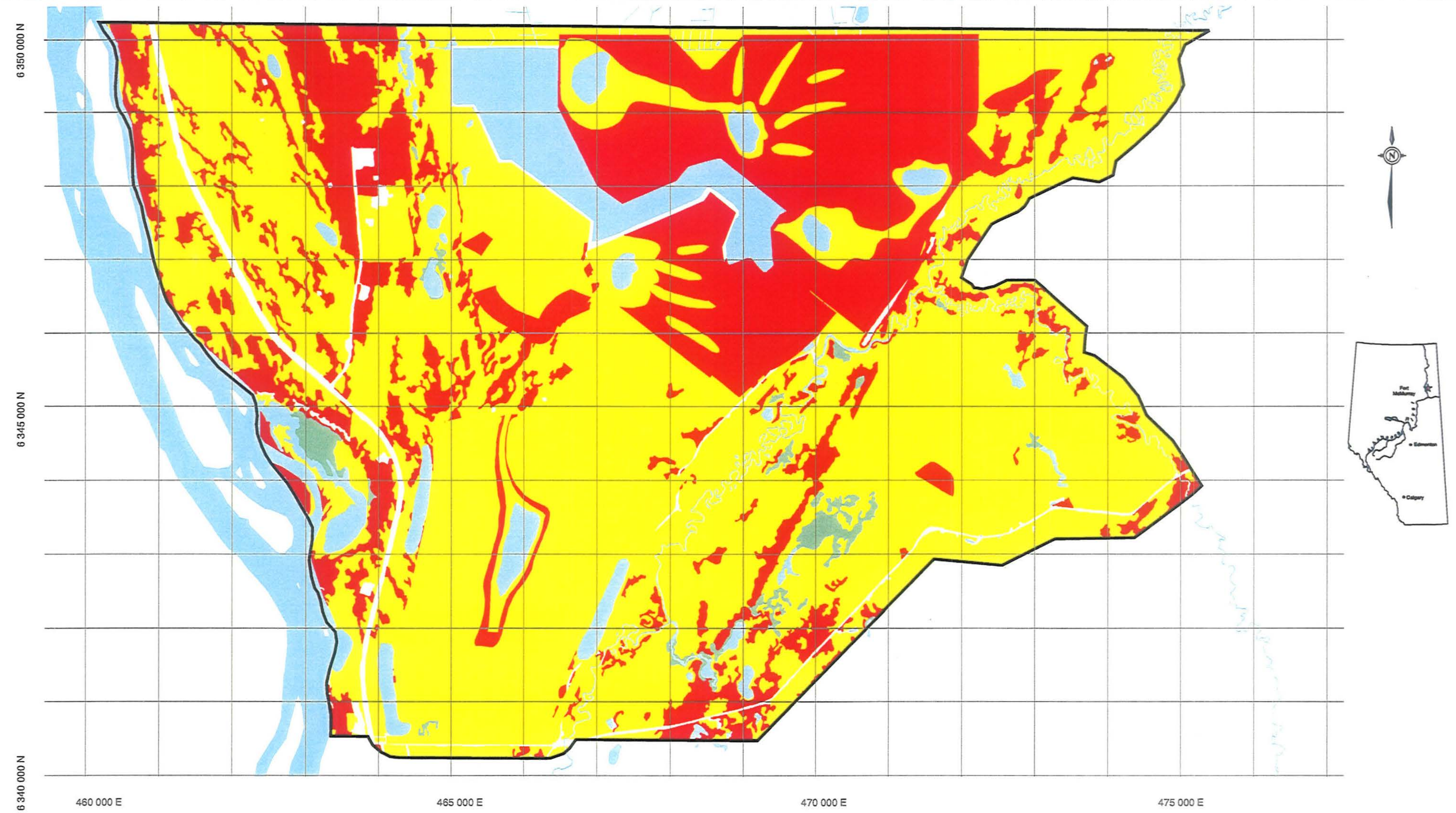

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LEGEND

Local Terrestrial Study Area

Open water

HABITAT SUITABILITY INDEX

No Habitat

Low

Moderate

High

SOURCE: The Forestry Corp.
Golder Associates

1 0 1 2
Kilometres

MAP PROJECTION: Universal Transverse Mercator Zone 12

DATUM: NAD 83

Golder Associates

SHELL CANADA LIMITED

MUSKEG RIVER MINE PROJECT
RED-BACKED VOLE HABITAT SUITABILITY
CLOSURE SCENARIO

29 Jan. 1998	Figure 32	PRODUCED BY: J.H. REVIEWED BY:

Table 30 Impact of Clearing, Drawdown, Disturbance and Reclamation on the Red-backed Vole Habitat Units Within the LSA

Species	Rating	Baseline	Development Impacts			Closure
			Clearing	Drawdown	Disturbance	
Red-backed Vole	Low	24	18	230	230	7
	Medium	4,187	2,356	2,030	2,030	3,430
	High	1,258	974	784	784	2,255
	Total	5,469	3,348	3,044	3,044	5,692

Table 31 Percent Impact of Clearing, Drawdown, Disturbance and Reclamation on the Red-backed Vole Habitat Units Within the LSA

Species	Rating	Baseline	Development Impacts				Reclamation Change From Baseline
			Clearing Change	Drawdown Change	Disturbance Change	Total Change	
Red-backed Vole	Low	24	-25.0	+883.3	0.0	+858.3	-70.8
	Medium	4,187	-43.7	-7.8	0.0	-51.5	-18.1
	High	1,258	-22.6	-15.1	0.0	-37.7	+79.3
	Total	5,469	-38.8	-5.6	0.0	-44.3	+4.1

6.1.10 Ruffed Grouse

6.1.10.1 Baseline Conditions

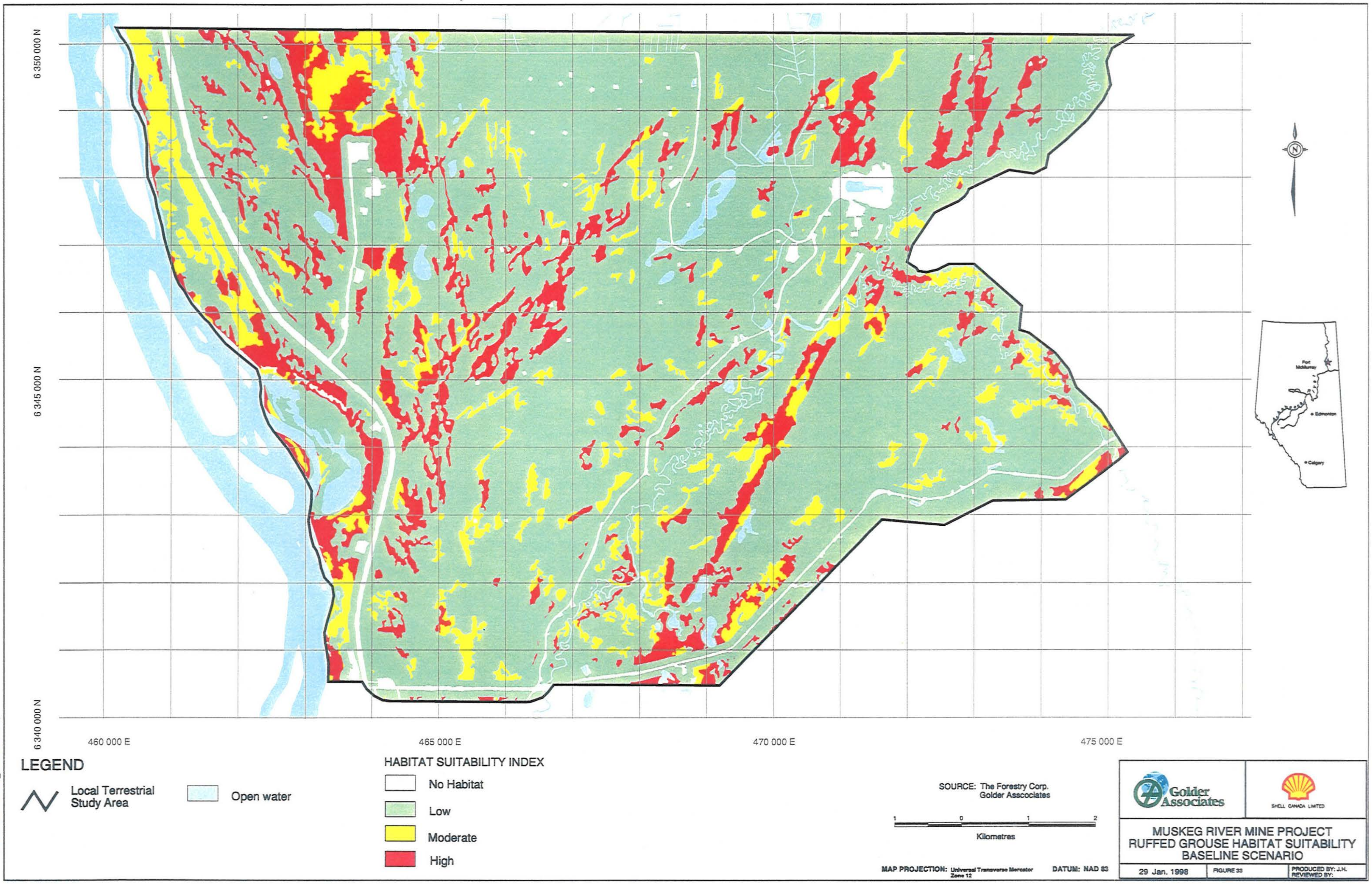
High suitability habitats for the ruffed grouse included aspen (n=1), balsam poplar (3) and mixedwood-dominated (2) vegetation types (Table 23, Appendix IV).

A total of 3,305 HUs were mapped for the LSA (Figure 33). 11.9% of the LSA was mapped as high suitability habitat, 8.2% as medium suitability habitat, 75% as low suitability habitat and 4.9% as unsuitable habitat.

6.1.10.2 Impact of Muskeg River Mine Project

Impacts of the Project on ruffed grouse habitat (Tables 32-33) include an overall loss of 28.5% due to site clearing, 6.5% due to drawdown and 9.8% due to disturbance for a total loss of 44.8% of the baseline HUs (Figure 34).

Reclamation is expected to result in an overall gain of 16.2% of HUs over baseline conditions (Table 33, Figure 35).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Fort McMurray
Edmonton
Calgary
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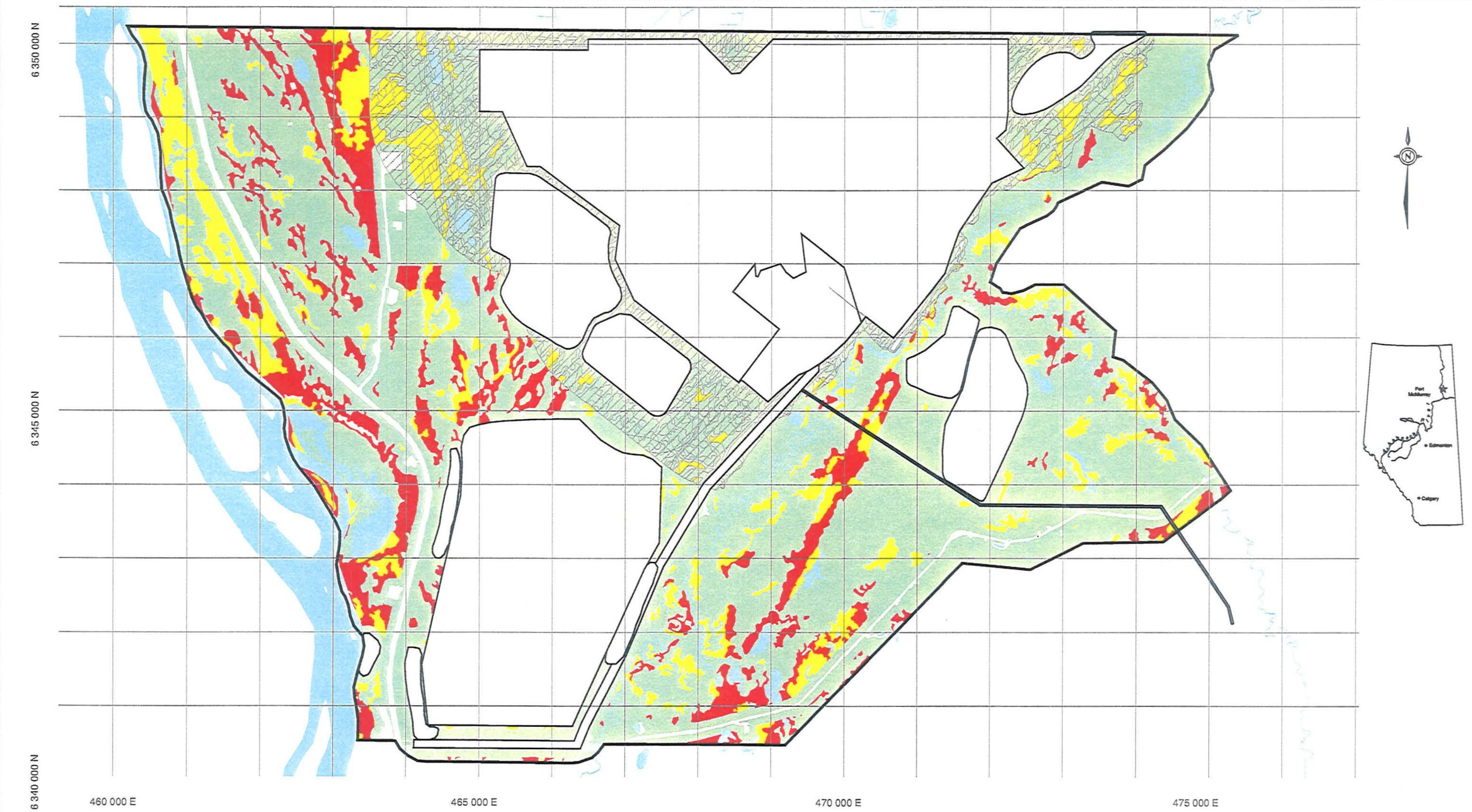
LEGEND
Local Terrestrial Study Area
Open water
HABITAT SUITABILITY INDEX
No Habitat
Low
Moderate
High
SOURCE: The Forestry Corp. Golder Associates
Kilometres
MAP PROJECTION: Universal Transverse Mercator Zone 12
DATUM: NAD 83
Golder Associates
SHELL CANADA LIMITED
MUSKEG RIVER MINE PROJECT
RUFFED GROUSE HABITAT SUITABILITY
BASELINE SCENARIO
29 Jan. 1998
FIGURE 33
PRODUCED BY: J.H.
REVIEWED BY:



/data0/oilsands/shell_hsi/local/vole.apr

LEGEND

Local Terrestrial Study Area

Open water

Drawdown Area

HABITAT SUITABILITY INDEX

No Habitat

Low

Moderate

High

SOURCE: The Forestry Corp.
Golder Associates

1 0 1 2

Kilometres

MAP PROJECTION: Universal Transverse Mercator Zone 12

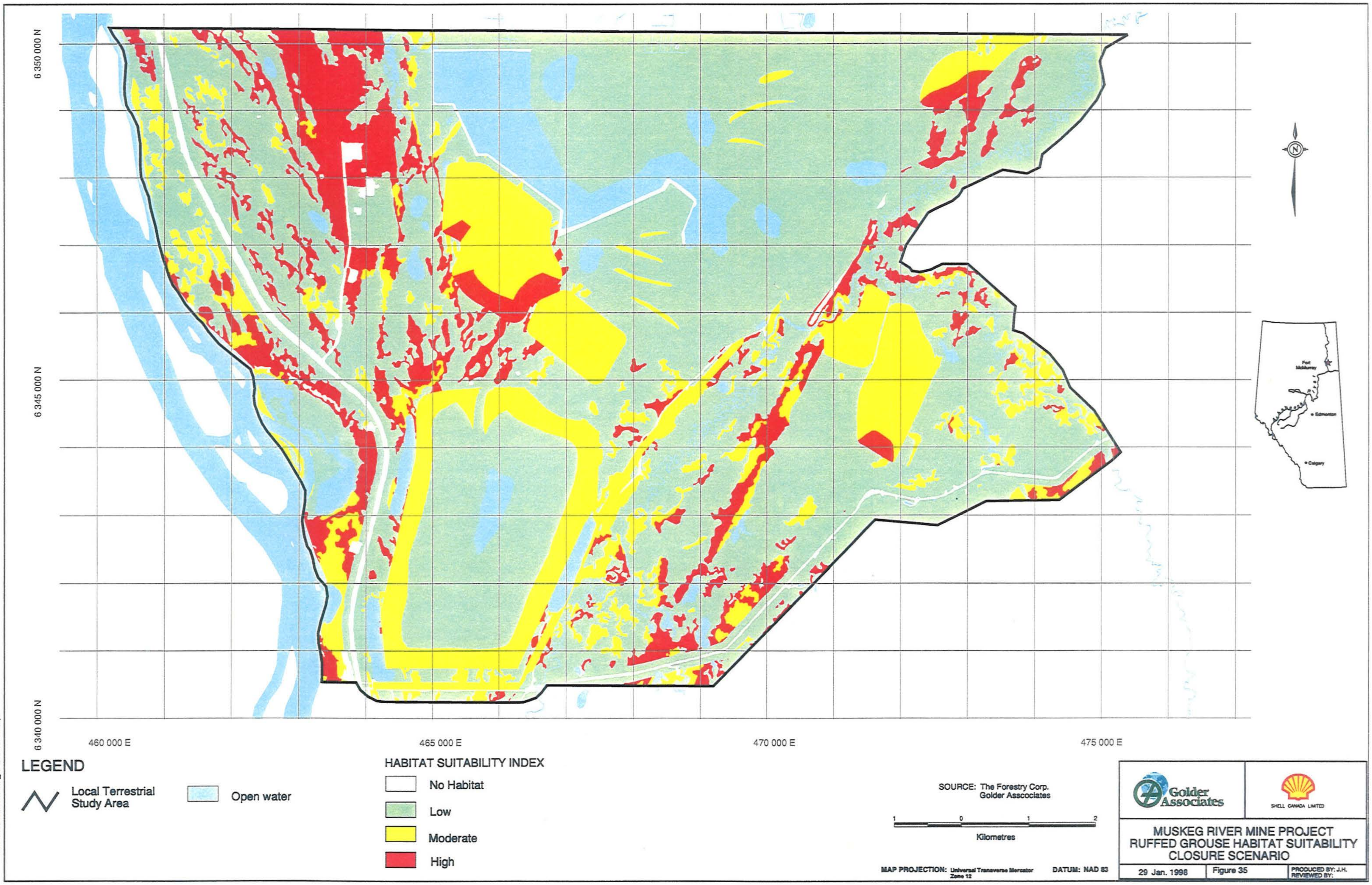
DATUM: NAD 83

Golder Associates

SHELL CANADA LIMITED

MUSKEG RIVER MINE PROJECT
RUFFED GROUSE HABITAT SUITABILITY
IMPACT SCENARIO

29 Jan. 1998	Figure 34	PRODUCED BY: J.H. REVIEWED BY:



/data9/oilsands/shell_hsi/local/vole.apr

Table 32 Impact of Clearing, Drawdown, Disturbance and Reclamation on Ruffed Grouse Habitat Units Within the LSA

Species	Rating	Baseline	Development Impacts			Closure
			Clearing	Drawdown	Disturbance	
Ruffed Grouse	Low	1,745	998	934	845	1,715
	Medium	490	419	464	359	1,155
	High	1,070	947	750	621	971
	Total	3,305	2,364	2148	1,825	3,841

Table 33 Percent Impact of Clearing, Drawdown, Disturbance and Reclamation on Ruffed Grouse Habitat Units Within the LSA

Species	Rating	Baseline	Development Impacts				Reclamation Change From Baseline
			Clearing Change	Drawdown Change	Disturbance Change	Total Change	
Ruffed Grouse	Low	1,745	-42.8	-3.7	-5.1	-51.6	-1.7
	Medium	490	-14.5	+9.2	-21.4	-26.7	+135.7
	High	1,070	-11.5	-18.4	-12.1	-42.0	-9.3
	Total	3,305	-28.5	-6.5	-9.8	-44.8	+16.2

6.1.11 Snowshoe Hare

6.1.11.1 Baseline Conditions

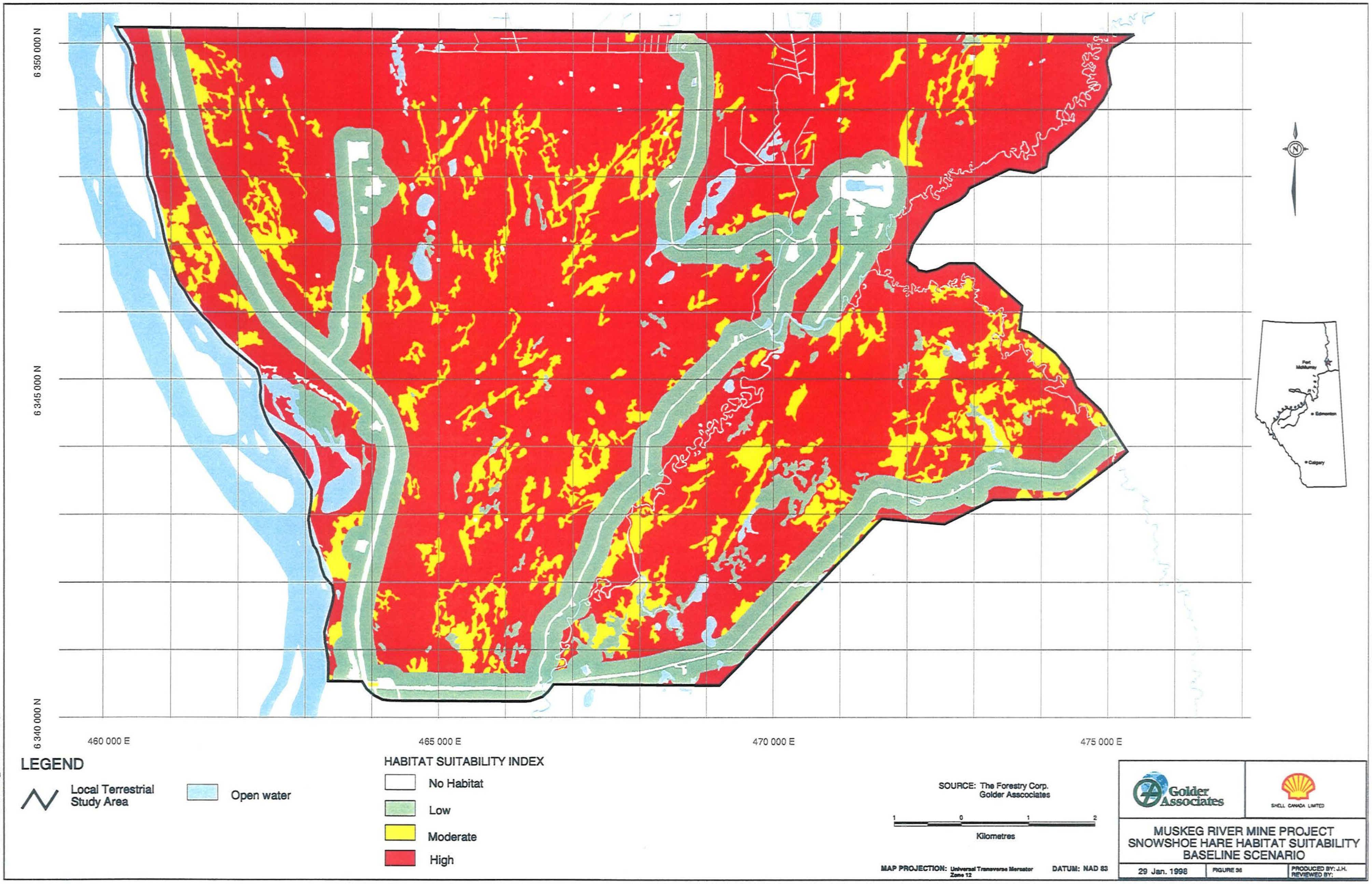
High suitability habitats for the snowshoe hare included wetland (n=24), aspen/balsam poplar (n=4), upland shrub (1), reclaimed riparian shrub (1), and white spruce-dominated (2) vegetation types (Table 25, Appendix IV).

A total of 7,319 HUs were mapped for the LSA (Figure 36). 65.5% of the LSA was mapped as high suitability habitat, 10.8% as medium suitability habitat, 18.8% as low suitability habitat and 4.9% as unsuitable habitat.

6.1.11.2 Impact of Muskeg River Mine Project

Impacts of the Project on snowshoe hare habitat (Tables 34-35) include an overall loss of 31% due to site clearing, 6.5% due to drawdown and 16% due to disturbance for a total loss of 53.5% of the baseline HUs (Figure 37).

Reclamation is expected to result in an overall loss of 0.8% of HUs over baseline conditions (Table 35, Figure 38).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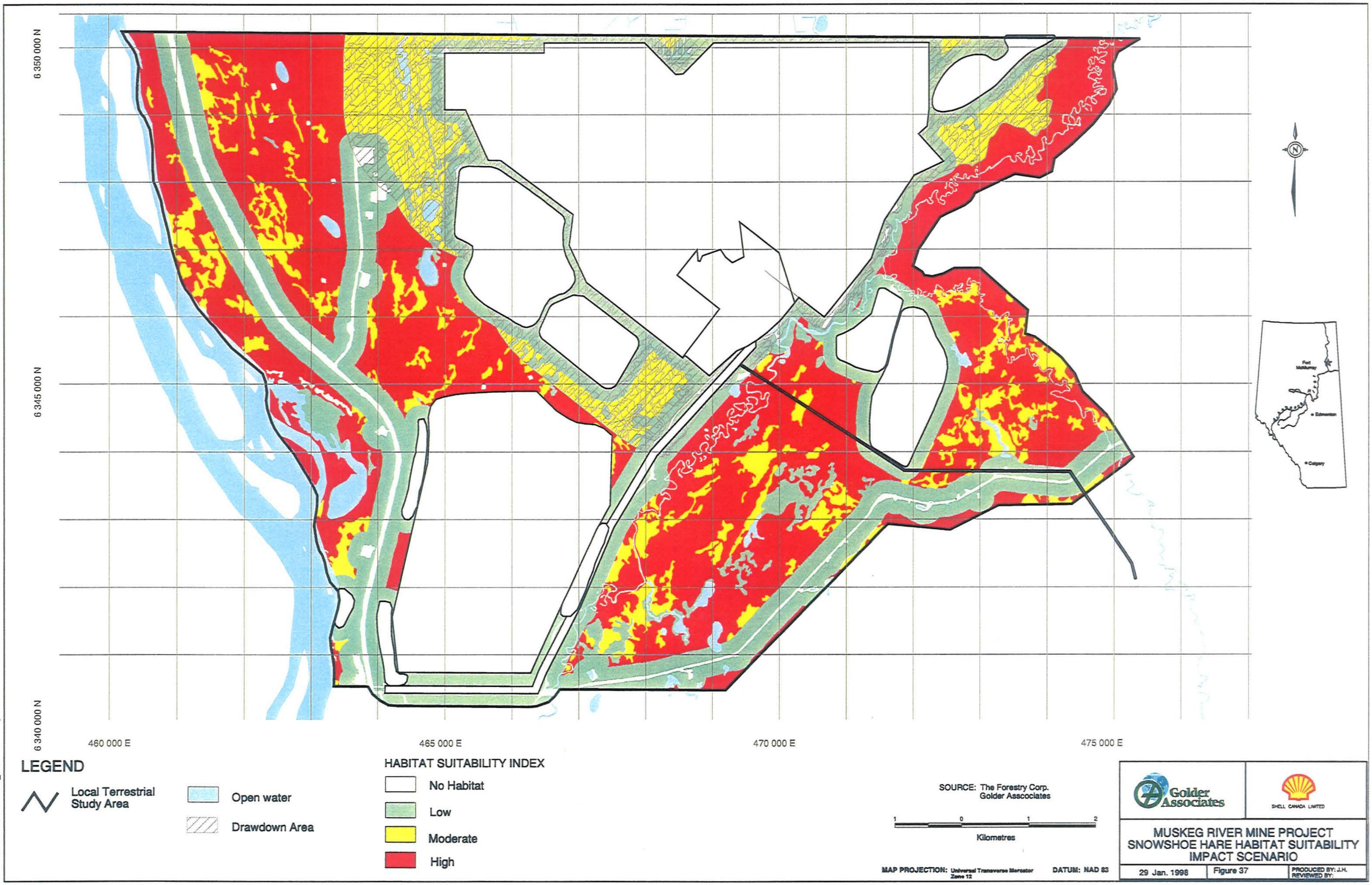
LEGEND
Local Terrestrial Study Area
Open water
HABITAT SUITABILITY INDEX
No Habitat
Low
Moderate
High
SOURCE: The Forestry Corp. Golder Associates
1 0 1 2
Kilometres
MAP PROJECTION: Universal Transverse Mercator Zone 12
DATUM: NAD 83
Golder Associates
SHELL CANADA LIMITED
MUSKEG RIVER MINE PROJECT
SNOWSHOE HARE HABITAT SUITABILITY
BASELINE SCENARIO
29 Jan. 1998
FIGURE 36
PRODUCED BY: J.H.
REVIEWED BY:



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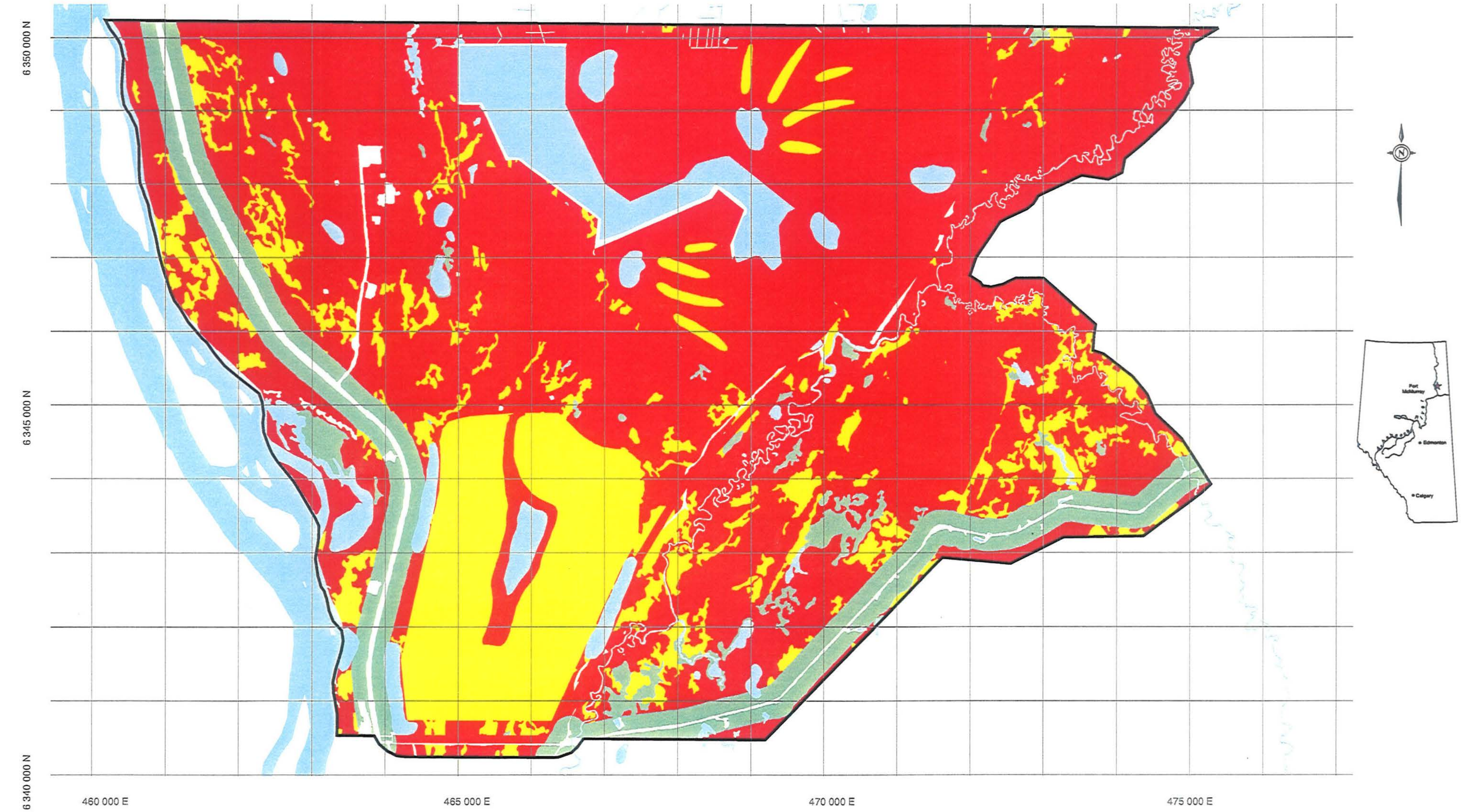

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LEGEND

- Local Terrestrial Study Area
- Open water

HABITAT SUITABILITY INDEX

- No Habitat
- Low
- Moderate
- High

SOURCE: The Forestry Corp.
Golder Associates

1 0 1 2
Kilometres

MAP PROJECTION: Universal Transverse Mercator Zone 12 DATUM: NAD 83

Golder Associates

SHELL CANADA LIMITED

MUSKEG RIVER MINE PROJECT
SNOWSHOE HARE HABITAT SUITABILITY
CLOSURE SCENARIO

29 Jan. 1998	Figure 38	PRODUCED BY: J.H. REVIEWED BY:

Table 34 Impact of Clearing, Drawdown, Disturbance and Reclamation on Snowshoe Hare Habitat Units Within the LSA

Species	Rating	Baseline	Development Impacts			Closure
			Clearing	Drawdown	Disturbance	
Snowshoe Hare	Low	323	21	45	244	177
	Medium	628	545	946	532	928
	High	6,368	4,486	3,587	2,628	6,155
	Total	7,319	5,052	4,578	3,404	7,260

Table 35 Percent Impact of Clearing, Drawdown, Disturbance and Reclamation on Snowshoe Hare Habitat Units Within the LSA

Species	Rating	Baseline	Development Impacts				Reclamation Change From Baseline
			Clearing Change	Drawdown Change	Disturbance Change	Total Change	
Snowshoe Hare	Low	323	-93.5	+7.4	+61.6	-24.5	-45.2
	Medium	628	-13.2	+63.9	-65.9	-15.3	+47.8
	High	6,368	-29.6	-14.1	-15.1	-58.7	-3.3
	Total	7,319	-31.0	-6.5	-16.0	-53.5	-0.8

6.1.12 Western Tanager

6.1.12.1 Baseline Conditions

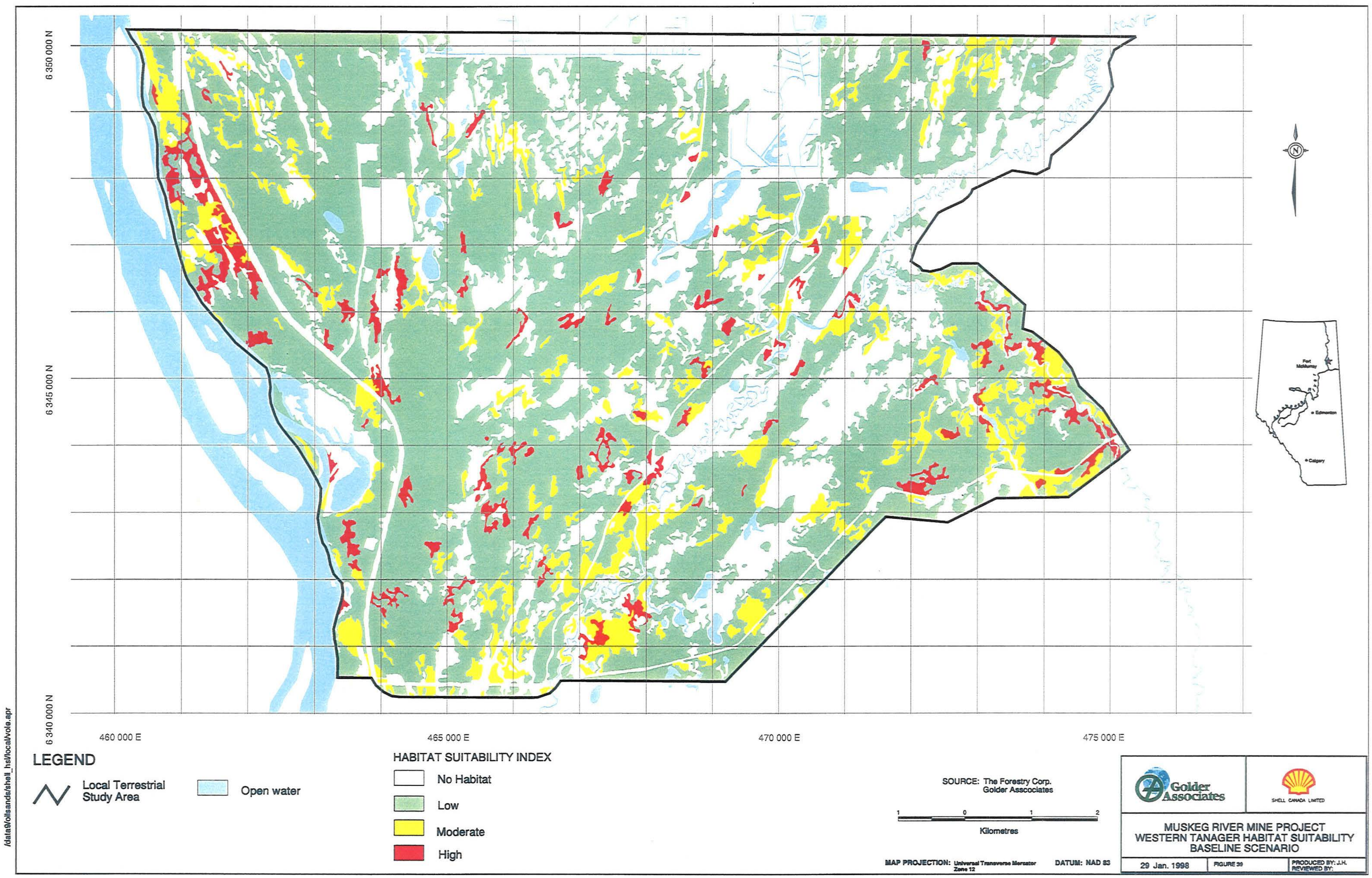
High suitability habitats for the western tanager included white spruce (n=3), jack pine (1), and mixedwood -dominated (2) vegetation types (Table 27, Appendix IV).

A total of 1,104 HUs were mapped for the LSA (Figure 39). 3.3% of the LSA was mapped as high suitability habitat, 7.8% as medium suitability habitat, 52.5% as low suitability habitat and 36.4% as unsuitable habitat.

6.1.12.2 Impact of Muskeg River Mine Project

Impacts of the Project on western tanager habitat (Tables 36-37) include an overall loss of 30.4% due to site clearing, 3.9% due to drawdown and 0% due to disturbance for a total loss of 34.3% of the baseline HUs (Figure 40).

Reclamation is expected to result in an overall gain of 189.4% of HUs over baseline conditions (Table 37, Figure 41).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Edmonton
Calgary
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LEGEND
Local Terrestrial Study Area
Open water
HABITAT SUITABILITY INDEX
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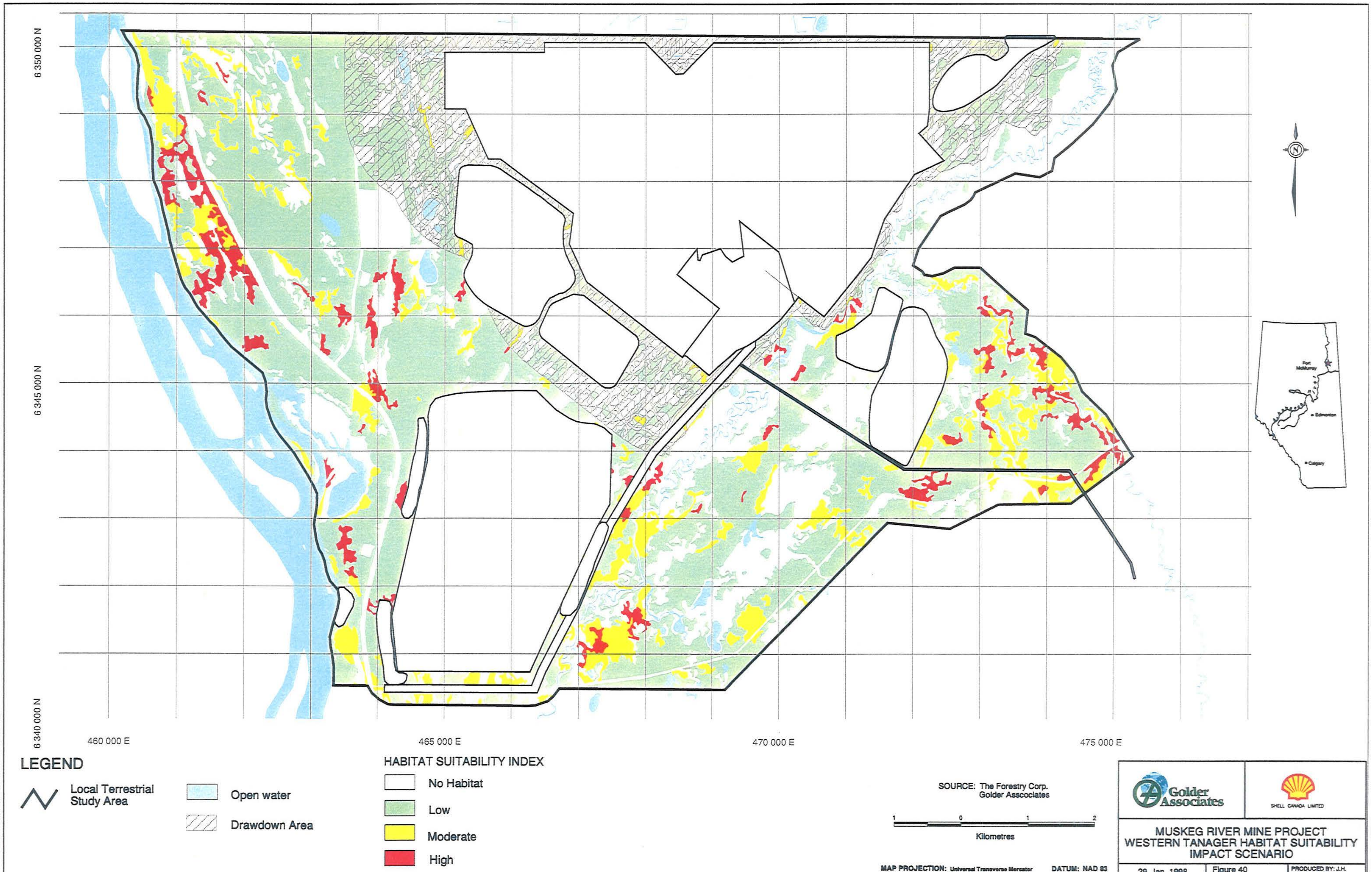
Low
Moderate
High
SOURCE: The Forestry Corp. Golder Associates
Kilometres
MAP PROJECTION: Universal Transverse Mercator Zone 12
DATUM: NAD 83
Golder Associates
SHELL CANADA LIMITED
MUSKEG RIVER MINE PROJECT
WESTERN TANAGER HABITAT SUITABILITY
BASELINE SCENARIO
29 Jan. 1998
FIGURE 30
PRODUCED BY: J.H.
REVIEWED BY: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470 000 E
475 000 E
LEGEND
Local Terrestrial Study Area
Open water
Drawdown Area
HABITAT SUITABILITY INDEX
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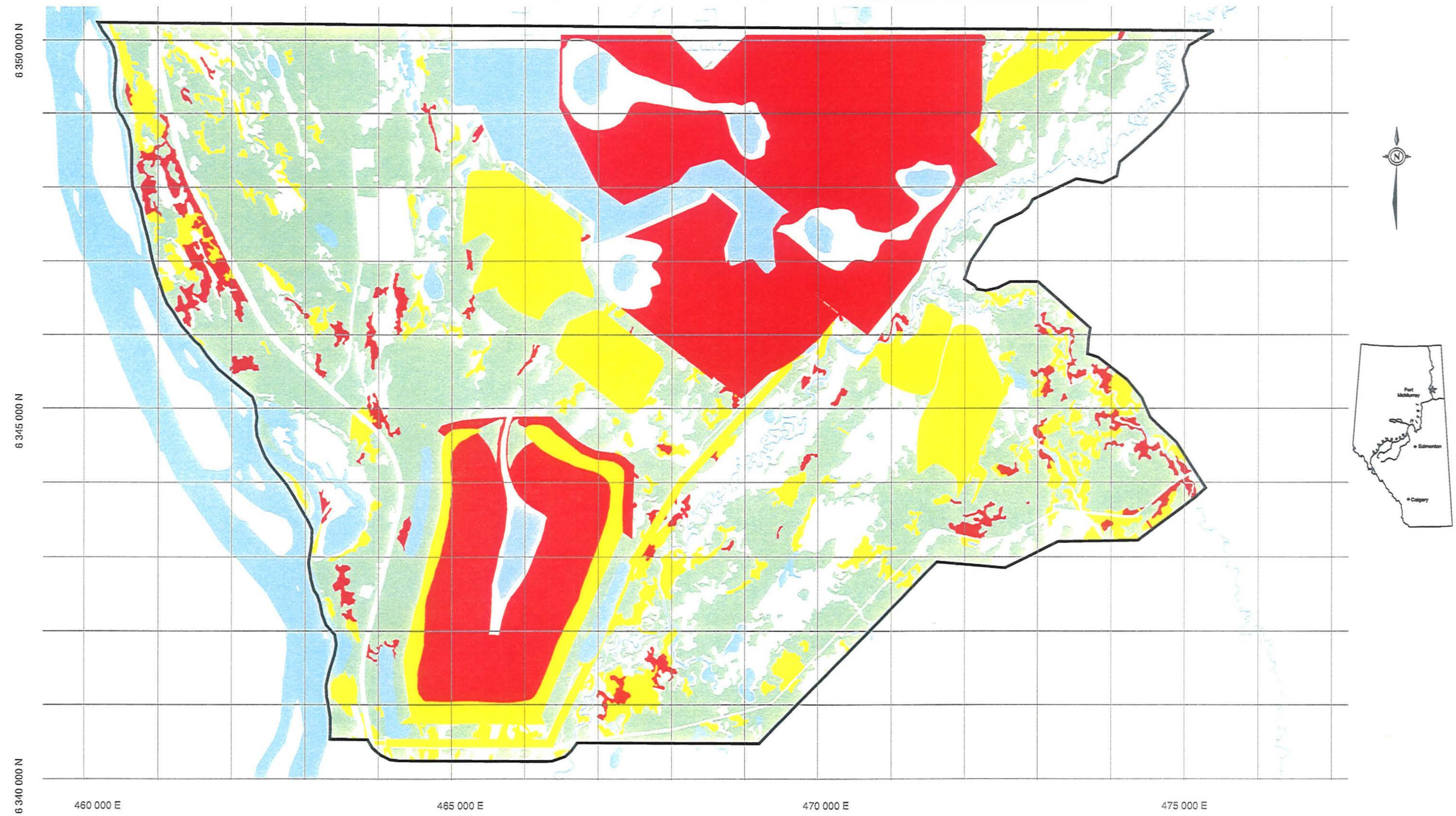
Moderate
High
SOURCE: The Forestry Corp. Golder Associates
1 0 1 2
Kilometres
MAP PROJECTION: Universal Transverse Mercator Zone 12
DATUM: NAD 83
Golder Associates
SHELL CANADA LIMITED
MUSKEG RIVER MINE PROJECT
WESTERN TANAGER HABITAT SUITABILITY
IMPACT SCENARIO
29 Jan. 1998
Figure 40
PRODUCED BY: J.H.
REVIEWED BY:
Fort McMurray
Edmonton
Calgary
/data9/oilsands/shell_hsi/local/vole.apr



/data9/oilsands/shell_hsi/local/vole.apr

LEGEND

Local Terrestrial Study Area

Open water

HABITAT SUITABILITY INDEX

No Habitat

Low

Moderate

High

SOURCE: The Forestry Corp.
Golder Associates

1 0 1 2

Kilometres

MAP PROJECTION: Universal Transverse Mercator Zone 12

DATUM: NAD 83

Golder Associates

SHELL CANADA LIMITED

MUSKEG RIVER MINE PROJECT
WESTERN TANAGER HABITAT SUITABILITY
CLOSURE SCENARIO

29 Jan. 1998	Figure 41	PRODUCED BY: J.H. REVIEWED BY:

Table 36 Impact of Clearing, Drawdown, Disturbance and Reclamation on Western Tanager Habitat Units Within the LSA

Species	Rating	Baseline	Development Impacts			Closure
			Clearing	Drawdown	Disturbance	
Western Tanager	Low	357	235	230	230	254
	Medium	417	290	267	267	724
	High	330	243	228	228	2,217
	Total	1,104	768	725	725	3,195

Table 37 Percent Impact of Clearing, Drawdown, Disturbance and Reclamation on Western Tanager Habitat Units Within the LSA

Species	Rating	Baseline	Development Impacts				Reclamation Change From Baseline
			Clearing Change	Drawdown Change	Disturbance Change	Total Change	
Western Tanager	Low	357	-34.2	-1.4	0.0	-35.6	-28.9
	Medium	417	-30.5	-5.5	0.0	-36.0	+73.6
	High	330	-26.4	-4.5	0.0	-30.9	+571.8
	Total	1,104	-30.4	-3.9	0.0	-34.3	+189.4

6.1.13 Biodiversity

6.1.13.1 Baseline Conditions

Results of the assessment of species richness per vegetation type (grouped into broad forest types) are provided in Appendix V and are summarized in Table 38.

Table 38 Number Of Species Per Forest Type

Group	Name	Mammal	Bird	Reptile/ Amphibian
A	Open Water	8	63	0
B	Jack Pine Forest	21	48	2
C	Mixedwood Forest	27	81	2
D	Black and White Spruce Forest	25	57	2
E	Aspen (Poplar) Forest	20	67	2
F	Graminoid/Shrubby Fen	16	70	4
G	Riparian	18	97	4
H	Marsh	10	78	4
I	Wooded Fen/Bog	28	112	4
J	Birch	20	67	2
K	Disturbed Areas	0	0	0

The relative richness of species per forest type (Table 39) indicates that wooded fens and bogs (1.0), mixedwood forests (0.96) and spruce forests (0.89) had the highest richness indices for mammals. For birds, the highest richness values were for wooded fens and bogs (1.0), riparian areas (0.87) and mixedwood forests (0.72). For reptiles and amphibians, the highest richness values were for graminoid/shrubby fens (1.0), riparian areas (1.0), marshes (1.0) and wooded fens and bogs (1.0).

The area of each forest type within the LSA is provided in Table 40, while the change in number and percent of biodiversity HUs due to construction and then reclamation and closure of the Project are shown in Tables 41 and 42, respectively. A total of 7,516 mammal, 7,293 bird and 8,531 reptile/amphibian biodiversity HUs were calculated for the LSA (Table 39). Of these, some 39.5% of the mammal, 40.4% of the bird and 42.1% of the reptile/amphibian richness HUs are projected to be lost due to development. Eventual reclamation is projected to result in a 5.7% gain of mammal richness HUs, a 5.5% loss of bird richness HUs and a 17.2% loss of reptile/amphibian richness HUs (Table 42).

Table 39 Relative Richness Index Values by Forest Type

Group	Name	Mammal	Bird	Reptile/ Amphibian
A	Open Water	0.29	0.56	0.00
B	Jack Pine Forest	0.75	0.43	0.50
C	Mixedwood Forest	0.96	0.72	0.50
D	Black and White Spruce Forest	0.89	0.51	0.50
E	Aspen (Poplar) Forest	0.71	0.60	0.50
F	Graminoid/Shrubby Fen	0.57	0.63	1.00
G	Riparian	0.64	0.87	1.00
H	Marsh	0.36	0.70	1.00
I	Wooded Fen/Bog	1.00	1.00	1.00
J	Birch	0.71	0.60	0.50
K	Disturbed Areas	0.00	0.00	0.00

Table 40 Areas In Hectares Associated With Each Forest Type

Group	Habitat Type	Baseline	Impact	Reclaimed
A	Open Water	178	140	676
B	Jack Pine Forest	1,025	634	852
C	Mixedwood Forest	249	198	999
D	Black and White Spruce Forest	599	442	2,588
E	Aspen (Poplar) Forest	1,652	1,284	1,482
F	Graminoid/Shrubby Fen	3,369	1,747	1,764
G	Riparian	1,478	935	1,243
H	Marsh	85	81	200
I	Wooded Fen/Bog	1,836	899	899
K	Disturbed Areas	483	4,594	251
	Total	10,954	10,954	10,954

Table 41 Changes in Richness Habitat Units From Baseline in the LSA

Group	Habitat Type	Mammal Diversity Units			Bird Diversity Units			Reptile/Amphibian Diversity Units		
		Baseline	Impact	Closure	Baseline	Impact	Closure	Baseline	Impact	Closure
A	Open Water	51	40	193	100	79	380	0	0	0
B	Jack Pine Forest	769	476	639	439	272	365	513	317	426
C	Mixedwood Forest	240	191	963	180	143	722	125	99	500
D	Black and White Spruce Forest	535	395	2,311	305	225	1,317	300	221	1,294
E	Aspen (Poplar) Forest	1,80	917	1,059	988	768	887	826	642	741
F	Graminoid/Shrubby Fen	1,925	998	1,008	2,106	1,092	1,103	3,369	1747	1,764
G	Riparian	950	601	799	1,280	810	1077	1,478	935	1,243
H	Marsh	30	29	71	59	56	139	85	81	200
I	Wooded Fen/Bog	1,836	899	899	1,836	899	899	1,836	899	899
K	Disturbed Areas	0	0	0	0	0	0	0	0	0
	Total	**7,516**	**4,546**	**7,942**	**7,293**	**4344**	**6,889**	**8,531**	**4,941**	**7,067**

Table 42 Percent Changes in Diversity Habitat Units From Baseline in the LSA

Group	Habitat Type	Mammal Diversity Units			Bird Diversity Units			Reptile/Amphibian Diversity Units		
		Baseline	Impact	Closure	Baseline	Impact	Closure	Baseline	Impact	Closure
A	Open Water	51	-21.3	+279.8	100	-21.3	+279.8	0	0.0	0.0
B	Jack Pine Forest	769	-38.1	-16.9	439	-38.1	-16.9	513	-38.1	-16.9
C	Mixedwood Forest	240	-20.5	+301.2	180	-20.5	+301.2	125	-20.5	+301.2
D	Black and White Spruce Forest	535	-26.2	+332.1	305	-26.2	+332.1	300	-26.2	+332.1
E	Aspen (Poplar) Forest	1,180	-22.3	-10.3	988	-22.3	-10.3	826	-22.3	-10.3
F	Graminoid/Shrubby Fen	1,925	-48.1	-47.6	2,106	-48.1	-47.6	3,369	-48.1	-47.6
G	Riparian	950	-36.7	-15.9	1,280	-36.7	-15.9	1,478	-36.7	-15.9
H	Marsh	30	-4.7	+135.3	59	-4.7	+135.3	85	-4.7	+135.3
I	Wooded Fen/Bog	1,836	-51.0	-51.0	1,836	-51.0	-51.0	1,836	-51.0	-51.0
K	Disturbed Areas	0	0.0	0.0	0	0.0	0.0	0	0.0	0.0
	Total	**7,516**	**-39.5**	**+5.7**	**7,293**	**-40.4**	**-5.5**	**8,531**	**-42.1**	**-17.2**

6.2 REGIONAL ANALYSES

6.2.1 Beaver

6.2.1.1 Baseline Conditions

A total of 105,498 HUs were calculated to be available to beavers within the RSA (Table 43, Figure 42). Of these, 10.5% represent high suitability habitat, 1.3% represent moderate suitability habitat, 0% represent low suitability habitat and 88.2% represent unsuitable habitat.

Table 43 Percentage of Beaver Habitat Units and Habitat Areas Among Unsuitable, Low, Medium and High Classes in the RSA for each Development Scenario

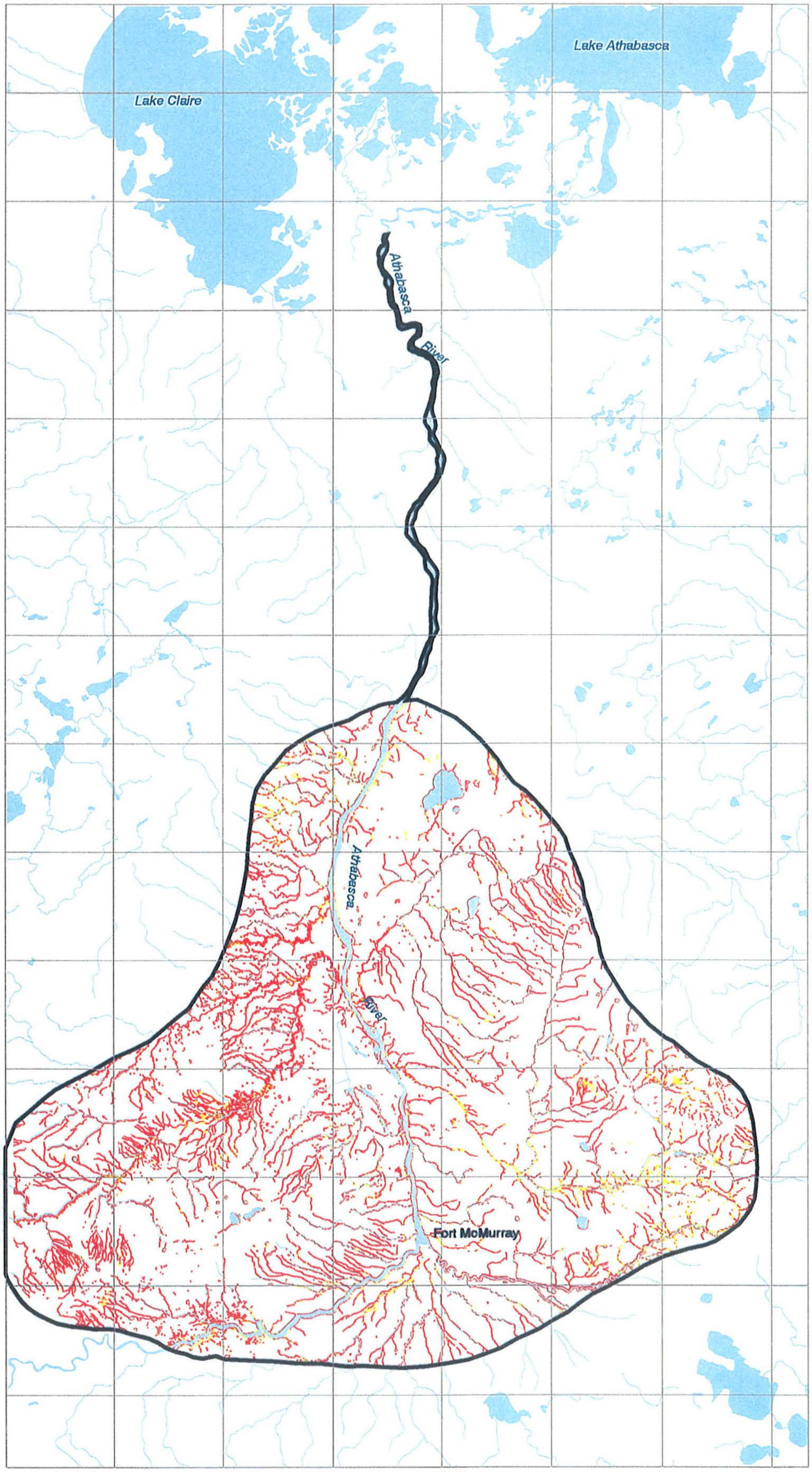
Species	Scenario	HUs	Percent of HUs			Percent of Area			
			Low	Medium	High	Unsuit-able	Low	Medium	High
Beaver	Baseline	105408	0.0	4.6	95.4	88.2	0.0	1.3	10.5
	Scenario 1	105325	0.0	4.7	95.3	88.2	0.0	1.3	10.5
	Scenario 2	103833	0.0	4.7	95.3	88.3	0.0	1.3	10.4
	Scenario 3	102891	0.0	4.7	95.3	88.4	0.0	1.3	10.3

6.2.1.2 Development Scenarios

Impacts related to the Muskeg River Mine (Scenario 1: Tables 44-45, Figure 43) are predicted to decrease 0.1% of the total beaver HUs within the RSA. Scenario 2 (CEA) (Figure 44) is expected to result in the loss of 1.5% of the total HUs within the RSA while Scenario 3 (RDR) (Figure 45) is projecting the loss of 2.4% of the total HUs. All three development scenarios are considered to have a low impact magnitude on habitat loss for the region.

Table 44 Impact of Development Scenarios on Beaver Habitat Units Within the RSA

Species	Rating	Baseline	Scenario 1	Scenario 2	Scenario 3
Beaver	Low	0	0	0	0
	Medium	4901	4,899	4,873	4,807
	High	100,508	100,426	98,959	98,083
	Total	105,408	105,325	103,833	102,891



LEGEND

Regional Study Boundary

Disturbance Effect Boundary

Hydrology

Habitat Suitability Index

Unknown

Low

Moderate

High

5 0 5 10 15 20 25

Kilometres

SOURCE: Golder Associates Ltd., Petro-Canada, RADARSAT International, Suncor, Syncrude

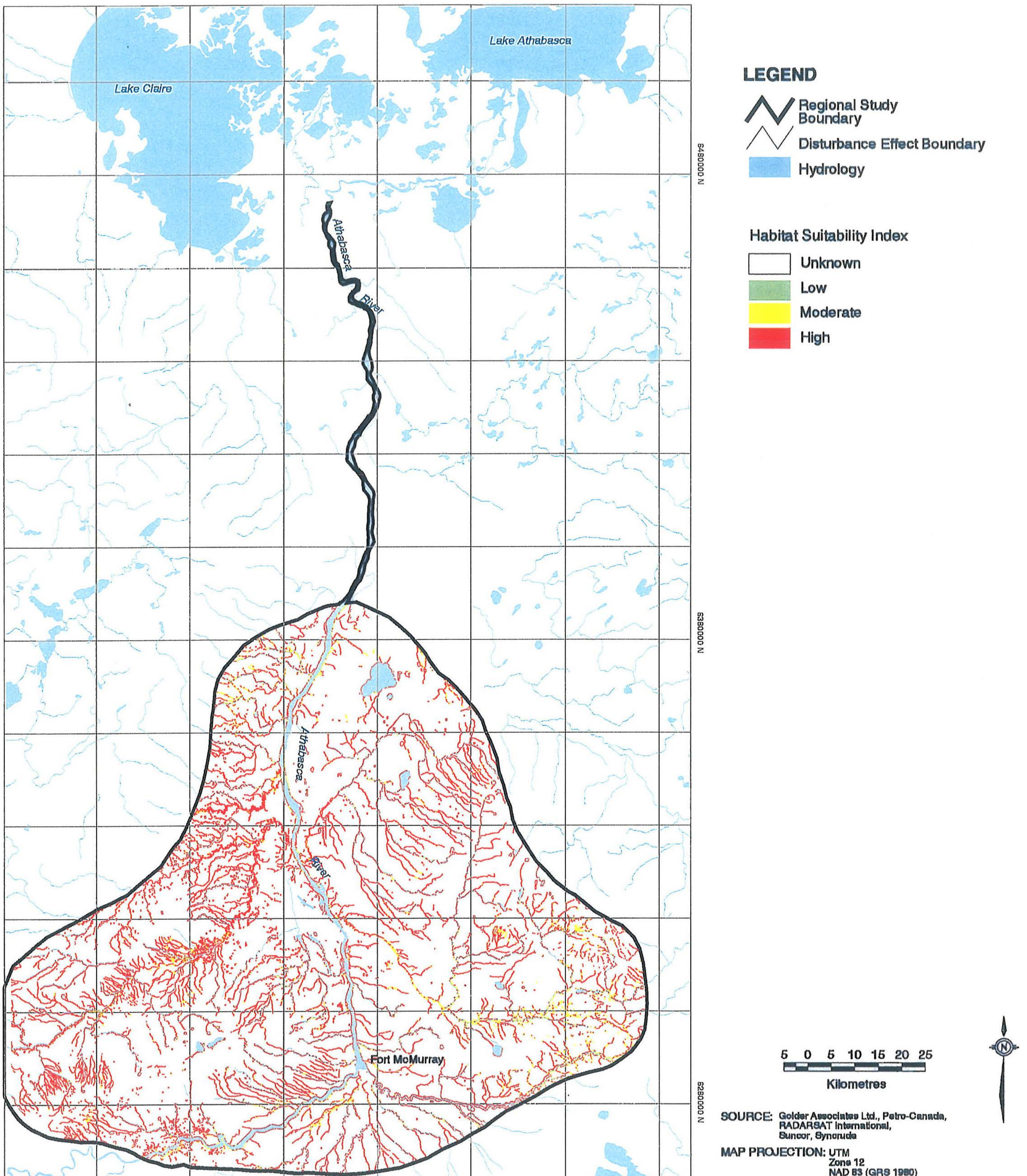
MAP PROJECTION: UTM
Zone 12
NAD 83 (GRS 1980)

Golder Associates

SHELL CANADA LIMITED

REGIONAL STUDY AREA
BEAVER HABITAT SUITABILITY
BASELINE SCENARIO

6 Feb. 1998	Figure 42	PRODUCED BY: J.H. REVIEWED BY:



Golder Associates

SHELL CANADA LIMITED

REGIONAL STUDY AREA
BEAVER HABITAT SUITABILITY
IMPACT SCENARIO 1

6 Feb. 1998	Figure 43	PRODUCED BY: J.H. REVIEWED BY:

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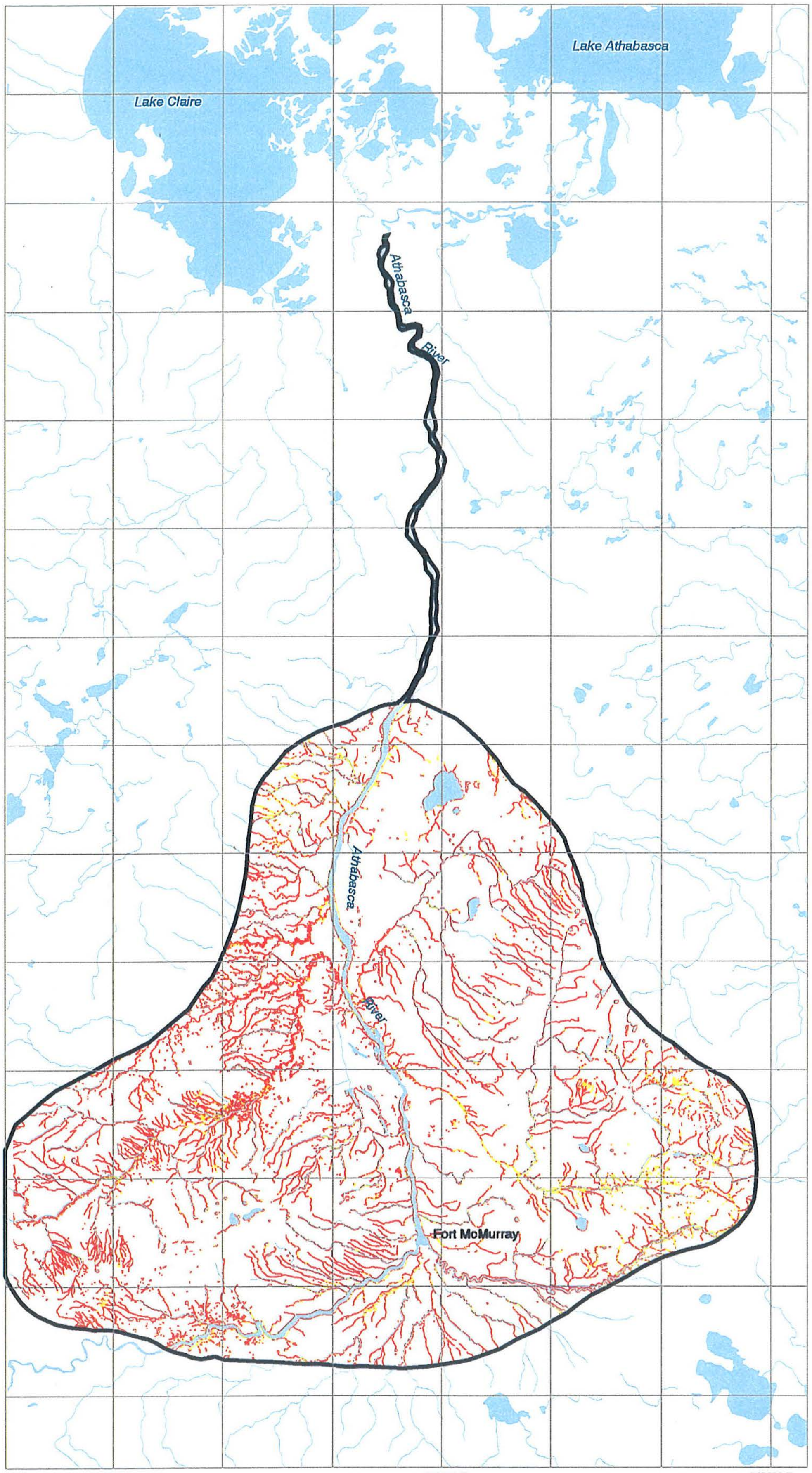

LEGEND

- Regional Study Boundary
- Disturbance Effect Boundary
- Hydrology

Habitat Suitability Index

- Unknown
- Low
- Moderate
- High

5 0 5 10 15 20 25
Kilometres

SOURCE: Golder Associates Ltd., Petro-Canada, RADARSAT International, Suncor, Syncrude

MAP PROJECTION: UTM Zone 12 NAD 83 (GRS 1980)

Golder Associates | SHELL CANADA LIMITED

REGIONAL STUDY AREA BEAVER HABITAT SUITABILITY IMPACT SCENARIO 2

6 Feb. 1998	Figure 44	PRODUCED BY: J.H. REVIEWED BY:

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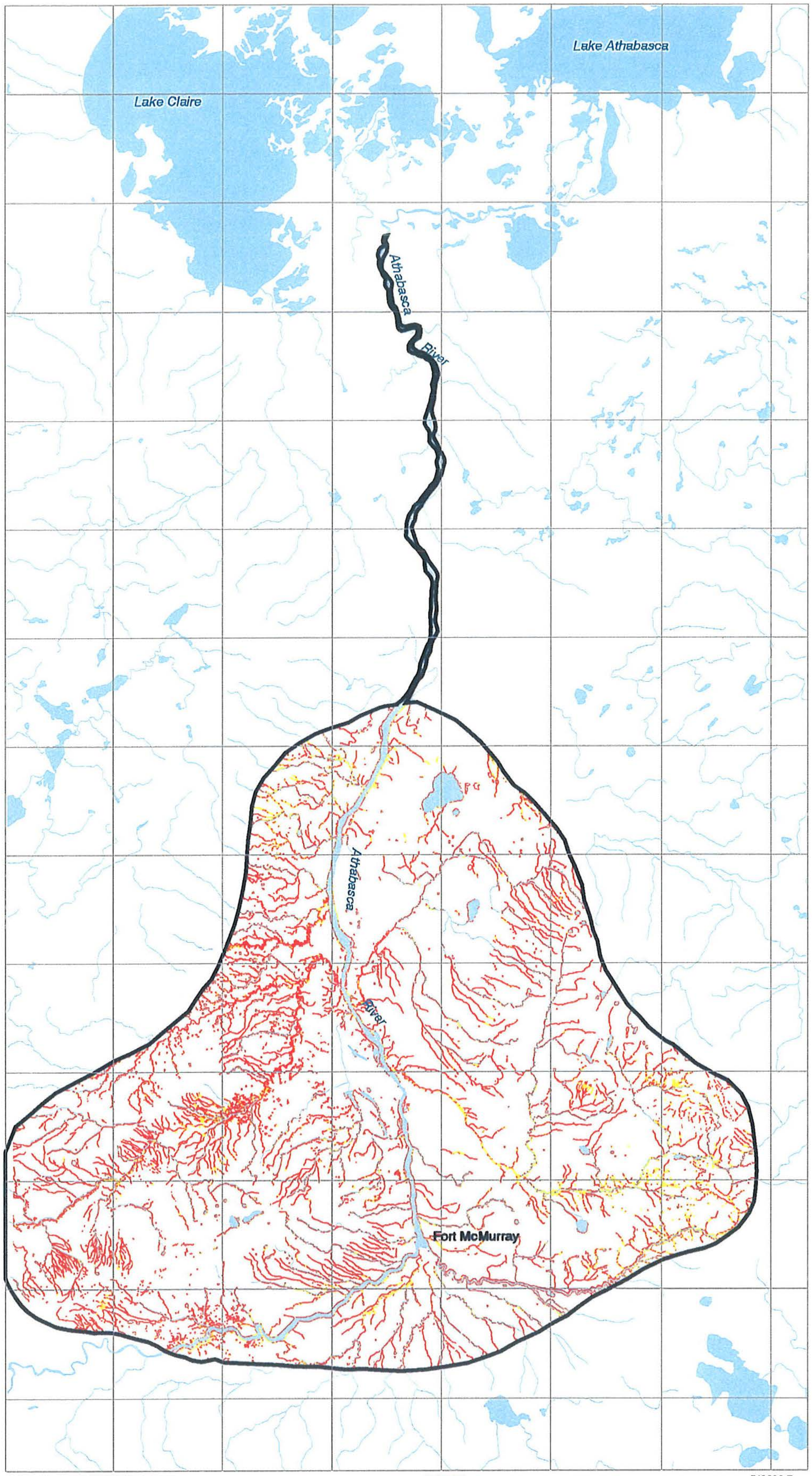


LEGEND

- Regional Study Boundary
- Disturbance Effect Boundary
- Hydrology

Habitat Suitability Index

- Unknown
- Low
- Moderate
- High

5 0 5 10 15 20 25

Kilometres

SOURCE: Golder Associates Ltd., Petro-Canada, RADARSAT International, Suncor, Syncrude

MAP PROJECTION: UTM
Zone 12
NAD 83 (GRS 1980)

Golder Associates

SHELL CANADA LIMITED

REGIONAL STUDY AREA BEAVER HABITAT SUITABILITY IMPACT SCENARIO 3

6 Feb. 1998	Figure 45	PRODUCED BY: J.H. REVIEWED BY:

Table 45 Percent Impact of Development Scenarios on Beaver Habitat Units Within the RSA

Species	Rating	Baseline	Scenario 1	Scenario 2	Scenario 3
Beaver	Low	0	0.0	0.0	0.0
	Medium	4901	-0.0	-0.6	-1.9
	High	100,508	-0.1	-1.5	-2.4
	Total	105,408	-0.1	-1.5	-2.4

6.2.1.3 Incremental Impacts of the Muskeg River Mine Project

Impacts of the Muskeg River Mine Project on beaver habitat represent 5.3% of the habitat loss due to Scenario 2 and 3.3% of the losses associated with Scenario 3 (Table 46).

Table 46 Cumulative Assessment of Beaver Habitat Losses Associated With the Muskeg River Mine Project (MRM) in Scenario 2 (CEA) and Scenario 3 (RDR)

Scenario	Baseline HUs	Scenario HUs	HUs Loss Including MRM	HUs Loss due to MRM (% of Scenario Loss)	HUs Loss Excluding MRM	HUs Loss Excluding MRM (% of Baseline)	HUs Loss Including MRM (% of Baseline)
1: MRM	105,408	105,325	83				
2: CEA	105,408	103,833	1,576	5.3	1,493	1.4	1.5
3: RDR	105,408	102,891	2,517	3.3	2,435	2.3	2.4

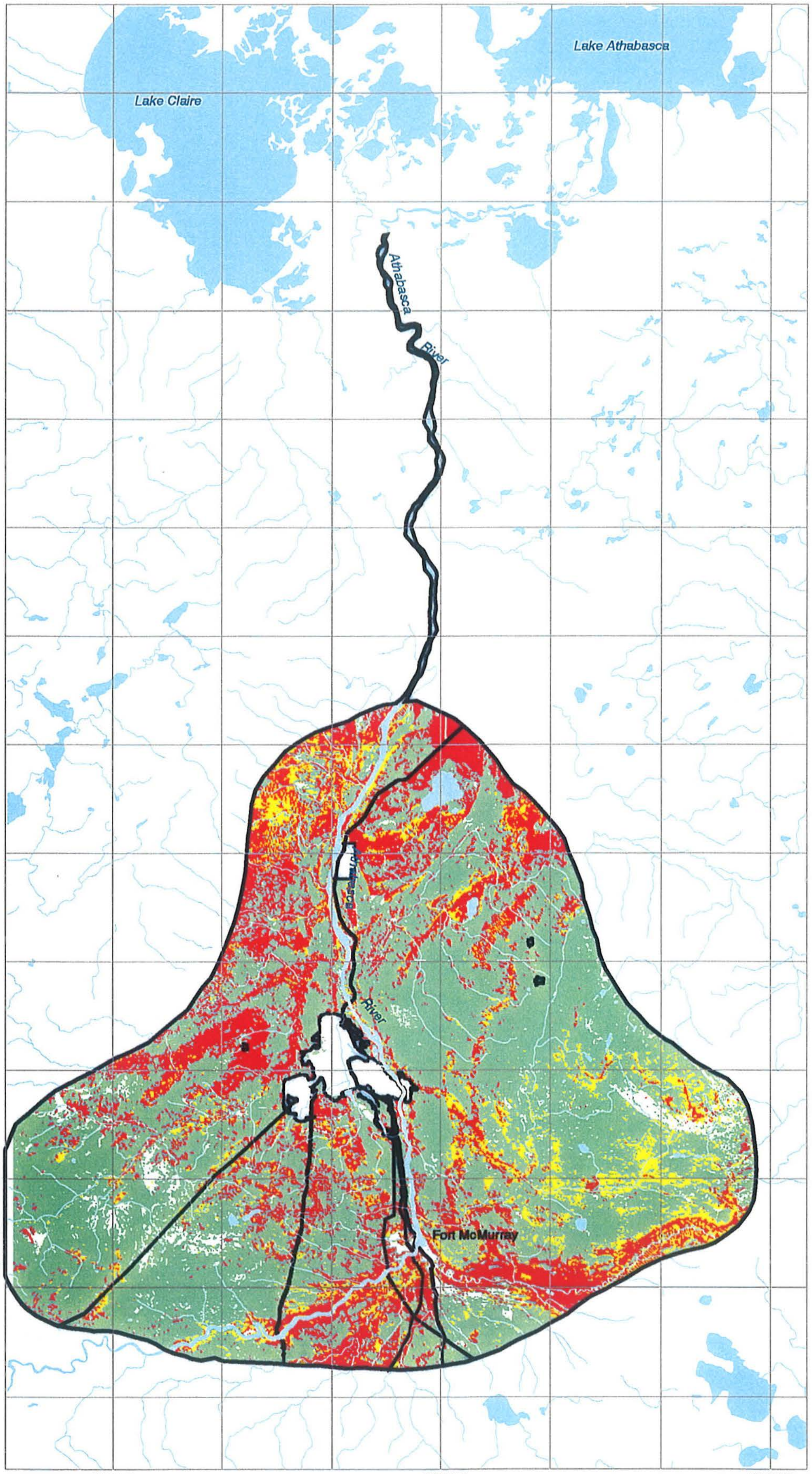
6.2.2 Black Bear

6.2.2.1 Baseline Conditions

A total of 362,016 HUs were calculated to be available to black bears within the RSA (Table 47, Figure 46). Of these, 21.8% represent high suitability habitat, 7.7% represent moderate suitability habitat, 61.9% represent low suitability habitat and 8.7% represent unsuitable habitat.

Table 47 Percentage of Black Bear Habitat Units and Habitat Areas Among Unsuitable, Low, Medium and High Classes in the RSA for Each Development Scenario

Species	Scenario	HUs	Percent of HUs			Percent of Area			
			Low	Medium	High	Unsuit-able	Low	Medium	High
Black Bear	Baseline	362,016	39.1	11.2	49.7	8.7	61.9	7.7	21.8
	Scenario 1	360,427	39.1	11.2	49.7	9.1	61.6	7.6	21.7
	Scenario 2	353,651	39.0	11.2	49.8	10.9	60.2	7.5	21.3
	Scenario 3	344,799	39.2	11.3	49.5	12.8	59.2	7.4	20.7



LEGEND

- Regional Study Boundary
- Disturbance Effect Boundary
- Hydrology

Habitat Suitability Index

- Unknown
- Low
- Moderate
- High

5 0 5 10 15 20 25

Kilometres

SOURCE: Golder Associates Ltd., Petro-Canada, RADARSAT International, Suncor, Syncrude

MAP PROJECTION: UTM Zone 12 NAD 83 (GRS 1980)

Golder Associates

SHELL CANADA LIMITED

REGIONAL STUDY AREA
BLACK BEAR HABITAT SUITABILITY
BASELINE SCENARIO

6 Feb. 1998	Figure 46	PRODUCED BY: J.H. REVIEWED BY:

6.2.2.2 Development Scenarios

Impacts related to the Muskeg River Mine (Scenario 1: Tables 48-49; Figure 47) are predicted to decrease 0.4% of the total black bear HUs within the RSA. Scenario 2 (CEA) (Figure 48) is expected to result in the loss of 2.3% of the total HUs within the RSA while Scenario 3 (RDR) (Figure 49) is projecting the loss of 4.8% of the total HUs. All three development scenarios are considered to have a low impact magnitude on habitat loss for the region.

Table 48 Impact of Development Scenarios on Black Bear Habitat Units Within the RSA

Species	Rating	Baseline	Scenario 1	Scenario 2	Scenario 3
Black Bear	Low	141,703	140,890	137,764	135,121
	Medium	40,437	40,363	39,711	38,915
	High	179,876	179,174	176,177	170,764
	Total	362,016	360,427	353,651	344,799

Table 49 Percent Impact of Development Scenarios on Black Bear Habitat Units within the RSA

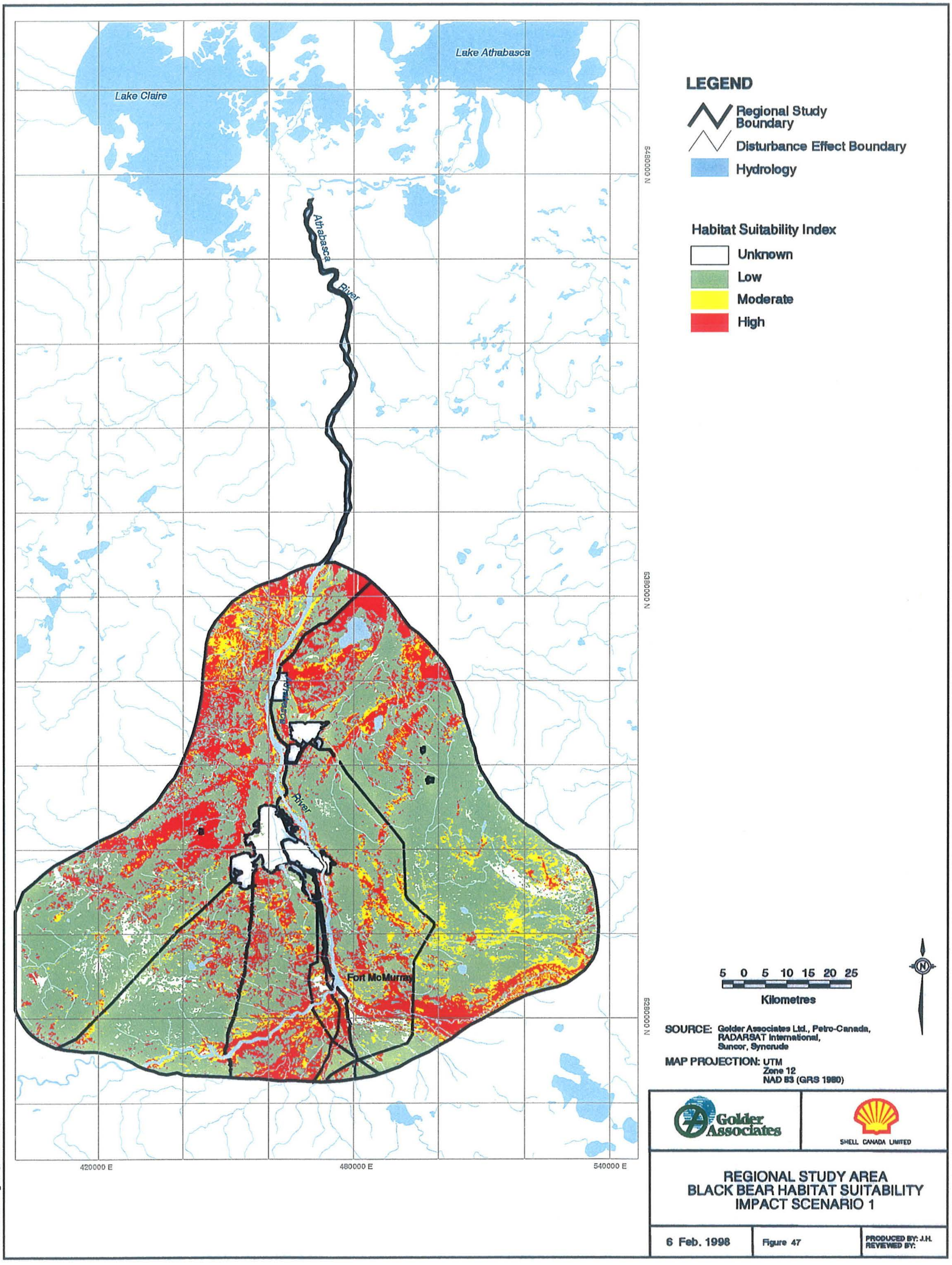
Species	Rating	Baseline	Scenario 1	Scenario 2	Scenario 3
Black Bear	Low	141,703	0.6	2.8	4.6
	Medium	40,437	0.2	1.8	3.8
	High	179,876	0.4	2.1	5.1
	Total	362,016	0.4	2.3	4.8

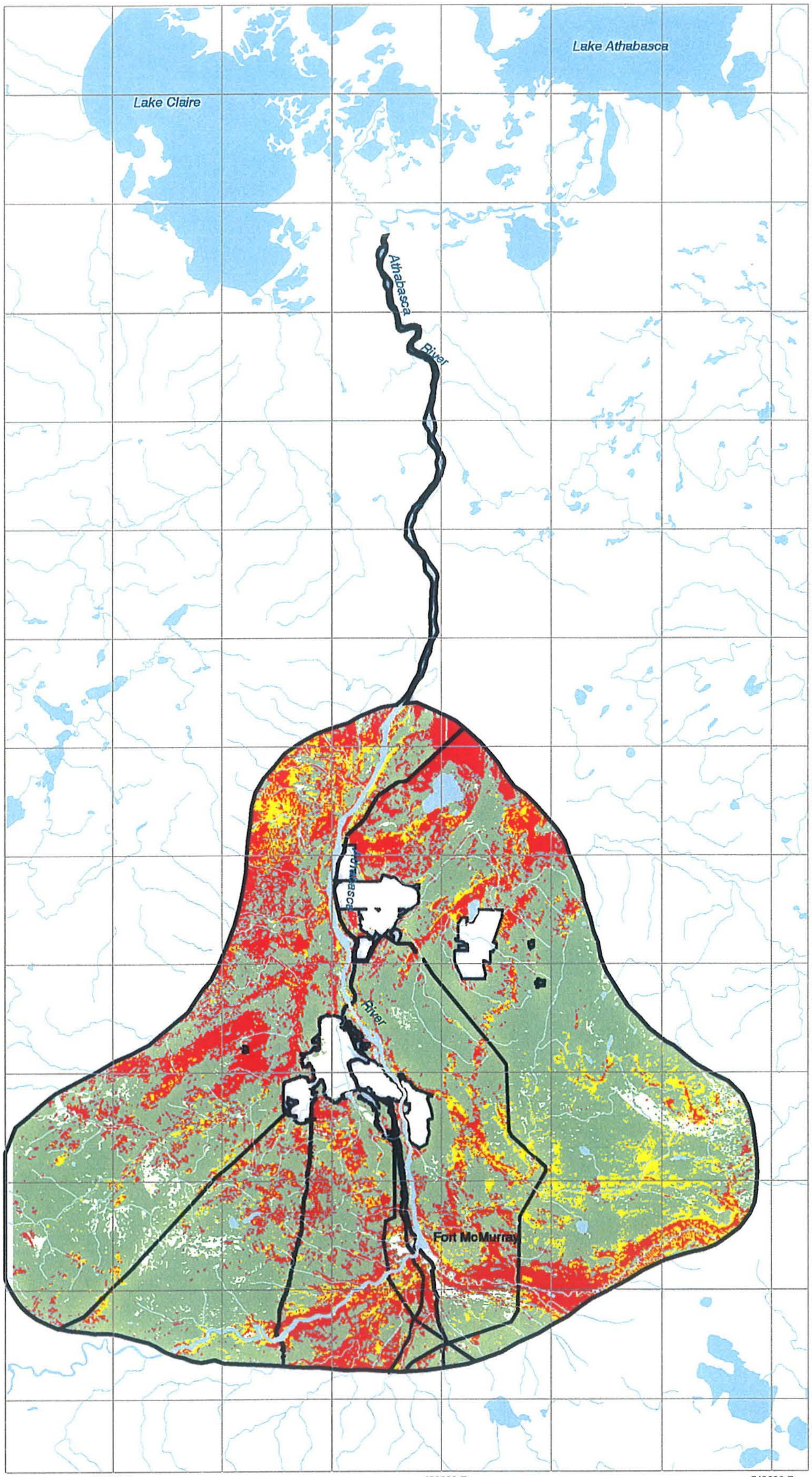
6.2.2.3 Incremental Impacts of the Muskeg River Mine Project

Impacts of the Muskeg River Mine Project on black bear habitat represent 19% of the habitat loss due to Scenario 2 and 9.2% of the losses associated with Scenario 3 (Table 50).

Table50 Cumulative Assessment of Black Bear Habitat Losses Associated With the Muskeg River Mine Project (MRM) in Scenario 2 (CEA) and Scenario 3 (RDR)

Scenario	Baseline HUs	Scenario HUs	HUs Loss Including MRM	HUs Loss due to MRM (% of Scenario Loss)	HUs Loss Excluding MRM	HUs Loss Excluding MRM (% of Baseline)	HUs Loss Including MRM (% of Baseline)
1: MRM	362,016	360,427	1,589				
2: CEA	362,016	353,651	8,364	19.0	6,776	1.9	2.3
3: RDR	362,016	344,799	17,216	9.2	15,628	4.3	4.8


Lake Athabasca
Lake Claire
Athabasca River
River
Fort McMurray
6480000 N
6380000 N
6280000 N
420000 E
480000 E
540000 E
LEGEND
Regional Study Boundary
Disturbance Effect Boundary
Hydrology
Habitat Suitability Index
Unknown
Low
Moderate
High
5 0 5 10 15 20 25
Kilometres
SOURCE: Golder Associates Ltd., Petro-Canada, RADARSAT International, Suncor, Syncrude
MAP PROJECTION: UTM Zone 12 NAD 83 (GRS 1980)
Golder Associates
SHELL CANADA LIMITED
REGIONAL STUDY AREA
BLACK BEAR HABITAT SUITABILITY
IMPACT SCENARIO 1
6 Feb. 1998
Figure 47
PRODUCED BY: J.H.
REVIEWED BY:



LEGEND

Regional Study Boundary

Disturbance Effect Boundary

Hydrology

Habitat Suitability Index

Unknown

Low

Moderate

High

5 0 5 10 15 20 25

Kilometres

SOURCE: Golder Associates Ltd., Petro-Canada, RADARSAT International, Suncor, Syncrude

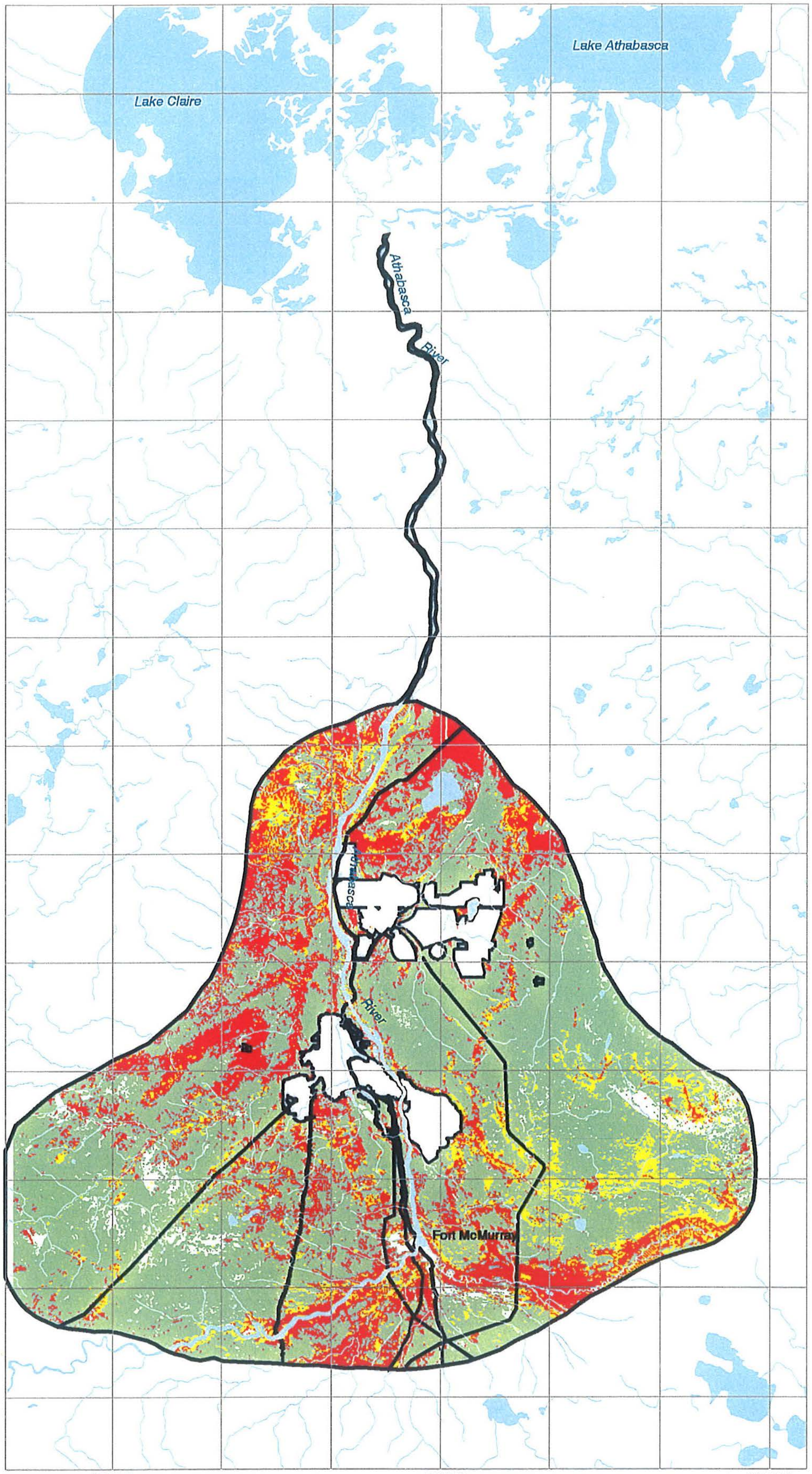
MAP PROJECTION: UTM
Zone 12
NAD 83 (GRS 1980)

Golder Associates

SHELL CANADA LIMITED

REGIONAL STUDY AREA
BLACK BEAR HABITAT SUITABILITY
IMPACT SCENARIO 2

6 Feb. 1998 | Figure 48 | PRODUCED BY: J.H. REVIEWED BY:



SOURCE: Golder Associates Ltd., Petro-Canada, RADARSAT International, Suncor, Syncrude

MAP PROJECTION: UTM Zone 12 NAD 83 (GRS 1980)

Golder Associates

SHELL CANADA LIMITED

REGIONAL STUDY AREA
BLACK BEAR HABITAT SUITABILITY
IMPACT SCENARIO 3

6 Feb. 1998 | Figure 49 | PRODUCED BY: J.H. REVIEWED BY:

6.2.3 Cape May Warbler

6.2.3.1 Baseline Conditions

A total of 162,454 HUs were calculated to be available to Cape May warblers within the RSA (Table 51, Figure 50). Of these, 8.6% represent moderate suitability habitat, 73.1% represent low suitability habitat and 18.3% represent unsuitable habitat. No high suitability habitat was mapped as variables derived from regional sources were all low relative to the high suitability indices.

Table 51 Percentage of Cape May Warbler Habitat Units and Habitat Areas among Unsuitable, Low, Medium and High Classes in the RSA for Each Development Scenario

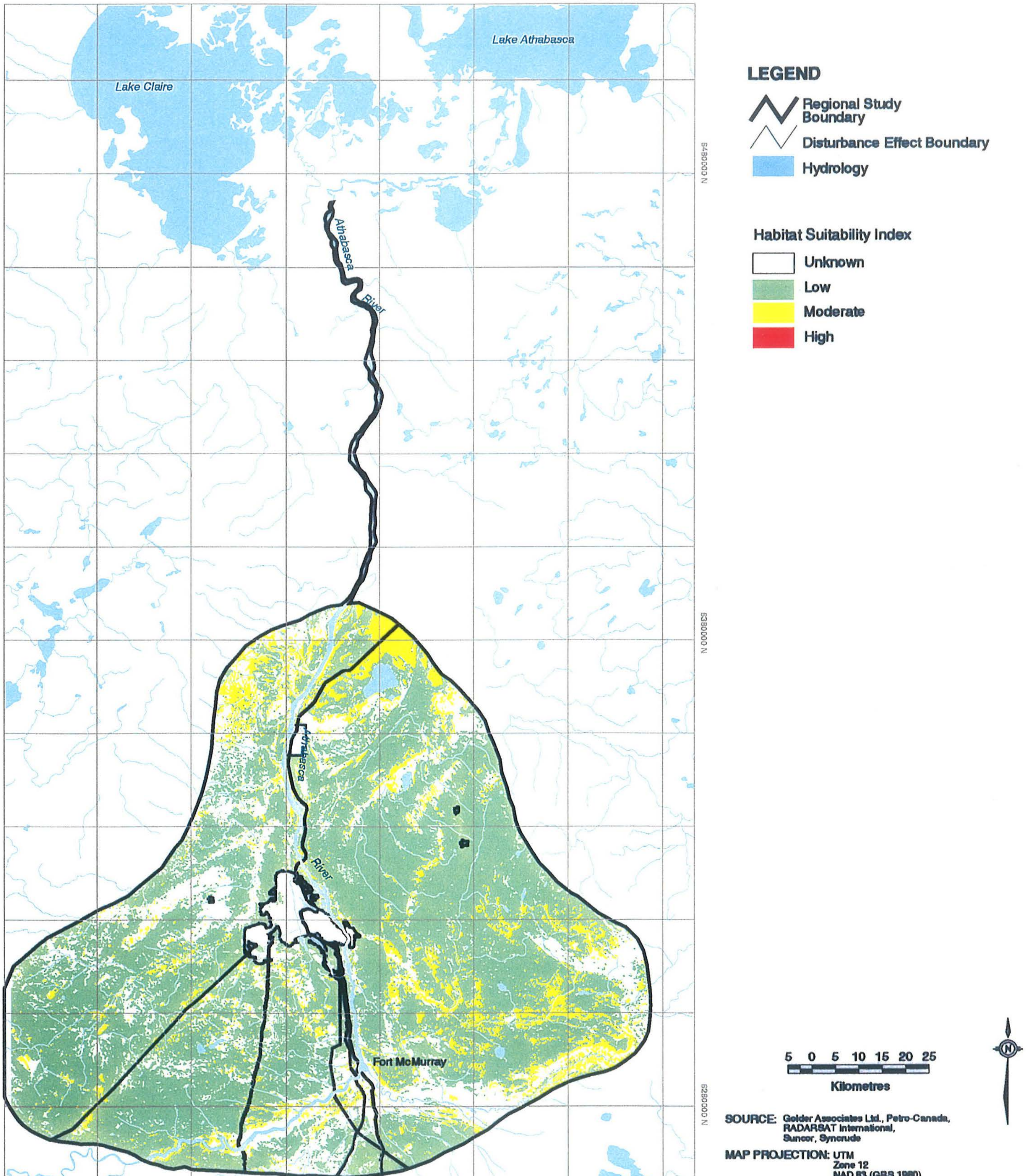
Species	Scenario	HUs	Percent of HUs			Percent of Area			
			Low	Medium	High	Unsuitable	Low	Medium	High
Cape May Warbler	Baseline	162,454	66.2	33.8	0.0	18.3	73.1	8.6	0.0
	Scenario 1	161,621	66.1	33.9	0.0	18.7	72.7	8.6	0.0
	Scenario 2	159,071	65.9	34.1	0.0	20.2	71.3	8.5	0.0
	Scenario 3	155,536	65.9	34.1	0.0	21.8	69.9	8.3	0.0

6.2.3.2 Development Scenarios

Impacts related to the Muskeg River Mine (Scenario 1: Tables 52-53; Figure 51) are predicted to decrease 0.5% of the total Cape May warbler HUs within the RSA. Scenario 2 (CEA) (Figure 52) is expected to result in the loss of 2.1% of the total HUs within the RSA while Scenario 3 (RDR) (Figure 53) is projecting the loss of 4.3% of the total HUs. All three development scenarios are considered to have a low impact magnitude on habitat loss for the region.

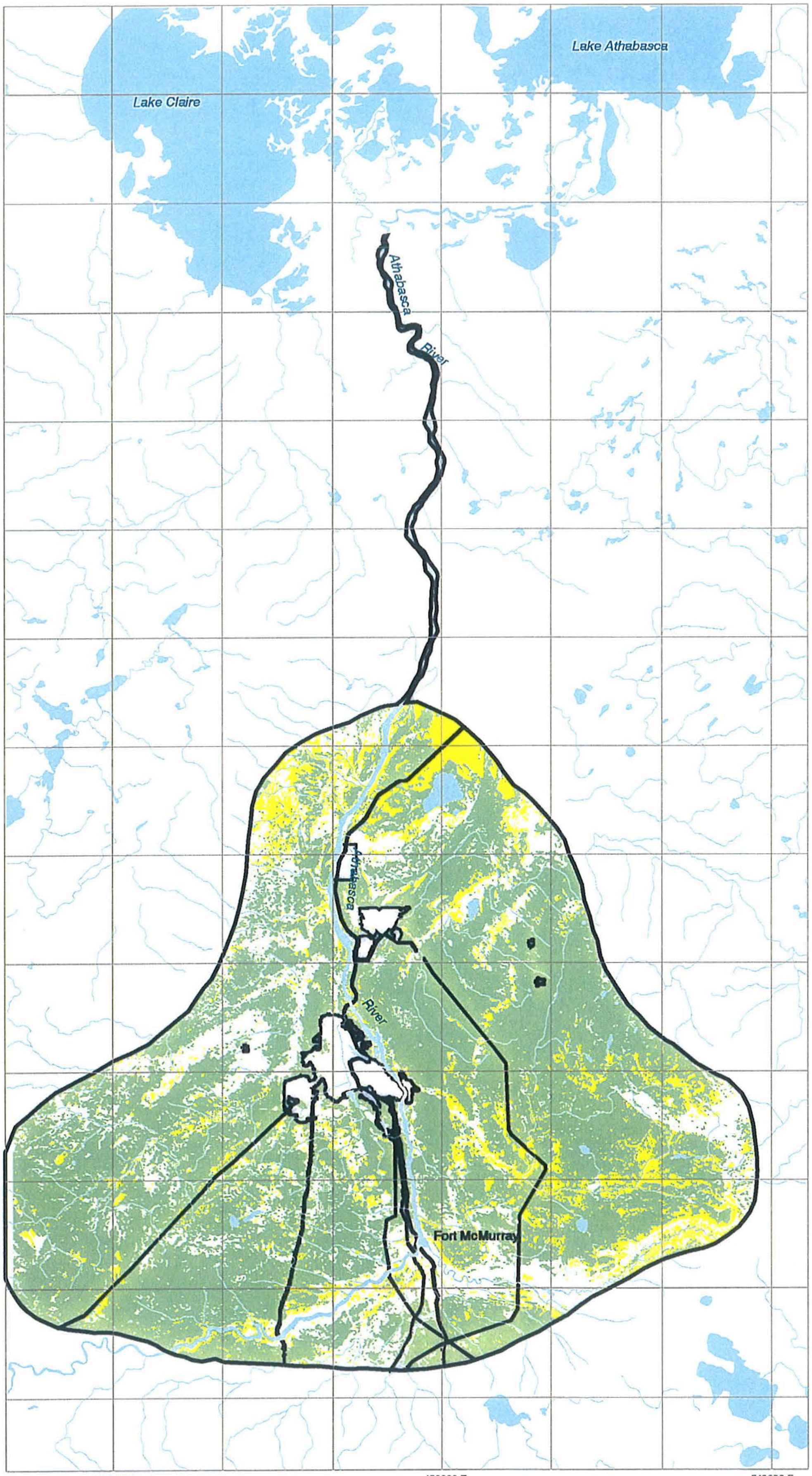
Table 52 Impact of Development Scenarios on Cape May Warbler Habitat Units Within the RSA

Species	Rating	Baseline	Scenario 1	Scenario 2	Scenario 3
Cape May Warbler	Low	107,592	106,873	104,857	102,479
	Medium	54,862	54,747	54,214	53,057
	High	0	0	0	0
	Total	162,454	161,621	159,071	155,536



REGIONAL STUDY AREA
CAPE MAY WARBLER HABITAT SUITABILITY
BASELINE SCENARIO

6 Feb. 1998 | Figure 50 | PRODUCED BY: J.H. REVIEWED BY:



LEGEND

Regional Study Boundary

Disturbance Effect Boundary

Hydrology

Habitat Suitability Index

- Unknown
- Low
- Moderate
- High

5 0 5 10 15 20 25

Kilometres

SOURCE: Golder Associates Ltd., Petro-Canada, RADARSAT International, Suncor, Syncrude

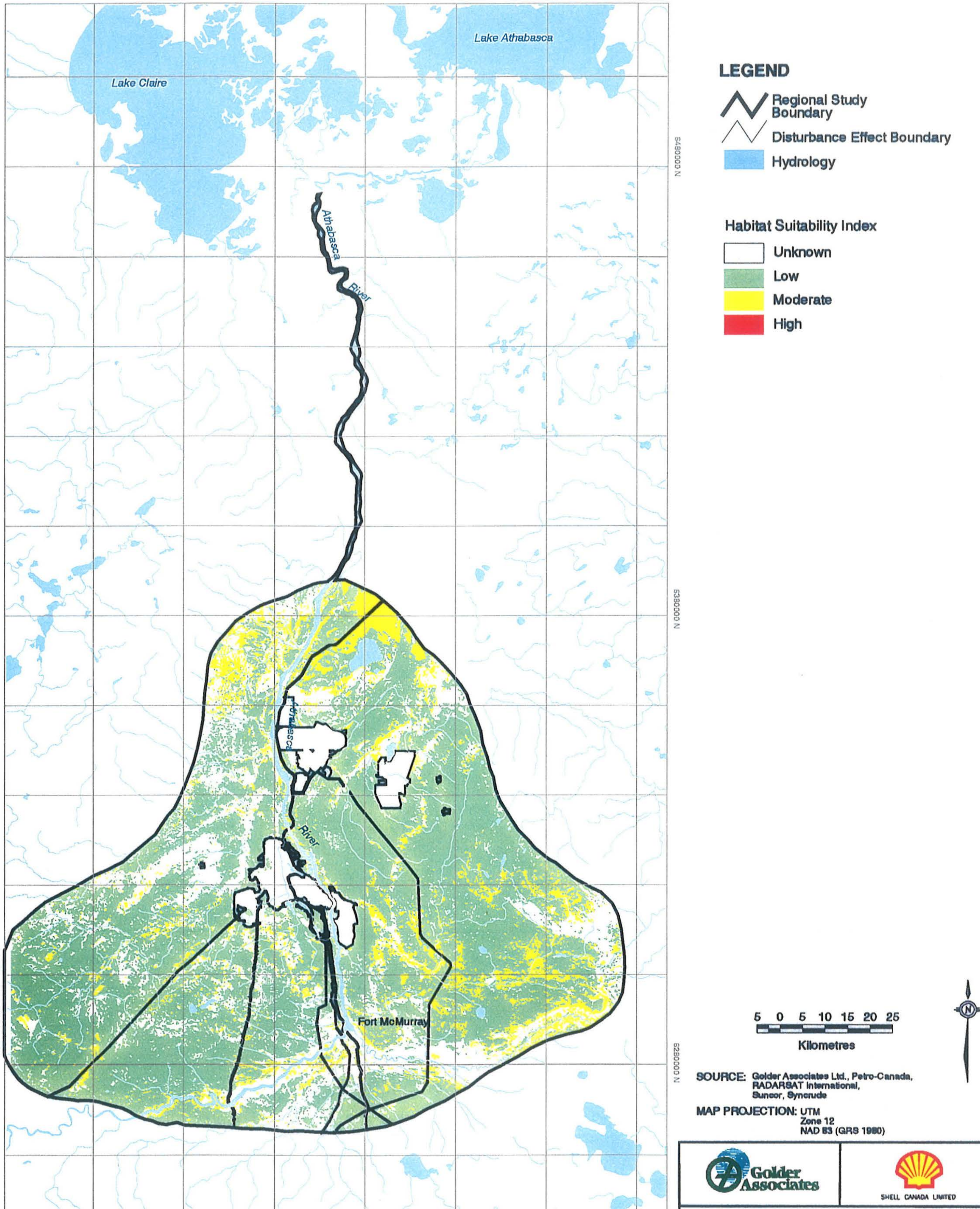
MAP PROJECTION: UTM
Zone 12
NAD 83 (GRS 1980)

Golder Associates

SHELL CANADA LIMITED

REGIONAL STUDY AREA
CAPE MAY WARBLER HABITAT SUITABILITY
IMPACT SCENARIO 1

6 Feb. 1998	Figure 51	PRODUCED BY: J.H. REVIEWED BY:

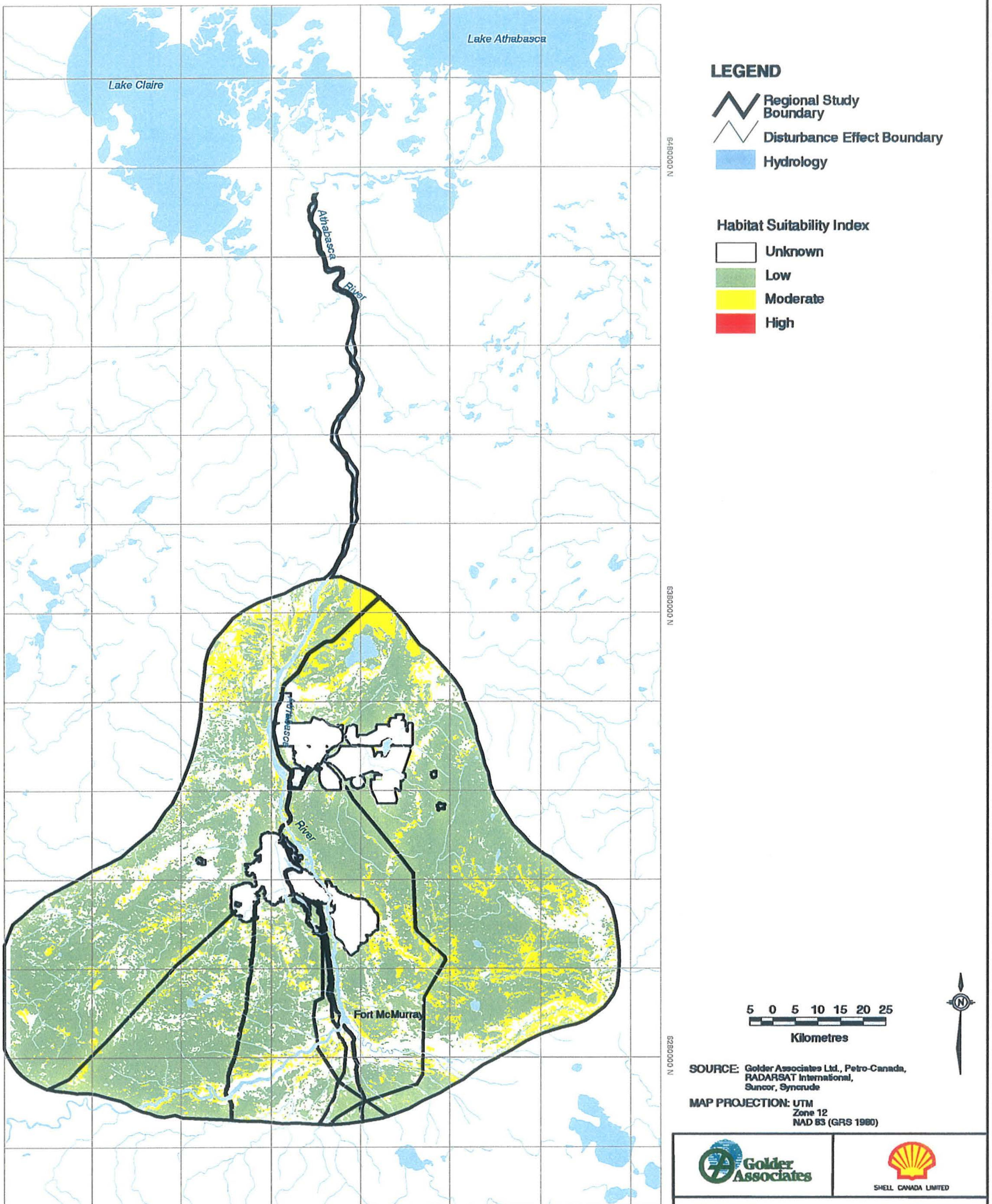


Golder Associates

SHELL CANADA LIMITED

REGIONAL STUDY AREA
CAPE MAY WARBLER HABITAT SUITABILITY
IMPACT SCENARIO 2

6 Feb. 1998	Figure 52	PRODUCED BY: J.H. REVIEWED BY:



SOURCE: Golder Associates Ltd., Petro-Canada, RADARSAT International, Suncor, Syncrude

MAP PROJECTION: UTM Zone 12 NAD 83 (GRS 1980)

Golder Associates

SHELL CANADA LIMITED

REGIONAL STUDY AREA
CAPE MAY WARBLER HABITAT SUITABILITY
IMPACT SCENARIO 3

6 Feb. 1998 | Figure 53 | PRODUCED BY: J.H. REVIEWED BY:

Table 53 Percent Impact of Development Scenarios on Cape May Warbler Habitat Units Within the RSA

Species	Rating	Baseline	Scenario 1	Scenario 2	Scenario 3
Cape May Warbler	Low	107,592	-0.7	-2.5	-4.8
	Medium	54,862	-0.2	-1.2	-3.3
	High	0	+0.0	+0.0	+0.0
	Total	162,454	-0.5	-2.1	-4.3

6.2.3.3 Incremental Impacts of the Muskeg River Mine Project

Effects of the Muskeg River Mine Project on Cape May warbler habitat represent 24.6% of the habitat loss due to Scenario 2 and 12% of the losses associated with Scenario 3 (Table 54).

Table 54 Cumulative Assessment of Cape May Warbler Habitat Losses Associated With the Muskeg River Mine Project (MRM) in Scenario 2 (CEA) and Scenario 3 (RDR)

Section	Baseline HUs	Scenario HUs	HUs Loss Including MRM	HUs Loss due to MRM (% of Scenario Loss)	HUs Loss Excluding MRM	HUs Loss Excluding MRM (% of Baseline)	HUs Loss Including MRM (% of Baseline)
1: MRM	162,454	161,621	833				
2: CEA	162,454	159,071	3,383	24.6	2549	1.6	2.1
3: RDR	162,454	155,536	6,918	12.0	6085	3.7	4.3

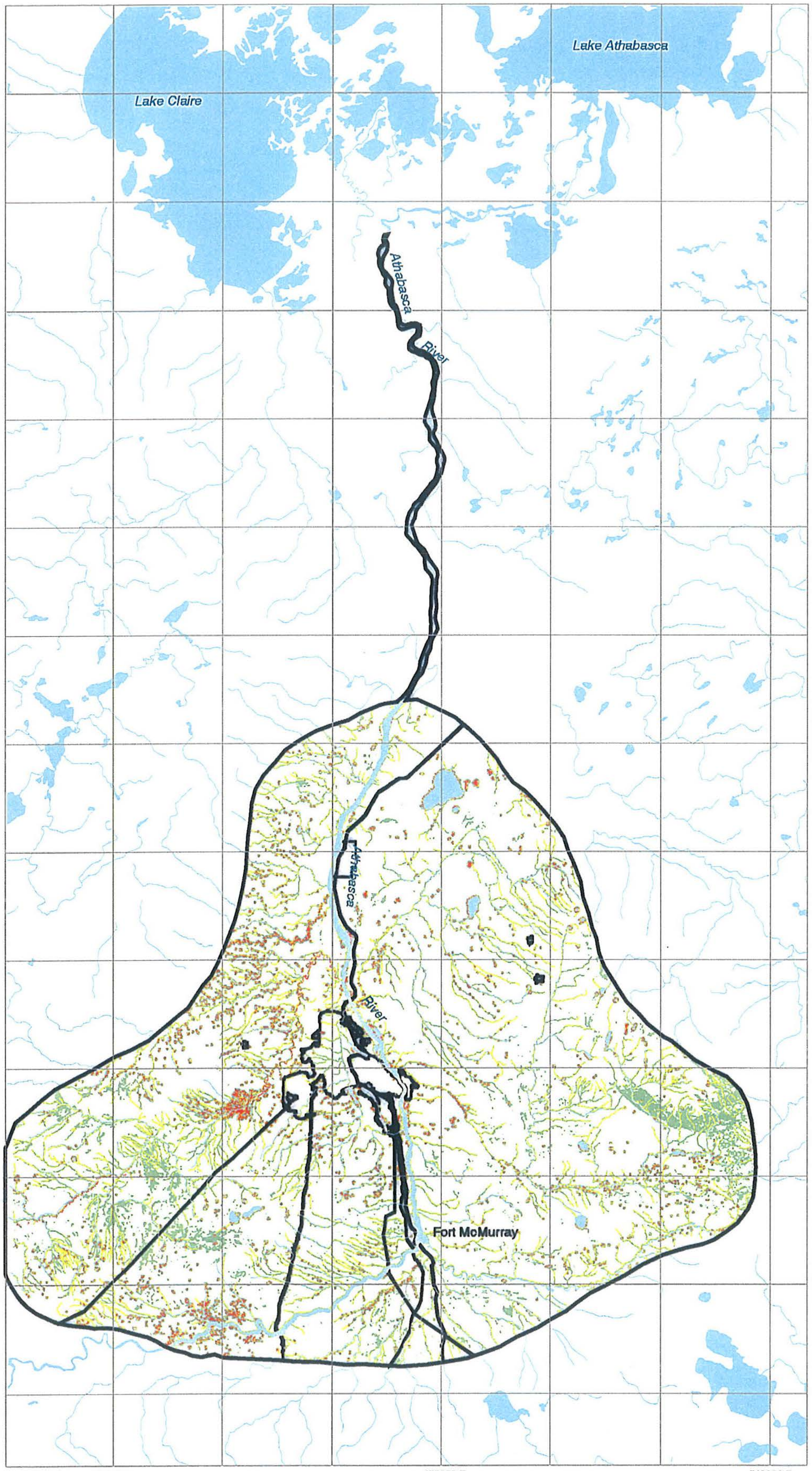
6.2.4 Dabbling Ducks

6.2.4.1 Baseline Conditions

A total of 108,916 HUs were calculated to be available to dabbling ducks within the RSA (Table 55, Figure 51). Of these, 1.9% represent high suitability habitat, 7.1% represent moderate suitability habitat, 12% represent low suitability habitat and 79% represent unsuitable habitat.

Table 55 Percentage of Dabbling Ducks Habitat Units and Habitat Areas Among Unsuitable, Low, Medium and High Classes in the RSA for Each Development Scenario

Species	Scenario	HUs	Percent of HUs			Percent of Area			
			Low	Medium	High	Unsuit-able	Low	Medium	High
Dabbling Ducks	Baseline	108,916	36.5	45.0	18.5	79.0	12.0	7.1	1.9
	Scenario 1	108,712	36.5	45.0	18.5	75.7	12.0	7.1	1.9
	Scenario 2	107,613	36.4	45.1	18.5	79.2	11.9	7.0	1.9
	Scenario 3	106,529	36.4	45.1	18.5	79.4	11.8	6.9	1.9



LEGEND

Regional Study Boundary

Disturbance Effect Boundary

Hydrology

Habitat Suitability Index

Unknown

Low

Moderate

High

5 0 5 10 15 20 25

Kilometres

SOURCE: Golder Associates Ltd., Petro-Canada, RADARSAT International, Suncor, Syncrude

MAP PROJECTION: UTM
Zone 12
NAD 83 (GRS 1980)

Golder Associates

SHELL CANADA LIMITED

REGIONAL STUDY AREA
DABBLING DUCKS HABITAT SUITABILITY
BASELINE SCENARIO

6 Feb. 1998	Figure 54	PRODUCED BY: J.H. REVIEWED BY:

6.2.4.2 Development Scenarios

Impacts related to the Muskeg River Mine (Scenario 1: Tables 56-57; Figure 55) are predicted to decrease 0.2% of the total dabbling duck HUss within the RSA. Scenario 2 (CEA) (Figure 56) is expected to result in the loss of 1.2% of the total HUs within the RSA while Scenario 3 (RDR) (Figure 57) is projecting the loss of 2.2% of the total HUs. All three development scenarios are considered to have a low impact magnitude on habitat loss for the region.

Table 56 Impact of Development Scenarios on Dabbling Ducks Habitat Units Within the RSA

Species	Rating	Baseline	Scenario 1	Scenario 2	Scenario 3
Dabbling Ducks	Low	39,748	39,660	39,202	38,788
	Medium	49,024	48,953	48,506	48021
	High	20,145	20,099	19,905	19,720
	Total	108,916	108,712	107,613	106,529

Table 57 Percent Impact of Development Scenarios on Dabbling Ducks Habitat Units Within the RSA

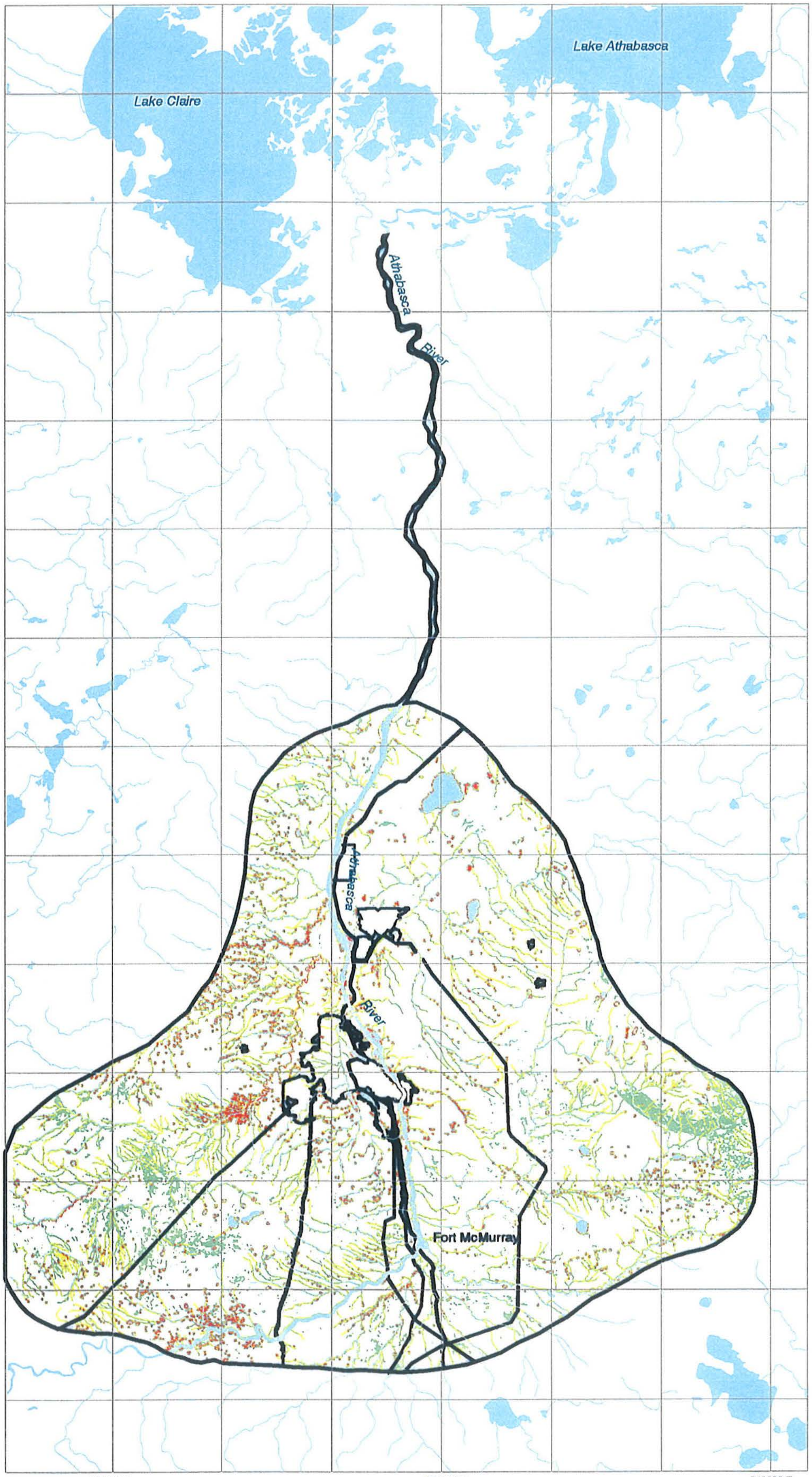
Species	Rating	Baseline	Scenario 1	Scenario 2	Scenario 3
Dabbling Ducks	Low	39,748	-0.2	-1.4	-2.4
	Medium	49,024	-0.1	-1.1	-2.0
	High	20,145	-0.2	-1.2	-2.1
	Total	108,916	-0.2	-1.2	-2.2

6.2.4.3 Incremental Impacts of the Muskeg River Mine Project

Impacts of the Muskeg River Mine Project on dabbling duck habitat represent 15.7% of the habitat loss due to Scenario 2 and 8.6% of the losses associated with Scenario 3 (Table 58).

Table 58 Cumulative Assessment of Dabbling Ducks Habitat Losses Associated With the Muskeg River Mine Project (MRM) in Scenario 2 (CEA) and Scenario 3 (RDR)

Scenario	Baseline HUs	Scenario HUs	HUs Loss Including MRM	HUs Loss due to MRM (% of Scenario Loss)	HUs Loss Excluding MRM	HUs Loss Excluding MRM (% of Baseline)	HUs Loss Including MRM (% of Baseline)
1: MRM	108,916	108,712	204				
2: CEA	108,916	107,613	1,304	15.7	1,099	1.0	1.2
3: RDR	108,916	106,529	2,387	8.6	2,182	2.0	2.2



LEGEND

Regional Study Boundary

Disturbance Effect Boundary

Hydrology

Habitat Suitability Index

Unknown

Low

Moderate

High

5 0 5 10 15 20 25

Kilometres

N

SOURCE: Golder Associates Ltd., Petro-Canada, RADARSAT International, Suncor, Syncrude

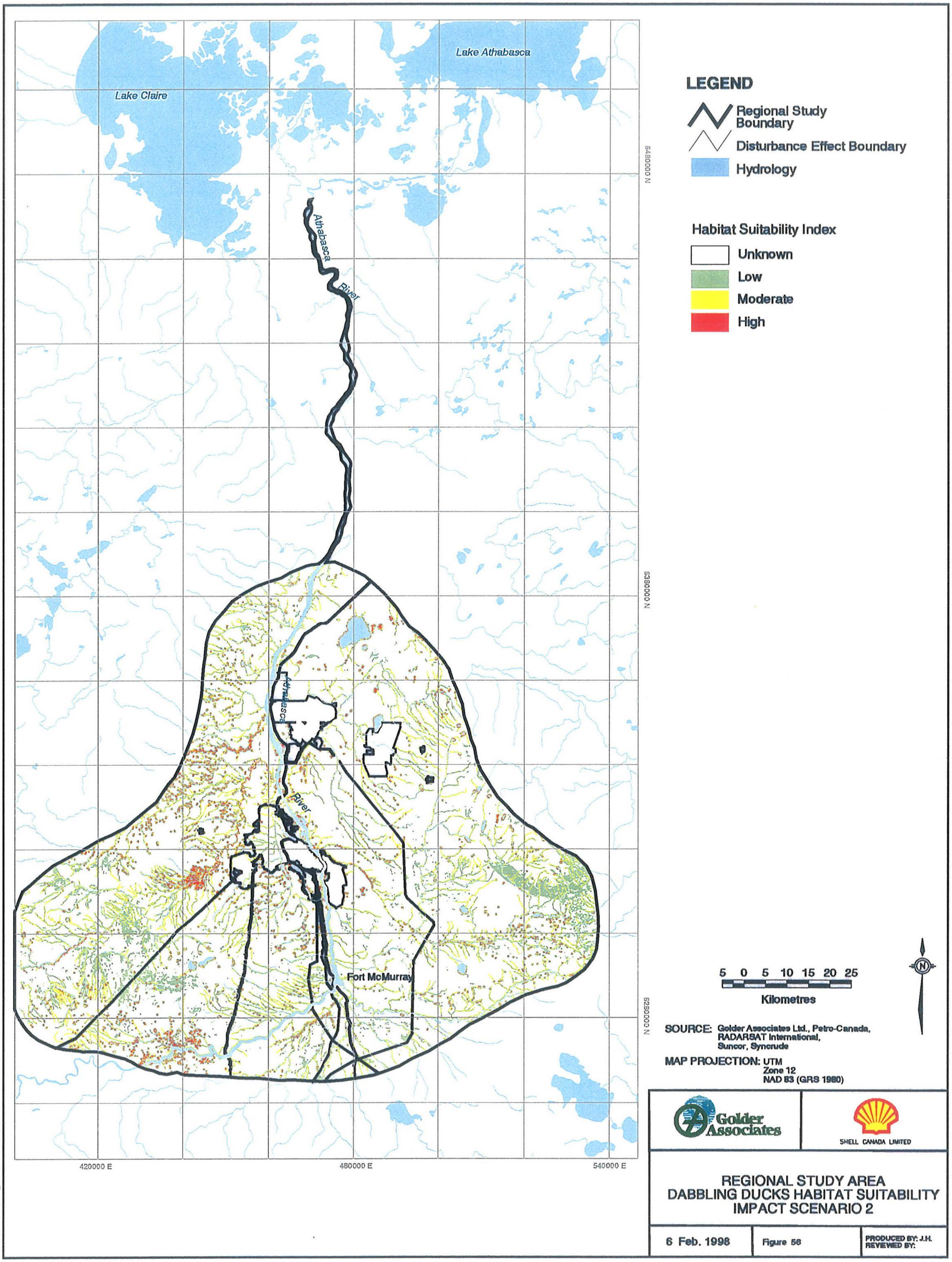
MAP PROJECTION: UTM Zone 12 NAD 83 (GRS 1980)

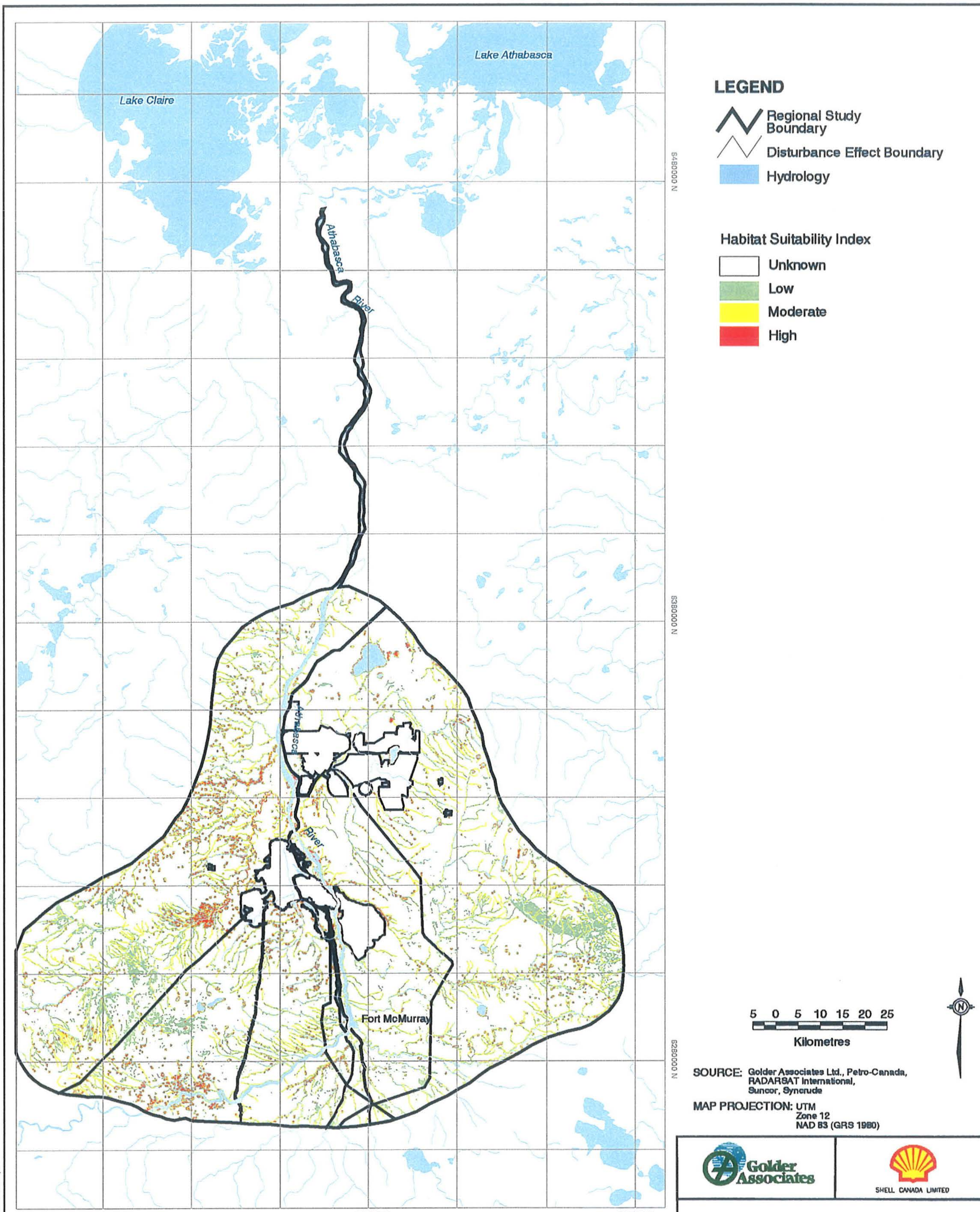
Golder Associates

SHELL CANADA LIMITED

REGIONAL STUDY AREA
DABBLING DUCKS HABITAT SUITABILITY
IMPACT SCENARIO 1

6 Feb. 1998	Figure 55	PRODUCED BY: J.H. REVIEWED BY:


Lake Athabasca
Lake Claire
Athabasca River
Athabasca
River
Fort McMurray
6480000 N
6380000 N
6280000 N
420000 E
480000 E
540000 E
LEGEND
Regional Study Boundary
Disturbance Effect Boundary
Hydrology
Habitat Suitability Index
Unknown
Low
Moderate
High
5 0 5 10 15 20 25
Kilometres
N
SOURCE: Golder Associates Ltd., Petro-Canada, RADARSAT International, Suncor, Syncrude
MAP PROJECTION: UTM Zone 12 NAD 83 (GRS 1980)
Golder Associates
SHELL CANADA LIMITED
REGIONAL STUDY AREA
DABBLING DUCKS HABITAT SUITABILITY
IMPACT SCENARIO 2
6 Feb. 1998
Figure 56
PRODUCED BY: J.H.
REVIEWED BY:



Golder Associates

SHELL CANADA LIMITED

REGIONAL STUDY AREA
DABBLING DUCKS HABITAT SUITABILITY
IMPACT SCENARIO 3

6 Feb. 1998	Figure 57	PRODUCED BY: J.H. REVIEWED BY:

6.2.5 Fisher

6.2.5.1 Baseline Conditions

A total of 555,957 HUs were calculated to be available to fishers within the RSA (Table 57, Figure 58). Of these, 26% represent high suitability habitat, 64.59% represent moderate suitability habitat, 4.4% represent low suitability habitat and 5.1% represent unsuitable habitat.

Table 59 Percentage of Fisher Habitat Units and Habitat Areas Among Unsuitable, Low, Medium and High Classes in the RSA for Each Development Scenario

Species	Scenario	HUs	Percent of HUs			Percent of Area			
			Low	Medium	High	Unsuitable	Low	Medium	High
Fisher	Baseline	555,957	0.4	64.2	35.4	5.1	4.4	64.5	26.0
	Scenario 1	553,656	0.4	64.3	35.3	5.5	4.6	64.0	25.9
	Scenario 2	542,173	0.4	64.1	35.5	7.2	4.8	62.4	25.5
	Scenario 3	528,692	0.4	64.2	35.4	9.0	5.0	61.3	24.7

6.2.5.2 Development Scenarios

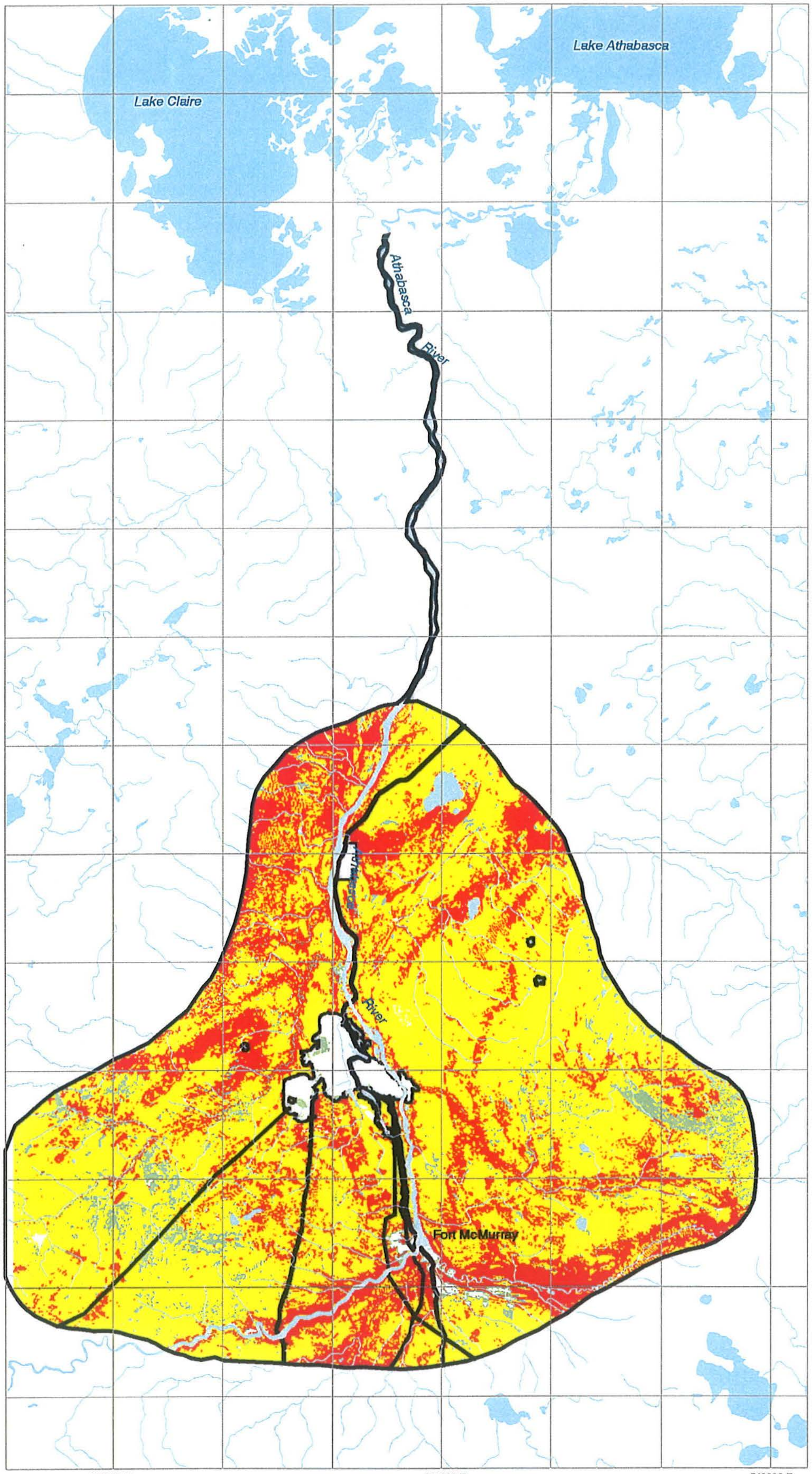
Impacts related to the Muskeg River Mine (Scenario 1: Tables 60-61; Figure 59) are predicted to decrease 0.4% of the total fisher HUs within the RSA. Scenario 2 (CEA) (Figure 60) is expected to result in the loss of 2.5% of the total HUs within the RSA while Scenario 3 (RDR) (Figure 61) is projecting the loss of 4.9% of the total HUs. All three development scenarios are considered to have a low impact magnitude on habitat loss for the region.

Table 60 Impact of Development Scenarios on Fisher Habitat Units Within the RSA

Species	Rating	Baseline	Scenario 1	Scenario 2	Scenario 3
Fisher	Low	2,039	2,358	2,421	2,273
	Medium	357,197	356,128	347526	339,512
	High	196,722	195,170	192,227	186,907
	Total	555,957	553,656	542,173	528,692

Table 61 Percent Impact of Development Scenarios on Fisher Habitat Units Within the RSA

Species	Rating	Baseline	Scenario 1	Scenario 2	Scenario 3
Fisher	Low	2,039	+15.6	+18.7	+11.5
	Medium	357,197	-0.3	-2.7	-5.0
	High	196,722	-0.8	-2.3	-5.0
	Total	555,957	-0.4	-2.5	-4.9



LEGEND

Regional Study Boundary

Disturbance Effect Boundary

Hydrology

Habitat Suitability Index

Unknown

Low

Moderate

High

5 0 5 10 15 20 25

Kilometres

SOURCE: Golder Associates Ltd., Petro-Canada, RADARSAT International, Suncor, Syncrude

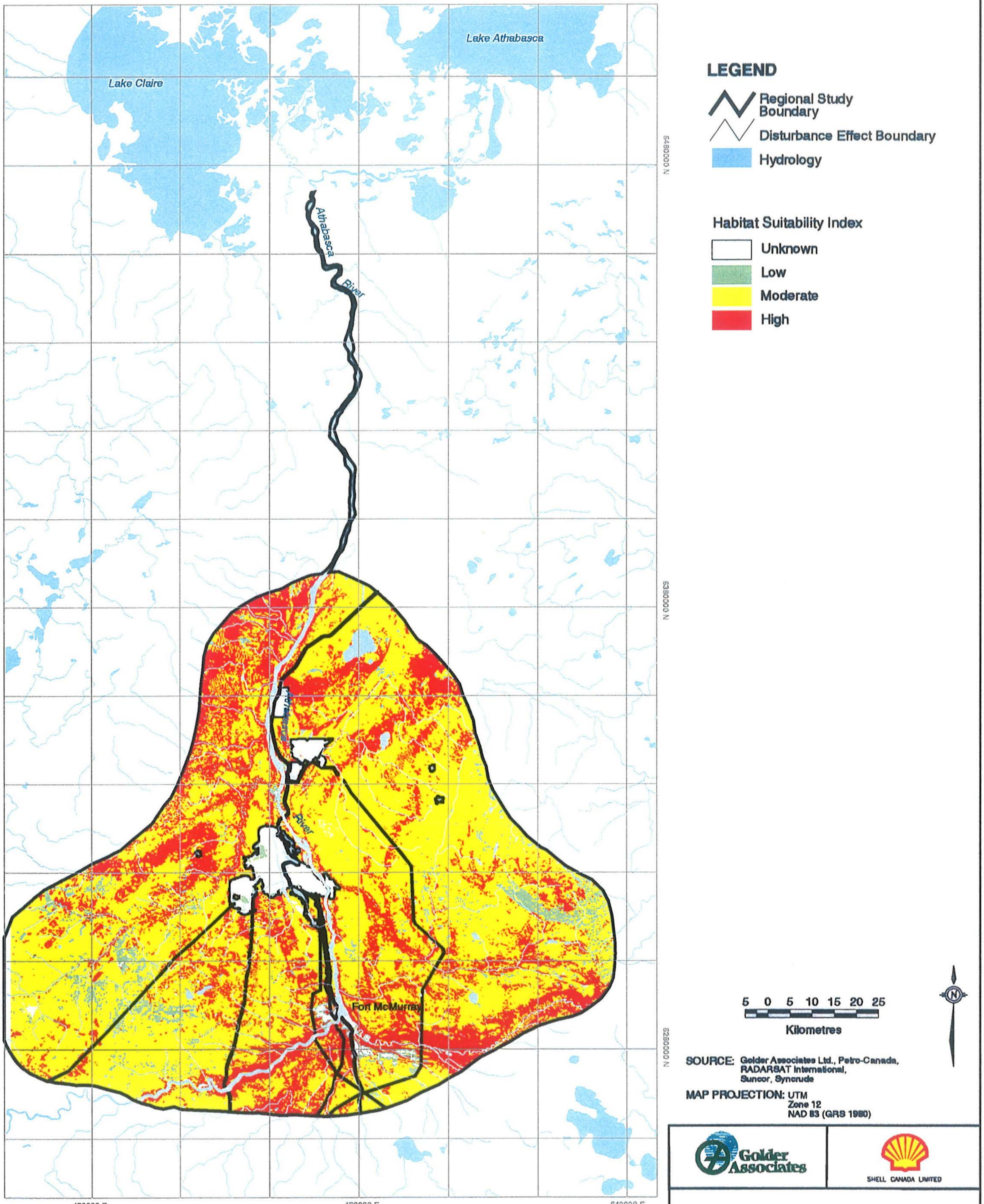
MAP PROJECTION: UTM Zone 12 NAD 83 (GRS 1980)

Golder Associates

SHELL CANADA LIMITED

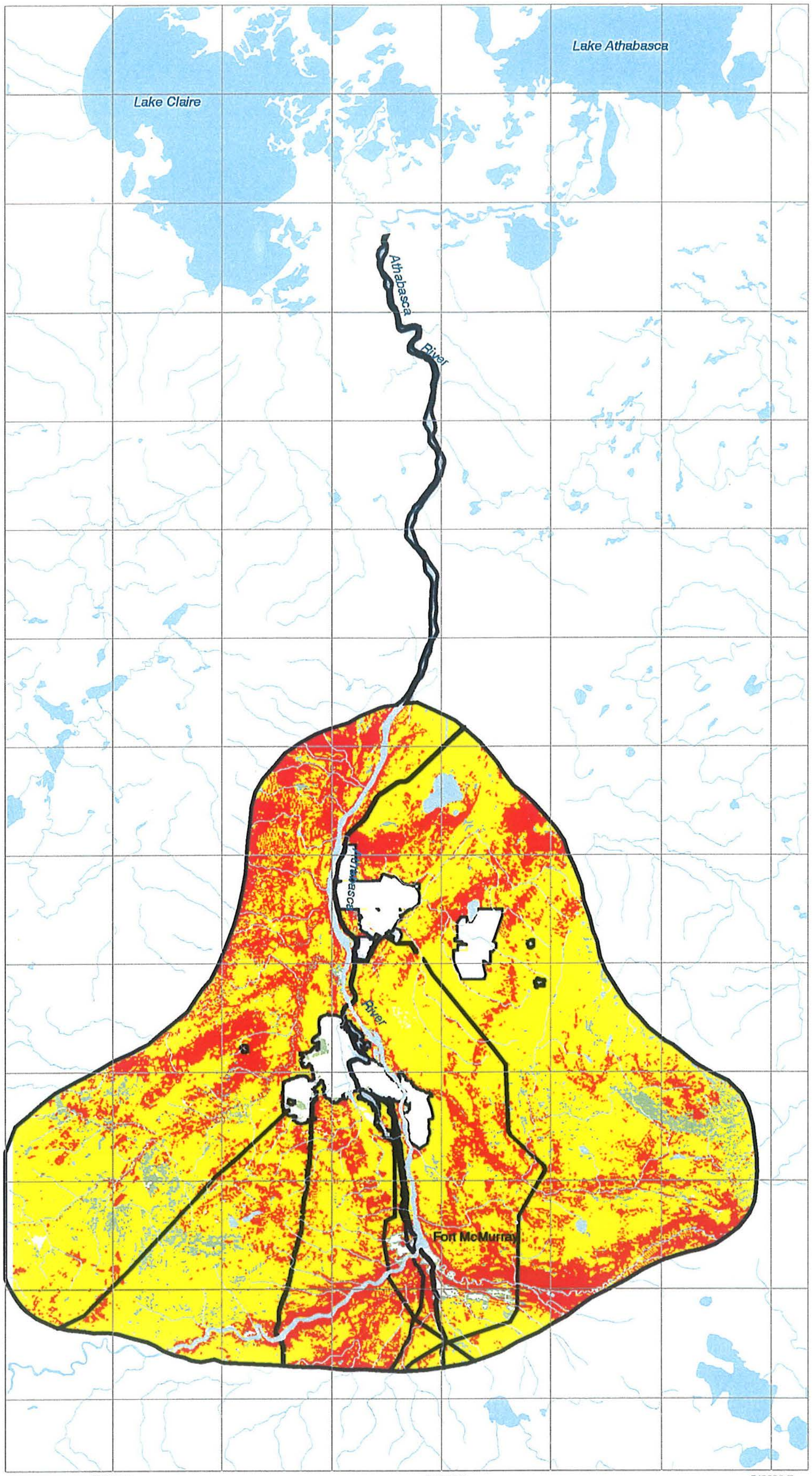
REGIONAL STUDY AREA
FISHER HABITAT SUITABILITY
BASELINE SCENARIO

6 Feb. 1998	Figure 58	PRODUCED BY: J.H. REVIEWED BY:



REGIONAL STUDY AREA
FISHER HABITAT SUITABILITY
IMPACT SCENARIO 1

6 Feb. 1998	Figure 59	PRODUCED BY: J.H. REVIEWED BY:



LEGEND

Regional Study Boundary

Disturbance Effect Boundary

Hydrology

Habitat Suitability Index

Unknown

Low

Moderate

High

5 0 5 10 15 20 25

Kilometres

SOURCE: Golder Associates Ltd., Petro-Canada, RADARSAT International, Suncor, Syncrude

MAP PROJECTION: UTM Zone 12 NAD 83 (GRS 1980)

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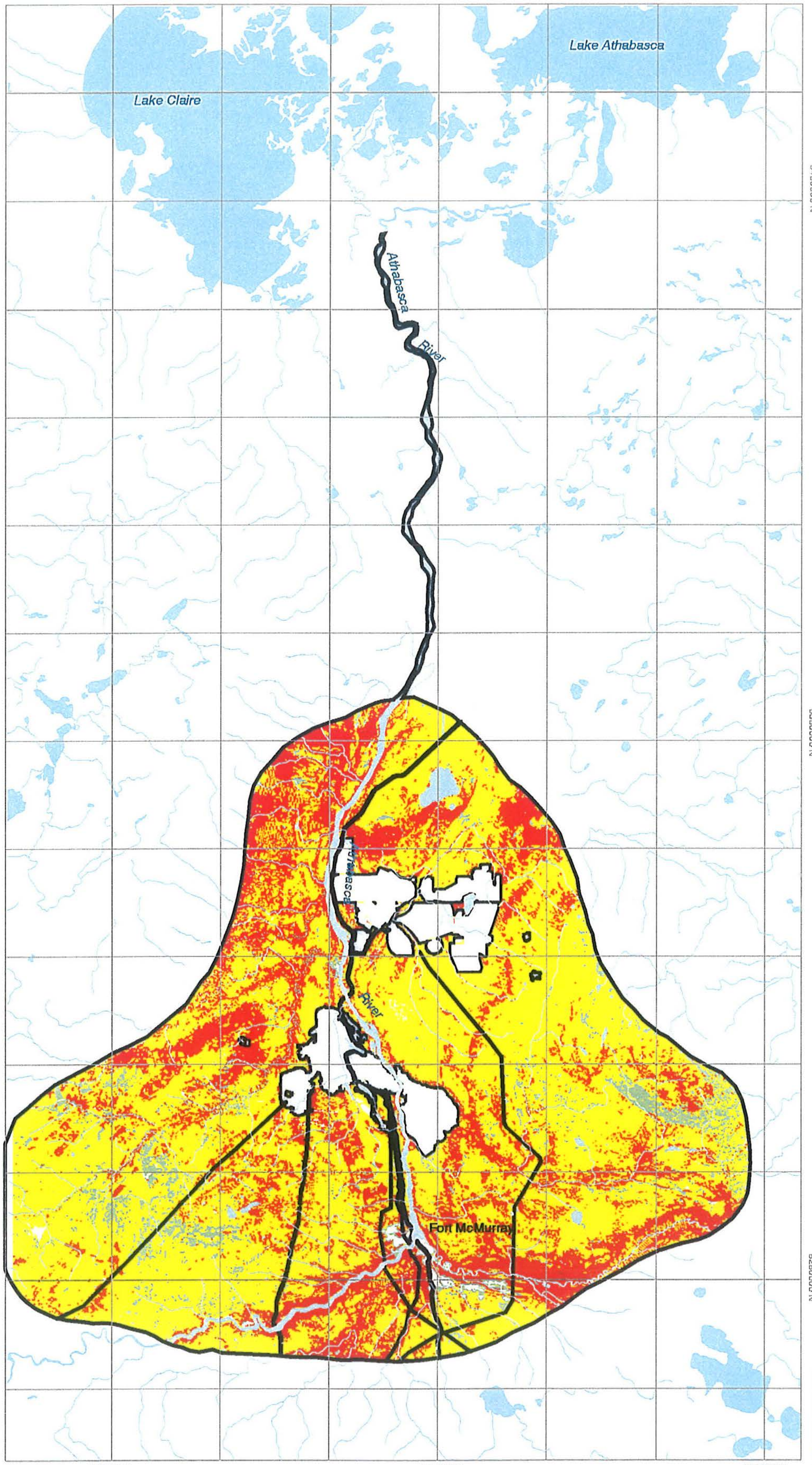
REGIONAL STUDY AREA
FISHER HABITAT SUITABILITY
IMPACT SCENARIO 2

6 Feb. 1998	Figure 60	PRODUCED BY: J.H. REVIEWED BY:



LEGEND

Regional Study Boundary

Disturbance Effect Boundary

Hydrology

Habitat Suitability Index

- Unknown
- Low
- Moderate
- High

5 0 5 10 15 20 25

Kilometres

SOURCE: Golder Associates Ltd., Petro-Canada, RADARSAT International, Suncor, Syncrude

MAP PROJECTION: UTM
Zone 12
NAD 83 (GRS 1980)

Golder Associates

SHELL CANADA LIMITED

REGIONAL STUDY AREA
FISHER HABITAT SUITABILITY
IMPACT SCENARIO 3

6 Feb. 1998	Figure 61	PRODUCED BY: J.H. REVIEWED BY:

/data9/oilsands/shell_hsi/regional/habitat.apr

6.2.5.3 Incremental Impacts of the Muskeg River Mine Project

Impacts of the Muskeg River Mine Project on fisher habitat represent 16.7% of the habitat loss due to Scenario 2 and 8.4% of the losses associated with Scenario 3 (Table 62).

Table 62 Cumulative Assessment of Fisher Habitat Losses Associated With the Muskeg River Mine Project (MRM) in Scenario 2 (CEA) and Scenario 3 (RDR)

Scenario	Baseline HUs	Scenario HUs	HUs Loss Including MRM	HUs Loss due to MRM (% of Scenario Loss)	HUs Loss Excluding MRM	HUs Loss Excluding MRM (% of Baseline)	HUs Loss Including MRM (% of Baseline)
1: MRM	555,957	553,656	2,302				
2: CEA	555,957	542,173	13,784	16.7	11,483	2.1	2.5
3: RDR	555,957	528,692	27,266	8.4	24,964	4.5	4.9

6.2.6 Great Gray Owl

6.2.6.1 Baseline Conditions

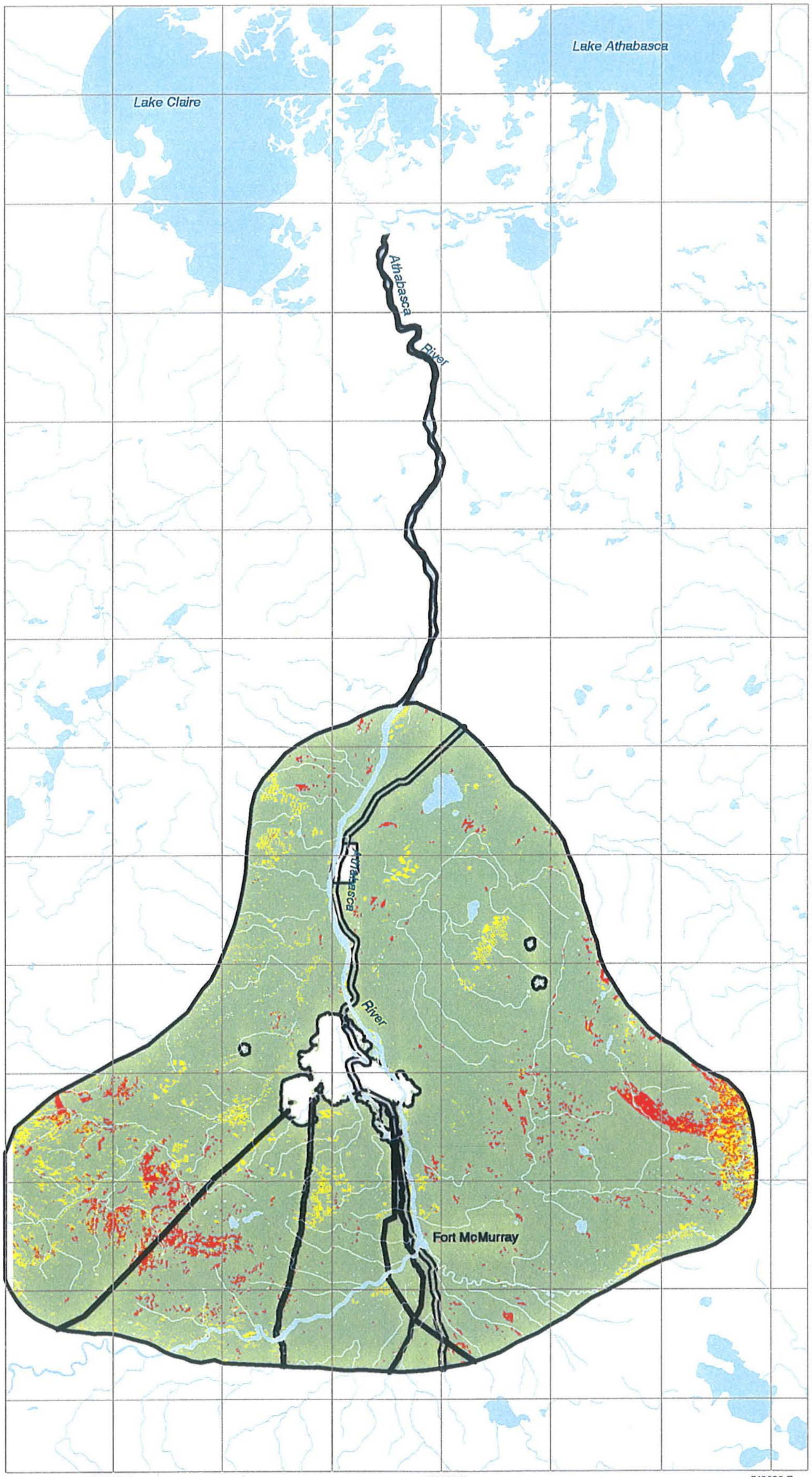
A total of 308,237 HUs were calculated to be available to great gray owls within the RSA (Table 63, Figure 62). Of these, 3% represent high suitability habitat, 2.7% represent moderate suitability habitat, 89.4% represent low suitability habitat and 4.9% represent unsuitable habitat.

Table 63 Percentage of Great Gray Owl Habitat Units and Habitat Areas Among Unsuitable, Low, Medium and High Classes in the RSA for Each Development Scenario

Species	Scenario	HUs	Percent of HUs			Percent of Area			
			Low	Medium	High	Unsuitable	Low	Medium	High
Great Gray Owl	Baseline	308,237	88.9	4.0	7.2	4.9	89.4	2.7	3.0
	Scenario 1	305,932	88.8	4.0	7.2	5.3	89.0	2.8	3.0
	Scenario 2	299,281	88.8	3.9	7.3	7.0	87.5	2.6	2.9
	Scenario 3	292,706	88.6	4.0	7.4	8.6	85.8	2.6	2.9

6.2.6.2 Development Scenarios

Impacts related to the Muskeg River Mine (Scenario 1: Tables 64-6; Figure 63) are predicted to decrease 0.7% of the total great gray owl HUs within the RSA. Scenario 2 (CEA) (Figure 64) is expected to result in the loss of 2.9% of the total HUs within the RSA while Scenario 3 (RDR) (Figure 65) is projecting the loss of 5.0% of the total HUs. All three development



LEGEND

Regional Study Boundary

Disturbance Effect Boundary

Hydrology

Habitat Suitability Index

Unknown

Low

Moderate

High

5 0 5 10 15 20 25

Kilometres

SOURCE: Golder Associates Ltd., Petro-Canada, RADARSAT International, Suncor, Syncrude

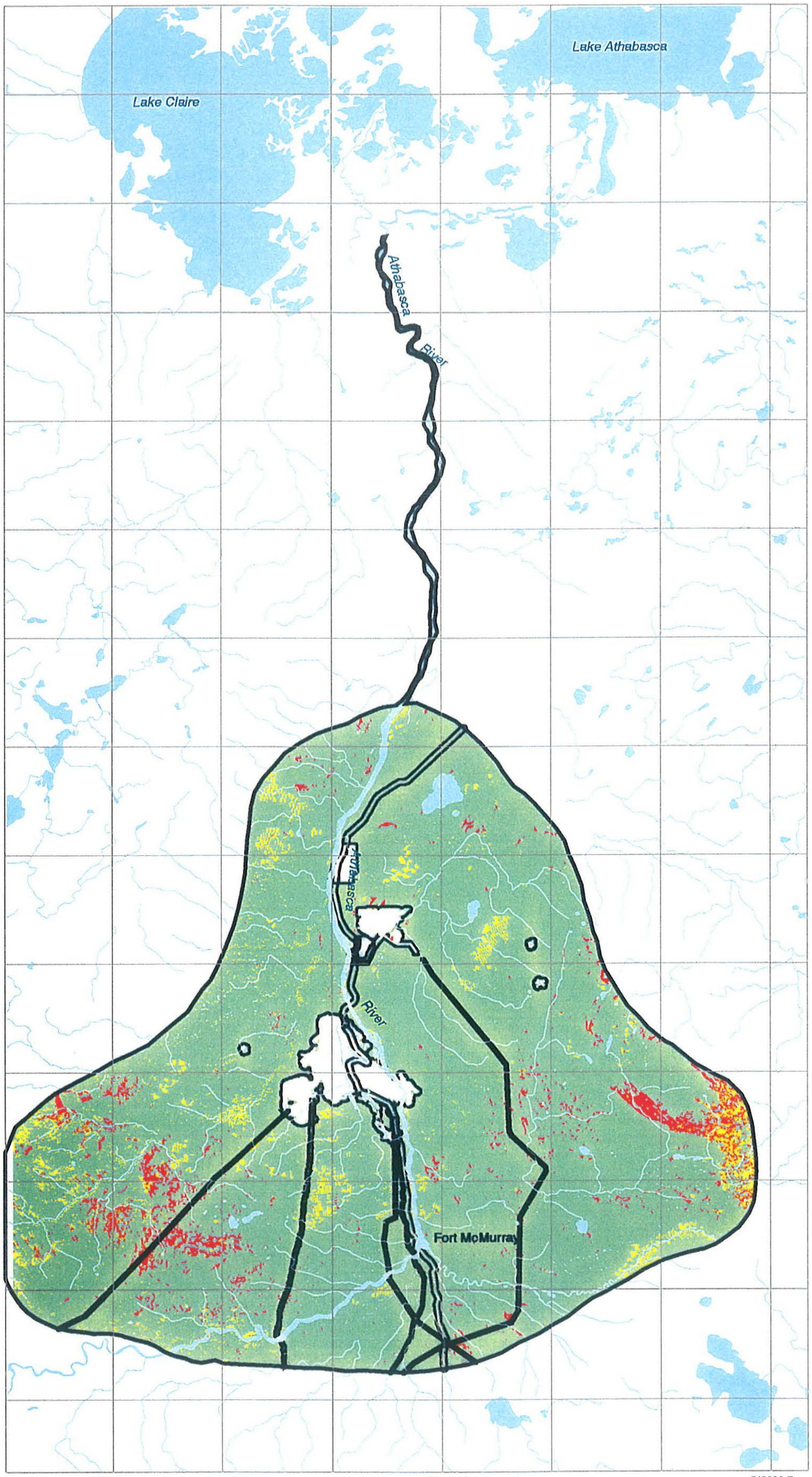
MAP PROJECTION: UTM
Zone 12
NAD 83 (GRS 1980)

Golder Associates

SHELL CANADA LIMITED

REGIONAL STUDY AREA
GREAT GRAY OWL HABITAT SUITABILITY
BASELINE SCENARIO

6 Feb. 1998	Figure 62	PRODUCED BY: J.H. REVIEWED BY:



LEGEND

Regional Study Boundary

Disturbance Effect Boundary

Hydrology

Habitat Suitability Index

- Unknown
- Low
- Moderate
- High

5 0 5 10 15 20 25

Kilometres

N

SOURCE: Golder Associates Ltd., Petro-Canada, RADARSAT International, Suncor, Syncrude

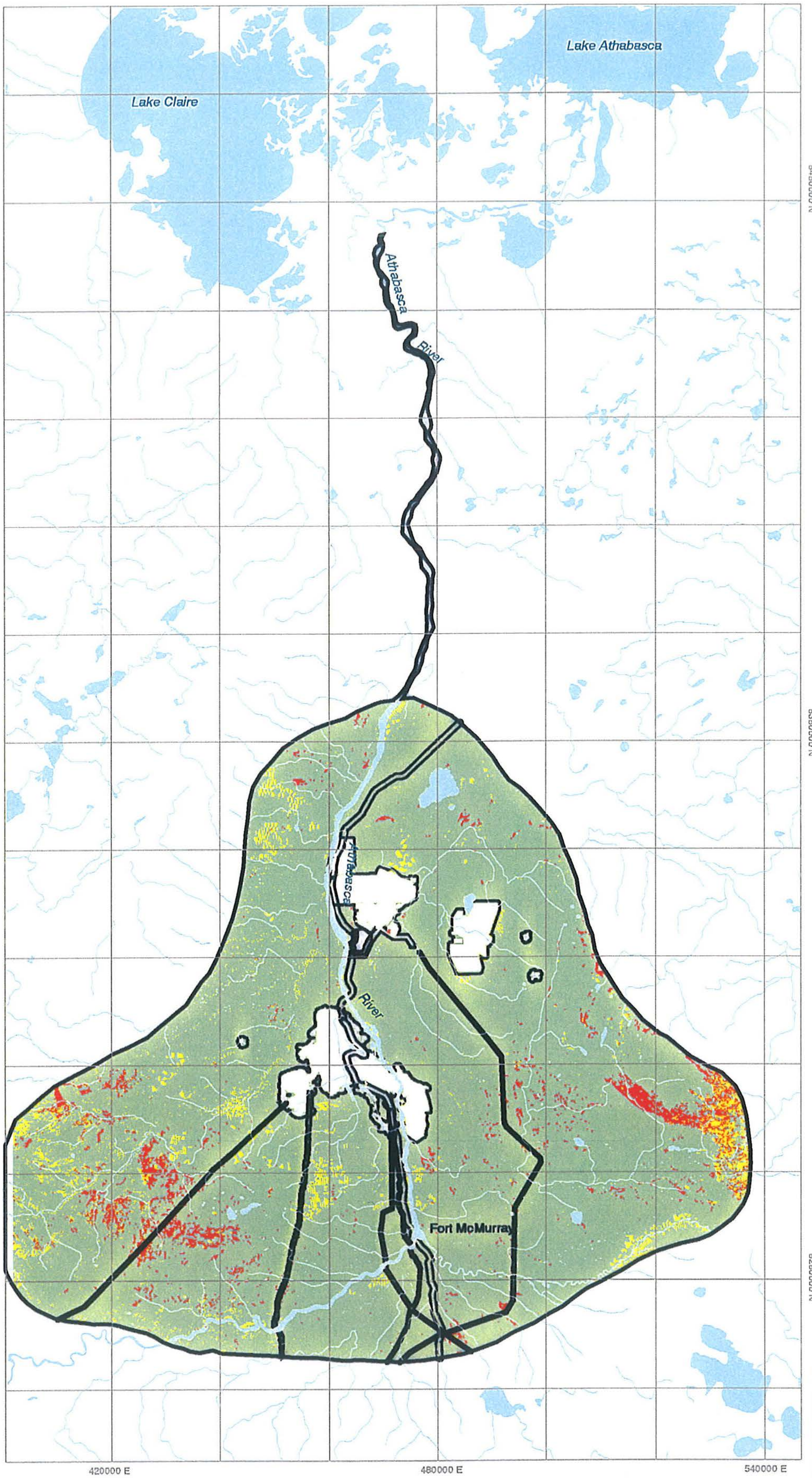
MAP PROJECTION: UTM Zone 12 NAD 83 (GRS 1980)

Golder Associates

SHELL CANADA LIMITED

REGIONAL STUDY AREA GREAT GRAY OWL HABITAT SUITABILITY IMPACT SCENARIO 1

6 Feb. 1998	Figure 63	PRODUCED BY: J.H. REVIEWED BY:



LEGEND

- Regional Study Boundary
- Disturbance Effect Boundary
- Hydrology

Habitat Suitability Index

- Unknown
- Low
- Moderate
- High

5 0 5 10 15 20 25
Kilometres

N

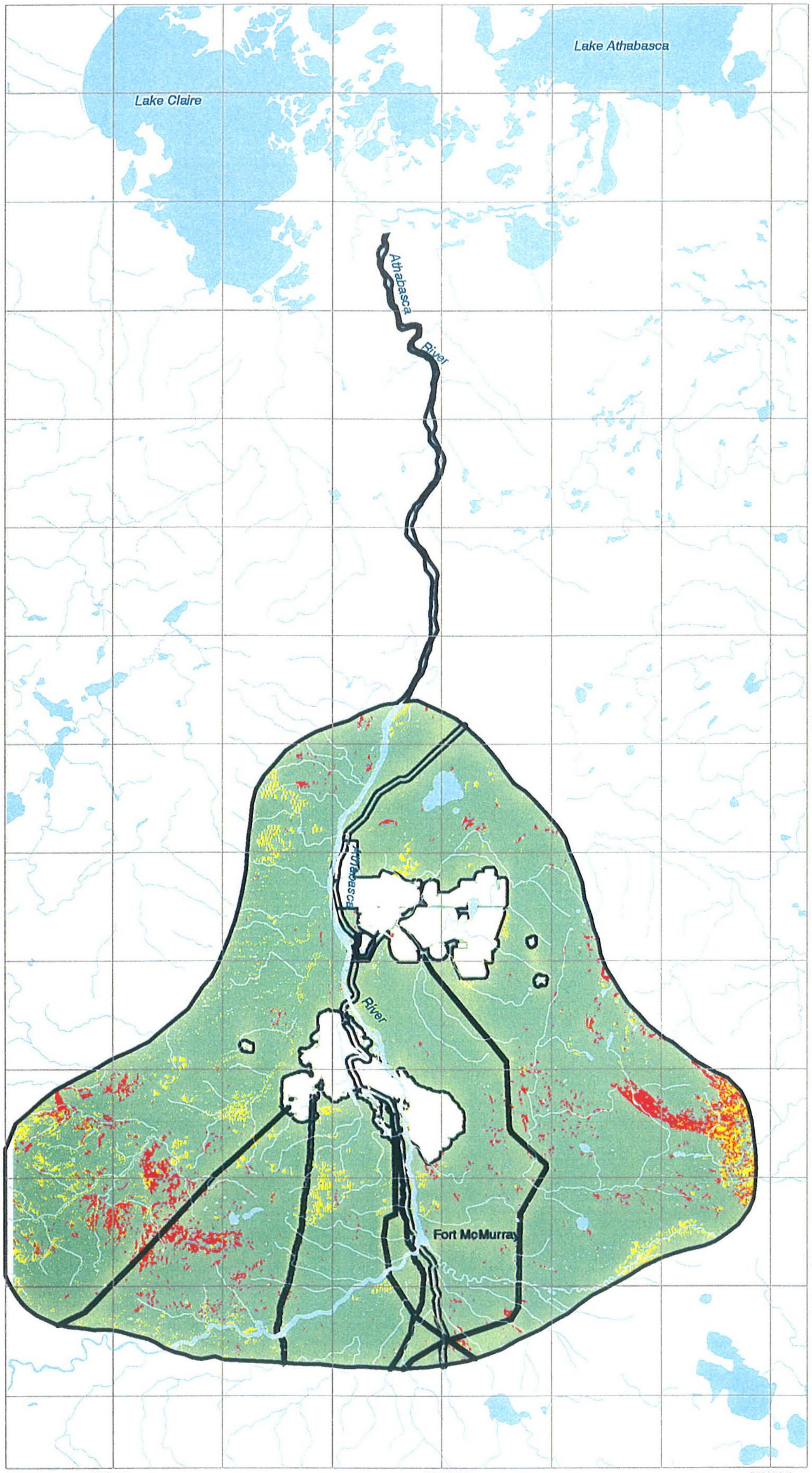
SOURCE: Golder Associates Ltd., Petro-Canada, RADARSAT International, Suncor, Syncrude

MAP PROJECTION: UTM
Zone 12
NAD 83 (GRS 1980)

Golder Associates | SHELL CANADA LIMITED

REGIONAL STUDY AREA
GREAT GRAY OWL HABITAT SUITABILITY
IMPACT SCENARIO 2

6 Feb. 1998	Figure 64	PRODUCED BY: J.H. REVIEWED BY:



LEGEND

Regional Study Boundary

Disturbance Effect Boundary

Hydrology

Habitat Suitability Index

Unknown

Low

Moderate

High

5 0 5 10 15 20 25

Kilometres

SOURCE: Golder Associates Ltd., Petro-Canada, RADARSAT International, Suncor, Syncrude

MAP PROJECTION: UTM
Zone 12
NAD 83 (GRS 1980)

Golder Associates

SHELL CANADA LIMITED

REGIONAL STUDY AREA
GREAT GRAY OWL HABITAT SUITABILITY
IMPACT SCENARIO 3

6 Feb. 1998	Figure 65	PRODUCED BY: J.H. REVIEWED BY:

scenarios are considered to have a low impact magnitude on habitat loss for the region.

Table 64 Impact of Development Scenarios on Great Gray Owl Habitat Units Within the RSA

Species	Rating	Baseline	Scenario 1	Scenario 2	Scenario 3
Great Gray Owl	Low	273,891	271,672	265,836	259,369
	Medium	12,197	12,306	11,621	11,600
	High	22,149	21954	21,825	21,737
	Total	308,237	305,932	299,281	292,706

Table 65 Percent Impact of Development Scenarios on Great Gray Owl Habitat Units Within the RSA

Species	Rating	Baseline	Scenario 1	Scenario 2	Scenario 3
Great Gray Owl	Low	273,891	-0.8	-2.9	-5.3
	Medium	12,197	+0.9	-4.7	-4.9
	High	22,149	-0.9	-1.5	-1.9
	Total	308,237	-0.7	-2.9	-5.0

6.2.6.3 Incremental Impacts of the Muskeg River Mine Project

Impacts of the Muskeg River Mine Project on great gray owl habitat represent 25.7% of the habitat loss due to Scenario 2 and 14.8% of the losses associated with Scenario 3 (Table 66).

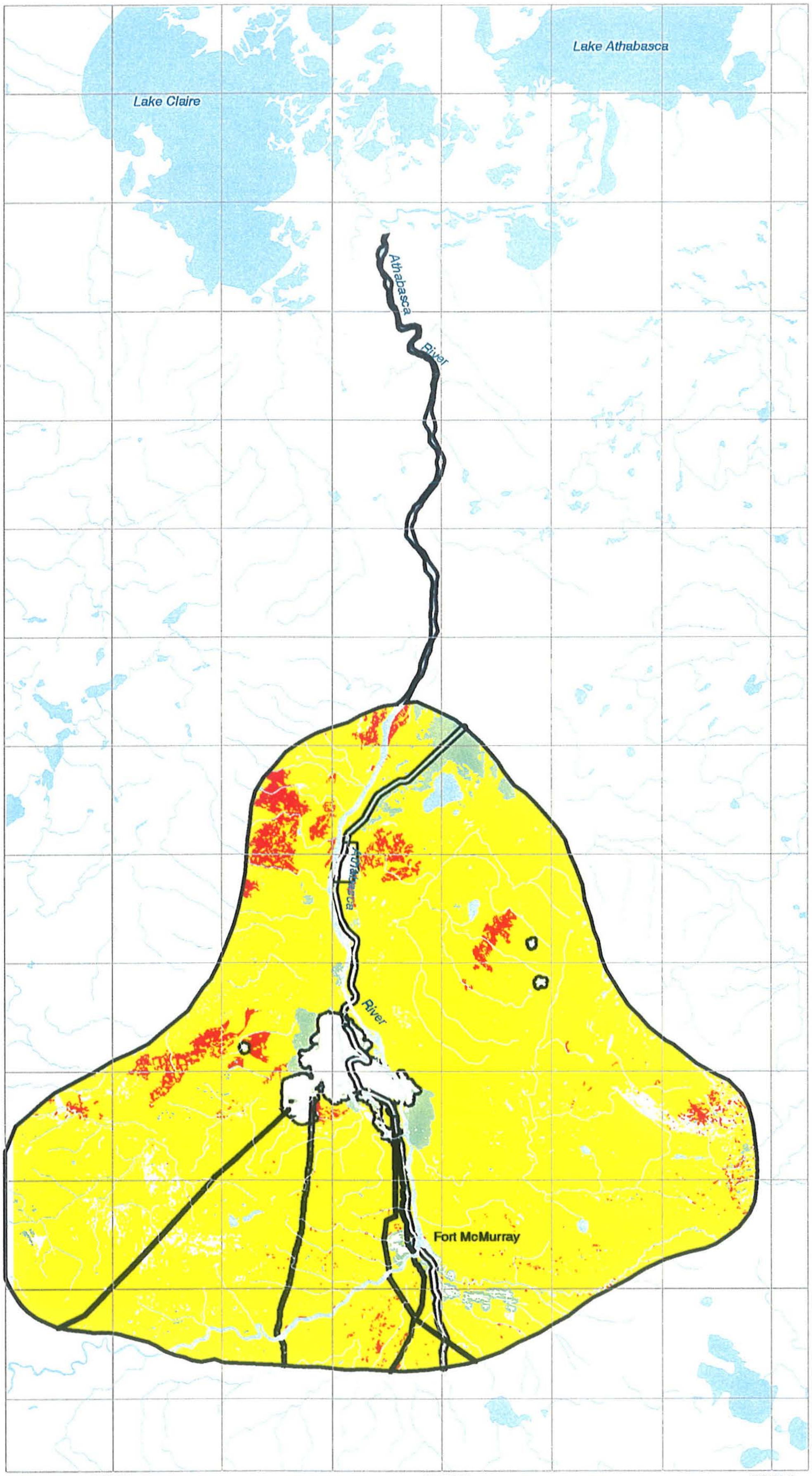
Table 66 Cumulative Assessment of Great Gray Owl Habitat Losses Associated With the Muskeg River Mine Project (MRM) in Scenario 2 (CEA) and Scenario 3 (RDR)

Scenario	Baseline HUs	Scenario HUs	HUs Loss Including MRM	HUs Loss due to MRM (% of Scenario Loss)	HUs Loss Excluding MRM	HUs Loss Excluding MRM (% of Baseline)	HUs Loss Including MRM (% of Baseline)
1: MRM	308,237	305,932	2,304				
2: CEA	308,237	299,281	8,955	25.7	6,651	2.2	2.9
3: RDR	308,237	292,706	15,530	14.8	13,226	4.3	5.0

6.2.7 Moose

6.2.7.1 Baseline Conditions

A total of 385,291 HUs were calculated to be available to moose within the RSA (Table 67, Figure 66). Of these, 3.6% represent high suitability habitat, 83.1% represent moderate suitability habitat, 5% represent low suitability habitat and 8.2% represent unsuitable habitat.



SOURCE: Golder Associates Ltd., Petro-Canada, RADARSAT International, Suncor, Syncrude

MAP PROJECTION: UTM
Zone 12
NAD 83 (GRS 1980)

Golder Associates

SHELL CANADA LIMITED

REGIONAL STUDY AREA
MOOSE HABITAT SUITABILITY
BASELINE SCENARIO

6 Feb. 1998 | Figure 66 | PRODUCED BY: J.H. REVIEWED BY:

/data6/oilsands/shell_hal/regional/habitat.apr

Table 67 Percentage of Moose Habitat Units and Habitat Areas among Unsuitable, Low, Medium and High Classes in the RSA for each Development Scenario

Species	Scenario	HUs	Percent of HUs			Percent of Area			
			Low	Medium	High	Unsuitable	Low	Medium	High
Moose	Baseline	385,291	2.5	89.8	7.7	8.2	5.0	83.1	3.6
	Scenario 1	382,860	2.6	89.7	7.7	8.6	5.3	82.5	3.6
	Scenario 2	373,963	2.8	89.9	7.3	10.3	5.6	80.7	3.3
	Scenario 3	363,886	3.3	88.7	8.0	12.1	6.4	78.2	3.3

6.2.7.2 Development Scenarios

Impacts related to the Muskeg River Mine (Scenario 1: Tables 68-69; Figure 67) are predicted to decrease 0.6% of the total moose HUs within the RSA. Scenario 2 (CEA) (Figure 68) is expected to result in the loss of 2.9% of the total HUs within the RSA while Scenario 3 (RDR) (Figure 69) is projecting the loss of 5.6% of the total HUs. All three development scenarios are considered to have a low impact magnitude on habitat loss for the region.

Table 68 Impact of Development Scenarios on Moose Habitat Units Within the RSA

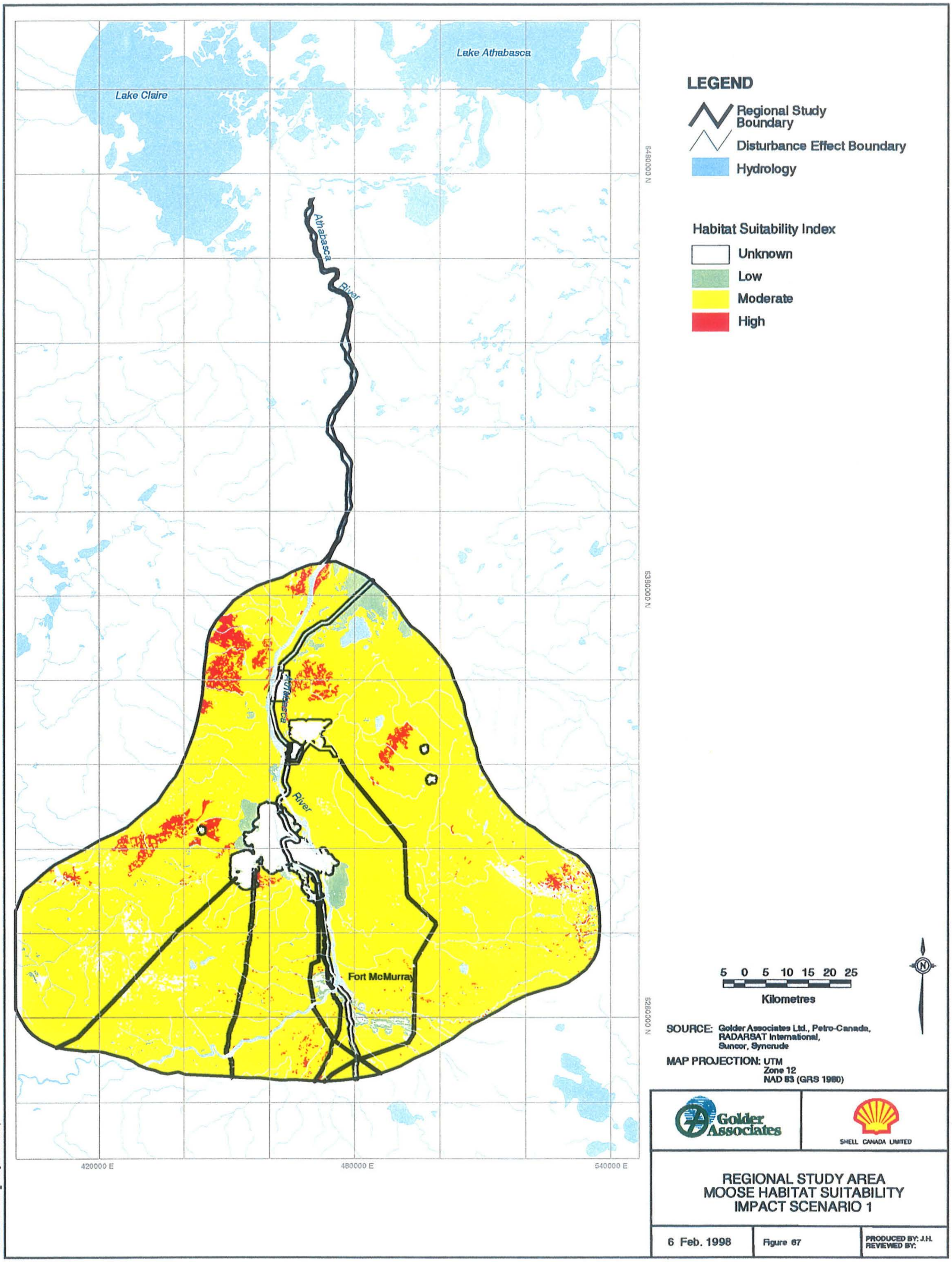
Species	Rating	Baseline	Scenario 1	Scenario 2	Scenario 3
Moose	Low	9,499	9,832	10,401	12,166
	Medium	346,117	343,477	336,105	322,670
	High	29,675	29,551	27,457	29050
	Total	385,291	382,860	373,963	363,886

Table 69 Percent Impact of Development Scenarios on Moose Habitat Units Within the RSA

Species	Rating	Baseline	Scenario 1	Scenario 2	Scenario 3
Moose	Low	9,499	+3.5	+9.5	+28.1
	Medium	346,117	-0.8	-2.9	-6.8
	High	29,675	-0.4	-7.5	-2.1
	Total	385,291	-0.6	-2.9	-5.6

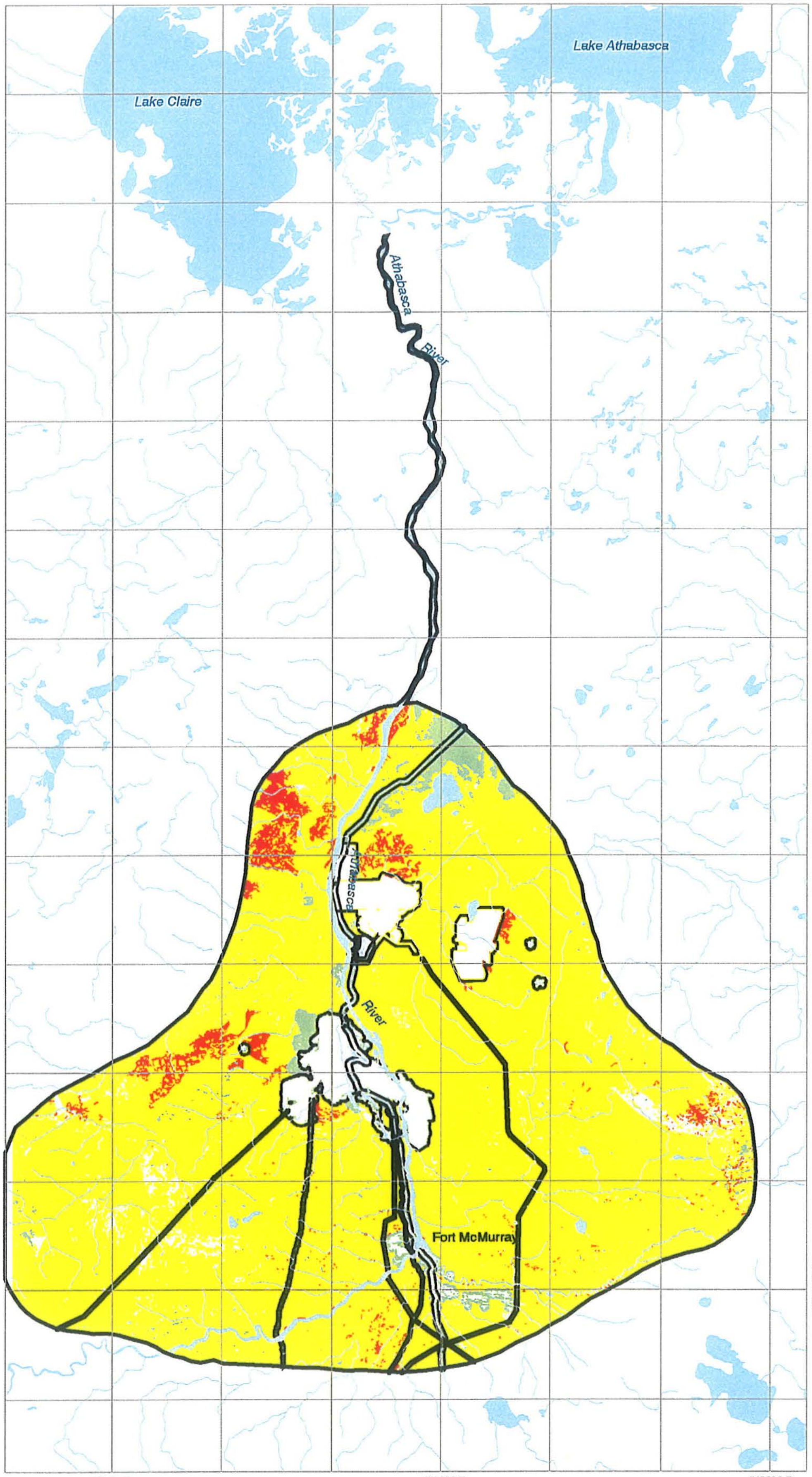
6.2.7.3 Incremental Impacts of the Muskeg River Mine Project

Impacts of the Muskeg River Mine Project on moose habitat represent 21.5% of the habitat loss due to Scenario 2 and 11.4% of the losses associated with Scenario 3 (Table 70).



REGIONAL STUDY AREA
MOOSE HABITAT SUITABILITY
IMPACT SCENARIO 1

6 Feb. 1998 | Figure 67 | PRODUCED BY: J.H. REVIEWED BY:



LEGEND

Regional Study Boundary

Disturbance Effect Boundary

Hydrology

Habitat Suitability Index

Unknown

Low

Moderate

High

5 0 5 10 15 20 25

Kilometres

SOURCE: Golder Associates Ltd., Petro-Canada, RADARSAT International, Suncor, Syncrude

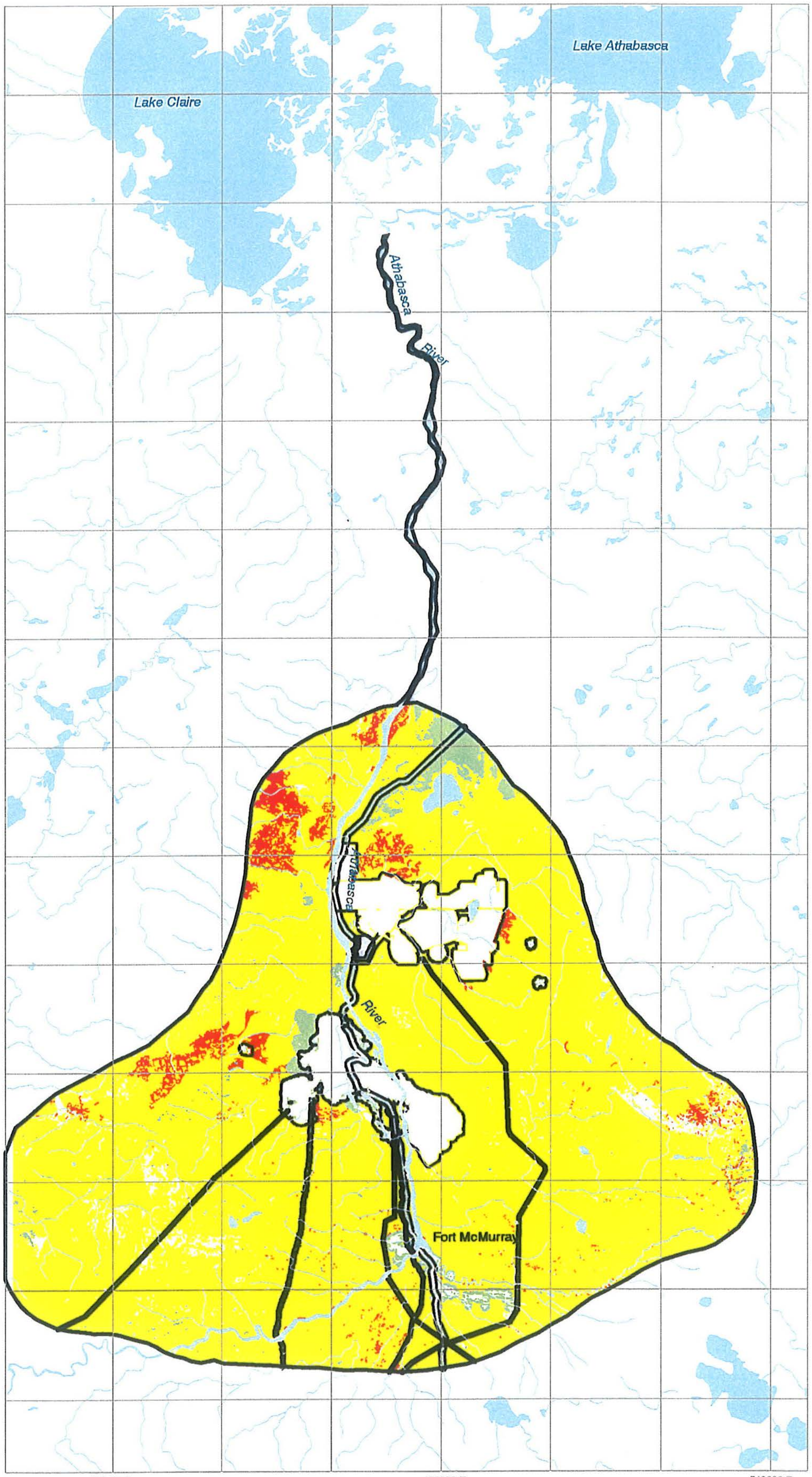
MAP PROJECTION: UTM
Zone 12
NAD 83 (GRS 1980)

Golder Associates

SHELL CANADA LIMITED

REGIONAL STUDY AREA MOOSE HABITAT SUITABILITY IMPACT SCENARIO 2

6 Feb. 1998	Figure 68	PRODUCED BY: J.H. REVIEWED BY:



SOURCE: Golder Associates Ltd., Petro-Canada, RADARSAT International, Suncor, Syncrude

MAP PROJECTION: UTM Zone 12 NAD 83 (GRS 1980)

Golder Associates

SHELL CANADA LIMITED

REGIONAL STUDY AREA
MOOSE HABITAT SUITABILITY
IMPACT SCENARIO 3

6 Feb. 1998 | Figure 69 | PRODUCED BY: J.H. REVIEWED BY:

Table 70 Cumulative Assessment of Moose Habitat Losses Associated With the Muskeg River Mine Project (MRM) in Scenario 2 (CEA) and Scenario 3 (RDR)

Scenario	Baseline HUs	Scenario HUs	HUs Loss Including MRM	HUs Loss due to MRM (% of Scenario Loss)	HUs Loss Excluding MRM	HUs Loss Excluding MRM (% of Baseline)	HUs Loss Including MRM (% of Baseline)
1: MRM	385,291	382,860	2,431				
2: CEA	385,291	373,963	11,328	21.5	8,897	2.3	2.9
3: RDR	385,291	363,886	21,405	11.4	18,974	4.9	5.6

6.2.8 Pileated Woodpecker

6.2.8.1 Baseline Conditions

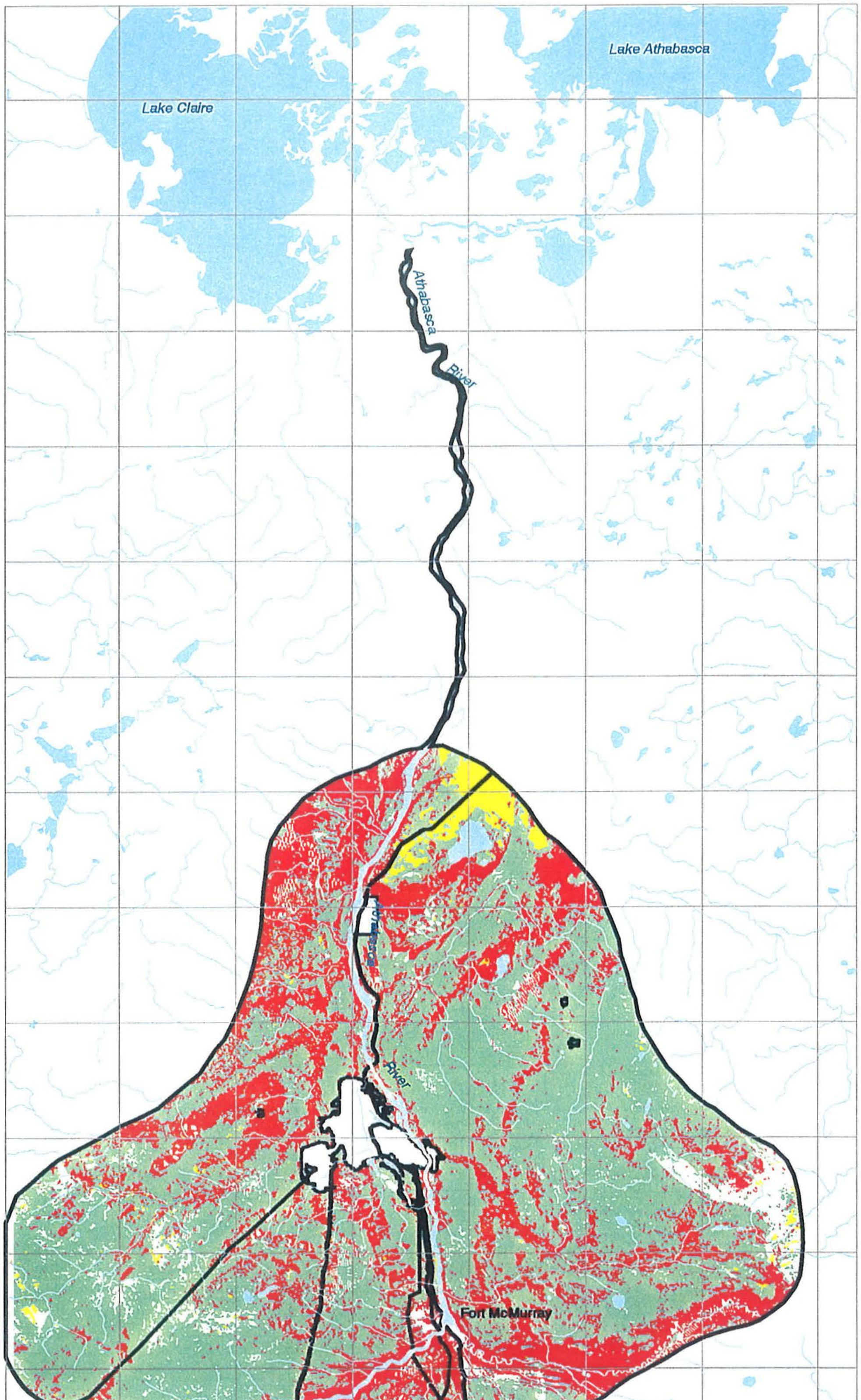
A total of 324,826 HUs were calculated to be available to pileated woodpeckers within the RSA (Table 71, Figure 70). Of these, 18.2% represent high suitability habitat, 8.9% represent moderate suitability habitat, 62% represent low suitability habitat and 10.9% represent unsuitable habitat.

Table 71 Percentage of Pileated Woodpecker Habitat Units and Habitat Areas Among Unsuitable, Low, Medium and High Classes in the RSA for Each Development Scenario

Species	Scenario	HUs	Percent of HUs			Percent of Area			
			Low	Medium	High	Unsuitable	Low	Medium	High
Pileated Woodpecker	Baseline	324,826	28.2	18.6	53.2	10.9	62.0	8.9	18.2
	Scenario 1	323315	28.2	18.6	53.2	11.3	61.7	8.8	18.2
	Scenario 2	318,695	28.0	18.7	53.3	12.8	60.5	8.8	17.9
	Scenario 3	311,457	28.1	18.7	53.2	14.5	59.4	8.6	17.5

6.2.8.2 Development Scenarios

Impacts related to the Muskeg River Mine (Scenario 1: Tables 72-73; Figure 71) are predicted to decrease 0.5% of the total pileated woodpecker HUs within the RSA. Scenario 2 (CEA) (Figure 72) is expected to result in the loss of 1.9% of the total HUs within the RSA while Scenario 3 (RDR) (Figure 73) is projecting the loss of 4.1% of the total HUs. All three development scenarios are considered to have a low impact magnitude on habitat loss for the region.



LEGEND

Regional Study Boundary

Disturbance Effect Boundary

Hydrology

Habitat Suitability Index

Unknown

Low

Moderate

High

5 0 5 10 15 20 25

Kilometres

SOURCE: Golder Associates Ltd., Petro-Canada, RADARSAT International, Suncor, Syncrude

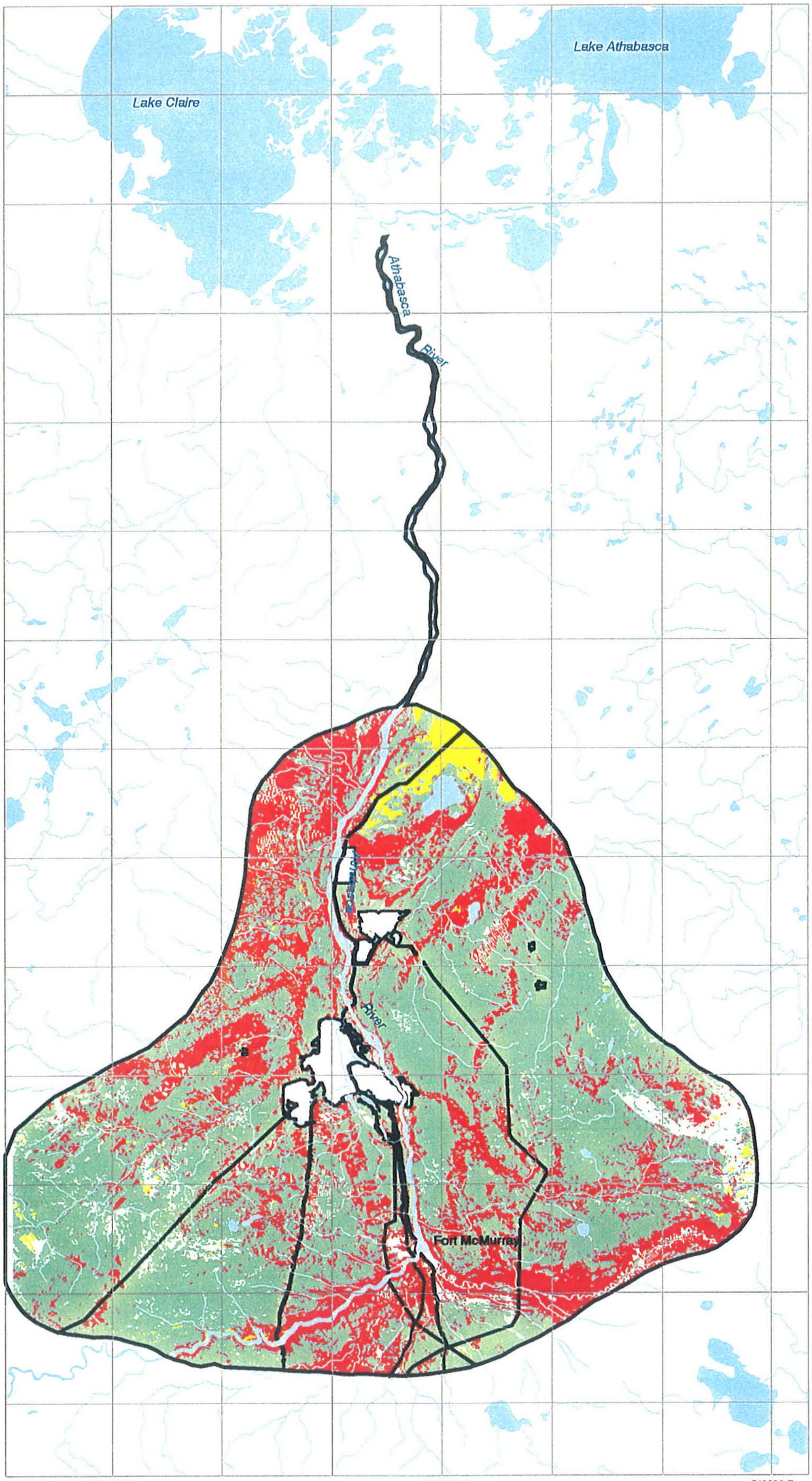
MAP PROJECTION: UTM
Zone 12
NAD 83 (GRS 1980)

Golder Associates

SHELL CANADA LIMITED

REGIONAL STUDY AREA
PILEATED WOODPECKER HABITAT SUITABILITY
BASELINE SCENARIO

6 Feb. 1998 | Figure 70 | PRODUCED BY: J.H. REVIEWED BY:



LEGEND

Regional Study Boundary

Disturbance Effect Boundary

Hydrology

Habitat Suitability Index

Unknown

Low

Moderate

High

5 0 5 10 15 20 25

Kilometres

SOURCE: Golder Associates Ltd., Petro-Canada, RADARSAT International, Suncor, Syncrude

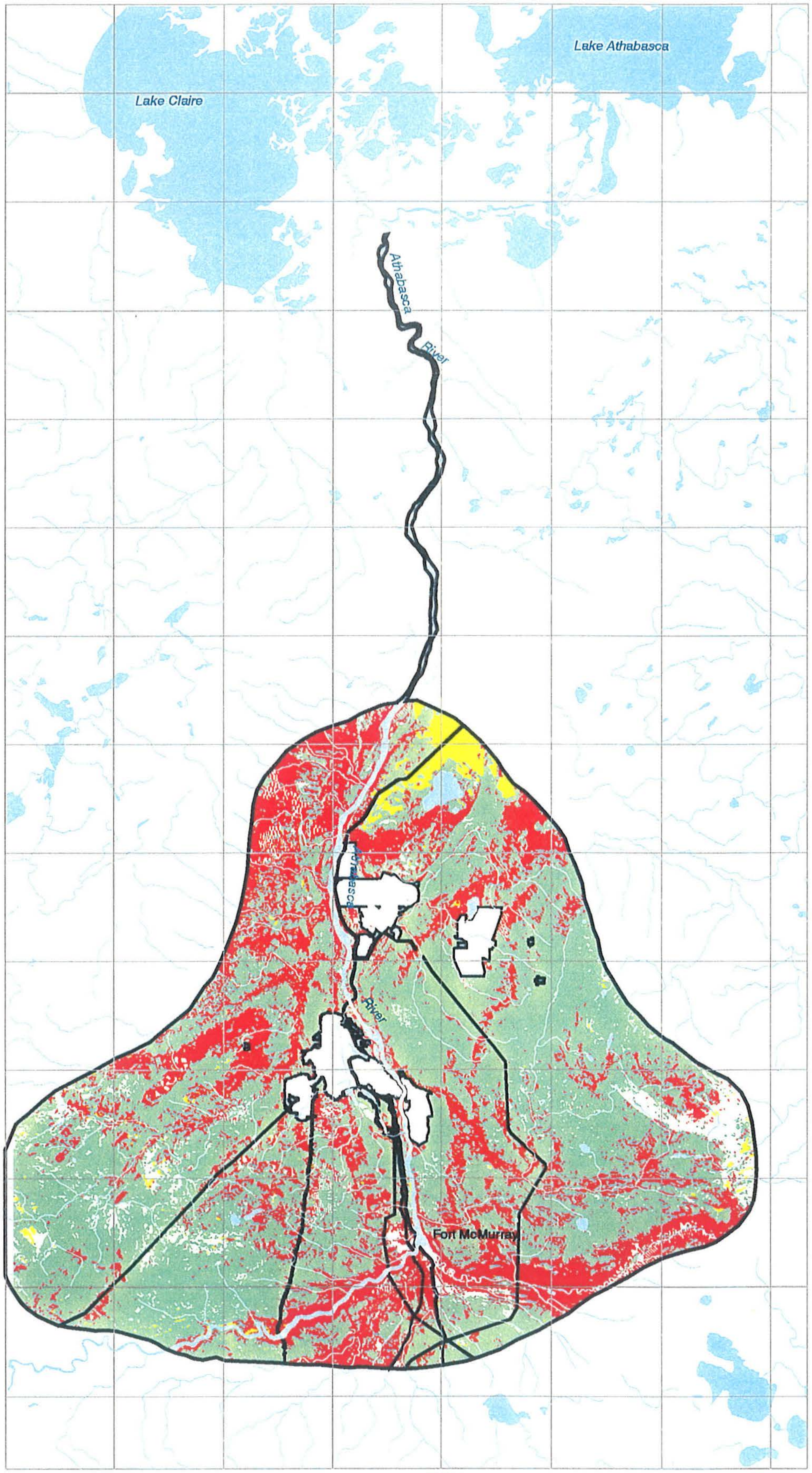
MAP PROJECTION: UTM
Zone 12
NAD 83 (GRS 1980)

Golder Associates

SHELL CANADA LIMITED

REGIONAL STUDY AREA
PILEATED WOODPECKER HABITAT SUITABILITY
IMPACT SCENARIO 1

6 Feb. 1998 | Figure 71 | PRODUCED BY: J.H. REVIEWED BY:



LEGEND

Regional Study Boundary

Disturbance Effect Boundary

Hydrology

Habitat Suitability Index

- Unknown
- Low
- Moderate
- High

5 0 5 10 15 20 25

Kilometres

SOURCE: Golder Associates Ltd., Petro-Canada, RADARSAT International, Suncor, Syncrude

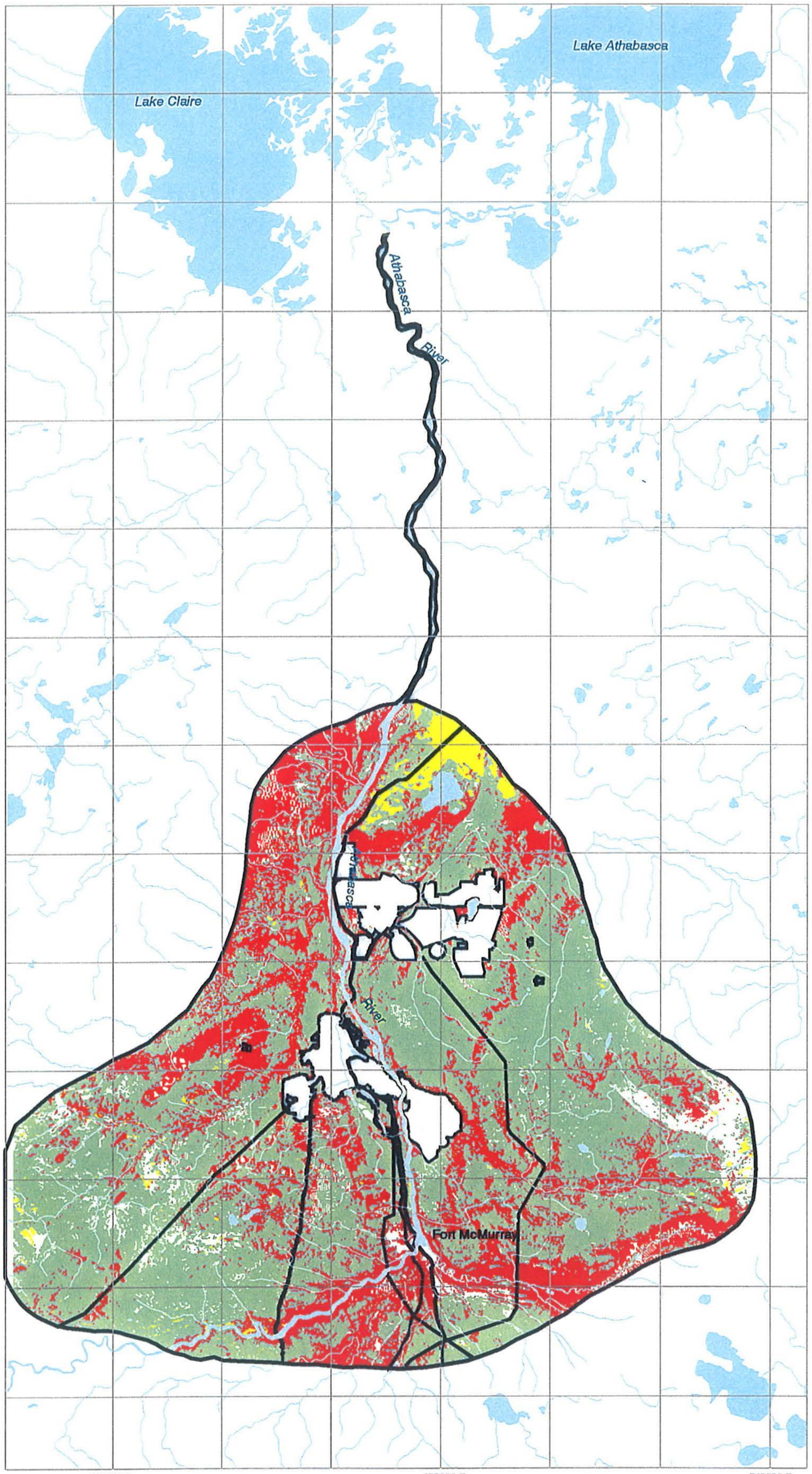
MAP PROJECTION: UTM Zone 12 NAD 83 (GRS 1980)

Golder Associates

SHELL CANADA LIMITED

REGIONAL STUDY AREA
PILEATED WOODPECKER HABITAT SUITABILITY
IMPACT SCENARIO 2

6 Feb. 1998	Figure 72	PRODUCED BY: J.H. REVIEWED BY:



LEGEND

- Regional Study Boundary
- Disturbance Effect Boundary
- Hydrology

Habitat Suitability Index

- Unknown
- Low
- Moderate
- High

5 0 5 10 15 20 25

Kilometres

N

SOURCE: Golder Associates Ltd., Petro-Canada, RADARSAT International, Suncor, Syncrude

MAP PROJECTION: UTM
Zone 12
NAD 83 (GRS 1980)

Golder Associates

SHELL CANADA LIMITED

REGIONAL STUDY AREA PILEATED WOODPECKER HABITAT SUITABILITY IMPACT SCENARIO 3

6 Feb. 1998	Figure 73	PRODUCED BY: J.H. REVIEWED BY:

Table 72 Impact of Development Scenarios on Pileated Woodpecker Habitat Units Within the RSA

Species	Rating	Baseline	Scenario 1	Scenario 2	Scenario 3
Pileated Woodpecker	Low	91,692	91,103	89,375	87,479
	Medium	60,263	60,139	59,564	58,321
	High	172,871	172,073	169,756	165,658
	Total	324,826	323,315	318,695	311,457

Table 73 Percent Impact of Development Scenarios on Pileated Woodpecker Habitat Units Within the RSA

Species	Rating	Baseline	Scenario 1	Scenario 2	Scenario 3
Pileated Woodpecker	Low	91,692	-0.6	-2.5	-4.6
	Medium	60,263	-0.2	-1.2	-3.2
	High	172,871	-0.5	-1.8	-4.2
	Total	324,826	-0.5	-1.9	-4.1

6.2.8.3 Incremental Impacts of the Muskeg River Mine Project

Impacts of the Muskeg River Mine Project on pileated woodpecker habitat represent 24.6% of the habitat loss due to Scenario 2 and 11.3% of the losses associated with Scenario 3 (Table 74).

Table 74 Cumulative Assessment of Pileated Woodpecker Habitat Losses Associated With the Muskeg River Mine Project (MRM) in Scenario 2 (CEA) and Scenario 3 (RDR)

Scenario	Baseline HUs	Scenario HUs	HUs Loss Including MRM	HUs Loss due to MRM (% of Scenario Loss)	HUs Loss Excluding MRM	HUs Loss Excluding MRM (% of Baseline)	HUs Loss Including MRM (% of Baseline)
1: MRM	324,826	323,315	1,511				
2: CEA	324,826	318,695	6,131	24.6	4,620	1.4	1.9
3: RDR	324,826	311,457	13,369	11.3	11,858	3.7	4.1

6.2.9 Red-backed Vole

6.2.9.1 Baseline Conditions

A total of 505,202 HUs were calculated to be available to red-backed voles within the RSA (Table 75, Figure 74). Of these, 7.8% represent high suitability habitat, 83.7% represent moderate suitability habitat, 3.4% represent low suitability habitat and 5.1% represent unsuitable habitat.

Table 75 Percentage of Red-backed Vole Habitat Units and Habitat Areas Among Unsuitable, Low, Medium and High Classes in the RSA for Each Development Scenario

Species	Scenario	HUs	Percent of HUs			Percent of Area			
			Low	Medium	High	Unsuitable	Low	Medium	High
Red-backed Vole	Baseline	505,202	0.3	86.6	13.0	5.1	3.4	83.7	7.8
	Scenario 1	503,176	0.4	86.6	13.1	5.5	3.4	83.3	7.8
	Scenario 2	494,279	0.4	86.4	13.3	7.2	3.4	81.6	7.8
	Scenario 3	483,948	0.4	86.4	13.2	9.0	3.4	80.0	7.6

6.2.9.2 Development Scenarios

Impacts related to the Muskeg River Mine (Scenario 1: Tables 76-77; Figure 75) are predicted to decrease 0.4% of the total red-backed vole HUs within the RSA. Scenario 2 (CEA) (Figure 76) is expected to result in the loss of 2.2% of the total HUs within the RSA while Scenario 3 (RDR) (Figure 77) is projecting the loss of 4.2% of the total HUs. All three development scenarios are considered to have a low impact magnitude on habitat loss for the region.

Table 76 Impact of Development Scenarios on Red-backed Vole Habitat Units Within the RSA

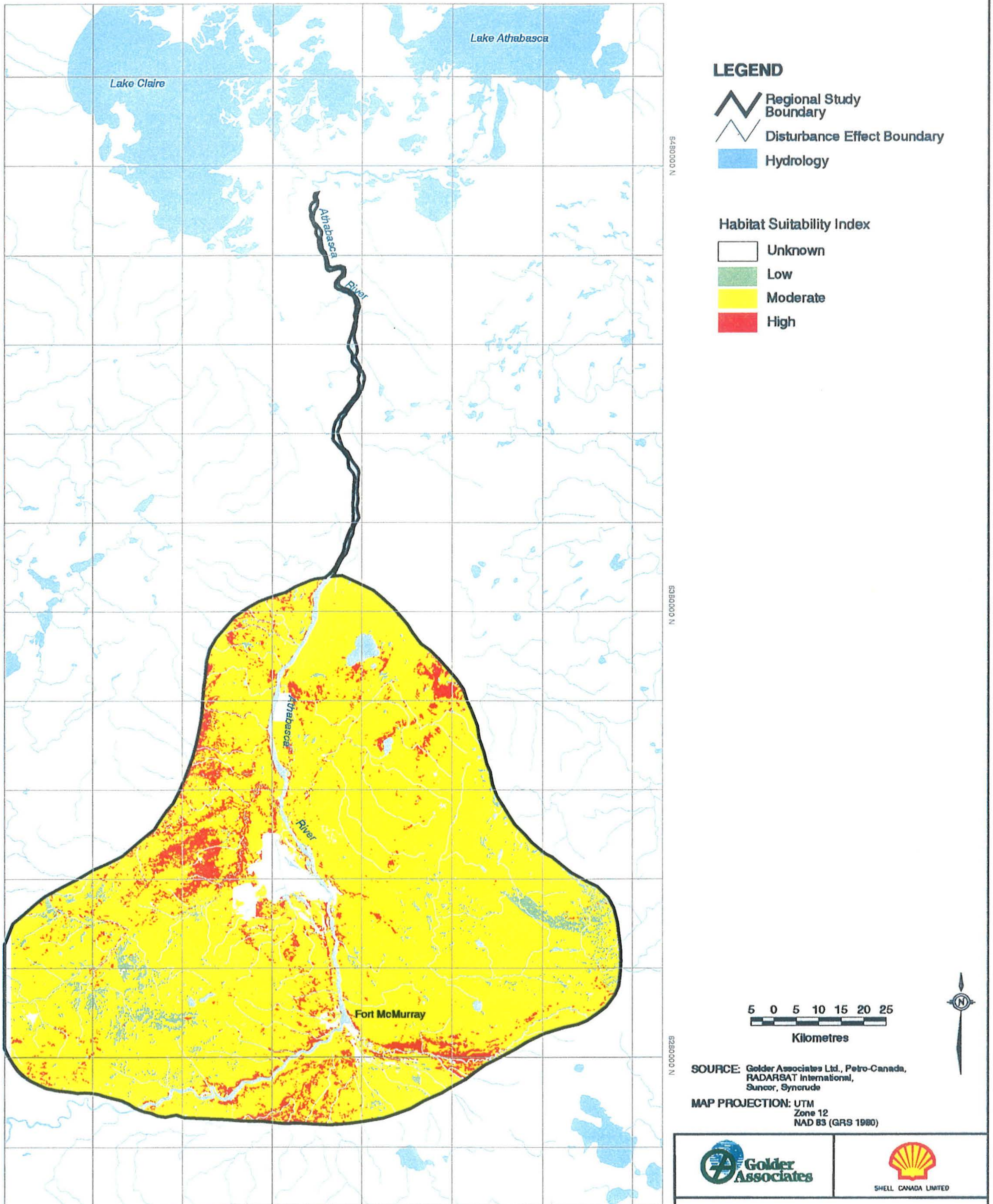
Species	Rating	Baseline	Scenario 1	Scenario 2	Scenario 3
Red-backed Vole	Low	1,767	1,766	1,757	1,764
	Medium	437,700	435,707	426,828	418,356
	High	65,735	65,704	65,694	63,829
	Total	505,202	503,176	49,4279	483,948

Table 77 Percent Impact of Development Scenarios on Red-backed Vole Habitat Units Within the RSA

Species	Rating	Baseline	Scenario 1	Scenario 2	Scenario 3
Red-backed Vole	Low	1,767	-0.1	-0.6	-0.2
	Medium	437,700	-0.5	-2.5	-4.4
	High	65,735	-0.0	-0.1	-2.9
	Total	505,202	-0.4	-2.2	-4.2

6.2.9.3 Incremental Impacts of the Muskeg River Mine Project

Impacts of the Muskeg River Mine Project on red-backed vole habitat represent 18.5% of the habitat loss due to Scenario 2 and 9.5% of the losses associated with Scenario 3 (Table 78).

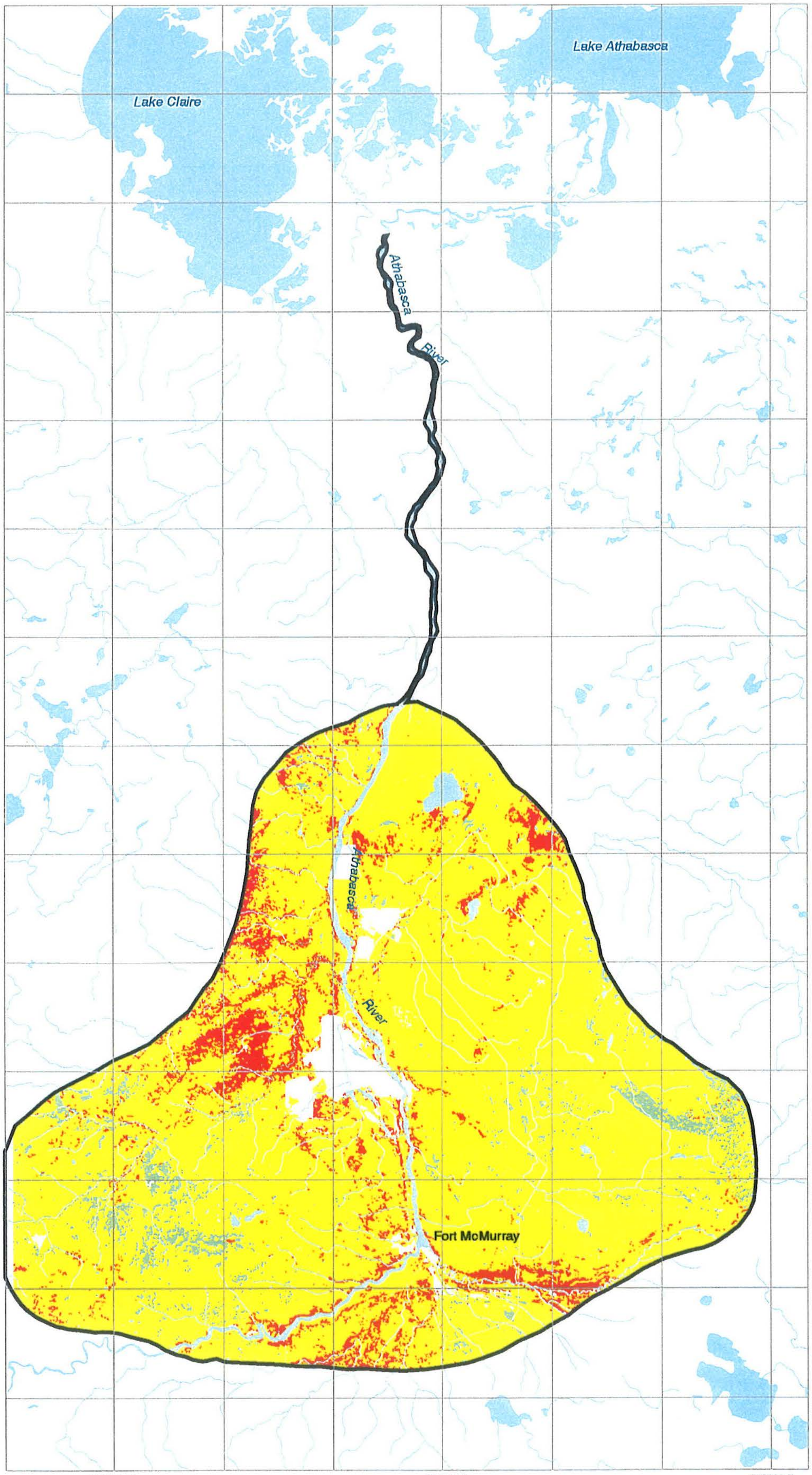


Golder Associates

SHELL CANADA LIMITED

REGIONAL STUDY AREA
RED-BACKED VOLE HABITAT SUITABILITY
BASELINE SCENARIO

6 Feb. 1998	Figure 74	PRODUCED BY: J.H. REVIEWED BY:



LEGEND

Regional Study Boundary

Disturbance Effect Boundary

Hydrology

Habitat Suitability Index

Unknown

Low

Moderate

High

5 0 5 10 15 20 25

Kilometres

SOURCE: Golder Associates Ltd., Petro-Canada, RADARSAT International, Suncor, Syncrude

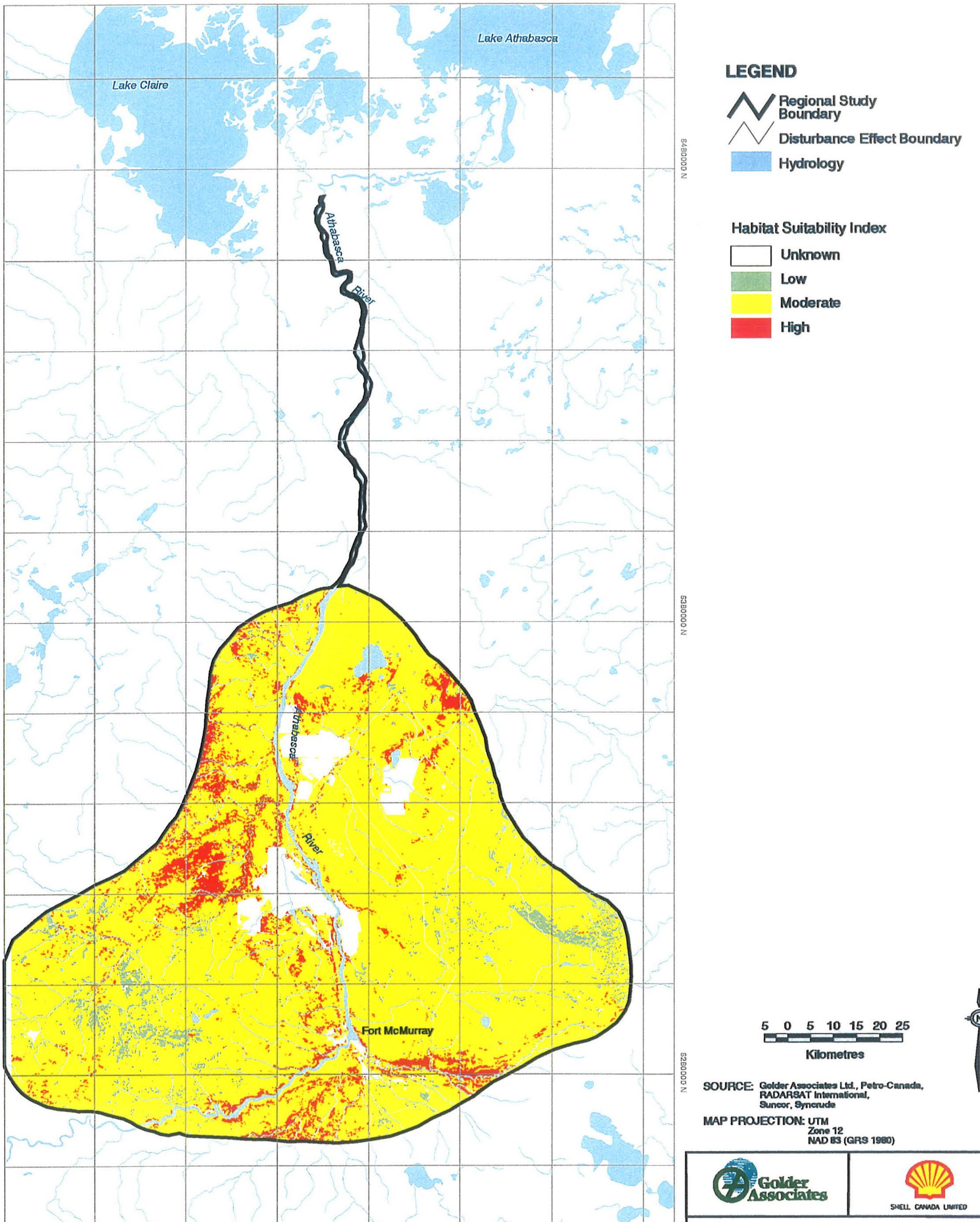
MAP PROJECTION: UTM
Zone 12
NAD 83 (GRS 1980)

Golder Associates

SHELL CANADA LIMITED

REGIONAL STUDY AREA
RED-BACKED VOLE HABITAT SUITABILITY
IMPACT SCENARIO 1

6 Feb. 1998	Figure 75	PRODUCED BY: J.H. REVIEWED BY:



SOURCE: Golder Associates Ltd., Petro-Canada, RADARSAT International, Suncor, Syncrude

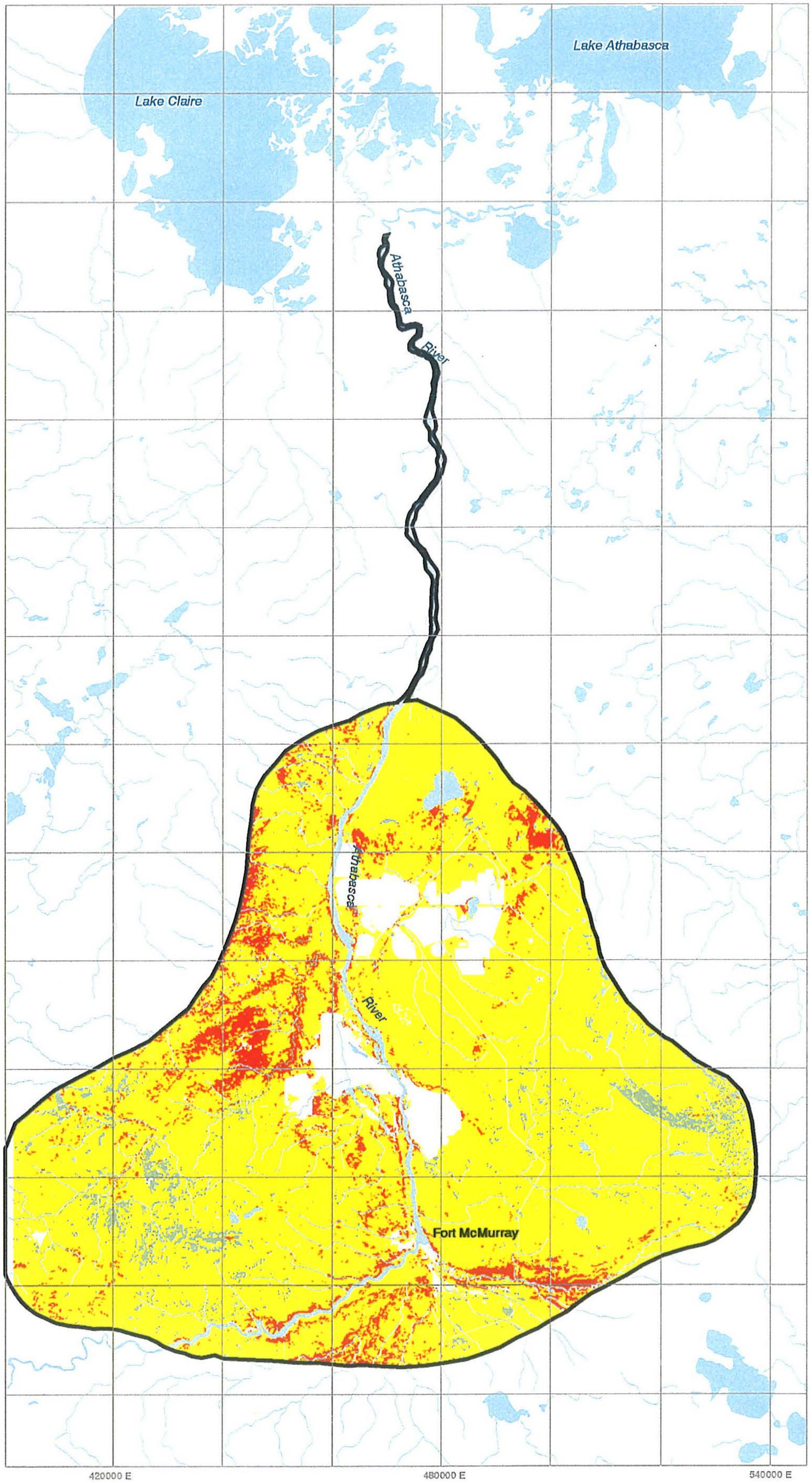
MAP PROJECTION: UTM
Zone 12
NAD 83 (GRS 1980)

Golder Associates

SHELL CANADA LIMITED

REGIONAL STUDY AREA
RED-BACKED VOLE HABITAT SUITABILITY
IMPACT SCENARIO 2

6 Feb. 1998	Figure 78	PRODUCED BY: J.H. REVIEWED BY:



LEGEND

- Regional Study Boundary
- Disturbance Effect Boundary
- Hydrology

Habitat Suitability Index

- Unknown
- Low
- Moderate
- High

5 0 5 10 15 20 25

Kilometres

SOURCE: Golder Associates Ltd., Petro-Canada, RADARSAT International, Suncor, Syncrude

MAP PROJECTION: UTM Zone 12 NAD 83 (GRS 1980)

Golder Associates

SHELL CANADA LIMITED

REGIONAL STUDY AREA
RED-BACKED VOLE HABITAT SUITABILITY
IMPACT SCENARIO 3

6 Feb. 1998	Figure 77	PRODUCED BY: J.H. REVIEWED BY:

/data9/oilsands/shell_hs/regional/habitat.apr

Table 78 Cumulative Assessment of Red-backed Vole Habitat Losses Associated With the Muskeg River Mine Project (MRM) in Scenario 2 (CEA) and Scenario 3 (RDR)

Scenario	Baseline HUs	Scenario HUs	HUs Loss Including MRM	HUs Loss due to MRM (% of Scenario Loss)	HUs Loss Excluding MRM	HUs Loss Excluding MRM (% of Baseline)	HUs Loss Including MRM (% of Baseline)
1: MRM	505,202	503,176	2,026				
2: CEA	505,202	494,279	10,923	18.5	8897	1.8	2.2
3: RDR	505,202	483,948	21,254	9.5	19228	3.8	4.2

6.2.10 Ruffed Grouse

6.2.10.1 Baseline Conditions

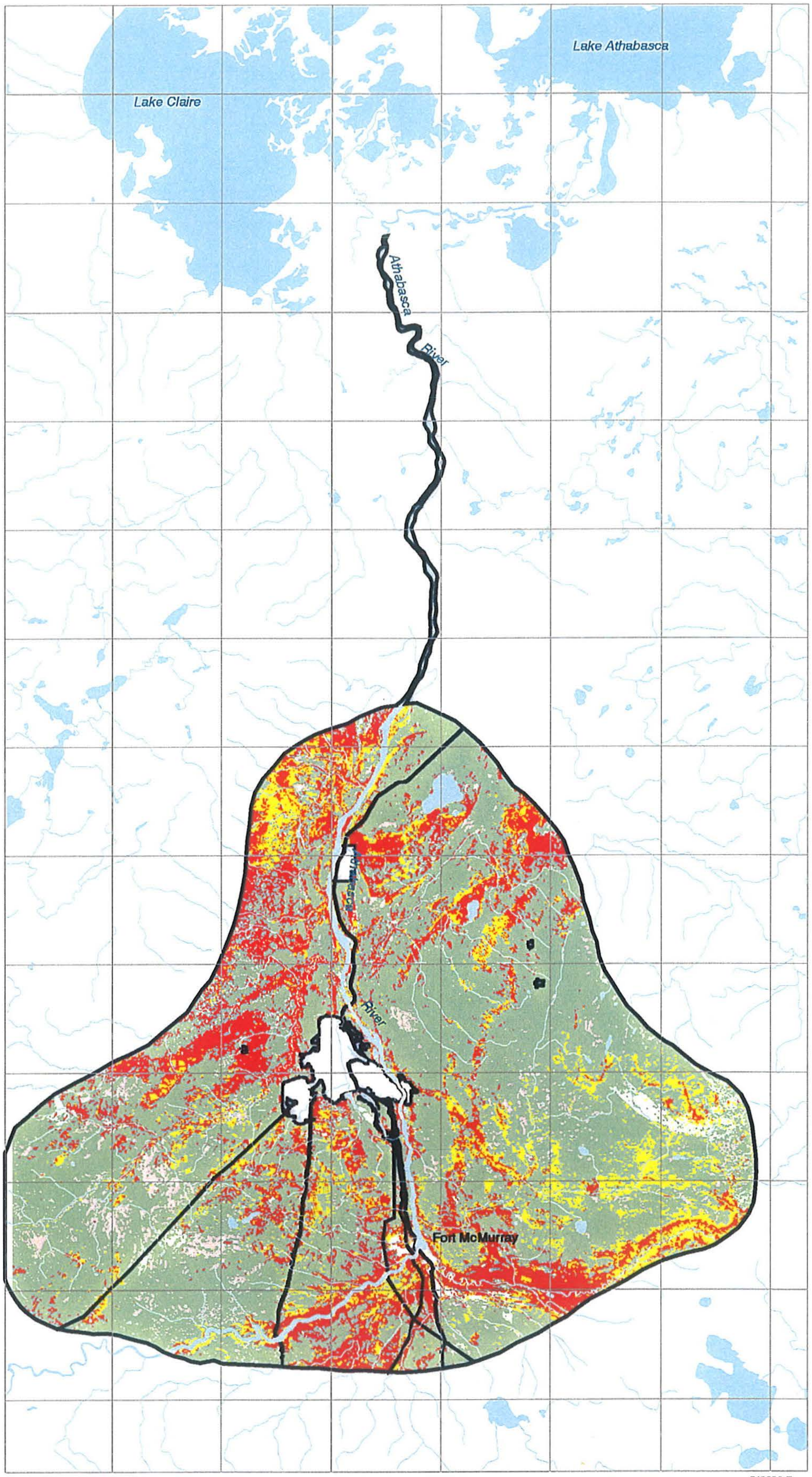
A total of 318,183 HUs were calculated to be available to ruffed grouse within the RSA (Table 79, Figure 78). Of these, 18.2% represent high suitability habitat, 7.6% represent moderate suitability habitat, 66% represent low suitability habitat and 8.2% represent unsuitable habitat.

Table 79 Percentage of Ruffed Grouse Habitat Units and Habitat Areas Among Unsuitable, Low, Medium and High Classes in the RSA for Each Development Scenario

Species	Scenario	HUs	Percent of HUs			Percent of Area			
			Low	Medium	High	Unsuitable	Low	Medium	High
Ruffed Grouse	Baseline	318,183	45.4	9.3	45.3	8.2	66.0	7.6	18.2
	Scenario 1	316,626	45.4	9.3	45.3	8.7	65.7	7.5	18.2
	Scenario 2	311,534	45.2	9.4	45.4	10.3	64.3	7.5	17.9
	Scenario 3	304,716	45.3	9.4	45.4	12.0	63.3	7.3	17.5

6.2.10.2 Development Scenarios

Impacts related to the Muskeg River Mine (Scenario 1: Tables 80-81; Figure 79) are predicted to decrease 0.5% of the total ruffed grouse HUs within the RSA. Scenario 2 (CEA) (Figure 80) is expected to result in the loss of 2.1% of the total HUs within the RSA while Scenario 3 (RDR) (Figure 81) is projecting the loss of 4.2% of the total HUs. All three development scenarios are considered to have a low impact magnitude on habitat loss for the region.



LEGEND

Regional Study Boundary

Disturbance Effect Boundary

Hydrology

Habitat Suitability Index

Unknown

Low

Moderate

High

5 0 5 10 15 20 25

Kilometres

SOURCE: Golder Associates Ltd., Petro-Canada, RADARSAT International, Suncor, Syncrude

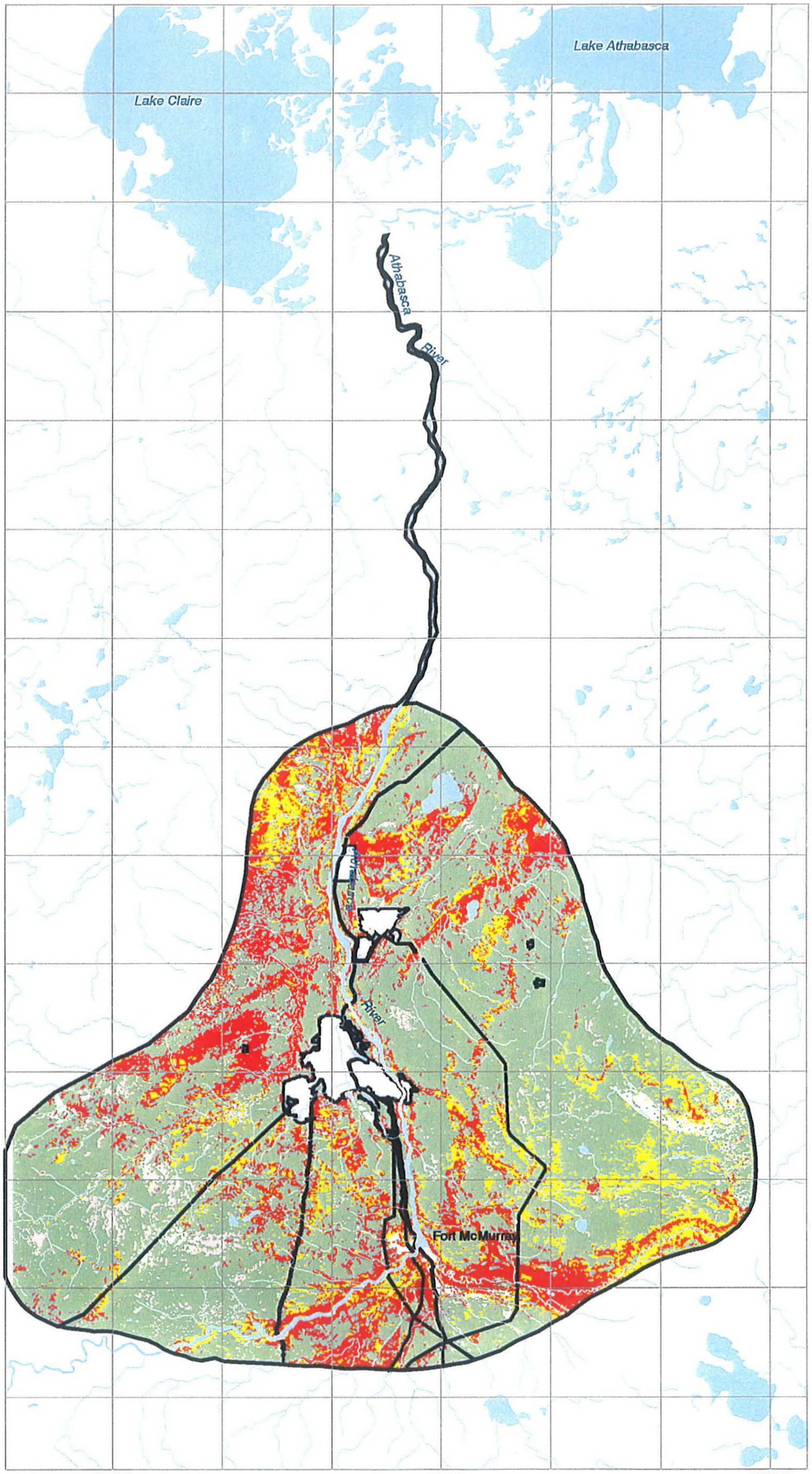
MAP PROJECTION: UTM
Zone 12
NAD 83 (GRS 1980)

Golder Associates

SHELL CANADA LIMITED

REGIONAL STUDY AREA
RUFFED GROUSE HABITAT SUITABILITY
BASELINE SCENARIO

6 Feb. 1998	Figure 78	PRODUCED BY: J.H. REVIEWED BY:



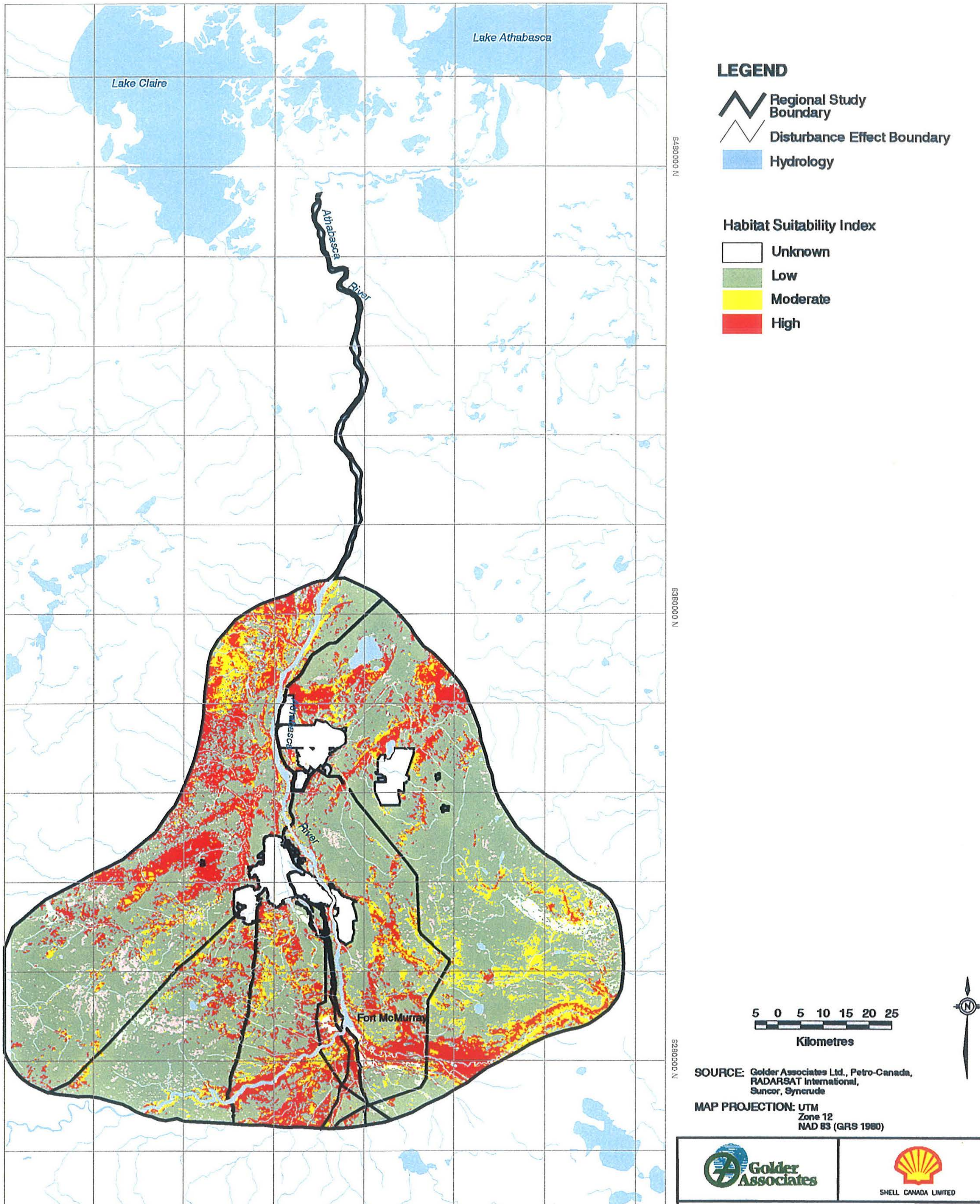
SOURCE: Golder Associates Ltd., Petro-Canada, RADARSAT International, Suncor, Syncrude

MAP PROJECTION: UTM
Zone 12
NAD 83 (GRS 1980)

Golder Associates | SHELL CANADA LIMITED

REGIONAL STUDY AREA
RUFFED GROUSE HABITAT SUITABILITY
IMPACT SCENARIO 1

6 Feb. 1998	Figure 79	PRODUCED BY: J.H. REVIEWED BY:



SOURCE: Golder Associates Ltd., Petro-Canada, RADARSAT International, Suncor, Syncrude

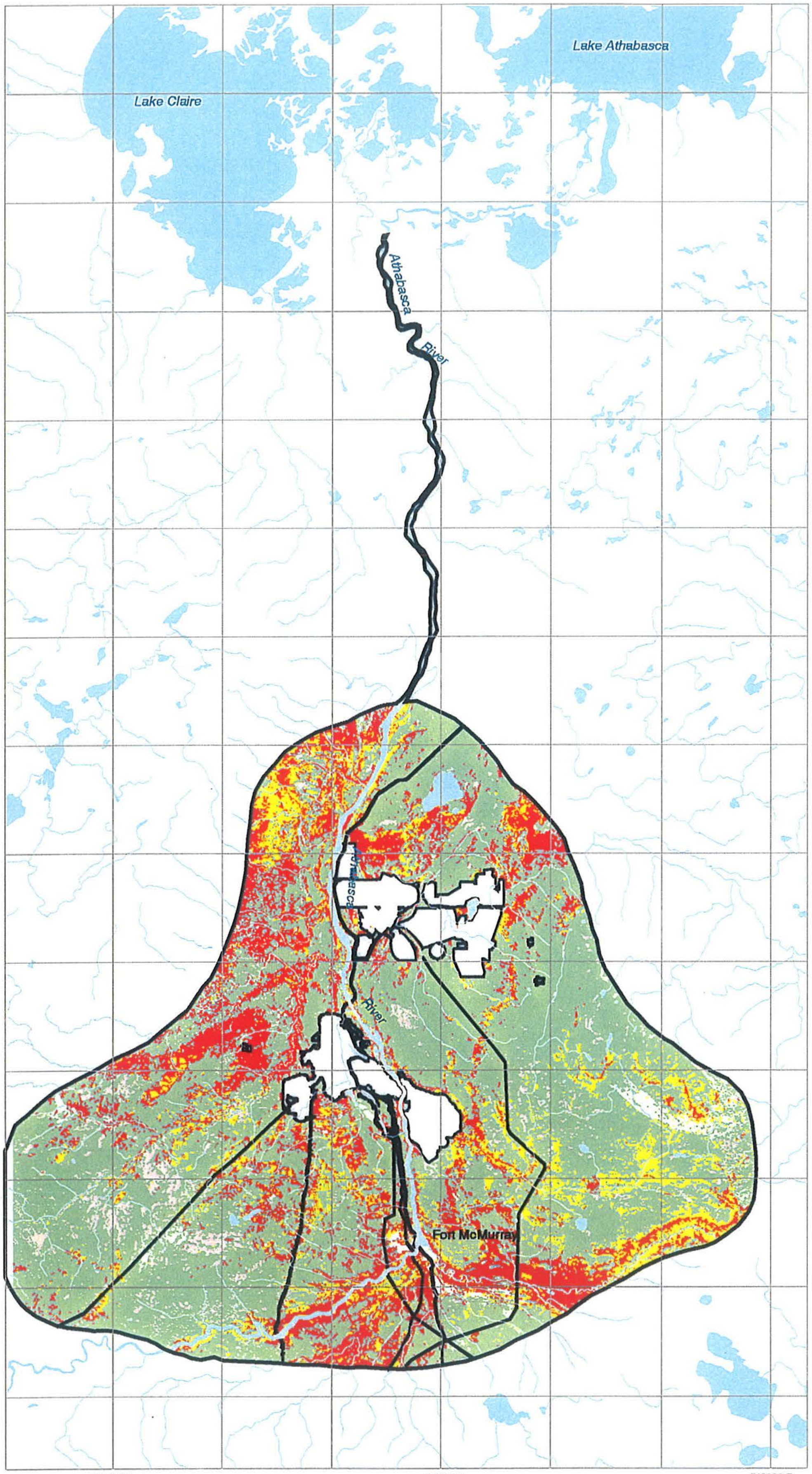
MAP PROJECTION: UTM
Zone 12
NAD 83 (GRS 1980)

Golder Associates

SHELL CANADA LIMITED

REGIONAL STUDY AREA
RUFFED GROUSE HABITAT SUITABILITY
IMPACT SCENARIO 2

6 Feb. 1998 | Figure 80 | PRODUCED BY: J.H. REVIEWED BY:



LEGEND

Regional Study Boundary

Disturbance Effect Boundary

Hydrology

Habitat Suitability Index

- Unknown
- Low
- Moderate
- High

5 0 5 10 15 20 25

Kilometres

SOURCE: Golder Associates Ltd., Petro-Canada, RADARSAT International, Suncor, Syncrude

MAP PROJECTION: UTM Zone 12 NAD 83 (GRS 1980)

Golder Associates

SHELL CANADA LIMITED

REGIONAL STUDY AREA RUFFED GROUSE HABITAT SUITABILITY IMPACT SCENARIO 3

6 Feb. 1998	Figure 81	PRODUCED BY: J.H. REVIEWED BY:

Table 80 Impact of Development Scenarios on Ruffed Grouse Habitat Units Within the RSA

Species	Rating	Baseline	Scenario 1	Scenario 2	Scenario 3
Ruffed Grouse	Low	144,486	143,648	140,706	137,889
	Medium	29,666	29,602	29,282	28,626
	High	144,030	143,376	141,546	138,201
	Total	318,183	316,626	311,534	304,716

Table 81 Percent Impact of Development Scenarios on Ruffed Grouse Habitat Units Within the RSA

Species	Rating	Baseline	Scenario 1	Scenario 2	Scenario 3
Ruffed Grouse	Low	144,486	-0.6	-2.6	-4.6
	Medium	29,666	-0.2	-1.3	-3.5
	High	144,030	-0.5	-1.7	-4.0
	Total	318,183	-0.5	-2.1	-4.2

6.2.10.3 Incremental Impacts of the Muskeg River Mine Project

Impacts of the Muskeg River Mine Project on ruffed grouse habitat represent 23.4% of the habitat loss due to Scenario 2 and 11.6% of the losses associated with Scenario 3 (Table 82).

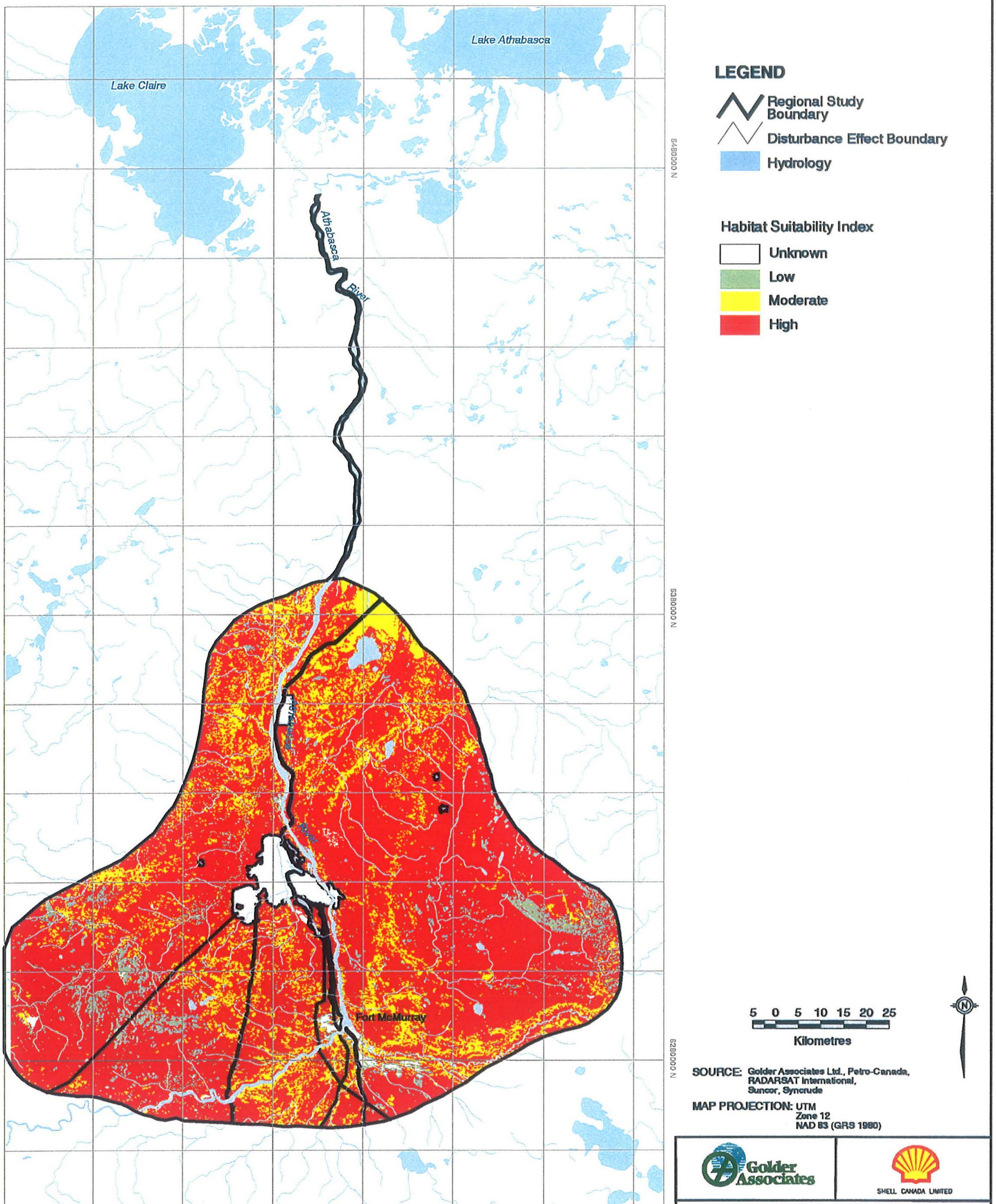
Table 82 Cumulative Assessment of Ruffed Grouse Habitat Losses Associated With the Muskeg River Mine Project (MRM) in Scenario 2 (CEA) and Scenario 3 (RDR)

Scenario	Baseline HUs	Scenario HUs	HUs Loss Including MRM	HUs Loss due to MRM (% of Scenario Loss)	HUs Loss Excluding MRM	HUs Loss Excluding MRM (% of Baseline)	HUs Loss Including MRM (% of Baseline)
1: MRM	318,183	316,626	1,556				
2: CEA	318,183	311,534	6,649	23.4	5,093	1.6	2.1
3: RDR	318,183	304,716	13,466	11.6	11,910	3.7	4.2

6.2.11 Snowshoe Hare

6.2.11.1 Baseline Conditions

A total of 786,163 HUs were calculated to be available to sowshoe hares within the RSA (Table 83, Figure 82). Of these, 77.8% represent high suitability habitat, 12.7% represent moderate suitability habitat, 4.4% represent low suitability habitat and 5.1% represent unsuitable habitat.



REGIONAL STUDY AREA
SNOWSHOE HARE HABITAT SUITABILITY
BASELINE SCENARIO

6 Feb. 1998 | Figure 82 | PRODUCED BY: J.H. REVIEWED BY:

Table 83 Percentage of Snowshoe Hare Habitat Units and Habitat Areas Among Unsuitable, Low, Medium and High Classes in the RSA for Each Development Scenario

Species	Scenario	HUs	Percent of HUs			Percent of Area			
			Low	Medium	High	Unsuitable	Low	Medium	High
Snowshoe Hare	Baseline	786,163	0.4	9.7	89.9	5.1	4.4	12.7	77.8
	Scenario 1	781,907	0.4	9.7	89.9	5.5	4.5	12.6	77.4
	Scenario 2	765,177	0.4	9.7	89.9	7.2	4.7	12.4	75.7
	Scenario 3	747,698	0.5	9.6	89.9	9.0	5.0	12.0	74.0

6.2.11.2 Development Scenarios

Impacts related to the Muskeg River Mine (Scenario 1: Tables 84-85; Figure 83) are predicted to decrease 0.5% of the total snowshoe hare HUs within the RSA. Scenario 2 (CEA) (Figure 84) is expected to result in the loss of 2.7% of the total HUs within the RSA while Scenario 3 (RDR) (Figure 85) is projecting the loss of 4.9% of the total HUs. All three development scenarios are considered to have a low impact magnitude on habitat loss for the region.

Table 84 Impact of Development Scenarios on Snowshoe Hare Habitat Units Within the RSA

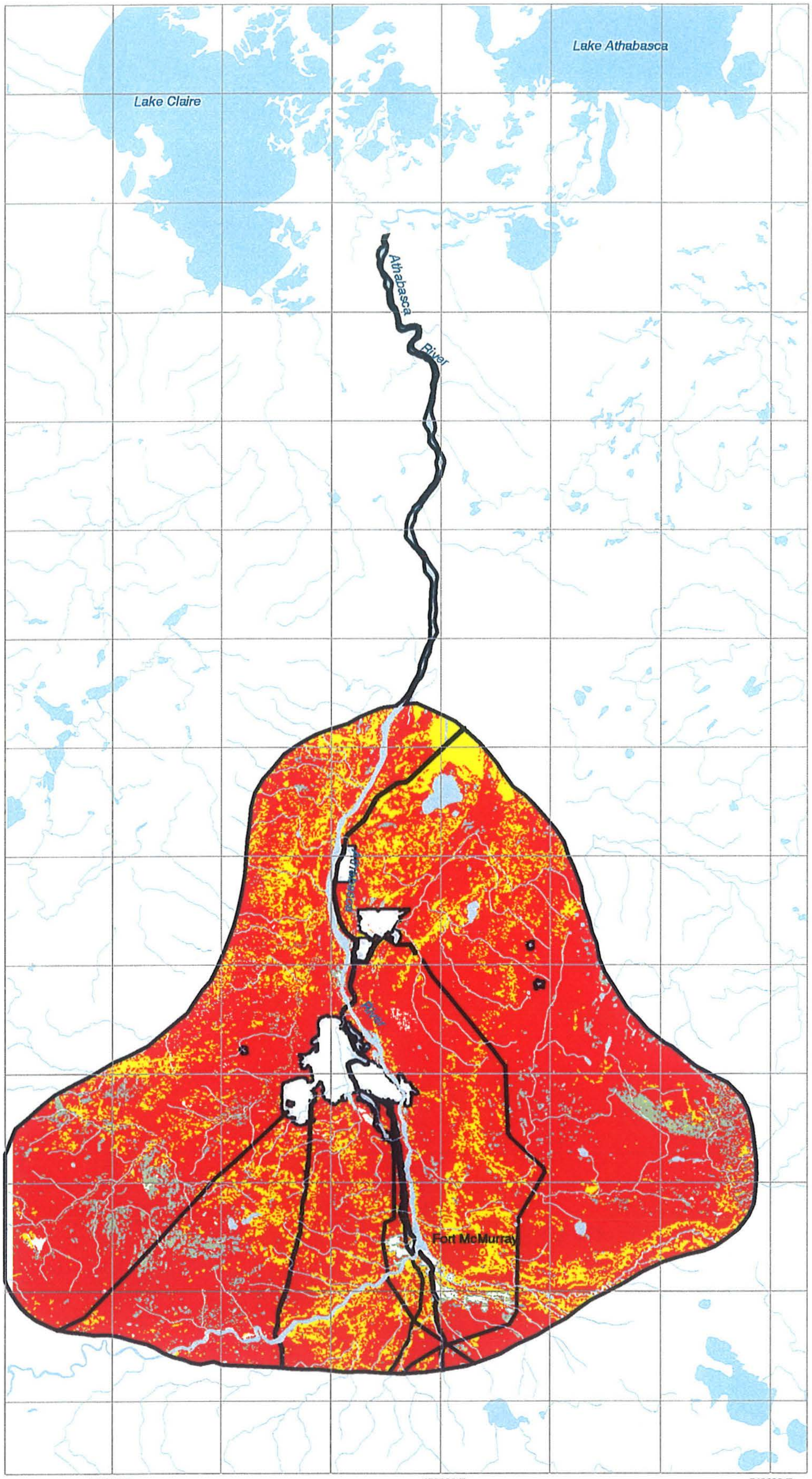
Species	Rating	Baseline	Scenario 1	Scenario 2	Scenario 3
Snowshoe Hare	Low	3,013	3,098	3,240	3,454
	Medium	76,166	75,627	74,122	71,780
	High	706,983	703,182	687,815	672,464
	Total	786,163	781,907	765,177	747,698

Table 85 Percent Impact of Development Scenarios on Snowshoe Hare Habitat Units Within the RSA

Species	Rating	Baseline	Scenario 1	Scenario 2	Scenario 3
Snowshoe Hare	Low	3,013	+2.8	+7.5	+14.6
	Medium	76,166	-0.7	-2.7	-5.8
	High	706,983	-0.5	-2.7	-4.9
	Total	786,163	-0.5	-2.7	-4.9

6.2.11.3 Incremental Impacts of the Muskeg River Mine Project

Impacts of the Muskeg River Mine Project on snowshoe hare habitat represent 20.3% of the habitat loss due to Scenario 2 and 11.1% of the losses associated with Scenario 3 (Table 86).



LEGEND

Regional Study Boundary

Disturbance Effect Boundary

Hydrology

Habitat Suitability Index

Unknown

Low

Moderate

High

5 0 5 10 15 20 25

Kilometres

SOURCE: Golder Associates Ltd., Petro-Canada, RADARSAT International, Suncor, Syncrude

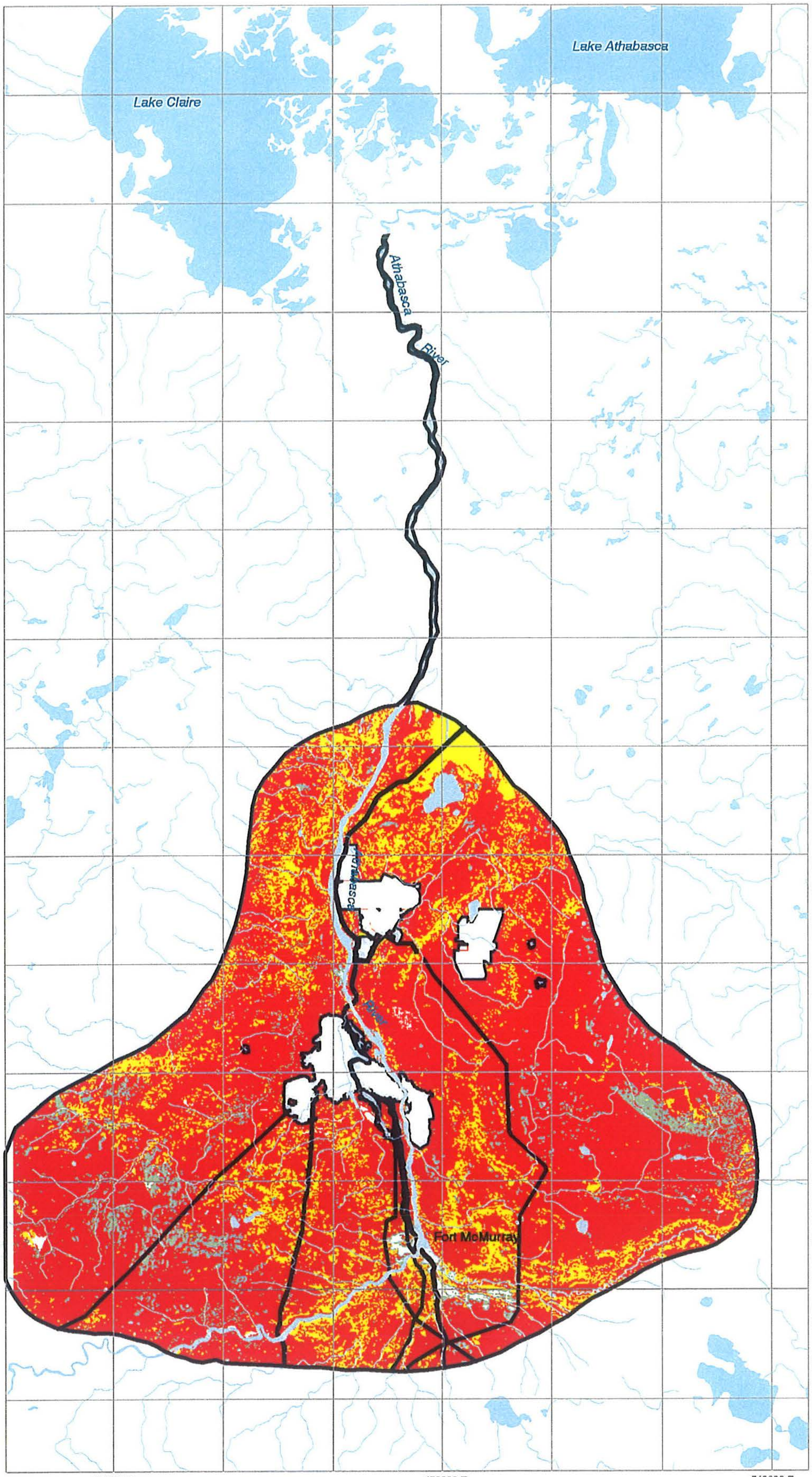
MAP PROJECTION: UTM
Zone 12
NAD 83 (GRS 1980)

Golder Associates

SHELL CANADA LIMITED

REGIONAL STUDY AREA
SNOWSHOE HARE HABITAT SUITABILITY
IMPACT SCENARIO 1

6 Feb. 1998	Figure 83	PRODUCED BY: J.H. REVIEWED BY:



LEGEND

Regional Study Boundary

Disturbance Effect Boundary

Hydrology

Habitat Suitability Index

Unknown

Low

Moderate

High

5 0 5 10 15 20 25

Kilometres

SOURCE: Golder Associates Ltd., Petro-Canada, RADARSAT International, Suncor, Syncrude

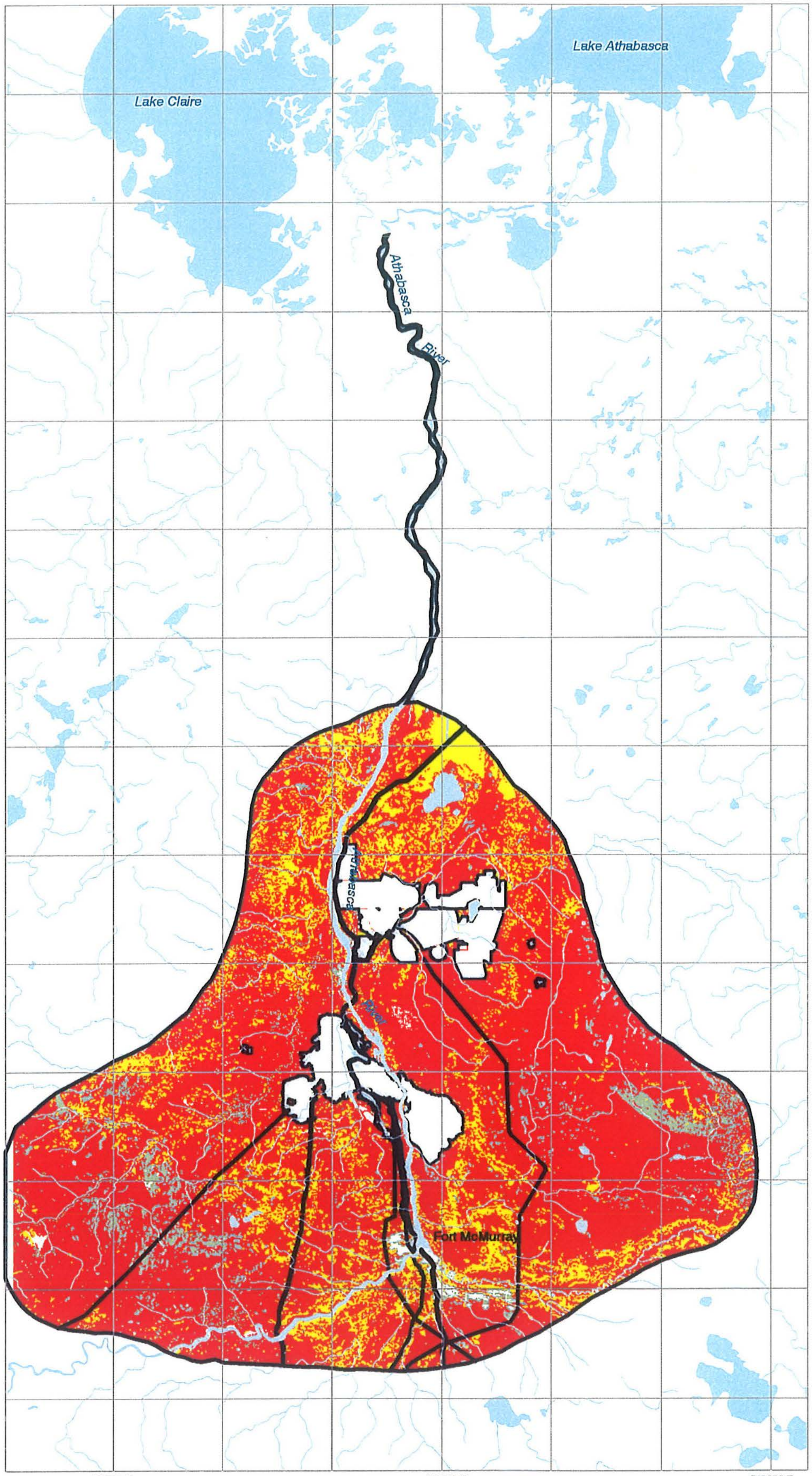
MAP PROJECTION: UTM Zone 12 NAD 83 (GRS 1980)

Golder Associates

SHELL CANADA LIMITED

REGIONAL STUDY AREA
SNOWSHOE HARE HABITAT SUITABILITY
IMPACT SCENARIO 2

6 Feb. 1998	Figure B4	PRODUCED BY: J.H. REVIEWED BY:



LEGEND

Regional Study Boundary

Disturbance Effect Boundary

Hydrology

Habitat Suitability Index

- Unknown
- Low
- Moderate
- High

5 0 5 10 15 20 25
Kilometres

SOURCE: Golder Associates Ltd., Petro-Canada, RADARSAT International, Suncor, Syncrude

MAP PROJECTION: UTM Zone 12 NAD 83 (GRS 1980)

Golder Associates

SHELL CANADA LIMITED

REGIONAL STUDY AREA
SNOWSHOE HARE HABITAT SUITABILITY
IMPACT SCENARIO 3

6 Feb. 1998 | Figure 85 | PRODUCED BY: J.H. REVIEWED BY:

Table 86 Cumulative Assessment of Snowshoe Hare Habitat Losses Associated With the Muskeg River Mine Project (MRM) in Scenario 2 (CEA) and Scenario 3 (RDR)

Scenario	Baseline HUs	Scenario HUs	HUs Loss Including MRM	HUs Loss due to MRM (% of Scenario Loss)	HUs Loss Excluding MRM	HUs Loss Excluding MRM (% of Baseline)	HUs Loss Including MRM (% of Baseline)
1: MRM	786,163	781,907	4,255				
2: CEA	786,163	765,177	20,985	20.3	16,730	2.1	2.7
3: RDR	786,163	747,698	38,464	11.1	34,209	4.4	4.9

6.2.12 Western Tanager

6.2.12.1 Baseline Conditions

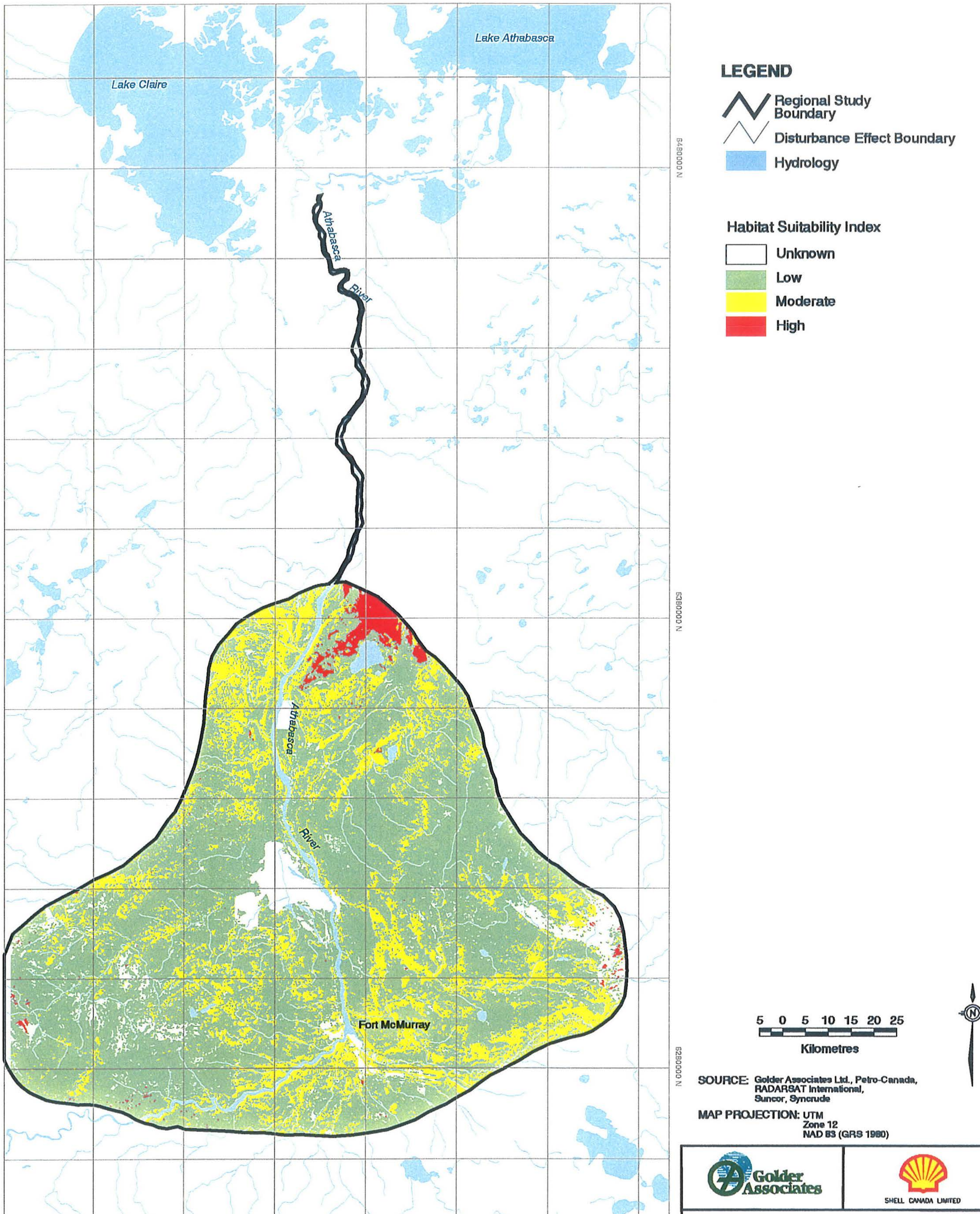
A total of 127,278 HUs were calculated to be available to western tanagers within the RSA (Table 87, Figure 86). Of these, 1.5% represent high suitability habitat, 18.7% represent moderate suitability habitat, 70.3% represent low suitability habitat and 9.6% represent unsuitable habitat.

Table 87 Percentage of Western Tanager Habitat Units and Habitat Areas Among Unsuitable, Low, Medium and High Classes in the RSA for Each Development Scenario

Species	Scenario	HUs	Percent of HUs			Percent of Area			
			Low	Medium	High	Unsuitable	Low	Medium	High
Western Tanager	Baseline	127,278	17.0	73.1	10.0	9.6	70.3	18.7	1.5
	Scenario 1	126,840	17.0	73.0	10.0	10.0	70.0	18.6	1.5
	Scenario 2	125,073	17.0	72.9	10.2	11.7	68.6	18.3	1.5
	Scenario 3	121,961	17.1	72.5	10.4	13.4	67.3	17.8	1.5

6.2.12.2 Development Scenarios

Impacts related to the Muskeg River Mine (Scenario 1: Tables 88-89; Figure 87) are predicted to decrease 0.3% of the total western tanager HUs within the RSA. Scenario 2 (CEA) (Figure 88) is expected to result in the loss of 1.7% of the total HUs within the RSA while Scenario 3 (RDR) (Figure 89) is projecting the loss of 4.2% of the total HUs. All three development scenarios are considered to have a low impact magnitude on habitat loss for the region.



SOURCE: Golder Associates Ltd., Petro-Canada, RADARSAT International, Suncor, Syncrude

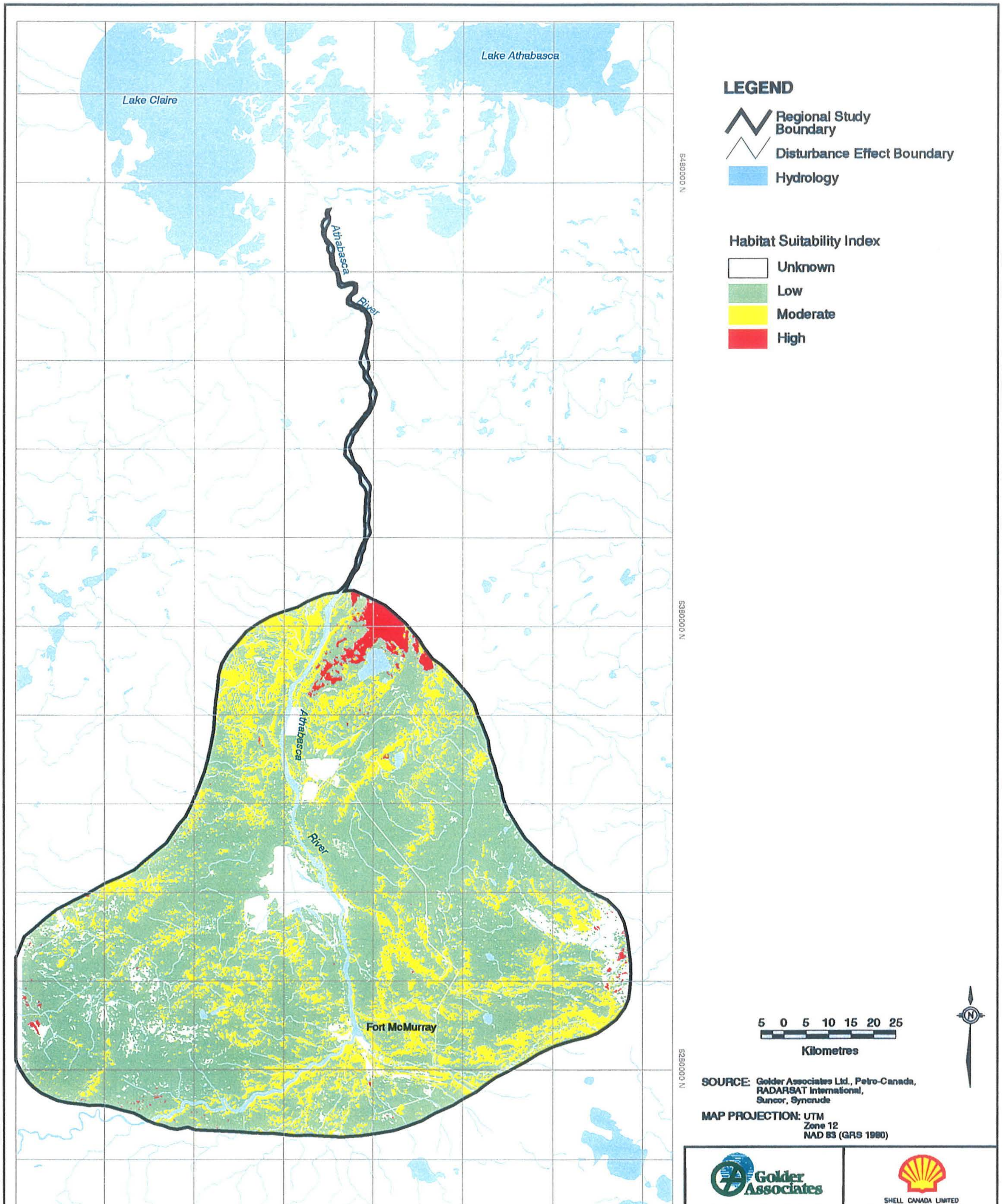
MAP PROJECTION: UTM Zone 12 NAD 83 (GRS 1980)

Golder Associates

SHELL CANADA LIMITED

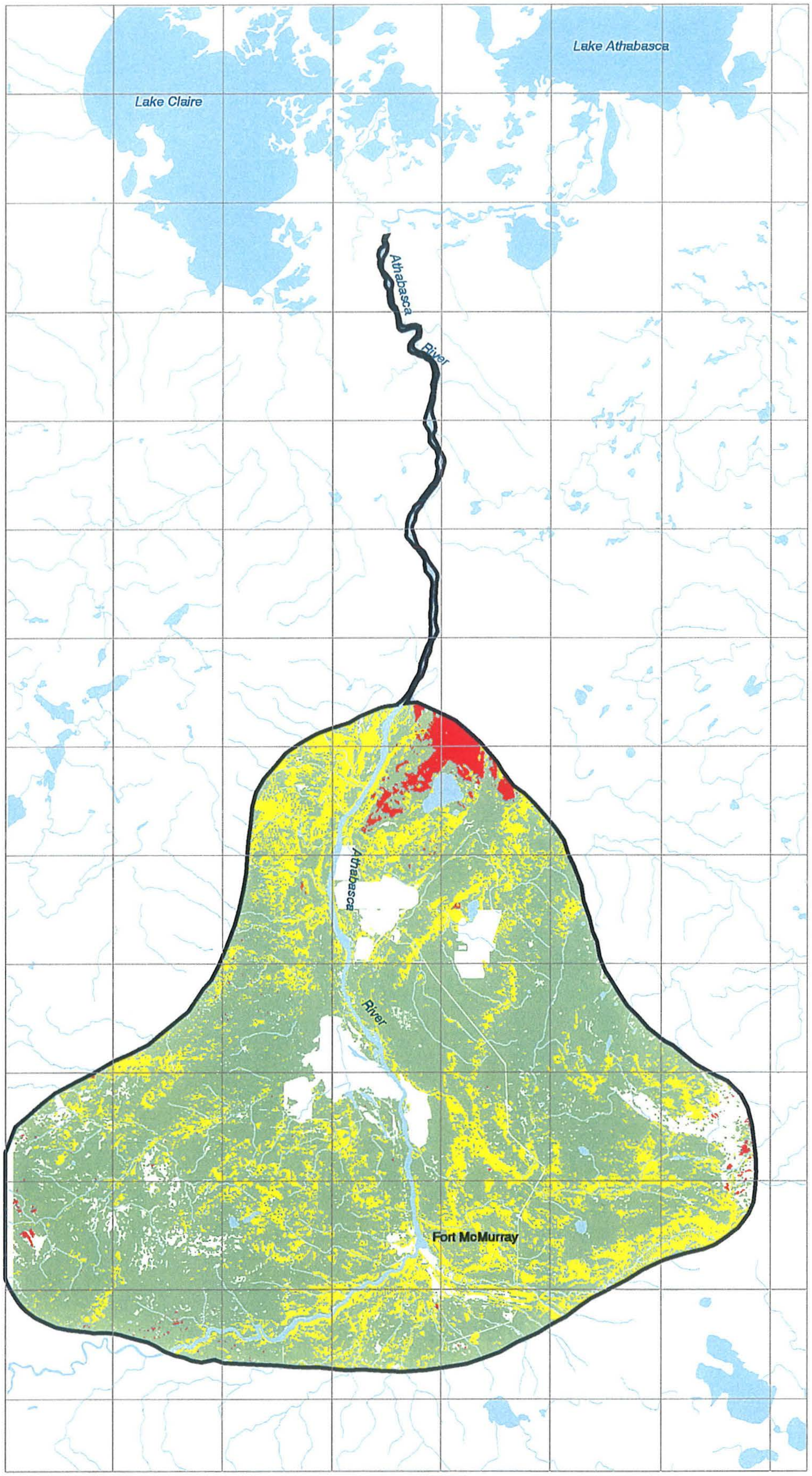
REGIONAL STUDY AREA
WESTERN TANAGER HABITAT SUITABILITY
BASELINE SCENARIO

6 Feb. 1998	Figure 86	PRODUCED BY: J.H. REVIEWED BY:



REGIONAL STUDY AREA
WESTERN TANAGER HABITAT SUITABILITY
IMPACT SCENARIO 1

6 Feb. 1998 | Figure 87 | PRODUCED BY: J.H. REVIEWED BY:



LEGEND

Regional Study Boundary
Disturbance Effect Boundary
Hydrology

Habitat Suitability Index
Unknown
Low
Moderate
High

5 0 5 10 15 20 25
Kilometres

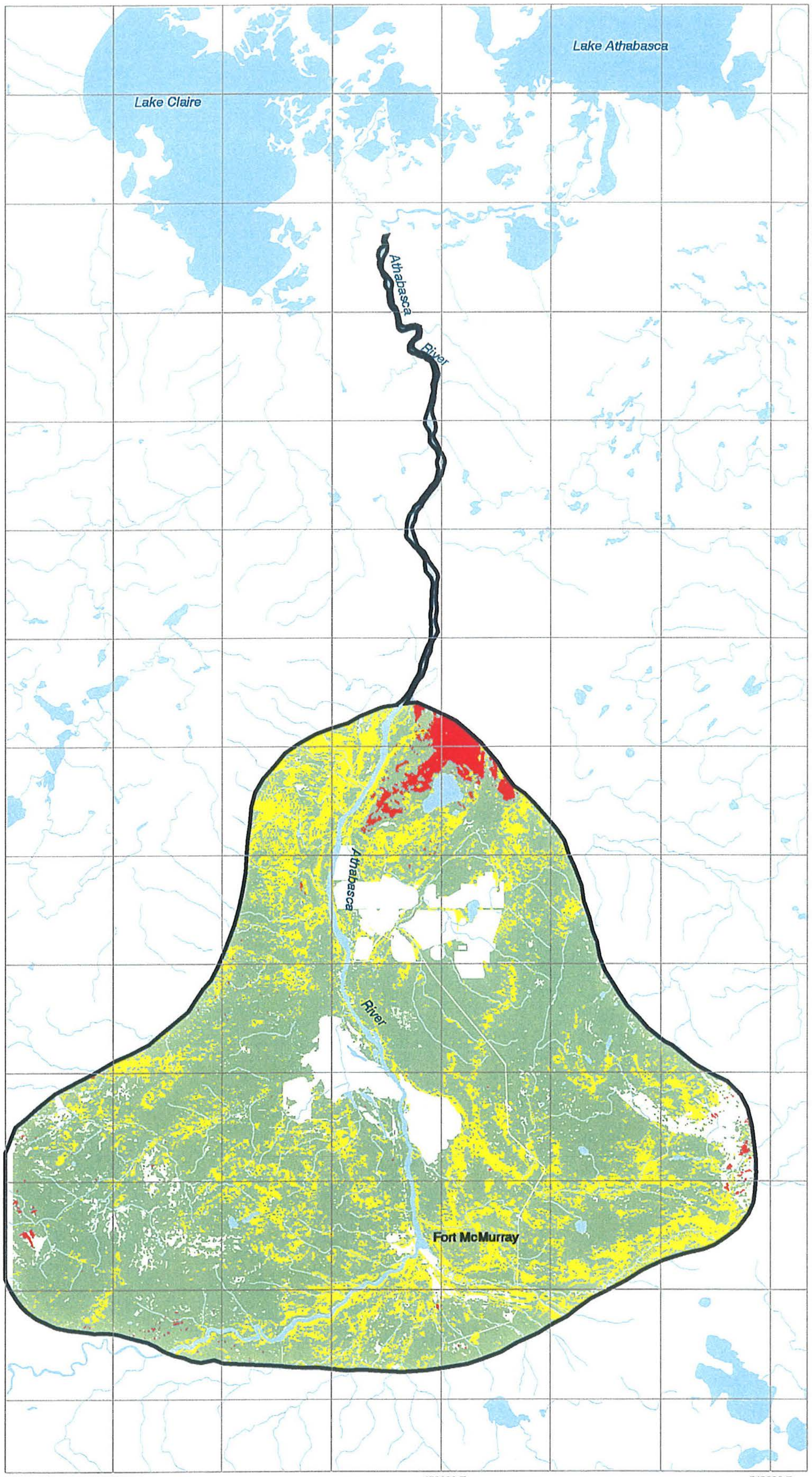
SOURCE: Golder Associates Ltd., Petro-Canada, RADARSAT International, Suncor, Syncrude

MAP PROJECTION: UTM
Zone 12
NAD 83 (GRS 1980)

Golder Associates
SHELL CANADA LIMITED

REGIONAL STUDY AREA
WESTERN TANAGER HABITAT SUITABILITY
IMPACT SCENARIO 2

6 Feb. 1998	Figure 88	PRODUCED BY: J.H. REVIEWED BY:



LEGEND

Regional Study Boundary

Disturbance Effect Boundary

Hydrology

Habitat Suitability Index

Unknown

Low

Moderate

High

5 0 5 10 15 20 25

Kilometres

SOURCE: Golder Associates Ltd., Petro-Canada, RADARSAT International, Suncor, Syncrude

MAP PROJECTION: UTM
Zone 12
NAD 83 (GRS 1980)

Golder Associates

SHELL CANADA LIMITED

REGIONAL STUDY AREA
WESTERN TANAGER HABITAT SUITABILITY
IMPACT SCENARIO 3

6 Feb. 1998	Figure 89	PRODUCED BY: J.H. REVIEWED BY:

Table 88 Impact of Development Scenarios on Western Tanager Habitat Units Within the RSA

Species	Rating	Baseline	Scenario 1	Scenario 2	Scenario 3
Western Tanager	Low	21,613	21,543	21,251	20,839
	Medium	92,983	92,614	91,120	88,406
	High	12,683	12,683	12,702	12,716
	Total	127,278	126,840	125,073	121961

Table 89 Percent Impact of Development Scenarios on Western Tanager Habitat Units Within the RSA

Species	Rating	Baseline	Scenario 1	Scenario 2	Scenario 3
Western Tanager	Low	21,613	-0.3	-1.7	-3.6
	Medium	92,983	-0.4	-2.0	-4.9
	High	12,683	+0.0	+0.2	+0.3
	Total	127,278	-0.3	-1.7	-4.2

6.2.12.3 Incremental Impacts of the Muskeg River Mine Project

Impacts of the Muskeg River Mine Project on western tanager habitat represent 19.9% of the habitat loss due to Scenario 2 and 8.3% of the losses associated with Scenario 3 (Table 90).

Table 90 Cumulative Assessment of Western Tanager Habitat Losses Associated With the Muskeg River Mine Project (MRM) in Scenario 2 (CEA) and Scenario 3 (RDR)

Scenario	Baseline HUs	Scenario HUs	HUs Loss Including MRM	HUs Loss due to MRM (% of Scenario Loss)	HUs Loss Excluding MRM	HUs Loss Excluding MRM (% of Baseline)	HUs Loss Including MRM (% of Baseline)
1: MRM	127,278	126,840	439				
2: CEA	127,278	125,073	2,206	19.9	1,767	1.4	1.7
3: RDR	127,278	121,961	5,317	8.3	4,879	3.8	4.2

6.2.13 Biodiversity

6.2.13.1 Baseline Conditions

Species expected to be found within each forest type within the RSA are summarized in Appendix V. The relative richness of species per forest type (Table 91) indicates that wooded peatlands (1.0), mixedwood forests (0.96) and spruce forests (0.89) had the highest richness indices for mammals. For birds, the highest richness values were for wooded peatlands (1.0), wet shrublands (0.87) and mixedwood forests (0.72). For reptiles and amphibians, the highest richness values were for wooded peatlands (1.0), burned fens (1.0), marshes (1.0), wet shrublands (1.0) and graminoid fens (1.0).

The area of each forest type within the RSA is provided in Table 92, while the change in number and percent of biodiversity HUs due to the three impact scenarios are shown in Tables 93 and 94, respectively. A total of 936,331 mammal, 874,441 bird and 850,641 reptile/amphibian biodiversity HUs were calculated for the RSA (Table 92).

Of these, some 0.4% of the mammal, bird and reptile/amphibian richness HUs are projected to be lost in the RSA due to construction of the Muskeg River Mine (Table 94). For the CEA, some 2.3% of mammal, 2.3% of bird and 2.4% of reptile/amphibian richness HUs are predicted to be lost. Finally, for the RDR, some 6.1% of the mammal, 6.0% of the bird and 6.0% of the reptile/amphibian richness HUs are projected to be lost.

Table 91 Relative Richness Index Values by Forest Type

Record	HabitatType	Mammal	Bird	Reptile/ Amphibian
2	open water	0.29	0.56	0.00
3	aspen (poplar) forest	0.71	0.60	0.50
4	marsh	0.36	0.70	1.00
5	spruce forest	0.89	0.51	0.50
6	wooded peatland	1.00	1.00	1.00
7	mixedwood forest	0.96	0.72	0.50
8	jack pine forest	0.75	0.43	0.50
9	disturbances	0.00	0.00	0.00
10	unclassified	0.50	0.50	0.50
11	graminoid fen	0.57	0.63	1.00
12	paper birch forest	0.71	0.60	0.50
13	cutblocks	0.57	0.63	1.00
14	burned fen	0.57	0.63	1.00
15	impacts	0.00	0.00	0.00
16	unclassed (cloud)	0.50	0.50	0.50
17	wet shrublands	0.64	0.87	1.00

Table 92 Area (ha) of Forest Types in the RSA by Impact Scenario

Record	Habitat Type	Baseline	Scenario 1: Muskeg River Mine	Scenario 2: CEA	Scenario 3: RDR
2	open water	20,971	20,954	20,933	20,773
3	aspen (poplar) forest	82,169	82,130	81,909	77,676
4	marsh	3,479	3,474	3,416	3,291
5	spruce forest	76,589	76,469	75,336	72,419
6	wooded peatland	639,296	636,006	623,099	599,941
7	mixedwood forest	119,425	118,781	116,503	110,246
8	jack pine forest	15,280	15,280	15,280	15,195
9	disturbances	30,035	29,860	29,726	27,217
10	unclassified	2,314	2,314	2,314	2,292
11	graminoid fen	31,913	31,893	31,674	31,596
12	paper birch forest	901	901	901	892
13	cutblocks	13,443	13,443	12,177	11,217
14	burned fen	10,131	10,126	10,120	10,119
15	Impacts	0	4,313	22,557	40,382
16	unclassed (cloud)	5	5	5	5
17	wet shrublands	4,039	4,039	4,039	4,029
	Total	1,049,989	1,049,989	1,049,989	1,049,989

Table 93 Changes in Richness Habitat Units From Baseline in the RSA

NAME	Mammal				Bird				Reptile/Amphibian			
Habitat Type	Baseline	Scenario 1	Scenario 2	Full Impact	Baseline	Scenario 1	Scenario 2	Full Impact	Baseline	Scenario 1	Scenario 2	Full Impact
open water	5,992	5,987	5,981	5,935	11,796	11,787	11,775	11,685	0	0	0	0
aspen (poplar) forest	58,692	58,664	58,506	55483	49155	49131	48,999	46,467	41085	41,065	40,954	38,838
marsh	1,242	1,241	1,220	1,175	2,423	2,419	2,379	2,292	3,479	3,474	3,416	3,291
spruce forest	68,383	68,276	67,265	64,660	38,978	38,917	38,341	36,856	38,294	38,235	37,668	36,210
wooded peatland	639,296	636,006	623,099	599,941	639,296	636,006	623,099	599,941	639,296	636,006	623,099	599,941
mixedwood forest	115,159	114,539	112342	106,309	86,370	85,904	84,257	79,732	59,712	59,391	58,252	55,123
jack pine forest	11,460	11,460	11,460	11,396	6,549	6,549	6,549	6,512	7,640	7,640	7,640	7,597
disturbances	0	0	0	0	0	0	0	0	0	0	0	0
unclassified	1157	1,157	1,157	1,146	1,157	1,157	1,157	1,146	1,157	1,157	1,157	1,146
graminoid fen	18,236	18,224	18,099	18,055	19,945	19,933	19,796	19,748	31,913	31,893	31,674	31,596
paper birch forest	643	643	643	637	539	539	539	533	450	450	450	446
cutblocks	7,682	7,682	6,958	6,410	8,402	8,402	7,610	7,011	13,443	13,443	12,177	11,217
burned fen	5,789	5,786	5,783	5,783	6,332	6,329	6,325	6,325	10,131	10,126	10,120	10,119
impacts	0	0	0	0	0	0	0	0	0	0	0	0
unclassed (cloud)	3	3	3	3	3	3	3	3	3	3	3	3
wet shrublands	2,596	2,596	2,596	2,590	3,498	3,498	3,498	3,490	4,039	4,039	4,039	4,029
Total	936,331	932,265	915,113	879,522	874,441	870,573	854,326	821,739	850,641	846,920	830,648	799,556

Table 94 Percent Changes in Richness Habitat Units From Baseline in the RSA

NAME	Mammal				Bird				Reptile/Amphibian			
Habitat Type	Baseline	Scenario 1	Scenario 2	Full Impact	Baseline	Scenario 1	Scenario 2	Full Impact	Baseline	Scenario 1	Scenario 2	Full Impact
open water	5,992	-0.1	-0.2	-0.9	11,796	-0.1	-0.2	-0.9	0	0.0	0.0	0.0
aspen (poplar) for	58,692	0.0	-0.3	-5.5	49,155	0.0	-0.3	-5.5	41,085	0.0	-0.3	-5.5
marsh	1242	-0.2	-1.8	-5.4	2,423	-0.2	-1.8	-5.4	3,479	-0.2	-1.8	-5.4
spruce forest	68,383	-0.2	-1.6	-5.4	38978	-0.2	-1.6	-5.4	38,294	-0.2	-1.6	-5.4
wooded peatland	639,296	-0.5	-2.5	-6.2	639,296	-0.5	-2.5	-6.2	639,296	-0.5	-2.5	-6.2
mixedwood forest	115,159	-0.5	-2.4	-7.7	86,370	-0.5	-2.4	-7.7	59,712	-0.5	-2.4	-7.7
jack pine forest	11,460	0.0	0.0	-0.6	6,549	0.0	0.0	-0.6	7,640	0.0	0.0	-0.6
disturbances	0	0.0	0.0	0.0	0	0.0	0.0	0.0	0	0.0	0.0	0.0
unclassified	1157	0.0	0.0	-1.0	1,157	0.0	0.0	-1.0	1157	0.0	0.0	-1.0
graminoid fen	18,236	-0.1	-0.7	-1.0	19,945	-0.1	-0.7	-1.0	31,913	-0.1	-0.7	-1.0
paper birch forest	643	0.0	0.0	-1.0	539	0.0	0.0	-1.0	450	0.0	0.0	-1.0
cutblocks	7,682	0.0	-9.4	-16.6	8,402	0.0	-9.4	-16.6	13,443	0.0	-9.4	-16.6
burned fen	5,789	0.0	-0.1	-0.1	6,332	0.0	-0.1	-0.1	10,131	0.0	-0.1	-0.1
impacts	0	0.0	0.0	0.0	0	0.0	0.0	0.0	0	0.0	0.0	0.0
unclassed (cloud)	3	0.0	0.0	0.0	3	0.0	0.0	0.0	3	0.0	0.0	0.0
wet shrublands	2,596	0.0	0.0	-0.2	3,498	0.0	0.0	-0.2	4,039	0.0	0.0	-0.2
Total	936,331	-0.4	-2.3	-6.1	874,441	-0.4	-2.3	-6.0	850,641	-0.4	-2.4	-6.0

6.2.14 Linkage Zone Analysis

Results of the Linkage Zone Analysis for moose will be expressed in terms of percentage of areas that are effectively blocking moose (fracture zones) from moving. The model is described in Appendix I and raw results are provided in Appendix VII.

6.2.14.1 Baseline Conditions

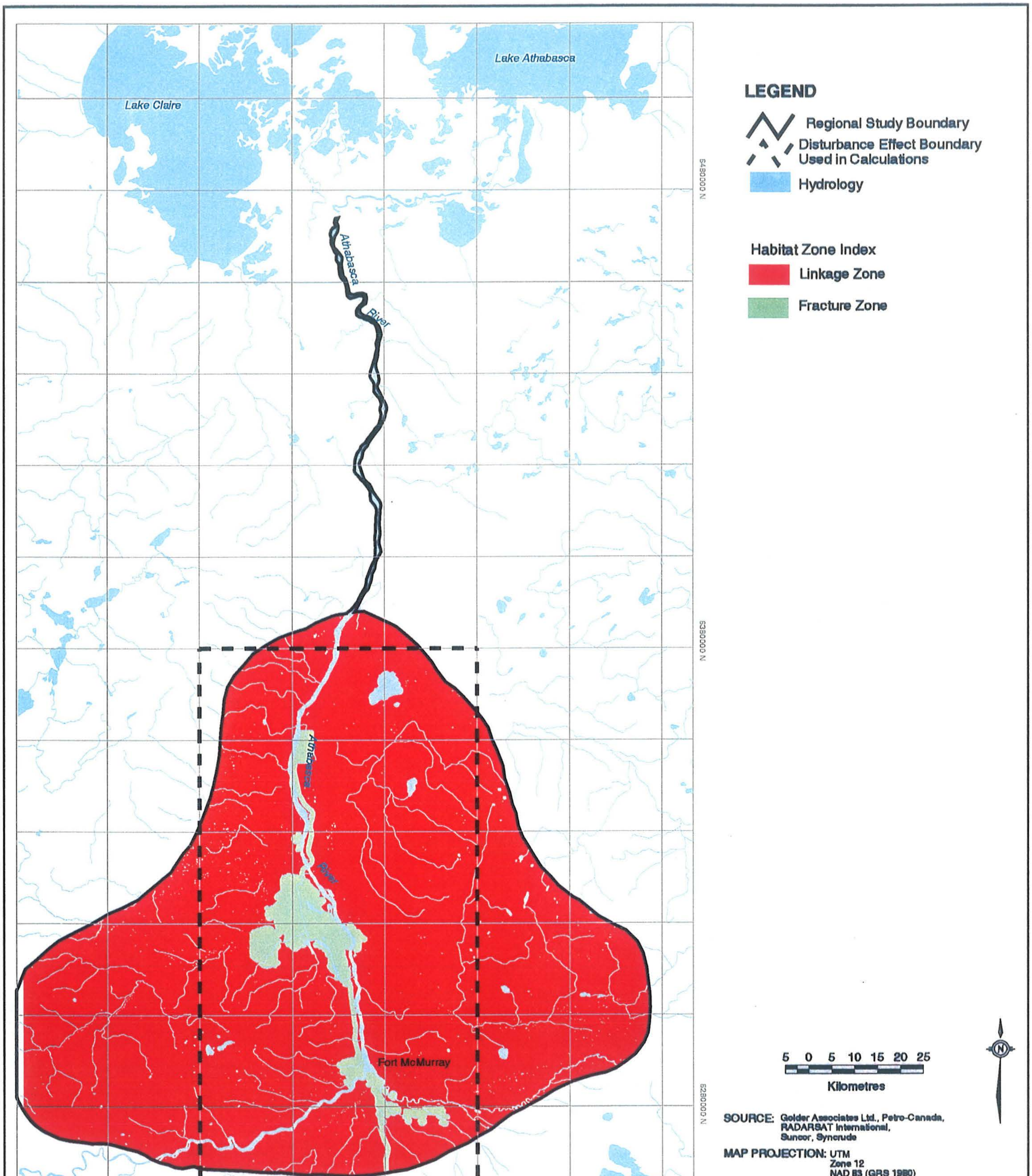
Baseline conditions (Figure 90) show that current fracture zones are concentrated in the Fort McMurray and Syncrude/Suncor areas. In total, 4.1% of the RSA was considered to be fracture zone for moose (Table 95). The highway was modelled as a fracture zone for moose, although this should not be regarded as an impermeable barrier. Fracture percentages of east-west movement rectangles ranged from 0 to 15.4%. The highest amounts of fractured habitat were found in east-west rectangles 3 (9.8%) and 4 (15.4%), which correspond to the Suncor/Syncrude area. East-west rectangle 2, where the Project is proposed, was modelled as having a fracture percentage of 0%.

Table 95 Incremental Increase in Fracture Zone Percentages due to the Three Impact Scenarios

Area Sampled	Baseline	Scenario 1	Scenario 2	Scenario 3
Entire RSA	4.1	4.9	7.8	9.8
East-West 1	0.0	0.0	0.9	0.9
East-West 2	0.0	6.0	24.0	38.8
East-West 3	9.8	10.8	12.3	12.4
East-West 4	15.4	15.4	21.5	24.8
East-West 5	6.1	6.1	6.1	6.1
East-West 6	6.6	6.6	6.6	6.6
North-South 1	5.2	5.2	5.2	5.3
North-South 2	11.8	15.3	23.2	28.6
North-South 3	2.3	2.3	8.2	12.2

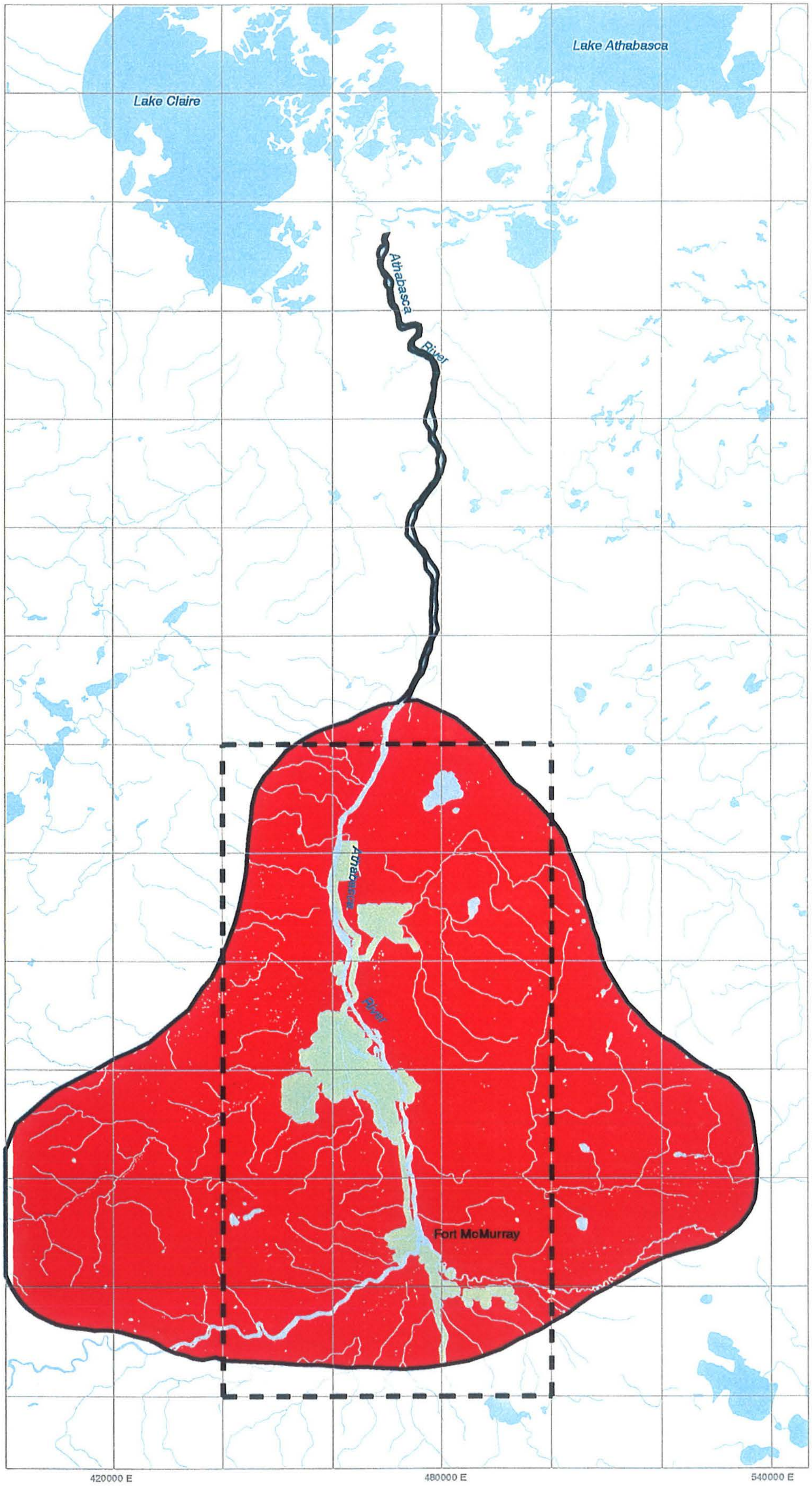
Scenario 1: Muskeg River Mine

Inclusion of the Project in the Linkage Zone Model (Figure 91) results in an increase in fractured habitat from 4.1 to 4.9%, an increase of 0.8% over baseline (Table 95). Nearly all of the effects are within east-west rectangle 2, where the fractured habitat increases from 0 to 6%. Similarly, all of the increases in fractured habitat occurred within north-south rectangle 2, where the increase was from 11.8 to 15.3%.



REGIONAL STUDY AREA
RESULTS OF MOOSE LINKAGE MODEL
BASELINE SCENARIO

11 Jan. 1998 | Map 90 | PRODUCED BY: J.H. REVIEWED BY:



LEGEND

Regional Study Boundary

Disturbance Effect Boundary Used in Calculations

Hydrology

Habitat Zone Index

Linkage Zone

Fracture Zone

5 0 5 10 15 20 25

Kilometres

SOURCE: Golder Associates Ltd., Petro-Canada, RADARSAT International, Suncor, Syncrude

MAP PROJECTION: UTM Zone 12 NAD 83 (GRS 1980)

Golder Associates

SHELL CANADA LIMITED

REGIONAL STUDY AREA RESULTS OF MOOSE LINKAGE MODEL IMPACT SCENARIO 1

11 Jan. 1998	Map 91	PRODUCED BY: J.H. REVIEWED BY:

It should be noted that the Linkage Zone Model as constructed for this assessment was conservative in its assumptions. It is very likely, and in fact anticipated, that moose will be able to utilize local movement corridors designed as mitigation for the EIA (Golder 1997h) within the LSA. These corridors were designed to have a minimum average width of 1 km, a width considered in the Linkage Zone Model to be inadequate for moose, as it was designed to assess larger, inter-regional movements by moose.

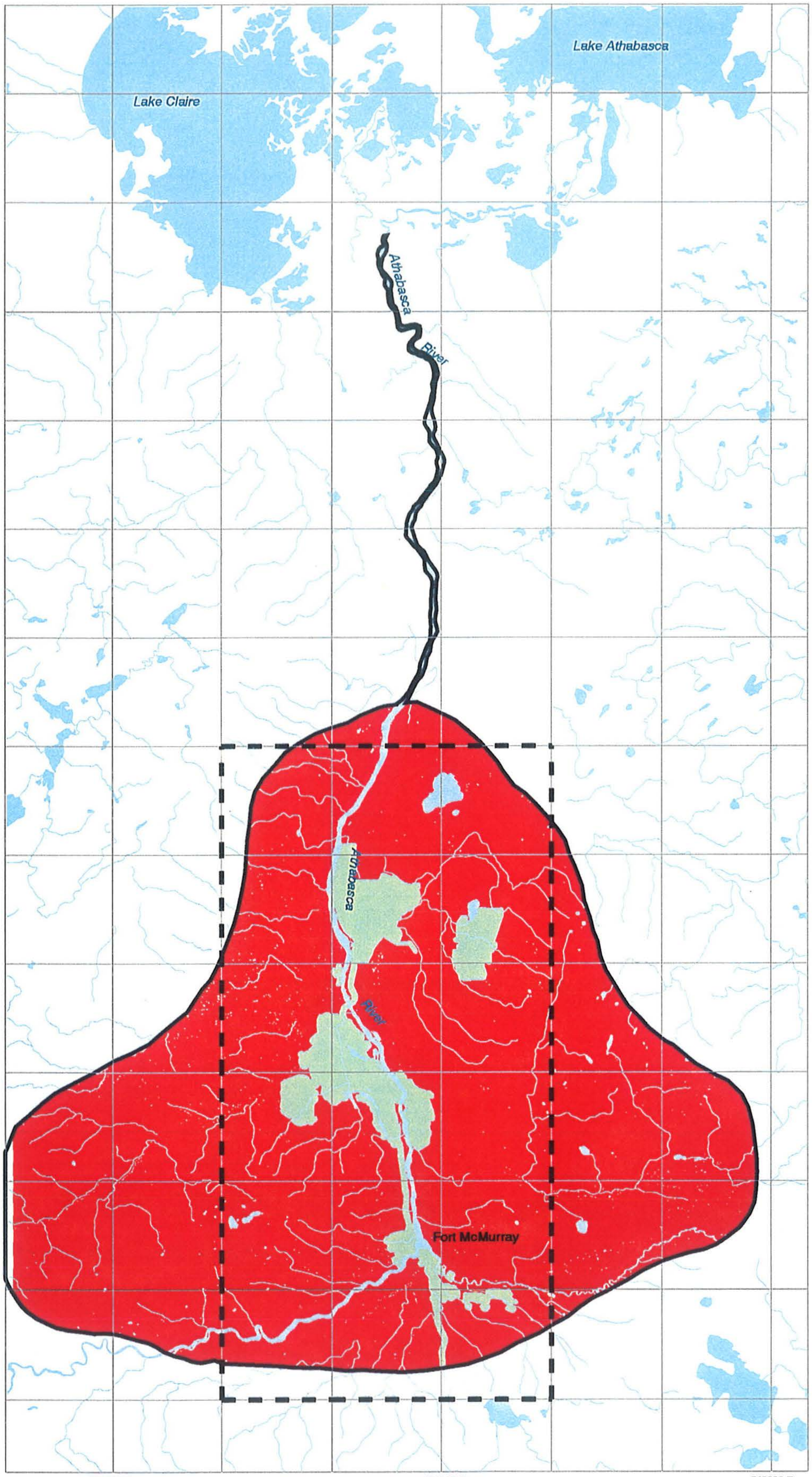
Scenario 2: CEA

Analysis of the effects of approved projects in addition to the Project in the Linkage Zone Model (Figure 92) shows an increase in fractured habitat from 4.1% of the RSA at baseline to 7.8%, an increase of 3.7% (Table 95). While the largest effects are within east-west rectangle 2, where the fractured habitat increases from 0 to 24%, increases are also noted for east-west rectangles 3 (9.8 to 12.3%) and 4 (15.4 to 21.5%). Increases in fractured habitat for north-south rectangles occurred only in rectangles 2 (11.8 to 23.2%) and 3 (2.3 to 8.2%).

Scenario 3: RDR

Analysis of the effects of all publicly approved projects, approved projects and the Project is provided in Figure 93. This map shows an increase in fractured habitat from 4.1% of the RSA at baseline to 9.8%, an increase of 5.7% (Table 95). The largest effects are again within east-west rectangle 2, where the fractured habitat increases from 0 to 38%; increases are also noted for east-west rectangles 3 (9.8 to 12.4%) and 4 (15.4 to 24.8%). Increases in fractured habitat for north-south rectangles occurred primarily in rectangles 2 (11.8 to 28.6%) and 3 (2.3 to 12.2%).

For this scenario, it is apparent that moose movements will be restricted over current conditions, especially in east-west rectangle 2. Whether or not these effects would have a deleterious effect on moose population genetics due to lowered dispersal rates is open to conjecture. However, it is recommended that corridors be designed at the local level, within and between the various developments, to lessen this effect. These corridors should be monitored during development construction and operation phases to determine their efficacy as travel corridors. Also, if development beyond the RDR scenario is contemplated, planners should ensure that east-west linkages between the northern oil sands developments in east-west rectangle 2 and rectangles 3/4 are maintained. To this end, the effect of the highway on moose movements should be investigated to determine if it acts as a barrier.



LEGEND

Regional Study Boundary

Disturbance Effect Boundary Used in Calculations

Hydrology

Habitat Zone Index

Linkage Zone

Fracture Zone

5 0 5 10 15 20 25

Kilometres

N

SOURCE: Golder Associates Ltd., Petro-Canada, RADARSAT International, Suncor, Syncrude

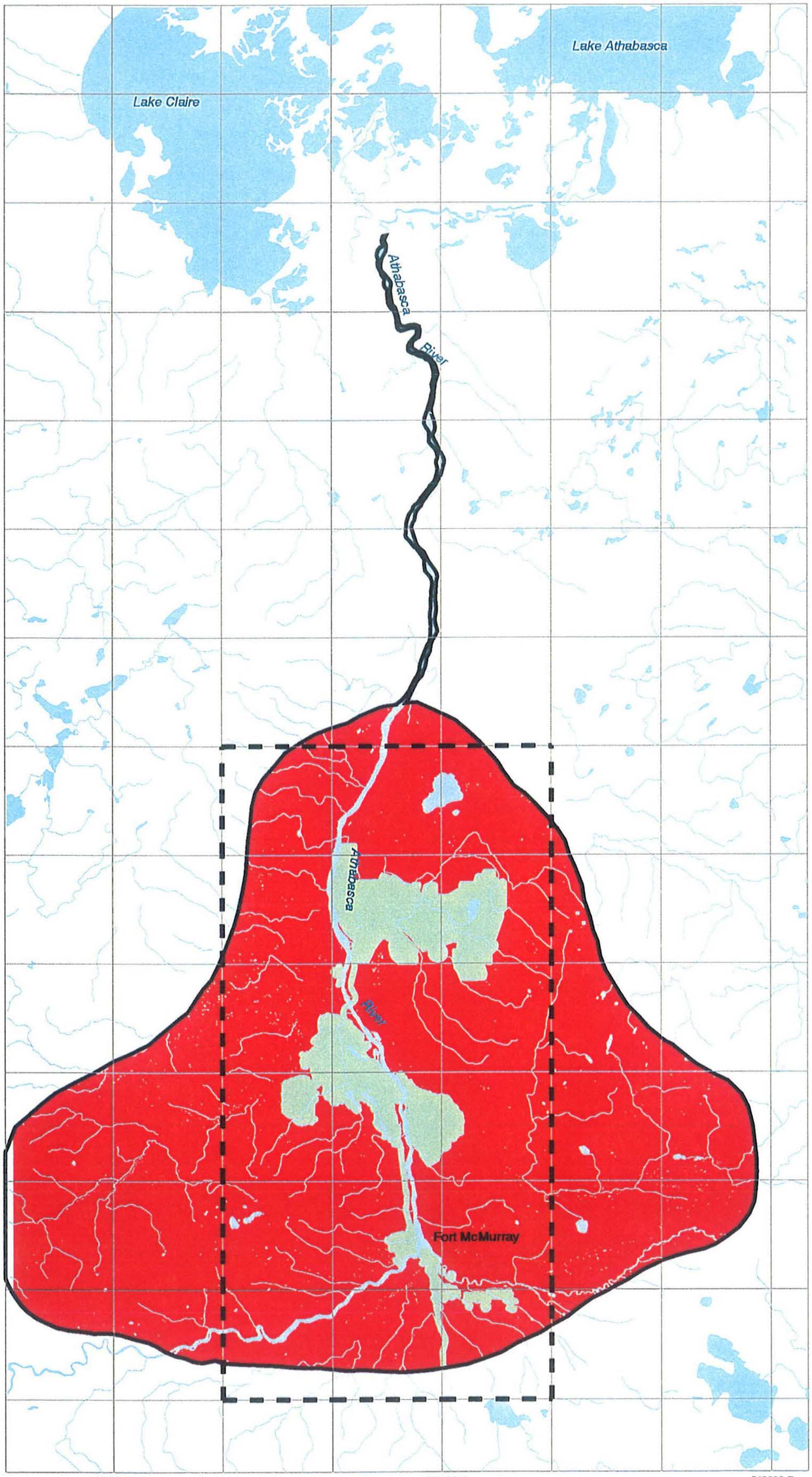
MAP PROJECTION: UTM
Zone 12
NAD 83 (GRS 1980)

Golder Associates

SHELL CANADA LIMITED

REGIONAL STUDY AREA
RESULTS OF MOOSE LINKAGE MODEL
IMPACT SCENARIO 2

11 Jan. 1998	Map 92	PRODUCED BY: J.H. REVIEWED BY:



LEGEND

- Regional Study Boundary
- Disturbance Effect Boundary Used in Calculations
- Hydrology

Habitat Zone Index

- Linkage Zone
- Fracture Zone

5 0 5 10 15 20 25

Kilometres

N

SOURCE: Golder Associates Ltd., Petro-Canada, RADARSAT International, Suncor, Syncrude

MAP PROJECTION: UTM
Zone 12
NAD 83 (GRS 1980)

Golder Associates

SHELL CANADA LIMITED

REGIONAL STUDY AREA RESULTS OF MOOSE LINKAGE MODEL IMPACT SCENARIO 3

11 Jan. 1998	Map 93	PRODUCED BY: J.H. REVIEWED BY:

7. SUMMARY OF HSI RESULTS

A summary of the HSI results is provided in this Section. Summaries of the LSA and RSA data are provided in 7.1 and 7.2, respectively.

7.1 LOCAL STUDY AREA

A summary of baseline conditions and the impacts of LSA clearing, drawdown, disturbance and reclamation on wildlife KIRs is expressed in terms of HUs in Table 96 and in percentages in Table 97.

7.1.1 Baseline Conditions

The KIR with the highest amount of habitat within the LSA was the snowshoe hare (7,319 HUs, or 67% of the possible 10,954 HUs that is theoretically possible within the LSA). Red-backed voles (5,469 or 50%) and fishers (4,798 or 44%) were mapped as having the second and third most habitat, respectively. The western tanager was calculated as having the least amount of habitat (1,104 or 10%) of all the KIRs.

Table 96 Impact of Clearing, Drawdown, Disturbance and Reclamation on KIR Habitat Units Within the LSA

Species	Baseline	Mine Impacts			Closure
		Clearing	Drawdown	Disturbance	
Beaver	1,424	1,063	990	990	1,339
Black Bear	3,809	2,746	2,513	2,092	4,880
Cape May Warbler	1,583	1,029	966	814	2,387
Dabbling Ducks	1,446	1,118	1,012	940	2,070
Fisher	4,798	3,014	2,849	2,173	5,135
Great Gray Owl	2,559	2,138	1,954	995	2,985
Moose	4,678	3,671	3,339	2,136	5,126
Pileated Woodpecker	3,403	2,503	2,290	1,915	5,173
Red-backed Vole	5,469	3,348	3,044	3,044	5,692
Ruffed Grouse	3,305	2,364	2,148	1,825	3,841
Snowshoe Hare	7,319	5,052	4,578	3,404	7,260
Western Tanager	1,104	768	725	725	3,195

Table 97 Percent Impact of Clearing, Drawdown, Disturbance and Reclamation on KIR Habitat Units within the LSA

Species	Baseline	Mine Impacts				Reclamation Change From Baseline
		Clearing Change	Drawdown Change	Disturbance Change	Total Change	
Beaver	1,424	-25.4	-5.1	0.0	-30.5	-6.0
Black Bear	3809	-27.9	-6.1	-11.1	-45.1	+28.1
Cape May Warbler	1,583	-35.0	-4.0	-9.6	-48.6	+50.8
Dabbling Ducks	1,446	-22.7	-7.3	-5.0	-35.0	+43.2
Fisher	4,798	-37.2	-3.4	-14.1	-54.7	+7.0
Great Gray Owl	2,559	-16.5	-7.2	-37.5	-61.1	+16.6
Moose	4,678	-21.5	-7.1	-25.7	-54.3	+9.6
Pileated Woodpecker	3,403	-26.4	-6.3	-11.0	-43.7	+52.0
Red-backed Vole	5,469	-38.8	-5.6	0.0	-44.3	+4.1
Ruffed Grouse	3,305	-28.5	-6.5	-9.8	-44.8	+16.2
Snowshoe Hare	7,319	-31.0	-6.5	-16.0	-53.5	-0.8
Western Tanager	1,104	-30.4	-3.9	0.0	-34.3	+189.4

7.1.2 Impact of Muskeg River Mine Project

Impacts related to site clearing for the Project were estimated to range from 16.5 to 38.8% of any KIRs habitat supply (Table 97). Impacts were predicted to have the greatest relative impact on habitat for the red-backed vole (38.8%), fisher (37.2%) and the Cape May warbler (35%). Major impacts (impacts affecting >20% of the habitat: see Golder 1997b for definitions) were predicted for all KIRs except the great gray owl.

Impacts related to drawdown were similar, in terms of percentages, for all KIRs (range of 3.4% for fishers to 7.3% for dabbling ducks). All impacts were considered to be low in magnitude.

Disturbance effects were found to range from 0 (for beavers, red-backed voles and western tanagers, all of which were assumed not to be disturbed) to 37.5% for the great gray owl. As stated previously, it is likely that the effects of disturbance on great gray owls was overestimated. Moderate impacts due to disturbance were predicted for black bears, Cape May warblers, dabbling ducks, fishers, pileated woodpeckers, ruffed grouse and snowshoe hares. Major impacts were predicted for great gray owls and moose.

Total effects due to clearing, drawdown and disturbance ranged from habitat losses of 30.5% (beavers) to 61.1% (great gray owls). All impacts were considered to be major in magnitude, but reversible.

Reclamation of the Project site was predicted to have minor negative to major positive impacts on KIR habitat relative to baseline conditions. Most predicted changes were due to greater amounts of upland habitats being planned under the closure scenario. Thus wetlands species, such as beavers, were predicted to lose 6% of their habitat, while upland species were predicted to have minor to major habitat gains. In total, the goal of achieving an equivalent or greater habitat capability for KIRs following reclamation was met, given that the average relative change in habitat for all KIRs was +34%.

Regional Study Area

A summary of baseline conditions and the impacts of incremental development scenarios on wildlife KIRs is demonstrated in terms of the total habitat units and the percentage change in those units (Table 98).

Table 98 Changes in Total Habitat Units for each Species among Development Scenarios in the RSA

Species	Habitat Units				Percent Change in Habitat Units		
	Baseline	Scenario 1	Scenario 2	Scenario 3	Scenario 1	Scenario 2	Scenario 3
Beaver	105,408	105,325	103,833	102,891	-0.1	-1.5	-2.4
Black Bear	362,016	360,427	353,651	344,799	-0.4	-2.3	-4.8
Cape May Warbler	162,454	161,621	159,071	155,536	-0.5	-2.1	-4.3
Dabbling Ducks	108,916	108,712	107,613	106,529	-0.2	-1.2	-2.2
Fisher	555,957	553,656	542,173	528,692	-0.4	-2.5	-4.9
Great Gray Owl	308,237	305,932	299,281	292,706	-0.7	-2.9	-5.0
Moose	385,291	382,860	373,963	363,886	-0.6	-2.9	-5.6
Pileated Woodpecker	324,826	323,315	318,695	311,457	-0.5	-1.9	-4.1
Red-backed Vole	505,202	503,176	494,279	483,948	-0.4	-2.2	-4.2
Ruffed Grouse	318,183	316,626	311,534	304,716	-0.5	-2.1	-4.2
Snowshoe Hare	786,163	781,907	765,177	747,698	-0.5	-2.7	-4.9
Western Tanager	127,278	126,840	125,073	121,961	-0.3	-1.7	-4.2

Baseline Conditions

Similar to the results for the LSA, the snowshoe hare had the highest baseline HUs (786,163 or 74.9 % of the possible 1.05 million ha) which resulted from a very high proportion of high suitability habitat Table 99). The only other species which had > 50 % of the habitat area as HUs was the fisher. The species with the least regional habitat was the beaver with 105,048 (10 %), and dabbling ducks with 108,916 (10.4%) HUs. These results are not surprising, considering that these two species must be located in or adjacent to open water resources.

Table 99 Rank Order by HUs of Wildlife KIRs in the RSA.

Species	Total Baseline HUs	Percent of Potential HUs
Snowshoe Hare	786,163	74.9
Fisher	555,957	52.9
Red-backed Vole	505,202	48.1
Moose	385,291	36.7
Black Bear	362,016	34.5
Pileated Woodpecker	324,826	30.9
Ruffed Grouse	318,183	30.3
Great Gray Owl	308,237	29.4
Cape May Warbler	162,454	15.5
Western Tanager	127,278	12.1
Dabbling Ducks	108,916	10.4
Beaver	105,408	10.0

Cumulative Impact Analyses

Changes to wildlife KIRs related to the Project were assessed in terms of the changes to total HUs in relation to the currently approved projects. The Project in the RSA resulted in losses of HUs ranging from 0.1% (beaver) to 0.7% (great gray owl; Table 100). In exclusion of the Project, the currently approved projects (Scenario 2) resulted in losses of HUs ranging from 1.0% (dabbling ducks) to 2.3% (moose). Thus, the additional losses due to the Project in the RSA in this scenario are considered to be low (< 10%). The range of total losses in Scenario 2 ranged from 1.2% (dabbling ducks) to 2.9% (moose, great gray owl).

In exclusion of the Project, all the possible projects which have been included in the Regional Development Review (Scenario 3) resulted in losses of HUs ranging from 2.0% (dabbling ducks) to 4.9% (moose). The additional losses in the RSA are considered to be low (< 1%). The ranged of total losses in Scenario 3 range from 2.0% (dabbling ducks) to 5.6% (moose).

Table 100 Cumulative Impacts of Regional Development Scenarios on Wildlife KIRs Which Demonstrate the Impacts of Muskeg River Mine (MRM) Project.

Species	HUs Loss (%) due to Project (Scenario 1)	HUs Loss (%) in Scenario 2 excluding Project	HUs Loss (%) in Scenario 2 including Project	HUs Loss (%) in Scenario 3 excluding Project	HUs Loss (%) in Scenario 3 including Project
Beaver	0.1	1.4	1.5	2.3	2.4
Black Bear	0.4	1.9	2.3	4.3	4.8
Cape May Warbler	0.5	1.6	2.1	3.7	4.3
Dabbling Ducks	0.2	1.0	1.2	2.0	2.2
Fisher	0.4	2.1	2.5	4.5	4.9
Great Gray Owl	0.7	2.2	2.9	4.3	5.0
Moose	0.6	2.3	2.9	4.9	5.6
Pileated Woodpecker	0.5	1.4	1.9	3.7	4.1
Red-backed Vole	0.4	1.8	2.2	3.8	4.2
Ruffed Grouse	0.5	1.6	2.1	3.7	4.2
Snowshoe Hare	0.5	2.1	2.7	4.4	4.9
Western Tanager	0.3	1.4	1.7	3.8	4.2

8. CLOSURE

We trust that this report presents the information that you require. Should any part of the report need clarification, please do not hesitate to contact the undersigned.

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APPENDIX I

HSI, BIODIVERSITY AND LINKAGE ZONE MODELS

1. HSI MODELS

1.1 BEAVER

1.1.1 Introduction

The beaver model was adapted from one developed by Westworth (1996) for the Suncor Steepbank Mine study area. The rationale for variable selection and model form will not be discussed except for changes to the model. This model assesses beaver habitat by first determining the proximity of land to open water (river, creek, pond, or marsh) areas. Then it examines if food and cover of the appropriate types exist in those zones.

1.1.2 Habitat Requirements

1.1.2.1 Food

Beaver food is determined by the relative proportion of deciduous shrubs and trees in the habitat adjacent to open water. Deciduous trees and shrubs, particularly willows, aspen and balsam poplar, are preferred food sources, although all deciduous trees and shrubs are ranked equally in this model based on their cover.

1.1.2.2 Cover

Cover for beavers is provided by the canopy closure of large trees and of shrubs, regardless of species. Additional cover also results in additional food resources (quantity), whereas the species composition (above) deals with the quality.

1.1.3 Model Development

1.1.3.1 Woody Vegetation Cover

This is the canopy closure of trees, converted from density classes (use 15% for A, 37.5% for B, 62.5% for C and 87.5% for D) added to the total shrub cover value. The cover of trees and shrubs is required to be greater than 0, and reaches optimum suitability at mid-cover ranges. At high ranges, the cover decreases due to the reduced ability to cut trees at high densities. Over the range 0 to 40% cover, the value increases from 0.0 to 1.0 (SI(1) = Cover/40). The suitability remains optimum (1.0) over the range 40 to 70%. It then decreases to 0.7 between 70 and 100% (SI(1) = 1.0 - [(cover - 70) x 0.01]). Then it remains at 0.7 for values greater than 100% (Figure 1a).

1.1.3.2 Deciduous Tree + Shrub Composition

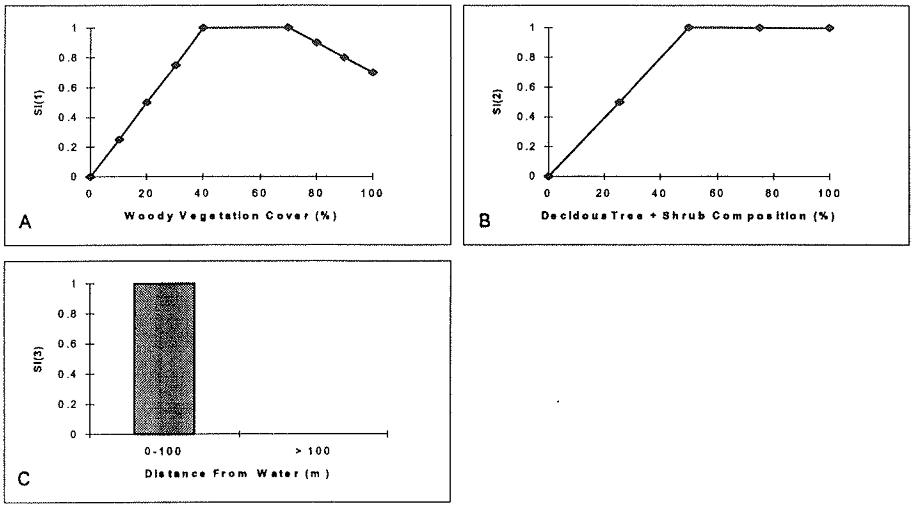
This variable is the relative proportion of deciduous trees and shrubs which make up the woody vegetation cover. It is determined as the sum of the deciduous tree cover and deciduous shrub cover divided by the total woody cover. As the proportion of deciduous trees and shrubs increases the suitability also increases, until the optimum is reached at 50% or higher. Thus over the range 0 to 50%, SI(2) = composition/50, whereas at all higher values SI(2) = 1 (Figure 1b).

1.1.3.3 Distance to Water

The model has been adapted from the Westworth (1996) model to reduce the number of calculations required to determine whether a water source is appropriate. This was done for two reasons. First, the area in which the model is being applied has very little slope, so it was not deemed necessary to determine the slope gradient component in Westworth's (1996) model. Secondly, the original model included a variable to determine the annual water fluctuation, a variable for which data was not available to demonstrate or a method to predict this feature. A third variable used in the original model determined which pond and lake habitats were most suitable based on size and shoreline development index values. However, the small size of most ponds in this area would have resulted in almost all being rated as optimum, and thus, the step was deemed unnecessary. It was assumed that all permanent creeks and rivers, as well as all ponds and marshes which appeared on the base-map hydrological layer were equally useful for acting as beaver habitat. This included man made as well as natural open water features.

A disturbance to water buffer of 100 m is applied for every creek, river, or pond in the study area. Within 100 m the habitat may be considered suitable if food and cover are available. Areas >100 m from water are considered unsuitable (Figure 10).

Figure 1 Suitability Index Values in Relation to Habitat Variables in the Beaver HSI Model



1.1.3.4 Equation

The modified HSI model for beavers assumes that all three suitability index components are required for habitat to be used by beavers and high values for one index cannot compensate for low values of any other. Thus, the model is the product of the three indices.

$$HSI = SI(1) \times SI(2) \times SI(3)$$

1.1.4 Current Status On Model Validation

The beaver model has only been developed based on literature reviews and has not been tested with independent data. The model runs presented in this document are the first runs completed for this model. Thus, the results for this model are not validated and are best to be regarded as potential habitat for our understanding of beavers rather than actual beaver habitat predictions.

1.2 BLACK BEAR

1.2.1 Introduction

The black bear model was adapted from one developed by Axys (1996) for the Syncrude/Suncor regional study area. The rationale for variable selection and model form will not be discussed except for changes to the model. This model assesses black bear habitat by determining food and cover requirements. The food and cover needs are then combined in an overall suitability equation. The main modification to the Axys (1996) model was the conversion of relationships from histograms to continuous curves over the range of the habitat variables. This resulted in a few changes to the values of the suitability indices over the ranges of the variables, but did not result in structural changes to the model or the equation. However, one variable was changed to reflect differences in the data used to predict the food cover index, and there was an addition of a disturbance buffer to reduce suitability in proximity to roads, mine sites and other disturbances.

1.2.2 Habitat Requirements

1.2.2.1 Food

Black bear food is determined by the cover of berry producing shrubs within the habitat area. This variable is used because bears require large numbers of berries to store energy for over-winter survival, and this period of time is critical for year-round survival. In this model, the weighted cover of the main berry producing shrubs in the diet of the black bear was used to quantify this variable. The shrubs which provide the most energy (most berries per foraging patch) were rated the highest, and other shrubs were progressively rated lower.

1.2.2.2 Cover

Black bears require escape cover from predators and intraspecific competitors, especially when immature. In this model, the cover of shrubs, tree canopy closure and the tree maturity all relate to increased black bear cover. The tree maturity is represented by the mean tree diameter at breast height (DBH) in centimetres, and relates to the ability of a bear to climb a tree for protection.

1.2.3 Model Development

1.2.3.1 Shrub Cover

This variable is the cover of all species of erect shrubs determined by summing individual species coverages. A stand with no shrub cover is rated as unsuitable (SI(1) = 0.0). Over the range of 0 to 70% cover, the suitability increases to fully optimum (thus, over this range SI(1) = cover /70). From 70 to 80% the suitability remains optimum(SI(1)= 1.0, then decreases to 0.8 over the range 80 -100% (SI(1) = 1.0 - (cover-80)/100) (Figure 2a).

1.2.3.2 Tree Canopy Closure Class

Tree canopy closure is measured by classes in the inventory used to predict the models. Open (O) class is unsuitable (0.0). A crown closure is rated at 0.25. B crown closure is rated at 0.75. C crown closure is optimum (1.0), and D crown closure decreases slightly to 0.9 (Figure 2b).

1.2.3.3 Mean Tree DBH

As tree DBH increases the suitability for escape cover increases from 0.1 where DBH = 0 to 1.0 at DBH= 15 cm. Thus over this range SI(3) = (DBH + 1 2/3)/16 2/3. For all trees > 15 cm, the suitability is optimum (1.0) (Figure 2C).

1.2.3.4 Weighted Berry Shrub Cover

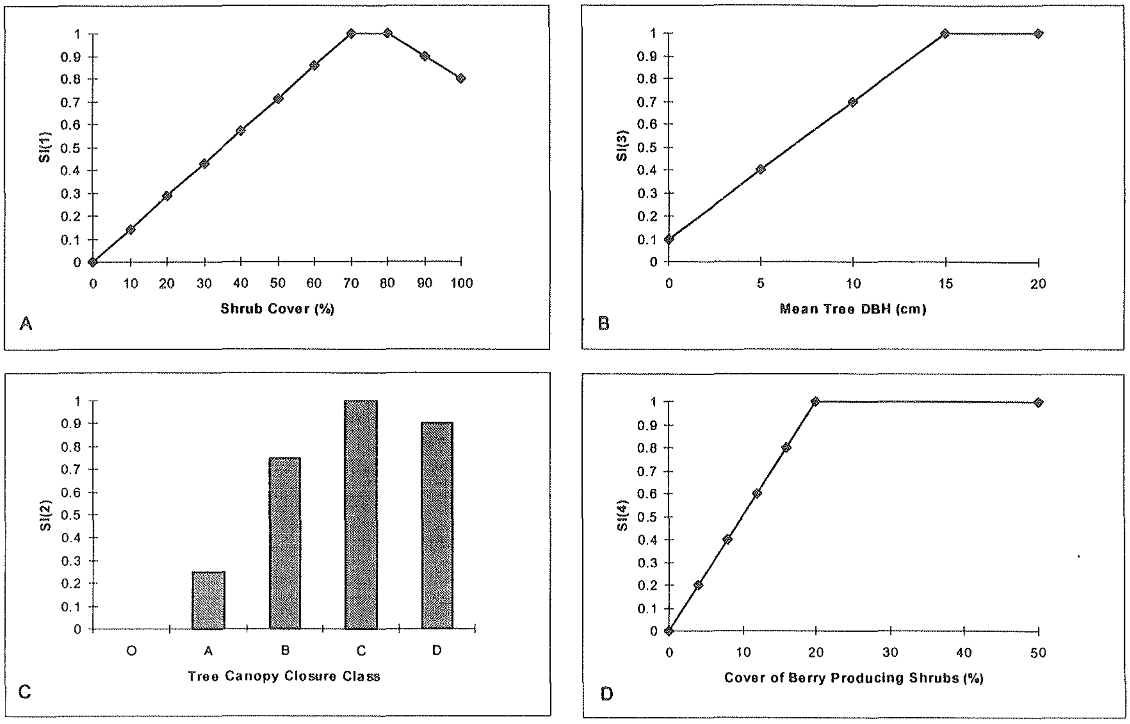
The variable was determined from the percent cover and weightings of the following species:

1.0 x (buffaloberry + blueberry) + 0.67 x (saskatoon + low-bush cranberry + pin cherry + choke cherry) + 0.33 x (currant + gooseberry + raspberry + dwarf shrubs).

Dwarf shrubs includes all shrubs which grow horizontally from rhizomatous stems including bearberry, creeping juniper, twinflower, crowberry, dwarf bilberry and bog cranberry.

In the previous version of this model the variable ranged from 0.25 at the lowest values to 1.0 at > 50% cover. Our data-set of cover values rarely had berry coverage at greater than 20%, so the relationship was altered to start at no suitability where there were no berry shrubs (SI(4) = 0.0) and increased to optimum over the range 0 to 20% and remained optimum at all higher values. Thus, SI(4) = min (1,cover/20) (Figure 2d).

Figure 2 Suitability Index Values in Relation to Habitat Variables in the Black Bear HSI Model



1.2.3.5 Disturbance Coefficients

The disturbance coefficient is used to reduce habitat suitability in areas adjacent to human disturbances (within a zone of influence) including roads, towns, pipeline and utility corridors, and industrial developments. The zones of influence and the disturbance coefficients for black bears are listed in Table 1, and vary depending on the cover characteristics of the habitat within the zone of influence. Where the cover HSI is ≥ 0.5 one value is applied, and where cover HSI is < 0.5 a second value is applied. Where more than one zone of influence overlaps, the lowest disturbance coefficient will be applied.

Table 1 Zones of Influence and Disturbance Coefficients for Black Bears

Disturbance Type	Zone of Influence	Disturbance Coefficient where HSI Cover ≥ 0.5	Disturbance Coefficient where HSI Cover < 0.5
Main Roads	100 m	0.25	0.05
Secondary Roads	100 m	0.75	0.375
Active Mine sites, gravel pits, dumps, plant facilities	100 m	0.1	0.0
Plant and Camp Sites, Towns	100 m	0.2	0.1
Tailings Ponds	50 m	0.9	0.8
Utility Corridors	50 m	0.9	0.8

1.2.3.6 Equations

The cover HSI equation considers that 60% of the cover is determined by shrub cover and 40 % is determined from tree cover. Thus the following weighted average was used:

HSI Cover = [0.6 x SI(1)] + [(0.4 x SI(2)) x SI(3)]

The food cover was directly related to SI(4).

HSI Food = SI(4)

The overall HSI for bear habitat was determined by weighting the value of food at 70% and cover at 30% in a weighted average. Thus a site with no cover could have a suitability value if it had food and vice versa, but it cannot have optimum conditions unless both food and cover are high. This average is then reduced by the disturbance coefficient.

HSI Overall = {[0.7 x HSI Food] + [0.3 x HSI Cover]} x Disturbance Coefficient

1.2.4 Current Status On Model Validation

The black bear model has been developed based on literature reviews and has not been tested with independent data. The previous version of the model was applied as part of the Syncrude Aurora Mine EIA (Axys 1996), but was not validated by population or habitat use data. However, the model was reviewed by Alberta Fish and Wildlife. Thus, the results for this model are not empirically validated and are best to be regarded as potential habitat based on our understanding of black bear rather than actual black bear habitat predictions.

1.3 CAPE MAY WARBLER

1.3.1 Introduction

The Cape May warbler model was adapted from one developed by Axys (1996) for the Syncrude/Suncor regional study area. The rationale for variable selection and model form will not be discussed except for changes to the model. This model assesses Cape May warbler habitat by use of variables which relate to both food and cover requirements. The main modification to the Axys (1996) model was the conversion of relationships from histograms to continuous curves over the range of the habitat variables. This resulted in a few changes to the values of the suitability indices over the ranges of the variables, but did not result in structural changes to the model or the equation.

1.3.2 Habitat Requirements

1.3.2.1 Food

Cape may warbler food and cover are determined from the same habitat variables. These include tree canopy closure, percentage conifer composition, mean tree height, and dominant tree species. The insectivorous Cape May warbler mainly catches insects amongst the branches of tall conifers (Axys 1996).

1.3.2.2 Cover

Cover requirements include open canopied forests comprised mainly of tall conifers in which white spruce is the most suitable species.

1.3.3 Model Development

1.3.3.1 Tree Canopy Closure

The Cape May warbler prefers open canopied forest stands. Thus, open (non-forested) habitats are unsuitable (SI(1) = 0.0). A canopy closure stands (6 to 30%) are rated as optimum (1.0), B (31 to 50%) are rated at 0.7, and higher crown closure classes (C and D: 51 to 100%) are rated at 0.3 (Figure 3a).

1.3.3.2 Conifer Tree Percent Composition

Conifer tree percent composition is related to Cape May warbler suitability through a series of linear relationships over different ranges of the percentage. From 0 to 40%, SI(2) increases from unsuitable (0.0) to 0.2

(SI(2) = 0.2 x comp/40). Then from 40 to 50% conifers the suitability increases from 0.2 to 0.75 (SI(2) = 0.2 + (comp-40) x 0.055). It then increases to full suitability at 75% (SI(2) = 0.75 + (comp-50) x 0.01) and remains optimum (1.0) at all percentages greater than 75. Note that tamarack is not included in the conifer percentage (Figure 3b).

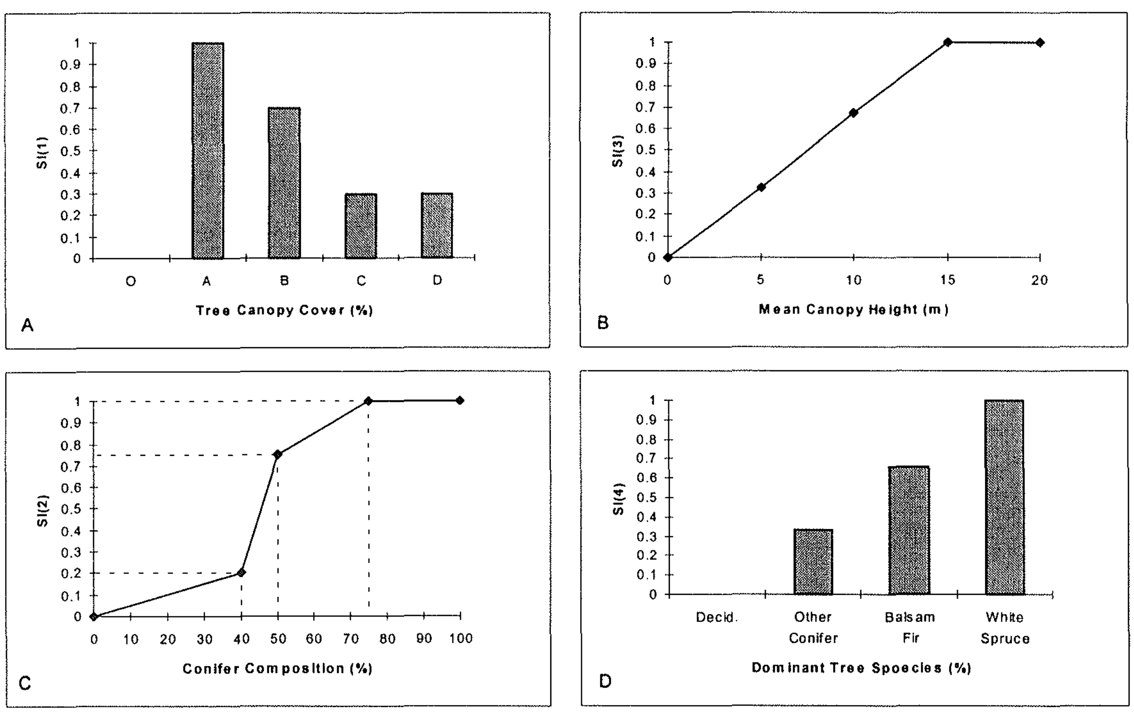
1.3.3.3 Mean Canopy Tree Height

Canopy tree height is directly related to suitability over the range 0 to 15 m height (SI(3) = height/15). At all taller heights the stand height is optimum (1.0) (Figure 3c).

1.3.3.4 Dominant Tree Species

The dominant tree species has been included because it determines the availability of singing sites for reproductive behaviours. Dominant tree species is based on the percentage composition of each species measured in the vegetation inventory. Where two species are tied for cover, the highest ranking species is listed as the dominant species. White spruce is the highest ranked species and receives a rating of 1.0. Balsam fir is second most preferred and is rated at 0.67. Other conifers are rated at 0.33, and deciduous trees are unsuitable (0.0) (Figure 3d).

Figure 3 Suitability Index Values in Relation to Habitat Variables in the Cape May Warbler HSI Model



1.3.3.5 Disturbance Coefficient

The disturbance coefficient is used to reduce habitat suitability in areas adjacent to human disturbances (within a zone of influence) including roads, towns, pipeline and utility corridors, and industrial developments. The zones of influence and the disturbance coefficients for Cape May warblers are listed in Table 2. Where more than one zone of influence overlaps, the lowest disturbance coefficient will be applied.

Table 2 Zones of Influence and Disturbance Coefficients for Cape May Warbler

Disturbance Type	Zone of Influence	Disturbance Coefficient
Main Roads,	100 m	0.25
Secondary Roads	100 m	0.75
Active Mine sites, gravel pits, dumps, plant facilities	100 m	0.1
Plant and Camp Site, Towns	100 m	0.2
Tailings Ponds	50 m	0.9
Utility Corridors	50 m	0.9

1.3.3.6 Equation

The Cape May warbler equation is the average of the product of the first two indices and the last two indices. This average is multiplied to the disturbance coefficient.

$$HSI = \{[0.5 \times SI(1) \times SI(2)] + [0.5 \times SI(3) \times SI(4)]\} \times \text{Disturbance Coefficient}$$

1.3.4 Current Status On Model Validation

The Cape May warbler model was developed for the Alberta oil sands region based on literature reviews and has not been tested with independent data. The previous version of the model was applied as part of the Syncrude Aurora Mine EIA (Axys 1996), but was not validated by population or habitat use data, nor was it reviewed by outside experts. Thus, the results for this model are not empirically validated and are best to be regarded as potential habitat based on our understanding of Cape May warbler rather than actual Cape May warbler habitat predictions.

1.4 DABBLING DUCKS

1.4.1 Introduction

This model was initially based on the model developed for dabbling ducks for the Suncor Steepbank Mine study area (Westworth and Associates 1996), which lists Sousa (1985) as the author of a model for blue-winged teals in the prairie pothole region of the United States, as the primary model source. This model, which was not applied in previous environmental assessments was considered to be unsuitable for the Alberta oil sands region for the following reasons. First: the pond types used in the model were not comparable to pond and wetlands classes in the boreal forest region of Alberta. Second, the model was designed to run on a section (mile squared) by section basis, and was likely designed for use at a very different scale of application. Third, the model involved a complicated procedure to perform the following obvious relationship: find duck habitat in ponds, marshes, and areas next to water bodies. It was therefore considered that a much simpler version of the model could be developed specifically for the oil sands area which would perform the same task.

1.4.2 Habitat Requirements

1.4.2.1 Food and Cover

Dabbling ducks primarily feed and seek cover in the same habitat types: namely in the vegetated shoreline on the edges of ponds, marshes and rivers. Ducks also feed throughout open water areas, and may use those habitats as safe sites away from land-dwelling predators. Cover is very important at early stages of a dabbling ducks life, and this usually occurs at the edges of ponds. marshes or rivers.

1.4.2.2 Distance to Water

The distance inland that a duck will make use of vegetation was assumed to be 250 m in the Westworth (1996) model. However, ephemeral wetlands were thought to only be used up to a maximum of 100 m distance. Although the Westworth (1996) model did not consider rivers and creeks as habitat for evaluation, the large size and slow moving nature of many of the edge habitats of rivers in the Alberta oil sands region suggested that they would be worthy for inclusion. Duck surveys in this area have confirmed that ducks are present along creeks, mainly in relation to beaver activity. It was considered that the distance from a river in which a duck would use habitat would be lower than the distance from ponds and marshes. This would tend to weight the importance of ponds much higher than rivers and creeks.

1.4.3 Model Development

1.4.3.1 Habitat Type

The first suitability index was determined from the type of habitat in the study areas (Table 3). Upland forests, disturbed areas and bogs were not considered to be suitable habitat (0.0). Swamps and fens considered to be low suitability (0.33). This was chosen since these areas often occur either near existing rivers or creeks, or in areas which have underground flowing water which occasionally floods or opens up along the length. The grassy vegetation which occurs in fens may be used as nesting sites. Lakes, ponds, rivers and creeks were rated as medium habitat (0.66). This was chosen since the ducks may use open areas for feeding and escape cover, but they still require vegetation in order to nest and receive a high rating. The highest rating (1.00) was given to marshes since there is abundant food and cover in these habitats, which often occur at the edges of ponds and rivers.

Table 3 Suitability of Habitat Types, Independent of Distance From the Nearest Water Body

Habitat Type	SI(1)
Upland Forests, Shrublands and Meadows	0.00
Disturbed Areas	0.00
Bogs	0.00
Swamps and Fens	0.33
Lakes, Ponds, Rivers and Creeks	0.66
Marshes	1.00

1.4.3.2 Distance to Open Water

The second suitability index is determined from the distance to the nearest pond, lake, marsh, creek or river. Any (natural) habitat which falls within the distances from the edge of these habitats as shown in Table 4 is rated as either high (1.00), moderate (0.66) or low (0.33). Any area greater than 250 m from ponds or marshes, or greater than 100 m from a river or creek receives no suitability (0.0).

Table 4 Suitability Index for Various Distances From Open Water Habitats

Wetland Type	Buffer Distance	SI(2)
Pond, Lake, Marsh, Open Water, Reclaimed Wetland or pond	0 - 50 m	1.00
	50 - 100 m	0.66
	100 - 250 m	0.33
	> 250 m	0.00
Rivers and Streams	0 - 50 m	0.66
	50 - 100 m	0.33
	> 100 m	0.00

1.4.3.3 Disturbance Coefficient

The disturbance coefficient is used to reduce habitat suitability in areas adjacent to human disturbances (within a zone of influence) including roads, towns, pipeline and utility corridors, and industrial developments. The zones of influence and the disturbance coefficients for dabbling ducks are listed in Table 5. Where more than one zone of influence overlaps, the lowest disturbance coefficient is applied.

Table 5 Zones of Influence and Disturbance Coefficients for Dabbling Ducks

Disturbance Type	Zone of Influence	Disturbance Coefficient
Main Roads,	100 m	0.25
Secondary Roads	100 m	0.75
Active Mine sites, gravel pits, dumps and plant facilities	100 m	0.1
Plant and Camp Site, Towns	100 m	0.2
Tailings Ponds	50 m	0.9
Utility Corridors	50 m	0.9

1.4.3.4 Equation

Habitat for dabbling ducks is thought to be related either to the first or second suitability index, whichever is highest. The equation then reduced the suitability by the disturbance coefficient.

HSI = Maximum (Habitat Rating, Distance Rating) x Disturbance Coefficient

1.4.4 Current Status On Model Validation

The dabbling duck model has been developed based on literature reviews and has not been tested with independent data. The model runs presented in this document are the first runs completed for this model. Thus, the results for this model are not validated and are best to be regarded as potential habitat, based on our understanding of dabbling duck ecology, rather than actual duck habitat predictions.

1.5 FISHER

1.5.1 Introduction

The fisher model was adapted from one developed by Axys (1996) for the Syncrude/Suncor regional study area. The rationale for variable selection and model form will not be discussed except for changes to the model. This model assesses fisher habitat by use of variables which relate to both food and cover requirements. The main modification to the Axys (1996) model was the conversion of relationships from histograms to continuous curves over the range of the habitat variables. This resulted in a few changes to the values of the suitability indices over the ranges of the variables, but did not result in structural changes to the model or the equation.

1.5.2 Habitat Requirements

1.5.2.1 Food

Fishers make use of many species of prey ranging from insects to carrion, but the most important food sources are snowshoe hare and other small mammals (Axys 1996). Food habitat is therefore closely associated with the cover habitats of the dominant prey. In this model, the habitat suitability model output from the snowshoe hare model and red-backed vole model have been incorporated to determine the habitat areas which will provide the most food.

1.5.2.2 Cover

Fishers make use of dense canopy cover, especially of coniferous forests or mixedwoods. Fishers tend to avoid open stands. Optimum fisher cover is related to stand maturity (Axys 1996).

1.5.3 Model Development

1.5.3.1 Tree Canopy Closure Class

Fishers prefer stands with high canopy closure, although they will occasionally use open stands for feeding if it is near concealment cover. Open stands (0 -5% closure) result in a suitability index of 0.1. A canopy closure stands (6 - 30%) have SI(1) = 0.2, and B canopy closure (31 - 50%)

is set at 0.3. This then jumps to 0.8 in C (51 - 85%) and to optimum suitability in D canopy closure (86 - 100%) stands (SI(1) = 1.0); (Figure 4a).

1.5.3.2 Conifer Percent in Canopy

Conifer tree percent composition is related to fisher suitability through a series of linear relationships over different ranges of the percentage. From 0 - 40%, SI(2) increases from unsuitable (0.0) to 0.2 (SI(2) = 0.2 x comp/40). Then from 40 - 50 % conifers the suitability increases from 0.2 to 0.75 (SI(2) = 0.2 + (comp-40) x 0.055). It then increases to full suitability at 75% (SI(2) = 0.75 + (comp-50) x 0.01) and remains optimum (1.0) at all percentages greater than 75. Note that tamarack is not included in the conifer percentage (Figure 4b).

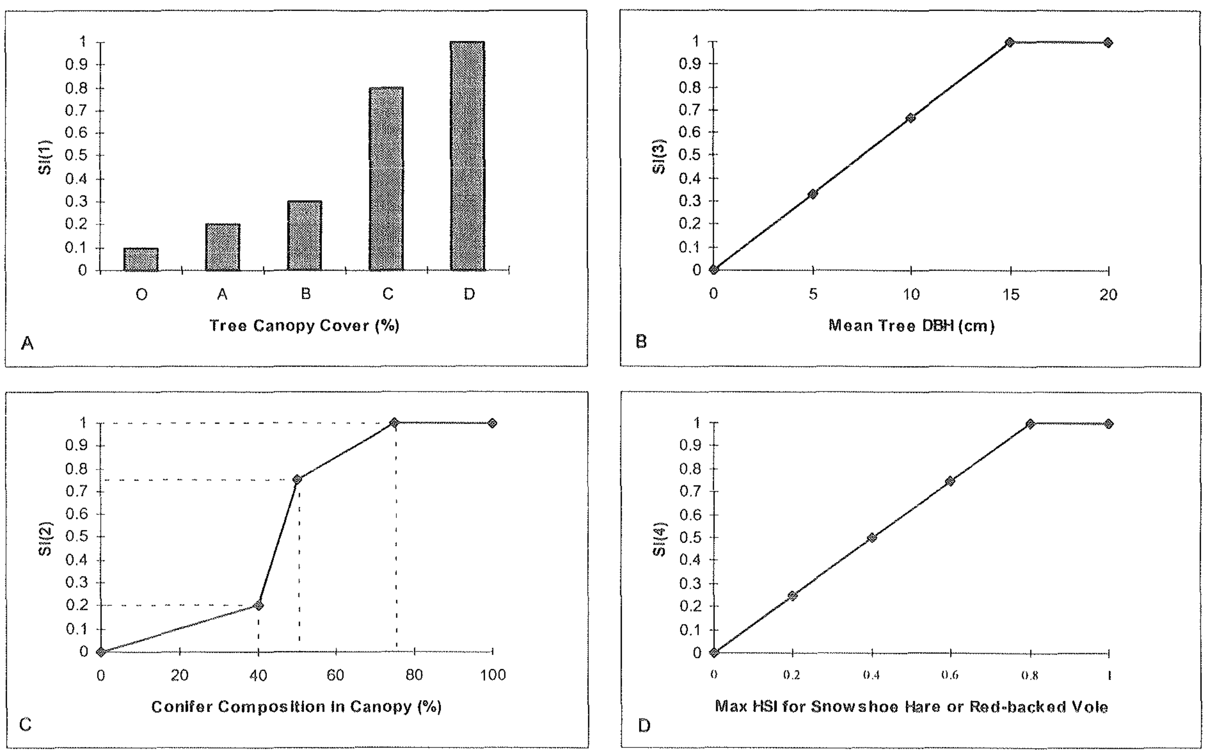
1.5.3.3 Mean Tree DBH

Diameter at breast height is used to determine an index of stand maturity (SI(3)). In this case, the use of the continuous curve resulted in stands with DBH = 0 having no suitability, whereas with the histogram used in the Axys (1996) model, the minimum value was 0.2. Over the diameter range 0 - 15cm, the suitability increased from 0 - 1 (SI(3) = DBH/15). At all higher values, SI(3) remains optimum (1.0); (Figure 4c).

1.5.3.4 Prey HSI

The suitability index values of snowshoe hares and red backed voles are examined to determine this next variable. First, the highest of the two values is chosen. Then the suitability for fisher food (SI(4)) is set to increase from 0 at unsuitable prey HSI to optimum at all values greater than or equal to 0.8 (Figure 4d).

Figure 4 Suitability index Values in Relation to Habitat Variables in the Fisher HSI Model



1.5.3.5 Disturbance Coefficient

The disturbance coefficient is used to reduce habitat suitability in areas adjacent to human disturbances (within a zone of influence) including roads, towns, pipeline and utility corridors, and industrial developments. The zones of influence and the disturbance coefficients for fisher are listed in Table 6. Where more than one zone of influence overlaps, the lowest disturbance coefficient will be applied.

Table 6 Zones of Influence and Disturbance Coefficients for Fisher

Disturbance Type	Zone of Influence	Disturbance Coefficient
Main Roads,	200 m	0.25
Secondary Roads	200 m	0.75
Active Mine sites, gravel pits, dumps and plant facilities	200 m	0.1
Plant and Camp Site, Towns	200 m	0.2
Tailings Ponds	100 m	0.9
Utility Corridors	100 m	0.9

1.5.3.6 Equations

The fisher equation is split into a food and cover index. The food index is based simply on the Prey HSI component. The cover index is determined as the average of the conifer percentage index and the stand maturity index, multiplied to the canopy closure index. The food and cover indices are then averaged, and this is multiplied to the disturbance coefficient.

$$\text{HSI Cover} = \text{SI}(1) \times [0.5 \times \text{SI}(2) + 0.5 \times \text{SI}(3)]$$

$$\text{HSI Food} = \text{SI}(4)$$

$$\text{HSI} = (0.5 \times \text{HSI Cover} + 0.5 \times \text{HSI Food}) \times \text{Disturbance Coefficient}$$

1.5.4 Current Status On Model Validation

The fisher model was developed for the Alberta oil sands region based on literature reviews and has not been tested with independent data. The previous version of the model was applied as part of the Syncrude Aurora Mine EIA (Axys 1996), but was not validated by population or habitat use data. It was, however, reviewed by from Alberta Fish and Wildlife and thought to be an acceptable model. However, the results for this model have not been empirically validated and are best to be regarded as potential habitat based on our understanding of fisher ecology rather than actual fisher habitat predictions.

1.6 GREAT GRAY OWL

1.6.1 Introduction

The great gray owl model was adapted from one developed by Axys (1996) for the Syncrude/Suncor regional study area. The rationale for variable selection and model form will not be discussed except for changes to the model. This model assesses great gray owl habitat by use of variables which relate to both food and cover requirements. The main modification to the Axys (1996) model was the conversion of relationships from histograms to continuous curves over the range of the habitat variables. This resulted in a few changes to the values of the suitability indices over the ranges of the variables, but did not result in structural changes to the model or the equations.

1.6.2 Habitat Requirements

1.6.2.1 Food

Great gray owls prey primarily on small rodents which inhabit at forest clearings, grassy areas, open fens or other vegetation types with open canopies and few shrubs. They also hunt in wet peatlands (fens and bogs). Favourite prey include red-backed voles, mice and lemmings, although prey use varies with abundance.

1.6.2.2 Cover

Great gray owls prefer a diverse mix of peatland and mixedwood forest types near open feeding areas. They hunt from a perch, so trees must be present in the open area or on the edge. For nesting, great gray owls prefer high canopy closure near the nest site, but they will nest in areas with as little as 10 to 30 % closure in some cases.

1.6.2.3 Nest Trees

These owls utilize pre-existing stick nests or broken topped trees. Stick nests are most often found high in the canopy in the crotch of a mature aspen or balsam poplar tree. Thus, great gray owls tend to nest in mature forests. Foraging habitat must be near the nest site to ensure food for owlets. The distance is usually within the range of 100 to 250 m from a forest clearing edge.

1.6.3 Model Development

1.6.3.1 Tree Canopy Closure Class

In this model, the tree canopy closure class has been set high to match the cover needs for nesting habitat. Open stands receive no suitability (SI(1)=0.0), A crown closure stands (0 to 30 %) receive a 0.5 value, and all other stands (31 to 100 %) are rated as fully optimum (1.0; Figure 5a).

1.6.3.2 Mean Stand DBH

Tree DBH is used as an index of stand maturity. Stands where the average DBH is less than 15 cm are unsuitable (SI(2) = 0.0). Over the range 15 to 25 cm SI(2) increases from 0.0 to 1.0, and SI(2) remains optimum for all greater mean diameters (Figure 5b).

1.6.3.3 Percent Deciduous Trees

Deciduous tree composition is included to restrict high suitability great gray owl cover to pure deciduous or mixedwood forests. Suitability increases from 0.6 at 0% cover to 1.0 at 80 % cover (SI(3) = (percent + 120)/200. At greater than 80% deciduous the suitability index is optimum. (Figure 5c)

1.6.3.4 Graminoid Cover

Graminoid cover (that is grass, sedge, and rush cover) is used to determine foraging habitat. Where graminoid cover is greater than or equal to 50%, SI(4) = 1. At lower covers the value decreases until it is 0.0 at no cover (Figure 5d)

1.6.3.5 Soil Moisture Class

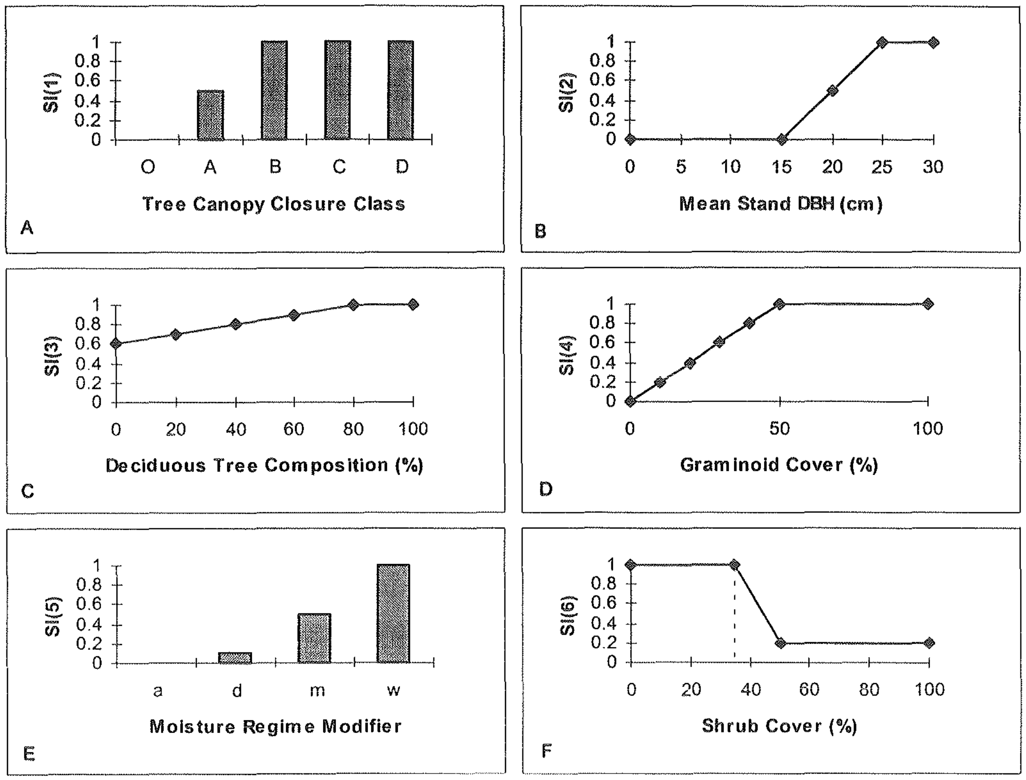
Soil moisture class has been included in this model to indicate areas which are most likely to be used as foraging cover. Aquatic sites (a) are unsuitable since the water is standing at the surface and rodents will not be inhabiting these sites. These sites include most lakes, ponds and some marshes. Wet sites (w) are rated as fully optimum (SI(5)=1.0), and include most marshes, fens, bogs, and swamps. Mesic areas (m) are rated as 1/2 suitable, and include most upland forests. Dry sites (d) are only rated at 0.1 suitability and include vegetation on rocky or sandy substrate (Figure 5e).

1.6.3.6 Shrub Cover

Shrub cover has been include to determine foraging habitat. Sites with up to 35% shrub cover are considered optimum, since ample sites exist for capture of prey. This index decreases to 0.2 over the range 30 to 50 %

cover (SI(6) = 1 - {(cover - 35)/18.75}. Then, the suitability remains at 0.2 for all greater cover values (Figure 5f).

Figure 5 Suitability Index Values in Relation to Habitat Variables in the Great Gray Owl HSI Model



1.6.3.7 Disturbance Coefficient

The disturbance coefficient is used to reduce habitat suitability in areas adjacent to human disturbances (within a zone of influence) including roads, towns, pipeline and utility corridors, and industrial developments. The zones of influence and the disturbance coefficients for great gray owls are listed in Table 7. Where more than one zone of influence overlaps, the lowest disturbance coefficient will be applied.

Table 7 Zones of Influence and Disturbance Coefficients for Great Gray Owl

Disturbance Type	Zone of Influence	Disturbance Coefficient
Main Roads	500 m	0.25
Secondary Roads	500 m	0.75
Active Mine sites, gravel pits, dumps and plant facilities	500 m	0.1
Plant and Camp Site, Towns	500 m	0.2
Tailings Ponds	250 m	0.9
Utility Corridors	250 m	0.9

1.6.3.8 Cover and Food HSI Equations

The great gray owl model first determines cover and food HSI values. These are later combined after spatially analysing the adjacency between high food habitat and cover habitat. The cover index is determined as the mean of SI(1) and the-product of SI(2) and SI(3). The food habitat is determined similarly using the mean of SI(4) and the product of SI(5) and SI(6). However, in this equation, the graminoid cover index has been weighted at 0.7 and the product of moisture index and shrub cover index at 0.3.

$$\text{HSI Cover} = 0.5 \times SI(1) + 0.5 \times SI(2) \times SI(3)$$

$$\text{HSI Food} = 0.7 \times SI(4) + 0.3 \times SI(5) \times SI(6)$$

1.6.3.9 Spatial Analysis

The spatial analysis examines all high food habitat (HSI Food $\geq 2/3$) for the greatest HSI Cover within 500 m. These areas are then assigned the highest cover HSI. Next all polygons where HSI Food. In the RSA, instead of using a 500 m buffer around the food areas, only the stand types which were adjacent to the polygon were examined. This was done on the assumption that most aggregated polygons in the RSA were greater than 500 m in diameter.

1.6.3.10 Overall HSI Equation

The great gray owl HSI was then calculated using the weighted average of food and cover HSI. Food is the more important requirement for determining owl habitat, so this index is weighted at 0.7 and cover HSI is rated at 0.3. The disturbance coefficient is then multiplied to the weighted mean.

HSI Overall = {0.7 x HSI Food + 0.3 x HSI Cover} x Disturbance Coefficient

1.6.4 Current Status On Model Validation

The great gray owl model was developed for the Alberta oil sands region based on literature reviews and has not been tested with independent data. The previous version of the model was applied as part of the Syncrude Aurora Mine EIA (Axys 1996), but was not validated by population or habitat use data. It was, however, reviewed by Alberta Fish and Wildlife and is thought to be an acceptable model. However, the results for this model have not been empirically validated and are best to be regarded as potential habitat based on our understanding of great gray owl ecology rather than actual great gray owl habitat predictions.

1.7 MOOSE

1.7.1 Introduction

The moose model was adapted from one developed by Axys (1996) for the Syncrude/Suncor regional study area. The rationale for variable selection and model form will not be discussed except for changes to the model. This model assesses moose habitat by use of variables which relate to both food and cover requirements. The main modification to the Axys (1996) model was the conversion of relationships from histograms to continuous curves over the range of the habitat variables. The spatial modelling component, where foraging areas were assigned higher adjacent cover values, and vice-versa was also changed for ease of calculation and will be discussed below. This resulted in a few changes to the values of the suitability indices over the ranges of the variables, but did not result in structural changes to the model or the equations.

1.7.2 Habitat Requirements

1.7.2.1 Food

Moose generally consume woody browse during the fall and winter seasons. Preferred browse include all willow species, red osier dogwwod, several other deciduous species and subalpine/balsam fir (Axys 1996). Aspen, birch and baslam polar are also highly utilized species. In spring and summer herbaceous plants, aquatic plants and browse (complete with leaves) are consumed, although browse still makes up the bulk of the diet.

1.7.2.2 Cover

Cover is important for providing protection from predators, insects and extreme weather, and is used during feeding, resting and movement activities. Often the same areas provide food and cover habitat. However, areas with high shrub cover and thus high food are often lacking in thermal and protective cover. Open areas with no shrubs or trees are generally avoided. In general an interspersion of cover types is considered the best moose habitat, since these areas provide food and cover areas that moose can easily travel between. Dense forest stands are preferred for winter cover as they provide ample shelter from wind and tend to accumulate less snow.

1.7.3 Model Development

1.7.3.1 Cover of Preferred Browse Species

Preferred browse species were summed from shrub cover values using various weightings which relate to the preference and importance of the species in the diet. Species weighted by 1.0 include willow, aspen, balsam poplar, red-osier dogwood and beaked hazelnut. Species weighted by 0.75 include saskatoon, pin and choke cherry, prickly rose, gooseberry and currant and raspberry. Species weighted by 0.5 include buffaloberry, balsam fir, green and river alder, bracted honeysuckle, paper birch, jack pine, and dwarf and bog birch. White spruce and black spruce are weighted by 0.25.

SI(1) increases from 0.0 when there is no weighted browse cover, to 1.0 at 50% or higher values (Figure 6a).

1.7.3.2 Tree Canopy Closure Class

Tree canopy closure class ensures thermal and escape cover. Thus open stands (0 to 5%) are unsuitable, A canopy closure stands (6 to 30%) are rated at 0.2, B stands (31 to 50%) are rated 0.4, C stands (51 to 85%) are rated 0.8, and D stands (86 to 100%) are 1.0 (Figure 6b).

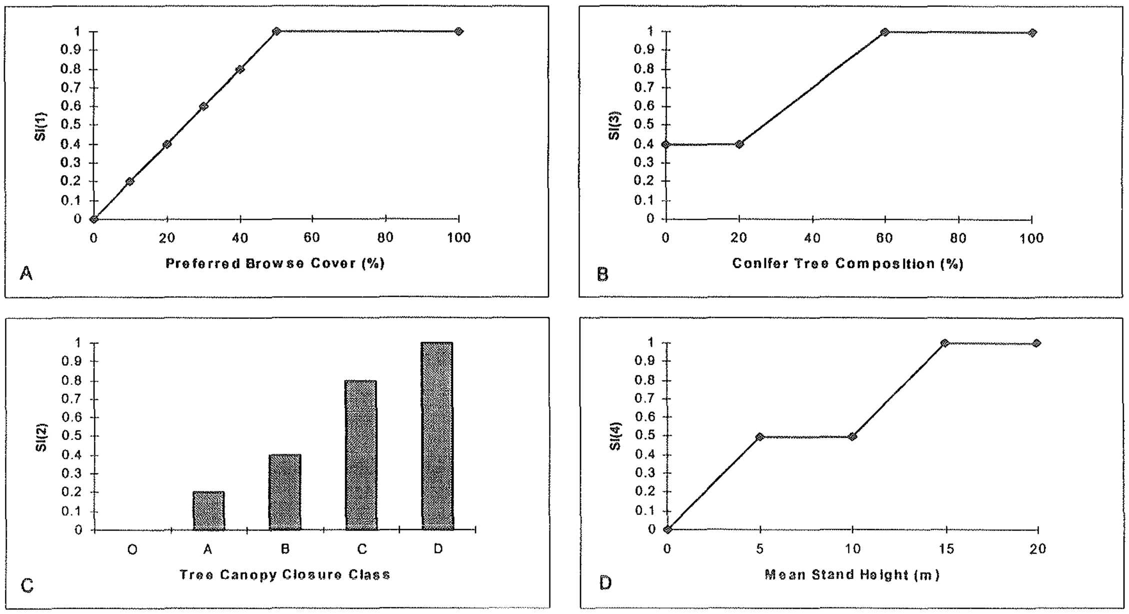
1.7.3.3 Percent Conifer Composition

Conifer trees provide superior protection against wind and provide greater visual cover than deciduous trees. However, pure deciduous stands will still be utilized by moose to a lesser degree. Thus, no conifer percentage up to 20% conifers results in SI(3) = 0.4. This increases to 1.0 at 60% conifers or higher (Figure 6c). Over 20 to 60%, the index value is determined as (percent + 6.67)/66.67 (Figure 6c).

1.7.3.4 Mean Canopy Tree Height

Canopy height has been added as a variable to reduce cover suitability in regenerating forest stands and shrublands. From 0 - 5 m, SI(4) increases from 0.0 to 0.5 (SI(4) = height/10). The suitability then remains at 0.5 until 10 m is reached. Then between 10 and 15 m the suitability increase to 1.0 (SI(4) = (height - 5)/10; Figure 6d).

Figure 6 Suitability Index Values in Relation to Habitat Variables in the Moose HSI Model



1.7.3.5 Disturbance Coefficient

The disturbance coefficient is used to reduce habitat suitability in areas adjacent to human disturbances (within a zone of influence) including roads, towns, pipeline and utility corridors, and industrial developments. The zones of influence and the disturbance coefficients for moose are listed in Table 8, and vary depending on the cover characteristics of the habitat within the zone of influence. Where the cover HSI is ≥ 0.5 one value is applied, and where cover HSI is < 0.5 a second value is applied. Where more than one zone of influence overlaps, the lowest disturbance coefficient will be applied. Note that the disturbance coefficient for moose is calculated before the spatial analysis between food and cover, since that will tend to increase the stands cover values.

Table 8 Zones of Influence and Disturbance Coefficients for Moose.

Disturbance Type	Zone of Influence	Disturbance Coefficient where HSI Cover ≥ 0.5	Disturbance Coefficient where HSI Cover < 0.5
Main Roads	500 m	0.25	0.05
Secondary Roads	500 m	0.75	0.375
Active Mine sites, gravel pits, dumps and plant facilities	500 m	0.1	0.0
Plant and Camp Sites, Towns	500 m	0.2	0.1
Tailings Ponds	250 m	0.9	0.8
Utility Corridors	250 m	0.9	0.8

1.7.3.6 Food and Cover HSI Equations

The moose habitat model first determines cover and food HSI values. These are later combined after spatially analysing the adjacency between food habitat and cover habitat. The cover index is determined simply from the browse index:

HSI Food = SI(1);

whereas the cover index is determined from the product of SI(2) and the mean of SI(3) and SI(4):

HSI Cover = SI(2) x [0.5 x SI(3) + 0.5 x SI(4)]

1.7.3.7 Spatial Analysis of Food and Cover

Cover habitat where HSI Cover ≥ 0.5, is assigned the highest HSI Food value of all adjacent stands but only if the highest adjacent value is greater than its own value. Keep a record of the calculated food value and the highest adjacent value.

Likewise, foraging habitat where HSI Food ≥ 0.5, is assigned the highest HSI Cover value of all touching adjacent stands but only if the highest adjacent value is greater than the stands own value. Keep a record of the calculated cover value and the highest adjacent value.

1.7.3.8 Overall HSI Equation

The overall HSI equation is a weighted mean in which food is weighted at 0.7 and cover at 0.3. This mean is then multiplied to the disturbance coefficient.

HSI Overall = {0.7 x highest HSI Food + 0.3 x highest HSI Cover} x Disturbance Coefficient

1.7.3.9 Current Status On Model Validation

The moose model was developed for the Alberta oil sands region based on literature reviews and has been compared to moose habitat use within the Syncrude local study area and throughout the regional area (Axys 1996). The moose model was applied as part of the Syncrude Aurora Mine EIA (Axys 1996) and was reviewed by Alberta Fish and Wildlife. It is thought to be an acceptable model. The results for this model were at least partially empirically validated and thus the results from this model should be considered to be validated moose habitat predictions, assuming that the results from this study are similar to the results in the previous study.

1.8 PILEATED WOODPECKER

1.8.1 Introduction

The pileated woodpecker model was developed using two recently developed models as a basic guideline for development. The first was developed by Golder Associates (1997d) for use in Central Saskatchewan. The second was developed by the Foothills Model Forest (1996) for west-central Alberta.

The pileated woodpecker is the largest North American woodpecker and is widely distributed across the boreal forest and other forest types. These year-round residents are notable for being tree cavity excavators and for their use of bark/wood dwelling insects as their primary food source. They are thus generally associated with mature forest types with high densities of large diameter snags and downed wood.

1.8.2 Habitat Requirements

1.8.2.1 Nesting and Roosting

Pileated woodpeckers require large diameter trees for nesting. In the boreal forest they prefer aspen or balsam poplar live trees, but are also known to excavate nests in dead snags and paper birch. Aspens appear to be preferred since these trees are susceptible to heartwood rot which is easier to excavate than solid wood. Nests are usually excavated high in the canopy on the main trunk of the tree. As well as nesting, several other large trees are utilized for roosting cavities which are used as rest stops during long foraging activities, as an alternative location for the mate not incubating the eggs or chicks, or during inclement weather. Roost trees are often previous years nests but also include large diameter snags of conifers or deciduous trees.

1.8.2.2 Food

Pileated woodpeckers forage primarily on carpenter ants and wood boring beetle larvae, but will feed on nuts, berries and other insect prey opportunistically. Foraging substrate consists of large diameter downed logs, snags and insect interested live trees. During the winter, downed logs are usually unavailable for foraging due to snow and freezing temperatures. Usually mature forests are used for foraging since these have the highest number of large snags and logs, but harvested forest areas may also be used due to the presence of rotten stumps and other slash materials.

1.8.2.3 Cover and Habitat Area

Cover resources are associated with both foraging and predator avoidance. Pileated woodpeckers usually prefer areas with high canopy closure or other concealment to protect them from their main predator: the goshawk. Closed canopied forests also tend to accumulate less snow and are thus more able to provide food in the winter. They are highly territorial and defend a year-round range with ample food, cover and nesting resources. Home range sizes vary among studies but are usually on the order of 250 - 500 hectares.

1.8.3 Model Development

1.8.3.1 Tree Canopy Closure Class

Only forested habitats are suitable for pileated woodpecker year-round habitat. Thus, all open stands (class O: 0 to 5% canopy closure) are unsuitable. A canopy closure stands (6 - 30%) are rated at 0.5, B stands (31 to 50%) are rated at 0.8, and higher canopy closure stands (C and D: 51 to 100%) are fully optimum (SI(1) = 1.0); Figure 7a). This reflects the needs for high cover for food and concealment.

1.8.3.2 Deciduous Tree Composition

Deciduous tree composition has been included to ensure that aspen or other preferred tree species are present in at least minimal amount to provide the nest tree. The optimum condition has been set to occur at 10% deciduous trees which is the minimum value for deciduous tree composition which appears in the forest inventory (AVI; Figure 7b).

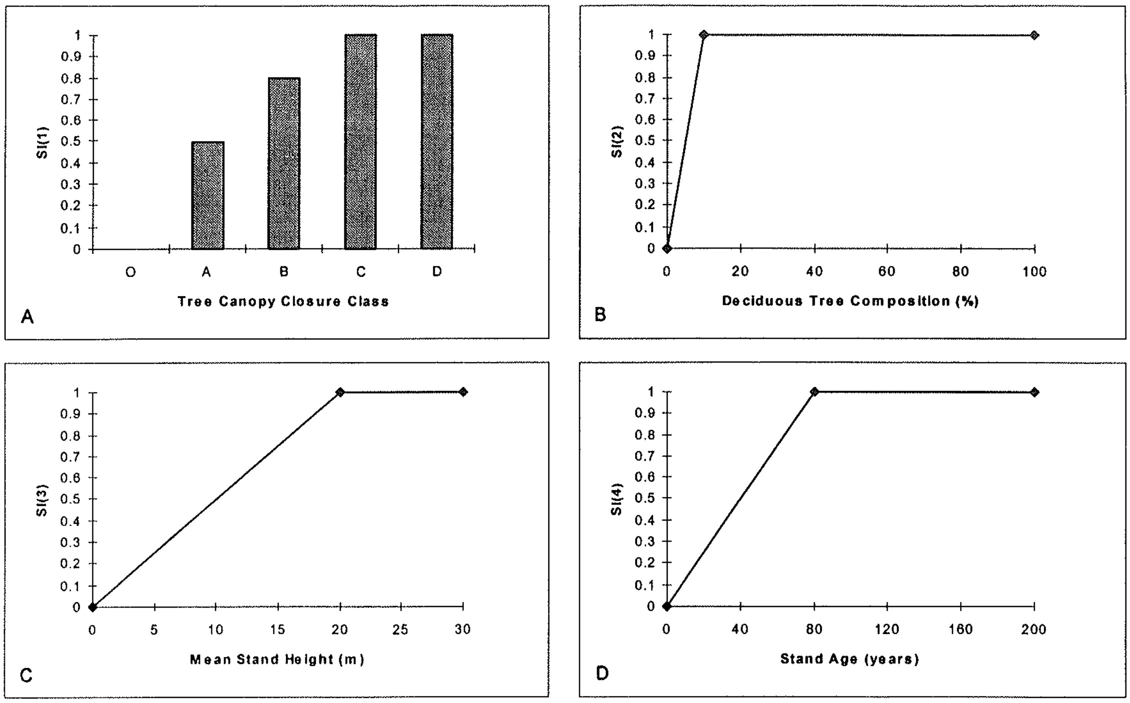
1.8.3.3 Mean Stand Height

Mean stand height has been used in this model to determine conditions in which trees are tall enough for nesting and in which trees are of large enough diameter for providing roosting and nesting opportunities. Tree height was used instead of DBH in this model since height is directly available in the Alberta Vegetation Inventory which is being used to determine tree values in this project. Also, in this project, DBH is being predicted from height so including both variables would be redundant. Over the range 0 to 20 m height, SI(3) increases from unsuitable (0.0) to optimum suitability (1.0). The suitability remains at 1.0 for all taller heights (Figure 7c).

1.8.3.4 Stand Age

Stand age is used as an indirect measure of snag and downed wood density. This was done since there was no data on snag abundance in our inventory (since this species was added as a KIR after the inventory work was completed). Snag abundance and sufficient downed wood density is assumed to be unsuitable at 0 years post disturbance, and increase to optimum at 80 years post disturbance. Some concern has been expressed regarding the large influx of snags and downed wood immediately following disturbance by fire. However, this wood tends to remain hard and charcoal coated for many years and should not be available as insect substrate until the new forest reaches advanced ages. Note that this variable only applies to forested stands; for all other stands SI(4) = 0.

Figure 7 Suitability Index Values in Relation to Habitat Variables in the Pileated Woodpecker HSI Model



1.8.3.5 Disturbance Coefficient

The disturbance coefficient is used to reduce habitat suitability in areas adjacent to human disturbances (within a zone of influence) including roads, towns, pipeline and utility corridors, and industrial developments. The zones of influence and the disturbance coefficients for pileated woodpeckers are listed in Table 9. Where more than one zone of influence overlaps, the lowest disturbance coefficient will be applied.

Table 9 Zones of Influence and Disturbance Coefficients for Pileated Woodpeckers

Disturbance Type	Zone of Influence	Disturbance Coefficient
Main Roads	100 m	0.25
Secondary Roads	100 m	0.75
Active Mine sites, gravel pits, dumps and plant facilities	100 m	0.1
Plant and Camp Site, Towns	100 m	0.2
Tailings Ponds	50 m	0.9
Utility Corridors	50 m	0.9

1.8.3.6 Equation

The pileated woodpecker HSI considers that the canopy closure variable and the disturbance coefficient has the most influence on habitat utilization, so SI(1) and the coefficient are multiplied directly to the weighted mean of the other three indices. The weighting used rates SI(2) as twice as important as SI(3) and SI(4).

HSI = SI(1) x [(SI(2) x 0.5) + (SI(3) x 0.25) + (SI(4) x 0.25)] x Disturbance Coefficient

1.8.4 Current Status On Model Validation

The pileated woodpecker model has only been developed based on literature reviews and has not been tested with independent data. The model runs presented in this document are the first runs completed for this model. Thus, the results for this model are not validated and are best to be regarded as potential habitat based on our understanding of pileated woodpecker ecology rather than actual pileated woodpecker habitat predictions.

1.9 RED-BACKED VOLE

1.9.1 Introduction

The red-backed vole model was adapted from one developed by Axys (1996) for the Syncrude/Suncor regional study area. The rationale for variable selection and model form will not be discussed except for changes to the model. This model assesses red-backed vole habitat by use of variables which relate to both food and cover requirements. The main modification to the Axys (1996) model was the conversion of relationships from histograms to continuous curves over the range of the habitat variables. This resulted in a few changes to the values of the suitability indices over the ranges of the variables, but did not result in structural changes to the model or the equations.

1.9.2 Habitat Requirements

1.9.2.1 Food

Red-backed voles are omnivorous and feed on herbaceous plants, twigs, berries, fungi, arthropods and other foods which are available in abundance. The relative use of herbaceous plants and fungi increases in summer. In winter, fruits, twigs and leaf litter may be consumed via subnivean access.

1.9.2.2 Cover

In winter, cover is provided by snow, but the presence of downed wood or shrubs aids in maintaining subnivean corridors. In summer, downed wood, leaf litter and mature forest tree and shrub canopy closure provide protective cover.

1.9.3 Model Development

1.9.3.1 Cover of Herbaceous Plants and Litter (%)

This variable is the sum of rhizomatous shrubs forbs, graminoids and areas with open leaf or needle litter. From 0 to 30% cover SI(1) increases from 0.2 to 0.4. Then from 30 to 70% cover, SI(1) increases to 1.0 and remains at 1 for higher covers (Figure 8a).

1.9.3.2 Downed Wood Density (per ha)

Downed wood density refers to logs greater than 10 cm diameter. Over the range 0 - 250 logs per hectare, suitability increases from 0.0 to 1.0, and remains optimum at all higher densities (Figure 8b).

1.9.3.3 Shrub Cover (%)

SI(3) is 0.1 between 0 and 10% shrub cover. It then increases to 1.0 at 50 % cover, and remains optimum until 80%. Above 80% the shrub cover will inhibit herbaceous growth and thus reduce food suitability. Thus, SI(3) decreases slightly from 1.0 to 0.7 at 100% or higher cover (Figure 8c).

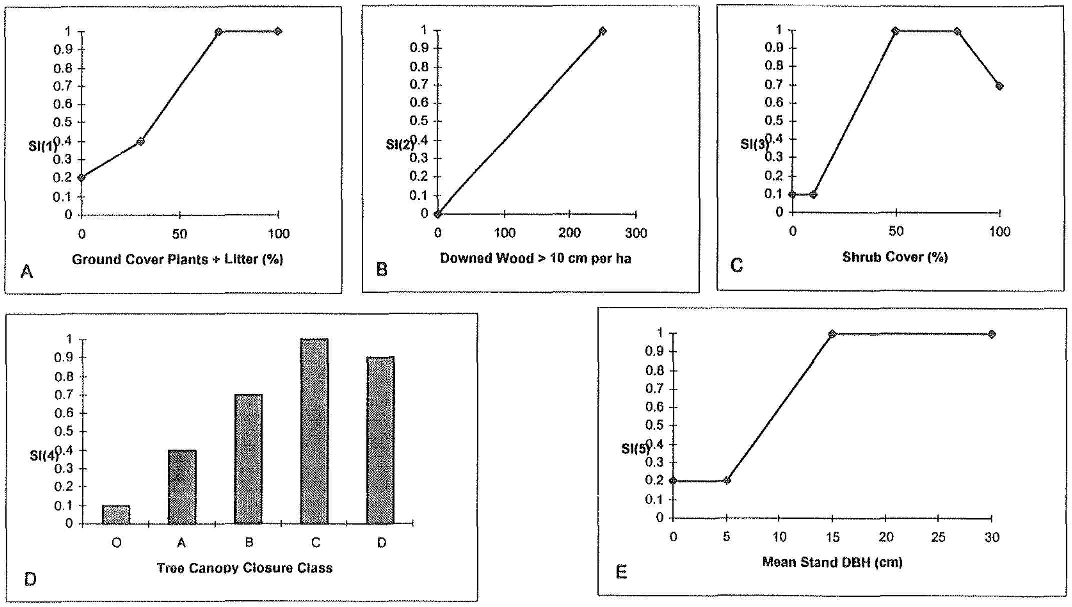
1.9.3.4 Tree Canopy Closure Class

High tree canopy closures provide more optimal cover for red-backed voles. Thus, open stands are rated at 0.1, A closure stands are rated 0.4, B stands are rated 0.7 and C stands are rated 1.0. D stands decrease slightly to 0.9 for reasons similar to the decrease noted above (Figure 8d).

1.9.3.5 Mean Stand DBH

The final variable influencing habitat suitability for red-backed voles is mean DBH which is used as an indicator of stand maturity. Stands up to 5 cm of DBH receive an index value of 0.2. Over the range 5 to 15 cm DBH the suitability increases to 1.0, and this remains at 1.0 for all greater DBH values (Figure 8e).

Figure 8 Suitability Index Values in Relation to Habitat Variables in the Red-backed Vole HSI Model



1.9.3.6 Equation

The red backed vole model does not include a disturbance coefficient. First the product of SI(1) and SI(2) is found, as is the produce of SI(4) and SI(5). The two products and SI(3) are then used in a weighted mean to determine the vole's HSI:

$$HSI = [0.3 \times SI(1) \times SI(2)] + [0.4 \times SI(3)] + [0.3 \times SI(4) \times SI(5)]$$

1.9.4 Current Status On Model Validation

The red-backed vole model was developed for the Alberta oil sands region based on literature reviews and has not been tested with independent data. The previous version of the model was applied as part of the Syncrude Aurora Mine EIA (Axys 1996), but was not validated by population or habitat use data. It was, however, reviewed by Alberta Fish and Wildlife and thought to be an acceptable model. However, the results for this model have not been empirically validated and are best to be regarded as potential habitat based on our understanding of red-backed vole ecology rather than actual red-backed vole habitat predictions.

1.10 RUFFED GROUSE

1.10.1 Introduction

The ruffed grouse model was adapted from one developed by Axys (1996) for the Syncrude/Suncor regional study area. The rationale for variable selection and model form will not be discussed except for changes to the model. This model assesses grouse habitat by use of variables which relate to both food and cover requirements. The main modification to the Axys (1996) model was the conversion of relationships from histograms to continuous curves over the range of the habitat variables. This resulted in a few changes to the values of the suitability indices over the ranges of the variables, but did not result in structural changes to the model or the equations.

1.10.2 Habitat Requirements

1.10.2.1 Food

Ruffed grouse are omnivores and feed on twigs, buds, herbaceous plants, berries, seeds and insects. Insects are especially important in the first two months of life. Fall foods consist of shrubs with berry fruit, twigs and buds. In winter, the buds of trembling aspen (and to a lesser extent, willow) are the main foods.

1.10.2.2 Cover

Mixedwood and pure deciduous forest types are the most common habitats. Shrub densities are also influential on habitat cover, such that dense stands are rated higher. Mature stands are preferred but not essential.

1.10.3 Model Development

1.10.3.1 Tree Canopy Closure Class

Open canopied stands receive a rating of only 0.1. This increases to 0.4 for A closure stands, then 0.6, 0.8 and 1.0 for B, C and D stands respectively (Figure 9a).

1.10.3.2 Deciduous Composition (%)

Stands with 0 to 20% deciduous trees are rated at 0.2. This increases over the range 20 to 50% by the formula (percent - 12.5)/37.5. At 50% and higher cover the value is 1.0 (Figure 9b)

1.10.3.3 Mean Stand DBH (cm)

DBH is used as an index of forest maturity. Stands with < 7.5 cm mean diameter are rated at 0.2. SI(3) increases to 1.0 at 15 cm DBH and remains at 1 for all greater values (Figure 9c).

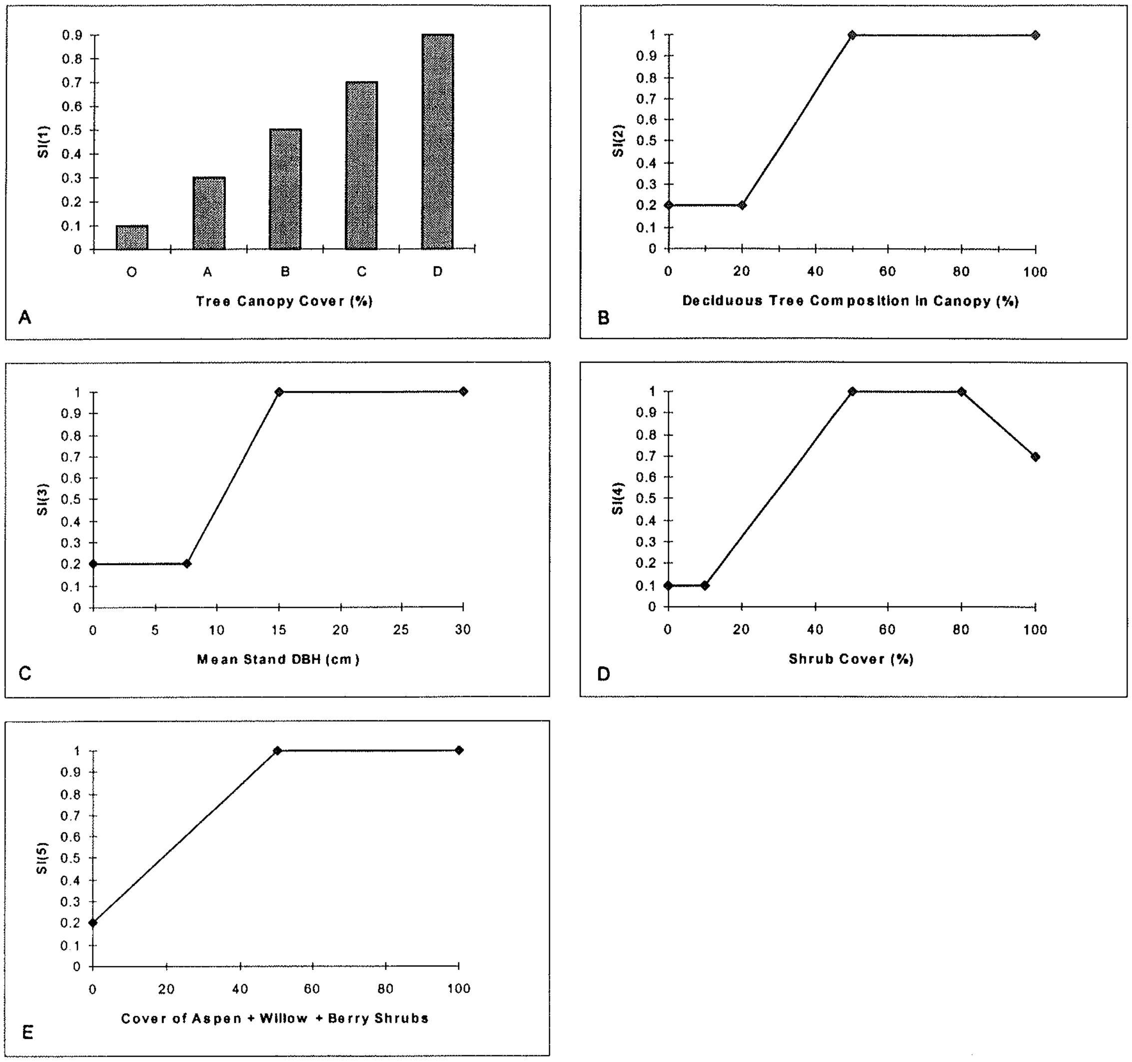
1.10.3.4 Shrub Cover (%)

Shrub cover generally increases habitat suitability, but at extremely high values, the stand becomes a dense thick which is not preferred. Thus SI(4) increases from 0.1 at 0 to 10%, to 1.0 at 50%. It then remains at 1.0 until 80%, after which it decreases to 0.7 at 100% or higher (Figure 9d).

1.10.3.5 Cover of Food Shrubs

Food shrubs include the sum of aspen (saplings), willow, raspberry, pin and choke cherry, saskatoon, blueberry, low bush cranberry, prickly rose, red osier dogwood, beaked hazelnut and buffaloberry. (SI(5) is never less than 0.2. Between 0 and 50 % cover SI(5) increases by the formula (cover + 12.5)/62.5). Then at all coverages greater than 50% the index value is 1.0 (Figure 9e).

Figure 9 Suitability Index Values in Relation to Habitat Variables in the Ruffed Grouse HSI Model



1.10.3.6 Disturbance Coefficient

The disturbance coefficient is used to reduce habitat suitability in areas adjacent to human disturbances (within a zone of influence) including roads, towns, pipeline and utility corridors, and industrial developments. The zones of influence and the disturbance coefficients for ruffed grouse are listed in Table 10. Where more than one zone of influence overlaps, the lowest disturbance coefficient will be applied.

Table 10 Zones of Influence and Disturbance Coefficients for Ruffed Grouse

Disturbance Type	Zone of Influence	Disturbance Coefficient
Main Roads,	100 m	0.25
Secondary Roads	100 m	0.75
Active Mine sites, gravel pits, dumps, plant facilities	100 m	0.1
Plant and Camp Site	100 m	0.2
Tailings Ponds	50 m	0.9
Utility Corridors	50 m	0.9

1.10.3.7 Equations

HSI Cover = SI(1) x 0.7 x SI(2) + 0.3 x SI(3)

HSI Food = SI(4) x SI(5)

HSI Overall = (0.3 x HSI Food + 0.7 x HSI Cover) x Disturbance Coefficient

1.10.4 Current Status On Model Validation

The ruffed grouse model was developed for the Alberta oil sands region based on literature reviews and has not been tested with independent data. The previous version of the model was applied as part of the Syncrude Aurora Mine EIA (Axys 1996), but was not validated by population or habitat use data. It was, however, reviewed by Alberta Fish and Wildlife and is thought to be an acceptable model. However, the results for this model have not been empirically validated and are best to be regarded as potential habitat based on our understanding of ruffed grouse ecology rather than actual ruffed grouse habitat predictions.

1.11 SNOWSHOE HARE

1.11.1 Introduction

The snowshoe hare model was adapted from one developed by Axys (1996) for the Syncrude/Suncor regional study area. The rationale for variable selection and model form will not be discussed except for changes to the model. This model assesses hare habitat by use of variables which relate to both food and cover requirements. The main modification to the Axys (1996) model was the conversion of relationships from histograms to continuous curves over the range of the habitat variables. This resulted in a few changes to the values of the suitability indices over the ranges of the variables, but did not result in structural changes to the model or the equations.

1.11.2 Habitat Requirements

1.11.2.1 Food

In winter, hares feed on woody plant buds and twigs, evergreen leaves and the bark of trees. Although many species will be eaten if necessary, they are generally considered survival foods for years with high snowfall. These include black spruce, labrador tea, and snowberry. Preferred species include willow, birch, alder, raspberry, blueberry and rose. Many other species will also be consumed. In summer, diet shifts to mainly forbs.

1.11.2.2 Cover

Snowshoe hares are habitat generalists and seem to make use of high coverage habitat of shrubs or trees.

1.11.3 Model Development

1.11.3.1 Shrub Cover

Shrub cover from 0 to 50% increases habitat suitability from unsuitable (0.0) to optimum (1.0; Figure 10a). This was changed from Axys (1996) where the optimum was not achieved until 80%. This was changed due to the very low number of stands with > 50% cover in our data-set, which indicated that the shrub component was likely obtained with lower average values than the values that Axys (1996) had previously used.

1.11.3.2 Tree Canopy Closure Class

Tree canopy closure also increase suitability, but the lack of trees is not considered unsuitable. Open stands (0-5% closure) are rated 0.4. A closure stands (6 to 30%) are rated 0.6. B stands (31 to 50%) are rated 0.8, C stands (51 to 85%) are fully optimum and D stands (86 to 100%) decrease back to 0.8 (Figure 10b).

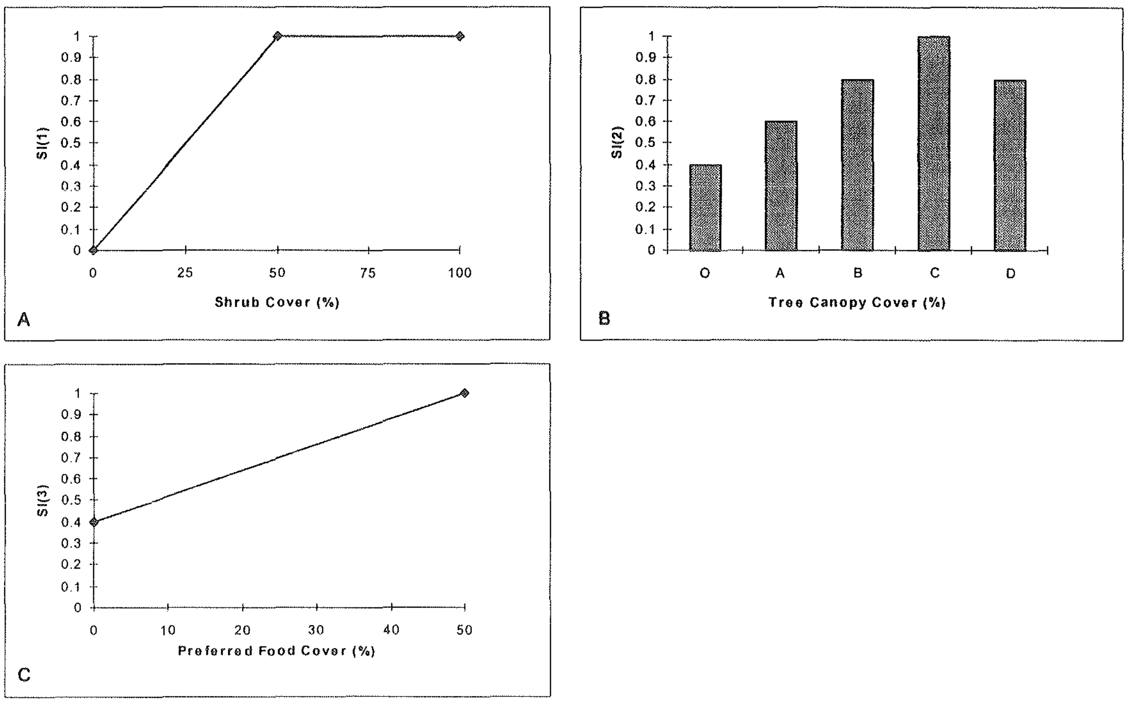
1.11.3.3 Food Cover (%)

Food cover related to winter food species and is determined by summing species with the following weightings of shrub or tree sapling species (and trees combined):

Food Cover = beaked hazelnut + willow + aspen + balsam poplar + red-osier dogwood + paper birch + dwarf/bog birch + low bush cranberry + 0.75 x (prickly rose + raspberry + alder + saskatoon + buffaloberry + tamarack + pine + fir) + 0.25 x (white spruce + black spruce) + 0.1 x (tree cover).

Over the range 0 to 50% SI(3) increases from 0.4 to 1.0. Food is never rated less than 0.4 since some food is always present (Figure 10c).

Figure 10 Suitability Index Values in Relation to Habitat Variables in the Snowshoe Hare HSI Model



1.11.3.4 Disturbance Coefficient

The disturbance coefficient is used to reduce habitat suitability in areas adjacent to human disturbances (within a zone of influence) including roads, towns, pipeline and utility corridors, and industrial developments. The zones of influence and the disturbance coefficients for snowshoe hare are listed in Table 11. Where more than one zone of influence overlaps, the lowest disturbance coefficient will be applied.

Table 13 Zones of Influence and Disturbance Coefficients for Snowshoe Hare HSI

Disturbance Type	Zone of Influence	Disturbance Coefficient
Main Roads	200 m	0.25
Secondary Roads	200 m	0.75
Active Mine sites, gravel pits, dumps and plant facilities	200 m	0.1
Plant and Camp Site, Towns	200 m	0.2
Tailings Ponds	100 m	0.9
Utility Corridors	100 m	0.9

1.11.3.5 Equations

HSI Cover = 0.8 x SI(1) + 0.2 x SI(2)

HSI Food = SI(1) x SI(3)

HSI Overall = (0.5 x HSI Cover + 0.5 x HSI Food) x Disturbance Coefficient

1.11.4 Current Status On Model Validation

The snowshoe hare model was developed for the Alberta oil sands region based on literature reviews and has been compared to snowshoe hare habitat use within the Syncrude local study area and throughout the regional area (Axys 1996). The snowshoe hare model was applied as part of the Syncrude Aurora Mine EIA (Axys 1996) and was reviewed by from Alberta Fish and Wildlife and thought to be an acceptable model. The results for this model were at least partially empirically validated and thus the results from this model should be considered to be validated snowshoe hare habitat predictions, assuming that the results from this study are similar to the results in the previous study.

1.12 WESTERN TANAGER

1.12.1 Introduction

The western tanager is widely distributed but uncommon throughout most of northern Alberta. The western tanager prefers open forest mixedwood or pure conifer boreal forests (Peterson 1961), but is occasionally found in pure deciduous stands in Alberta (Semenchuk 1992). In the western National Parks western tanagers are generally found in montane pine or aspen forests (Holroyd and Van Tighem 1983). They nest high in the canopy of trees with near-horizontal branches, up to 15 m (Semenchuk 1992). They prefer upland rather than lowland habitat types. This model was developed for use in the oil sands region of Alberta during this project.

1.12.2 Habitat Requirements

1.12.2.1 Food

The western tanager consumes both insects and berries (Peterson 1961, Semenchuk 1992). They usually feed in the higher portions of trees or among bushes, but will also catch insects aerially. Feeding opportunities are dependent on the number of fine branches available for insect habitat. Thus, shrubs and coniferous tree branches are preferred feeding sources and deciduous branches are less preferred. Berries are also a preferred food but are highly seasonal. However, habitats with high berry species cover may be important in habitat selection, since berries are a highly energetic food resource.

1.12.2.2 Cover

Cover requirements include an open canopied forest area with tall trees for nesting and a high percentage of conifers for cover. However, tanagers will still occur in pure deciduous stands in low abundance, and only a few conifers are required in a stand to provide the needed thermal and concealment cover.

1.12.3 Model Development

1.12.3.1 Tree Canopy Closure

The tanager will most likely be found in open (A and B crown closure stands) of pure conifers or mixedwoods. Thus, we have rated A canopy closure stands (6 to 30%) as optimum (SI(1) = 1.0), B stands (31 to 50%) are rated at 0.9, C (51 to 85%) are set at 0.5, and D (86 to 100%) are set at 0.1 suitability. Open stands are also rated very low (SI(1) = 0.1) due to lack of cover requirements (Figure 11a).

1.12.3.2 Coniferous Tree Percentage in Canopy

Tanagers will occur in pure deciduous, so the minimum value of SI(2) has been set The minimum value of SI(2) = 0.2, and this increases to 1 at 20% conifers SI(2) = (composition + 5)/25 (Figure 11b). At all higher values, SI(2) remains optimum (1.0) (Figure 11b).

1.12.3.3 Mean Canopy Tree Height

The tree height value has been used to allow for proper nesting height. Although 15 m is not required for nesting, at this tree height, nests at 10 or more metres will be possible, since the branch they use must also be large and stable (Figure 11c). Up to 10 metres in height, nesting opportunities are limited, and SI(3) increases slowly from unsuitable at 0 m height to 0.2 at 10 m height (SI(3) = height/50). Between 10 and 15 metres, the suitability increases to optimum (SI(3) = (height - 8.75)/6.25), and remains at 1.0 for all taller heights (Figure 11c).

1.12.3.4 Weighted Woody Cover

Insect food is generally abundant in most forest stands so SI(4) has been rated at a minimum of 0.5. As woody cover increases, the foraging opportunities also increases, since the tanager has more small branches available for concealment and insect capture. We have weighted cover by shrub, conifer and deciduous tree types at 1, 0.5 and 0.25 respectively. This was done because the architecture of shrubs generally provides the most feeding cover and also locations for insects to be found, this is followed by the multi-branched conifers and finally the sparsely branched deciduous trees. Thus:

Weighted Woody Cover (%) = Shrub Cover + 0.25 x Deciduous Cover + 0.5 x Coniferous Cover

Between 0 and 100% weighted cover, the suitability increases from 0.5 to 1.0 (SI(4) = 0.5 + cover/200) (Figure 11d).

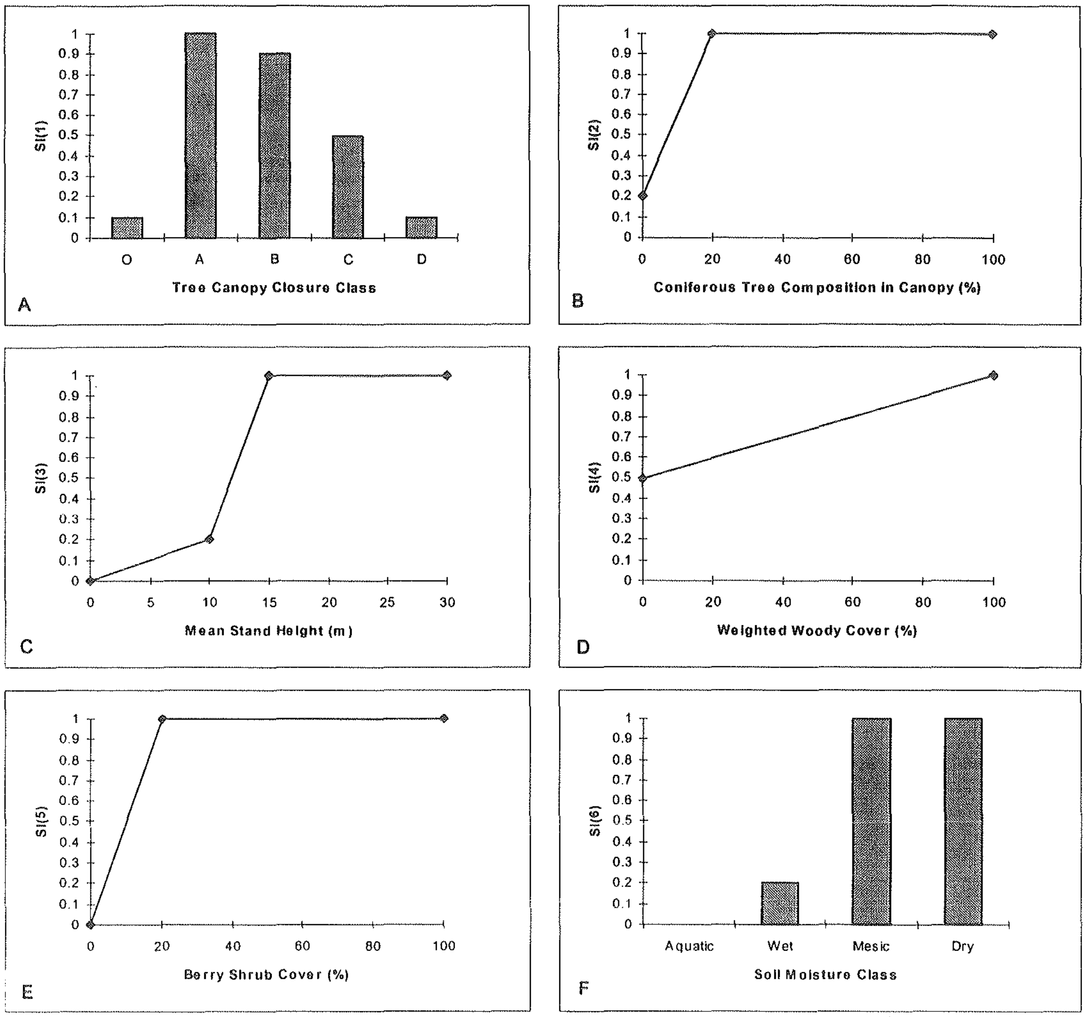
1.12.3.5 Berry Shrub Cover

As berry shrub cover increases from 0 to 20%, the suitability increases from 0.0 to 1.0 (SI(5) = berry cover/20). Suitability remains at 1.0 for all higher values. Berry shrubs are determined by adding together the individual coverages of saskatoon, pin and choke cherry, currant, gooseberry, rose, raspberry, buffaloberry, blueberry and low-bush cranberry (Figure 11e).

1.12.3.6 Soil Moisture Class

Finally the soil moisture class was included simply to restrict the best results to dry and mesic forest types rather than fens, bogs and treed swamps. Aquatic sites (ponds, marshes) are set at 0.0. Peatland sites are set at 0.2. All other stand types are set at 1.0 (Figure 11f).

Figure 11 Suitability Index Values in Relation to Habitat Variables in the Western Tanager HSI Model



1.12.3.7 Equations

Western tanager cover HSI is determined from the product of the first three indices, since all are considered equally important in determining tanager cover habitat. The food HSI, however, is determined by an additive equation, since the two food sources are believed to be independent. Thus, the lack of insect food can be compensated by berry food and vice-versa.

$$\text{HSI Cover} = SI(1) \times SI(2) \times SI(3)$$

$$\text{HSI Food} = \min\,[1, SI(4) + SI(5)]$$

HSI Overall = HSI Cover x HSI Food x SI(6) x disturbance coefficient.

1.12.4 Current Status On Model Validation

The western tanager model has only been developed based on literature reviews and has not been tested with independent data. The model runs presented in this document are the first runs completed for this model. Thus, the results for this model are not validated and are best to be regarded as potential habitat based on our understanding of western tanager ecology rather than actual tanager habitat predictions.

2. BIODIVERSITY HABITAT MODELLING

2.1 INTRODUCTION

There are four generally-accepted levels at which biodiversity may be examined: landscape, community, species and genetic. This model addresses wildlife species-level diversity and then links these values to habitat types in an attempt to understand community level diversity. The goal of biodiversity analysis for the EIA is to assess current levels of diversity and then predict any changes associated with the development impacts, reclamation and closure. Then, the maintenance of biodiversity can be incorporated into development and reclamation/closure planning.

2.2 METHODS

Wildlife diversity was first measured by species richness in habitat types. These values were used to create a relative richness index which is the ratio of species richness in each habitat type to the maximum species richness among all habitat types. This creates an index, similar to HSI values which range from 0 to 1.

The relative richness values were then assigned to each habitat type throughout the study areas, multiplied by the area in hectares and summed to determine diversity habitat units. These diversity habitat units were then compared between baseline, impact and post-closure reclamation conditions. Diversity habitat units were also calculated for the regional study area to determine cumulative losses of wildlife diversity among development scenarios.

3. MOOSE LINKAGE ZONE ANALYSIS

3.1 INTRODUCTION

Cumulative effects of the Project on wildlife movement corridors were assessed by analyzing moose movement corridors. A quantitative procedure known as Linkage Zone Analysis was used for the assessment (e.g., Meitz 1994; Gibeau et al. 1996). Moose were selected for the analysis as this species is: 1) of high concern in the RSA; 2) wide-ranging and thus requires space for movements; and 3) sensitive to disturbance. It was considered that a regional corridor network designed for moose could benefit other wildlife KIRs.

Linkage zones (movement corridors) are combinations of landscape features that allow animals to move through and live in areas impacted by man (Gibeau et al. 1996). Soule (1991) defined a conservation (wildlife) corridor as a "linear landscape feature that facilitates the biologically effective transport of animals between larger patches of habitat". With increasing development pressure and fragmentation of wildlife habitat, species are often confined to such patches of habitat or "habitat islands". The objective in planning for conservation corridors is to allow for sufficient movement between habitat islands such that a species can persist in a region. Soule (1991) points out that corridors must be designed on a species-specific basis. A detailed description of corridor planning is provided in Golder (1997a).

Understanding of movement corridor requirements is based on results of studies on higher profile wildlife species, such as grizzly bears. Core areas for grizzly bears were defined by Puchlerz and Servheen (1994) as areas that: 1) have no motorized use nor high intensity, non-motorized use of roads or trails during the non-denning period; 2) are a minimum of 500 m from any road or motorized trail; 3) are representative of important seasonal habitats; and 4) are in place for 10 years (the generation time of a female grizzly bear).

To our knowledge, only two CEA studies (Gibeau et al. 1996 and Apps 1997) have used these components to study grizzly bears in Canada. Recent work with linkage zone models has been done in the US by Meitz (1994) and Kehoe (1995). Methods from these sources were adapted to derive a moose linkage zone analysis for the RSA.

3.2 LINKAGE ZONE MODEL DEVELOPMENT

This model attempts to identify those areas in which moose can freely move within the study areas. It is an additional understanding of species habitat quantity after performing HSI analysis which demonstrates habitat quality. Thus, each scenario analyzed demonstrates two areas:

1. Linkage Areas which allow free movement among habitats (which may be low, medium, or high).
2. Fracture Zones which act as barriers to moose movement due to roads, towns, or industrial developments.

The following mapped land features at different development scenarios and associated zones of influence were used within a vector-based GIS model to define areas likely to act as barriers to moose movement:

- Large Areas (> 100 contiguous hectares) of Unsuitable Habitat
- Urban Developments
- Heavy Use Roads (highways and heavy truck roads)
- Industrial Development Areas

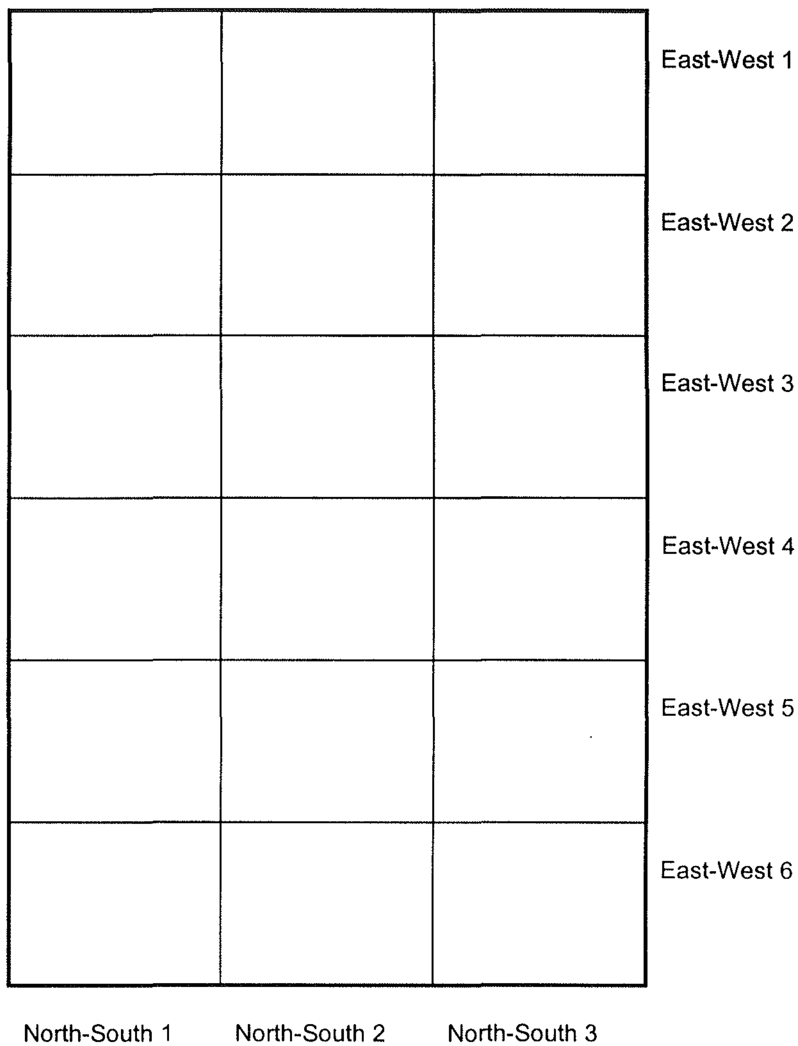
All areas where HSI scores were greater than zero were considered potential linkage areas. Areas which were unsuitable could act as natural barriers if large enough. 100 ha was used as the size threshold for the assessment. Areas of sufficient size with no suitability received a score of 1. Areas with suitability > 0 received a score of 1.

All of the above developments were assumed to have an associated disturbance zone of influence of 500 metres from their outside peripheries. All areas within the disturbance area or zone of influence received a score of 1. All areas outside each zone received a score of 0.

All areas which had a score of 1 were considered to be barrier or fracture zones. All remaining areas with a 0 score were considered to be linkage zones.

Moose linkage and fracture zone impacts due to cumulative effects were analyzed for the entire RSA by determining the percentage of the RSA fractured under each regional impact scenario. Then, the specific amounts of linkage habitat for moose within corridors in an east-west direction and a north-south direction were analysed. This was accomplished by dividing the RSA along map grid within the RSA. This analysis was restricted to 3 blocks in an east-west direction and 6 blocks in a north-south direction, so that each comparison would be based on the same linear movement distance. The entire rectangle described by the blocks measures 60 km (east-west) by 120 km (north-south). East-west blocks are 60 km by 20 km, and north-south blocks are 20 km by 120 km. In the results, blocks were described according to the position on the maps (Figure 12). For, example, the results described as East-West 3 refer to moose movements across the map zone in an east-west direction in about the middle of the regional study area.

Figure 12 Linkage Zone Model Analysis Template



APPENDIX II

HABITAT VARIABLES FOR MODELS

Habitat Attributes Used for HSI Modelling in the Local Study Area

Code	Vegetation Type	Jack Pine Tree Cover (%)	White Spruce Tree Cover (%)	Black Spruce Tree Cover (%)	Balsam Fir Tree Cover (%)	Larch Tree Cover (%)	Aspen Tree Cover (%)	Balsam Poplar Tree Cover (%)	Paper Birch Tree Cover (%)	Total Conifer Tree Cover (%)[1]	Total Decid. Tree Cover (%)	Total Tree Cover (%)
	Upland Vegetation Types											
a1	Lichen Pj	27	0	0	0	0	0	0	0	27	0	27
a1/g1	Pj-Lt	25	0	1	0	10	0	0	0	26	0	36
b1	Blueberry Pj-Aw	26	0	0	0	0	14	0	3	26	17	43
b2	Blueberry Aw(Bw)	0	2	0	0	0	37	0	9	2	46	48
b3	Blueberry Aw-Sw	0	20	0	0	0	27	0	2	20	29	49
b4	Blueberry Sw-Pj	14	25	0	0	0	2	0	3	39	5	44
c1	Labrador Tea-mesic Pj-Sb	27	0	13	0	0	0	0	0	40	0	40
d1	Low Bush Cranberry Aw	0	1	0	0	0	50	5	2	1	57	58
d2	Low Bush Cranberry Aw-Sw	0	22	2	3	0	28	3	3	27	34	61
d3	Low Bush Cranberry Sw	0	39	0	6	0	2	1	1	45	4	49
e1	Dogwood Pb-Aw	0	1	0	0	0	30	22	2	1	54	55
e1/f1	Pb-Aw	0	1	0	0	0	27	23	4	1	54	55
e2	Dogwood Pb-Sw	0	26	0	2	0	15	8	5	28	28	56
e2/f2	Pb-Sw	0	31	0	3	0	12	8	9	34	29	63
e3	Dogwood Sw	0	41	0	10	0	2	2	2	51	6	57
g1	Labrador Tea-subhygric Sb-Pj	12	0	31	0	0	0	0	0	43	0	43
h1	Labrador Tea/Horsetail Sw-Sb	0	34	13	0	0	0	0	1	47	1	48
Lt-Sb	Upland Lt-Sb	1	1	6	0	16	0	0	0	9	0	25
Sb-Lt	Upland Sb-Lt	1	1	18	0	5	0	0	0	20	0	25
shrub	Upland Shrubland	0	0	0	0	0	0	0	0	0	0	0
	Lowland Vegetation Types											
b4(STNN)	Coniferous Swamp Sw-Pj	14	25	0	0	0	2	0	3	39	5	44
c1(STNN)	Coniferous Swamp Pj-Sb	25	2	13	0	0	0	0	0	40	0	40
d2(STNN)	Coniferous Swamp Aw-Sw	0	22	2	3	0	28	3	3	27	34	61
d3(STNN)	Coniferous Swamp Sw	0	39	0	6	0	2	1	1	45	4	49
g1(STNN)	Coniferous Swamp Pj-Sb	12	0	31	0	0	0	0	0	43	0	43
h1(STNN)	Coniferous Swamp Sw-Sb	0	34	13	0	0	0	0	1	47	1	48
(Sb-Lt)SFNN	Coniferous Swamp(Sb-Lt)	0	0	85	0	0	0	0	0	85	0	85
Sb-Lt(SFNN)	Coniferous Swamp Sb-Lt	0	1	21	0	3	0	0	0	23	0	25
Sb-Lt(STNN)	Coniferous Swamp Sb-Lt	0	1	18	0	5	0	0	0	20	0	25
Sb(STNN)	Coniferous Swamp Sb	0	0	25	0	0	0	0	0	25	0	25
Lt(STNN)	Coniferous Swamp Lt	0	0	0	0	25	0	0	0	0	0	25
Lt-Aw(STNN)	Coniferous Swamp Lt-Aw	0	0	0	0	23	3	0	0	0	3	25

[1] Excludes Larch

Habitat Attributes Used for HSI Modelling in the Local Study Area

Code	Vegetation Type	Jack Pine Tree Cover (%)	White Spruce Tree Cover (%)	Black Spruce Tree Cover (%)	Balsam Fir Tree Cover (%)	Larch Tree Cover (%)	Aspen Tree Cover (%)	Balsam Poplar Tree Cover (%)	Paper Birch Tree Cover (%)	Total Conifer Tree Cover (%)[1]	Total Decid. Tree Cover (%)	Total Tree Cover (%)
Lt-Pb(STNN)	Coniferous Swamp Lt-Pb	0	0	3	0	20	0	3	0	3	3	25
Lt-Sb(STNN)	Coniferous Swamp Lt-Sb	0	0	5	0	19	0	0	0	6	0	25
shrub(SONS)	Shrubby Swamp	0	0	0	0	0	0	0	0	0	0	0
r	Reclaimed Riparian Shrub	0	0	0	0	0	0	0	0	0	0	0
i2(BTNN)	Shrubby Bog	0	0	0	0	0	0	0	0	0	0	0
j1(FTNN)	Treed Poor Fen Sb-Lt	0	0	21	0	10	0	0	0	21	0	31
j1/g1 (FTNN)	Treed Poor Fen Lt-Sb-Pj	6	0	7	0	25	0	0	0	13	0	38
j1/g1(FFNN)	Treed Poor Fen Sb-Pj	6	0	26	0	1	0	0	0	32	0	33
j1/g1(FTNN)	Treed Poor Fen Lt-Sb-Pj	6	0	7	0	25	0	0	0	13	0	38
j1/h1(FTNN)	Treed Poor Fen Sb-Sw-Lt	0	17	17	0	5	0	0	1	34	1	40
j2(FFNN)	Treed Poor Fen Sb-Lt	0	0	38	0	15	0	0	1	38	1	54
j2(FTNN)	Treed Poor Fen Sb-Lt	0	0	22	0	12	0	0	1	22	1	35
j2/h1(FTNN)	Treed Poor Fen Sb/Sw-Lt	0	10	25	0	10	0	0	1	35	1	46
k1(FOPN)	Patterned Open Rich Fen	0	0	0	0	0	0	0	0	0	0	0
k1(FTNN)	Treed Rich Fen	0	0	1	0	18	0	0	0	1	0	19
k2(FONS)	Shrubby Rich Fen	0	0	0	0	0	0	0	0	0	0	0
k2(FTNN)	Shrubby Treed Rich Fen	0	0	1	0	9	0	0	0	1	0	10
k3(FONG)	Graminoid Rich Fen	0	0	0	0	0	0	0	0	0	0	0
	Open Water and Marsh Types											
l1(MONG)	Marsh	0	0	0	0	0	0	0	0	0	0	0
w	Reclaimed Wetland (Marsh)	0	0	0	0	0	0	0	0	0	0	0
NWF(WONN)	Shallow Open Water	0	0	0	0	0	0	0	0	0	0	0
o	Reclaimed Open Water	0	0	0	0	0	0	0	0	0	0	0
NWL	Lakes and Ponds	0	0	0	0	0	0	0	0	0	0	0
NWR	Rivers	0	0	0	0	0	0	0	0	0	0	0
	Other Types											
AIG	Gravel Pits	0	0	0	0	0	0	0	0	0	0	0
AIH	Roads and Rights-of-way	0	0	0	0	0	0	0	0	0	0	0
AIM	Surface Mines	0	0	0	0	0	0	0	0	0	0	0
NMC	Cutbanks	0	0	0	0	0	0	0	0	0	0	0
UN	Unclassified	0	0	0	0	0	0	0	0	0	0	0
rr	Rip-Rap	0	0	0	0	0	0	0	0	0	0	0

Habitat Attributes Used for HSI Modelling in the Local Study Area

Code	Vegetation Type	Jack Pine Shrub Cover (%)	White Spruce Shrub Cover (%)	Black Spruce Shrub Cover (%)	Balsam Fir Shrub Cover (%)	Larch Shrub Cover (%)	Aspen Shrub Cover (%)	Balsam Poplar Shrub Cover (%)	Paper Birch Shrub Cover (%)	Alder Shrub Cover (%)	Blue-berry Shrub Cover (%)	Buffalo-berry Shrub Cover (%)
	Upland Vegetation Types											
a1	Lichen Pj	3	0	0	0	0	0	0	0	0	11	0
a1/g1	Pj-Lt	3	0	0	0	5	0	0	0	0	8	0
b1	Blueberry Pj-Aw	0	3	0	0	0	3	0	0	6	9	3
b2	Blueberry Aw(Bw)	0	0	0	0	0	2	0	0	6	9	0
b3	Blueberry Aw-Sw	0	5	0	0	0	2	0	0	4	18	0
b4	Blueberry Sw-Pj	0	6	0	0	0	0	0	0	6	11	0
c1	Labrador Tea-mesic Pj-Sb	0	0	6	0	0	0	0	0	3	6	0
d1	Low Bush Cranberry Aw	0	0	0	0	0	3	0	0	4	0	6
d2	Low Bush Cranberry Aw-Sw	0	3	0	3	0	3	0	0	2	0	3
d3	Low Bush Cranberry Sw	0	0	0	6	0	0	0	0	3	0	1
e1	Dogwood Pb-Aw	0	0	0	0	0	0	0	0	7	0	0
e1/f1	Pb-Aw	0	1	0	0	0	0	1	0	7	0	0
e2	Dogwood Pb-Sw	0	0	0	0	0	0	1	0	2	0	0
e2/f2	Pb-Sw	0	2	0	2	0	0	1	1	1	0	0
e3	Dogwood Sw	0	0	0	8	0	0	0	0	7	0	0
g1	Labrador Tea-subhygric Sb-Pj	0	0	8	0	0	0	0	0	0	4	0
h1	Labrador Tea/Horsetail Sw-Sb	0	0	0	0	0	0	0	0	0	0	0
Lt-Sb	Upland Lt-Sb	0	0	8	0	0	0	0	0	0	4	0
Sb-Lt	Upland Sb-Lt	0	0	8	0	0	0	0	0	0	4	0
shrub	Upland Shrubland	1	1	2	0	0	2	1	3	5	4	0
	Lowland Vegetation Types											
b4(STNN)	Coniferous Swamp Sw-Pj	0	0	20	0	20	0	0	0	0	0	0
c1(STNN)	Coniferous Swamp Pj-Sb	0	0	6	0	0	0	0	0	0	6	0
d2(STNN)	Coniferous Swamp Aw-Sw	0	0	20	0	20	0	0	0	0	0	0
d3(STNN)	Coniferous Swamp Sw	0	0	20	0	20	0	0	0	0	0	0
g1(STNN)	Coniferous Swamp Pj-Sb	0	0	20	0	20	0	0	0	0	0	0
h1(STNN)	Coniferous Swamp Sw-Sb	0	0	20	0	20	0	0	0	0	0	0
(Sb-Lt)SFNN	Coniferous Swamp(Sb-Lt)	0	0	20	0	20	0	0	0	0	0	0
Sb-Lt(SFNN)	Coniferous Swamp Sb-Lt	0	0	20	0	20	0	0	0	0	0	0
Sb-Lt(STNN)	Coniferous Swamp Sb-Lt	0	0	20	0	20	0	0	0	0	0	0
Sb(STNN)	Coniferous Swamp Sb	0	0	20	0	20	0	0	0	0	0	0
Lt(STNN)	Coniferous Swamp Lt	0	0	20	0	20	0	0	0	0	0	0
Lt-Aw(STNN)	Coniferous Swamp Lt-Aw	0	0	20	0	20	0	0	0	0	0	0
Lt-Pb(STNN)	Coniferous Swamp Lt-Pb	0	0	20	0	20	0	0	0	0	0	0
Lt-Sb(STNN)	Coniferous Swamp Lt-Sb	0	0	20	0	20	0	0	0	0	0	0

Habitat Attributes Used for HSI Modelling in the Local Study Area

Code	Vegetation Type	Jack Pine Shrub Cover (%)	White Spruce Shrub Cover (%)	Black Spruce Shrub Cover (%)	Balsam Fir Shrub Cover (%)	Larch Shrub Cover (%)	Aspen Shrub Cover (%)	Balsam Poplar Shrub Cover (%)	Paper Birch Shrub Cover (%)	Alder Shrub Cover (%)	Blue-berry Shrub Cover (%)	Buffalo-berry Shrub Cover (%)
shrub(SONS)	Shrubby Swamp	0	0	1	0	0	3	5	4	0	0	0
r	Reclaimed Riparian Shrub	0	0	1	0	5	3	5	4	0	0	0
i2(BTNN)	Shrubby Bog	0	0	35	0	0	0	0	0	0	0	0
j1(FTNN)	Treed Poor Fen Sb-Lt	0	0	16	0	5	0	0	0	0	0	0
j1/g1 (FTNN)	Treed Poor Fen Lt-Sb-Pj	0	0	12	0	3	0	0	0	0	2	0
j1/g1(FFNN)	Treed Poor Fen Sb-Pj	0	0	12	0	3	0	0	0	0	2	0
j1/g1(FTNN)	Treed Poor Fen Lt-Sb-Pj	0	0	12	0	3	0	0	0	0	2	0
j1/h1(FTNN)	Treed Poor Fen Sb-Sw-Lt	0	0	8	0	3	0	0	0	0	0	0
j2(FFNN)	Treed Poor Fen Sb-Lt	0	0	20	0	3	0	0	0	0	0	0
j2(FTNN)	Treed Poor Fen Sb-Lt	0	0	20	0	3	0	0	0	0	0	0
j2/h1(FTNN)	Treed Poor Fen Sb/Sw-Lt	0	0	20	0	3	0	0	0	0	0	0
k1(FOPN)	Patterned Open Rich Fen	0	0	1	0	12	0	0	0	0	0	0
k1(FTNN)	Treed Rich Fen	0	0	1	0	12	0	0	0	0	0	0
k2(FONS)	Shrubby Rich Fen	0	0	0	0	1	0	0	0	5	0	0
k2(FTNN)	Shrubby Treed Rich Fen	0	0	1	0	7	0	0	0	3	0	0
k3(FONG)	Graminoid Rich Fen	0	0	0	0	0	0	0	0	0	0	0
	Open Water and Marsh Types											
l1(MONG)	Marsh	0	0	0	0	0	0	0	0	0	0	0
w	Reclaimed Wetland (Marsh)	0	0	0	0	0	0	0	0	0	0	0
NWF(WONN)	Shallow Open Water	0	0	0	0	0	0	0	0	0	0	0
o	Reclaimed Open Water	0	0	0	0	0	0	0	0	0	0	0
NWL	Lakes and Ponds	0	0	0	0	0	0	0	0	0	0	0
NWR	Rivers	0	0	0	0	0	0	0	0	0	0	0
	Other Types											
AIG	Gravel Pits	0	0	0	0	0	0	0	0	0	0	0
AIH	Roads and Rights-of-way	0	0	0	0	0	0	0	0	0	0	0
AIM	Surface Mines	0	0	0	0	0	0	0	0	0	0	0
NMC	Cutbanks	0	0	0	0	0	0	0	0	0	0	0
UN	Unclassified	0	0	0	0	0	0	0	0	0	0	0
rr	Rip-Rap	0	0	0	0	0	0	0	0	0	0	0

Habitat Attributes Used for HSI Modelling in the Local Study Area

Code	Vegetation Type	Currant Shrub Cover (%)	Dwarf Birch Shrub Cover (%)	Dog-wood Shrub Cover (%)	Hazelnut Shrub Cover (%)	Honey-suckle Shrub Cover (%)	Labra-dor Tea Shrub Cover (%)	Leather-leaf Shrub Cover (%)	Cran-berry Shrub Cover (%)	Cherry Shrub Cover (%)	Rasp-berry Shrub Cover (%)	Rose Shrub Cover (%)
	Upland Vegetation Types											
a1	Lichen Pj	0	0	0	0	0	0	0	0	0	0	0
a1/g1	Pj-Lt	0	0	0	0	0	8	0	0	0	0	1
b1	Blueberry Pj-Aw	0	0	0	0	0	6	0	0	0	0	3
b2	Blueberry Aw(Bw)	0	0	0	0	0	9	0	0	0	0	3
b3	Blueberry Aw-Sw	0	0	0	0	0	2	0	0	0	0	6
b4	Blueberry Sw-Pj	0	0	0	0	0	2	0	0	0	0	3
c1	Labrador Tea-mesic Pj-Sb	0	0	0	0	0	10	0	0	0	0	0
d1	Low Bush Cranberry Aw	0	0	0	3	0	0	0	8	0	0	15
d2	Low Bush Cranberry Aw-Sw	0	0	0	1	0	0	0	10	0	0	9
d3	Low Bush Cranberry Sw	0	0	0	0	0	0	0	6	0	0	6
e1	Dogwood Pb-Aw	3	0	11	0	8	0	0	9	0	2	14
e1/f1	Pb-Aw	2	0	8	0	4	0	0	7	0	3	11
e2	Dogwood Pb-Sw	3	0	12	0	7	0	0	8	0	1	8
e2/f2	Pb-Sw	2	0	8	0	4	0	0	8	0	1	6
e3	Dogwood Sw	4	0	3	0	5	0	0	8	0	2	8
g1	Labrador Tea-subhygric Sb-Pj	0	0	0	0	0	16	0	0	0	0	2
h1	Labrador Tea/Horsetail Sw-Sb	0	0	0	0	0	14	0	0	0	0	4
Lt-Sb	Upland Lt-Sb	0	0	0	0	0	16	0	0	0	0	2
Sb-Lt	Upland Sb-Lt	0	0	0	0	0	16	0	0	0	0	2
shrub	Upland Shrubland	2	1	2	0	2	5	0	1	1	1	2
	Lowland Vegetation Types											
b4(STNN)	Coniferous Swamp Sw-Pj	0	2	0	0	0	2	2	0	0	0	0
c1(STNN)	Coniferous Swamp Pj-Sb	0	0	0	0	0	0	0	0	0	0	0
d2(STNN)	Coniferous Swamp Aw-Sw	0	2	0	0	0	2	2	0	0	0	0
d3(STNN)	Coniferous Swamp Sw	0	2	0	0	0	2	2	0	0	0	0
g1(STNN)	Coniferous Swamp Pj-Sb	0	2	0	0	0	2	2	0	0	0	0
h1(STNN)	Coniferous Swamp Sw-Sb	0	2	0	0	0	2	2	0	0	0	0
(Sb-Lt)SFNN	Coniferous Swamp(Sb-Lt)	0	5	0	0	0	0	0	0	0	0	0
Sb-Lt(SFNN)	Coniferous Swamp Sb-Lt	0	2	0	0	0	2	2	0	0	0	0
Sb-Lt(STNN)	Coniferous Swamp Sb-Lt	0	2	0	0	0	2	2	0	0	0	0
Sb(STNN)	Coniferous Swamp Sb	0	2	0	0	0	2	2	0	0	0	0
Lt(STNN)	Coniferous Swamp Lt	0	2	0	0	0	2	2	0	0	0	0
Lt-Aw(STNN)	Coniferous Swamp Lt-Aw	0	2	0	0	0	2	2	0	0	0	0
Lt-Pb(STNN)	Coniferous Swamp Lt-Pb	0	2	0	0	0	2	2	0	0	0	0
Lt-Sb(STNN)	Coniferous Swamp Lt-Sb	0	2	0	0	0	2	2	0	0	0	0

Habitat Attributes Used for HSI Modelling in the Local Study Area

Code	Vegetation Type	Currant Shrub Cover (%)	Dwarf Birch Shrub Cover (%)	Dog-wood Shrub Cover (%)	Hazelnut Shrub Cover (%)	Honey-suckle Shrub Cover (%)	Labra-dor Tea Shrub Cover (%)	Leather-leaf Shrub Cover (%)	Cran-berry Shrub Cover (%)	Cherry Shrub Cover (%)	Rasp-berry Shrub Cover (%)	Rose Shrub Cover (%)
shrub(SONS)	Shrubby Swamp	1	10	0	0	0	0	5	0	0	0	1
r	Reclaimed Riparian Shrub	1	10	0	0	0	0	5	0	0	0	1
i2(BTNN)	Shrubby Bog	0	0	0	0	0	37	7	0	0	0	0
j1(FTNN)	Treed Poor Fen Sb-Lt	0	4	0	0	0	26	0	0	0	0	0
j1/g1 (FTNN)	Treed Poor Fen Lt-Sb-Pj	0	2	0	0	0	21	0	0	0	0	1
j1/g1(FFNN)	Treed Poor Fen Sb-Pj	0	2	0	0	0	21	0	0	0	0	1
j1/g1(FTNN)	Treed Poor Fen Lt-Sb-Pj	0	2	0	0	0	21	0	0	0	0	1
j1/h1(FTNN)	Treed Poor Fen Sb-Sw-Lt	0	2	0	0	0	20	0	0	0	0	2
j2(FFNN)	Treed Poor Fen Sb-Lt	0	12	0	0	0	23	0	0	0	0	0
j2(FTNN)	Treed Poor Fen Sb-Lt	0	12	0	0	0	23	0	0	0	0	0
j2/h1(FTNN)	Treed Poor Fen Sb/Sw-Lt	0	12	0	0	0	23	0	0	0	0	0
k1(FOPN)	Patterned Open Rich Fen	0	21	0	0	0	6	0	0	0	0	0
k1(FTNN)	Treed Rich Fen	0	21	0	0	0	6	0	0	0	0	0
k2(FONS)	Shrubby Rich Fen	0	7	0	0	0	0	0	0	0	0	0
k2(FTNN)	Shrubby Treed Rich Fen	0	14	0	0	0	3	0	0	0	0	0
k3(FONG)	Graminoid Rich Fen	0	0	0	0	0	0	0	0	0	0	0
	Open Water and Marsh Types											
l1(MONG)	Marsh	0	0	0	0	0	0	0	0	0	0	0
w	Reclaimed Wetland (Marsh)	0	0	0	0	0	0	0	0	0	0	0
NWF(WONN)	Shallow Open Water	0	0	0	0	0	0	0	0	0	0	0
o	Reclaimed Open Water	0	0	0	0	0	0	0	0	0	0	0
NWL	Lakes and Ponds	0	0	0	0	0	0	0	0	0	0	0
NWR	Rivers	0	0	0	0	0	0	0	0	0	0	0
	Other Types											
AIG	Gravel Pits	0	0	0	0	0	0	0	0	0	0	0
AIH	Roads and Rights-of-way	0	0	0	0	0	0	0	0	0	0	0
AIM	Surface Mines	0	0	0	0	0	0	0	0	0	0	0
NMC	Cutbanks	0	0	0	0	0	0	0	0	0	0	0
UN	Unclassified	0	0	0	0	0	0	0	0	0	0	0
rr	Rip-Rap	0	0	0	0	0	0	0	0	0	0	0

Habitat Attributes Used for HSI Modelling in the Local Study Area

Code	Vegetation Type	Saska-toon Shrub Cover (%)	Snow-berry Shrub Cover (%)	Willow Shrub Cover (%)	Total Conifer Shrub Cover (%)	Total Decid. Shrub Cover (%)	Total Shrub Cover (%)	Trailing Shrub Cover (%)	Broad-leaf Herb Cover (%)	Grass / Sedge / Rush Cover (%)	Moss Cover (%)	Surface Lichen Cover (%)
	Upland Vegetation Types											
a1	Lichen Pj	0	0	0	3	11	14	20	2	0	10	31
a1/g1	Pj-Lt	0	0	0	8	17	25	14	2	0	41	20
b1	Blueberry Pj-Aw	0	0	0	3	30	33	20	5	3	21	6
b2	Blueberry Aw(Bw)	0	0	0	0	29	29	20	13	3	4	0
b3	Blueberry Aw-Sw	0	0	0	5	32	37	24	12	5	15	2
b4	Blueberry Sw-Pj	2	0	0	6	24	30	26	7	1	34	6
c1	Labrador Tea-mesic Pj-Sb	0	0	0	6	19	25	13	4	0	60	6
d1	Low Bush Cranberry Aw	3	0	4	0	46	46	5	25	12	0	0
d2	Low Bush Cranberry Aw-Sw	1	0	1	6	30	36	6	19	9	27	0
d3	Low Bush Cranberry Sw	0	0	0	6	16	22	8	16	0	71	0
e1	Dogwood Pb-Aw	0	0	4	0	58	58	2	24	5	0	0
e1/f1	Pb-Aw	0	0	6	1	49	50	1	31	8	0	0
e2	Dogwood Pb-Sw	0	0	0	0	42	42	5	31	9	21	0
e2/f2	Pb-Sw	0	0	3	4	35	39	4	42	5	36	0
e3	Dogwood Sw	0	0	0	8	37	45	6	36	9	49	0
g1	Labrador Tea-subhygric Sb-Pj	0	0	0	8	22	30	8	2	0	72	8
h1	Labrador Tea/Horsetail Sw-Sb	0	0	5	0	23	23	11	24	4	79	0
Lt-Sb	Upland Lt-Sb	0	0	0	8	22	30	8	2	0	72	8
Sb-Lt	Upland Sb-Lt	0	0	0	8	22	30	8	2	0	72	8
shrub	Upland Shrubland	1	2	40	4	75	79	8	5	3	15	0
	Lowland Vegetation Types											
b4(STNN)	Coniferous Swamp Sw-Pj	0	0	10	40	16	56	10	2	3	10	0
c1(STNN)	Coniferous Swamp Pj-Sb	0	0	10	6	16	22	13	4	0	60	6
d2(STNN)	Coniferous Swamp Aw-Sw	0	0	10	40	16	56	10	2	3	10	0
d3(STNN)	Coniferous Swamp Sw	0	0	10	40	16	56	10	2	3	10	0
g1(STNN)	Coniferous Swamp Pj-Sb	0	0	10	40	16	56	10	2	3	10	0
h1(STNN)	Coniferous Swamp Sw-Sb	0	0	10	40	16	56	10	2	3	10	0
(Sb-Lt)SFNN	Coniferous Swamp(Sb-Lt)	0	0	10	40	15	55	10	2	3	10	0
Sb-Lt(SFNN)	Coniferous Swamp Sb-Lt	0	0	10	40	16	56	10	2	3	10	0
Sb-Lt(STNN)	Coniferous Swamp Sb-Lt	0	0	10	40	16	56	10	2	3	10	0
Sb(STNN)	Coniferous Swamp Sb	0	0	10	40	16	56	10	2	3	10	0
Lt(STNN)	Coniferous Swamp Lt	0	0	10	40	16	56	10	2	3	10	0
Lt-Aw(STNN)	Coniferous Swamp Lt-Aw	0	0	10	40	16	56	10	2	3	10	0
Lt-Pb(STNN)	Coniferous Swamp Lt-Pb	0	0	10	40	16	56	10	2	3	10	0
Lt-Sb(STNN)	Coniferous Swamp Lt-Sb	0	0	10	40	16	56	10	2	3	10	0

Habitat Attributes Used for HSI Modelling in the Local Study Area

Code	Vegetation Type	Saska-toon Shrub Cover (%)	Snow-berry Shrub Cover (%)	Willow Shrub Cover (%)	Total Conifer Shrub Cover (%)	Total Decid. Shrub Cover (%)	Total Shrub Cover (%)	Trailing Shrub Cover (%)	Broad-leaf Herb Cover (%)	Grass / Sedge / Rush Cover (%)	Moss Cover (%)	Surface Lichen Cover (%)
shrub(SONS)	Shrubby Swamp	0	0	50	1	79	80	10	5	30	10	0
r	Reclaimed Riparian Shrub	0	0	50	6	79	85	10	5	30	10	0
i2(BTNN)	Shrubby Bog	0	0	0	35	44	79	14	10	0	75	12
j1(FTNN)	Treed Poor Fen Sb-Lt	0	0	5	21	35	56	11	13	10	64	5
j1/g1 (FTNN)	Treed Poor Fen Lt-Sb-Pj	0	0	3	15	29	43	10	8	5	68	7
j1/g1(FFNN)	Treed Poor Fen Sb-Pj	0	0	3	15	29	43	10	8	5	68	7
j1/g1(FTNN)	Treed Poor Fen Lt-Sb-Pj	0	0	3	15	29	43	10	8	5	68	7
j1/h1(FTNN)	Treed Poor Fen Sb-Sw-Lt	0	0	5	11	29	40	11	19	7	72	3
j2(FFNN)	Treed Poor Fen Sb-Lt	0	0	7	23	42	65	12	6	10	80	4
j2(FTNN)	Treed Poor Fen Sb-Lt	0	0	7	23	42	65	12	6	10	80	4
j2/h1(FTNN)	Treed Poor Fen Sb/Sw-Lt	0	0	7	23	42	65	12	6	10	80	4
k1(FOPN)	Patterned Open Rich Fen	0	0	6	13	33	46	3	8	22	65	0
k1(FTNN)	Treed Rich Fen	0	0	6	13	33	46	3	8	22	65	0
k2(FONS)	Shrubby Rich Fen	0	0	37	1	49	50	0	4	43	14	0
k2(FTNN)	Shrubby Treed Rich Fen	0	0	22	7	41	48	2	6	33	40	0
k3(FONG)	Graminoid Rich Fen	0	0	0	0	0	0	0	3	68	17	0
	Open Water and Marsh Types											
l1(MONG)	Marsh	0	0	0	0	0	0	0	9	62	6	0
w	Reclaimed Wetland (Marsh)	0	0	0	0	0	0	0	9	62	6	0
NWF(WONN)	Shallow Open Water	0	0	0	0	0	0	0	0	0	0	0
o	Reclaimed Open Water	0	0	0	0	0	0	0	0	0	0	0
NWL	Lakes and Ponds	0	0	0	0	0	0	0	0	0	0	0
NWR	Rivers	0	0	0	0	0	0	0	0	0	0	0
	Other Types											
AIG	Gravel Pits	0	0	0	0	0	0	0	2	2	0	0
AIH	Roads and Rights-of-way	0	0	0	0	0	0	0	10	40	0	0
AIM	Surface Mines	0	0	0	0	0	0	0	2	2	0	0
NMC	Cutbanks	0	0	0	0	0	0	0	1	1	0	0
UN	Unclassified	0	0	0	0	0	0	0	0	0	0	0
rr	Rip-Rap	0	0	0	0	0	0	0	0	0	0	0

Habitat Attributes Used for HSI Modelling in the Local Study Area

Code	Vegetation Type	Downed Wood Pieces (#/ha)	Litter Cover (%)	Jack Pine Canopy Comp. (%)	White Spruce Canopy Comp. (%)	Black Spruce Canopy Comp. (%)	Balsam Fir Canopy Comp. (%)	Larch Canopy Comp. (%)	Aspen Canopy Comp. (%)	Balsam Poplar Canopy Comp. (%)	Paper Birch Canopy Comp. (%)
	Upland Vegetation Types										
a1	Lichen Pj	174	28	100	0	0	0	0	0	0	0
a1/g1	Pj-Lt	118	22	67	4	7	0	21	0	0	0
b1	Blueberry Pj-Aw	56	38	44	3	0	0	0	54	0	0
b2	Blueberry Aw(Bw)	13	65	0	0	0	0	0	20	5	75
b3	Blueberry Aw-Sw	58	18	10	21	0	0	0	68	1	0
b4	Blueberry Sw-Pj	58	48	69	20	2	0	1	9	0	0
c1	Labrador Tea-mesic Pj-Sb	29	42	71	5	11	0	11	1	0	0
d1	Low Bush Cranberry Aw	108	70	0	0	0	0	0	100	0	0
d2	Low Bush Cranberry Aw-Sw	106	69	0	33	5	0	1	61	1	0
d3	Low Bush Cranberry Sw	88	91	13	85	0	0	0	1	1	0
e1	Dogwood Pb-Aw	56	64	0	1	0	0	0	82	17	0
e1/f1	Pb-Aw	78	57	0	1	0	0	0	14	85	0
e2	Dogwood Pb-Sw	125	50	0	47	0	0	7	7	40	0
e2/f2	Pb-Sw	113	45	0	18	0	0	2	2	78	0
e3	Dogwood Sw	125	50	0	89	0	0	1	6	5	0
g1	Labrador Tea-subhygric Sb-Pj	61	15	17	3	37	0	37	7	0	0
h1	Labrador Tea/Horsetail Sw-Sb	60	15	3	57	25	0	12	3	0	0
Lt-Sb	Upland Lt-Sb	10	0	5	5	25	0	65	0	0	0
Sb-Lt	Upland Sb-Lt	61	15	3	3	73	0	20	0	0	0
shrub	Upland Shrubland	3	25	0	0	0	0	0	0	0	0
	Lowland Vegetation Types										
b4(STNN)	Coniferous Swamp Sw-Pj	58	48	55	33	3	0	10	0	0	0
c1(STNN)	Coniferous Swamp Pj-Sb	29	42	70	5	25	0	0	0	0	0
d2(STNN)	Coniferous Swamp Aw-Sw	10	0	0	20	55	0	8	18	0	0
d3(STNN)	Coniferous Swamp Sw	10	0	0	67	0	0	27	7	0	0
g1(STNN)	Coniferous Swamp Pj-Sb	10	0	17	1	18	0	64	0	0	0
h1(STNN)	Coniferous Swamp Sw-Sb	10	0	2	37	39	0	18	3	1	0
(Sb-Lt)SFNN	Coniferous Swamp(Sb-Lt)	10	0	0	0	100	0	0	0	0	0
Sb-Lt(SFNN)	Coniferous Swamp Sb-Lt	10	0	0	5	85	0	10	0	0	0
Sb-Lt(STNN)	Coniferous Swamp Sb-Lt	10	0	1	5	73	0	19	1	0	0
Sb(STNN)	Coniferous Swamp Sb	10	0	0	0	100	0	0	0	0	0
Lt(STNN)	Coniferous Swamp Lt	10	0	0	0	0	0	100	0	0	0
Lt-Aw(STNN)	Coniferous Swamp Lt-Aw	10	0	0	0	0	0	90	10	0	0
Lt-Pb(STNN)	Coniferous Swamp Lt-Pb	10	0	0	0	10	0	80	0	10	0
Lt-Sb(STNN)	Coniferous Swamp Lt-Sb	10	0	1	1	20	0	77	0	0	0

Habitat Attributes Used for HSI Modelling in the Local Study Area

Code	Vegetation Type	Downed Wood Pieces (#/ha)	Litter Cover (%)	Jack Pine Canopy Comp. (%)	White Spruce Canopy Comp. (%)	Black Spruce Canopy Comp. (%)	Balsam Fir Canopy Comp. (%)	Larch Canopy Comp. (%)	Aspen Canopy Comp. (%)	Balsam Poplar Canopy Comp. (%)	Paper Birch Canopy Comp. (%)
shrub(SONS)	Shrubby Swamp	3	0	0	0	0	0	0	0	0	0
r	Reclaimed Riparian Shrub	3	0	0	0	0	0	0	0	0	0
i2(BTNN)	Shrubby Bog	10	12	0	0	100	0	0	0	0	0
j1(FTNN)	Treed Poor Fen Sb-Lt	50	17	0	0	79	0	21	0	0	0
j1/g1 (FTNN)	Treed Poor Fen Lt-Sb-Pj	56	16	10	0	10	0	80	0	0	0
j1/g1(FFNN)	Treed Poor Fen Sb-Pj	56	16	10	0	90	0	0	0	0	0
j1/g1(FTNN)	Treed Poor Fen Lt-Sb-Pj	56	16	10	0	10	0	80	0	0	0
j1/h1(FTNN)	Treed Poor Fen Sb-Sw-Lt	55	16	0	11	81	0	7	1	0	0
j2(FFNN)	Treed Poor Fen Sb-Lt	8	14	0	0	80	0	20	0	0	0
j2(FTNN)	Treed Poor Fen Sb-Lt	8	14	0	0	83	0	17	0	0	0
j2/h1(FTNN)	Treed Poor Fen Sb/Sw-Lt	8	14	0	60	40	0	0	0	0	0
k1(FOPN)	Patterned Open Rich Fen	40	30	0	0	0	0	100	0	0	0
k1(FTNN)	Treed Rich Fen	40	30	0	0	10	0	89	0	0	0
k2(FONS)	Shrubby Rich Fen	40	30	0	0	0	0	0	0	0	0
k2(FTNN)	Shrubby Treed Rich Fen	29	46	0	0	12	0	87	0	0	0
k3(FONG)	Graminoid Rich Fen	0	27	0	0	0	0	0	0	0	0
	Open Water and Marsh Types										
l1(MONG)	Marsh	0	0	0	0	0	0	0	0	0	0
w	Reclaimed Wetland (Marsh)	0	0	0	0	0	0	0	0	0	0
NWF(WONN)	Shallow Open Water	0	0	0	0	0	0	0	0	0	0
o	Reclaimed Open Water	0	0	0	0	0	0	0	0	0	0
NWL	Lakes and Ponds	0	0	0	0	0	0	0	0	0	0
NWR	Rivers	0	0	0	0	0	0	0	0	0	0
	Other Types										
AIG	Gravel Pits	0	0	0	0	0	0	0	0	0	0
AIH	Roads and Rights-of-way	0	0	0	0	0	0	0	0	0	0
AIM	Surface Mines	0	0	0	0	0	0	0	0	0	0
NMC	Cutbanks	0	0	0	0	0	0	0	0	0	0
UN	Unclassified	0	0	0	0	0	0	0	0	0	0
rr	Rip-Rap	0	0	0	0	0	0	0	0	0	0

Habitat Attributes Used for HSI Modelling in the Local Study Area

Code	Vegetation Type	Total Conifer Canopy Comp. (%)	Total Decid. Canopy Comp. (%)	Total Canopy Comp. (%)	Mean Canopy Height (metres)	Modal Canopy Closure Class	Modal Moisture Class	Mean Stand Age (years)	Mean DBH (cm)	Modal Dominant Tree Species
	Upland Vegetation Types									
a1	Lichen Pj	100	0	100	15.0	C	m	68	16.7	Pj
a1/g1	Pj-Lt	79	0	100	14.9	A	w	70	16.9	Pj
b1	Blueberry Pj-Aw	46	54	100	14.9	C	m	64	14.3	Aw
b2	Blueberry Aw(Bw)	0	100	100	12	B	m	60	12	Bw
b3	Blueberry Aw-Sw	31	69	100	16.0	B	m	73	15.0	Aw
b4	Blueberry Sw-Pj	91	9	100	14.8	B	m	67	15.9	Pj
c1	Labrador Tea-mesic Pj-Sb	88	1	100	15.8	B	m	73	18.2	Pj
d1	Low Bush Cranberry Aw	0	100	100	16.3	C	m	65	14.3	Aw
d2	Low Bush Cranberry Aw-Sw	38	62	100	14.4	C	m	64	13.2	Aw
d3	Low Bush Cranberry Sw	98	3	100	16.9	B	m	97	18.5	Sw
e1	Dogwood Pb-Aw	1	99	100	17.8	C	m	70	17.3	Aw
e1/f1	Pb-Aw	1	99	100	19.6	B	m	92	24.1	Pb
e2	Dogwood Pb-Sw	47	47	100	16.0	C	m	70	17.0	Sw
e2/f2	Pb-Sw	18	80	100	20.2	B	m	107	25.8	Pb
e3	Dogwood Sw	89	11	100	24.4	B	m	117	33.0	Sw
g1	Labrador Tea-subhygric Sb-Pj	57	7	100	10.7	B	w	80	11.2	Sb
h1	Labrador Tea/Horsetail Sw-Sb	85	3	100	13.5	C	w	80	14.4	Sw
Lt-Sb	Upland Lt-Sb	35	0	100	14.0	B	w	107	16.4	Lt
Sb-Lt	Upland Sb-Lt	80	0	100	9.7	B	w	94	10.0	Sb
shrub	Upland Shrubland	0	0	0	2.5	O	m	0	0.0	None
	Lowland Vegetation Types									
b4(STNN)	Coniferous Swamp Sw-Pj	90	0	100	15.0	A	w	77	16.7	Pj
c1(STNN)	Coniferous Swamp Pj-Sb	100	0	100	14.0	A	w	67	15.4	Pj
d2(STNN)	Coniferous Swamp Aw-Sw	75	18	100	11.0	B	w	85	10.9	Sb
d3(STNN)	Coniferous Swamp Sw	67	7	100	16.0	A	w	124	17.7	Sw
g1(STNN)	Coniferous Swamp Pj-Sb	36	0	100	12.4	B	w	107	14.0	Lt
h1(STNN)	Coniferous Swamp Sw-Sb	78	4	100	11.3	B	w	85	11.8	Sb
(Sb-Lt)SFNN	Coniferous Swamp(Sb-Lt)	100	0	100	6.0	D	w	72	5.5	Sb
Sb-Lt(SFNN)	Coniferous Swamp Sb-Lt	90	0	100	4.5	D	w	62	4.0	Sb
Sb-Lt(STNN)	Coniferous Swamp Sb-Lt	79	1	100	9.5	C	w	93	9.7	Sb
Sb(STNN)	Coniferous Swamp Sb	100	0	100	6.0	D	w	67	5.5	Sb
Lt(STNN)	Coniferous Swamp Lt	0	0	100	11.4	B	w	106	13.1	Lt
Lt-Aw(STNN)	Coniferous Swamp Lt-Aw	0	10	100	9.0	A	w	107	9.6	Lt
Lt-Pb(STNN)	Coniferous Swamp Lt-Pb	10	10	100	12.0	A	w	107	13.5	Lt
Lt-Sb(STNN)	Coniferous Swamp Lt-Sb	22	0	100	11.6	A	w	108	13.2	Lt
shrub(SONS)	Shrubby Swamp	0	0	0	2.5	O	w	0	0.0	None

Habitat Attributes Used for HSI Modelling in the Local Study Area

Code	Vegetation Type	Total Conifer Canopy Comp. (%)	Total Decid. Canopy Comp. (%)	Total Canopy Comp. (%)	Mean Canopy Height (metres)	Modal Canopy Closure Class	Modal Moisture Class	Mean Stand Age (years)	Mean DBH (cm)	Modal Dominant Tree Species
r	Reclaimed Riparian Shrub	0	0	0	2.5	O	w	0	0.0	None
i2(BTNN)	Shrubby Bog	100	0	100	3.0	C	w	60	2.2	Sb
j1(FTNN)	Treed Poor Fen Sb-Lt	79	0	100	8.3	B	w	85	8.3	Sb
j1/g1 (FTNN)	Treed Poor Fen Lt-Sb-Pj	20	0	100	12.0	A	w	107	13.7	Lt
j1/g1(FFNN)	Treed Poor Fen Sb-Pj	100	0	100	6.0	D	w	67	5.5	Sb
j1/g1(FTNN)	Treed Poor Fen Lt-Sb-Pj	20	0	100	13.0	A	w	157	15.1	Lt
j1/h1(FTNN)	Treed Poor Fen Sb-Sw-Lt	92	1	100	6.3	C	w	69	5.9	Sb
j2(FFNN)	Treed Poor Fen Sb-Lt	80	0	100	2.3	D	w	67	1.5	Sb
j2(FTNN)	Treed Poor Fen Sb-Lt	83	0	100	3.7	C	w	66	3.1	Sb
j2/h1(FTNN)	Treed Poor Fen Sb/Sw-Lt	100	0	100	12.0	C	w	77	12.5	Sw
k1(FOPN)	Patterned Open Rich Fen	0	0	100	5.0	A	w	107	5.3	Lt
k1(FTNN)	Treed Rich Fen	11	0	100	8.9	A	w	105	9.8	Lt
k2(FONS)	Shrubby Rich Fen	0	0	0	1.3	O	w	0	0.0	None
k2(FTNN)	Shrubby Treed Rich Fen	12	0	99	3.2	B	w	67	2.9	Lt
k3(FONG)	Graminoid Rich Fen	0	0	0	0.3	O	w	0	0.0	None
	Open Water and Marsh Types									
l1(MONG)	Marsh	0	0	0	0.0	O	a	0	0.0	None
w	Reclaimed Wetland (Marsh)	0	0	0	0.0	O	a	0	0.0	None
NWF(WONN)	Shallow Open Water	0	0	0	0.0	O	a	0	0.0	None
o	Reclaimed Open Water	0	0	0	0.0	O	a	0	0.0	None
NWL	Lakes and Ponds	0	0	0	0.0	O	a	0	0.0	None
NWR	Rivers	0	0	0	0.0	O	a	0	0.0	None
	Other Types									
AIG	Gravel Pits	0	0	0	0.0	O	na	0	0.0	None
AIH	Roads and Rights-of-way	0	0	0	0.0	O	na	0	0.0	None
AIM	Surface Mines	0	0	0	0.0	O	na	0	0.0	None
NMC	Cutbanks	0	0	0	0.0	O	na	0	0.0	None
UN	Unclassified	0	0	0	0.0	O	na	0	0.0	None
rr	Rip-Rap	0	0	0	0	O	d	0	0	None

APPENDIX III

RAW HSI RESULTS FOR THE LSA

HSI Results by species and scenario for the Local Study Area

Beaver - Baseline

Habitat Class	Area	Percent	HU	Percent
No Habitat Total (HSI = 0.0)	9210	84.1	0	0.0
Cutbank	12	0.1	0	0.0
Cultural Disturbances	327	3.0	0	0.0
Unclassified	15	0.1	0	0.0
Open Water	177	1.6	0	0.0
Unsuitable Vegetated Areas	8678	79.2	0	0.0
Low Suitability (0.01-0.33)	36	0.3	8	0.6
Medium Suitability (0.34-0.66)	246	2.2	121	8.5
High Suitability (0.67-1.00)	1463	13.4	1295	90.9
Total Area	10954	100.0	1424	100.0

Beaver - Full Mine Impact - No Aquifer Drawdown

Habitat Class	Area	Percent	HU	Percent
No Habitat Total (HSI = 0.0)	9654	88.1	0	0.0
Cutbank	12	0.1	0	0.0
Cultural Disturbances	211	1.9	0	0.0
Mine Footprint	4313	39.4	0	0.0
Unclassified	15	0.1	0	0.0
Open Water	139	1.3	0	0.0
Unsuitable Vegetated Areas	4964	45.3	0	0.0
Low Suitability (0.01-0.33)	22	0.2	5	0.5
Medium Suitability (0.34-0.66)	174	1.6	85	8.0
High Suitability (0.67-1.00)	1104	10.1	973	91.5
Total Area	10954	100.0	1064	100.0

Beaver - Full Mine Impact - With Aquifer Drawdown

Habitat Class	Area	Percent	HU	Percent
No Habitat Total (HSI = 0.0)	9654	88.1	0	0.0
Cutbank	12	0.1	0	0.0
Cultural Disturbances	211	1.9	0	0.0
Mine Footprint	4313	39.4	0	0.0
Unclassified	15	0.1	0	0.0
Open Water	139	1.3	0	0.0
Unsuitable Vegetated Areas	4964	45.3	0	0.0
Low Suitability (0.01-0.33)	37	0.3	9	0.9
Medium Suitability (0.34-0.66)	315	2.9	149	15.0
High Suitability (0.67-1.00)	948	8.7	832	84.1
Total Area	10954	100.0	989	100.0

HSI Results by species and scenario for the Local Study Area

Beaver - Reclaimed Landscape

Habitat Class	Area	Percent	HU	Percent
No Habitat Total (HSI = 0.0)	9323	85.1	0	0.0
Cutbank	12	0.1	0	0.0
Cultural Disturbances	211	1.9	0	0.0
Rip-Rap	36	0.3	0	0.0
Unclassified	15	0.1	0	0.0
Open Water	747	6.8	0	0.0
Unsuitable Vegetated Areas	8303	75.8	0	0.0
Low Suitability (0.01-0.33)	24	0.2	6	0.4
Medium Suitability (0.34-0.66)	197	1.8	97	7.2
High Suitability (0.67-1.00)	1409	12.9	1236	92.4
Total Area	10954	100.0	1338	100.0

Black Bear Baseline - No Disturbance Buffering

Habitat Class	Area (ha)	Percent by Area	HU	Percent by HU
No Habitat Total (HSI = 0.0)	667	6.1	0	0.0
Cutbank	12	0.1	0	0.0
Cultural Disturbances	327	3.0	0	0.0
Unclassified	15	0.1	0	0.0
Open Water	177	1.6	0	0.0
Unsuitable Vegetated Areas	136	1.2	0	0.0
Low Suitability (0.01-0.33)	5139	46.9	1060	25.1
Medium Suitability (0.34-0.66)	2285	20.9	898	21.2
High Suitability (0.67-1.00)	2862	26.1	2269	53.7
Total Area	10954	100.0	4227	100.0

Black Bear Baseline - With Disturbance Buffering

Habitat Class	Area	Percent	HU	Percent
No Habitat Total (HSI = 0.0)	794	7.2	0	0.0
Cutbank	12	0.1	0	0.0
Cultural Disturbances	327	3.0	0	0.0
Unclassified	15	0.1	0	0.0
Open Water	177	1.6	0	0.0
Unsuitable Vegetated Areas	262	2.4	0	0.0
Low Suitability (0.01-0.33)	5692	52.0	1079	28.3
Medium Suitability (0.34-0.66)	2020	18.4	791	20.8
High Suitability (0.67-1.00)	2448	22.3	1939	50.9
Total Area	10954	100.0	3809	100.0

HSI Results by species and scenario for the Local Study Area

Black Bear **Full Mine Impact - No Aquifer Drawdown or Disturbance Buffering**

Habitat Class	Area	Percent	HU	Percent
No Habitat Total (HSI = 0.0)	4816	44.0	0	0.0
Cutbank	12	0.1	0	0.0
Cultural Disturbances	211	1.9	0	0.0
Mine Footprint	4313	39.4	0	0.0
Unclassified	15	0.1	0	0.0
Open Water	139	1.3	0	0.0
Unsuitable Vegetated Areas	125	1.1	0	0.0
Low Suitability (0.01-0.33)	2693	24.6	572	20.8
Medium Suitability (0.34-0.66)	1436	13.1	590	21.5
High Suitability (0.67-1.00)	2010	18.4	1585	57.7
Total Area	10954	100.0	2747	100.0

Black Bear **Full Mine Impact - With Aquifer Drawdown, No Disturbance Buffering**

Habitat Class	Area	Percent	HU	Percent
No Habitat Total (HSI = 0.0)	4816	44.0	0	0.0
Cutbank	12	0.1	0	0.0
Cultural Disturbances	211	1.9	0	0.0
Mine Footprint	4313	39.4	0	0.0
Unclassified	15	0.1	0	0.0
Open Water	139	1.3	0	0.0
Unsuitable Vegetated Areas	125	1.1	0	0.0
Low Suitability (0.01-0.33)	2901	26.5	559	22.2
Medium Suitability (0.34-0.66)	1578	14.4	639	25.4
High Suitability (0.67-1.00)	1659	15.1	1315	52.3
Total Area	10954	100.0	2514	100.0

Black Bear **Full Mine Impact - With Aquifer Drawdown and Disturbance Buffering**

Habitat Class	Area	Percent	HU	Percent
No Habitat Total (HSI = 0.0)	5362	48.9	0	0.0
Cutbank	12	0.1	0	0.0
Cultural Disturbances	211	1.9	0	0.0
Mine Footprint	4313	39.4	0	0.0
Unclassified	15	0.1	0	0.0
Open Water	139	1.3	0	0.0
Unsuitable Vegetated Areas	672	6.1	0	0.0
Low Suitability (0.01-0.33)	3001	27.4	528	25.2
Medium Suitability (0.34-0.66)	1254	11.5	508	24.3
High Suitability (0.67-1.00)	1337	12.2	1056	50.5
Total Area	10954	100.0	2092	100.0

HSI Results by species and scenario for the Local Study Area

Black Bear **Reclaimed Landscape - No Disturbance Buffering**

Habitat Class	Area	Percent	HU	Percent
No Habitat Total (HSI = 0.0)	1146	10.5	0	0.0
Cutbank	12	0.1	0	0.0
Cultural Disturbances	211	1.9	0	0.0
Rip-Rap	36	0.3	0	0.0
Unclassified	15	0.1	0	0.0
Open Water	747	6.8	0	0.0
Unsuitable Vegetated Areas	125	1.1	0	0.0
Low Suitability (0.01-0.33)	2944	26.9	647	12.8
Medium Suitability (0.34-0.66)	3772	34.4	1892	37.4
High Suitability (0.67-1.00)	3093	28.2	2515	49.8
Total Area	10954	100.0	5054	100.0

Black Bear **Reclaimed Landscape - With Disturbance Buffering**

Habitat Class	Area	Percent	HU	Percent
No Habitat Total (HSI = 0.0)	1146	10.5	0	0.0
Cutbank	12	0.1	0	0.0
Cultural Disturbances	211	1.9	0	0.0
Rip-Rap	36	0.3	0	0.0
Unclassified	15	0.1	0	0.0
Open Water	747	6.8	0	0.0
Unsuitable Vegetated Areas	125	1.1	0	0.0
Low Suitability (0.01-0.33)	3223	29.4	659	13.5
Medium Suitability (0.34-0.66)	3669	33.5	1850	37.9
High Suitability (0.67-1.00)	2916	26.6	2371	48.6
Total Area	10954	100.0	4881	100.0

Cape May Warbler **Baseline - No Disturbance Buffering**

Habitat Class	Area (ha)	Percent by Area	HU	Percent by HU
No Habitat Total (HSI = 0.0)	4573	41.7	0	0.0
Cutbank	12	0.1	0	0.0
Cultural Disturbances	327	3.0	0	0.0
Unclassified	15	0.1	0	0.0
Open Water	177	1.6	0	0.0
Unsuitable Vegetated Areas	4042	36.9	0	0.0
Low Suitability (0.01-0.33)	4882	44.6	764	44.5
Medium Suitability (0.34-0.66)	1089	9.9	590	34.4
High Suitability (0.67-1.00)	410	3.7	362	21.1
Total Area	10954	100.0	1716	100.0

HSI Results by species and scenario for the Local Study Area

Cape May Warbler **Baseline - With Disturbance Buffering**

Habitat Class	Area	Percent	HU	Percent
No Habitat Total (HSI = 0.0)	4592	41.9	0	0.0
Cutbank	12	0.1	0	0.0
Cultural Disturbances	327	3.0	0	0.0
Unclassified	15	0.1	0	0.0
Open Water	177	1.6	0	0.0
Unsuitable Vegetated Areas	4060	37.1	0	0.0
Low Suitability (0.01-0.33)	4999	45.6	711	44.9
Medium Suitability (0.34-0.66)	980	8.9	534	33.7
High Suitability (0.67-1.00)	384	3.5	338	21.4
Total Area	10954	100.0	1583	100.0

Cape May Warbler **Full Mine Impact - No Aquifer Drawdown or Disturbance Buffering**

Habitat Class	Area	Percent	HU	Percent
No Habitat Total (HSI = 0.0)	7530	68.7	0	0.0
Cutbank	12	0.1	0	0.0
Cultural Disturbances	211	1.9	0	0.0
Mine Footprint	4313	39.4	0	0.0
Unclassified	15	0.1	0	0.0
Open Water	139	1.3	0	0.0
Unsuitable Vegetated Areas	2839	25.9	0	0.0
Low Suitability (0.01-0.33)	2431	22.2	412	40.0
Medium Suitability (0.34-0.66)	752	6.9	408	39.6
High Suitability (0.67-1.00)	242	2.2	209	20.3
Total Area	10954	100.0	1029	100.0

Cape May Warbler **Full Mine Impact - With Aquifer Drawdown, No Disturbance Buffering**

Habitat Class	Area	Percent	HU	Percent
No Habitat Total (HSI = 0.0)	7530	68.7	0	0.0
Cutbank	12	0.1	0	0.0
Cultural Disturbances	211	1.9	0	0.0
Mine Footprint	4313	39.4	0	0.0
Unclassified	15	0.1	0	0.0
Open Water	139	1.3	0	0.0
Unsuitable Vegetated Areas	2839	25.9	0	0.0
Low Suitability (0.01-0.33)	2511	22.9	407	42.1
Medium Suitability (0.34-0.66)	711	6.5	383	39.6
High Suitability (0.67-1.00)	203	1.9	176	18.2
Total Area	10954	100.0	965	100.0

HSI Results by species and scenario for the Local Study Area

Cape May Warbler **Full Mine Impact - With Aquifer Drawdown and Disturbance Buffering**

Habitat Class	Area	Percent	HU	Percent
No Habitat Total (HSI = 0.0)	7590	69.3	0	0.0
Cutbank	12	0.1	0	0.0
Cultural Disturbances	211	1.9	0	0.0
Mine Footprint	4313	39.4	0	0.0
Unclassified	15	0.1	0	0.0
Open Water	139	1.3	0	0.0
Unsuitable Vegetated Areas	2900	26.5	0	0.0
Low Suitability (0.01-0.33)	2596	23.7	341	41.9
Medium Suitability (0.34-0.66)	589	5.4	320	39.3
High Suitability (0.67-1.00)	178	1.6	153	18.8
Total Area	10954	100.0	814	100.0

Cape May Warbler **Reclaimed Landscape - No Disturbance Buffering**

Habitat Class	Area	Percent	HU	Percent
No Habitat Total (HSI = 0.0)	4368	39.9	0	0.0
Cutbank	12	0.1	0	0.0
Cultural Disturbances	211	1.9	0	0.0
Rip-Rap	36	0.3	0	0.0
Unclassified	15	0.1	0	0.0
Open Water	747	6.8	0	0.0
Unsuitable Vegetated Areas	3347	30.6	0	0.0
Low Suitability (0.01-0.33)	3696	33.7	405	16.6
Medium Suitability (0.34-0.66)	1229	11.2	617	25.3
High Suitability (0.67-1.00)	1662	15.2	1413	58.0
Total Area	10954	100.0	2435	100.0

Cape May Warbler **Reclaimed Landscape - With Disturbance Buffering**

Habitat Class	Area	Percent	HU	Percent
No Habitat Total (HSI = 0.0)	4368	39.9	0	0.0
Cutbank	12	0.1	0	0.0
Cultural Disturbances	211	1.9	0	0.0
Rip-Rap	36	0.3	0	0.0
Unclassified	15	0.1	0	0.0
Open Water	747	6.8	0	0.0
Unsuitable Vegetated Areas	3347	30.6	0	0.0
Low Suitability (0.01-0.33)	3757	34.3	390	16.3
Medium Suitability (0.34-0.66)	1175	10.7	590	24.7
High Suitability (0.67-1.00)	1655	15.1	1407	58.9
Total Area	10954	100.0	2386	100.0

HSI Results by species and scenario for the Local Study Area

Dabbling Ducks **Baseline - No Disturbance Buffering**

Habitat Class	Area (ha)	Percent by Area	HU	Percent by HU
No Habitat Total (HSI = 0.0)	7770	70.9	0	0.0
Cutbank	12	0.1	0	0.0
Cultural Disturbances	327	3.0	0	0.0
Unclassified	15	0.1	0	0.0
Unsuitable Vegetated Areas	7416	67.7	0	0.0
Low Suitability (0.01-0.33)	2285	20.9	754	50.2
Medium Suitability (0.34-0.66)	442	4.0	292	19.4
High Suitability (0.67-1.00)	457	4.2	457	30.4
Total Area	10954	100.0	1503	100.0

Dabbling Ducks **Baseline - With Disturbance Buffering**

Habitat Class	Area	Percent	HU	Percent
No Habitat Total (HSI = 0.0)	7770	70.9	0	0.0
Cutbank	12	0.1	0	0.0
Cultural Disturbances	327	3.0	0	0.0
Unclassified	15	0.1	0	0.0
Unsuitable Vegetated Areas	7416	67.7	0	0.0
Low Suitability (0.01-0.33)	2316	21.1	721	49.9
Medium Suitability (0.34-0.66)	421	3.8	278	19.2
High Suitability (0.67-1.00)	447	4.1	447	30.9
Total Area	10954	100.0	1446	100.0

Dabbling Ducks **Full Mine Impact - No Aquifer Drawdown or Disturbance Buffering**

Habitat Class	Area	Percent	HU	Percent
No Habitat Total (HSI = 0.0)	8713	79.5	0	0.0
Cutbank	12	0.1	0	0.0
Cultural Disturbances	211	1.9	0	0.0
Mine Footprint	4313	39.4	0	0.0
Unclassified	15	0.1	0	0.0
Unsuitable Vegetated Areas	4162	38.0	0	0.0
Low Suitability (0.01-0.33)	1498	13.7	494	44.2
Medium Suitability (0.34-0.66)	352	3.2	233	20.8
High Suitability (0.67-1.00)	391	3.6	391	35.0
Total Area	10954	100.0	1118	100.0

HSI Results by species and scenario for the Local Study Area

Dabbling Ducks **Full Mine Impact - With Aquifer Drawdown, No Disturbance Buffering**

Habitat Class	Area	Percent	HU	Percent
No Habitat Total (HSI = 0.0)	8713	79.5	0	0.0
Cutbank	12	0.1	0	0.0
Cultural Disturbances	211	1.9	0	0.0
Mine Footprint	4313	39.4	0	0.0
Unclassified	15	0.1	0	0.0
Unsuitable Vegetated Areas	4162	38.0	0	0.0
Low Suitability (0.01-0.33)	1564	14.3	463	45.7
Medium Suitability (0.34-0.66)	347	3.2	219	21.6
High Suitability (0.67-1.00)	330	3.0	330	32.6
Total Area	10954	100.0	1012	100.0

Dabbling Ducks **Full Mine Impact - With Aquifer Drawdown and Disturbance Buffering**

Habitat Class	Area	Percent	HU	Percent
No Habitat Total (HSI = 0.0)	8713	79.5	0	0.0
Cutbank	12	0.1	0	0.0
Cultural Disturbances	211	1.9	0	0.0
Mine Footprint	4313	39.4	0	0.0
Unclassified	15	0.1	0	0.0
Unsuitable Vegetated Areas	4162	38.0	0	0.0
Low Suitability (0.01-0.33)	1597	14.6	414	44.0
Medium Suitability (0.34-0.66)	323	2.9	204	21.7
High Suitability (0.67-1.00)	322	2.9	322	34.2
Total Area	10954	100.0	940	100.0

Dabbling Ducks **Reclaimed Landscape - No Disturbance Buffering**

Habitat Class	Area	Percent	HU	Percent
No Habitat Total (HSI = 0.0)	7064	64.5	0	0.0
Cutbank	12	0.1	0	0.0
Cultural Disturbances	211	1.9	0	0.0
Rip-Rap	36	0.3	0	0.0
Unclassified	15	0.1	0	0.0
Unsuitable Vegetated Areas	6790	62.0	0	0.0
Low Suitability (0.01-0.33)	2177	19.9	718	34.2
Medium Suitability (0.34-0.66)	979	8.9	646	30.8
High Suitability (0.67-1.00)	735	6.7	735	35.0
Total Area	10954	100.0	2099	100.0

HSI Results by species and scenario for the Local Study Area

Dabbling Ducks **Reclaimed Landscape - With Disturbance Buffering**

Habitat Class	Area	Percent	HU	Percent
No Habitat Total (HSI = 0.0)	7064	64.5	0	0.0
Cutbank	12	0.1	0	0.0
Cultural Disturbances	211	1.9	0	0.0
Rip-Rap	36	0.3	0	0.0
Unclassified	15	0.1	0	0.0
Unsuitable Vegetated Areas	6790	62.0	0	0.0
Low Suitability (0.01-0.33)	2192	20.0	701	33.9
Medium Suitability (0.34-0.66)	967	8.8	638	30.8
High Suitability (0.67-1.00)	731	6.7	731	35.3
Total Area	10954	100.0	2070	100.0

Fisher **Baseline - No Disturbance Buffering**

Habitat Class	Area (ha)	Percent by Area	HU	Percent by HU
No Habitat Total (HSI = 0.0)	532	4.9	0	0.0
Cutbank	12	0.1	0	0.0
Cultural Disturbances	327	3.0	0	0.0
Unclassified	15	0.1	0	0.0
Open Water	177	1.6	0	0.0
Unsuitable Vegetated Areas	0	0.0	0	0.0
Low Suitability (0.01-0.33)	511	4.7	111	2.0
Medium Suitability (0.34-0.66)	6131	56.0	2743	49.1
High Suitability (0.67-1.00)	3780	34.5	2735	48.9
Total Area	10954	100.0	5588	100.0

Fisher **Baseline - With Disturbance Buffering**

Habitat Class	Area	Percent	HU	Percent
No Habitat Total (HSI = 0.0)	534	4.9	0	0.0
Cutbank	12	0.1	0	0.0
Cultural Disturbances	327	3.0	0	0.0
Unclassified	15	0.1	0	0.0
Open Water	177	1.6	0	0.0
Unsuitable Vegetated Areas	2	0.0	0	0.0
Low Suitability (0.01-0.33)	2064	18.8	237	4.9
Medium Suitability (0.34-0.66)	5312	48.5	2360	49.2
High Suitability (0.67-1.00)	3044	27.8	2201	45.9
Total Area	10954	100.0	4798	100.0

HSI Results by species and scenario for the Local Study Area

Fisher — Full Mine Impact - No Aquifer Drawdown or Disturbance Buffering

Habitat Class	Area	Percent	HU	Percent
No Habitat Total (HSI = 0.0)	4690	42.8	0	0.0
Cutbank	12	0.1	0	0.0
Cultural Disturbances	211	1.9	0	0.0
Mine Footprint	4313	39.4	0	0.0
Unclassified	15	0.1	0	0.0
Open Water	139	1.3	0	0.0
Unsuitable Vegetated Areas	0	0.0	0	0.0
Low Suitability (0.01-0.33)	1213	11.1	260	8.6
Medium Suitability (0.34-0.66)	3264	29.8	1474	48.9
High Suitability (0.67-1.00)	1787	16.3	1280	42.5
Total Area	10954	100.0	3014	100.0

Fisher — Full Mine Impact - With Aquifer Drawdown, No Disturbance Buffering

Habitat Class	Area	Percent	HU	Percent
No Habitat Total (HSI = 0.0)	4690	42.8	0	0.0
Cutbank	12	0.1	0	0.0
Cultural Disturbances	211	1.9	0	0.0
Mine Footprint	4313	39.4	0	0.0
Unclassified	15	0.1	0	0.0
Open Water	139	1.3	0	0.0
Unsuitable Vegetated Areas	0	0.0	0	0.0
Low Suitability (0.01-0.33)	1606	14.7	277	9.7
Medium Suitability (0.34-0.66)	2872	26.2	1293	45.4
High Suitability (0.67-1.00)	1786	16.3	1280	44.9
Total Area	10954	100.0	2850	100.0

Fisher — Full Mine Impact - With Aquifer Drawdown and Disturbance Buffering

Habitat Class	Area	Percent	HU	Percent
No Habitat Total (HSI = 0.0)	4694	42.8	0	0.0
Cutbank	12	0.1	0	0.0
Cultural Disturbances	211	1.9	0	0.0
Mine Footprint	4313	39.4	0	0.0
Unclassified	15	0.1	0	0.0
Open Water	139	1.3	0	0.0
Unsuitable Vegetated Areas	3	0.0	0	0.0
Low Suitability (0.01-0.33)	2806	25.6	268	12.3
Medium Suitability (0.34-0.66)	2132	19.5	955	44.0
High Suitability (0.67-1.00)	1323	12.1	950	43.7
Total Area	10954	100.0	2172	100.0

HSI Results by species and scenario for the Local Study Area

Fisher — Reclaimed Landscape - No Disturbance Buffering

Habitat Class	Area	Percent	HU	Percent
No Habitat Total (HSI = 0.0)	1021	9.3	0	0.0
Cutbank	12	0.1	0	0.0
Cultural Disturbances	211	1.9	0	0.0
Rip-Rap	36	0.3	0	0.0
Unclassified	15	0.1	0	0.0
Open Water	747	6.8	0	0.0
Unsuitable Vegetated Areas	0	0.0	0	0.0
Low Suitability (0.01-0.33)	309	2.8	60	1.1
Medium Suitability (0.34-0.66)	6726	61.4	3405	62.4
High Suitability (0.67-1.00)	2899	26.5	1993	36.5
Total Area	10954	100.0	5458	100.0

Fisher — Reclaimed Landscape - With Disturbance Buffering

Habitat Class	Area	Percent	HU	Percent
No Habitat Total (HSI = 0.0)	1021	9.3	0	0.0
Cutbank	12	0.1	0	0.0
Cultural Disturbances	211	1.9	0	0.0
Rip-Rap	36	0.3	0	0.0
Unclassified	15	0.1	0	0.0
Open Water	747	6.8	0	0.0
Unsuitable Vegetated Areas	0	0.0	0	0.0
Low Suitability (0.01-0.33)	1051	9.6	150	2.9
Medium Suitability (0.34-0.66)	6287	57.4	3198	62.3
High Suitability (0.67-1.00)	2596	23.7	1788	34.8
Total Area	10954	100.0	5135	100.0

Great Gray Owl — Baseline - No Disturbance Buffering

Habitat Class	Area (ha)	Percent by Area	HU	Percent by HU
No Habitat Total (HSI = 0.0)	532	4.9	0	0.0
Cutbank	12	0.1	0	0.0
Cultural Disturbances	327	3.0	0	0.0
Unclassified	15	0.1	0	0.0
Open Water	177	1.6	0	0.0
Unsuitable Vegetated Areas	0	0.0	0	0.0
Low Suitability (0.01-0.33)	5664	51.7	1528	42.2
Medium Suitability (0.34-0.66)	4624	42.2	1960	54.2
High Suitability (0.67-1.00)	134	1.2	128	3.5
Total Area	10954	100.0	3616	100.0

HSI Results by species and scenario for the Local Study Area

Great Gray Owl **Baseline - With Disturbance Buffering**

Habitat Class	Area	Percent	HU	Percent
No Habitat Total (HSI = 0.0)	532	4.9	0	0.0
Cutbank	12	0.1	0	0.0
Cultural Disturbances	327	3.0	0	0.0
Unclassified	15	0.1	0	0.0
Open Water	177	1.6	0	0.0
Unsuitable Vegetated Areas	0	0.0	0	0.0
Low Suitability (0.01-0.33)	7124	65.0	1088	42.5
Medium Suitability (0.34-0.66)	3182	29.1	1360	53.2
High Suitability (0.67-1.00)	116	1.1	111	4.3
Total Area	10954	100.0	2558	100.0

Great Gray Owl **Full Mine Impact - No Aquifer Drawdown or Disturbance Buffering**

Habitat Class	Area	Percent	HU	Percent
No Habitat Total (HSI = 0.0)	4690	42.8	0	0.0
Cutbank	12	0.1	0	0.0
Cultural Disturbances	211	1.9	0	0.0
Mine Footprint	4313	39.4	0	0.0
Unclassified	15	0.1	0	0.0
Open Water	139	1.3	0	0.0
Unsuitable Vegetated Areas	0	0.0	0	0.0
Low Suitability (0.01-0.33)	3632	33.2	984	46.0
Medium Suitability (0.34-0.66)	2507	22.9	1034	48.3
High Suitability (0.67-1.00)	125	1.1	120	5.6
Total Area	10954	100.0	2138	100.0

Great Gray Owl **Full Mine Impact - With Aquifer Drawdown, No Disturbance Buffering**

Habitat Class	Area	Percent	HU	Percent
No Habitat Total (HSI = 0.0)	4690	42.8	0	0.0
Cutbank	12	0.1	0	0.0
Cultural Disturbances	211	1.9	0	0.0
Mine Footprint	4313	39.4	0	0.0
Unclassified	15	0.1	0	0.0
Open Water	139	1.3	0	0.0
Unsuitable Vegetated Areas	0	0.0	0	0.0
Low Suitability (0.01-0.33)	4117	37.6	1008	51.6
Medium Suitability (0.34-0.66)	2024	18.5	828	42.4
High Suitability (0.67-1.00)	123	1.1	118	6.1
Total Area	10954	100.0	1954	100.0

HSI Results by species and scenario for the Local Study Area

Great Gray Owl **Full Mine Impact - With Aquifer Drawdown and Disturbance Buffering**

Habitat Class	Area	Percent	HU	Percent
No Habitat Total (HSI = 0.0)	4718	43.1	0	0.0
Cutbank	12	0.1	0	0.0
Cultural Disturbances	211	1.9	0	0.0
Mine Footprint	4313	39.4	0	0.0
Unclassified	15	0.1	0	0.0
Open Water	139	1.3	0	0.0
Unsuitable Vegetated Areas	28	0.3	0	0.0
Low Suitability (0.01-0.33)	5225	47.7	523	52.6
Medium Suitability (0.34-0.66)	909	8.3	374	37.6
High Suitability (0.67-1.00)	102	0.9	98	9.8
Total Area	10954	100.0	995	100.0

Great Gray Owl **Reclaimed Landscape - No Disturbance Buffering**

Habitat Class	Area	Percent	HU	Percent
No Habitat Total (HSI = 0.0)	1021	9.3	0	0.0
Cutbank	12	0.1	0	0.0
Cultural Disturbances	211	1.9	0	0.0
Rip-Rap	36	0.3	0	0.0
Unclassified	15	0.1	0	0.0
Open Water	747	6.8	0	0.0
Unsuitable Vegetated Areas	0	0.0	0	0.0
Low Suitability (0.01-0.33)	4585	41.9	1270	37.2
Medium Suitability (0.34-0.66)	5223	47.7	2039	59.7
High Suitability (0.67-1.00)	125	1.1	107	3.1
Total Area	10954	100.0	3416	100.0

Great Gray Owl **Reclaimed Landscape - With Disturbance Buffering**

Habitat Class	Area	Percent	HU	Percent
No Habitat Total (HSI = 0.0)	1021	9.3	0	0.0
Cutbank	12	0.1	0	0.0
Cultural Disturbances	211	1.9	0	0.0
Rip-Rap	36	0.3	0	0.0
Unclassified	15	0.1	0	0.0
Open Water	747	6.8	0	0.0
Unsuitable Vegetated Areas	0	0.0	0	0.0
Low Suitability (0.01-0.33)	5168	47.2	1076	36.0
Medium Suitability (0.34-0.66)	4650	42.4	1811	60.7
High Suitability (0.67-1.00)	116	1.1	98	3.3
Total Area	10954	100.0	2985	100.0

HSI Results by species and scenario for the Local Study Area

Moose Baseline - No Disturbance Buffering

Habitat Class	Area (ha)	Percent by Area	HU	Percent by HU
No Habitat Total (HSI = 0.0)	667	6.1	0	0.0
Cutbank	12	0.1	0	0.0
Cultural Disturbances	327	3.0	0	0.0
Unclassified	15	0.1	0	0.0
Open Water	177	1.6	0	0.0
Unsuitable Vegetated Areas	136	1.2	0	0.0
Low Suitability (0.01-0.33)	2792	25.5	715	11.8
Medium Suitability (0.34-0.66)	3191	29.1	1784	29.5
High Suitability (0.67-1.00)	4304	39.3	3548	58.7
Total Area	10954	100.0	6048	100.0

Moose Baseline - With Disturbance Buffering

Habitat Class	Area	Percent	HU	Percent
No Habitat Total (HSI = 0.0)	667	6.1	0	0.0
Cutbank	12	0.1	0	0.0
Cultural Disturbances	327	3.0	0	0.0
Unclassified	15	0.1	0	0.0
Open Water	177	1.6	0	0.0
Unsuitable Vegetated Areas	136	1.2	0	0.0
Low Suitability (0.01-0.33)	4672	42.7	955	20.4
Medium Suitability (0.34-0.66)	2881	26.3	1483	31.7
High Suitability (0.67-1.00)	2734	25.0	2240	47.9
Total Area	10954	100.0	4679	100.0

Moose Full Mine Impact - No Aquifer Drawdown or Disturbance Buffering

Habitat Class	Area	Percent	HU	Percent
No Habitat Total (HSI = 0.0)	4816	44.0	0	0.0
Cutbank	12	0.1	0	0.0
Cultural Disturbances	211	1.9	0	0.0
Mine Footprint	4313	39.4	0	0.0
Unclassified	15	0.1	0	0.0
Open Water	139	1.3	0	0.0
Unsuitable Vegetated Areas	125	1.1	0	0.0
Low Suitability (0.01-0.33)	1486	13.6	375	10.2
Medium Suitability (0.34-0.66)	1973	18.0	1086	29.6
High Suitability (0.67-1.00)	2680	24.5	2210	60.2
Total Area	10954	100.0	3671	100.0

HSI Results by species and scenario for the Local Study Area

Moose Full Mine Impact - With Aquifer Drawdown, No Disturbance Buffering

Habitat Class	Area	Percent	HU	Percent
No Habitat Total (HSI = 0.0)	4816	44.0	0	0.0
Cutbank	12	0.1	0	0.0
Cultural Disturbances	211	1.9	0	0.0
Mine Footprint	4313	39.4	0	0.0
Unclassified	15	0.1	0	0.0
Open Water	139	1.3	0	0.0
Unsuitable Vegetated Areas	125	1.1	0	0.0
Low Suitability (0.01-0.33)	1828	16.7	435	13.0
Medium Suitability (0.34-0.66)	2122	19.4	1087	32.6
High Suitability (0.67-1.00)	2188	20.0	1817	54.4
Total Area	10954	100.0	3338	100.0

Moose Full Mine Impact - With Aquifer Drawdown and Disturbance Buffering

Habitat Class	Area	Percent	HU	Percent
No Habitat Total (HSI = 0.0)	4816	44.0	0	0.0
Cutbank	12	0.1	0	0.0
Cultural Disturbances	211	1.9	0	0.0
Mine Footprint	4313	39.4	0	0.0
Unclassified	15	0.1	0	0.0
Open Water	139	1.3	0	0.0
Unsuitable Vegetated Areas	125	1.1	0	0.0
Low Suitability (0.01-0.33)	3753	34.3	625	29.3
Medium Suitability (0.34-0.66)	1338	12.2	646	30.3
High Suitability (0.67-1.00)	1048	9.6	865	40.5
Total Area	10954	100.0	2137	100.0

Moose Reclaimed Landscape - No Disturbance Buffering

Habitat Class	Area	Percent	HU	Percent
No Habitat Total (HSI = 0.0)	1146	10.5	0	0.0
Cutbank	12	0.1	0	0.0
Cultural Disturbances	211	1.9	0	0.0
Rip-Rap	36	0.3	0	0.0
Unclassified	15	0.1	0	0.0
Open Water	747	6.8	0	0.0
Unsuitable Vegetated Areas	125	1.1	0	0.0
Low Suitability (0.01-0.33)	2253	20.6	549	10.1
Medium Suitability (0.34-0.66)	3589	32.8	1841	33.8
High Suitability (0.67-1.00)	3966	36.2	3051	56.1
Total Area	10954	100.0	5441	100.0

HSI Results by species and scenario for the Local Study Area

Moose **Reclaimed Landscape - With Disturbance Buffering**

Habitat Class	Area	Percent	HU	Percent
No Habitat Total (HSI = 0.0)	1146	10.5	0	0.0
Cutbank	12	0.1	0	0.0
Cultural Disturbances	211	1.9	0	0.0
Rip-Rap	36	0.3	0	0.0
Unclassified	15	0.1	0	0.0
Open Water	747	6.8	0	0.0
Unsuitable Vegetated Areas	125	1.1	0	0.0
Low Suitability (0.01-0.33)	3030	27.7	632	12.3
Medium Suitability (0.34-0.66)	3383	30.9	1670	32.6
High Suitability (0.67-1.00)	3395	31.0	2824	55.1
Total Area	10954	100.0	5127	100.0

Pileated Woodpecker **Baseline - No Disturbance Buffering**

Habitat Class	Area (ha)	Percent by Area	HU	Percent by HU
No Habitat Total (HSI = 0.0)	2923	26.7	0	0.0
Cutbank	12	0.1	0	0.0
Cultural Disturbances	327	3.0	0	0.0
Unclassified	15	0.1	0	0.0
Open Water	177	1.6	0	0.0
Unsuitable Vegetated Areas	2391	21.8	0	0.0
Low Suitability (0.01-0.33)	4504	41.1	999	26.4
Medium Suitability (0.34-0.66)	736	6.7	317	8.4
High Suitability (0.67-1.00)	2791	25.5	2468	65.2
Total Area	10954	100.0	3784	100.0

Pileated Woodpecker **Baseline - With Disturbance Buffering**

Habitat Class	Area	Percent	HU	Percent
No Habitat Total (HSI = 0.0)	2923	26.7	0	0.0
Cutbank	12	0.1	0	0.0
Cultural Disturbances	327	3.0	0	0.0
Unclassified	15	0.1	0	0.0
Open Water	177	1.6	0	0.0
Unsuitable Vegetated Areas	2391	21.8	0	0.0
Low Suitability (0.01-0.33)	5000	45.6	1016	29.9
Medium Suitability (0.34-0.66)	656	6.0	283	8.3
High Suitability (0.67-1.00)	2374	21.7	2104	61.8
Total Area	10954	100.0	3403	100.0

HSI Results by species and scenario for the Local Study Area

Pileated Woodpecker **Full Mine Impact - No Aquifer Drawdown or Disturbance Buffering**

Habitat Class	Area	Percent	HU	Percent
No Habitat Total (HSI = 0.0)	6253	57.1	0	0.0
Cutbank	12	0.1	0	0.0
Cultural Disturbances	211	1.9	0	0.0
Mine Footprint	4313	39.4	0	0.0
Unclassified	15	0.1	0	0.0
Open Water	139	1.3	0	0.0
Unsuitable Vegetated Areas	1562	14.3	0	0.0
Low Suitability (0.01-0.33)	2186	20.0	487	19.5
Medium Suitability (0.34-0.66)	458	4.2	200	8.0
High Suitability (0.67-1.00)	2057	18.8	1816	72.5
Total Area	10954	100.0	2504	100.0

Pileated Woodpecker **Full Mine Impact - With Aquifer Drawdown, No Disturbance Buffering**

Habitat Class	Area	Percent	HU	Percent
No Habitat Total (HSI = 0.0)	6253	57.1	0	0.0
Cutbank	12	0.1	0	0.0
Cultural Disturbances	211	1.9	0	0.0
Mine Footprint	4313	39.4	0	0.0
Unclassified	15	0.1	0	0.0
Open Water	139	1.3	0	0.0
Unsuitable Vegetated Areas	1562	14.3	0	0.0
Low Suitability (0.01-0.33)	2276	20.8	464	20.3
Medium Suitability (0.34-0.66)	700	6.4	312	13.6
High Suitability (0.67-1.00)	1726	15.8	1514	66.1
Total Area	10954	100.0	2291	100.0

Pileated Woodpecker **Full Mine Impact - With Aquifer Drawdown and Disturbance Buffering**

Habitat Class	Area	Percent	HU	Percent
No Habitat Total (HSI = 0.0)	6253	57.1	0	0.0
Cutbank	12	0.1	0	0.0
Cultural Disturbances	211	1.9	0	0.0
Mine Footprint	4313	39.4	0	0.0
Unclassified	15	0.1	0	0.0
Open Water	139	1.3	0	0.0
Unsuitable Vegetated Areas	1562	14.3	0	0.0
Low Suitability (0.01-0.33)	2772	25.3	453	23.7
Medium Suitability (0.34-0.66)	534	4.9	240	12.5
High Suitability (0.67-1.00)	1396	12.7	1222	63.8
Total Area	10954	100.0	1916	100.0

HSI Results by species and scenario for the Local Study Area

Pileated Woodpecker — Reclaimed Landscape - No Disturbance Buffering

Habitat Class	Area	Percent	HU	Percent
No Habitat Total (HSI = 0.0)	2885	26.3	0	0.0
Cutbank	12	0.1	0	0.0
Cultural Disturbances	211	1.9	0	0.0
Rip-Rap	36	0.3	0	0.0
Unclassified	15	0.1	0	0.0
Open Water	747	6.8	0	0.0
Unsuitable Vegetated Areas	1864	17.0	0	0.0
Low Suitability (0.01-0.33)	1995	18.2	453	8.5
Medium Suitability (0.34-0.66)	407	3.7	183	3.4
High Suitability (0.67-1.00)	5668	51.7	4703	88.1
Total Area	10954	100.0	5339	100.0

Pileated Woodpecker — Reclaimed Landscape - With Disturbance Buffering

Habitat Class	Area	Percent	HU	Percent
No Habitat Total (HSI = 0.0)	2885	26.3	0	0.0
Cutbank	12	0.1	0	0.0
Cultural Disturbances	211	1.9	0	0.0
Rip-Rap	36	0.3	0	0.0
Unclassified	15	0.1	0	0.0
Open Water	747	6.8	0	0.0
Unsuitable Vegetated Areas	1864	17.0	0	0.0
Low Suitability (0.01-0.33)	2229	20.3	474	9.2
Medium Suitability (0.34-0.66)	370	3.4	166	3.2
High Suitability (0.67-1.00)	5471	49.9	4533	87.6
Total Area	10954	100.0	5172	100.0

Red-backed Vole — Baseline

Habitat Class	Area (ha)	Percent by Area	HU	Percent by HU
No Habitat Total (HSI = 0.0)	532	4.9	0	0.0
Cutbank	12	0.1	0	0.0
Cultural Disturbances	327	3.0	0	0.0
Unclassified	15	0.1	0	0.0
Open Water	177	1.6	0	0.0
Unsuitable Vegetated Areas	0	0.0	0	0.0
Low Suitability (0.01-0.33)	191	1.7	24	0.4
Medium Suitability (0.34-0.66)	8587	78.4	4187	76.5
High Suitability (0.67-1.00)	1644	15.0	1258	23.0
Total Area	10954	100.0	5469	100.0

HSI Results by species and scenario for the Local Study Area

Red-backed Vole **Full Mine Impact - No Aquifer Drawdown**

Habitat Class	Area	Percent	HU	Percent
No Habitat Total (HSI = 0.0)	4690	42.8	0	0.0
Cutbank	12	0.1	0	0.0
Cultural Disturbances	211	1.9	0	0.0
Mine Footprint	4313	39.4	0	0.0
Unclassified	15	0.1	0	0.0
Open Water	139	1.3	0	0.0
Unsuitable Vegetated Areas	0	0.0	0	0.0
Low Suitability (0.01-0.33)	162	1.5	18	0.5
Medium Suitability (0.34-0.66)	4829	44.1	2356	70.4
High Suitability (0.67-1.00)	1273	11.6	974	29.1
Total Area	10954	100.0	3347	100.0

Red-backed Vole **Full Mine Impact - With Aquifer Drawdown**

Habitat Class	Area	Percent	HU	Percent
No Habitat Total (HSI = 0.0)	4690	42.8	0	0.0
Cutbank	12	0.1	0	0.0
Cultural Disturbances	211	1.9	0	0.0
Mine Footprint	4313	39.4	0	0.0
Unclassified	15	0.1	0	0.0
Open Water	139	1.3	0	0.0
Unsuitable Vegetated Areas	0	0.0	0	0.0
Low Suitability (0.01-0.33)	1032	9.4	230	7.6
Medium Suitability (0.34-0.66)	4206	38.4	2030	66.7
High Suitability (0.67-1.00)	1025	9.4	784	25.8
Total Area	10954	100.0	3045	100.0

Red-backed Vole **Reclaimed Landscape**

Habitat Class	Area	Percent	HU	Percent
No Habitat Total (HSI = 0.0)	1021	9.3	0	0.0
Cutbank	12	0.1	0	0.0
Cultural Disturbances	211	1.9	0	0.0
Rip-Rap	36	0.3	0	0.0
Unclassified	15	0.1	0	0.0
Open Water	747	6.8	0	0.0
Unsuitable Vegetated Areas	0	0.0	0	0.0
Low Suitability (0.01-0.33)	127	1.2	7	0.1
Medium Suitability (0.34-0.66)	6780	61.9	3430	60.3
High Suitability (0.67-1.00)	3026	27.6	2256	39.6
Total Area	10954	100.0	5693	100.0

HSI Results by species and scenario for the Local Study Area

Ruffed Grouse Baseline - No Disturbance Buffering

Habitat Class	Area (ha)	Percent by Area	HU	Percent by HU
No Habitat Total (HSI = 0.0)	532	4.9	0	0.0
Cutbank	12	0.1	0	0.0
Cultural Disturbances	327	3.0	0	0.0
Unclassified	15	0.1	0	0.0
Open Water	177	1.6	0	0.0
Unsuitable Vegetated Areas	0	0.0	0	0.0
Low Suitability (0.01-0.33)	7834	71.5	1799	49.6
Medium Suitability (0.34-0.66)	1050	9.6	570	15.7
High Suitability (0.67-1.00)	1538	14.0	1260	34.7
Total Area	10954	100.0	3629	100.0

Ruffed Grouse Baseline - With Disturbance Buffering

Habitat Class	Area	Percent	HU	Percent
No Habitat Total (HSI = 0.0)	533	4.9	0	0.0
Cutbank	12	0.1	0	0.0
Cultural Disturbances	327	3.0	0	0.0
Unclassified	15	0.1	0	0.0
Open Water	177	1.6	0	0.0
Unsuitable Vegetated Areas	1	0.0	0	0.0
Low Suitability (0.01-0.33)	8217	75.0	1745	52.8
Medium Suitability (0.34-0.66)	899	8.2	490	14.8
High Suitability (0.67-1.00)	1305	11.9	1070	32.4
Total Area	10954	100.0	3304	100.0

Ruffed Grouse Full Mine Impact - No Aquifer Drawdown or Disturbance Buffering

Habitat Class	Area	Percent	HU	Percent
No Habitat Total (HSI = 0.0)	4690	42.8	0	0.0
Cutbank	12	0.1	0	0.0
Cultural Disturbances	211	1.9	0	0.0
Mine Footprint	4313	39.4	0	0.0
Unclassified	15	0.1	0	0.0
Open Water	139	1.3	0	0.0
Unsuitable Vegetated Areas	0	0.0	0	0.0
Low Suitability (0.01-0.33)	4319	39.4	998	42.2
Medium Suitability (0.34-0.66)	785	7.2	419	17.7
High Suitability (0.67-1.00)	1160	10.6	947	40.0
Total Area	10954	100.0	2364	100.0

HSI Results by species and scenario for the Local Study Area

Ruffed Grouse — Full Mine Impact - With Aquifer Drawdown, No Disturbance Buffering

Habitat Class	Area	Percent	HU	Percent
No Habitat Total (HSI = 0.0)	4690	42.8	0	0.0
Cutbank	12	0.1	0	0.0
Cultural Disturbances	211	1.9	0	0.0
Mine Footprint	4313	39.4	0	0.0
Unclassified	15	0.1	0	0.0
Open Water	139	1.3	0	0.0
Unsuitable Vegetated Areas	0	0.0	0	0.0
Low Suitability (0.01-0.33)	4412	40.3	934	43.5
Medium Suitability (0.34-0.66)	933	8.5	464	21.6
High Suitability (0.67-1.00)	918	8.4	750	34.9
Total Area	10954	100.0	2148	100.0

Ruffed Grouse — Full Mine Impact - With Aquifer Drawdown and Disturbance Buffering

Habitat Class	Area	Percent	HU	Percent
No Habitat Total (HSI = 0.0)	4692	42.8	0	0.0
Cutbank	12	0.1	0	0.0
Cultural Disturbances	211	1.9	0	0.0
Mine Footprint	4313	39.4	0	0.0
Unclassified	15	0.1	0	0.0
Open Water	139	1.3	0	0.0
Unsuitable Vegetated Areas	1	0.0	0	0.0
Low Suitability (0.01-0.33)	4786	43.7	845	46.3
Medium Suitability (0.34-0.66)	720	6.6	359	19.7
High Suitability (0.67-1.00)	756	6.9	621	34.0
Total Area	10954	100.0	1825	100.0

Ruffed Grouse — Reclaimed Landscape - No Disturbance Buffering

Habitat Class	Area	Percent	HU	Percent
No Habitat Total (HSI = 0.0)	1021	9.3	0	0.0
Cutbank	12	0.1	0	0.0
Cultural Disturbances	211	1.9	0	0.0
Rip-Rap	36	0.3	0	0.0
Unclassified	15	0.1	0	0.0
Open Water	747	6.8	0	0.0
Unsuitable Vegetated Areas	0	0.0	0	0.0
Low Suitability (0.01-0.33)	6689	61.1	1723	43.4
Medium Suitability (0.34-0.66)	1924	17.6	1217	30.6
High Suitability (0.67-1.00)	1320	12.1	1031	26.0
Total Area	10954	100.0	3970	100.0

HSI Results by species and scenario for the Local Study Area

Ruffed Grouse **Reclaimed Landscape - With Disturbance Buffering**

Habitat Class	Area	Percent	HU	Percent
No Habitat Total (HSI = 0.0)	1021	9.3	0	0.0
Cutbank	12	0.1	0	0.0
Cultural Disturbances	211	1.9	0	0.0
Rip-Rap	36	0.3	0	0.0
Unclassified	15	0.1	0	0.0
Open Water	747	6.8	0	0.0
Unsuitable Vegetated Areas	0	0.0	0	0.0
Low Suitability (0.01-0.33)	6864	62.7	1715	44.7
Medium Suitability (0.34-0.66)	1827	16.7	1155	30.1
High Suitability (0.67-1.00)	1243	11.3	971	25.3
Total Area	10954	100.0	3840	100.0

Snowshoe Hare **Baseline - No Disturbance Buffering**

Habitat Class	Area (ha)	Percent by Area	HU	Percent by HU
No Habitat Total (HSI = 0.0)	532	4.9	0	0.0
Cutbank	12	0.1	0	0.0
Cultural Disturbances	327	3.0	0	0.0
Unclassified	15	0.1	0	0.0
Open Water	177	1.6	0	0.0
Unsuitable Vegetated Areas	0	0.0	0	0.0
Low Suitability (0.01-0.33)	241	2.2	34	0.4
Medium Suitability (0.34-0.66)	1602	14.6	856	10.1
High Suitability (0.67-1.00)	8580	78.3	7598	89.5
Total Area	10954	100.0	8488	100.0

Snowshoe Hare **Baseline - With Disturbance Buffering**

Habitat Class	Area	Percent	HU	Percent
No Habitat Total (HSI = 0.0)	534	4.9	0	0.0
Cutbank	12	0.1	0	0.0
Cultural Disturbances	327	3.0	0	0.0
Unclassified	15	0.1	0	0.0
Open Water	177	1.6	0	0.0
Unsuitable Vegetated Areas	2	0.0	0	0.0
Low Suitability (0.01-0.33)	2054	18.8	323	4.4
Medium Suitability (0.34-0.66)	1186	10.8	628	8.6
High Suitability (0.67-1.00)	7180	65.5	6368	87.0
Total Area	10954	100.0	7319	100.0

HSI Results by species and scenario for the Local Study Area

Snowshoe Hare **Full Mine Impact - No Aquifer Drawdown or Disturbance Buffering**

Habitat Class	Area	Percent	HU	Percent
No Habitat Total (HSI = 0.0)	4690	42.8	0	0.0
Cutbank	12	0.1	0	0.0
Cultural Disturbances	211	1.9	0	0.0
Mine Footprint	4313	39.4	0	0.0
Unclassified	15	0.1	0	0.0
Open Water	139	1.3	0	0.0
Unsuitable Vegetated Areas	0	0.0	0	0.0
Low Suitability (0.01-0.33)	182	1.7	21	0.4
Medium Suitability (0.34-0.66)	1018	9.3	545	10.8
High Suitability (0.67-1.00)	5064	46.2	4486	88.8
Total Area	10954	100.0	5052	100.0

Snowshoe Hare **Full Mine Impact - With Aquifer Drawdown, No Disturbance Buffering**

Habitat Class	Area	Percent	HU	Percent
No Habitat Total (HSI = 0.0)	4690	42.8	0	0.0
Cutbank	12	0.1	0	0.0
Cultural Disturbances	211	1.9	0	0.0
Mine Footprint	4313	39.4	0	0.0
Unclassified	15	0.1	0	0.0
Open Water	139	1.3	0	0.0
Unsuitable Vegetated Areas	0	0.0	0	0.0
Low Suitability (0.01-0.33)	280	2.6	45	1.0
Medium Suitability (0.34-0.66)	1931	17.6	946	20.7
High Suitability (0.67-1.00)	4054	37.0	3587	78.4
Total Area	10954	100.0	4577	100.0

Snowshoe Hare **Full Mine Impact - With Aquifer Drawdown and Disturbance Buffering**

Habitat Class	Area	Percent	HU	Percent
No Habitat Total (HSI = 0.0)	4694	42.8	0	0.0
Cutbank	12	0.1	0	0.0
Cultural Disturbances	211	1.9	0	0.0
Mine Footprint	4313	39.4	0	0.0
Unclassified	15	0.1	0	0.0
Open Water	139	1.3	0	0.0
Unsuitable Vegetated Areas	3	0.0	0	0.0
Low Suitability (0.01-0.33)	2204	20.1	244	7.2
Medium Suitability (0.34-0.66)	1086	9.9	532	15.6
High Suitability (0.67-1.00)	2971	27.1	2628	77.2
Total Area	10954	100.0	3405	100.0

HSI Results by species and scenario for the Local Study Area

Snowshoe Hare **Reclaimed Landscape - No Disturbance Buffering**

Habitat Class	Area	Percent	HU	Percent
No Habitat Total (HSI = 0.0)	1021	9.3	0	0.0
Cutbank	12	0.1	0	0.0
Cultural Disturbances	211	1.9	0	0.0
Rip-Rap	36	0.3	0	0.0
Unclassified	15	0.1	0	0.0
Open Water	747	6.8	0	0.0
Unsuitable Vegetated Areas	0	0.0	0	0.0
Low Suitability (0.01-0.33)	182	1.7	21	0.3
Medium Suitability (0.34-0.66)	1993	18.2	1050	13.6
High Suitability (0.67-1.00)	7759	70.8	6658	86.1
Total Area	10954	100.0	7729	100.0

Snowshoe Hare **Reclaimed Landscape - With Disturbance Buffering**

Habitat Class	Area	Percent	HU	Percent
No Habitat Total (HSI = 0.0)	1021	9.3	0	0.0
Cutbank	12	0.1	0	0.0
Cultural Disturbances	211	1.9	0	0.0
Rip-Rap	36	0.3	0	0.0
Unclassified	15	0.1	0	0.0
Open Water	747	6.8	0	0.0
Unsuitable Vegetated Areas	0	0.0	0	0.0
Low Suitability (0.01-0.33)	985	9.0	177	2.4
Medium Suitability (0.34-0.66)	1774	16.2	928	12.8
High Suitability (0.67-1.00)	7175	65.5	6155	84.8
Total Area	10954	100.0	7260	100.0

Western Tanager **Baseline**

Habitat Class	Area (ha)	Percent by Area	HU	Percent by HU
No Habitat Total (HSI = 0.0)	3987	36.4	0	0.0
Cutbank	12	0.1	0	0.0
Cultural Disturbances	327	3.0	0	0.0
Unclassified	15	0.1	0	0.0
Open Water	177	1.6	0	0.0
Unsuitable Vegetated Areas	3456	31.5	0	0.0
Low Suitability (0.01-0.33)	5749	52.5	357	32.4
Medium Suitability (0.34-0.66)	853	7.8	417	37.7
High Suitability (0.67-1.00)	365	3.3	330	29.9
Total Area	10954	100.0	1105	100.0

HSI Results by species and scenario for the Local Study Area

Western Tanager **Full Mine Impact - No Aquifer Drawdown**

Habitat Class	Area	Percent	HU	Percent
No Habitat Total (HSI = 0.0)	6706	61.2	0	0.0
Cutbank	12	0.1	0	0.0
Cultural Disturbances	211	1.9	0	0.0
Mine Footprint	4313	39.4	0	0.0
Unclassified	15	0.1	0	0.0
Open Water	139	1.3	0	0.0
Unsuitable Vegetated Areas	2016	18.4	0	0.0
Low Suitability (0.01-0.33)	3389	30.9	235	30.6
Medium Suitability (0.34-0.66)	590	5.4	290	37.7
High Suitability (0.67-1.00)	269	2.5	243	31.6
Total Area	10954	100.0	769	100.0

Western Tanager **Full Mine Impact - With Aquifer Drawdown**

Habitat Class	Area	Percent	HU	Percent
No Habitat Total (HSI = 0.0)	6836	62.4	0	0.0
Cutbank	12	0.1	0	0.0
Cultural Disturbances	211	1.9	0	0.0
Mine Footprint	4313	39.4	0	0.0
Unclassified	15	0.1	0	0.0
Open Water	139	1.3	0	0.0
Unsuitable Vegetated Areas	2145	19.6	0	0.0
Low Suitability (0.01-0.33)	3320	30.3	230	31.7
Medium Suitability (0.34-0.66)	547	5.0	267	36.8
High Suitability (0.67-1.00)	252	2.3	228	31.5
Total Area	10954	100.0	726	100.0

Western Tanager **Reclaimed Landscape**

Habitat Class	Area	Percent	HU	Percent
No Habitat Total (HSI = 0.0)	3342	30.5	0	0.0
Cutbank	12	0.1	0	0.0
Cultural Disturbances	211	1.9	0	0.0
Rip-Rap	36	0.3	0	0.0
Unclassified	15	0.1	0	0.0
Open Water	747	6.8	0	0.0
Unsuitable Vegetated Areas	2321	21.2	0	0.0
Low Suitability (0.01-0.33)	3597	32.8	254	8.0
Medium Suitability (0.34-0.66)	1535	14.0	724	22.6
High Suitability (0.67-1.00)	2482	22.7	2217	69.4
Total Area	10954	100.0	3196	100.0

HSI Results by species and scenario for the Local Study Area

Baseline Habitat Units for KIRs Within the Local Study Area

Species	Scenario	HU	Percent of HU by Suitability Class			Percent of Area by Suitability Class			
			Low	Medium	High	Un-suitable	Low	Medium	High
Beaver	Baseline	1424	0.6	8.5	90.9	84.1	0.3	2.2	13.4
	Impact	989	0.9	15.0	84.1	88.1	0.3	2.9	8.7
	Reclaimed	1338	0.4	7.2	92.4	85.1	0.2	1.8	12.9
Black Bear	Baseline	3809	28.3	20.8	50.9	7.2	52.0	18.4	22.3
	Impact	2092	25.2	24.3	50.5	48.9	27.4	11.5	12.2
	Reclaimed	4881	13.5	37.9	48.6	10.5	29.4	33.5	26.6
Cape May Warbler	Baseline	1583	44.9	33.7	21.4	41.9	45.6	8.9	3.5
	Impact	814	41.9	39.3	18.8	69.3	23.7	5.4	1.6
	Reclaimed	2386	16.3	24.7	58.9	39.9	34.3	10.7	15.1
Dabbling Ducks	Baseline	1446	49.9	19.2	30.9	70.9	21.1	3.8	4.1
	Impact	940	44.0	21.7	34.2	79.5	14.6	2.9	2.9
	Reclaimed	2070	33.9	30.8	35.3	64.5	20.0	8.8	6.7
Fisher	Baseline	4798	4.9	49.2	45.9	4.9	18.8	48.5	27.8
	Impact	2172	12.3	44.0	43.7	42.8	25.6	19.5	12.1
	Reclaimed	5135	2.9	62.3	34.8	9.3	9.6	57.4	23.7
Great Gray Owl	Baseline	2558	42.5	53.2	4.3	4.9	65.0	29.1	1.1
	Impact	995	52.6	37.6	9.8	43.1	47.7	8.3	0.9
	Reclaimed	2985	36.0	60.7	3.3	9.3	47.2	42.4	1.1
Moose	Baseline	4679	20.4	31.7	47.9	6.1	42.7	26.3	25.0
	Impact	2137	29.3	30.3	40.5	44.0	34.3	12.2	9.6
	Reclaimed	5127	12.3	32.6	55.1	10.5	27.7	30.9	31.0
Pileated Woodpecker	Baseline	3403	29.9	8.3	61.8	26.7	45.6	6.0	21.7
	Impact	1916	23.7	12.5	63.8	57.1	25.3	4.9	12.7
	Reclaimed	5172	9.2	3.2	87.6	26.3	20.3	3.4	49.9
Red-backed Vole	Baseline	5469	0.4	76.5	23.0	4.9	1.7	78.4	15.0
	Impact	3045	7.6	66.7	25.8	42.8	9.4	38.4	9.4
	Reclaimed	5693	0.1	60.3	39.6	9.3	1.2	61.9	27.6
Ruffed Grouse	Baseline	3304	52.8	14.8	32.4	4.9	75.0	8.2	11.9
	Impact	1825	46.3	19.7	34.0	42.8	43.7	6.6	6.9
	Reclaimed	3840	44.7	30.1	25.3	9.3	62.7	16.7	11.3
Snowshoe Hare	Baseline	7319	4.4	8.6	87.0	4.9	18.8	10.8	65.5
	Impact	3405	7.2	15.6	77.2	42.8	20.1	9.9	27.1
	Reclaimed	7260	2.4	12.8	84.8	9.3	9.0	16.2	65.5
Western Tanager	Baseline	1105	32.4	37.7	29.9	36.4	52.5	7.8	3.3
	Impact	726	31.7	36.8	31.5	62.4	30.3	5.0	2.3
	Reclaimed	3196	8.0	22.6	69.4	30.5	32.8	14.0	22.7

APPENDIX IV
HSI VALUES FOR VEGETATION TYPES

Table 1 Habitat Suitability Index Values for Beavers in the Local Study Area

Habitat Suitability Class	Code	Vegetation Type	HSI[1]
High Suitability	k1(FOPN)	Patterned Open Rich Fen	1.00
(0.67 - 1.00)	k1(FTNN)	Treed Rich Fen	1.00
	k2(FONS)	Shrubby Rich Fen	1.00
	b2	Blueberry Aw(Bw)	1.00
	j1/g1 (FTNN)	Treed Poor Fen Lt-Sb-Pj	0.98
	j1/g1(FTNN)	Treed Poor Fen Lt-Sb-Pj	0.98
	b3	Blueberry Aw-Sw	0.96
	e2/f2	Pb-Sw	0.94
	shrub	Upland Shrubland	0.91
	shrub(SONS)	Shrubby Swamp	0.90
	e3	Dogwood Sw	0.87
	a1/g1 complex	Pj-Lt	0.85
	r	Reclaimed Riparian Shrub	0.85
	e1/f1	Pb-Aw	0.83
	k2(FTNN)	Shrubby Treed Rich Fen	0.81
	b4	Blueberry Sw-Pj	0.81
	c1(STNN)	Coniferous Swamp Pj-Sb	0.80
	b1	Blueberry Pj-Aw	0.75
	g1	Labrador Tea-subhygric Sb-Pj	0.73
	d2	Low Bush Cranberry Aw-Sw	0.72
	d1	Low Bush Cranberry Aw	0.70
	e1	Dogwood Pb-Aw	0.70
	e2	Dogwood Pb-Sw	0.70
Moderate Suitability	Lt-Sb	Upland Lt-Sb	0.65
(0.34 - 0.66)	Sb-Lt	Upland Sb-Lt	0.65
	c1	Labrador Tea-mesic Pj-Sb	0.62
	j1(FTNN)	Treed Poor Fen Sb-Lt	0.57
	d3	Low Bush Cranberry Sw	0.57
	h1	Labrador Tea/Horsetail Sw-Sb	0.50
	Lt-Aw(STNN)	Coniferous Swamp Lt-Aw	0.49
	Lt-Pb(STNN)	Coniferous Swamp Lt-Pb	0.49
	d3(STNN)	Coniferous Swamp Sw	0.47
	j2(FTNN)	Treed Poor Fen Sb-Lt	0.46
	j2/h1(FTNN)	Treed Poor Fen Sb/Sw-Lt	0.46
	Lt-Sb(STNN)	Coniferous Swamp Lt-Sb	0.45
	b4(STNN)	Coniferous Swamp Sw-Pj	0.45
	i2(BTNN)	Shrubby Bog	0.44
	j1/h1(FTNN)	Treed Poor Fen Sb-Sw-Lt	0.40
	j2(FFNN)	Treed Poor Fen Sb-Lt	0.39
	d2(STNN)	Coniferous Swamp Aw-Sw	0.37

[1] HSI Values for beaver apply to habitat areas within 30 m of open water.

Habitat Suitability Class	Code	Vegetation Type	HSI[1]
Low Suitability	j1/g1(FFNN)	Treed Poor Fen Sb-Pj	0.31
(0.01 - 0.33)	h1(STNN)	Coniferous Swamp Sw-Sb	0.29
	a1	Lichen Pj	0.27
	g1(STNN)	Coniferous Swamp Pj-Sb	0.26
	Lt(STNN)	Coniferous Swamp Lt	0.26
	Sb-Lt(STNN)	Coniferous Swamp Sb-Lt	0.20
	Sb(STNN)	Coniferous Swamp Sb	0.16
	Sb-Lt(SFNN)	Coniferous Swamp Sb-Lt	0.16
	(Sb-Lt)SFNN	Coniferous Swamp(Sb-Lt)	0.15
Unsuitable Habitat	AIG	Gravel Pits	0.00
(0.00)	AIH	Roads and Rights-of-way	0.00
	AIM	Surface Mines	0.00
	k3(FONG)	Graminoid Rich Fen	0.00
	l1(MONG)	Marsh	0.00
	NMC	Cutbanks	0.00
	NWF(WONN)	Shallow Open Water	0.00
	NWL	Lakes and Ponds	0.00
	NWR	Rivers	0.00
	UN	Unclassified	0.00
	o	Reclaimed Open Water	0.00
	w	Reclaimed Wetland	0.00
	rr	Rip-rap	0.00

Table 2 Habitat Suitability Index Values for Beavers in the Regional Study Area

Habitat Suitability Class	Code	Vegetation Type	HSI
High Suitability	11	Wooded Peatland	1.00
(0.67 - 1.00)	12	Paper Birch Forest	1.00
	13/14	Burned Fen	1.00
	15	Cutblocks	1.00
	7	Wet Shrublands	0.96
	10	Unclassified	0.88
	3	Mixedwood Forest	0.73
	5	Aspen (Poplar) Forest	0.70
Moderate Suitability	2	Jack Pine Forest	0.59
(0.34 - 0.66)	4	Spruce Forest	0.34
Unsuitable Habitat	1	Open Water	0.00
(0.00)	6	Graminoid Fen	0.00
	8	Marsh	0.00
	9	Disturbances	0.00

Table 3 Habitat Suitability Index Values for Black Bears in the Local Study Area

Habitat Suitability Class	Code	Vegetation Type	HSI
High Suitability	b3	Blueberry Aw-Sw	0.89
(0.67 - 1.00)	b4	Blueberry Sw-Pj	0.87
	b1	Blueberry Pj-Aw	0.85
	a1	Lichen Pj	0.77
	d1	Low Bush Cranberry Aw	0.75
	b2	Blueberry Aw(Bw)	0.69
Moderate Suitability	d2	Low Bush Cranberry Aw-Sw	0.63
(0.34 - 0.66)	e1	Dogwood Pb-Aw	0.56
	a1/g1	Pj-Lt	0.54
	e3	Dogwood Sw	0.53
	e2	Dogwood Pb-Sw	0.52
	shrub	Upland Shrubland	0.52
	c1	Labrador Tea-mesic Pj-Sb	0.51
	e2/f2	Pb-Sw	0.46
	e1/f1	Pb-Aw	0.45
	c1(STNN)	Coniferous Swamp Pj-Sb	0.45
	d3	Low Bush Cranberry Sw	0.41
	j2/h1(FTNN)	Treed Poor Fen Sb/Sw-Lt	0.41
	Lt-Sb	Upland Lt-Sb	0.40
	g1	Labrador Tea-subhygric Sb-Pj	0.38
	Sb-Lt	Upland Sb-Lt	0.37
	i2(BTNN)	Shrubby Bog	0.37
	g1(STNN)	Coniferous Swamp Pj-Sb	0.34
	Sb-Lt(STNN)	Coniferous Swamp Sb-Lt	0.34
	j2(FTNN)	Treed Poor Fen Sb-Lt	0.34
	Lt(STNN)	Coniferous Swamp Lt	0.34
	j1/g1(FFNN)	Treed Poor Fen Sb-Pj	0.34
Low Suitability	h1(STNN)	Coniferous Swamp Sw-Sb	0.33
(0.01 - 0.33)	d2(STNN)	Coniferous Swamp Aw-Sw	0.33
	j2(FFNN)	Treed Poor Fen Sb-Lt	0.33
	j1(FTNN)	Treed Poor Fen Sb-Lt	0.33
	j1/g1(FTNN)	Treed Poor Fen Lt-Sb-Pj	0.32
	j1/g1 (FTNN)	Treed Poor Fen Lt-Sb-Pj	0.32
	shrub(SONS)	Shrubby Swamp	0.31
	Sb(STNN)	Coniferous Swamp Sb	0.31
	(Sb-Lt)SFNN	Coniferous Swamp(Sb-Lt)	0.30
	h1	Labrador Tea/Horsetail Sw-Sb	0.30
	r	Reclaimed Riparian Shrub	0.30
	Sb-Lt(SFNN)	Coniferous Swamp Sb-Lt	0.30
	b4(STNN)	Coniferous Swamp Sw-Pj	0.29

Habitat Suitability Class	Code	Vegetation Type	HSI
Low Suitability	d3(STNN)	Coniferous Swamp Sw	0.29
Continued	Lt-Pb(STNN)	Coniferous Swamp Lt-Pb	0.29
	Lt-Sb(STNN)	Coniferous Swamp Lt-Sb	0.29
	j1/h1(FTNN)	Treed Poor Fen Sb-Sw-Lt	0.28
	Lt-Aw(STNN)	Coniferous Swamp Lt-Aw	0.28
	k1(FTNN)	Treed Rich Fen	0.17
	k2(FTNN)	Shrubby Treed Rich Fen	0.17
	k1(FOPN)	Patterned Open Rich Fen	0.17
	k2(FONS)	Shrubby Rich Fen	0.13
Unsuitable Habitat	AIG	Gravel Pits	0.00
(0.00)	AIH	Roads and Rights-of-way	0.00
	AIM	Surface Mines	0.00
	k3(FONG)	Graminoid Rich Fen	0.00
	l1(MONG)	Marsh	0.00
	NMC	Cutbanks	0.00
	NWF(WONN)	Shallow Open Water	0.00
	NWL	Lakes and Ponds	0.00
	NWR	Rivers	0.00
	UN	Unclassified	0.00
	o	Reclaimed Open Water	0.00
	w	Reclaimed Wetland	0.00
	rr	Rip-rap	0.00

Table 4 Habitat Suitability Index Values for Black Bears in the Regional Study Area

Habitat Suitability Class	Code	Vegetation Type	HSI
High Suitability	3	Mixedwood Forest	0.82
(0.67 - 1.00)	2	Jack Pine Forest	0.74
	5	Aspen (Poplar) Forest	0.73
	15	Cutblocks	0.72
	12	Paper Birch Forest	0.69
Moderate Suitability	4	Spruce Forest	0.54
(0.34 - 0.66)	10	Unclassified	0.44
	7	Wet Shrublands	0.36
Low Suitability	11	Wooded Peatland	0.22
(0.01 - 0.33)	13/14	Burned Fen	0.13
Unsuitable Habitat	1	Open Water	0.00
(0.00)	6	Graminoid Fen	0.00
	8	Marsh	0.00
	9	Disturbances	0.00

Table 5 Habitat Suitability Index Values for Cape May Warblers in the Local Study Area

Habitat Suitability Class	Code	Vegetation Type	HSI
High Suitability	d3(STNN)	Coniferous Swamp Sw	0.96
(0.67 - 1.00)	d3	Low Bush Cranberry Sw	0.85
	e3	Dogwood Sw	0.85
	b4(STNN)	Coniferous Swamp Sw-Pj	0.67
Moderate Suitability	a1/g1 complex	Pj-Lt	0.66
(0.34 - 0.66)	c1(STNN)	Coniferous Swamp Pj-Sb	0.65
	h1	Labrador Tea/Horsetail Sw-Sb	0.60
	e2	Dogwood Pb-Sw	0.59
	j2/h1(FTNN)	Treed Poor Fen Sb/Sw-Lt	0.55
	c1	Labrador Tea-mesic Pj-Sb	0.52
	b4	Blueberry Sw-Pj	0.51
	h1(STNN)	Coniferous Swamp Sw-Sb	0.47
	d2(STNN)	Coniferous Swamp Aw-Sw	0.47
	Sb-Lt	Upland Sb-Lt	0.46
	j1(FTNN)	Treed Poor Fen Sb-Lt	0.44
	g1	Labrador Tea-subhygric Sb-Pj	0.40
Low Suitability	a1	Lichen Pj	0.31
(0.01 - 0.33)	Sb-Lt(STNN)	Coniferous Swamp Sb-Lt	0.25
	j1/h1(FTNN)	Treed Poor Fen Sb-Sw-Lt	0.22
	(Sb-Lt)SFNN	Coniferous Swamp(Sb-Lt)	0.22
	j1/g1(FFNN)	Treed Poor Fen Sb-Pj	0.22
	Sb(STNN)	Coniferous Swamp Sb	0.22
	Lt-Sb	Upland Lt-Sb	0.22
	Sb-Lt(SFNN)	Coniferous Swamp Sb-Lt	0.20
	g1(STNN)	Coniferous Swamp Pj-Sb	0.20
	j1/g1(FTNN)	Treed Poor Fen Lt-Sb-Pj	0.19
	j2(FTNN)	Treed Poor Fen Sb-Lt	0.19
	Lt-Sb(STNN)	Coniferous Swamp Lt-Sb	0.18
	i2(BTNN)	Shrubby Bog	0.18
	j1/g1 (FTNN)	Treed Poor Fen Lt-Sb-Pj	0.18
	j2(FFNN)	Treed Poor Fen Sb-Lt	0.18
	Lt-Pb(STNN)	Coniferous Swamp Lt-Pb	0.16
	Lt(STNN)	Coniferous Swamp Lt	0.13
	k1(FTNN)	Treed Rich Fen	0.12
	Lt-Aw(STNN)	Coniferous Swamp Lt-Aw	0.10
	b1	Blueberry Pj-Aw	0.08
	k2(FTNN)	Shrubby Treed Rich Fen	0.06
	k1(FOPN)	Patterned Open Rich Fen	0.06
	b3	Blueberry Aw-Sw	0.05
	e2/f2	Pb-Sw	0.03

Habitat Suitability Class	Code	Vegetation Type	HSI
	d2	Low Bush Cranberry Aw-Sw	0.03
Unsuitable Habitat	e1/f1	Pb-Aw	0.00
(0.00)	e1	Dogwood Pb-Aw	0.00
	d1	Low Bush Cranberry Aw	0.00
	AIG	Gravel Pits	0.00
	AIH	Roads and Rights-of-way	0.00
	AIM	Surface Mines	0.00
	k2(FONS)	Shrubby Rich Fen	0.00
	k3(FONG)	Graminoid Rich Fen	0.00
	l1(MONG)	Marsh	0.00
	NMC	Cutbanks	0.00
	NWF(WONN)	Shallow Open Water	0.00
	NWL	Lakes and Ponds	0.00
	NWR	Rivers	0.00
	shrub	Upland Shrubland	0.00
	shrub(SONS)	Shrubby Swamp	0.00
	UN	Unclassified	0.00
	b2	Blueberry Aw(Bw)	0.00
	r	Reclaimed Riparian Shrub	0.00
	o	Reclaimed Open Water	0.00
	w	Reclaimed Wetland	0.00
	rr	Rip-rap	0.00

Table 6 Habitat Suitability Index Values for Cape May Warblers in the Regional Study Area

Habitat Suitability Class	Code	Vegetation Type	HSI
Moderate Suitability	4	Spruce Forest	0.63
(0.34 - 0.66)	2	Jack Pine Forest	0.51
Low Suitability	11	Wooded Peatland	0.16
(0.01 - 0.33)	3	Mixedwood Forest	0.06
	10	Unclassified	0.06
	13/14	Burned Fen	0.02
Unsuitable Habitat	5	Aspen (Poplar) Forest	0.00
(0.00)	1	Open Water	0.00
	6	Graminoid Fen	0.00
	7	Wet Shrublands	0.00
	8	Marsh	0.00
	9	Disturbances	0.00
	12	Paper Birch Forest	0.00
	15	Cutblocks	0.00

Table 7 Habitat Suitability Index Values for Dabbling Ducks in the Local Study Area

Habitat Suitability Class	Code	Vegetation Type	HSI
High Suitability	I1(MONG)	Marsh	1.00
(0.67 - 1.00)	NWF(WONN)	Shallow Open Water	1.00
	w	Reclaimed Wetland	1.00
	N/A	All habitat 0 - 50 m from Ponds/Marshes	1.00
Moderate Suitability	NWL	Lakes and Ponds	0.66
(0.34 - 0.66)	NWR	Rivers	0.66
	o	Reclaimed Open Water	0.66
	N/A	All Habitat 50 - 100 m from Ponds/Marshes	0.66
	N/A	All Habitat 0 - 50 m from Creeks/Rivers	0.66
Low Suitability	(Sb-Lt)SFNN	Coniferous Swamp(Sb-Lt)	0.33
(0.01 - 0.33)	b4(STNN)	Coniferous Swamp Sw-Pj	0.33
	c1(STNN)	Coniferous Swamp Pj-Sb	0.33
	d2(STNN)	Coniferous Swamp Aw-Sw	0.33
	d3(STNN)	Coniferous Swamp Sw	0.33
	g1(STNN)	Coniferous Swamp Pj-Sb	0.33
	h1(STNN)	Coniferous Swamp Sw-Sb	0.33
	k1(FOPN)	Patterned Open Rich Fen	0.33
	k3(FONG)	Graminoid Rich Fen	0.33
	Lt(STNN)	Coniferous Swamp Lt	0.33
	Lt-Aw(STNN)	Coniferous Swamp Lt-Aw	0.33
	Lt-Pb(STNN)	Coniferous Swamp Lt-Pb	0.33
	Lt-Sb(STNN)	Coniferous Swamp Lt-Sb	0.33
	Sb(STNN)	Coniferous Swamp Sb	0.33
	Sb-Lt(SFNN)	Coniferous Swamp Sb-Lt	0.33
	Sb-Lt(STNN)	Coniferous Swamp Sb-Lt	0.33
	shrub(SONS)	Shrubby Swamp	0.33
	r	Reclaimed Riparian Shrub	0.33
	N/A	All Habitat 100 - 250 m from Ponds/Marshes	0.33
	N/A	All Habitat 50 - 100 m from Creeks/Rivers	0.33
Unsuitable Habitat	a1	Lichen Pj	0.00
(0.00)	a1/g1 complex	Pj-Lt	0.00
	AIG	Gravel Pits	0.00
	AIH	Roads and Rights-of-way	0.00
	AIM	Surface Mines	0.00
	b1	Blueberry Pj-Aw	0.00
	b3	Blueberry Aw-Sw	0.00

Habitat Suitability Class	Code	Vegetation Type	HSI
Unsuitable Habitat	b4	Blueberry Sw-Pj	0.00
Continued	c1	Labrador Tea-mesic Pj-Sb	0.00
	d1	Low Bush Cranberry Aw	0.00
	d2	Low Bush Cranberry Aw-Sw	0.00
	d3	Low Bush Cranberry Sw	0.00
	e1	Dogwood Pb-Aw	0.00
	e1/f1	Pb-Aw	0.00
	e2	Dogwood Pb-Sw	0.00
	e2/f2	Pb-Sw	0.00
	e3	Dogwood Sw	0.00
	g1	Labrador Tea-subhygric Sb-Pj	0.00
	h1	Labrador Tea/Horsetail Sw-Sb	0.00
	i2(BTNN)	Shrubby Bog	0.00
	j1(FTNN)	Treed Poor Fen Sb-Lt	0.00
	j1/g1 (FTNN)	Treed Poor Fen Lt-Sb-Pj	0.00
	j1/g1(FFNN)	Treed Poor Fen Sb-Pj	0.00
	j1/g1(FTNN)	Treed Poor Fen Lt-Sb-Pj	0.00
	j1/h1(FTNN)	Treed Poor Fen Sb-Sw-Lt	0.00
	j2(FFNN)	Treed Poor Fen Sb-Lt	0.00
	j2(FTNN)	Treed Poor Fen Sb-Lt	0.00
	j2/h1(FTNN)	Treed Poor Fen Sb/Sw-Lt	0.00
	k1(FTNN)	Treed Rich Fen	0.00
	k2(FONS)	Shrubby Rich Fen	0.00
	k2(FTNN)	Shrubby Treed Rich Fen	0.00
	Lt-Sb	Upland Lt-Sb	0.00
	NMC	Cutbanks	0.00
	Sb-Lt	Upland Sb-Lt	0.00
	shrub	Upland Shrubland	0.00
	UN	Unclassified	0.00
	b2	Blueberry Aw(Bw)	0.00
	rr	Rip-rap	0.00

Table 8 Habitat Suitability Index Values for Dabbling Ducks in the Regional Study Area

Habitat Suitability Class	Code	Vegetation Type	HSI
High Suitability	8	Marsh	1.00
(0.67 - 1.00)		0 - 50 m from Ponds/Marshes	1.00
Moderate Suitability	1	Open Water	0.66
(0.34 - 0.66)		50 - 100 m from Ponds/Marshes	0.66
		0 - 50 m from Creeks/Rivers	0.66
Low Suitability	6	Graminoid Fen	0.33
(0.01 - 0.33)	7	Wet Shrublands	0.33
		100 - 250 m from Ponds/Marshes	0.33
		50 - 100 m from Creeks/Rivers	0.33
Unsuitable Habitat	2	Jack Pine Forest	0.00
(0.00)	3	Mixedwood Forest	0.00
	4	Spruce Forest	0.00
	5	Aspen (Poplar) Forest	0.00
	9	Disturbances	0.00
	10	Unclassified	0.00
	11	Wooded Peatland	0.00
	12	Paper Birch Forest	0.00
	13/14	Burned Fen	0.00
	15	Cutblocks	0.00

Table 9 Habitat Suitability Index Values for Fishers in the Local Study Area

Habitat Suitability Class	Code	Vegetation Type	HSI
High Suitability	(Sb-Lt)SFNN	Coniferous Swamp(Sb-Lt)	1.00
(0.67 - 1.00)	j2(FFNN)	Treed Poor Fen Sb-Lt	1.00
	Sb(STNN)	Coniferous Swamp Sb	1.00
	Sb-Lt(SFNN)	Coniferous Swamp Sb-Lt	1.00
	j1/g1(FFNN)	Treed Poor Fen Sb-Pj	0.92
	j2(FTNN)	Treed Poor Fen Sb-Lt	0.90
	j2/h1(FTNN)	Treed Poor Fen Sb/Sw-Lt	0.90
	Sb-Lt(STNN)	Coniferous Swamp Sb-Lt	0.90
	i2(BTNN)	Shrubby Bog	0.87
	j1/h1(FTNN)	Treed Poor Fen Sb-Sw-Lt	0.81
	e2	Dogwood Pb-Sw	0.80
	a1	Lichen Pj	0.73
	h1	Labrador Tea/Horsetail Sw-Sb	0.71
	b1	Blueberry Pj-Aw	0.68
	d2	Low Bush Cranberry Aw-Sw	0.67
Moderate Suitability	d2(STNN)	Coniferous Swamp Aw-Sw	0.65
(0.34 - 0.66)	e3	Dogwood Sw	0.65
	h1(STNN)	Coniferous Swamp Sw-Sb	0.65
	j1(FTNN)	Treed Poor Fen Sb-Lt	0.65
	b4(STNN)	Coniferous Swamp Sw-Pj	0.60
	d3(STNN)	Coniferous Swamp Sw	0.60
	g1(STNN)	Coniferous Swamp Pj-Sb	0.59
	k2(FTNN)	Shrubby Treed Rich Fen	0.56
	Lt-Sb(STNN)	Coniferous Swamp Lt-Sb	0.56
	k1(FTNN)	Treed Rich Fen	0.54
	Lt-Pb(STNN)	Coniferous Swamp Lt-Pb	0.54
	e2/f2	Pb-Sw	0.53
	e1	Dogwood Pb-Aw	0.51
	e1/f1	Pb-Aw	0.51
	d1	Low Bush Cranberry Aw	0.50
	k1(FOPN)	Patterned Open Rich Fen	0.50
	k2(FONS)	Shrubby Rich Fen	0.50
	Lt(STNN)	Coniferous Swamp Lt	0.50
	Lt-Aw(STNN)	Coniferous Swamp Lt-Aw	0.50
	shrub	Upland Shrubland	0.50
	shrub(SONS)	Shrubby Swamp	0.50
	r	Reclaimed Riparian Shrub	0.50
	b4	Blueberry Sw-Pj	0.46
	j1/g1 (FTNN)	Treed Poor Fen Lt-Sb-Pj	0.46
	j1/g1(FTNN)	Treed Poor Fen Lt-Sb-Pj	0.46
	b3	Blueberry Aw-Sw	0.46
	d3	Low Bush Cranberry Sw	0.44

Habitat Suitability Class	Code	Vegetation Type	HSI
Moderate Suitability	Sb-Lt	Upland Sb-Lt	0.44
Continued	g1	Labrador Tea-subhygric Sb-Pj	0.43
	c1	Labrador Tea-mesic Pj-Sb	0.41
	Lt-Sb	Upland Lt-Sb	0.38
	a1/g1 complex	Pj-Lt	0.34
Low Suitability	c1(STNN)	Coniferous Swamp Pj-Sb	0.33
(0.01 - 0.33)	b2	Blueberry Aw(Bw)	0.30
	k3(FONG)	Graminoid Rich Fen	0.03
Unsuitable Habitat	AIG	Gravel Pits	0.00
(0.00)	AIH	Roads and Rights-of-way	0.00
	AIM	Surface Mines	0.00
	l1(MONG)	Marsh	0.00
	NMC	Cutbanks	0.00
	NWF(WONN)	Shallow Open Water	0.00
	NWL	Lakes and Ponds	0.00
	NWR	Rivers	0.00
	UN	Unclassified	0.00
	o	Reclaimed Open Water	0.00
	w	Reclaimed Wetland	0.00
	rr	Rip-rap	0.00

Table 10 Habitat Suitability Index values for Fishers in the Regional Study Area

Habitat Suitability Class	Code	Vegetation Type	HSI
High Suitability	4	Spruce Forest	0.83
(0.67 - 1.00)	3	Mixedwood Forest	0.67
Moderate Suitability	10	Unclassified	0.58
(0.34 - 0.66)	11	Wooded Peatland	0.56
	15	Cutblocks	0.53
	13/14	Burned Fen	0.51
	5	Aspen (Poplar) Forest	0.50
	7	Wet Shrublands	0.50
	2	Jack Pine Forest	0.46
Low Suitability	12	Paper Birch Forest	0.30
(0.01 - 0.33)	6	Graminoid Fen	0.03
Unsuitable Habitat	9	Disturbances	0.00
(0.00)	1	Open Water	0.00
	8	Marsh	0.00

Table 11 Habitat Suitability Index Values for Great Gray Owl Food in the Local Study Area

Habitat Suitability Class	Code	Vegetation Type	Food HSI
High Suitability	k3(FONG)	Graminoid Rich Fen	1.00
(0.67 - 1.00)	l1(MONG)	Marsh	0.70
	w	Reclaimed Wetland	0.70
Moderate Suitability	k2(FONS)	Shrubby Rich Fen	0.66
(0.34 - 0.66)	AIH	Roads and Rights-of-way	0.56
	k2(FTNN)	Shrubby Treed Rich Fen	0.55
	shrub(SONS)	Shrubby Swamp	0.48
	r	Reclaimed Riparian Shrub	0.48
	k1(FOPN)	Patterned Open Rich Fen	0.43
	k1(FTNN)	Treed Rich Fen	0.43
	h1	Labrador Tea/Horsetail Sw-Sb	0.36
Low Suitability	j1/h1(FTNN)	Treed Poor Fen Sb-Sw-Lt	0.32
(0.01 - 0.33)	a1/g1 complex	Pj-Lt	0.30
	c1(STNN)	Coniferous Swamp Pj-Sb	0.30
	g1	Labrador Tea-subhygric Sb-Pj	0.30
	Lt-Sb	Upland Lt-Sb	0.30
	Sb-Lt	Upland Sb-Lt	0.30
	d2	Low Bush Cranberry Aw-Sw	0.27
	j1/g1 (FTNN)	Treed Poor Fen Lt-Sb-Pj	0.24
	j1/g1(FFNN)	Treed Poor Fen Sb-Pj	0.24
	j1/g1(FTNN)	Treed Poor Fen Lt-Sb-Pj	0.24
	d1	Low Bush Cranberry Aw	0.23
	e2	Dogwood Pb-Sw	0.22
	b3	Blueberry Aw-Sw	0.20
	j1(FTNN)	Treed Poor Fen Sb-Lt	0.20
	j2(FFNN)	Treed Poor Fen Sb-Lt	0.20
	j2(FTNN)	Treed Poor Fen Sb-Lt	0.20
	j2/h1(FTNN)	Treed Poor Fen Sb/Sw-Lt	0.20
	e3	Dogwood Sw	0.20
	b1	Blueberry Pj-Aw	0.19
	b2	Blueberry Aw(Bw)	0.19
	e2/f2	Pb-Sw	0.19
	b4	Blueberry Sw-Pj	0.16
	a1	Lichen Pj	0.15
	c1	Labrador Tea-mesic Pj-Sb	0.15
	d3	Low Bush Cranberry Sw	0.15
	e1/f1	Pb-Aw	0.14
	(Sb-Lt)SFNN	Coniferous Swamp(Sb-Lt)	0.10
	b4(STNN)	Coniferous Swamp Sw-Pj	0.10
	d2(STNN)	Coniferous Swamp Aw-Sw	0.10

Habitat Suitability Class	Code	Vegetation Type	Food HSI
	d3(STNN)	Coniferous Swamp Sw	0.10
Low Suitability	g1(STNN)	Coniferous Swamp Pj-Sb	0.10
Continued	h1(STNN)	Coniferous Swamp Sw-Sb	0.10
	Lt(STNN)	Coniferous Swamp Lt	0.10
	Lt-Aw(STNN)	Coniferous Swamp Lt-Aw	0.10
	Lt-Pb(STNN)	Coniferous Swamp Lt-Pb	0.10
	Lt-Sb(STNN)	Coniferous Swamp Lt-Sb	0.10
	Sb(STNN)	Coniferous Swamp Sb	0.10
	Sb-Lt(SFNN)	Coniferous Swamp Sb-Lt	0.10
	Sb-Lt(STNN)	Coniferous Swamp Sb-Lt	0.10
	e1	Dogwood Pb-Aw	0.10
	shrub	Upland Shrubland	0.07
	i2(BTNN)	Shrubby Bog	0.06

Unsuitable Habitat	rr	Rip-rap	0.00
(0.00)	AIG	Gravel Pits	0.00
	AIM	Surface Mines	0.00
	NMC	Cutbanks	0.00
	NWF(WONN)	Shallow Open Water	0.00
	NWL	Lakes and Ponds	0.00
	NWR	Rivers	0.00
	UN	Unclassified	0.00
	o	Reclaimed Open Water	0.00

Table 12 Habitat Suitability Index Values for Great Gray Owl Food in the Regional Study Area

Habitat Suitability Class	Code	Vegetation Type	Food HSI
High Suitability	6	Graminoid Fen	1.00
(0.67 - 1.00)	8	Marsh	0.70
Moderate Suitability	13/14	Burned Fen	0.61
(0.34 - 0.66)	15	Cutblocks	0.59
	7	Wet Shrublands	0.37
	11	Wooded Peatland	0.34
Low Suitability	10	Unclassified	0.27
(0.01 - 0.33)	5	Aspen (Poplar) Forest	0.21
	3	Mixedwood Forest	0.21
	12	Paper Birch Forest	0.19
	2	Jack Pine Forest	0.16
	4	Spruce Forest	0.15
Unsuitable Habitat	9	Disturbances	0.00
(0.00)	1	Open Water	0.00

Table 13 Habitat Suitability Index Values for Great Gray Owl Cover in the Local Study Area

Habitat Suitability Class	Code	Vegetation Type	Cover HSI
High Suitability	e2/f2	Pb-Sw	1.00
(0.67 - 1.00)	e1/f1	Pb-Aw	0.95
	e3	Dogwood Sw	0.83
Moderate Suitability	e1	Dogwood Pb-Aw	0.62
(0.34 - 0.66)	d3	Low Bush Cranberry Sw	0.61
	c1	Labrador Tea-mesic Pj-Sb	0.60
	e2	Dogwood Pb-Sw	0.58
	a1	Lichen Pj	0.55
	Lt-Sb	Upland Lt-Sb	0.54
	b4	Blueberry Sw-Pj	0.53
	b3	Blueberry Aw-Sw	0.50
	(Sb-Lt)SFNN	Coniferous Swamp(Sb-Lt)	0.50
	b1	Blueberry Pj-Aw	0.50
	d1	Low Bush Cranberry Aw	0.50
	d2	Low Bush Cranberry Aw-Sw	0.50
	d2(STNN)	Coniferous Swamp Aw-Sw	0.50
	g1	Labrador Tea-subhygric Sb-Pj	0.50
	g1(STNN)	Coniferous Swamp Pj-Sb	0.50
	h1	Labrador Tea/Horsetail Sw-Sb	0.50
	h1(STNN)	Coniferous Swamp Sw-Sb	0.50
	i2(BTNN)	Shrubby Bog	0.50
	j1(FTNN)	Treed Poor Fen Sb-Lt	0.50
	j1/g1(FFNN)	Treed Poor Fen Sb-Pj	0.50
	j1/h1(FTNN)	Treed Poor Fen Sb-Sw-Lt	0.50
	j2(FFNN)	Treed Poor Fen Sb-Lt	0.50
	j2(FTNN)	Treed Poor Fen Sb-Lt	0.50
	j2/h1(FTNN)	Treed Poor Fen Sb/Sw-Lt	0.50
	k2(FTNN)	Shrubby Treed Rich Fen	0.50
	Lt(STNN)	Coniferous Swamp Lt	0.50
	Sb(STNN)	Coniferous Swamp Sb	0.50
	Sb-Lt	Upland Sb-Lt	0.50
	Sb-Lt(SFNN)	Coniferous Swamp Sb-Lt	0.50
	Sb-Lt(STNN)	Coniferous Swamp Sb-Lt	0.50
	b2	Blueberry Aw(Bw)	0.50
	d3(STNN)	Coniferous Swamp Sw	0.34
Low Suitability	a1/g1 complex	Pj-Lt	0.31
(0.01 - 0.33)	b4(STNN)	Coniferous Swamp Sw-Pj	0.30
	c1(STNN)	Coniferous Swamp Pj-Sb	0.26
	j1/g1(FTNN)	Treed Poor Fen Lt-Sb-Pj	0.25
	j1/g1 (FTNN)	Treed Poor Fen Lt-Sb-Pj	0.25

Habitat Suitability Class	Code	Vegetation Type	Cover HSI
Low Suitability	k1(FOPN)	Patterned Open Rich Fen	0.25
Continued	k1(FTNN)	Treed Rich Fen	0.25
	Lt-Aw(STNN)	Coniferous Swamp Lt-Aw	0.25
	Lt-Pb(STNN)	Coniferous Swamp Lt-Pb	0.25
	Lt-Sb(STNN)	Coniferous Swamp Lt-Sb	0.25

Unsuitable Habitat	AIG	Gravel Pits	0.00
(0.00)	AIH	Roads and Rights-of-way	0.00
	AIM	Surface Mines	0.00
	k2(FONS)	Shrubby Rich Fen	0.00
	k3(FONG)	Graminoid Rich Fen	0.00
	l1(MONG)	Marsh	0.00
	NMC	Cutbanks	0.00
	NWF(WONN)	Shallow Open Water	0.00
	NWL	Lakes and Ponds	0.00
	NWR	Rivers	0.00
	shrub	Upland Shrubland	0.00
	shrub(SONS)	Shrubby Swamp	0.00
	UN	Unclassified	0.00
	r	Reclaimed Riparian Shrub	0.00
	o	Reclaimed Open Water	0.00
	w	Reclaimed Wetland	0.00
	rr	Rip-rap	0.00

Table 14 Habitat Suitability Index Values for Great Gray Owl Cover in the Regional Study Area

Habitat Suitability Class	Code	Vegetation Type	Cover HSI
Moderate Suitability	4	Spruce Forest	0.54
(0.34 - 0.66)	2	Jack Pine Forest	0.53
	5	Aspen (Poplar) Forest	0.51
	3	Mixedwood Forest	0.50
	10	Unclassified	0.50
	12	Paper Birch Forest	0.50
Low Suitability	11	Wooded Peatland	0.25
(0.01 - 0.33)			
Unsuitable Habitat	1	Open Water	0.00
(0.00)	6	Graminoid Fen	0.00
	7	Wet Shrublands	0.00
	8	Marsh	0.00
	9	Disturbances	0.00
	13/14	Burned Fen	0.00
	15	Cutblocks	0.00

Table 15 Habitat Suitability Index Values for Moose Food in the Local Study Area

Habitat Suitability Class	Code	Vegetation Type	Food HSI
High Suitability	shrub	Upland Shrubland	1.00
(0.67 - 1.00)	shrub(SONS)	Shrubby Swamp	1.00
	r	Reclaimed Riparian Shrub	1.00
	k2(FONS)	Shrubby Rich Fen	0.98
	e1	Dogwood Pb-Aw	0.89
	e1/f1	Pb-Aw	0.77
	k2(FTNN)	Shrubby Treed Rich Fen	0.76
	d1	Low Bush Cranberry Aw	0.73
	e3	Dogwood Sw	0.67
Moderate Suitability	e2	Dogwood Pb-Sw	0.62
(0.34 - 0.66)	e2/f2	Pb-Sw	0.55
	k1(FOPN)	Patterned Open Rich Fen	0.55
	k1(FTNN)	Treed Rich Fen	0.55
	j2(FFNN)	Treed Poor Fen Sb-Lt	0.48
	j2(FTNN)	Treed Poor Fen Sb-Lt	0.48
	j2/h1(FTNN)	Treed Poor Fen Sb/Sw-Lt	0.48
	d2	Low Bush Cranberry Aw-Sw	0.46
	(Sb-Lt)SFNN	Coniferous Swamp(Sb-Lt)	0.40
	b4(STNN)	Coniferous Swamp Sw-Pj	0.34
	d2(STNN)	Coniferous Swamp Aw-Sw	0.34
	d3(STNN)	Coniferous Swamp Sw	0.34
	g1(STNN)	Coniferous Swamp Pj-Sb	0.34
	h1(STNN)	Coniferous Swamp Sw-Sb	0.34
	Lt(STNN)	Coniferous Swamp Lt	0.34
	Lt-Aw(STNN)	Coniferous Swamp Lt-Aw	0.34
	Lt-Pb(STNN)	Coniferous Swamp Lt-Pb	0.34
	Lt-Sb(STNN)	Coniferous Swamp Lt-Sb	0.34
	Sb(STNN)	Coniferous Swamp Sb	0.34
	Sb-Lt(SFNN)	Coniferous Swamp Sb-Lt	0.34
	Sb-Lt(STNN)	Coniferous Swamp Sb-Lt	0.34
Low Suitability	b1	Blueberry Pj-Aw	0.33
(0.01 - 0.33)	d3	Low Bush Cranberry Sw	0.30
	j1(FTNN)	Treed Poor Fen Sb-Lt	0.26
	b3	Blueberry Aw-Sw	0.24
	c1(STNN)	Coniferous Swamp Pj-Sb	0.23
	b4	Blueberry Sw-Pj	0.23
	j1/h1(FTNN)	Treed Poor Fen Sb-Sw-Lt	0.21
	b2	Blueberry Aw(Bw)	0.21
	i2(BTNN)	Shrubby Bog	0.18
	j1/g1 (FTNN)	Treed Poor Fen Lt-Sb-Pj	0.17

Habitat Suitability Class	Code	Vegetation Type	Food HSI
Low Suitability	j1/g1(FFNN)	Treed Poor Fen Sb-Pj	0.17
Continued	j1/g1(FTNN)	Treed Poor Fen Lt-Sb-Pj	0.17
	h1	Labrador Tea/Horsetail Sw-Sb	0.16
	c1	Labrador Tea-mesic Pj-Sb	0.09
	a1/g1 complex	Pj-Lt	0.08
	g1	Labrador Tea-subhygric Sb-Pj	0.07
	Lt-Sb	Upland Lt-Sb	0.07
	Sb-Lt	Upland Sb-Lt	0.07
	a1	Lichen Pj	0.06

Unsuitable Habitat	AIG	Gravel Pits	0.00
(0.00)	AIH	Roads and Rights-of-way	0.00
	AIM	Surface Mines	0.00
	k3(FONG)	Graminoid Rich Fen	0.00
	l1(MONG)	Marsh	0.00
	NMC	Cutbanks	0.00
	NWF(WONN)	Shallow Open Water	0.00
	NWL	Lakes and Ponds	0.00
	NWR	Rivers	0.00
	UN	Unclassified	0.00
	o	Reclaimed Open Water	0.00
	w	Reclaimed Wetland	0.00
	rr	Rip-rap	0.00

Table 16 Habitat Suitability Index Values Moose Food for in the Regional Study Area

Habitat Suitability Class	Code	Vegetation Type	Food HSI
High Suitability	7	Wet Shrublands	1.00
(0.67 - 1.00)	15	Cutblocks	1.00
	13/14	Burned Fen	0.88
	5	Aspen (Poplar) Forest	0.74
Moderate Suitability	11	Wooded Peatland	0.58
(0.34 - 0.66)	10	Unclassified	0.52
	3	Mixedwood Forest	0.35
Low Suitability	4	Spruce Forest	0.30
(0.01 - 0.33)	12	Paper Birch Forest	0.21
	2	Jack Pine Forest	0.15
Unsuitable Habitat	1	Open Water	0.00
(0.00)	6	Graminoid Fen	0.00
	8	Marsh	0.00
	9	Disturbances	0.00

Table 17 Habitat Suitability Index Values for Moose Cover in the Local Study Area

Habitat Suitability Class	Code	Vegetation Type	Cover HSI
High Suitability	a1	Lichen Pj	0.80
(0.67 - 1.00)	(Sb-Lt)SFNN	Coniferous Swamp(Sb-Lt)	0.75
	j1/g1(FFNN)	Treed Poor Fen Sb-Pj	0.75
	Sb(STNN)	Coniferous Swamp Sb	0.75
	h1	Labrador Tea/Horsetail Sw-Sb	0.74
	Sb-Lt(SFNN)	Coniferous Swamp Sb-Lt	0.73
	e2	Dogwood Pb-Sw	0.72
	b1	Blueberry Pj-Aw	0.71
	j2/h1(FTNN)	Treed Poor Fen Sb/Sw-Lt	0.68
Moderate Suitability	d2	Low Bush Cranberry Aw-Sw	0.64
(0.34 - 0.66)	j2(FFNN)	Treed Poor Fen Sb-Lt	0.62
	j1/h1(FTNN)	Treed Poor Fen Sb-Sw-Lt	0.60
	Sb-Lt(STNN)	Coniferous Swamp Sb-Lt	0.60
	d1	Low Bush Cranberry Aw	0.56
	e1	Dogwood Pb-Aw	0.56
	j2(FTNN)	Treed Poor Fen Sb-Lt	0.55
	i2(BTNN)	Shrubby Bog	0.52
	c1	Labrador Tea-mesic Pj-Sb	0.40
	d3	Low Bush Cranberry Sw	0.40
	e3	Dogwood Sw	0.40
	b4	Blueberry Sw-Pj	0.40
Low Suitability	h1(STNN)	Coniferous Swamp Sw-Sb	0.33
(0.01 - 0.33)	d2(STNN)	Coniferous Swamp Aw-Sw	0.32
	b3	Blueberry Aw-Sw	0.31
	Lt-Sb	Upland Lt-Sb	0.30
	g1	Labrador Tea-subhygric Sb-Pj	0.30
	j1(FTNN)	Treed Poor Fen Sb-Lt	0.30
	Sb-Lt	Upland Sb-Lt	0.30
	e1/f1	Pb-Aw	0.28
	e2/f2	Pb-Sw	0.28
	g1(STNN)	Coniferous Swamp Pj-Sb	0.28
	b2	Blueberry Aw(Bw)	0.22
	Lt(STNN)	Coniferous Swamp Lt	0.21
	b4(STNN)	Coniferous Swamp Sw-Pj	0.20
	d3(STNN)	Coniferous Swamp Sw	0.20
	a1/g1 complex	Pj-Lt	0.20
	c1(STNN)	Coniferous Swamp Pj-Sb	0.19
	k2(FTNN)	Shrubby Treed Rich Fen	0.14
	j1/g1(FTNN)	Treed Poor Fen Lt-Sb-Pj	0.12
	j1/g1 (FTNN)	Treed Poor Fen Lt-Sb-Pj	0.11

Habitat Suitability Class	Code	Vegetation Type	Cover HSI
Low Suitability	Lt-Pb(STNN)	Coniferous Swamp Lt-Pb	0.11
Continued	Lt-Sb(STNN)	Coniferous Swamp Lt-Sb	0.11
	k1(FOPN)	Patterned Open Rich Fen	0.09
	k1(FTNN)	Treed Rich Fen	0.09
	Lt-Aw(STNN)	Coniferous Swamp Lt-Aw	0.09

Unsuitable Habitat	AIG	Gravel Pits	0.00
(0.00)	AIH	Roads and Rights-of-way	0.00
	AIM	Surface Mines	0.00
	k2(FONS)	Shrubby Rich Fen	0.00
	k3(FONG)	Graminoid Rich Fen	0.00
	l1(MONG)	Marsh	0.00
	NMC	Cutbanks	0.00
	NWF(WONN)	Shallow Open Water	0.00
	NWL	Lakes and Ponds	0.00
	NWR	Rivers	0.00
	shrub	Upland Shrubland	0.00
	shrub(SONS)	Shrubby Swamp	0.00
	UN	Unclassified	0.00
	r	Reclaimed Riparian Shrub	0.00
	o	Reclaimed Open Water	0.00
	w	Reclaimed Wetland	0.00
	rr	Rip-rap	0.00

Table 18 Habitat Suitability Index Values for Moose Cover in the Regional Study Area

Habitat Suitability Class	Code	Vegetation Type	Cover HSI
High Suitability	4	Spruce Forest	0.77
(0.67 - 1.00)	3	Mixedwood Forest	0.70
Moderate Suitability	5	Aspen (Poplar) Forest	0.56
(0.34 - 0.66)	2	Jack Pine Forest	0.39
Low Suitability	10	Unclassified	0.23
(0.01 - 0.33)	12	Paper Birch Forest	0.22
	11	Wooded Peatland	0.12
Unsuitable Habitat	1	Open Water	0.00
(0.00)	6	Graminoid Fen	0.00
	7	Wet Shrublands	0.00
	8	Marsh	0.00
	9	Disturbances	0.00
	13/14	Burned Fen	0.00
	15	Cutblocks	0.00

Table 19 Habitat Suitability Index Values for Pileated Woodpeckers in the Local Study Area

Habitat Suitability Class	Code	Vegetation Type	HSI
High Suitability	e1	Dogwood Pb-Aw	0.94
(0.67 - 1.00)	e2	Dogwood Pb-Sw	0.92
	d1	Low Bush Cranberry Aw	0.91
	b1	Blueberry Pj-Aw	0.89
	d2	Low Bush Cranberry Aw-Sw	0.88
	e2/f2	Pb-Sw	0.80
	e3	Dogwood Sw	0.80
	e1/f1	Pb-Aw	0.80
	b3	Blueberry Aw-Sw	0.74
	d2(STNN)	Coniferous Swamp Aw-Sw	0.71
	b2	Blueberry Aw(Bw)	0.67
Moderate Suitability	b4	Blueberry Sw-Pj	0.66
(0.34 - 0.66)	h1	Labrador Tea/Horsetail Sw-Sb	0.59
	g1	Labrador Tea-subhygric Sb-Pj	0.57
	d3	Low Bush Cranberry Sw	0.47
	h1(STNN)	Coniferous Swamp Sw-Sb	0.46
	Lt-Pb(STNN)	Coniferous Swamp Lt-Pb	0.45
	Lt-Aw(STNN)	Coniferous Swamp Lt-Aw	0.43
	Sb-Lt(STNN)	Coniferous Swamp Sb-Lt	0.43
	a1	Lichen Pj	0.40
	d3(STNN)	Coniferous Swamp Sw	0.39
	c1	Labrador Tea-mesic Pj-Sb	0.39
	j2/h1(FTNN)	Treed Poor Fen Sb/Sw-Lt	0.39
	Lt-Sb	Upland Lt-Sb	0.34
Low Suitability	j1/h1(FTNN)	Treed Poor Fen Sb-Sw-Lt	0.33
(0.01 - 0.33)	g1(STNN)	Coniferous Swamp Pj-Sb	0.32
	Lt(STNN)	Coniferous Swamp Lt	0.31
	(Sb-Lt)SFNN	Coniferous Swamp(Sb-Lt)	0.30
	Sb-Lt	Upland Sb-Lt	0.30
	j1/g1(FFNN)	Treed Poor Fen Sb-Pj	0.28
	Sb(STNN)	Coniferous Swamp Sb	0.28
	j1(FTNN)	Treed Poor Fen Sb-Lt	0.28
	j2(FTNN)	Treed Poor Fen Sb-Lt	0.25
	Sb-Lt(SFNN)	Coniferous Swamp Sb-Lt	0.25
	j2(FFNN)	Treed Poor Fen Sb-Lt	0.24
	i2(BTNN)	Shrubby Bog	0.22
	b4(STNN)	Coniferous Swamp Sw-Pj	0.21
	j1/g1(FTNN)	Treed Poor Fen Lt-Sb-Pj	0.21
	k2(FTNN)	Shrubby Treed Rich Fen	0.21
	Lt-Sb(STNN)	Coniferous Swamp Lt-Sb	0.20

Habitat Suitability Class	Code	Vegetation Type	HSI
	a1/g1 complex	Pj-Lt	0.20
Low Suitability	j1/g1 (FTNN)	Treed Poor Fen Lt-Sb-Pj	0.20
Continued	c1(STNN)	Coniferous Swamp Pj-Sb	0.19
	k1(FTNN)	Treed Rich Fen	0.18
	k1(FOPN)	Patterned Open Rich Fen	0.16

Unsuitable Habitat	AIG	Gravel Pits	0.00
(0.00)	AIH	Roads and Rights-of-way	0.00
	AIM	Surface Mines	0.00
	k2(FONS)	Shrubby Rich Fen	0.00
	k3(FONG)	Graminoid Rich Fen	0.00
	l1(MONG)	Marsh	0.00
	NMC	Cutbanks	0.00
	NWF(WONN)	Shallow Open Water	0.00
	NWL	Lakes and Ponds	0.00
	NWR	Rivers	0.00
	shrub	Upland Shrubland	0.00
	shrub(SONS)	Shrubby Swamp	0.00
	UN	Unclassified	0.00
	r	Reclaimed Riparian Shrub	0.00
	o	Reclaimed Open Water	0.00
	w	Reclaimed Wetland	0.00
	rr	Rip-rap	0.00

Table 20 Habitat Suitability Index Values for Pileated Woodpeckers in the Regional Study Area

Habitat Suitability Class	Code	Vegetation Type	HSI
High Suitability	5	Aspen (Poplar) Forest	0.92
(0.67 - 1.00)	3	Mixedwood Forest	0.89
	4	Spruce Forest	0.69
	12	Paper Birch Forest	0.67
Moderate Suitability	10	Unclassified	0.65
(0.34 - 0.66)	2	Jack Pine Forest	0.46
Low Suitability	11	Wooded Peatland	0.15
(0.01 - 0.33)			
Unsuitable Habitat	1	Open Water	0.00
(0.00)	6	Graminoid Fen	0.00
	7	Wet Shrublands	0.00
	8	Marsh	0.00
	9	Disturbances	0.00
	13/14	Burned Fen	0.00
	15	Cutblocks	0.00

Table 21 Habitat Suitability Index Values for Red-backed Voles in the Local Study Area

Habitat Suitability Class	Code	Vegetation Type	HSI
High Suitability	e2	Dogwood Pb-Sw	0.78
(0.67 - 1.00)	d1	Low Bush Cranberry Aw	0.78
	e1	Dogwood Pb-Aw	0.77
	e3	Dogwood Sw	0.72
	e1/f1	Pb-Aw	0.70
Moderate Suitability	d2	Low Bush Cranberry Aw-Sw	0.66
(0.34 - 0.66)	e2/f2	Pb-Sw	0.65
	j2/h1(FTNN)	Treed Poor Fen Sb/Sw-Lt	0.65
	g1(STNN)	Coniferous Swamp Pj-Sb	0.60
	b1	Blueberry Pj-Aw	0.59
	b4(STNN)	Coniferous Swamp Sw-Pj	0.58
	Lt(STNN)	Coniferous Swamp Lt	0.58
	Sb-Lt(STNN)	Coniferous Swamp Sb-Lt	0.58
	h1(STNN)	Coniferous Swamp Sw-Sb	0.56
	b3	Blueberry Aw-Sw	0.55
	d2(STNN)	Coniferous Swamp Aw-Sw	0.55
	j1(FTNN)	Treed Poor Fen Sb-Lt	0.54
	d3(STNN)	Coniferous Swamp Sw	0.52
	a1	Lichen Pj	0.52
	Lt-Pb(STNN)	Coniferous Swamp Lt-Pb	0.51
	Lt-Sb(STNN)	Coniferous Swamp Lt-Sb	0.51
	b4	Blueberry Sw-Pj	0.50
	h1	Labrador Tea/Horsetail Sw-Sb	0.50
	j1/g1(FTNN)	Treed Poor Fen Lt-Sb-Pj	0.49
	j1/g1 (FTNN)	Treed Poor Fen Lt-Sb-Pj	0.48
	k1(FTNN)	Treed Rich Fen	0.48
	Lt-Aw(STNN)	Coniferous Swamp Lt-Aw	0.47
	(Sb-Lt)SFNN	Coniferous Swamp(Sb-Lt)	0.47
	Sb(STNN)	Coniferous Swamp Sb	0.47
	i2(BTNN)	Shrubby Bog	0.47
	j2(FTNN)	Treed Poor Fen Sb-Lt	0.47
	d3	Low Bush Cranberry Sw	0.46
	j2(FFNN)	Treed Poor Fen Sb-Lt	0.46
	k2(FTNN)	Shrubby Treed Rich Fen	0.46
	Sb-Lt(SFNN)	Coniferous Swamp Sb-Lt	0.46
	k2(FONS)	Shrubby Rich Fen	0.45
	j1/h1(FTNN)	Treed Poor Fen Sb-Sw-Lt	0.44
	j1/g1(FFNN)	Treed Poor Fen Sb-Pj	0.44
	k1(FOPN)	Patterned Open Rich Fen	0.43
	Lt-Sb	Upland Lt-Sb	0.43
	c1	Labrador Tea-mesic Pj-Sb	0.41

Habitat Suitability Class	Code	Vegetation Type	HSI
Moderate Suitability	shrub(SONS)	Shrubby Swamp	0.41
Continued	shrub	Upland Shrubland	0.41
	g1	Labrador Tea-subhygric Sb-Pj	0.39
	b2	Blueberry Aw(Bw)	0.39
	r	Reclaimed Riparian Shrub	0.38
	Sb-Lt	Upland Sb-Lt	0.37
	a1/g1 complex	Pj-Lt	0.37

Low Suitability	c1(STNN)	Coniferous Swamp Pj-Sb	0.30
(0.01 - 0.33)	k3(FONG)	Graminoid Rich Fen	0.05

Unsuitable Habitat	AIG	Gravel Pits	0.00
(0.00)	AIH	Roads and Rights-of-way	0.00
	AIM	Surface Mines	0.00
	I1(MONG)	Marsh	0.00
	NMC	Cutbanks	0.00
	NWF(WONN)	Shallow Open Water	0.00
	NWL	Lakes and Ponds	0.00
	NWR	Rivers	0.00
	UN	Unclassified	0.00
	o	Reclaimed Open Water	0.00
	w	Reclaimed Wetland	0.00
	rr	Rip-rap	0.00

Table 22 Habitat Suitability Index Values for Red-backed Voles in the Regional Study Area

Habitat Suitability Class	Code	Vegetation Type	HSI
High Suitability	5	Aspen (Poplar) Forest	0.80
(0.67 - 1.00)			
Moderate Suitability	4	Spruce Forest	0.65
(0.34 - 0.66)	3	Mixedwood Forest	0.62
	10	Unclassified	0.51
	2	Jack Pine Forest	0.50
	11	Wooded Peatland	0.46
	13/14	Burned Fen	0.44
	15	Cutblocks	0.42
	7	Wet Shrublands	0.42
	12	Paper Birch Forest	0.39
Low Suitability	6	Graminoid Fen	0.05
(0.01 - 0.33)			
Unsuitable Habitat	9	Disturbances	0.00
(0.00)	1	Open Water	0.00
	8	Marsh	0.00

Table 23 Habitat Suitability Index Values for Ruffed Grouse in the Local Study Area

Habitat Suitability Class	Code	Vegetation Type	HSI
High Suitability	e1	Dogwood Pb-Aw	0.85
(0.67 - 1.00)	d1	Low Bush Cranberry Aw	0.82
	e1/f1	Pb-Aw	0.74
	e2	Dogwood Pb-Sw	0.73
	d2	Low Bush Cranberry Aw-Sw	0.69
	b1	Blueberry Pj-Aw	0.68
Moderate Suitability	e2/f2	Pb-Sw	0.65
(0.34 - 0.66)	b3	Blueberry Aw-Sw	0.63
	b2	Blueberry Aw(Bw)	0.50
	e3	Dogwood Sw	0.41
	b4(STNN)	Coniferous Swamp Sw-Pj	0.36
	d3(STNN)	Coniferous Swamp Sw	0.36
	g1(STNN)	Coniferous Swamp Pj-Sb	0.36
	shrub	Upland Shrubland	0.35
	shrub(SONS)	Shrubby Swamp	0.35
	b4	Blueberry Sw-Pj	0.34
	Lt(STNN)	Coniferous Swamp Lt	0.34
Low Suitability	r	Reclaimed Riparian Shrub	0.33
(0.01 - 0.33)	j2/h1(FTNN)	Treed Poor Fen Sb/Sw-Lt	0.33
	Lt-Pb(STNN)	Coniferous Swamp Lt-Pb	0.32
	j1/g1(FTNN)	Treed Poor Fen Lt-Sb-Pj	0.32
	Lt-Sb	Upland Lt-Sb	0.32
	Lt-Sb(STNN)	Coniferous Swamp Lt-Sb	0.32
	h1	Labrador Tea/Horsetail Sw-Sb	0.32
	d3	Low Bush Cranberry Sw	0.31
	a1	Lichen Pj	0.31
	c1	Labrador Tea-mesic Pj-Sb	0.31
	h1(STNN)	Coniferous Swamp Sw-Sb	0.30
	c1(STNN)	Coniferous Swamp Pj-Sb	0.30
	a1/g1 complex	Pj-Lt	0.29
	j1/g1 (FTNN)	Treed Poor Fen Lt-Sb-Pj	0.29
	k2(FONS)	Shrubby Rich Fen	0.29
	d2(STNN)	Coniferous Swamp Aw-Sw	0.29
	Sb-Lt(STNN)	Coniferous Swamp Sb-Lt	0.28
	k2(FTNN)	Shrubby Treed Rich Fen	0.26
	(Sb-Lt)SFNN	Coniferous Swamp(Sb-Lt)	0.25
	Sb(STNN)	Coniferous Swamp Sb	0.25
	Sb-Lt(SFNN)	Coniferous Swamp Sb-Lt	0.25
	Lt-Aw(STNN)	Coniferous Swamp Lt-Aw	0.24
	j2(FFNN)	Treed Poor Fen Sb-Lt	0.23

Habitat Suitability Class	Code	Vegetation Type	HSI
Low Suitability	g1	Labrador Tea-subhygric Sb-Pj	0.23
Continued	j2(FTNN)	Treed Poor Fen Sb-Lt	0.21
	j1/g1(FFNN)	Treed Poor Fen Sb-Pj	0.21
	k1(FTNN)	Treed Rich Fen	0.21
	Sb-Lt	Upland Sb-Lt	0.21
	j1(FTNN)	Treed Poor Fen Sb-Lt	0.20
	j1/h1(FTNN)	Treed Poor Fen Sb-Sw-Lt	0.19
	i2(BTNN)	Shrubby Bog	0.18
	k1(FOPN)	Patterned Open Rich Fen	0.16
	k3(FONG)	Graminoid Rich Fen	0.06

Unsuitable Habitat	AIG	Gravel Pits	0.00
(0.00)	AIH	Roads and Rights-of-way	0.00
	AIM	Surface Mines	0.00
	l1(MONG)	Marsh	0.00
	NMC	Cutbanks	0.00
	NWF(WONN)	Shallow Open Water	0.00
	NWL	Lakes and Ponds	0.00
	NWR	Rivers	0.00
	UN	Unclassified	0.00
	o	Reclaimed Open Water	0.00
	w	Reclaimed Wetland	0.00
	rr	Rip-rap	0.00

Table 24 Habitat Suitability Index Values for Ruffed Grouse in the Regional Study Area

Habitat Suitability Class	Code	Vegetation Type	HSI
High Suitability	5	Aspen (Poplar) Forest	0.84
(0.67 - 1.00)	3	Mixedwood Forest	0.69
Moderate Suitability	12	Paper Birch Forest	0.50
(0.34 - 0.66)	4	Spruce Forest	0.38
	15	Cutblocks	0.38
	7	Wet Shrublands	0.35
Low Suitability	2	Jack Pine Forest	0.32
(0.01 - 0.33)	10	Unclassified	0.31
	13/14	Burned Fen	0.25
	11	Wooded Peatland	0.21
Unsuitable Habitat	1	Open Water	0.00
(0.00)	6	Graminoid Fen	0.00
	8	Marsh	0.00
	9	Disturbances	0.00

Table 25 Habitat Suitability Index Values for Snowshoe Hares in the Local Study Area

Habitat Suitability Class	Code	Vegetation Type	HSI
High Suitability	e1	Dogwood Pb-Aw	0.98
(0.67 - 1.00)	(Sb-Lt)SFNN	Coniferous Swamp(Sb-Lt)	0.94
	e1/f1	Pb-Aw	0.94
	shrub	Upland Shrubland	0.94
	shrub(SONS)	Shrubby Swamp	0.94
	r	Reclaimed Riparian Shrub	0.94
	k2(FONS)	Shrubby Rich Fen	0.93
	d2(STNN)	Coniferous Swamp Aw-Sw	0.91
	Sb-Lt(STNN)	Coniferous Swamp Sb-Lt	0.91
	k2(FTNN)	Shrubby Treed Rich Fen	0.91
	h1(STNN)	Coniferous Swamp Sw-Sb	0.90
	d1	Low Bush Cranberry Aw	0.90
	g1(STNN)	Coniferous Swamp Pj-Sb	0.90
	Lt(STNN)	Coniferous Swamp Lt	0.89
	Sb(STNN)	Coniferous Swamp Sb	0.89
	Sb-Lt(SFNN)	Coniferous Swamp Sb-Lt	0.89
	j2/h1(FTNN)	Treed Poor Fen Sb/Sw-Lt	0.89
	d3(STNN)	Coniferous Swamp Sw	0.88
	j2(FTNN)	Treed Poor Fen Sb-Lt	0.88
	b4(STNN)	Coniferous Swamp Sw-Pj	0.88
	j2(FFNN)	Treed Poor Fen Sb-Lt	0.87
	Lt-Aw(STNN)	Coniferous Swamp Lt-Aw	0.87
	Lt-Pb(STNN)	Coniferous Swamp Lt-Pb	0.87
	Lt-Sb(STNN)	Coniferous Swamp Lt-Sb	0.87
	k1(FTNN)	Treed Rich Fen	0.82
	k1(FOPN)	Patterned Open Rich Fen	0.81
	e3	Dogwood Sw	0.81
	j1(FTNN)	Treed Poor Fen Sb-Lt	0.80
	e2	Dogwood Pb-Sw	0.78
	i2(BTNN)	Shrubby Bog	0.75
	e2/f2	Pb-Sw	0.71
	d2	Low Bush Cranberry Aw-Sw	0.68
	j1/g1(FFNN)	Treed Poor Fen Sb-Pj	0.67
Moderate Suitability	j1/h1(FTNN)	Treed Poor Fen Sb-Sw-Lt	0.66
(0.34 - 0.66)	j1/g1 (FTNN)	Treed Poor Fen Lt-Sb-Pj	0.65
	j1/g1(FTNN)	Treed Poor Fen Lt-Sb-Pj	0.65
	b3	Blueberry Aw-Sw	0.59
	b1	Blueberry Pj-Aw	0.56
	b4	Blueberry Sw-Pj	0.49
	b2	Blueberry Aw(Bw)	0.48
	g1	Labrador Tea-subhygric Sb-Pj	0.47

Habitat Suitability Class	Code	Vegetation Type	HSI
Moderate Suitability	Lt-Sb	Upland Lt-Sb	0.46
Continued	Sb-Lt	Upland Sb-Lt	0.46
	h1	Labrador Tea/Horsetail Sw-Sb	0.41
	d3	Low Bush Cranberry Sw	0.40
	c1	Labrador Tea-mesic Pj-Sb	0.40
	a1/g1 complex	Pj-Lt	0.39
	c1(STNN)	Coniferous Swamp Pj-Sb	0.36
Low Suitability	a1	Lichen Pj	0.28
(0.01 - 0.33)	k3(FONG)	Graminoid Rich Fen	0.04
Unsuitable Habitat	AIG	Gravel Pits	0.00
(0.00)	AIH	Roads and Rights-of-way	0.00
	AIM	Surface Mines	0.00
	i1(MONG)	Marsh	0.00
	NMC	Cutbanks	0.00
	NWF(WONN)	Shallow Open Water	0.00
	NWL	Lakes and Ponds	0.00
	NWR	Rivers	0.00
	UN	Unclassified	0.00
	o	Reclaimed Open Water	0.00
	w	Reclaimed Wetland	0.00
	rr	Rip-rap	0.00

Table 26 Habitat Suitability Index Values for Snowshoe Hares in the Regional Study Area

Habitat Suitability Class	Code	Vegetation Type	HSI
High Suitability	7	Wet Shrublands	0.94
(0.67 - 1.00)	15	Cutblocks	0.94
	5	Aspen (Poplar) Forest	0.92
	13/14	Burned Fen	0.90
	11	Wooded Peatland	0.88
	10	Unclassified	0.78
	4	Spruce Forest	0.69
Moderate Suitability	3	Mixedwood Forest	0.59
(0.34 - 0.66)	12	Paper Birch Forest	0.48
	2	Jack Pine Forest	0.42
Low Suitability	6	Graminoid Fen	0.04
(0.01 - 0.33)			
Unsuitable Habitat	8	Marsh	0.00
(0.00)	1	Open Water	0.00
	9	Disturbances	0.00

Table 27 Habitat Suitability Index Values for Western Tanagers in the Local Study Area

Habitat Suitability Class	Code	Vegetation Type	HSI
High Suitability	b3	Blueberry Aw-Sw	0.90
(0.67 - 1.00)	c1	Labrador Tea-mesic Pj-Sb	0.90
	d3	Low Bush Cranberry Sw	0.90
	e3	Dogwood Sw	0.90
	b4	Blueberry Sw-Pj	0.86
	e2/f2	Pb-Sw	0.83
Moderate Suitability	e2	Dogwood Pb-Sw	0.50
(0.34 - 0.66)	a1	Lichen Pj	0.50
	b1	Blueberry Pj-Aw	0.49
	d2	Low Bush Cranberry Aw-Sw	0.45
Low Suitability	e1/f1	Pb-Aw	0.22
(0.01 - 0.33)	a1/g1 complex	Pj-Lt	0.20
	d3(STNN)	Coniferous Swamp Sw	0.18
	b4(STNN)	Coniferous Swamp Sw-Pj	0.18
	c1(STNN)	Coniferous Swamp Pj-Sb	0.17
	Lt-Sb	Upland Lt-Sb	0.15
	j1/g1(FTNN)	Treed Poor Fen Lt-Sb-Pj	0.12
	e1	Dogwood Pb-Aw	0.12
	d1	Low Bush Cranberry Aw	0.10
	b2	Blueberry Aw(Bw)	0.09
	j1/g1 (FTNN)	Treed Poor Fen Lt-Sb-Pj	0.09
	g1(STNN)	Coniferous Swamp Pj-Sb	0.09
	Lt-Sb(STNN)	Coniferous Swamp Lt-Sb	0.07
	h1	Labrador Tea/Horsetail Sw-Sb	0.07
	h1(STNN)	Coniferous Swamp Sw-Sb	0.06
	d2(STNN)	Coniferous Swamp Aw-Sw	0.06
	g1	Labrador Tea-subhygric Sb-Pj	0.06
	Lt-Pb(STNN)	Coniferous Swamp Lt-Pb	0.05
	j2/h1(FTNN)	Treed Poor Fen Sb/Sw-Lt	0.05
	Sb-Lt	Upland Sb-Lt	0.03
	j1(FTNN)	Treed Poor Fen Sb-Lt	0.02
	k1(FTNN)	Treed Rich Fen	0.02
	Sb-Lt(STNN)	Coniferous Swamp Sb-Lt	0.02
	Lt(STNN)	Coniferous Swamp Lt	0.01
	j1/h1(FTNN)	Treed Poor Fen Sb-Sw-Lt	0.01
	j2(FTNN)	Treed Poor Fen Sb-Lt	0.01
	k2(FTNN)	Shrubby Treed Rich Fen	0.01
	Lt-Aw(STNN)	Coniferous Swamp Lt-Aw	0.01
	i2(BTNN)	Shrubby Bog	0.01
	k1(FOPN)	Patterned Open Rich Fen	0.00

Habitat Suitability Class	Code	Vegetation Type	HSI
(0.00)	(Sb-Lt)SFNN	Coniferous Swamp(Sb-Lt)	0.00
Unsuitable Habitat	j1/g1(FFNN)	Treed Poor Fen Sb-Pj	0.00
	Sb(STNN)	Coniferous Swamp Sb	0.00
	Sb-Lt(SFNN)	Coniferous Swamp Sb-Lt	0.00
	shrub	Upland Shrubland	0.00
	j2(FFNN)	Treed Poor Fen Sb-Lt	0.00
	shrub(SONS)	Shrubby Swamp	0.00
	r	Reclaimed Riparian Shrub	0.00
	k2(FONS)	Shrubby Rich Fen	0.00
	k3(FONG)	Graminoid Rich Fen	0.00
	AIG	Gravel Pits	0.00
	AIH	Roads and Rights-of-way	0.00
	AIM	Surface Mines	0.00
	l1(MONG)	Marsh	0.00
	NMC	Cutbanks	0.00
	NWF(WONN)	Shallow Open Water	0.00
	NWL	Lakes and Ponds	0.00
	NWR	Rivers	0.00
	UN	Unclassified	0.00
	o	Reclaimed Open Water	0.00
	w	Reclaimed Wetland	0.00
	rr	Rip-rap	0.00

Table 28 Habitat Suitability Index Values for Western Tanagers in the Regional Study Area

Habitat Suitability Class	Code	Vegetation Type	HSI
High Suitability	2	Jack Pine Forest	0.84
(0.67 - 1.00)			
Moderate Suitability	3	Mixedwood Forest	0.49
(0.34 - 0.66)	4	Spruce Forest	0.45
Low Suitability	10	Unclassified	0.17
(0.01 - 0.33)	5	Aspen (Poplar) Forest	0.10
	12	Paper Birch Forest	0.09
	11	Wooded Peatland	0.02
	15	Cutblocks	0.01
Unsuitable Habitat	7	Wet Shrublands	0.00
(0.00)	13/14	Burned Fen	0.00
	6	Graminoid Fen	0.00
	1	Open Water	0.00
	8	Marsh	0.00
	9	Disturbances	0.00

APPENDIX V
SPECIES OCCURRENCE BY VEGETATION TYPE

APPENDIX V

Table 1 Potential and Observed use of Vegetation Communities by Bird Species

Common Name	Open Water	Jack Pine Forest	Mixed Wood Forest	Black and White Spruce Forest	Aspen (Poplar) Forest	Graminoid Fen/Shrubby	Riparian	Marsh	Wooded Fens or Bogs	Paper Birch Forest
red-throated loon	x									
arctic loon	x									
common loon	x						P			
pied-billed grebe	x						P	x		
horned grebe	x						P	x	P	
red-necked grebe	x						P	x		
eared grebe	x							x		
western grebe	x									
American white pelican	x						P			
cormorant	x						P	x		
American bittern						x	P	x	P	
great blue heron	x		x	x	P	x	P	x		P
great egret	x					x		x		
tundra swan	x									
trumpeter swan	x									
goose	x									
snow goose	x									
Ross' goose	x									
Canada goose	x						P		P	
wood duck	x					x		x		
green-winged teal	x					x	P	x	P	
American black duck	x					x		x		
mallard	x				x	x	P	x	P	x
northern pintail	x					x	P	x	P	
blue-winged teal	x					x	P	x	P	
cinnamon teal	x					x		x		
northern shoveler	x					x	P	x	P	
gadwall	x					x	P	x	P	
Eurasian wigeon	x					x		x		
American wigeon	x					x	P	x	P	
canvasback	x					x	P	x	P	
redhead	x					x	P	x	P	
ring-necked duck	x					x	P	x	P	
greater scaup	x					x		x		
lesser scaup	x					x	P	x	P	
harlequin duck										
oldsquaw	x									
surf scoter	x					x		x		
white-winged scoter	x					x		x		
common goldeneye	x				P	x	P	x		P
Barrow's goldeneye	x					x		x		
bufflehead	x				x	x	P	x		x
hooded merganser	x					x	P	x	P	
common merganser	x					x	P	x		
merganser	x					x	P	x		
ruddy duck	x						P	x	P	
osprey	x						P		P	
bald eagle	x				x		P			x
northern harrier						x	P	x	P	
sharp-shinned hawk		P	P	P	P				x	P
Cooper's hawk										
northern goshawk			P							
broad-winged hawk			x		P				P	P
Swainson's hawk										
red-tailed hawk		P	P	P	P					P
rough-legged hawk		M								
golden eagle									P	
American kestrel			x		P		P			P
merlin							P		P	
peregrine falcon	x						P	x	P	
gyrfalcon		G								
spruce grouse		P	P	P					P	
willow ptarmigan		M								
ruffed grouse			P		P					P
sharp-tailed grouse							P		P	

X. indicates species observed on Lease 13.
P. indicates species potentially on Lease 13.

APPENDIX V

Table 1 Potential and Observed use of Vegetation Communities by Bird Species

Common Name	Open Water	Jack Pine Forest	Mixed Wood Forest	Black and White Spruce Forest	Aspen (Poplar) Forest	Graminoid Fen/Shrubby	Riparian	Marsh	Wooded Fens or Bogs	Paper Birch Forest
sora					x	x	P	x	P	x
American coot	x					x	P	x	P	
sandhill crane						x	P	x	P	
whooping crane										
black-bellied plover										
lesser golden plover										
semipalmated plover							P			
killdeer							P		P	
American avocet	x							x		
greater yellowlegs						x		x	y	
lesser yellowlegs						x		x	P	
solitary sandpiper						x	P	x	P	
willet								x		
spotted sandpiper							P	x	x	
upland sandpiper										
whimbrel										
hudsonian godwit										
marbled godwit							P		x	
ruddy turnstone										
sanderling										
sandpiper										
western sandpiper										
least sandpiper							P		P	
sandpiper										
Baird's sandpiper										
pectoral sandpiper										
dunlin										
stilt sandpiper										
sandpiper										
short-billed dowitcher									P	
long-billed dowitcher										
common snipe			x	x	x	x		x	P	x
Wilson's phalarope	x					x	P	x	P	
red-necked phalarope	x					x		x		
red phalarope	x					x		x		
Franklin's gull	x					x	P	x	P	
Bonaparte's gull	x					x	P	x	P	
mew gull	x						P	x		
ring-billed gull	x						P	x		
California gull	x						P	x		
herring gull	x						P	x		
Iceland gull	x							x		
glaucous gull	x							x		
Caspian tern	x									
common tern	x					x	P	x	P	
arctic tern	x							x		
black tern	x					x	P	x	P	
rock dove										
mourning dove		G								
great-horned owl		P	P	P	P		P		P	P
snowy owl		M								
northern hawk owl		P	P			x			P	
barred owl										
great gray owl		P	P	P	P	x	P		P	P
long-eared owl										
short-eared owl						x		x		
boreal owl			x	P					P	
common nighthawk										
belted kingfisher						x	P	x	P	
sapsucker			P	x	P					P
downy woodpecker			P		P					P
hairy woodpecker		P	P	P	P					P
three-toed woodpecker		P	P	P					x	
woodpecker		P	P	P					x	
northern flicker		P	x	x	P					P

X. indicates species observed on Lease 13.
P. indicates species potentially on Lease 13.

APPENDIX V

Table 1 Potential and Observed use of Vegetation Communities by Bird Species

Common Name	Open Water	Jack Pine Forest	Mixed Wood Forest	Black and White Spruce Forest	Aspen (Poplar) Forest	Graminoid Fen/Shrubby	Riparian	Marsh	Wooded Fens or Bogs	Paper Birch Forest
pileated woodpecker			P	x	P					P
olive-sided flycatcher		P	x			x	P		P	
great-crested flycatcher			x	x	P					P
western wood-pewee		P	P	x	x	x	P	x	P	P
flycatcher		P	x	x	x				x	x
alder flycatcher			x	x	x		P		x	x
least flycatcher			x						x	x
eastern phoebe			P		P	x	P		P	P
Say's phoebe							P			
eastern kingbird			x		P	x	P		P	P
horned lark					P					P
tree swallow			x		P	x	P	x	P	P
bank swallow							P	x		
cliff swallow							P	x		
barn swallow							P	x		
gray jay		P	x	x	x				x	x
blue jay			P		P					P
black-billed magpie		P	x		P		P			P
American crow		P	x	x	P				P	P
common raven		P	x	P	x		P		P	x
chickadee			P		P					P
boreal chickadee		P	P	x			P		x	
red-breasted nuthatch		P	P	x					x	
brown creeper		P	P	P						
house wren		P								
winter wren		P	x	P					x	
marsh wren						x	P	x	P	
golden-crowned kinglet		P	x	P						
ruby-crowned kinglet		P	x	x	x				x	x
mountain bluebird			x		P				P	P
veery										
gray-cheeked thrush										
Swainson's thrush			x	x	x		P		x	x
hermit thrush		P	x	x	x				x	x
American robin			x	P			P			
northern mockingbird		P								
brown thrasher		P								
American pipit									P	
Bohemian waxwing		P	x	P			P			
cedar waxwing			x	x	P		P		x	P
northern shrike										
European starling			x		P					P
solitary vireo			x						x	
warbling vireo			P		P					P
Philadelphia vireo			x		x				x	x
red-eyed vireo			x	x	x		P			x
Tennessee warbler			x	x	x	x	P	x	x	x
warbler			x		P		P		x	P
yellow warbler						x	P		x	
magnolia warbler		P	x	x	x		P		y	x
Cape May warbler			x	P						
yellow-rumped warbler		P	x	x	x				y	x
warbler		P	x	P						
palm warbler			x	x	x	x			x	x
bay-breasted warbler				P	x				P	x
blackpoll warbler			x	P					x	
warbler			x	x	x		P		P	x
American redstart			x	x	P		P		x	P
ovenbird			x	x	x				x	x
northern waterthrush			x	x		x	P	x	x	
Connecticut warbler			x	x	x				P	x
mourning warbler			x		P					P
common yellowthroat			x	x		x	P	x	P	
Wilson's warbler			x				P		P	
Canada warbler			x		x		P		P	x

X. indicates species observed on Lease 13.
P. indicates species potentially on Lease 13.

APPENDIX V

Table 1 Potential and Observed use of Vegetation Communities by Bird Species

Common Name	Open Water	Jack Pine Forest	Mixed Wood Forest	Black and White Spruce Forest	Aspen (Poplar) Forest	Graminoid Fen/Shrubby	Riparian	Marsh	Wooded Fens or Bogs	Paper Birch Forest
western tanager			x		x				x	x
grosbeak			x	x	x					x
indigo bunting		G								
American tree sparrow							P		P	
chipping sparrow			x	x	x				x	x
clay-colored sparrow						x	P		P	
vesper sparrow									P	
savannah sparrow						x		x	P	
LeConte's sparrow			x			x		x	x	
sharp-tailed sparrow						x	P	x	P	
fox sparrow							P		P	
song sparrow						x	P	x	P	
Lincoln's sparrow						x	P	x	P	
swamp sparrow						x	P	x	x	
white-throated sparrow		P	x	x	x		P		x	x
white-crowned sparrow							P		P	
Harris' sparrow		M								
dark-eyed junco		P	P	x					x	
Lapland longspur		M								
Smith's longspur		M								
snow bunting		M								
bobolink		G								
red-winged blackbird					x	x	P	x	P	x
western meadowlark		G								
blackbird						x	P	x	P	
rusty blackbird						x	P		P	
Brewer's blackbird					P	x	P		P	P
common grackle						x	P		P	
brown-headed cowbird						x				
northern oriole										
pine grosbeak										
purple finch			P	P	P					P
red crossbill		P	P	P	P					P
white-winged crossbill			P	x	x				x	x
common redpoll			x	x	P				P	P
hoary redpoll		M								
pine siskin		P	P	P	x				x	x
American goldfinch										
evening grosbeak			P	P	P				x	P
house sparrow										
Species Richness	63	48	81	57	66	70	97	78	112	67
Richness Index	0.23	0.00	0.52	0.14	0.28	0.34	0.77	0.47	1.00	0.30

X. indicates species observed on Lease 13.
P. indicates species potentially on Lease 13.

Table 2 Potential and Observed use of Vegetation Communities by Mammal Species

Common Name	open water	Jack Pine	Mixedwood Forest	Black and White Spruce	Aspen and Poplar Forest	Graminoid Fen/ShrubbP Fen	Riparian
masked shrew		P	P	P	P		
duskP shrew				P			P
water shrew						P	P
arctic shrew			P		P		
pPgmP shrew		P	P	P	P		
little brown bat	P					P	P
northern long-eared bat	P	P	P	P	P	P	P
silver-haired bat	P		P		P	P	P
big brown bat	P					P	P
hoarP bat	P	P	P	P	P	P	P
snowshoe hare		P	P	P	x		
least chipmunk		P	P	P	x		
woodchuck			P				
red squirrel		P	P	P			
northern flPing squirrel		P	P	P			
beaver	x					x	P
deer mouse		P	P	P	P		
southern red-backed vole		P	x	P	P		
heather vole		P					P
meadow vole			P		P	P	P
muskrat	x					x	P
northern bog lemming				x		x	P
meadow jumping mouse						x	P
porcupine			P		P		
coPote		P	P	P	P		P
graP wolf		P	P	P	P		
red fox		P	P	P	P		P
black bear		P	P	P	P		
marten		P		P		x	
fisher		P		P		x	
ermine		P	P	P			
least weasel		P	P	P			
mink				x		x	P
wolverine		P	x	P			
striped skunk			P	P	P		
river otter	x					x	P
canada lPnx		P	P	P			
mule deer			P		P		
white-tailed deer			P		P		
moose			P	P	P	x	P
caribou			x	P			
Species Richness	8	21	28	26	20	16	18
Richness Index	0.00	0.62	0.95	0.86	0.57	0.38	0.48

x indicates species observed on Lease 13
P indicates species potentiallP on Lease 13

APPENDIX V

Table 3 Potential and Observed use of Vegetation Communities by Amphibian and Reptile Species

Common Name	open Water	Jack Pine Forest	Mixedwood Forest	Black and White Spruce Forest	Aspen (Poplar) Forest	Fen	Riparian	Marsh	Treed Bog (black spruce)	Paper Birch Forest
Canadian toad		x	x	x	x	x	P	x	P	x
stripped chorus frog						x	P	x	P	
wood frog						x	P	x	P	
red-sided garter snake		x	x	x	x	x	P	x	P	x
Species Richness	0	2	2	2	2	4	4	4	4	2
Richness Index	0.00	0.50	0.50	0.50	0.50	1.00	1.00	1.00	1.00	0.50

x indicates species observed on Lease 13
P indicates species potentially on Lease 13

APPENDIX VI
RAW HSI RESULTS FOR THE RSA

Beaver - Regional Study Area Baseline Scenario

Habitat Class	Area	Percent	HU	Percent
No Habitat Total (HSI = 0.0)	925630	88.2	0	0.0
Existing Disturbances	30035	2.9	0	0.0
New Disturbances	0	0.0	0	0.0
Open Water	20971	2.0	0	0.0
Unsuitable Vegetated Areas	874624	83.3	0	0.0
Low Suitability (0.01-0.33)	0	0.0	0	0.0
Medium Suitability (0.34-0.66)	13778	1.3	4901	4.6
High Suitability (0.67-1.00)	110581	10.5	100508	95.4
Total Area	1049989	100.0	105408	100.0

Beaver - Regional Study Area Scenario 1 (Muskeg River Mine)

Habitat Class	Area	Percent	HU	Percent
No Habitat Total (HSI = 0.0)	925720	88.2	0	0.0
Existing Disturbances	29860	2.8	0	0.0
New Disturbances	4313	0.4	0	0.0
Open Water	20954	2.0	0	0.0
Unsuitable Vegetated Areas	870592	82.9	0	0.0
Low Suitability (0.01-0.33)	0	0.0	0	0.0
Medium Suitability (0.34-0.66)	13774	1.3	4899	4.7
High Suitability (0.67-1.00)	110494	10.5	100426	95.3
Total Area	1049989	100.0	105325	100.0

Beaver - Regional Study Area Scenario 2 (CEA)

Habitat Class	Area	Percent	HU	Percent
No Habitat Total (HSI = 0.0)	926838	88.3	0	0.0
Existing Disturbances	29695	2.8	0	0.0
New Disturbances	22556	2.1	0	0.0
Open Water	20936	2.0	0	0.0
Unsuitable Vegetated Areas	853651	81.3	0	0.0
Low Suitability (0.01-0.33)	0	0.0	0	0.0
Medium Suitability (0.34-0.66)	13700	1.3	4873	4.7
High Suitability (0.67-1.00)	109450	10.4	98959	95.3
Total Area	1049988	100.0	103833	100.0

Beaver - Regional Study Area Scenario 3 (RDR)

Habitat Class	Area	Percent	HU	Percent
No Habitat Total (HSI = 0.0)	928501	88.4	0	0.0
Existing Disturbances	29485	2.8	0	0.0
New Disturbances	40382	3.8	0	0.0
Open Water	20924	2.0	0	0.0
Unsuitable Vegetated Areas	837710	79.8	0	0.0
Low Suitability (0.01-0.33)	0	0.0	0	0.0
Medium Suitability (0.34-0.66)	13509	1.3	4807	4.7
High Suitability (0.67-1.00)	107979	10.3	98083	95.3
Total Area	1049989	100.0	102891	100.0

Black Bear - Regional Study Area Baseline Scenario

Habitat Class	Area	Percent	HU	Percent
No Habitat Total (HSI = 0.0)	90917	8.7	0	0.0
Existing Disturbances	30035	2.9	0	0.0
New Disturbances	0	0.0	0	0.0
Open Water	20971	2.0	0	0.0
Unsuitable Vegetated Areas	39912	3.8	0	0.0
Low Suitability (0.01-0.33)	650168	61.9	141703	39.1
Medium Suitability (0.34-0.66)	80329	7.7	40437	11.2
High Suitability (0.67-1.00)	228574	21.8	179876	49.7
Total Area	1049989	100.0	362016	100.0

Black Bear - Regional Study Area Scenario 1 (Muskeg River Mine)

Habitat Class	Area	Percent	HU	Percent
No Habitat Total (HSI = 0.0)	95489	9.1	0	0.0
Existing Disturbances	29860	2.8	0	0.0
New Disturbances	4313	0.4	0	0.0
Open Water	20954	2.0	0	0.0
Unsuitable Vegetated Areas	40361	3.8	0	0.0
Low Suitability (0.01-0.33)	646584	61.6	140890	39.1
Medium Suitability (0.34-0.66)	80184	7.6	40363	11.2
High Suitability (0.67-1.00)	227732	21.7	179174	49.7
Total Area	1049989	100.0	360427	100.0

Black Bear - Regional Study Area Scenario 2 (CEA)

Habitat Class	Area	Percent	HU	Percent
No Habitat Total (HSI = 0.0)	114490	10.9	0	0.0
Existing Disturbances	29695	2.8	0	0.0
New Disturbances	22556	2.1	0	0.0
Open Water	20936	2.0	0	0.0
Unsuitable Vegetated Areas	41303	3.9	0	0.0
Low Suitability (0.01-0.33)	632615	60.2	137764	39.0
Medium Suitability (0.34-0.66)	78911	7.5	39711	11.2
High Suitability (0.67-1.00)	223973	21.3	176177	49.8
Total Area	1049988	100.0	353651	100.0

Black Bear - Regional Study Area Scenario 3 (RDR)

Habitat Class	Area	Percent	HU	Percent
No Habitat Total (HSI = 0.0)	134378	12.8	0	0.0
Existing Disturbances	29485	2.8	0	0.0
New Disturbances	40382	3.8	0	0.0
Open Water	20924	2.0	0	0.0
Unsuitable Vegetated Areas	43587	4.2	0	0.0
Low Suitability (0.01-0.33)	621117	59.2	135121	39.2
Medium Suitability (0.34-0.66)	77365	7.4	38915	11.3
High Suitability (0.67-1.00)	217128	20.7	170764	49.5
Total Area	1049988	100.0	344799	100.0

Cape May Warbler - Regional Study Area Baseline Scenario

Habitat Class	Area	Percent	HU	Percent
No Habitat Total (HSI = 0.0)	192083	18.3	0	0.0
Existing Disturbances	30035	2.9	0	0.0
New Disturbances	0	0.0	0	0.0
Open Water	20971	2.0	0	0.0
Unsuitable Vegetated Areas	141078	13.4	0	0.0
Low Suitability (0.01-0.33)	767952	73.1	107592	66.2
Medium Suitability (0.34-0.66)	89953	8.6	54862	33.8
High Suitability (0.67-1.00)	0	0.0	0	0.0
Total Area	1049989	100.0	162454	100.0

Cape May Warbler - Regional Study Area Scenario 1 (Muskeg River Mine)

Habitat Class	Area	Percent	HU	Percent
No Habitat Total (HSI = 0.0)	196744	18.7	0	0.0
Existing Disturbances	29859	2.8	0	0.0
New Disturbances	4313	0.4	0	0.0
Open Water	20953	2.0	0	0.0
Unsuitable Vegetated Areas	141619	13.5	0	0.0
Low Suitability (0.01-0.33)	763466	72.7	106873	66.1
Medium Suitability (0.34-0.66)	89778	8.6	54747	33.9
High Suitability (0.67-1.00)	0	0.0	0	0.0
Total Area	1049989	100.0	161621	100.0

Cape May Warbler - Regional Study Area Scenario 2 (CEA)

Habitat Class	Area	Percent	HU	Percent
No Habitat Total (HSI = 0.0)	212115	20.2	0	0.0
Existing Disturbances	29696	2.8	0	0.0
New Disturbances	22557	2.1	0	0.0
Open Water	20936	2.0	0	0.0
Unsuitable Vegetated Areas	138927	13.2	0	0.0
Low Suitability (0.01-0.33)	748949	71.3	104857	65.9
Medium Suitability (0.34-0.66)	88924	8.5	54214	34.1
High Suitability (0.67-1.00)	0	0.0	0	0.0
Total Area	1049989	100.0	159071	100.0

Cape May Warbler - Regional Study Area Scenario 3 (RDR)

Habitat Class	Area	Percent	HU	Percent
No Habitat Total (HSI = 0.0)	229211	21.8	0	0.0
Existing Disturbances	29486	2.8	0	0.0
New Disturbances	40382	3.8	0	0.0
Open Water	20924	2.0	0	0.0
Unsuitable Vegetated Areas	138419	13.2	0	0.0
Low Suitability (0.01-0.33)	733697	69.9	102479	65.9
Medium Suitability (0.34-0.66)	87080	8.3	53057	34.1
High Suitability (0.67-1.00)	0	0.0	0	0.0
Total Area	1049989	100.0	155536	100.0

Dabbling Duck - Regional Study Area Baseline Scenario

Habitat Class	Area	Percent	HU	Percent
No Habitat Total (HSI = 0.0)	829197	79.0	0	0.0
Existing Disturbances	30035	2.9	0	0.0
New Disturbances	0	0.0	0	0.0
Open Water	0	0.0	0	0.0
Unsuitable Vegetated Areas	799162	76.1	0	0.0
Low Suitability (0.01-0.33)	126365	12.0	39748	36.5
Medium Suitability (0.34-0.66)	74283	7.1	49024	45.0
High Suitability (0.67-1.00)	20145	1.9	20145	18.5
Total Area	1049988	100.0	108916	100.0

Dabbling Duck - Regional Study Area Scenario 1 (Muskeg River Mine)

Habitat Class	Area	Percent	HU	Percent
No Habitat Total (HSI = 0.0)	795338	75.7	0	0.0
Existing Disturbances	29860	2.8	0	0.0
New Disturbances	4313	0.4	0	0.0
Open Water	0	0.0	0	0.0
Unsuitable Vegetated Areas	795338	75.7	0	0.0
Low Suitability (0.01-0.33)	126201	12.0	39660	36.5
Medium Suitability (0.34-0.66)	74178	7.1	48953	45.0
High Suitability (0.67-1.00)	20099	1.9	20099	18.5
Total Area	1049989	100.0	108712	100.0

Dabbling Duck - Regional Study Area Scenario 2 (CEA)

Habitat Class	Area	Percent	HU	Percent
No Habitat Total (HSI = 0.0)	831876	79.2	0	0.0
Existing Disturbances	29696	2.8	0	0.0
New Disturbances	22557	2.1	0	0.0
Open Water	0	0.0	0	0.0
Unsuitable Vegetated Areas	779623	74.3	0	0.0
Low Suitability (0.01-0.33)	124711	11.9	39202	36.4
Medium Suitability (0.34-0.66)	73498	7.0	48506	45.1
High Suitability (0.67-1.00)	19904	1.9	19905	18.5
Total Area	1049988	100.0	107613	100.0

Dabbling Duck - Regional Study Area Scenario 3 (RDR)

Habitat Class	Area	Percent	HU	Percent
No Habitat Total (HSI = 0.0)	833668	79.4	0	0.0
Existing Disturbances	29486	2.8	0	0.0
New Disturbances	40382	3.8	0	0.0
Open Water	0	0.0	0	0.0
Unsuitable Vegetated Areas	763801	72.7	0	0.0
Low Suitability (0.01-0.33)	123834	11.8	38788	36.4
Medium Suitability (0.34-0.66)	72765	6.9	48021	45.1
High Suitability (0.67-1.00)	19721	1.9	19720	18.5
Total Area	1049988	100.0	106529	100.0

Fisher - Regional Study Area Baseline Scenario

Habitat Class	Area	Percent	HU	Percent
No Habitat Total (HSI = 0.0)	53488	5.1	0	0.0
Existing Disturbances	30035	2.9	0	0.0
New Disturbances	0	0.0	0	0.0
Open Water	20971	2.0	0	0.0
Unsuitable Vegetated Areas	2482	0.2	0	0.0
Low Suitability (0.01-0.33)	46524	4.4	2039	0.4
Medium Suitability (0.34-0.66)	676952	64.5	357197	64.2
High Suitability (0.67-1.00)	273025	26.0	196722	35.4
Total Area	1049989	100.0	555957	100.0

Fisher - Regional Study Area Scenario 1 (Muskeg River Mine)

Habitat Class	Area	Percent	HU	Percent
No Habitat Total (HSI = 0.0)	57645	5.5	0	0.0
Existing Disturbances	29860	2.8	0	0.0
New Disturbances	4313	0.4	0	0.0
Open Water	20954	2.0	0	0.0
Unsuitable Vegetated Areas	2517	0.2	0	0.0
Low Suitability (0.01-0.33)	48525	4.6	2358	0.4
Medium Suitability (0.34-0.66)	671940	64.0	356128	64.3
High Suitability (0.67-1.00)	271879	25.9	195170	35.3
Total Area	1049989	100.0	553656	100.0

Fisher - Regional Study Area Scenario 2 (CEA)

Habitat Class	Area	Percent	HU	Percent
No Habitat Total (HSI = 0.0)	75979	7.2	0	0.0
Existing Disturbances	29695	2.8	0	0.0
New Disturbances	22556	2.1	0	0.0
Open Water	20936	2.0	0	0.0
Unsuitable Vegetated Areas	2792	0.3	0	0.0
Low Suitability (0.01-0.33)	50524	4.8	2421	0.4
Medium Suitability (0.34-0.66)	655709	62.4	347526	64.1
High Suitability (0.67-1.00)	267777	25.5	192227	35.5
Total Area	1049989	100.0	542173	100.0

Fisher - Regional Study Area Scenario 3 (RDR)

Habitat Class	Area	Percent	HU	Percent
No Habitat Total (HSI = 0.0)	94894	9.0	0	0.0
Existing Disturbances	29485	2.8	0	0.0
New Disturbances	40382	3.8	0	0.0
Open Water	20924	2.0	0	0.0
Unsuitable Vegetated Areas	4103	0.4	0	0.0
Low Suitability (0.01-0.33)	52228	5.0	2273	0.4
Medium Suitability (0.34-0.66)	643618	61.3	339512	64.2
High Suitability (0.67-1.00)	259249	24.7	186907	35.4
Total Area	1049989	100.0	528692	100.0

Great Gray Owl - Regional Study Area Baseline Scenario

Habitat Class	Area	Percent	HU	Percent
No Habitat Total (HSI = 0.0)	51006	4.9	0	0.0
Existing Disturbances	30035	2.9	0	0.0
New Disturbances	0	0.0	0	0.0
Open Water	20971	2.0	0	0.0
Unsuitable Vegetated Areas	0	0.0	0	0.0
Low Suitability (0.01-0.33)	938860	89.4	273891	88.9
Medium Suitability (0.34-0.66)	28713	2.7	12197	4.0
High Suitability (0.67-1.00)	31409	3.0	22149	7.2
Total Area	1049988	100.0	308237	100.0

Great Gray Owl - Regional Study Area Scenario 1 (Muskeg River Mine)

Habitat Class	Area	Percent	HU	Percent
No Habitat Total (HSI = 0.0)	55128	5.3	0	0.0
Existing Disturbances	29860	2.8	0	0.0
New Disturbances	4313	0.4	0	0.0
Open Water	20954	2.0	0	0.0
Unsuitable Vegetated Areas	0	0.0	0	0.0
Low Suitability (0.01-0.33)	934847	89.0	271672	88.8
Medium Suitability (0.34-0.66)	28883	2.8	12306	4.0
High Suitability (0.67-1.00)	31131	3.0	21954	7.2
Total Area	1049989	100.0	305932	100.0

Great Gray Owl - Regional Study Area Scenario 2 (CEA)

Habitat Class	Area	Percent	HU	Percent
No Habitat Total (HSI = 0.0)	73188	7.0	0	0.0
Existing Disturbances	29696	2.8	0	0.0
New Disturbances	22557	2.1	0	0.0
Open Water	20936	2.0	0	0.0
Unsuitable Vegetated Areas	0	0.0	0	0.0
Low Suitability (0.01-0.33)	918620	87.5	265836	88.8
Medium Suitability (0.34-0.66)	27234	2.6	11621	3.9
High Suitability (0.67-1.00)	30947	2.9	21825	7.3
Total Area	1049989	100.0	299281	100.0

Great Gray Owl - Regional Study Area Scenario 3 (RDR)

Habitat Class	Area	Percent	HU	Percent
No Habitat Total (HSI = 0.0)	90792	8.6	0	0.0
Existing Disturbances	29486	2.8	0	0.0
New Disturbances	40382	3.8	0	0.0
Open Water	20924	2.0	0	0.0
Unsuitable Vegetated Areas	0	0.0	0	0.0
Low Suitability (0.01-0.33)	901178	85.8	259369	88.6
Medium Suitability (0.34-0.66)	27193	2.6	11600	4.0
High Suitability (0.67-1.00)	30825	2.9	21737	7.4
Total Area	1049988	100.0	292706	100.0

Moose - Regional Study Area Baseline Scenario

Habitat Class	Area	Percent	HU	Percent
No Habitat Total (HSI = 0.0)	86397	8.2	0	0.0
Existing Disturbances	30035	2.9	0	0.0
New Disturbances	0	0.0	0	0.0
Open Water	20971	2.0	0	0.0
Unsuitable Vegetated Areas	35392	3.4	0	0.0
Low Suitability (0.01-0.33)	52966	5.0	9499	2.5
Medium Suitability (0.34-0.66)	872952	83.1	346117	89.8
High Suitability (0.67-1.00)	37674	3.6	29675	7.7
Total Area	1049989	100.0	385291	100.0

Moose - Regional Study Area Scenario 1 (Muskeg River Mine)

Habitat Class	Area	Percent	HU	Percent
No Habitat Total (HSI = 0.0)	90494	8.6	0	0.0
Existing Disturbances	29860	2.8	0	0.0
New Disturbances	4313	0.4	0	0.0
Open Water	20954	2.0	0	0.0
Unsuitable Vegetated Areas	35366	3.4	0	0.0
Low Suitability (0.01-0.33)	55401	5.3	9832	2.6
Medium Suitability (0.34-0.66)	866573	82.5	343477	89.7
High Suitability (0.67-1.00)	37521	3.6	29551	7.7
Total Area	1049989	100.0	382860	100.0

Moose - Regional Study Area Scenario 2 (CEA)

Habitat Class	Area	Percent	HU	Percent
No Habitat Total (HSI = 0.0)	108438	10.3	0	0.0
Existing Disturbances	29695	2.8	0	0.0
New Disturbances	22556	2.1	0	0.0
Open Water	20936	2.0	0	0.0
Unsuitable Vegetated Areas	35251	3.4	0	0.0
Low Suitability (0.01-0.33)	58772	5.6	10401	2.8
Medium Suitability (0.34-0.66)	847835	80.7	336105	89.9
High Suitability (0.67-1.00)	34944	3.3	27457	7.3
Total Area	1049989	100.0	373963	100.0

Moose - Regional Study Area Scenario 3 (RDR)

Habitat Class	Area	Percent	HU	Percent
No Habitat Total (HSI = 0.0)	126922	12.1	0	0.0
Existing Disturbances	29485	2.8	0	0.0
New Disturbances	40382	3.8	0	0.0
Open Water	20924	2.0	0	0.0
Unsuitable Vegetated Areas	36131	3.4	0	0.0
Low Suitability (0.01-0.33)	67204	6.4	12166	3.3
Medium Suitability (0.34-0.66)	821442	78.2	322670	88.7
High Suitability (0.67-1.00)	34421	3.3	29050	8.0
Total Area	1049989	100.0	363886	100.0

Pileated Woodpecker - Regional Study Area Baseline Scenario

Habitat Class	Area	Percent	HU	Percent
No Habitat Total (HSI = 0.0)	114010	10.9	0	0.0
Existing Disturbances	30035	2.9	0	0.0
New Disturbances	0	0.0	0	0.0
Open Water	20971	2.0	0	0.0
Unsuitable Vegetated Areas	63004	6.0	0	0.0
Low Suitability (0.01-0.33)	651291	62.0	91692	28.2
Medium Suitability (0.34-0.66)	93097	8.9	60263	18.6
High Suitability (0.67-1.00)	191591	18.2	172871	53.2
Total Area	1049988	100.0	324826	100.0

Pileated Woodpecker - Regional Study Area Scenario 1 (Muskeg River Mine)

Habitat Class	Area	Percent	HU	Percent
No Habitat Total (HSI = 0.0)	118561	11.3	0	0.0
Existing Disturbances	29860	2.8	0	0.0
New Disturbances	4313	0.4	0	0.0
Open Water	20954	2.0	0	0.0
Unsuitable Vegetated Areas	63434	6.0	0	0.0
Low Suitability (0.01-0.33)	647799	61.7	91103	28.2
Medium Suitability (0.34-0.66)	92922	8.8	60139	18.6
High Suitability (0.67-1.00)	190706	18.2	172073	53.2
Total Area	1049989	100.0	323315	100.0

Pileated Woodpecker - Regional Study Area Scenario 2 (CEA)

Habitat Class	Area	Percent	HU	Percent
No Habitat Total (HSI = 0.0)	134637	12.8	0	0.0
Existing Disturbances	29696	2.8	0	0.0
New Disturbances	22557	2.1	0	0.0
Open Water	20936	2.0	0	0.0
Unsuitable Vegetated Areas	61449	5.9	0	0.0
Low Suitability (0.01-0.33)	635165	60.5	89375	28.0
Medium Suitability (0.34-0.66)	92068	8.8	59564	18.7
High Suitability (0.67-1.00)	188180	17.9	169756	53.3
Total Area	1050051	100.0	318695	100.0

Pileated Woodpecker - Regional Study Area Scenario 3 (RDR)

Habitat Class	Area	Percent	HU	Percent
No Habitat Total (HSI = 0.0)	152148	14.5	0	0.0
Existing Disturbances	29486	2.8	0	0.0
New Disturbances	40382	3.8	0	0.0
Open Water	20924	2.0	0	0.0
Unsuitable Vegetated Areas	61356	5.8	0	0.0
Low Suitability (0.01-0.33)	624054	59.4	87479	28.1
Medium Suitability (0.34-0.66)	90223	8.6	58321	18.7
High Suitability (0.67-1.00)	183563	17.5	165658	53.2
Total Area	1049989	100.0	311457	100.0

Red-backed Vole - Regional Study Area Baseline Scenario

Habitat Class	Area	Percent	HU	Percent
No Habitat Total (HSI = 0.0)	53325	5.1	0	0.0
Existing Disturbances	30035	2.9	0	0.0
New Disturbances	0	0.0	0	0.0
Open Water	20971	2.0	0	0.0
Unsuitable Vegetated Areas	2320	0.2	0	0.0
Low Suitability (0.01-0.33)	35392	3.4	1767	0.3
Medium Suitability (0.34-0.66)	879103	83.7	437700	86.6
High Suitability (0.67-1.00)	82169	7.8	65735	13.0
Total Area	1049989	100.0	505202	100.0

Red-backed Vole - Regional Study Area Scenario 1 (Muskeg River Mine)

Habitat Class	Area	Percent	HU	Percent
No Habitat Total (HSI = 0.0)	57448	5.5	0	0.0
Existing Disturbances	29860	2.8	0	0.0
New Disturbances	4313	0.4	0	0.0
Open Water	20954	2.0	0	0.0
Unsuitable Vegetated Areas	2320	0.2	0	0.0
Low Suitability (0.01-0.33)	35366	3.4	1766	0.4
Medium Suitability (0.34-0.66)	875044	83.3	435707	86.6
High Suitability (0.67-1.00)	82130	7.8	65704	13.1
Total Area	1049989	100.0	503176	100.0

Red-backed Vole - Regional Study Area Scenario 2 (CEA)

Habitat Class	Area	Percent	HU	Percent
No Habitat Total (HSI = 0.0)	75771	7.2	0	0.0
Existing Disturbances	29695	2.8	0	0.0
New Disturbances	22556	2.1	0	0.0
Open Water	20936	2.0	0	0.0
Unsuitable Vegetated Areas	2584	0.2	0	0.0
Low Suitability (0.01-0.33)	35190	3.4	1757	0.4
Medium Suitability (0.34-0.66)	856910	81.6	426828	86.4
High Suitability (0.67-1.00)	82118	7.8	65694	13.3
Total Area	1049989	100.0	494279	100.0

Red-backed Vole - Regional Study Area Scenario 3 (RDR)

Habitat Class	Area	Percent	HU	Percent
No Habitat Total (HSI = 0.0)	94593	9.0	0	0.0
Existing Disturbances	29485	2.8	0	0.0
New Disturbances	40382	3.8	0	0.0
Open Water	20924	2.0	0	0.0
Unsuitable Vegetated Areas	3802	0.4	0	0.0
Low Suitability (0.01-0.33)	35330	3.4	1764	0.4
Medium Suitability (0.34-0.66)	840279	80.0	418356	86.4
High Suitability (0.67-1.00)	79786	7.6	63829	13.2
Total Area	1049988	100.0	483948	100.0

Ruffed Grouse - Regional Study Area Baseline Scenario

Habitat Class	Area	Percent	HU	Percent
No Habitat Total (HSI = 0.0)	86397	8.2	0	0.0
Existing Disturbances	30035	2.9	0	0.0
New Disturbances	0	0.0	0	0.0
Open Water	20971	2.0	0	0.0
Unsuitable Vegetated Areas	35392	3.4	0	0.0
Low Suitability (0.01-0.33)	692760	66.0	144486	45.4
Medium Suitability (0.34-0.66)	79309	7.6	29666	9.3
High Suitability (0.67-1.00)	191522	18.2	144030	45.3
Total Area	1049988	100.0	318183	100.0

Ruffed Grouse - Regional Study Area Scenario 1 (Muskeg River Mine)

Habitat Class	Area	Percent	HU	Percent
No Habitat Total (HSI = 0.0)	90954	8.7	0	0.0
Existing Disturbances	29860	2.8	0	0.0
New Disturbances	4313	0.4	0	0.0
Open Water	20954	2.0	0	0.0
Unsuitable Vegetated Areas	35826	3.4	0	0.0
Low Suitability (0.01-0.33)	689343	65.7	143648	45.4
Medium Suitability (0.34-0.66)	79105	7.5	29602	9.3
High Suitability (0.67-1.00)	190586	18.2	143376	45.3
Total Area	1049988	100.0	316626	100.0

Ruffed Grouse - Regional Study Area Scenario 2 (CEA)

Habitat Class	Area	Percent	HU	Percent
No Habitat Total (HSI = 0.0)	108302	10.3	0	0.0
Existing Disturbances	29696	2.8	0	0.0
New Disturbances	22557	2.1	0	0.0
Open Water	20936	2.0	0	0.0
Unsuitable Vegetated Areas	35114	3.3	0	0.0
Low Suitability (0.01-0.33)	675357	64.3	140706	45.2
Medium Suitability (0.34-0.66)	78280	7.5	29282	9.4
High Suitability (0.67-1.00)	188049	17.9	141546	45.4
Total Area	1049989	100.0	311534	100.0

Ruffed Grouse - Regional Study Area Scenario 3 (RDR)

Habitat Class	Area	Percent	HU	Percent
No Habitat Total (HSI = 0.0)	125813	12.0	0	0.0
Existing Disturbances	29486	2.8	0	0.0
New Disturbances	40382	3.8	0	0.0
Open Water	20924	2.0	0	0.0
Unsuitable Vegetated Areas	35022	3.3	0	0.0
Low Suitability (0.01-0.33)	664241	63.3	137889	45.3
Medium Suitability (0.34-0.66)	76491	7.3	28626	9.4
High Suitability (0.67-1.00)	183444	17.5	138201	45.4
Total Area	1049988	100.0	304716	100.0

Snowshoe Hare - Regional Study Area Baseline Scenario

Habitat Class	Area	Percent	HU	Percent
No Habitat Total (HSI = 0.0)	53488	5.1	0	0.0
Existing Disturbances	30035	2.9	0	0.0
New Disturbances	0	0.0	0	0.0
Open Water	20971	2.0	0	0.0
Unsuitable Vegetated Areas	2482	0.2	0	0.0
Low Suitability (0.01-0.33)	46524	4.4	3013	0.4
Medium Suitability (0.34-0.66)	133250	12.7	76166	9.7
High Suitability (0.67-1.00)	816727	77.8	706983	89.9
Total Area	1049989	100.0	786163	100.0

Snowshoe Hare - Regional Study Area Scenario 1 (Muskeg River Mine)

Habitat Class	Area	Percent	HU	Percent
No Habitat Total (HSI = 0.0)	57645	5.5	0	0.0
Existing Disturbances	29860	2.8	0	0.0
New Disturbances	4313	0.4	0	0.0
Open Water	20954	2.0	0	0.0
Unsuitable Vegetated Areas	2517	0.2	0	0.0
Low Suitability (0.01-0.33)	47631	4.5	3098	0.4
Medium Suitability (0.34-0.66)	132337	12.6	75627	9.7
High Suitability (0.67-1.00)	812376	77.4	703182	89.9
Total Area	1049989	100.0	781907	100.0

Snowshoe Hare - Regional Study Area Scenario 2 (CEA)

Habitat Class	Area	Percent	HU	Percent
No Habitat Total (HSI = 0.0)	75979	7.2	0	0.0
Existing Disturbances	29695	2.8	0	0.0
New Disturbances	22556	2.1	0	0.0
Open Water	20936	2.0	0	0.0
Unsuitable Vegetated Areas	2792	0.3	0	0.0
Low Suitability (0.01-0.33)	49626	4.7	3240	0.4
Medium Suitability (0.34-0.66)	129801	12.4	74122	9.7
High Suitability (0.67-1.00)	794583	75.7	687815	89.9
Total Area	1049989	100.0	765177	100.0

Snowshoe Hare - Regional Study Area Scenario 3 (RDR)

Habitat Class	Area	Percent	HU	Percent
No Habitat Total (HSI = 0.0)	94881	9.0	0	0.0
Existing Disturbances	29485	2.8	0	0.0
New Disturbances	40382	3.8	0	0.0
Open Water	20924	2.0	0	0.0
Unsuitable Vegetated Areas	4090	0.4	0	0.0
Low Suitability (0.01-0.33)	52228	5.0	3454	0.5
Medium Suitability (0.34-0.66)	125839	12.0	71780	9.6
High Suitability (0.67-1.00)	777040	74.0	672464	89.9
Total Area	1049988	100.0	747698	100.0

Western Tanager - Regional Study Area Baseline Scenario

Habitat Class	Area	Percent	HU	Percent
No Habitat Total (HSI = 0.0)	100567	9.6	0	0.0
Existing Disturbances	30035	2.9	0	0.0
New Disturbances	0	0.0	0	0.0
Open Water	20971	2.0	0	0.0
Unsuitable Vegetated Areas	49561	4.7	0	0.0
Low Suitability (0.01-0.33)	738128	70.3	21613	17.0
Medium Suitability (0.34-0.66)	196013	18.7	92983	73.1
High Suitability (0.67-1.00)	15280	1.5	12683	10.0
Total Area	1049989	100.0	127278	100.0

Western Tanager - Regional Study Area Scenario 1 (Muskeg River Mine)

Habitat Class	Area	Percent	HU	Percent
No Habitat Total (HSI = 0.0)	104659	10.0	0	0.0
Existing Disturbances	29860	2.8	0	0.0
New Disturbances	4313	0.4	0	0.0
Open Water	20954	2.0	0	0.0
Unsuitable Vegetated Areas	49531	4.7	0	0.0
Low Suitability (0.01-0.33)	734799	70.0	21543	17.0
Medium Suitability (0.34-0.66)	195251	18.6	92614	73.0
High Suitability (0.67-1.00)	15280	1.5	12683	10.0
Total Area	1049989	100.0	126840	100.0

Western Tanager - Regional Study Area Scenario 2 (CEA)

Habitat Class	Area	Percent	HU	Percent
No Habitat Total (HSI = 0.0)	122615	11.7	0	0.0
Existing Disturbances	29695	2.8	0	0.0
New Disturbances	22556	2.1	0	0.0
Open Water	20936	2.0	0	0.0
Unsuitable Vegetated Areas	49428	4.7	0	0.0
Low Suitability (0.01-0.33)	719951	68.6	21251	17.0
Medium Suitability (0.34-0.66)	192120	18.3	91120	72.9
High Suitability (0.67-1.00)	15303	1.5	12702	10.2
Total Area	1049989	100.0	125073	100.0

Western Tanager - Regional Study Area Scenario 3 (RDR)

Habitat Class	Area	Percent	HU	Percent
No Habitat Total (HSI = 0.0)	141196	13.4	0	0.0
Existing Disturbances	29485	2.8	0	0.0
New Disturbances	40382	3.8	0	0.0
Open Water	20924	2.0	0	0.0
Unsuitable Vegetated Areas	50405	4.8	0	0.0
Low Suitability (0.01-0.33)	707022	67.3	20839	17.1
Medium Suitability (0.34-0.66)	186450	17.8	88406	72.5
High Suitability (0.67-1.00)	15321	1.5	12716	10.4
Total Area	1049989	100.0	121961	100.0

Incremental Increase in Fracture Zone Percentages

Area Sampled	Baseline	Scenario 1	Scenario 2	Scenario 3
Entire RSA	4.7	5.3	7.5	9.8
East-West 1	0.9	0.9	0.9	0.9
East-West 2	3.5	9.0	24.0	38.8
East-West 3	10.8	10.8	12.3	12.4
East-West 4	15.4	15.4	19.1	24.8
East-West 5	6.1	6.1	6.1	6.1
East-West 6	6.6	6.6	6.6	6.6
North-South 1	5.3	5.3	5.3	5.3
North-South 2	14.4	17.2	23.3	28.6
North-South 3	2.3	2.3	6.7	12.2

Baseline linakage model results

Area Sampled	Linkage Zone (ha)	Fracture Zone (ha)	% Linkage	% Fracture
Entire RSA	1,001,048	48,940	95.3	4.7
East-West 1	96,588	847	99.1	0.9
East-West 2	110,761	3,967	96.5	3.5
East-West 3	107,035	12,965	89.2	10.8
East-West 4	101,508	18,493	84.6	15.4
East-West 5	112,645	7,355	93.9	6.1
East-West 6	74,675	5,314	93.4	6.6
North-South 1	198,079	10,979	94.7	5.3
North-South 2	196,562	33,018	85.6	14.4
North-South 3	208,570	4,944	97.7	2.3

Muskeg River Mine Project Linkage Zone Analysis Results

Area Sampled	Linkage Zone (ha)	Fracture Zone (ha)	Linkage %	Fracture %
Entire RSA	994,630	55,358	94.7	5.3
East-West 1	96,588	847	99.1	0.9
East-West 2	104,358	10,371	91.0	9.0
East-West 3	107,020	12,980	89.2	10.8
East-West 4	101,508	18,493	84.6	15.4
East-West 5	112,645	7,355	93.9	6.1
East-West 6	74,675	5,314	93.4	6.6
North-South 1	198,079	10,979	94.7	5.3
North-South 2	190,144	39,436	82.8	17.2
North-South 3	208,570	4,944	97.7	2.3

Scenario 2 (CEA) Linkage Zone Analysis Results

Area Sampled	Linkage Zone (ha)	Fracture Zone (ha)	Linkage %	Fracture %
Entire RSA	971,188	78,801	92.5	7.5
East-West 1	96,588	847	99.1	0.9
East-West 2	87,166	27,563	76.0	24.0
East-West 3	105,243	14,756	87.7	12.3
East-West 4	97,034	22,967	80.9	19.1
East-West 5	112,645	7,355	93.9	6.1
East-West 6	74,675	5,314	93.4	6.6
North-South 1	198,079	10,979	94.7	5.3
North-South 2	176,037	53,542	76.7	23.3
North-South 3	199,299	14,285	93.3	6.7

Scenario 3 (RDR) Linkage Zone Analysis Results

Area Sampled	Linkage Zone (ha)	Fracture Zone (ha)	Linkage %	Fracture %
Entire RSA	947,286	102,702	90.2	9.8
East-West 1	96,588	847	99.1	0.9
East-West 2	70,184	44,545	61.2	38.8
East-West 3	105,175	14,825	87.6	12.4
East-West 4	90,184	29,817	75.2	24.8
East-West 5	112,645	7,355	93.9	6.1
East-West 6	74,675	5,314	93.4	6.6
North-South 1	198,069	10,989	94.7	5.3
North-South 2	163,821	65,759	71.4	28.6
North-South 3	187,559	25,954	87.8	12.2

APPENDIX VII
LINKAGE ZONE MODEL RESULTS

LINKAGE ZONE MODEL RESULTS

Baseline Linkage Model Results

Area Sampled	Linkage Zone (ha)	Fracture Zone (ha)	% Linkage	% Fracture
Entire RSA	1007017	42972	95.9	4.1
East-West 1	97435	0	100.0	0.0
East-West 2	114724	5	100.0	0.0
East-West 3	108194	11806	90.2	9.8
East-West 4	101508	18493	84.6	15.4
East-West 5	112645	7355	93.9	6.1
East-West 6	74674	5314	93.4	6.6
North-South 1	198190	10868	94.8	5.2
North-South 2	202419	27161	88.2	11.8
North-South 3	208570	4944	97.7	2.3

Scenario 1: Muskeg River Mine Project Linkage Zone Analysis Results

Area Sampled	Linkage Zone (ha)	Fracture Zone (ha)	Linkage %	Fracture %
Entire RSA	998946	51043	95.1	4.9
East-West 1	97435	0	100.0	0.0
East-West 2	107826	6902	94.0	6.0
East-West 3	107020	12980	89.2	10.8
East-West 4	101508	18492	84.6	15.4
East-West 5	112645	7355	93.9	6.1
East-West 6	74674	5314	93.4	6.6
North-South 1	198190	10868	94.8	5.2
North-South 2	194348	35232	84.7	15.3
North-South 3	208570	4944	97.7	2.3

Scenario 2 (CEA) Linkage Zone Analysis Results

Area Sampled	Linkage Zone (ha)	Fracture Zone (ha)	Linkage %	Fracture %
Entire RSA	968372	81616	92.2	7.8
East-West 1	96587	847	99.1	0.9
East-West 2	87166	27563	76.0	24.0
East-West 3	105244	14756	87.7	12.3
East-West 4	94218	25782	78.5	21.5
East-West 5	112645	7355	93.9	6.1
East-West 6	74675	5314	93.4	6.6
North-South 1	198084	10974	94.8	5.2
North-South 2	176374	53205	76.8	23.2
North-South 3	196077	17437	91.8	8.2

Scenario 3 (RDR) Linkage Zone Analysis Results

Area Sampled	Linkage Zone (ha)	Fracture Zone (ha)	Linkage %	Fracture %
Entire RSA	947286	102702	90.2	9.8
East-West 1	96587	847	99.1	0.9
East-West 2	70184	44545	61.2	38.8
East-West 3	105175	14825	87.6	12.4
East-West 4	90184	29817	75.2	24.8
East-West 5	112645	7355	93.9	6.1
East-West 6	74675	5314	93.4	6.6
North-South 1	198069	10989	94.7	5.3
North-South 2	163821	65759	71.4	28.6
North-South 3	187559	25954	87.8	12.2