Fort Nelson Timber Supply Area

Timber Supply Review 3
Data Package
July 9, 2004

Prepared for: Fort Nelson Timber Supply Area Defined Forest Area Management (DFAM) Group

BC Timber Sales

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TSR 3 Timber Supply Analysis Data Package

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BC Ministry of Sustainable Resource Management – Prince George

BC Water Land and Air Protection

BC MOF Forest Analysis Branch

Canadian Forest Service – Pacific Forest Region

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List of Acronyms

Acronym	Definition
AAC	Allowable Annual Cut
AU	Analysis Unit
BCTS	BC Timber Sales
BEC	Biogeoclimatic Ecosystem Classification
BEO	Biodiversity Emphasis Option
CFS	Canadian Forest Service
CFLB	Crown forested land base
DBH	Diameter at Breast Height
DIB	Diameter Inside Bark
DWB	Decay, Waste, and breakage
ECA	Equivalent Clearcut Area
ESA	Environmentally Sensitive Area
FDP	Forest Development Plan
FESL	Forest Ecosystem Solutions Ltd.
FIZ	Forest Inventory Zone
FPC	Forest Practices Code
FSOS	Forest Simulation Optimization System
GIS	Geographic Information Systems
GMZ/GRZ	General Resource Zone
ISIS	Integrated Silviculture Information System
ITG	Inventory Type Group
LRMP	Land Resources Management Plan
LU	Landscape Unit
LUPG	Landscape Unit Planning Guide
MAI	Mean Annual Increment
MHA	Minimum Harvestable Age
MOF	British Columbia Ministry of Forests
MSRM	British Columbia Ministry of Sustainable Resource Management
MSYT	Managed Stand Yield Table
NSR	Not Satisfactorily Restocked
NSYT	Natural Stand Yield Table
OAF	Operational Adjustment Factor
OGSI	Old Growth Site Index
RMZ	Riparian Management Zone
RRZ	Riparian Reserve Zone
RVQC	Recommended Visual Quality Class
SI50	Site Index for age 50
SIBEC	Site index Biogeoclimatic Ecological Classification
Canfor	Canadian Forest Products Ltd.

Acronym	Definition
THLB	Timber Harvesting Land Base
TIPSY	Table Interpolation Program for Stand Yields
TSA	Timber Supply Area
TSR	Timber Supply Review
UWR	Ungulate Winter Range
VAC	Visual Absorption Capacity
VDYP	Variable Density Yield Prediction
VEG	Visually Effective Green-up
VRI	Vegetation Resources Inventory
WHA	Wildlife Habitat Area
WTP	Wildlife Tree Patch
WTR	Wildlife Tree Retention

1 Introduction

The Timber Supply Review (TSR) process facilitates the public and First Nations' review of the timber supply analysis, the incorporation of their inputs into the analysis, and the determination of allowable annual cuts (AAC) by the provincial Chief Forester. Timber supply analysis is the forecast of timber supply given the current management regime and associated sensitivity analyses. This document provides the information and management assumptions proposed for timber supply analysis for the Fort Nelson Timber Supply Area (TSA)

Under the proposed Defined Forest Area Management (DFAM) legislation, timber supply analysis is the collective responsibility of the DFAM group. The DFAM group includes the holders of replaceable forest licenses (Canadian Forest Products Ltd is the only major licensee in the Fort Nelson TSA) and BC Timber Sales (BCTS). The DFAM group will complete the following steps for timber supply analysis:

- Collect data and prepare a data package, which summarizes the data assumptions and critical issues to be examined in the analysis;
- Complete the timber supply analysis and report; and,
- Provide for public and First Nations' review.

TSR is conducted a minimum of every five years in order for new data, management assumptions and polices to be included. The last TSR (TSR 2) for the Fort Nelson TSA was completed in March 2000 and the AAC determination in September 2001. This TSR 3 data package review was completed on March 31, 2004 and the AAC determination will be completed at latest September 2006. Three primary documents will be provided through this process: 1) the data package (this document), 2) the analysis report and 3) the Chief Forester's AAC determination report. The data package is a technical document that summarizes the data and inputs for the analysis. The analysis report summarizes the timber supply analysis results and serves as the focus for public discussion.

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Copies of the data package can be obtained on the following website:
http://www.forestecosystem.ca/FortNelsonDFAMTSR3.html

1.1 Purpose of the data package

The purpose of this data package is to provide a clear description of information sources, assumptions, issues, and any relevant data processing or adjustments related to the land base, growth and yield, and management objectives and practices. Through its use, this package will:

- Provide a detailed account of the factors related to timber supply that the Chief Forester must consider under the Forest Act when determining an allowable annual cut (AAC) and how these factors will be applied in the timber supply analysis;

- Provide a means for communication between the staff from Canadian Forest Products Ltd (henceforth referred to as Canfor), BCTS, Ministry of Forests, Ministry of Sustainable Resource Management, Ministry of Water, Land, and Air Protection, the public and First Nations in the TSA.

- Provide the public, First Nations, and staff of the different provincial natural resources ministries with the opportunity to review data and information that will be used in the timber supply analysis before it is initiated;

- Ensure that all relevant information is accounted for in the analysis to an acceptable standard; and

- Reduce the risk of having analyses rejected because input assumptions and analysis methods were not agreed upon in advance.

During the analysis, various sensitivity analyses, harvest flow alternatives, and management options will be tested to determine the influence of various factors on harvest levels. All analyses and the final proposed option will be submitted to the Chief Forester for determination of the allowable annual cut (AAC).

1.2 Process

The requirement to conduct timber supply analysis on a periodic basis (at least once every 5 years) is the collective responsibility of the DFAM group. The DFAM group includes BC Timber Sales (BCTS) and Canadian Forest Products Ltd. The timber supply analysis for the Fort Nelson TSA will follow the *Interim Standards for Data Package Preparation and Timber Supply Analysis, DFAM Imitative*. The roles and responsibilities for the specific timber supply review steps are outlined in Table 1. Following completion of these steps, the Chief Forester or designate will review the final timber supply analysis report, assess its acceptability for supporting the AAC determination, and if necessary request additional information. After acceptance of the analysis, the Chief Forester determines an AAC while considering all the factors as required in the *Forest Act*, section 8 (8).

Table 1: Timber supply review steps with roles and responsibilities

DFAM Group	BC Ministry of Forests	
	Forest Analysis Branch	**District & Regional Staff**
Compiling data needed for the timber supply analysis, including forest cover and other data related to forest and land characteristics, administration and management regimes.		
Providing information to the public and First Nations (government retains consultation responsibilities with respect to First Nations).		
Compiling a data package that documents the data, management strategies, and methods that will be applied in the timber supply analysis, according to standards provided by the Ministry of Forests (*Supplemental Guide for Preparing Timber Supply Analysis Data Packages* is used as a template for this data package).	Reviewing and accepting the data package (focus on how data is to be applied in timber supply analysis).	Reviewing the data package (confirming current practice).
Performing and documenting a timber supply analysis according to standards provided by the Ministry of Forests.		
Submitting a file containing the complete dataset used in the timber supply analysis. This requirement is primarily to assist government in compiling and maintaining a complete coverage of the province for tracking of land base, management, and other strategic issues, as well as to enable audit analysis.	Reviewing and accepting (together with the Chief Forester) the analysis report	Reviewing the analysis report to ensure local issues and current practices are adequately reflected.
Providing additional information as required by the Chief Forester.	Compiling and preparing information, primarily from the analysis report, for presentation to the Chief Forester for the AAC determinations.	Assisting in compiling and preparing information, primarily from the analysis report, for presentation to the Chief Forester for the AAC determinations.

2 Inventory and model files

This section outlines the inventories, data and spatial coverage used in the preparation of the data package that will be used for the timber supply analysis in the Fort Nelson TSA.

2.1 Data Sources

Most of the data were provided from the Ministry of Forests (MOF), the Ministry of Sustainable Resources Management (MSRM), Canadian Forest Products Ltd. and BC Timber Sales. The list of inventory information is shown in Table 2. Some of the data sources are also discussed in more detail in the sections below.

Table 2: Inventory information for the Fort Nelson TSA

Data	Source*	Vintage	Update	Scale	Comments
Inventory					
Vegetation Resources Inventory	MSRM	2002/2003		1:20,000	Total of 836 (1:20 000) mapsheets. Of which, 249 are Phase II VRI and 587 are "rolled over" VRI.
Ecological					
Biogeoclimatic classification (version 5.0)	MOF	1995	2003	1: 20,000	
Natural Disturbance Units	MSRM	2001	2002	1:20, 000 to 1:250,000	
Karst potential map	MOF	1999		1:250,000	
Budworm incidence mapping	CFS – Pacific Forest Region	1998/2002		1:50,000	
PEM/TEM coverage	Various sources – see description			1:50,000	
Administrative					
Ownership	MOF	2000	2002	1:20,000	From FC1. Woodlots codes are not included.
Woodlots	MOF – Fort Nelson Forest District	2003		1:20,000	
Operating Areas	MOF – Fort Nelson Forest District			1:20,000	
Landscape Units	MSRM	1998	2003	1:250,000	
Region and district boundary	MOF – Fort Nelson Forest District	2000	2003	1:20,000	
Agricultural Land Reserve	LRC		2003	1:20,000	
Forest region and compartment	MOF – Fort Nelson Forest District	2000	2002	1:20,000	
Operational					
Forest Development Plan	Canfor/ BCTS	2002-2007		1:20,000	Includes wildlife tree patches and other reserves - all reserves have been coded as WTP; also includes roads
Depletions	MSRM	2002		1:20,000	
Terrain Stability	Canfor (Kokanee Forest Consulting, Klohn-Crippen, JM Ryder & Associates)	2000		1:20,000	
ESA	MSRM	2001	2002	1:20,000	
Range Burns	MOF – Fort Nelson Forest District	1999		1:20,000	
Water					
Domestic water licences	MSRM - Water licensing office	1997	2003	1:20,000	Point of Diversion
Wildlife					
Caribou Wildlife Winter Range	WLAP		2000		
Protected Area Strategy (PAS)	MOF	2001			
Recreation					
Visual landscape inventory (VLI)	MSRM	1997	2002	1:250,000 1: 50,000	The inventory is 1:250,000 except for the inventory around the Alaska Hwy and Klua Lakes, which were done to an accuracy of 1:50,000.
Recreation feature inventory (RFI)	MSRM	1991			
Recreation opportunity spectrum (ROS)	MSRM	1996		1:20,000?	
Planning					
LRMP – RMZ, ERDZ, SMZ	MSRM	1997	2002	1:250,000	
Natural Disturbance					
Spruce budworm infestation	CFS	1990	2002	1:20,000	
Roads and Seismic					
TRIM I and II	MSRM	1987, 1996		1:20,000	Used for roads, seismic lines, pipelines, streams.
Compiled road coverage	FESL			1:20,000	Variety of sources
Seismic and oil and gas roads	OGC	2000 -2003		1:20,000	

* MOF= Ministry of Forests, MELP= Ministry of Environment, Land, and Parks, WLAP= Ministry of Water, Land and Air Protection, LRC = Land Reserve Commission, LUCO= Land Use Coordination Office, OGC=Oil and Gas Commission, FESL=Forest Ecosystem Solutions Ltd., CFS = Canadian Forest Service

2.1.1 Vegetation Resource Inventory

During 2002/2003, Fort Nelson Division of Canfor received funding from the Forest Investment Account to re-inventory approximately one third of the TSA according to Vegetation Resource Inventory (VRI) standards: the other two thirds contained old forest cover data that have been "rolled-over" into the new VRI format (mdb). It should be noted that the "roll over" process does not generate a true VRI database. It maintains the old FC1/FIP inventory information in a new database format. The new VRI attributes will remain as blank fields in the "rolled over" VRI database as no information is gathered or available from the traditional inventory databases.

The completion of the VRI involved staff from BCTS and the Regional and District staff of MOF and MSRM. VRI Phase I photo-interpreted inventory has projected stand attributes to 2003 whereas VRI "rolled over" was projected to 2002. The "rolled over" VRI comprises a total of 6,863,581 ha of the TSA whereas 3,004,473 ha are in VRI Phase I. Adjustment factors derived from VRI Phase II ground sample data for age, height and net volume have been applied to the VRI Phase I area and are documented in Jahraus and Associates (2003).

In TSR 2, the Chief Forester noted that the existing older forest inventory was a primary concern due to issues with broad polygon typing, incorrect species labelling, incorrect site productivity (site index) estimates, and under-representation of the understory component. The Phase I photo-interpreted VRI has addressed some of the issues and in particular, provided an improved distinction between white and black spruce leading stands. In addition, the VRI Phase II ground sample data has provided a measure of confidence of the VRI Phase I photo-interpreted data with a known level of confidence.

2.1.2 PEM/TEM Mapping

Four TEM projects were completed in 1998 within the Fort Nelson TSA including the Smith/Vents River TEM, Labiche/Sandy TEM, Snake/Sahtaneh TEM and the Dunedin TEM. MSRM has also completed a PEM for the Muskwa-Kechika. No independent accuracy assessments have been completed for these projects.[1]

Canfor have initiated the Patry PEM project and the Sahtaneh TEM project, which are in the progress of completion. Accuracy assessments for this data are expected by April 2004.

2.1.3 Karst Potential Inventory

The provincial karst potential inventory indicates areas of potential karst and areas of known karst. There are 8,289 ha of known karst areas. The known karst is located in the northwestern region of the TSA. A continuous north-south band of known karst exists in the Grayling, Scatter, and Redpott Landscape Units (5,331 ha, 59ha, and 2,206 ha, respectively). In addition, there are 676 ha of known karst in the Liard Hot Springs landscape unit. The DFAM group do not feel that there will be a major timber supply impact in these karst areas as there are no local guidelines for their operational management at this time. As such, these areas are noted but not taken out of the THLB at this time.

[1] Email communication with Corey Erwin (March 9, 2004).

2.1.4 Ownership Inventory

There are two woodlots in the TSA; one is an active woodlot (W1817) comprising 588 ha and the other woodlot (W171), comprising 561 ha, is currently inactive. W1817 was not included in the original ownership file but has been added based on a spatial woodlot coverage provided by the Fort Nelson Forest District. W171 will be assigned to a miscellaneous reserve status, which may be harvested in the future.

2.1.5 BC Parks and Protected Area Boundaries

The Ministry of Water, Land and Air Protection provided the boundaries for BC parks, protected areas and ecological reserves. This data is updated to 2001 and confirmed to be accurate on a 1:20, 000 scale[2]. The existing ownership coverage for parks (63N and 67N) and ecological reserves (60N) was outdated, as many parks and protected areas have been legally established since TSR2. The Land Resource Management Plan map was also outdated as the areas with "proposed protected" resource management type are now "existing established" RMZs.

2.1.6 Road data

A spatial road coverage has been compiled from road features from TRIM I and II, existing and proposed roads from forest development plans provided by Canfor and BCTS, an in-house road coverage from Canfor, and petroleum development roads from the Oil and Gas Commission.

The compiled road network illustrates that many of the logging roads identified in the above sources were only accessible from seismic lines. It was confirmed by the DFAM group that many seismic lines are actively used for timber access. It is, however, impossible to determine which seismic lines are being used for transportation, therefore, no seismic lines have been reclassified as roads. Seismic features will be included in determining future access requirements.

2.1.7 TRIM data

Streams, roads, transmission lines, seismic lines and pipelines were extracted from TRIM I and II. A buffer width was applied to each feature to determine an appropriate area reduction for the land base netdown, which will be discussed in Section 3.3 and 0.

2.1.8 Visual landscape inventory

Detailed (1:50,000) visual landscape inventories were completed for the Klua Lakes view shed in 1992, and for a portion of the Alaska Highway corridor from Beaver Creek to Summit Lake in 1995. In 1995, a broad mapping of all the visually sensitive areas in the district was completed at a scale of 1:250,000 and the district manager has declared these areas as 'scenic areas' for consideration in all forestry planning activities.

[2] Phone correspondence with Steven Webb, Boundary Coordinator, Land & Permit Administration Section, WLAP. April 22, 2004.

3 Land base

This section describes how the timber harvesting land base (THLB), or the area that is available for harvest, is determined. The total land base initially contains a variety of land types including areas that are not Crown controlled. The TSA is defined as the total land base excluding private land, federal land, woodlots, and First Nations reserves. Once the TSA area is defined, areas not containing trees and considered non-productive are removed, such as bare ground/rock and water bodies, to identify the productive Crown forest land base (CFLB). Finally, those areas that are forested and contribute to non-timber values, but are not eligible for harvest are removed, resulting in the THLB.

3.1 Timber harvesting land base definition

The THLB is determined by a netdown process, in which areas ineligible for harvest are sequentially removed from the total land base. Once an area has been removed, it cannot be deducted again further along in the netdown process to eliminate the potential for double counting. For this reason, the gross area of netdown factors is usually greater than the net area removed (a result of overlapping resource issues).

Table 3 summarizes the netdown procedure where areas are removed in the order presented to define the total land base, TSA land base, Crown forested land base, current and future timber harvesting land base.

The total area for the Fort Nelson TSA is larger than that of TSR 2. The Cassiar Addition (an area of approximately 1.5 million hectares was transferred from the Bulkley-Cassiar Forest district to the Fort Nelson TSA in 1999) is included in the total land base for this analysis.

Table 3: Timber harvesting land base determination for the Fort Nelson TSA

Classification	Total Area (ha)	Net Area Removed (ha)	Percent of Total TSA area (%)	Percent of CFLB (%)	Report Section
Total area on inventory file (Fort Nelson Forest District)	**9,868,067**	**9,868,067**			
Land not managed by MOF (e.g.. private, woodlots, federal, Indian, military reserves)	29,927	29,927			3.2.1
Total TSA area		**9,838,140**	**100.00**		
Reductions to TSA:					
Non-forest, non-productive, no typing	3,831,375	3,814,238	38.77		3.3.1
Alpine (not previously accounted for)	3,006	3,006	0.03		3.3.2
Non-commercial cover (brush)	350,671	350,671	3.56		3.3.3
Existing roads, trails and landings	46,686	35,945	0.37		3.3.4
Total productive Crown forest land base (CFLB)		**5,634,280**	**57.27**	**100.00**	
Parks, UREPs and Ecological Reserves	1,059,861	369,785	3.76	6.56	3.2.1
NSR from wildfire, non-productive or misclassified	86,106	76,632	0.78	1.36	3.4.2
Non merchantable	301,193	236,424	2.40	4.20	3.4.2
Low timber productivity	4,416,007	2,662,085	27.06	47.25	3.4.3
Riparian reserve (stream, wetland and lake)	543,340	187,810	1.91	3.33	3.4.5
Environmentally sensitive areas	708,018	119,383	1.21	2.12	3.4.6
Unstable terrain	19,112	9,141	0.09	0.16	3.4.7
Wildlife range burn areas	354,999	26,728	0.27	0.47	3.4.8
Stand-level biodiversity (existing wildlife tree patches)	434	367	0.004	0.01	3.4.9
Seismic areas	111,957	25,598	0.26	0.45	3.4.10
Inoperable areas	7,379,194	344,811	3.50	6.12	3.4.11
Black spruce leading stands	1,215,896	143,259	1.46	2.54	3.4.12
Total Reductions to the CFLB:		**4,202,023**	**42.71**	**74.58**	
Current Timber Harvesting Land Base		**1,432,257**	**14.56**	**25.42**	
Future Reductions:					
Future roads, trails and landing		29,825			3.4.14
Future stand-level biodiversity (WTP)		6,272			3.4.15
Future Timber Harvesting Land Base		**1,396,160**			

3.1.1 Reasons for changes to the THLB since TSR 2

Since TSR 2 was completed for the Fort Nelson TSA, there have been numerous changes to input data and assumptions that will alter the individual land base reductions as well as the resulting timber harvesting land base area. Some of those changes include:

1) the Cassiar addition to the Fort Nelson TSA;
2) the new VRI Phase I photo interpreted inventory and adjustment factors derived from VRI Phase II ground sample data for approximately one third of the Fort Nelson TSA;
3) the revised operability assessment;
4) revised WTP reductions;
5) replacement of some older environmentally sensitive area (ESA) soils features with more recent terrain stability mapping (level D);
6) a new methodology to determine stream classification and riparian reserve reductions; and,
7) revised existing roads, trails and landings and oil and gas related reductions.

3.2 Exclusions from the TSA Land Base

The land base netdown will identify the numerous reductions applied to the total area within the Fort Nelson Forest District to identify the TSA land base, the productive Crown forest land base, and the timber harvesting land base. This section will describe those areas that are removed from the Fort Nelson Forest District to identify the TSA land base.

3.2.1 Administrative classes that do not contribute to TSA forest management objectives

Areas managed by the BC MOF and Parks are considered to contribute to landscape biodiversity and are therefore included in the Crown productive forest, whereas areas in the forest management unit area and miscellaneous reserves are available for timber harvesting (Table 4). Areas in private ownership, woodlots, and Indian, federal, and military reserves are not included in the TSA land base, as shown in Table 5.

Table 4: Land that contributes to the TSA forest management or biodiversity objectives (i.e. Crown forest land base) due to ownership

Ownership Code and Description	Total Area (ha)	% Contribution to CFLB	% Contribution to THLB
62-C Forest Management Unit	8,762,730	100	100
Parks, protected area and ecological reserves*	1,052,430	100	0
61-C Use, Public recreation, and enjoyment (UREP) reserves (>100 ha)	3,090	100	0
61-N UREP (≤100)	4,341	100	0
69-C Miscellaneous reserves (>100 ha)**	15,352	100	100
69-N Miscellaneous reserves (≤100)**	197	100	100
Total	**9,838,140**		

*Parks, protected areas and ecological reserves were derived from the BC Parks coverage. It did not contain ownership code; however, it would have encompassed 60N, 63N and 67N.

**Miscellaneous reserves include: forest service recreation reserve/corridor, watershed reserve, industrial reserve, islands reserve, map reserve, fish and wildlife management reserves and/or interpretive forests. Also included in category 69-C are 564 ha of what used to be woodlot W171.

Table 5: Land that does not contribute to the TSA forest management or biodiversity objectives due to ownership

Ownership Code and Description	Total Area (ha)	% Contribution to CFLB	% Contribution to THLB
40-N Private	16,102	0	0
50-N Federal Reserve	545	0	0
52-N Indian Reserve	8,126	0	0
53-N Military Reserve	4,552	0	0
77-N Woodlots	588	0	0
99-N Miscellaneous leases*	14	0	0
Total	**29,927**		

* Miscellaneous leases include: fairgrounds, rod and gun club sites, recreational cottage site leases and/or community organization leases.

3.3 Exclusions from the Crown Forest Land Base

This section describes the reductions, which are applied to the TSA land base to define the Crown forest land base, and are summarized in Table 3.

3.3.1 Non-forest and non-productive forest

VRI inventory attributes differ from the original FC1/FIP attributes in a number of important ways. While the FC1/FIP data standards provided a single attribute as far as the overall polygon classification is concerned, a polygon inventoried under VRI guidelines might contain several 'land classification' components (BCLCS). For example, a polygon might be classified as a

Lake following FC1/FIP guidelines; however, the same polygon might be classified as 80% Lake and 20% productive forest land under VRI guidelines.

Based on comparisons between area and land classification, it was decided that polygons with multiple 'land classification' components should be reclassified following a 50% rule. For example: if more than 50% of a polygon is classified as water or non-vegetated (*e.g.* rock or exposed soils), then the polygon would be reclassified as a water body or non-productive, respectively.

Where only rolled-over VRI information is available, the non-forest and non-productive forest category is classified according to the projected type identity label (PRJ_TYPID) 6.

Except for parks, ecological reserves, UREP and riparian areas, all areas that are classified as non-productive (or any of the land classification that will be removed from the Crown forest land base, as described in the following sections) but have been previously logged will remain in the Crown forest land base as well as the timber harvesting land base. The reductions for non-forest and non-productive areas within the Fort Nelson TSA are shown in Table 6.

Table 6: Areas in non-forest and non-productive forest

Description (NPD2)	TSA Area (ha)	% Reduction
Lake	85,027	100
River	80,542	100
Wetland	1,633,601	100
Non-Productive (NP)	2,027,644	100
No typing available (NTA)	4,561	100
Total	**3,831,375**	**100**

3.3.2 Alpine

All area classified as alpine tundra and sub alpine parkland (AT) under the Biogeoclimatic classification (BEC) is considered non-harvestable and excluded from the Crown forest and timber harvesting land base. Where trees do occur in these areas their growth is usually stunted and they are very widely spaced. Individual trees rarely meet the minimum harvestable dimensions and, therefore, have no merchantable value. In the Fort Nelson TSA, there are 1,353,578 ha of alpine tundra of which, 3,006 ha have not been excluded under the unproductive/nonforest category (Section 3.3.1) as shown in Table 7.

Table 7: Reduction for alpine and sub alpine tundra

Description	% Reduction	Total Area (ha)
Alpine and sub alpine tundra not previously accounted for	100	3,006

3.3.3 Non-commercial cover

Non-commercial cover represents sites within the Fort Nelson TSA that are considered inappropriate for timber harvesting as they currently contain non-commercial tree and shrub species. Only through rehabilitation would these sites be considered for timber management.

Areas for which rehabilitation of non-commercial brush sites has occurred in the Fort Nelson TSA remain in the THLB. Historical non-commercial brush rehabilitation of willow brush sites, which have been planted to spruce, has been updated in the resultant data set and the inventory where appropriate. It is understood that relatively little non-commercial brush is being rehabilitated within the Fort Nelson TSA due to limited funding for this activity. Therefore, at this point no further rehabilitation is planned.

The non-commercial brush areas with VRI Phase II inventory will be removed in the non-productive forest category in Section 3.3.1. The area of the TSA for which the "rolled-over" VRI is available is excluded from the Crown forest and timber harvesting land base (Table 8).

Table 8: Non-commercial brush

Description	Total Area (ha)	% Reduction
Non-commercial brush	350,671	100

3.3.4 Existing roads, trails and landings

Road data was acquired from TRIM I and II, Canfor's corporate road coverage, and forest development plan road coverage (from BCTS and Canfor). Two road coverages were also provided by OGC (including activity - fall of 2003). The second coverage provided about 384 km of additional roads classified as new petroleum development roads (PDR).

Roads are presented as linear features on maps: to determine an area, each road feature is buffered using Geographic Information Systems (GIS). The buffer represents half the road width and is applied to each side of the linear feature to equal the total width. Once the roads are buffered the associated area can be incorporated into the analysis dataset. A percent reduction for roads is calculated for each polygon that contains actual road segments. The reductions for each road class and its associated road length and buffer applied are shown in Table 9.

Table 9: Reductions for existing roads

Road Feature	Length (km)	Road width (m)	Buffer used in GIS (m)	Total Area (ha)*	Net Area Excluded (ha)
BC Rail	111	20	10	223	123
Highway	824	30	15	2,473	795
Paved	1,820	30	15	5,420	2,892
Road	4,898	20	10	9,778	9,068
Mainline	2,069	20	10	4,079	3,366
Petroleum Development Road (PDR)	384	20	10	746	289
Gravel	1,094	20	10	2,039	1,171
Rough Road	12,965	15	7.5	19,406	15,862
Overgrown Road	258	15	7.5	390	380
Total	**24,423**			**44,554**	**33,946**

* Road area listed above is the area resulting from the road buffer exercise and takes into account overlapping roads in which reductions are made in the same order the road features is presented in the table (*i.e*. where a highway crosses a paved road, the overlap is removed under 'net area excluded' for highway).

None of the road data provided contained landing features. However, it can be assumed that some road-related disturbances (landings and gravel pits) are captured in the vegetation resource inventory[3]. Where this is the case, they will have been removed as non-productive areas. Table 9 represents the area in main access roads: further road reductions are required for within block roads, trails and landings (RTL). The average percent area of permanent RTL in a cutblock is 2%, as determined by the amount of NP UNN (non-productive, unnatural) in ISIS (all data that was available between 1962 and 2003). Any area with a history of logging will receive an additional 2% reduction as shown in Table 10.

Table 10: Reductions for within block roads and trails

Description	% Reduction	Total Area (ha)	Net Area Excluded (ha)
Existing roads (Table 9)	100	44,554	33,946
In block roads – non-mapped roads (additional 2% to all polygons with a history of logging)	100	2,132	1,999
Total	**100**	**46,686**	**35,945**

[3] Sixty hectares of gravel pits in the Fort Nelson TSA have been identified by the VRI and 1,846 ha have been identified as road or urban areas in VRI but it is unknown how much, if any, of the latter is in landings.

3.4 Exclusions from the Timber Harvesting Land Base

This section describes the exclusions to the crown forested land base to determine the timber harvesting land base.

3.4.1 Parks, UREPs and Ecological Reserves

Area in parks, use, public recreation, and enjoyment (UREP) and ecological reserves will not contribute to timber harvest but are assumed to contribute to biodiversity (Table 11). The protected areas that were outlined in the *Fort Nelson Land and Resource Management Plan* (LRMP 1997) and additional protected areas and ecological reserves have now been formally established (Order in Council) and are excluded from the THLB.

Table 11: Park, UREPs and Ecological reserve reductions

Description	Total Area (ha)	% Removed	Net Area Removed (ha)
Use, Public recreation, and enjoyment (UREP) reserves	7,431	100	5,090
Parks, protected area and ecological reserves	1,052,430	100	369,785
Total	**1,059,861**		**369,785**

3.4.2 NSR from wildfire, non-productive or misclassified

Some land classified within the inventory as not satisfactorily restocked (NSR) has resulted from wildfire, is non-productive or is misclassified. These non-harvesting derived NSR areas (Table 12) are identified in the inventory based on a projected type identity label of 4, with no history of harvesting or silviculture activity. The regeneration of these areas remains uncertain and there are no commitments by the DFAM group for their regeneration, and as such they are excluded from the timber harvesting land base. The DFAM Group and Fort Nelson Forest District have confirmed that they do not replant following natural fires.

Table 12: NSR from wildfire, non-productive or misclassified

Description	Total Area (ha)	Net Area Excluded (ha)	% Reduction
NSR from wildfire, non-productive or misclassified	86,106	76,632	100

3.4.3 Non-merchantable forest types

Non-merchantable forest types are stands that may be physically operable, but are currently not utilized due to being economically marginal or unfeasible for development and as such are removed from the THLB. These forest types include birch leading and larch leading stands (Table 13). A sensitivity analysis will be performed to include birch stands for harvest because there remains interest in their potential utilization. Currently, the DFAM group is not targeting

birch leading stands for harvest in the TSA but they do utilize the minor component of birch when harvested in mixed species stands.

The DFAM group has identified that douglas-fir, hemlock and cedar do not grow naturally within the Fort Nelson TSA, and their occurrence in the inventory remains an error in species codes. It is unknown if these areas are forested or what species actually grow on these sites – they are therefore excluded from the THLB.

Table 13: Non-merchantable forest types

Leading Species	Inventory Type Group	% Reduction	Total Area (ha)	Net Area Excluded (ha)
N/A	0	100	25	20
Cedar	9	100	186	186
Douglas-fir	10	100	15	15
Hemlock-Spruce	16	100	16	15
Larch	34	100	39,927	15,508
Birch leading	40	100	261,022	220,679
Total			**301,193**	**236,424**

3.4.4 Sites with low growing potential

Throughout the Fort Nelson TSA there are stands that contain commercial tree species but have not, or will not, achieve a productive condition within a reasonable growing period and are therefore not included in the THLB. Existing mature stands (age being equal to or older than the 'reference age for maturity'), must achieve the minimum volume per hectare and height to be included in the THLB. The younger stands that have not reached maturity yet must meet a minimum reference SI.

The minimum reference SI was determined based on current performance in the TSA as well as consideration of the minimum site productivity that is required to achieve the minimum height and volume criteria within the reference age for each species (Table 14).

Table 14: Criteria to identify stands with low growing potential

Species	ITG	Reference Age for Maturity	Minimum Height	Minimum Vol/ha	Minimum SI	% Reduction	Total Area (ha)	Net Area Excluded (ha)
Spruce	21-26	121	20	140	10.8	100	2,572,222	1,447,859
Pine	27-31	81	20	140	16.4	100	1,129,277	644,460
Aspen	41-42	81	20	140	15.9	100	524,099	462,450
Cottonwood	35-36	81	20	140	14.0	100	5,698	3,982
Balsam	18-20	121	n/a	140	12.0	100	112,972	103,334
Birch*	40	51	16	40	16.8	100	71,739	0
Total							**4,416,007**	**2,662,085**

* Birch was excluded already due to non-merchantable category. It is provided here for sensitivity analysis.

3.4.5 Riparian reserve and management zones

3.4.5.1 Streams

No complete stream classification exists for the Fort Nelson TSA. As a result, a methodology was required to approximate stream riparian reductions, which could be used in the land base netdown. Some rivers (S1 and S2 streams) are identified as polygons in VRI and as such their widths are available and can be buffered according to the *Riparian Management Area Guidebook* (Table 16 in Section 3.4.5.2). The remaining streams were translated from single line features in TRIM I[4].

With no complete field-based stream classification data for the remaining streams, a methodology was developed that combined the results of the Lower Dunedin Landscape Unit Riparian Analysis (Poulin and Associates, 2001) and information provided by MSRM, Aquatic Information Branch in Prince George. The results from Poulin and Associates and MSRM show a statistical relationship between stream order and stream class (e.g. a high correlation between stream order 1 and 2 with stream class 5 and 6 as well as steam order 3+ with stream class 1 to 4). An analysis was also completed for TSR 3 for the Lower Dunedin where the sample points of known stream classification from the Poulin and Associates study were compared to the stream order classified using GIS processing. Again the results showed a high correlation between the stream order and stream class.

A GIS program was developed to assign all TRIM streams in the TSA the appropriate stream order. Assumptions were made on the percentage of streams in each stream class as well as the riparian buffer widths required for each class. The details of the methodology, the limitations of the approach, and comments provided by MSRM are documented in Appendix 1.

The resulting stream classes and their 'effective' widths are illustrated in Table 15. The 'effective width' is the combined riparian reserve zone and riparian management zone weighted by stream class[5]. Although this approach may be satisfactory for use in TSR, the relationships should not be used for operational stream classification.

Table 15: Riparian reserve and management zone widths for streams

Riparian feature	Stream class	Stream Length (km)	Effective width (m)	Total Area (ha)	Net Area Removed (ha)
Streams	S1-S4*	73,841	33.50	2,203,435	85,919
	S5-S6**	194,105	2.31		

* corresponds to streams of order 3 +

** corresponds to streams of order 1 or 2

[4] Note that the streams from TRIM I and TRIM II are identical.

[5] Please see Appendix 3 for the method of determining the effective width.

3.4.5.2 Lakes and wetlands

Both lakes and wetlands occur throughout the Fort Nelson TSA. Lake and wetland locations are identified explicitly in the "rolled over" VRI inventories while in the VRI Phase II they are identified based on a 50% rule as described earlier in this document (Section 3.3.1). Lake and wetland classes are categorized following the *Riparian Management Area Guidebook*. The appropriate buffer is applied to each wetland and lake class (Table 16) in order to calculate the appropriate reduction to the timber harvesting land base.

As mentioned in the previous section, some large rivers are identified as polygons (or double line streams in TRIM II), as such their widths are known for stream classification and are given the appropriate Guidebook reductions (Table 16). Therefore, reductions for streams are completed in two steps, one based on polygon-features (Table 16) and another based on the stream order methodology (Table 15).

Table 16: Riparian reserve and management zone widths for lakes and wetlands

Riparian feature	Wetland and Lake class	Class Definition	Reserve zone width (meters) 100% reduction	Management zone width (m)	Management zone retention (%)	Combined RZ and RMZ buffer width (m)*	RMA Gross area (ha)	Net Area Removed (ha)
Wetlands	W1	5 - 1000 ha	10	40	25	20	2,101,544	101,891
	W1 large	> 1000 ha	0	0	0	0		
	W3	1 - 5 ha	0	30	25	7.5		
	W5	wetland complex	10	40	25	20		
Lakes	L1	5 - 1000 ha	10	0	0	10		
	L1 large	> 1000 ha	0	0	0	0		
	L3	1 - 5 ha	0	30	25	7.5		
Streams	S1	20 - 100m wide	50	20	50	60		
	S1 large	>100m wide	0	100	50	50		
	S2	5 - 20m wide	30	20	50	40		

*the combined buffer width = reserve zone width + (management zone width x % management zone volume reduction)

3.4.6 Environmentally sensitive areas

Some forested areas are considered environmentally sensitive and/or significantly valuable for other resources. Many of these areas are identified and delineated during a forest inventory and are designated environmentally sensitive areas (ESAs). The ESA system uses the following categories: soil (Es), forest regeneration problems (Ep), recreation (Er), and wildlife (Ew). Two ESA categories are recognized: high and moderately sensitive, yet some of the ESA categories may overlap.

A complete table of ESA categories is presented in Table 17. In the context of timber supply analysis, ESAs result in a reduction in the harvesting opportunity on these sites. As in the TSR 2, all ESA areas identified as sensitive and/or significantly sensitive have been 100% excluded from the THLB.

Table 17: Environmentally sensitive areas

Feature*	Description	% Reduction	Total Area (ha)	Net Area Excluded (ha)
Ep1	High regeneration problems	100	408,953	40,809
Ep2	Moderate regeneration problems	100	807	43
Er1	High recreation sensitivity	100	105	7
Er2	Moderate recreation sensitivity	100	1,459	313
Es1	High soil sensitivity	100	263,257	38,541
Es2	Moderate soil sensitivity	100	1,896	1,467
Ew1**	High wildlife sensitivity	100	3,744	825
Ew2c	Significant caribou habitat	100	27,797	17,220
Ew2g***	Significant goat habitat	100	0	20,158
Total			**708,018**	**119,383**

*A polygon can contain more than one ESA category. In cases where such overlap exists, the polygon area is assigned to ESA category of primary significance (e.g. ESA SP will be assigned to Es1).
** Includes 1,145ha of significant caribou habitat
*** There is a total of 183ha of significant goat habitat. However, goat habitat completely overlaps with the caribou habitat listed as Ew2c, and is reported there.

3.4.7 Terrain Reconnaissance Mapping

Several terrain reconnaissance mapping (Level D[6]) study areas have been completed throughout the Fort Nelson TSA, mostly in areas where there is significant terrain related concerns. As the terrain reconnaissance mapping is considered best available information, it will replace the ESA soils mapping completed for the terrain study areas.

The DFAM group currently does not operate in any area above terrain class III. Since the terrain reconnaissance mapping does not provide terrain class, an assumption was made that the reconnaissance class P (potentially unstable) and U (unstable) were equivalent to terrain class IV and V and Es2 and Es1 respectively, based on Appendix 1 in *Mapping and Assessing Terrain Stability Guidebook*. Areas identified as reconnaissance class P or U will be 100% removed from the THLB (Table 18).

Table 18: Terrain reconnaissance reductions based on Level D mapping

Description	% Reduction	Total Area (ha)	Net Area Excluded (ha)
Terrain Reconnaissance Class P	100	12,612	6,797
Terrain Reconnaissance Class U	100	6,500	2,344
Total	**100**	**19,112**	**9,141**

[6] Level D refers to the Terrain Survey Intensity Level, where the scale ranges from A (most checked) to E (least checked). The level is a measure of the reliability of mapping, where 1 to 20% of the polygons are ground-checked (*Mapping and Assessing Terrain Stability Guidebook*, 1999)

3.4.8 Wildlife range burns

Range burns are a technique used by the Ministry of Water, Land and Air Protection (MWLAP) to create wildlife habitat (grassland forest complexes) which provide grazing opportunities for large ungulates. Most range burn areas are located in the western portion of the TSA. MWLAP have provided the GIS data for the range burn areas and these areas have been fully removed from the THLB, as they are not expected to contribute to timber production now or in the future. The associated reductions are shown in Table 19.

Table 19: Wildlife range burns

Description	% Reduction	Total Area (ha)	Net Area Excluded (ha)
Range Burn Areas	100	354,999	26,728

3.4.9 Stand-level biodiversity – wildlife tree retention

The management of stand level biodiversity is addressed through wildlife tree retention. In order to achieve landscape unit objectives, the establishment of wildlife trees by BEC variant is required. The *Landscape Unit Planning Guide* (March 17, 1999) provides direction for the management of wildlife trees, along with the approved changes to the *Landscape Unit Planning Guide* by the MOF and MELP (May 15, 2000), and the *Provincial Wildlife Tree Management Recommendations* (February 2000).

The existing spatial WTPs do not represent the full requirements across the entire TSA; therefore, further WTPs are required which are modelled as future WTPs. The additional area of WTPs required is calculated as the WTP target minus the existing WTP contribution (Refer to Section 3.4.15 for more details). Spatial WTPs from Canfor and BCTS forest development plans (FDPs) have been identified and are also removed from the timber harvesting land base (Table 20).

Table 20: Reductions for wildlife tree patch/retention

Description	% Reduction	Total Area (ha)	Net Area Excluded (ha)
Existing spatial WTP (from FDPs)	100	434	367

3.4.10 Oil and Gas and Transmission Lines

There is an extensive oil and gas exploration and development program throughout the Fort Nelson TSA, though most activity is concentrated on the lowland areas. Both activities result in a depletion of forest cover, mainly as a result of the establishment of seismic lines for exploration.

Quantifying the extent and location of oil and gas activities within the Fort Nelson TSA is a challenging undertaking given the amount of recent activity and the various types of seismic activity employed. Also, no one complete dataset currently exists which could provide a

comprehensive oil and gas estimation for the TSA. Therefore, a variety of approaches were employed to estimate the measure of oil and gas activities.

Spatial seismic and pipeline data were extracted from TRIM II and buffered at 7m and 15m, respectively[7]. It is understood that TRIM II data is current to 1995. A spatial seismic coverage for 2001-2003 disturbances was received from OGC and these seismic features were buffered at 5m. The average annual seismic development for the last 3 years was approximately 3,369 ha. It was assumed that the same annual development rate occurred during 1996-2000 (3,369 ha X 5 years = 16,845 ha), which was applied to the area of previous seismic activities in the Fort Nelson TSA (i.e. eastern half of Fort Nelson totalling 5,726,268 ha).

Approximately 210 km of transmission lines have been identified in the eastern portion of the TSA. The transmission lines were buffered by 25 m as an approximation of one tree length from the power line or a 50 m right of way (ROW). The transmission maintenance technologist from BC Hydro confirmed that the average ROW is approximately 18 m[8]. Because the information for the ROW came too late in the process of GIS buffering of roads and seismic, it will be noted here that the reductions for transmission lines have been overestimated but would only slightly overestimate the timber harvesting land base reduction.

In summary, this process identified a total of 111,957 ha in the Fort Nelson TSA, which would be covered by transmission lines and affected by oil and gas activities (Table 21).

Table 21: Transmission lines, oil and gas activity reductions

Feature	Length (km)	Width (m)	Buffer used in GIS (m)	Total Area (ha)*	Net Area Excluded (ha)
Transmission lines (TRIM II)	209.79	50.0	25.0	1,050	123
Pipelines (OGC)	4,668.52	15	7.5	5,607	1,232
Pipelines (TRIM II)	1,518.08	15	7.5	2,236	421
Seismic (OGC) (2001-2003)	28,856.43	5	2.5	12,927	3,260
Seismic (TRIM II) (<1995)	105,604.21	7	3.5	73,292	16,493
Seismic non-spatial reduction (1996-2000)				16,845	4,069
Total				**111,957**	**25,598**

*The total area for each feature is the area within the buffer and does not account for overlap between other types of oil and gas features. Therefore, the sum of this column would be an overestimate of the true total area.

[7] Based on seismic data for the Peace River region provided by OGC, the average width of seismic line was 6.47 m and 3.39 m for 1991 and 2003, respectively (period of analysis that the data was available for, which shows the trend in declining cut width over the past decade). Based on a meeting with the MoF and district staff (Dec. 16, 2003), it was decided that 7 metres is a reasonable width for seismic lines developed before 1995 and that an average 5 m width would be reflective of seismic widths for the 1996-2003 period. Based on an email correspondence with Grant Fox, Information Systems Manager, OGC, he estimated that the average right-of-way for pipelines in the TSA is approximately 15 m. Pipelines were extracted from TRIM and from a coverage provided by OGC.

[8] Telephone conversation with Micheal Bast, transmission maintenance technologist, BC Hydro. He estimates the width to be about 18.3m or about 9.15m buffer width (June 9, 2004).

It has been noted by the DFAM group that the 16,845 ha estimated for seismic disturbance during 1996 – 2000 may be overestimated. Without explicit data to support the calculation of seismic activity over this period of time, for the exception of the rate of disturbance provided by the OGC data (2000-2003), it is difficult to determine an appropriate estimate. While this assumption might overestimate the reduction for seismic activity, the magnitude of the difference is likely too small to have a significant impact on the timber harvesting land base. A sensitivity analysis is proposed to address the uncertainty of the timber harvesting land base size.

3.4.11 Inoperable/inaccessible/uneconomical areas

The assessment of operability is based on the anticipated extent to which a forested area within the Fort Nelson TSA will be harvested considering its physical and economical factors. Often, classifying operability includes a description of the timber quality, terrain conditions and cost and value of the timber. With the availability of new technologies harvesting is rarely impossible, but the related costs may be such that it is impractical.[9]

A revised operability analysis for the Fort Nelson TSA was developed based on the methodology from a 1997 harvest method mapping project undertaken in the Bulkley TSA[10]. The Fort Nelson operability analysis produced a spatial operability coverage for the entire TSA in which 'operable' polygons were identified through combinations of three derived attributes: stand quality codes, harvest method, and available land base. Queries were performed on the forest inventory to determine stand quality codes. Stand quality codes classified the stands into merchantability categories based on species, age, volume, diameter at breast height, and site index. Harvest method codes were defined by slope classes where ground based harvestable stands (< 35% slope) were considered to be available for harvest. The licensees are not pursuing cable or helicopter logging at this time. The available land base was defined as the available Crown forested land base. A combination of the merchantability criteria, harvest method and Crown productive forest was used to define the operability. Inoperable areas identified from this analysis are excluded from the timber harvesting land base (Table 22).

Table 22: Operable/inoperable classification

Operability Description	Total Area (ha)	% Reduction	Net Area Excluded (ha)
Operable	2,449,018	0	n/a
Inoperable	7,419,049	100	344,811

Given that this operability analysis was completed in a short timeline, there was not significant opportunity for a thorough review and critique. Several iterations of operability assessments were completed and provided to the DFAM group. Numerous reviews and meetings were held but no formal approval was received prior to completing the analysis dataset. It is proposed that several sensitivity analyses be completed regarding operability including testing the uneconomic criteria from TSR 2 and applying a transportation appraisal to the revised operability assessment.

[9] from: http://www.for.gov.bc.ca/hcp/fia/landbase/OperabilityStandards.pdf
[10] from: http://www.for.gov.bc.ca/hcp/fia/landbase/HMM_OutlineBulkley.pdf

If any further information becomes available regarding operability during the course of this analysis it will be incorporated as necessary.

3.4.12 Black spruce-leading stands

Black spruce is typically harvested when occurring in mixed stands or in small pockets adjacent to other merchantable species; however, black spruce-leading stands are rarely targeted for timber harvesting in the Fort Nelson TSA.

Black spruce-leading stands contain small stem sizes, which are currently not considered merchantable, and offer regeneration problems for future stands due to elevated water tables. For the base case, all black spruce-leading stands will be excluded from the THLB (Table 23). The minor component of black spruce that occurs in mixed species stands will remain as part of the merchantable stand volume.

Table 23: Reduction to black-spruce leading stands

Description	% Reduction	Total Area (ha)	Net Area Excluded (ha)
Black spruce-leading stands	100	1,216,437*	143,259

* There are approximately 2,396,054 ha of black spruce leading stands in the Fort Nelson TSA from the inventory file. However, about 50% (1,179,617ha) have been assigned to the Non-Forest category for wetland and non-productive reductions based on attribute within the VRI.

3.4.13 Cultural heritage resources

Three categories of cultural heritage resources are evident within the Fort Nelson TSA: archaeological sites containing physical remains of past human activity; historical sites often consisting of built structure or localities of events significant to living communities; and, traditional use sites which often lack the physical evidence of human-made artefacts or structures but maintain cultural significance for living communities. Natural heritage resources included in the Fort Nelson LRMP consist of all three types of cultural heritage resources.

An archaeological study, *Archaeological Overview of the Fort Nelson Land and Resource Management Plan Area, Heritage*, was completed in March 1996. The study was completed at a scale of 1:250 000 and classified the planning area into zones with a low, moderate or high potential to contain archaeological sites. This information has been refined to a scale of 1:50 000 or 1:20 000 to assist in operational decision-making.

The Muskwa-Kechika special management area (M-K SMA) covers approximately 6.4 million hectares, of which 2.3 million hectares overlap with the Fort Nelson TSA. The M-K SMA is composed of both special areas and protected areas. Protected areas, such as the historic Davie Trail, are removed from the THLB. Eleven new protected areas have been established, occupying more than 1 million hectares of land. Management in special areas is subject to the guidelines for management of special management zones as outlined in the Fort Nelson LRMP and will allow for logging activities that are sensitive to the wildlife, environmental and cultural values in the area. It is assumed that the wildlife and environmental rules and netdown provided in this data package will account for the Muskwa-Kechika special management requirements.

Trapping is a highly valued activity within the Fort Nelson TSA, particularly among First Nations communities whose families often maintain traplines. The LRMP identifies that, where traplines are not located in protected areas, a major concern for trappers is the need for adequate notice of pending development that might interfere with their traplines. This requires that any plan must co-ordinate access management planning to include the opportunity for participation by the trapline holder. Commercial/ industrial operators must work with trappers to minimize the impacts of their activities on furbearer habitat and trapline operations.

Currently there are no additional exclusions from the THLB for traplines or other cultural heritage resources.

3.4.14 Future roads, trails and seismic

A reduction for future roads, trails and seismic (RTS) activity is required to account for the resulting non-productive areas that will occur as access structures are built and logging and oil and gas activities occur. Future seismic activity is included in this reduction since seismic lines are often used for timber harvesting access.

To determine future requirements for roads, trails and seismic, a buffer of 200 m (total width of 400 m), representing the average yarding distance in the Fort Nelson TSA, will be spatially applied to all existing roads and seismic lines to determine the area currently accessed. The area inside the buffer will be considered the roaded area. All areas outside the buffer will be considered part of the non-roaded area. The area in road and seismic activities was determined to be approximately 3.9% of the THLB within the roaded-area (area in existing roads and seismic lines are described in Section 3.3.4 and 3.4.10). Assuming that the road-seismic density in the roaded area will also apply to the non-roaded area, a future RTS reduction will be applied to the THLB in the non-roaded area (Table 24).

Based on discussions with the DFAM group and confirmed by the MOF - Fort Nelson Forest District, roadside landings are used in the course of all current logging; additional reductions should therefore not be necessary since they would likely be incorporated into the future road widths. Any production landings within blocks are fully rehabilitated and regenerated and there is no further impact expected; therefore, no future in-block reductions will be made.

The DFAM group expects that future road requirements will remain similar to existing requirements throughout the THLB. The only exception is that the future area of seismic may not be applicable to the total non-roaded land base, but this is thought to be a conservative estimate.

Table 24: Future road reductions

Description	% Reduction	Reduction Applied to:	Net Area Excluded (ha)
Future between block structures (based on existing road density)	3.9	THLB in the "non-roaded" area	29,825

3.4.15 Future wildlife tree patches

After all other removals are completed, additional reductions are required to account for the amount of timber retention required for wildlife trees and wildlife tree patches (WTPs). Section 3.2 and Appendix 3 of the *Landscape Unit Planning Guide* (LUPG, updated in March 2000) will be the basis for modeling wildlife tree retention in this timber supply analysis. Further direction regarding the management of wildlife tree retention relates to the updated Section 3.2 provided by the Assistant Deputy Ministers of Environment, Lands and Parks[11] and Forests (May 2000) as well as the *Provincial Wildlife Tree Management Recommendations* (2002).

Wildlife tree targets are determined using Table 3.1 of the LUPG. The required wildlife tree retention %, to be applied to the THLB, was calculated by subtracting the THLB area requiring WTR from the WTR target. The results for this analysis are provided in Table 25. The process of determining the targets and THLB required for WTPs is described below:

Step 1
WTR requirements are calculated separately for each biogeoclimatic subzone within each landscape unit.

Step 2
The Crown forested area for all polygons within the TSA is identified. The current timber harvesting land base (THLB) is the total area remaining from the netdown process, excluding future roads and WTP requirements.

Step 3
The percentage of the BEC subzone within the landscape unit available for harvest is calculated as follows: (THLB/crown forested area)*100%.

Step 4
Estimate the portion of the THLB where previous harvesting does not meet WTR objectives. For the purposes of estimating this area, it is assumed that harvesting activities before the introduction of the *Biodiversity Guidebook* in 1995 do not meet WTR objectives.

Step 5
Based on the information derived from steps 1-3, total wildlife tree retention targets are determined from Table A3.2 in the revised Appendix 3 of the *Landscape Unit Planning Guide*.

Step 6
Reserves such as riparian reserve zones contribute to wildlife tree retention targets. The *Landscape Unit Planning Guide* states that there should be no more than 500m between wildlife tree patches. To determine the proportion of the THLB requiring wildlife tree patches, a 250-meter GIS buffer is applied to existing non-harvestable contributing land base (defined as >80% retention). WTR targets are applied uniformly to the areas beyond the 250-meter buffer from existing reserves.

[11] Now the Ministry of Sustainable Resource Management

The results of the analysis show that an additional 6,272 ha of THLB will be required for future wildlife tree retention.

Table 25: Future wildlife tree retention required by landscape unit and BEC subzone.

Landscape Unit	BEC Zone	BEC Subzone	Crown forest (ha)	THLB (ha)	% THLB harvested without WTP	% subzone available for harvest	WTP Target (%)	THLB Requiring WTP	Net Area Removed (ha)
July Lake	BWBS	mw	50,595	23,912	0.0	47.3	2	21,004	420
Shekilie	BWBS	mw	127,601	38,130	0.2	29.9	0	19,404	0
Timberwolf	BWBS	mw	66,769	37,748	0.0	56.5	3	25,326	760
Kyklo	BWBS	mw	144,883	67,545	1.1	46.6	2	33,252	665
Kwokullie	BWBS	mw	52,125	4,581	0.0	8.8	0	1,159	0
Hossitl	BWBS	mw	41,280	8,230	0.0	19.9	0	5,971	0
Ootta	BWBS	mw	46,551	7,824	0.0	16.8	0	2,702	0
Dilly	BWBS	mw	34,382	7,166	0.0	20.8	0	5,164	0
Sahtaneh	BWBS	mw	386,568	64,632	0.7	16.7	0	5,595	0
Hoffard	BWBS	mw	120,002	24,629	0.4	20.5	0	511	0
Elleh	BWBS	mw	77,393	25,505	0.2	33.0	0	4,428	0
Eskai	BWBS	mw	143,604	26,210	1.4	18.3	0	2,156	0
Klua	BWBS	mw	66,446	12,784	0.0	19.2	0	1,218	0
Klua	BWBS	wk	5,068	784	0.0	15.5	0	61	0
Big Beaver	BWBS	mw	93,481	20,567	0.7	22.0	0	1,847	0
Big Beaver	BWBS	wk	1,513	243	0.0	16.1	0	0	0
Snake	BWBS	mw	48,725	23,384	0.7	48.0	2	5,900	118
Kiwigana	BWBS	mw	197,588	85,146	0.0	43.1	1	21,758	218
D Easum	BWBS	mw	62,845	21,428	0.4	34.1	0	13,461	0
Sandy	BWBS	mw	27,370	15,980	1.7	58.4	3	9,249	277
Capot Blanc	BWBS	mw	38,661	22,800	5.7	59.0	4	10,314	413
Patry	BWBS	mw	67,448	26,058	4.3	38.6	1	5,847	58
Etane	BWBS	mw	46,370	24,574	3.4	53.0	2	2,704	54
Etane	BWBS	wk	342	160	0.0	46.8	2	0	0
Stanolind	BWBS	mw	93,763	36,395	0.9	38.8	1	5,129	51
Stanolind	BWBS	wk	216	190	0.0	87.9	6	73	4
Pouce	BWBS	mw	77,775	41,865	0.8	53.8	2	11,896	238
Pouce	BWBS	wk	275	132	0.0	48.1	2	7	0
Akue	BWBS	mw	59,735	28,347	0.7	47.5	2	5,720	114
Akue	BWBS	wk	231	26	0.0	11.2	0	0	0
Klowee	BWBS	mw	49,386	19,357	2.7	39.2	1	3,096	31
Holden	BWBS	mw	94,592	21,091	0.0	22.3	0	1,709	0
Holden	BWBS	wk	17,431	871	0.0	5.0	0	8	0
Holden	SWB	mk	27,803	1,403	0.0	5.0	0	37	0
Jackknife	BWBS	mw	35,276	6,812	0.0	19.3	0	150	0
Minaker	BWBS	mw	66,377	15,559	0.0	23.4	0	1,733	0
Minaker	BWBS	wk	1,959	208	0.0	10.6	0	3	0
Minaker	SWB	mk	866	11	0.0	1.3	0	0	0
Richards	BWBS	mw	1,947	194	0.0	9.9	0	0	0

Landscape Unit	BEC Zone	BEC Subzone	Crown forest (ha)	THLB (ha)	% THLB harvested without WTP	% subzone available for harvest	WTP Target (%)	THLB Requiring WTP	Net Area Removed (ha)
Richards	SWB	mk	24,292	601	0.0	2.5	0	84	0
Richards	SWB	mks	1,379	0	0.0	0.0	0	0	0
Hewer	BWBS	mw	2,263	172	0.0	7.6	0	6	0
Hewer	SWB	mk	31,269	336	0.0	1.1	0	19	0
Hewer	SWB	mks	1,128	0	0.0	0.0	0	0	0
Bunch	BWBS	mw	50,480	10,618	0.0	21.0	0	1,831	0
Bunch	BWBS	wk	2,793	102	0.0	3.7	0	0	0
Bunch	SWB	mk	5,859	25	0.0	0.4	0	0	0
Bunch	SWB	mks	2	0	0.0	0.0	0	0	0
Gammer	BWBS	mw	21,399	4,957	0.0	23.2	0	398	0
Gammer	BWBS	wk	576	47	0.0	8.2	0	2	0
Gammer	SWB	mk	6,465	237	0.0	3.7	0	0	0
Falk	BWBS	mw	91,040	13,813	0.0	15.2	0	4,918	0
Falk	SWB	mk	34,792	133	0.0	0.4	0	1	0
Falk	SWB	mks	37	0	0.0	0.0	0	0	0
Kledo	BWBS	mw	126,436	32,992	0.0	26.1	0	2,193	0
Kledo	BWBS	wk	20,201	2,005	0.0	9.9		99	0
Kledo	SWB	mk	38	0	0.0	0.0	0	0	0
Dunedin	BWBS	mw	65,892	11,881	0.0	18.0	0	5,233	0
Dunedin	BWBS	wk	2,002	49	0.0	2.4	0	7	0
Dunedin	SWB	mk	3,970	26	0.0	0.7	0	0	0
Dunedin	SWB	mks	4	0	0.0	0.0	0	0	0
Irene East	BWBS	mw	45,903	15,248	0.0	33.2	0	2,955	0
Irene West	BWBS	mw	84,730	35,215	0.0	41.6	1	11,889	119
Irene West	BWBS	wk	1,273	274	0.0	21.5	0	65	0
Catkin	BWBS	mw	30,864	22,038	0.0	71.4	4	12,955	518
La Biche	BWBS	mw	62,965	33,295	10.9	52.9	2	12,169	243
Crow	BWBS	mw	65,171	24,090	6.1	37.0	2	14,991	300
Crow	BWBS	wk	4,433	39	0.0	0.9	0	0	0
Crow	SWB	mk	1,170	0	0.0	0.0	0	0	0
Scatter	BWBS	mw	34,784	1,930	0.0	5.5	0	748	0
Scatter	BWBS	wk	32,279	1,855	0.0	5.7	0	374	0
Scatter	SWB	mk	33,020	191	0.0	0.6	0	5	0
Scatter	SWB	mks	54	0	0.0	0.0	0	0	0
Graybank	BWBS	dk	2,432	0	0.0	0.0	0	0	0
Graybank	BWBS	mw	43,721	18,095	0.0	41.4	1	12,006	120
Graybank	BWBS	wk	7,764	3,016	0.0	38.8	1	1,775	18
Graybank	SWB	mk	4,988	470	0.0	9.4	0	270	0
Crusty	BWBS	mw	25,271	6,160	0.0	24.4	0	2,764	0
Crusty	SWB	mk	3,590	12	0.0	0.3	0	0	0
Ram	BWBS	mw	14,837	1,736	0.0	11.7	0	536	0
Ram	SWB	mk	23,083	298	0.0	1.3	0	46	0
Ram	SWB	mks	67	0	0.0	0.0	0	0	0
Tetsa	BWBS	mw	178	0	0.0	0.0	0	0	0

Landscape Unit	BEC Zone	BEC Subzone	Crown forest (ha)	THLB (ha)	% THLB harvested without WTP	% subzone available for harvest	WTP Target (%)	THLB Requiring WTP	Net Area Removed (ha)
Tetsa	SWB	mk	19,925	15	0.0	0.1	0	0	0
Tetsa	SWB	mks	640	0	0.0	0.0	0	0	0
Tuchodi	BWBS	mw	4,272	0	0.0	0.0	0	0	0
Tuchodi	SWB	mk	58,704	0	0.0	0.0	0	0	0
Tuchodi	SWB	mks	2,718	0	0.0	0.0	0	0	0
Gathto	BWBS	mw	553	0	0.0	0.0	0	0	0
Gathto	SWB	mk	18,034	0	0.0	0.0	0	0	0
Gathto	SWB	mks	739	0	0.0	0.0	0	0	0
Crehan	BWBS	mw	6,369	55	0.0	0.9	0	0	0
Crehan	SWB	mk	27,435	0	0.0	0.0	0	0	0
Crehan	SWB	mks	564	0	0.0	0.0	0	0	0
Racing	SWB	mk	13,712	44	0.0	0.3	0	10	0
Racing	SWB	mks	588	0	0.0	0.0	0	0	0
MacDonald	BWBS	mw	2,710	160	0.0	5.9	0	1	0
MacDonald	SWB	mk	20,873	2,469	0.0	11.8	0	780	0
MacDonald	SWB	mks	96	0	0.0	0.0	0	0	0
Tentsi	BWBS	mw	6,219	788	0.0	12.7	0	175	0
Tentsi	SWB	mk	19,781	4,083	0.0	20.6	0	2,742	0
Tentsi	SWB	mks	3	0	0.0	0.0	0	0	0
Moose	SWB	mk	15,051	2,634	0.0	17.5	0	1,523	0
Moose	SWB	mks	84	0	0.0	0.0	0	0	0
Otelsas	BWBS	mw	343	0	0.0	0.0	0	0	0
Otelsas	SWB	mk	22,011	288	0.0	1.3	0	66	0
Otelsas	SWB	mks	983	0	0.0	0.0	0	0	0
Muncho	BWBS	dk	10,914	125	0.0	1.1	0	0	0
Muncho	SWB	mk	29,799	140	0.0	0.5	0	61	0
Muncho	SWB	mks	1,711	0	0.0	0.0	0	0	0
Eight Mile	BWBS	mw	10,802	522	0.0	4.8	0	173	0
Eight Mile	SWB	mk	33,947	911	0.0	2.7	0	254	0
Eight Mile	SWB	mks	46	0	0.0	0.0	0	0	0
Sulpher	BWBS	dk	32,954	637	0.0	1.9	0	113	0
Sulpher	BWBS	mw	745	0	0.0	0.0	0	0	0
Sulpher	SWB	mk	22,728	668	0.0	2.9	0	67	0
Sulpher	SWB	mks	22	0	0.0	0.0	0	0	0
Moule	BWBS	dk	32,240	531	0.0	1.6	0	22	0
Moule	BWBS	wk	139	0	0.0	0.0	0	0	0
Moule	SWB	mk	11,162	851	0.0	7.6	0	214	0
Moule	SWB	mks	97	1	0.0	0.9	0	0	0
Grayling	BWBS	dk	28	20	0.0	70.4	4	0	0
Grayling	BWBS	mw	22,699	5,356	0.0	23.6	0	2,649	0
Grayling	BWBS	wk	22,423	5,991	0.0	26.7	0	2,423	0
Grayling	SWB	mk	72,604	9,150	0.0	12.6	0	4,316	0
Grayling	SWB	mks	1,188	57	0.0	4.8	0	31	0
Redpott	BWBS	mw	184	82	0.0	44.6	1	13	0

Landscape Unit	BEC Zone	BEC Subzone	Crown forest (ha)	THLB (ha)	% THLB harvested without WTP	% subzone available for harvest	WTP Target (%)	THLB Requiring WTP	Net Area Removed (ha)
Redpott	BWBS	wk	6,473	1,902	0.0	29.4	0	823	0
Redpott	SWB	mk	26,010	3,821	0.0	14.7	0	1,999	0
Redpott	SWB	mks	9	1	0.0	11.5	0	1	0
Smith	BWBS	dk	140,711	57,613	0.0	40.9	1	39,343	393
Smith	BWBS	wk	994	594	0.0	59.8	3	511	15
Smith	SWB	mk	23,164	3,580	0.0	15.5	0	1,783	0
Liard Hot Springs	BWBS	dk	33,565	4,135	0.0	12.3	0	1,952	0
Liard Hot Springs	SWB	mk	12,225	145	0.0	1.2	0	13	0
Liard Hot Springs	SWB	mks	8	0	0.0	0.0	0	0	0
Forcier	BWBS	dk	23,439	430	0.0	1.8	0	114	0
Forcier	SWB	mk	14,640	373	0.0	2.5	0	96	0
Forcier	SWB	mks	1,332	4	0.0	0.3	0	0	0
Vents	BWBS	dk	61,415	17,724	0.0	28.9	0	11,125	0
Vents	SWB	mk	29,459	2,839	0.0	9.6	0	1,545	0
Vents	SWB	mks	392	0	0.0	0.0	0	0	0
Liard River A	BWBS	dk	115,668	21,495	0.0	18.6	0	12,217	0
Liard River A	SWB	mk	2,691	114	0.0	4.3	0	1	0
Liard River B	BWBS	mw	31,650	7,870	0.0	24.9	0	2,060	0
Liard River B	BWBS	wk	38	2	0.0	5.2	0	0	0
Liard River C	BWBS	mw	67,086	42,647	5.5	63.6	3	15,498	465
Fort Nelson River B	BWBS	mw	35,336	20,521	0.0	58.1	3	3,334	100
Fort Nelson River A	BWBS	mw	20,364	10,061	0.1	49.4	2	1,289	26
Muskwa River B	BWBS	mw	27,010	12,853	0.0	47.6	2	1,456	29
Prophet River	BWBS	mw	27,092	15,279	0.2	56.4	3	2,193	66
Muskwa River A	BWBS	mw	16,944	3,286	0.0	19.4	0	75	0
Muskwa River A	SWB	mk	1,632	0	0.0	0.0	0	0	0
Hay River	BWBS	mw	6,545	2,953	0.0	45.1	2	637	13
Petitot River	BWBS	mw	13,392	2,739	0.0	20.5	0	528	0
Kechika River	BWBS	dk	165,000	57,519	0.0	34.9	1	26,912	269
Kechika River	SWB	mk	18,246	3,005	0.0	16.5	0	882	0
Coal	BWBS	dk	60,587	13,954	0.0	23.0	0	8,621	0
Coal	SWB	mk	3,051	278	0.0	9.1	0	121	0
Kitza	BWBS	dk	19,700	9,973	0.0	50.6	2	6,752	135
Kitza	SWB	mk	921	170	0.0	18.5	0	43	0
Gemini	BWBS	dk	39,842	6,213	0.0	15.6	0	1,918	0
Gemini	SWB	mk	926	37	0.0	4.0	0	8	0
Rabbit	BWBS	dk	60,632	7,900	0.0	13.0	0	2,518	0
Rabbit	SWB	mk	16,614	1,035	0.0	6.2	0	250	0
Chee	BWBS	dk	17,220	490	0.0	2.8	0	38	0
Chee	SWB	mk	33,423	3,073	0.0	9.2	0	1,577	0
Chee	SWB	mks	145	71	0.0	48.6	2	71	1
Gundahoo	BWBS	dk	3,875	941	0.0	24.3	0	333	0
Gundahoo	SWB	mk	46,856	3,897	0.0	8.3	0	1,679	0
Gundahoo	SWB	mks	5,064	25	0.0	0.5	0	0	0

Landscape Unit	BEC Zone	BEC Subzone	Crown forest (ha)	THLB (ha)	% THLB harvested without WTP	% subzone available for harvest	WTP Target (%)	THLB Requiring WTP	Net Area Removed (ha)
Netson	BWBS	dk	10,641	3,904	0.0	36.7	1	1,873	19
Netson	SWB	mk	68,378	10,117	0.0	14.8	0	5,345	0
Netson	SWB	mks	6,199	294	0.0	4.7	0	193	0
Matulka	BWBS	dk	4,821	748	0.0	15.5	0	354	0
Matulka	SWB	mk	12,152	326	0.0	2.7	0	125	0
Matulka	SWB	mks	1,374	15	0.0	1.1	0	1	0
Boreal	BWBS	dk	19,441	2,626	0.0	13.5	0	922	0
Boreal	SWB	mk	51,882	4,010	0.0	7.7	0	1,972	0
Boreal	SWB	mks	6,009	6	0.0	0.1	0	0	0
Major Hart	BWBS	dk	43,791	12,952	0.0	29.6	0	5,797	0
Major Hart	SWB	mk	84,008	8,016	0.0	9.5	0	3,090	0
Major Hart	SWB	mks	3,239	65	0.0	2.0	0	8	0
Sharktooth	BWBS	dk	14,661	3,527	0.0	24.1	0	1,500	0
Sharktooth	SWB	mk	35,433	4,053	0.0	11.4	0	2,058	0
Sharktooth	SWB	mks	1,891	18	0.0	1.0	0	17	0
Total			**5,634,280**	**1,432,257**				**506,135**	**6,272**

4 Management zones and analysis units

4.1 Management zones and objectives

Management zones are used to differentiate areas with distinct management emphasis for the application of forest cover rules in the timber supply analysis, and reporting purposes.

The concept of management zones is used to distinguish areas with distinct management emphasis and homogeneous forest cover. For example, a zone may be based on a harvesting system, silviculture system, visual quality objective, wildlife consideration, or similar forest cover data. Zones may be thought of as layers required for different management objectives, which must be maintained and tracked over time. Seven management zones have been identified for the Fort Nelson TSA (Table 26).

Table 26: Resource emphasis zones in the Fort Nelson TSA

Resource Emphasis Zone	Total area (ha)	Crown forested land base area (ha)	Timber harvesting land base area (ha)
Enhanced Resource Development Zone	3,707,023	2,028,543	613,016
General Resource Zone	2,317,692	1,863,027	591,632
Muskwa-Kechika Special Management Zone	2,354,719	1,379,892	225,327
Visual Quality Objectives	16,702	13,930	1,684
Biodiversity Low Emphases	5,145,364	2,478,161	565,827
Biodiversity Intermediate Emphases	4,193,641	2,747,917	715,814
Biodiversity High Emphases	529,059	408,202	150,617

The Enhanced Resource Development Zone (ERDZ), General Resource Zone (GRZ), and Muskwa-Kechika Special Management Zone (M-KSMZ) are described by the *Fort Nelson LRMP* (1997). The objectives of the ERDZ include managing the land for oil and gas, and mineral and timber resources, while emphasizing recreation and tourism resources along the highway corridor; moreover, investments in resource development are encouraged. The intent of the GRZ is to manage for a wide array of resource values by integrating the requirements of these values with resource development. The management direction of M-KSMZ is that resource development can proceed while minimizing impacts on other resource values. The M-KSMZ contains the most restrictive objectives and strategies for development.

4.2 Analysis units

An analysis unit represents a combination of stands dominated by specific tree species, or a silviculture regime with a set range of timber growing capability – as indicated by the species and site index in the forest inventory file. Inventory stand groups define the primary analysis units and site index (SI) defines the secondary analysis units, whereby natural groupings of SI

were determined by means of SI distribution analysis (Table 27). Each analysis unit is assigned its own net merchantable volume projections for existing and future stands.

Table 27: Primary and secondary analysis units for the Fort Nelson TSA

Primary Analysis Unit	Secondary Analysis Unit*	Leading Species	Inventory Type Group	Site Index Range
1	011	Spruce	21, 23, 24	< 14.5
1	012			14.5 – 17.9
1	013			> 17.9
2	021	Spruce/pine	25	< 13.1
2	022			13.1 – 16.9
2	023			> 16.9
3	031	Spruce/deciduous	26	< 13.2
3	032			13.2 – 17.9
3	033			> 17.9
4	041	Aspen/coniferous	41	< 18.2
4	042			18.2 – 22.0
4	043			> 22.0
5	051	Aspen/deciduous	42	< 18.2
5	052			18.2 – 23.3
5	053			> 23.3
6	061	Pine	27-30	< 14.1
6	062			14.1 – 18.4
6	063			> 18.4
7	071	Pine/deciduous	31	< 14.3
7	072			14.3 – 18.4
7	073			> 18.4
8	081	Cottonwood/coniferous	35	< 16.2
8	082			16.3 – 22.2
8	083			> 22.2
9	091	Cottonwood/deciduous	36	< 16.1
9	092			16.1 – 23.1
9	093			> 23.1
10	101	Spruce/larch	22	< 14.0
10	102			14.0 – 18.0
10	103			> 18.0
11	111	Subalpine fir	18-20	< 11.0
11	112			11.0 – 14.5
11	113			> 14.5
12	121	Birch**	40	< 18.3
12	122			18.3 – 20.9
12	123			> 20.9

*The naming convention of the secondary analysis unit is where the first two digits are the primary analysis unit and the third digit is 1=low SI, 2 =medium SI, and 3 =high SI.

**Birch is used for sensitivity analysis only.

The analysis units will be organized within the following management groups:

Existing natural stands – stands that have not been logged yet or are not subject to forest management (planting/density control). This group will include current and future deciduous and naturally regenerating mixedwood spruce/larch and subalpine fir stands. Any stands logged pre-1990 are also considered 'natural'. These stands will be modeled with VDYP, as agreed to by the DFAM/District, as they are problematic and of low productivity: there is difficulty regenerating these stands, as represented by their longer regeneration delay.

Existing natural stand analysis units are presented in Table 28. Each analysis unit will also be split between VRI "rolled over" and VRI Phase II to recognize the differences between these inventory standards as well as for analysis comparison and modelling.

Existing managed stands –stands that have been subject to forest management (planting and density control) to the degree that they would exhibit different growth characteristics and attributes as compared to existing natural stands. Existing managed stands include stands harvested between 1990 and 2002. Only pure spruce, spruce/pine and pure pine stands are planted so it is expected that they will form the majority of existing managed stands. These stands will be modelled using TIPSY. As the existing managed pure conifer stands are harvested they will regenerate to future managed stands.

Current/future managed stands – stands that are currently being harvested and regenerated following current forest management (*i.e*. any stand logged or managed after 2003). Once the pure spruce, spruce/pine and pure pine existing natural and existing managed stands are harvested they will regenerate to pure conifer future managed stands. Future managed stands will be modelled using TIPSY. The difference between existing managed and current/future managed stands is that the latter will be modelled with genetic gain information applied to the yield curves.

Analysis units for existing natural stands (Table 28), existing managed stands (Table 29), and future managed stands (Table 30) are split between VRI "rolled over" and Phase II to represent the differences between these inventory standards. The SI values provided represent area-weighted averages for these stands.

Table 28: Existing natural stand primary analysis unit and site index

Primary Analysis Units	Secondary Analysis Units	Area-weighted SI based on VRI "rolled over"	Area-weighted SI based on VRI Phase II
1	011	12.22	12.81
1	012	15.73	15.90
1	013	19.43	19.81
2	021	11.39	12.24
2	022	14.95	14.58
2	023	21.38	19.40
3	031	11.60	12.18
3	032	14.98	15.41
3	033	20.65	19.97
4	041	16.48	16.87
4	042	19.57	20.04
4	043	23.32	23.47
5	051	17.12	17.08
5	052	20.40	20.39
5	053	24.98	24.59
6	061	11.58	12.25
6	062	15.95	16.06
6	063	19.92	20.04
7	071	11.40	13.08
7	072	15.82	16.37
7	073	20.12	20.46
8	081	15.13	15.19
8	082	18.51	18.69
8	083	24.29	26.48
9	091	15.16	15.01
9	092	18.85	19.30
9	093	25.03	27.81
10	101	11.71	12.30
10	102	15.24	15.55
10	103	24.72	20.92
11	111	8.56	9.68
11	112	12.95	13.50
11	113	17.46	16.37
12	121	12.28	14.27
12	122	19.57	19.36
12	123	24.16	23.00

*Birch is used for sensitivity analysis only.

Table 29: Existing managed stand analysis unit and site index

Primary Analysis Units	Secondary Analysis Units	Area-weighted SI based on VRI "rolled over"
1	012	15.27
6	062	17.35
6	063	20.00

Note: Only existing managed stands in the THLB are shown.

Table 30: Current/future managed stand analysis unit and site index

Primary Analysis Units	Secondary Analysis Units	Area-weighted SI based on VRI "rolled over"	Area-weighted SI based on VRI Phase II
1	011	12.22	12.81
1	012	15.73	15.90
1	013	19.43	19.81
2	021	11.39	12.24
2	022	14.95	14.58
2	023	21.38	19.40
6	061	11.58	12.25
6	062	15.95	16.06
6	063	19.92	20.04

5 Growth and Yield

This section describes the issues, information sources and assumptions, and methods related to growth and yield estimates for existing and future stands under both unmanaged and managed conditions in the Fort Nelson TSA.

5.1 Site index

Site index is a measure of the productive capacity of a given site to sustain the growth of trees to harvestable age. It is a key variable in predicting the growth of timber and its yield at harvest. Site index is defined as the height of a "site" tree at 50 years breast height age.

5.1.1 Site curves

Site index curves are used to define the correlation between stand age and height. This analysis will use those curves that are consistent with the accepted MOF standards. The site index sources are shown in Table 31.

Table 31: Source of site index equations

Species	Code	Site Curve Reference
White spruce	Sw	Goudie (1984)
Spruce	S	Goudie (1984)
Aspen	At	Alberta Forest Service (1985)
Lodgepole pine	Pl	Nigh (1999)
Cottonwood	Ac	J.S. Thrower and Associates (1992)
Larch	L	Milner (1989)
Subalpine fir	Bl	Goudie (1984)
Birch	Ep	Alberta Forest Service (1985)

5.1.2 Site index adjustments

No site index adjustments are planned for the base case. VRI Phase 2 inventory adjustments are incorporated in the inventory data and will be used in the base case.

As noted in Section 2.1.2 there is a variety of PEM and TEM data that exists for the Fort Nelson TSA but there are no independent accuracy assessments available. Therefore, a sensitivity analysis will be completed to quantify the impacts of using associations between ecological data and site productivity. The site index for all managed stands will be adjusted for the sensitivity analysis using the following methodology:

1. Overlay forest cover (leading species) and analysis units and PEM data to create SIBEC groups.
2. Generate site series distribution by BEC variant by analysis unit.
3. Develop an area weighted SIBEC site index estimate for each species by SIBEC group.

4. Once the adjusted site index estimates are known, the managed stand polygons can be adjusted by selecting the appropriate curve from the next highest SI grouping from the base case managed stand yield curves. If new managed yield stand curves are required, the adjusted site index estimates will be applied in TIPSY using the appropriate analysis unit inputs.

5.2 Utilization level

The development of the yield curves will include a standard utilization to define the maximum stump height, minimum top diameter inside bark (dib) and minimum diameter at breast height (dbh) by species (Table 32). These factors are used to define and calculate merchantable volume.

Table 32: Minimum utilization levels

Leading Species	Minimum dbh (cm)	Maximum Stump Height (cm)	Minimum top dib (cm)
Spruce	17.5	30	10
Pine	12.5	30	10
Subalpine fir	17.5	30	10
Cottonwood	12.5	30	10
Aspen	12.5	30	10
Larch*	17.5	30	10
Birch*	12.5	30	10

* Larch and birch are provided since they will be utilized as minor components of other leading species stands.

5.3 Decay, waste and breakage for unmanaged stands

Decay, waste and breakage factors by species are applied to unmanaged stand yield tables to calculate net volumes per hectare. The factors that will be used are the standard values that are included in the Variable Density Yield Prediction (VDYP) model.

5.4 Operational adjustment factors for managed stands

This section describes all operational adjustment factors (OAFs) that need to be applied to reduce potential yields generated by the Table Interpolation Program for Stand Yields (TIPSY) for managed stands, to better reflect expected operational yields.

The provincial default factors are an OAF 1 of 15% and an OAF 2 of 5%. OAF 1 includes accounting for openings in stands (4%), distribution of stems or clumpiness (4%), endemic pests and diseases (4%), and other risks to potential yield (3%) for a total of 15%.

OAF 2 is applied to account for decay, waste and breakage. The 5% factor originates from estimates for older immature stands documented in the *1976 Metric Diameter Class Decay, Waste and Breakage Factors.* OAF 2 is applied after OAF 1 and increases over time from 0% at

time 0 years to 5% at index age of 100 years. The reduction increases linearly at this rate (10% at 200 years, 15% at 300 years etc).

The standard provincial OAF values currently represent best available information for the Fort Nelson TSA to account for stand gaps, decay, waste and breakage, and endemic forest health losses.

5.5 Volume reductions

Volume reductions are used in timber supply analysis to account for non-merchantable components of otherwise merchantable stands. A stand may contain one or more species, which may be non-merchantable, and should therefore not contribute to the estimated volume of the stand for timber supply analysis. Table 33 indicates the species to be excluded from the estimated stand volumes.

Table 33: Non-merchantable species volume exclusions

Species	Volume exclusion (%)
Alder/maple	100
Douglas-fir	100
Hemlock	100
Cedar	100

5.6 Other issues related to yield table development

Yield curves for unmanaged, existing managed, and current/future stands are shown in Appendix 2. Sections 5.6.1 to 5.6.3 describe the models that will be used for growth and yield in this analysis.

5.6.1 Yields for Natural (Unmanaged) Stands

Yield tables for mature and unmanaged immature stands were predicted with BatchVDYP version 6.6d. The yield tables will be generated by creating a yield table for each polygon then using an area weighted function to develop an aggregate table for each AU.

5.6.2 Yields for Existing Managed Stands

Spruce, spruce/pine and pine stands which have been regenerated from 1990 – 2001 will be grown on managed stand yield tables (MSYTs) produced using the B.C. Forest Service Table Interpolation Program for Stand Yields (TIPSY ver. 3.0h) growth and yield model.

5.6.3 Yields for Current and Future Managed Stands

Spruce, spruce/pine and pine stands which have been regenerated from 2002 onwards will be grown on MSYTs produced using the B.C. Ministry of Forests TIPSY ver. 3.0h growth and yield model. Any current or future genetic gain benefits will be applicable to these stands.

5.6.4 Existing timber volume check

To verify that no errors were made in aggregation and that no significant aggregation bias exists, the total volume of the current inventory using polygon-specific inventory volumes was compared to the total volume of the current inventory based on analysis unit volumes (Table 34).

The difference of 2.29% is within an acceptable difference as dictated by the DFAM standards. No further analysis unit groupings are proposed at this time.

Table 34: Existing timber volume check

	Polygon volume derived using:		Percent (%) difference
	Inventory volume	Yield table (AU) volume	
Total Volume (m^3)	276,716,585	283,201,838	2.29

6 Silviculture

6.1 Silviculture management regimes

6.1.1 Unmanaged Stands

In the Fort Nelson TSA, unmanaged stands will be defined as all stands disturbed by fire and/or harvest prior to and including 1989, and all existing stands excluding pure pine, pure spruce and spruce/pine stands (i.e. analysis units 1, 2, and 6). Licensees and district staff felt that although some planting and density control was done between 1987 and 1989, it was not until 1990 and onwards that there was adequate planting and brush control in the TSA.

Therefore, unmanaged stands (i.e. stands that have not been harvested or managed since 1990) will be grown on unmanaged stand (VDYP) yield curves for several reasons:

1) Although some stands may have been planted prior to 1990, it is assumed that the lower volumes produced by VDYP yield curves (as compared to TIPSY curves) will more accurately reflect the management regimes and expected yield of these stands.

2) Modelling natural regeneration of these stands also reflects the longer regeneration delays compared to 'managed' stands and, in some cases, the lack of brush control in these stands.

3) Some of these stands have not been planted.

For the analysis, all stands harvested prior to 1990 will be naturally regenerated and will be grown on unmanaged stand yield tables, including pine, spruce, and pine/spruce. Existing stands of pure deciduous, spruce/deciduous, pine/deciduous, subalpine fir, spruce/larch, aspen/coniferous, aspen/deciduous, cottonwood/coniferous, cottonwood/deciduous and birch, whether harvested in the past or in the future, will be modelled using VDYP generated yield curves.

Table 35: Unmanaged stand regeneration assumptions for existing stands and all stands harvested prior to 1990

Analysis Unit #	Species	Future AU*	Future Regeneration Delay*	Future Regeneration Method	%	Species	%
1	Spruce	N/A	N/A	Planted	100	Spruce	100
2	Spruce/pine	N/A	N/A	Planted	100	Spruce/pine	100
3	Spruce/deciduous	Same	4	Natural	100	Spruce/deciduous	100
4	Aspen/coniferous	Same	1	Natural	100	Aspen/coniferous	100
5	Aspen/deciduous	Same	1	Natural	100	Aspen/deciduous	100
6	Pine	N/A	N/A	Planted	90	Pine	90
			4	Natural	10	Pine	10
7	Pine/deciduous	Same	4	Natural	100	Pine/deciduous	100
8	Cottonwood/ coniferous	Same	1	Natural	100	Cottonwood/ coniferous	100
9	Cottonwood/ deciduous	Same	1	Natural	100	Cottonwood/ deciduous	100
12	Birch	Same	4	Natural	100	Birch	100
10	Spruce/larch	Same	4	Natural	100	Spruce/larch	100
11	Subalpine fir	Same	4	Natural	100	Subalpine fir	100

* For existing stands and stands harvested prior to 1990 in Analysis Units 1, 2, and 6, they are currently following a natural stand yield curve but after harvest, they will be follow a managed stand yield curve (Section 6.1.2).

Regeneration delay is the time elapsed between the harvest date and the time when stand growth begins. The delay incorporates both the time taken to establish a stand, and the age of seedling stock planted or naturally regenerated. The regeneration delays provided were discussed with the DFAM group and the Fort Nelson Forest District and are considered representative given the variability that some stands have been planted, some have been brushed and others regenerated naturally. Spruce/larch and subalpine stands are often associated with high water table and problematic regeneration. Therefore, the DFAM Group felt it would be appropriate to model the spruce/larch and subalpine stands using VDYP as TIPSY would overestimate the volume. For pure pine stands, 90% of the stand will be planted according to assumptions on Table 36 and 10% of the stand will be naturally regenerated.

6.1.2 Managed Stands

6.1.2.1 Existing managed stands

Stands harvested from 1990 to 2002 that have been artificially regenerated, including spruce, spruce/pine and pine stands, are considered existing managed stands. They will be grown on managed stand yield curves produced using the MOF table interpolation program for stand yields (TIPSY) growth and yield model. It is assumed these stands will be actively managed through artificial regeneration, maintenance of stocking, and management of brush competition and control of crop tree density. Regeneration assumptions for existing managed stands are shown in Table 36.

For managed stands, the average free growing target density is approximately 1,300 stems/ha (ranges from 1,200 to 1,400 stems/ha) based on operational information provided by the DFAM group supported by ISIS data. It is assumed that the planting densities of 1,400 stems/ha are implemented to achieve target free growing densities of 1,300 stems/ha because planting survival is less than 100% and ingress of crop trees is felt to be minimal. Ten percent of pure pine stands will regenerate naturally to their initial natural (VDYP) yield curves. These stands will be identified randomly within the timber supply model.

The DFAM group and Fort Nelson Forest District staff consider a regeneration delay of 2 years to be a conservative assumption, given the variability of the regeneration delay between 1990 and 2002[12]. The younger existing managed stands have a lower regeneration delay to reflect current management of prompt regeneration while some of the older existing managed stands have a regeneration delay greater than 2 years.

Table 36: Existing managed stand regeneration rules

Primary Analysis Units	Leading species	Regeneration delay (years)	OAF 1	OAF 2	Regeneration method		Species		Planting Density
					Type	%	Code	%	Stems/ha
01	Spruce	2	15	5	Planted	100	Spruce	100	1,400
02	Spruce/pine	2	15	5	Planted	100	Spruce	100	1,400
06	Pine*	2	15	5	Planted	90	Pine	90	1,400
		4	15	5	Natural	10	Pine		

*10% of the pure pine stands will be regenerated naturally using the unmanaged yield curves.

6.1.2.2 Current and future managed stands

Current managed stands represent those areas within the TSA that have been harvested and planted after 2002. They exhibit similar regeneration rules to existing managed stands except for a change in the regeneration delay (Table 37). A regeneration delay of 1 year for current future managed stands is assumed to be reasonable given current performance, which the DFAM group and the Fort Nelson Forest District affirm to be approaching 0. These regeneration assumptions will also apply to future managed stands. Survival and ingress on future managed stands is assumed to be similar to current managed stands. Current and future managed stands will be grown with a genetic gain assumption of 3% for pine as described in Section 6.3.

[12] The effective regeneration delay of 2 years between the period 1990-2002 has been confirmed through an assessment of ISIS (using a query of Disturbance_Date – Planted_Date + Plant Stock Age).

Table 37: Current and future managed stand regeneration rules

Primary Analysis Units	Leading species	Regeneration delay (years)	OAF 1	OAF 2	Regeneration method		Species		Planting Density
					Type	%	Code	%	Stems/ha
01	Spruce	1	15	5	Planted	100	Spruce	100	1,400
02	Spruce/pine	1	15	5	Planted	100	Spruce	100	1,400
06	Pine*	1	15	5	Planted	90	Pine	90	1,400
		4	15	5	Natural	10	Pine		

*10% of the pure pine stands will be regenerated naturally using the unmanaged yield curves.

6.2 Species conversion

No species conversion will be modeled in this analysis. All mixedwood stands are expected to regenerate to the same mixedwood types following harvest.

6.3 Gene resources — use of select seed

The Forest Practices Code requires the use of best available genetic seed and vegetative material for regeneration treatments within management units in BC. Specific yield adjustments that recognize the use of select seed (orchard and superior provenance seed with a known Genetic Worth) must be described for use in the base case and sensitivity analysis. This information is typically managed by seed planning unit (SPU) for genetic worth and seedlot information.

Historic use of select seed was provided by Tree Improvement Branch[13] from SeedMap (Seed Use: Report 1 – Seedlings Requested by Species and Genetic Class) summary reports and illustrates that predominately Class B seedlings have been used for most regeneration in the Fort Nelson TSA. Class B seedlings have no effective genetic gain. Class B+ seed has been used in the Fort Nelson TSA since 2000 for all planted Pine types, exhibiting a genetic worth of 3% (Table 38). This information will be used to derive the appropriate genetic gain estimates for current/future managed pine stands in the Fort Nelson TSA. All other existing and future managed stands will be modelled with no genetic gains in the base case.

[13] personal communication and correspondence with Ron Planden (Tree Improvement Branch)

Table 38: Historical use of seed source in the Fort Nelson TSA

Year	Seed Planning Zone	Class B Seedlings Requested	Class B+ Seedlings Requested	Actual Genetic Worth (%)
2004	SX	1,100,000		
2003	AT	50,000		
	PLI	0	160,000	3
	SX	7,215,000		
2002	AT	30,000		
	EP	15,000		
	PLI	0	280,000	3
	SX	5,656,000		
2001	LARIDEC	2,000		
	LS	2,000		
	LT	2,000		
	PLI	2,000	252,000	3
	SX	5,382,000		
2000	AT	15,000		
	EP	15,000		
	PLI	226,000		
	SX	3,807,500		

Further SeedMap summary reports were provided by the Tree Improvement Branch (Species Plans: Report 1 – Species Plan Timeline) which identified that Class A Spruce seeds will be available in the future for the seed planning unit: SX PR MID and SX PR LOW (Table 39). This Class A Spruce seed and the associated genetic gain will be modelled for future stands as a sensitivity analysis but not included in the base case analysis. Two sensitivity analyses are proposed: a calculated 1% net genetic gain which will be applied to all spruce future managed yield curves which assumes that only 4.7% of the spruce seed required in the Fort Nelson TSA will be Class A. A second sensitivity analysis will apply a 20% average genetic gain to all future managed spruce stands which assumes that all spruce seed requirements for the Fort Nelson TSA will be fulfilled by Class A seed (Table 39). The yield curves will be adjusted for genetic gain using the TIPSY genetic gain function.

Table 39: Future genetic worth by SPU and year with calculated net genetic gain

SPU	Min./Max. Elevation	Time Period for Seed Availability	Total Class A Production for SPU during time period	Future Genetic Worth	Average Class A Requests for Fort Nelson TSA %	% of Class A of Total Seedlings Planted in TSA (a)	Weighted Average Genetic Gain (b)	Net Genetic Gain (a x b)
SX PR LOW	1/650	2006-2008	6,100,000	17	~ 9.3*	4.74**	20	1 %
SX PR MID	650/1200	2004-2012	19,100,000	21				

* average class A requests for Fort Nelson TSA provided by Ron Planden (Tree Improvement Branch)
** calculated based on average Class A planted of total seedling requirements

6.4 Backlog and current not satisfactorily restocked areas

There are currently 100,071 ha of NSR in the Crown forested land base, of which only 9,353 ha would contribute to the THLB (Table 40). NSR is considered part of the THLB if the land has been identified as previously logged or managed with silvicultural activities in VRI or in FDPs.

Table 40: Backlog and current not satisfactorily restocked stands

NSR Description	Area in inventory file (ha)	Area in the CFLB (ha)	Area in the THLB (ha)
No date	89,082	87,980	1,105
Backlog	2,346	2,215	670
Current	10,852	9,877	7,578
Total	**102,281**	**100,071**	**9,353**

The breakdown of NSR by Analysis Unit is provided in Table 41. It is expected that all current NSR will be regenerated according to current management assumptions, whereby AU 1, 2, and 6 will be modelled using TIPSY curves and the remainder of the AUs will be managed on natural growth and yield curves using VDYP. Based on a review by the Fort Nelson Forest District and the DFAM group, stands of backlog NSR and NSR with no establishment are expected to regenerate naturally and contribute to timber harvesting in the future. Both of these conditions will receive a regeneration delay of 10 years to account for the uncertainty associated with natural regeneration in these areas.

Table 41: Area (ha) in NSR that contributes to the THLB by analysis unit

Analysis Unit #	Analysis Unit	No year	Backlog NSR	Current NSR	Total NSR
1	Spruce	339	23	2,698	3,060
2	Spruce/ pine	6	0	17	23
3	Spruce/deciduous	203	70	861	1,134
4	Aspen/ coniferous	111	3	944	1,058
5	Aspen/ deciduous	260	1	2,491	2,752
6	Pine	108	570	446	1,124
7	Pine/ deciduous	9	0	0	9
8	Cottonwood/ coniferous	28	1	33	62
9	Cottonwood/ deciduous	39	3	87	129
10	Spruce/ larch	0	0	1	1
11	Subalpine fir	1	0	0	1
12	Birch	0	0	0	0
Total		**1,105**	**670**	**7,578**	**9,353**

7 Unsalvaged Losses

Unsalvaged losses are reductions in harvest volume due to epidemic insect, fire and wind catastrophes. These losses are necessary since only the smaller endemic events are captured by the forest cover inventory and yield curve assumptions.

A summary of all the unsalvaged losses for the Fort Nelson TSA is provided in Table 42. Explanations of the assumptions are provided in Sections 7.1 to 7.3.

Canfor provided salvage data in their operating area for the 1990-2003 period. On average, 595 m^3/ha were salvaged from insects and disease during the last 13 years. No salvage data was provided by BCTS so it was assumed that they had similar salvaged totals as Canfor. The total annual salvaged volume for insects and disease is assumed to be 1,190 m^3/year.

Table 42: Unsalvaged losses

Disturbance Event	Volume loss (m^3/year)		
	Gross	Salvage	Net
Spruce budworm	52,852	1,190	52,008
Spruce beetle	346		
Fire	114,570	58,173	57,611
Total	**167,768**	**59,363**	**109,619**

The gross losses associated with spruce budworm are higher than those estimated in TSR 2 (52,852 m^3/year – 31,543 m^3/year = 21,309 m^3/year). New information provided by FIDS mapping has identified a much larger area that would be susceptible to spruce budworm than estimated in TSR 2.

7.1 Spruce budworm

Spruce budworm is currently the dominant natural disturbance agent in the Fort Nelson TSA. A methodology to account for the volume losses due to budworm damage has been reviewed and accepted by Rene Alfaro at the CFS, and Bob Hodgkinson at the MOF Northern Interior Regional office.

A summary of the methodology is provided below:

1. Areas that are susceptible to budworm in the THLB were identified by stands that contain spruce or white spruce and areas of historic budworm infestations. The total area that is considered susceptible is: 3,118,572 ha.
2. From analyzing historic budworm data between 1988 and 2000, and assuming that historic infestation occurred within the susceptible area (as defined in step 1), it was found that on average 7.75% and 3.5% of the area were under a moderate and severe infestation respectively, during an outbreak period. Given the above percentage in

moderate and severe infestation and the area of susceptible stands, the area of severe susceptible stands is 109,150 ha and the area of moderate susceptible stands is 241,689 ha.

3. To represent potential volume loss, the area-weighted average volume for the susceptible stands was found to be 115.77 m^3/ha.
4. It was assumed that the duration of attack is 13 years.
   It was also assumed that stand mortality was 16% for moderate and 32% for severe stands[14].
5. Annual unsalvaged mortality during an outbreak = area susceptible to budworm (ha) * stand volume loss/ha ÷ duration of attack (years) * stand mortality.

   Annual unsalvaged mortality (severe) during an outbreak = 311,047 m^3/year
   Annual unsalvaged mortality (moderate) during an outbreak = 344,373 m^3/year

   Total for the entire TSA during an outbreak[15]: 655,420 m^3/year

6. Assume outbreak duration is 13 years and 37 years between outbreaks[16]. Assume there are no losses between outbreaks. Therefore, the "period of analysis", or the time between which an outbreak begins and ends and the second outbreak is about to begin, is about 50 years.

   Therefore, to quantify the annual unsalvaged losses due to spruce budworm during our "period of analysis" (*i.e.* when there are outbreaks and when there are no outbreaks):

   Annual unsalvaged mortality during the period of analysis = (Annual loss for the TSA during outbreaks * the duration of attack)/ period of analysis.

   Annual unsalvaged mortality during the period of analysis = (655,420 m^3/year *13 years)/ 50 years = 170,409 m^3/year.

7. Determine unsalvaged volume that is associated with the THLB. Of the 3,118,572 ha of susceptible stands, 980,691 ha (31%) are within the THLB. Therefore, the unsalvaged volume loss within the THLB is 52,852 m^3/year (170,490 m^3/year*.31).

7.2 Spruce beetle

Spruce beetles are known to target and attack large diameter, mature spruce (Engelmann, white, Sitka and, sometimes black spruce) when populations reach epidemic levels.[17]

Since no new data was available for spruce beetle losses in the Fort Nelson TSA, a methodology similar to that of TSR 2 was used.

[14] Assumption provided by Rene Alfaro, Research Scientist, Canadian Forest Service.
[15] This represents total mortality loss (i.e. tree is dead) and not growth losses.
[16] Assumption provided by Rene Alfaro, Research Scientist, Canadian Forest Service.
[17] Source: Field Guide to Forest Damage in British Columbia

The volume losses from spruce beetle are estimated to be 95 205 m^3 over the attack cycle from 1947 to 1994, resulting in an annual loss of 2,026 m^3/year (95 205 m^3/47 years) [18]. The calculated unsalvaged loss for spruce beetle on the timber harvesting land base would equal 346 m^3/year [2 026 m^3/year * (463,460 ha/2,715,448 ha)].

7.3 Fire

A similar assumption to TSR 2 will be used to account for unsalvaged losses due to fire. No new fire data was assembled; therefore the methodology applied in TSR 2 was felt to be the best available information.

Unsalvaged losses due to extreme fire events on the timber harvesting land base are calculated as follows:

Total annual losses * (timber harvesting land base/total forested land base)

Annual losses on timber harvesting land base from fire = 451 000 m^3/year * (1,432,257 ha /5,638,018 ha) = 114,570 m^3/year. The majority of the unsalvaged loss (95%) would be attributed to coniferous stands and the remainder from deciduous (5%).[19]

Since current salvage numbers for the TSA were not available for the entire TSA it is assumed that, similar to TSR 2, approximately 58,173 m^3 were salvaged annually from fires.

Salvage from fires varies annually in the Fort Nelson TSA and historically there have been two significant salvage programs dominated by two large fires in 1985 and 1996. Similar to TSR 2, the total volume salvaged (698,077 m^3) for these events are averaged over the 12-year period equaling 58,173 m^3/year.

[18] *Forest Susceptibility to Spruce Budworm Defoliation in the Forest Nelson Area of British Columbi*a, J.S. Clowater.

[19] Based on Fire Unsalvaged Losses from Fort Nelson Timber Supply Area - Analysis Report (MOF), March 2000

8 Resource Management Emphasis

This section provides details on how the modeling methodology will integrate non-timber resource values with timber objectives, which is often done through forest cover requirements. Forest cover management aims to maintain biodiversity, wildlife habitat, domestic water use, and visual quality by specifying target height or age distributions. The zones that have been identified can overlap, which requires the model to account for the rules as they apply to each specific zone.

The primary source of direction for forest cover management in the Fort Nelson TSA is the approved *Fort Nelson Land and Resource Management Plan (1997),* which includes the Muskwa-Kechika Management Area Plan. Table 43 provides a summary of forest cover rules for the Fort Nelson TSA.

Table 43: Forest cover rules for the Fort Nelson TSA

Zone or group**	Total Crown forest area (ha)	Timber harvesting land base (ha)	Maximum allowable disturbance (%)	Minimum height for disturbance (meters)	Applies to:
Established Retention VQO	1,327	88	*	*	CFLB
Established Partial retention VQO	4,998	476	*	*	CFLB
Established Modification VQO	5,725	895	*	*	CFLB
Established Maximum modification VQO	1,875	221	*	*	CFLB
Recommended Retention VQO	11,142	1,701	*	*	CFLB
Recommended Partial retention VQO	394,556	110,029	*	*	CFLB
Recommended Modification VQO	48,787	17,454	*	*	CFLB
Recommended Maximum modification VQO	14,149	7,242	*	*	CFLB
Enhanced resource development***	2,028,543	613,016	39	3 m	THLB
General resource development***	1,863,027	591,632	39	3 m	THLB
Muskwa-Kechika special management***	1,379,892	225,327	39	3 m	THLB

* The maximum allowable disturbance and the minimum height for disturbance will vary depending on VQO and VAC – see Section 8.2.1.

** Each polygon within a zone or group will be modeled individually (i.e. unique VQO or special management zone).

*** Enhanced resource development, general resource development and Muskwa-Kechika special management will be modeled by landscape unit. The maximum allowable disturbance assumption is taken from TSR 2.

All productive forest, whether it is considered part of the timber harvesting land base or not, is tracked and is considered to contribute towards maintaining the forest cover mature plus old and old-seral stage, and visual quality objectives (VQO) requirements.

Only the productive forest within the timber harvesting land base is tracked and is considered to contribute towards maintaining the forest cover adjacency requirements within the enhanced, general and special management zones.

8.1 Adjacency cutblock green-up

The forest cover rules for enhanced, general resource development and special management provided in Table 43 approximate the operational block adjacency rules for the Fort Nelson TSA. Operationally, adjacency requires a logged block to reach a certain height target (green-up) before a neighbouring area can be harvested. Based on direction provided in *the Landscape Unit Planning Guide 1999* and by the Fort Nelson Forest District, licensees are able to alter adjacency rules to achieve target patch sizes. It is understood that this is current management in the Fort Nelson TSA. No specific patch size targets will be modelled in the base case and adjacency green-up will be modelled using forest cover rules for each management zone (Table 43).

8.2 Visual resources

The broad Visual Landscape Inventory was made known in 1997, which identifies the visual sensitivity ratings and the recommended visual quality classes (RVQCs) for all visually sensitive conditions. A partial update of this broad mapping was completed in 2002 to reflect the Cassiar addition to the district land base. Also released in 1997 were detailed visual landscape inventories for the Alaska Highway and Klua Lakes[20], for which visual quality objectives (VQOs) were established. The visual quality modelling for the Fort Nelson TSA will follow closely the recommendations outlined in *Procedures for Factoring Visual Resources into Timber Supply Analyses* (the *Procedures*).

Polygons with established VQOs also contain a visual absorption capacity (VAC) rating in the visual landscape inventory. There are an additional 662,017 ha of areas with recommended visual quality classes (RVQCs). According to the established VQOs and VAC, the forest cover requirement based on percent denudation and visually effective green-up will be determined separately for each visual quality polygon.

8.2.1 Established Visual Quality Objectives

To achieve the VQOs, a percent denudation is usually modelled. Percent denudation is the permissible alteration in plan view, and it refers to the proportion of a visual polygon that can be less than the visually effective green-up (VEG) height. The VEG height will be determined for each VQO polygon based on slope (Table 6 in the *Procedures*). A range of percent denudation is provided for each VQO category based on the *Procedures:* the percent to be applied in the Fort Nelson TSA will be modified by the visual absorption capability (VAC[21]), whereby the low, medium and high VAC will correspond to the mid-point of the lower third, middle, and upper

[20] The Klua watershed has been established as a protected area after it was designated as an established VQO area. Therefore, this area is removed from the THLB and no undue impact is created by the VQOs per se.

[21] Visual absorption capability is a component of the visual landscape inventory that rates the relative capacity of a landscape to absorb visual alterations and still maintain its visual integrity. The VAC is based on an estimate of physical characteristics, including slope, vegetation-pattern diversity, soil/vegetation color contrast and aspect.

third of the percent denudation range (Table 44). For example, a polygon with VQO retention and a low VAC will have a 2.07% of allowable alteration. The percentages provided in the table will be rounded off for application in the timber supply model.

Table 44: Range of allowable percent alteration

VQO Category	% Denudation Range	Low VAC	Medium VAC	High VAC
Preservation	0 – 1	0.25	0.5	0.75
Retention	1.1 – 5	2.07	3.05	4.02
Partial Retention	5.1 – 15	7.57	10.05	12.52
Modification	15.1 – 25	17.57	20.05	22.52
Maximum Modification	25.1 – 40	28.82	32.55	36.27

8.2.2 Recommended Visual Quality Classes

The DFAM group currently tries to manage within the RVQCs to achieve the visual management objectives. The majority of the RVQCs occur within the river corridors where operations have been absent recently due to conflicting objectives between patch size objectives and severe Spruce budworm infestation.

Therefore, it is proposed that the RVQCs be included in the base case as reflective of current management. The RVQCs will be modelled following the guidelines in the *Procedures for Factoring Visual Resources into Timber Supply Analyses* (1998). Since no visual absorption capability (VAC) ratings are available, the RVQCs will be modelled based on Table 3 from the *Procedures*. Also, without a full visual landscape inventory and analysis, it is recommended that the mid-point of each RVQC percent denudation range be used, as illustrated in Table 45. Two other sensitivities are proposed to test the minimum allowable disturbance (Sensitivity 1) and maximum allowable disturbance (Sensitivity 2).

Table 45: Proposed forest cover requirements for RVQC

RVQC	% Denudation Range	Base Case %	Sensitivity 1 %	Sensitivity 2 %
Preservation	0 - 1	0	0	1
Retention	1.1 - 5	3	1	5
Partial Retention	5.1 - 15	10	5	15
Modification	15.1 - 25	20.5	15	25
Maximum Modification	25.1 - 40	33	25	40

8.3 Recreation resources

Recreation resources are of high value in the Fort Nelson TSA. As such, specific reductions associated with recreation have been applied across all biogeoclimatic zones throughout the

management unit. Refer to Section 3.4.6 for these "Environmentally Sensitive Areas" that have been accounted for in the netdown.

8.4 Wildlife

8.4.1 Wildlife habitat — identified wildlife

There is significant wildlife presence within the Fort Nelson TSA, as well as numerous species that are threatened or are of concern. It is understood that those red and blue listed species (Table 46) are affected by forest and range practices and may require detailed habitat management prescriptions to sustain regional populations.[22]

Table 46: Table of Red and Blue listed species in the Fort Nelson TSA.

Endangered or Threatened (Red-listed)		Vulnerable (Blue-listed)	
Scientific Name	**Common Name**	**Scientific Name**	**Common Name**
Martes pennanti	Fisher	*Botaurus lentiginosus*	American Bittern
Ammodramus nelsoni	Nelson's Sharp-tailed Sparrow	*Grus canadensis*	Sandhill Crane
Bison bison athabascae	Wood Bison	*Salvelinus confluentus*	Bull Trout
Coregonus artedi	Cisco	*Ursus arctos*	Grizzly Bear
Coregonus autumnalis	Arctic Cisco	*Asio flammeus*	Short-eared Owl
Dendroica castanea	Bay-breasted Warbler	*Dendroica virens*	Black-throated Green Warbler
Dendroica tigrina	Cape May Warbler	*Gulo gulo luscus*	Wolverine, *luscus* subspecies
Notropis atherinoides	Emerald Shiner	*Hiodon alosoides*	Goldeye
Notropis hudsonius	Spottail Shiner	*Melanitta perspicillata*	Surf Scoter
Oporornis agilis	Connecticut Warbler	*Myotis septentrionalis*	Northern Long-eared Myotis
Pungitius pungitius	Ninespine Stickleback	*Rangifer tarandus* pop. 14	Caribou (boreal population)
		Rangifer tarandus pop. 15	Caribou (northern mountain population)
		Salvelinus malma	Dolly Varden
		Stenodus leucichthys	Inconnu
		Vireo philadelphicus	Philadelphia Vireo
		Wilsonia canadensis	Canada Warbler

It is also understood that currently MWLAP is producing a list of Regionally Important Wildlife for the Peace Region which will include: arctic grayling, lake trout, walleye, mountain goat, Stone's sheep, trumpeter swan, northern goshawk, and the American bittern. The MWLAP feels

[22] Information provide by email communication Joelle Scheck, RP Bio, Ecosystem Biologist with the Ministry of Water, Land and Air Protection

these species will require measures above and beyond what is currently in place for forest and range practices (*e.g*. riparian buffers, WTPs, etc.). The strategies for Regionally Important Wildlife for the Peace Region will be developed once MWLAP's Deputy Minister has approved the list.

Also, there are procedures underway to develop ungulate winter range (UWR) in the Fort Nelson TSA. The MWLAP's priorities to complete this work are provided in Table 47. The priorities for the Identified Wildlife Management Strategy (IWMS) are also provided.

Table 47: List of MWLAP priorities for developing ungulate winter range and IWMS.

Species	UWR Priority	IWMS Version 2 Priority
Northern and boreal caribou	High	High
Stone's sheep	Medium - High	
Elk	Medium - High	
Mountain Goat	Medium - High	
Wood Bison	Medium	
Moose	Low	
Mule deer	Low	
Bull trout		High
Fisher		Medium
Wolverine		Medium
Sandhill crane		Medium
Bay-breasted warbler		Medium
Cape May warbler		Medium
Connecticut warbler		Medium
Black-throated green warbler		Low
Nelson's sharp-tailed sparrow		Low
Grizzly bear		Low
Short-eared owl		Low

The provincial IWMS provides direction, policy, procedures, and standards for managing Identified Wildlife on Crown forest and range land. The objectives are to minimize the effects of forest and range practices on Identified Wildlife and to maintain their critical habitats throughout their current and, where appropriate, historic ranges. Identified Wildlife are managed through the establishment of wildlife habitat areas (WHAs) and the implementation of general wildlife measures (GWMs), or through other management practices specified in strategic or landscape level plans. [23]Currently, there are no WHA or GWMs established within the Fort Nelson TSA but where identified wildlife have been sighted on a management unit, licensees are managing these areas as outlined in the *Managing Identified Wildlife: Procedures and Measures. Volume 1. Feb. 1999*.

[23] from: http://wlapwww.gov.bc.ca/wld/identified/index.htm

8.4.2 Caribou winter habitat

The caribou populations found within the Fort Nelson TSA are currently federally listed as Vulnerable or Not at Risk[24]. Caribou winter habitat area in the western portion of the Fort Nelson TSA (Cassiar addition) has been identified but currently there are no developed management plans or strategies: they will be developed after plans are complete for Endangered and Threatened population elsewhere in the province. There are also recovery strategies being developed for specific boreal caribou populations in the central/eastern portion of the district, which are not expected to cause an impact on future timber supply[25]. Since forest management practices for caribou winter habitat have not been formally established in the TSA, no net reductions to the THLB or forest cover requirements are necessary.

8.5 Biodiversity

8.5.1 Landscape-level biodiversity

8.5.1.1 Policy framework

The *Landscape Unit Planning Guide* provides direction regarding the establishment of old seral cover and wildlife tree retention as the current priorities for landscape and stand level biodiversity management in BC. Objectives for coarse woody debris and patch size distribution will not be modeled in the base case.

8.5.1.2 Landscape units

The Fort Nelson TSA contains 85 landscape units (LU) that have been established by the Chief Forester but the biodiversity emphasis options remain draft. Of the 85 LUs, there are 4 high, 45 intermediate and 36 low emphasis units. Current management is to follow the biodiversity emphasis options within the TSA.

8.5.1.3 Biodiversity emphasis options and forest cover requirements

Mature and old and old forest seral rules will be applied in the base case following the specific BEO that applies to each landscape unit (Appendix 3). The recommended seral stage distribution for each BEC unit/NDT (% of forest area within the landscape unit) is shown in Table 48.

[24] Information provided by email communication Joelle Scheck, RP Bio, Ecosystem Biologist with the Ministry of Water, Land and Air Protection.

[25] Telephone correspondence with Rod Backmeyer, Wildlife Biologist, Fisth and Wildlife Science And Allocation Section, in the Ministry of Water, Land and Air Protection. March 2, 2004.

Table 48: Recommended seral stage distribution for each biogeoclimatic unit and natural disturbance type combination

BEC unit	NDT	Biodiversity Emphasis Option								
		LOW			INTERMEDIATE			HIGH		
		early	*mature+ old*	*old**	*early*	*mature+ old*	*old*	*early*	*mature+ old*	*old*
SWB	2	n/a	n/a	>9	n/a	n/a	>9	n/a	n/a	>13
BWBS-conifer	3	n/a	>11	>11	n/a	>23	>11	n/a	>34	>16
BWBS-deciduous	3	n/a	>13	>13	n/a	>23	>13	n/a	>34	>19

* in the low emphasis units old seral can be modeled using 1/3 of the target for the first 70 years, 2/3 of the target in 140 years and the full old target by 210 years and beyond.

In the analysis, old seral targets will be applied at the BEC variant level as referenced in Tables A2.8 and A2.13 of the *Landscape Unit Planning Guide*. In low emphasis landscape units, the full old target can be achieved over 3 rotations by using a recruitment strategy. Mature + old seral targets would also be applied to NDT3 (*Landscape Unit Planning Guide)*. The age definitions that will be used in the analysis are defined in Table 49.

Table 49: Seral stage definitions by biogeoclimatic unit and natural disturbance type

BEC unit	NDT	Mature Seral	Old Seral
SWB	2	> 120	>250
BWBS-conifer	3	>100	>140
BWBS-deciduous	3	> 80	>100

8.6 Domestic Water Resources

One of the main objectives of the LRMP is to minimize man-made changes to stream configurations by managing resource development adjacent to sensitive water bodies, lakes, wetlands, rivers and streams to minimize negative impacts to water quality and quantity.

The water resources within the Fort Nelson TSA include the Arctic watershed. The plan area is drained by the Liard River and its major tributaries: the Fort Nelson, Prophet, Muskwa Toad, Petitot and Kechika rivers. A minor portion of the area near the Alberta border is drained by the Hay River, which flows toward the Mackenzie River. The town of Fort Nelson and Fort Nelson Indian Band draw their water supply from the Muskwa River. The community at Prophet River and the Indian Band draw water from Adsett Creek, and the community of Toad River draws its water from the Toad River. Groundwater reserves are scarce and are used sparingly.

There are no known Forest Practices Code designated community watersheds within the Fort Nelson TSA; however, there are 20 sources of domestic water intakes or points of diversion (POD) in the Fort Nelson TSA. These points represent domestic water licenses issued by the Ministry of Sustainable Resource Management under the *Water Ac*t. Recognizing these areas as a "forest resource", the Forest Practices Code specifies sufficient management and conservation of these values during operational forest activities and planning.

Each POD has been given a buffer width of 100 m to recognize the special consideration to maintain water resources (Table 50). No harvest is planned within these areas.

Table 50: Domestic water licence intakes

Name	Total area (ha)	Crown forested land base area (ha)	Timber harvesting land base area (ha)	Maximum % Disturbance
All domestic water intakes	48	36	16	0%

9 Timber harvesting

9.1 Minimum harvestable age

The minimum harvestable age (MHA) is an estimate of when immature or future managed stands will become available for harvest. It is not expected that all stands will be harvested at this age but harvesting may occur at the MHA to meet a harvest target for a relatively short period of time or to avoid large and abrupt changes in harvest levels. Within some areas, stands may not be harvested until they are much older than the minimum harvestable age due to extended rotations for forest cover requirements such as landscape biodiversity old forest objectives.

Based on discussions with the DFAM group, the minimum harvest criterion for the Fort Nelson TSA is 140 m^3/ha for natural stands. The resulting minimum harvest age will be compared with the age at which 95% of the maximum MAI is realized which will be tested in a sensitivity analysis. The minimum harvestable age was determined for each analysis unit/yield curve groups and is provided in Appendix 4. Polygons within the analysis unit/yield curve groups will be considered eligible for harvest within the timber supply model when they achieve the minimum criteria described above.

9.2 Harvest systems

Harvesting in the Fort Nelson TSA is dominated by conventional ground-based systems. There is some operable cable and helicopter ground around the Muskwa-Kechika special management area, but these systems are not being used at this time.

9.3 Initial harvest rate

The initial harvest rate for the base case analysis will be set to 1,389,880 m^3/year (the current AAC of 1,500,000 m^3/year plus the calculated unsalvaged losses minus 500m^3/year for woodlot W1817). There may be a need to increase or decrease the harvest level from this starting point but this will not be determined until the base case analysis is initiated. If such a change is required it will be discussed with the DFAM group and Forest Analysis Branch.

9.4 Harvest rules

Harvest rules define current management for the analyst to use in the forest level model. This will be accomplished by following the spatial forest development plan. By including the FDP, the approved and proposed blocks can be established as a fixed harvest schedule for the initial period. Following the FDP, priority harvest can be dictated by an established harvest rule. Relative oldest first will be used, as this rule best represents harvest priority within the TSA. It is also proposed that different harvest rules will be tested to determine the effect on the harvest level.

9.5 Disturbing the non-timber harvesting land base

To prevent the contributing, non-timber harvesting land base from continually aging and providing a disproportionate and often improbable amount of old forest cover conditions to satisfy landscape biodiversity requirements, a disturbance function must be applied.

The document *Modeling Options for Disturbance Outside the THLB – Working Paper* provides direction for disturbing areas of the landscape outside of the THLB. There are a variety of possible approaches to applying a disturbance in the contributing non-timber harvesting land base. While each approach has its strengths and weaknesses there remains a significant amount of uncertainty as to what the most appropriate methodology would be.

The age reset by variant for the contributing, non-timber harvesting land base methodology is proposed for the base case analysis. The methodology (*Modeling Options for Disturbance Outside the THLB – Working Paper*) is as follows:

1. List the estimated return interval for disturbance in each variant and NDT in the TSA (*Landscape Unit Planning Guide Appendix 2*).
2. Establish the estimated minimum target % of old seral that would be expected (*Landscape Unit Planning Guide Appendix 2*).
3. Calculate a rotation age based on the age distribution described in step 2 (target age/(1-target %).
4. Divide the contributing non-THLB area in the variant by the calculated rotation age to determine the annual minimum disturbance target for each variant.
5. Establish the estimated minimum target % of old seral (bullet 2) as well as the annual minimum disturbance target for each variant (bullet 4).

Table 51 identifies the minimum target area to be disturbed annually within each BEC variant for the Fort Nelson TSA. This analysis was completed on the BEC unit since the variants and NDTs represent the same groupings. The minimum area to disturb annually will be applied across each landscape unit based on the representation of each BEC unit.

Table 51: Minimum target area to be disturbed annually in each BEC variant

		a	b	c	d	e	f
BEC unit	**NDT**	***Return Interval***	***Min. Target % Old***	***Age of Old***	***Effective Rotation Age***	***Contributing Non-THLB***	***Min. Area to Disturb Annually***
		LUPG	*LUPG*	*LUPG*	(c/(1-b))		(e/d)
SWB	2	200	9	250	275	1,023,797	3,727
BWBS-conifer	3	100	11	140	157	2,091,136	13,294
BWBS-deciduous	3	125	13	100	115	581,967	5,063

9.6 Timber supply model

The model that will be used for this analysis will be:

Model Name: FSOS
Model Developer: Dr. Guoliang Liu
Model Development: UBC, Hugh Hamilton Limited, Forest Ecosystem Solutions Ltd.
Model Type: Forest and Landscape, Spatial/Non-spatial, Simulation and Optimization Model

FSOS has been used on over 24 management units (TFLs and TSAs) from small (<15,000 ha) to very large (> 4 million ha) forest areas throughout BC, Alberta, Manitoba and Ontario. Some of the management units that FSOS have been applied include: TFL 3, TFL 18, TFL 26, TFL 37, TFL 53, Soo TSA, Sunshine Coast TSA, Queen Charlotte TSA, Kingcome TSA and Kalum TSA. FSOS has been accepted for use in timber supply analysis by the chief forester in British Columbia and is currently being applied to 3 management units in Ontario.

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10 Timber Supply Forecast /Options /Sensitivity Analyses

10.1 Harvest flow objectives for the base case

The base case is the reference timber supply forecast by which timber supply implications of different management assumptions and uncertainty in data and assumptions may be measured. The base case should represent current management or a reasonable extrapolation of current management.

The harvest flow objectives for the base case and other sensitivity scenarios will follow standard provincial polices which are outlined in *Harvest flow Considerations for Timber Supply Draft Working Paper, 2003*. In general the harvest flow objectives are:

- Sustain the current harvest level until reductions are necessary for long-term sustainability;
- Control the mid-term harvest level so that it does not drop below the sustainable long-term harvest.
- Where decreases in the harvest rate are necessary, volume harvested will decrease by no more than 10% per ten-year period; and
- Maintain even flow in the long term while ensuring a non-declining growing stock.

10.2 Sensitivity analyses

Sensitivity analysis provides a measure of the timber supply impact if uncertainty in management assumptions and/or data integrity exists. The magnitude of the increase or decrease in a particular variable should reflect the degree of uncertainty surrounding the assumption. By developing and testing a number of sensitivity analyses, it is possible to determine which variables most affect results.

Sensitivity analysis specific to the Fort Nelson TSA:

- Inclusion of birch leading stands (SI >17),
- Landscape level biodiversity (model NDU and appropriate seral constraints),
- Remove requirement for a reasonable harvest flow from both the coniferous and deciduous stands (*i.e*. allow fluctuations in the amount of coniferous or deciduous volume removed in any decade),
- Remove VRI Phase 2 adjustments,
- A 1% net genetic gain to all spruce future managed yield curves and a 20% average genetic gain to all future managed spruce stands using the genetic gain function in TIPSY.
- Impact of changing the minimum low productivity volume requirement for deciduous by +/- 10 cubic metres, and minimum harvest age of 60 years for deciduous.

Other sensitivity analyses proposed for the Fort Nelson TSA are shown in Table 52.

Table 52: Proposed sensitivity analysis for the Fort Nelson TSA

Issue to be tested	Sensitivity levels
Existing stand yields	+/- 10%
Regenerated stand yields	+/- 10%
Minimum harvestable age	+/- 10 years 95% at maximum MAI
Site index adjustments	SIBEC (see Section 5.1.2)
Land base changes	+/- 10% changing the low site criteria
Visual quality objectives	Top and bottom of range % denudation.
Harvest rules	Oldest first, and random.
Harvest flow alternatives	1. Maintain present harvest level for 15 to 20 years. 2. Maintain present harvest level as long as possible. 3. Maximum short-term.
Green-up periods	+/- 5 years

These sensitivity analyses may be refined, reduced or added to during the data package review and analysis phase.

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Appendix 1: Stream Riparian Classification Methodology

Studies were available that allowed for the development of relationships between stream order and stream classes, and though limited in scope, this method provided an immediate opportunity to assign stream classes to stream features based on stream order and statistics. TRIM I stream features were GIS processed, using a custom Arc/Info AML, to determine a (simplified) stream order attribute that was appended to the Arc/Info Arc Attribute Table.

Having determined stream order, the following assumptions were made (Table 53 and Table 54):

1) Streams assigned to stream orders 3 and higher correspond to stream classes 1 to 4 (Table 53), while stream order 1 and 2 correspond to stream classes 5 and 6 (Table 54). This relationship was found in a watershed study done in the Fort Nelson TSA (Lower Dunedin Landscape Unit) and also from information provided by MSRM in Prince George. Using GIS utilities, the total lengths of streams were summed for the two stream order classes (*i.e*. 73, 841 km for S1-S4 and 194,105 km for S5-S6).
2) The percentages of each stream class within the two stream order classes (column A in Tables) were determined from a GIS analysis for TSR 3 (using the Lower Dunedin study) and from data in the Kamloops TSA.
3) The lengths of streams in each stream class were determined by multiplying the total length of the stream order class (determined in step 1) with the percentages in step 2 (Column B). e.g. for S4, 73,841km X 0.20 = 14, 768 km.
4) Each stream class was assumed to have a combined riparian buffer width (RZ and RMZ) as suggested by the *Riparian Management Area Guidebook* (Table 55). The combined riparian width is also shown in Column C in the Tables.
5) The Riparian Management Areas (RMA) for each stream class (Column D in Tables) is calculated from the lengths and widths in Column B and C. For example, for S1, RMA = [14, 768 km X 1000 m/km X (60m X 2)] ÷ 10 000 ha/m^2 = 177, 219 ha. Note that the combined riparian buffer width (Column C) is the buffer width for one side of the stream.
6) The effective riparian width is the width that needs to be applied to the stream order class to represent the combined RMA for all the corresponding stream classes. For example, for S1-S4 (Table 53), the effective riparian buffer width is: [(494, 737 ha X 10,000 m^2/ha) ÷ (73,841 km X 1,000m/ km)] ÷ 2 = 33.5m (buffer width for one side of the stream).

Table 53: Calculations for S1 to S4 streams

	A	B	C	D	E
Estimates of breakdown for S1 to S4	**Estimated % of Stream Order 3+**	**Length (km)**	**Combined riparian buffer width (RZ and RMZ) (m)**	**RMA (ha)**	**Effective riparian buffer width (m)**
GIS Length S1 (km)	20	14,768	60	177,219	33.5
GIS Length S2 (km)	20	14,768	40	118,146	
GIS Length S3 (km)	40	29,537	30	177,219	
GIS Length S4 (km)	20	14,768	7.5	22,152	
GIS Total Length S1-S4 (km)		**73,841**		**494,737**	

Table 54: Calculations for S5 and S6 streams

	A	B	C	D	E
Estimates of breakdown for S5 and S6	**Estimated % of Stream Order 1 and 2**	**Length (km)**	**Combined riparian buffer width (RZ and RMZ) (m)**	**RMA (ha)**	**Effective riparian width (m)**
GIS Length S5 (km)	20.15	39,104	7.5	58,656	2.31
GIS Length S6 (km)	79.85	155,001	1	31,000	
GIS Total Length S5-S6 (km)		**194,105**		**89,656**	

Table 55: Riparian reserve and management zone widths

Stream Class	**Reserve zone width (metres)** 100% reduction	**Management zone width (metres)**	**Management Zone Volume Reduction (%)**	**Combined riparian buffer width (RZ and RMZ) (m)**
S1 (except large rivers)	50	20	50	60
S2	30	20	50	40
S3	20	20	50	30
S4	0	30	25	7.5
S5	0	30	25	7.5
S6	0	20	5	1

The proposed methodology was recently reviewed by MSRM, Resource Information Branch in Prince George and Victoria Service Centre[26]. The review document notes that the methodology used for the TSA presents a generalized approximation of stream classification and calculated reduction, which contains inherent risks and biases, which must be understood. The risks identified are:

1. The Lower Dunedin analysis (Poulin and Associates) results used in the riparian methodology was limited mostly to the BWBS zones, but was extrapolated to the entire TSA. In particular, data from the SWB zone, which contains major rivers and streams, was not available. It is understood that there are sport and regionally important fish species in several 2nd order sampled streams.
2. Only fish that are managed for under the Forest Practices Code were included in the analysis. Since no regionally important species are currently designated for the Peace Region, they were not included in the study. If these species are identified in the future as species at risk or regionally significant under the Forest and Range Practices Act, they will obviously change the management assumptions.
3. The adjusted percentage of 1st and 2nd order streams calculated for the Fort Nelson TSA was different than those for the Lower Dunedin. The Lower Dunedin exhibited a higher percentage, which if applied to the Fort Nelson TSA would require a higher RMA.
4. The number of reaches in the Lower Dunedin was not sampled in the same proportion as the occurrence of reaches in the watershed nor in the same proportion as the number of reaches selected by the stratified random sample design.
5. The methodology used had documented that 18% of the observation points contained stream classification data but in fact only about 10% do.
6. The assumption correlating stream class to stream order does not recognize the variation in stream class associated with different stream reaches.
7. The fish occurrence point coverage does not match to specific streams for all points and can only be used to determine fish presence on a broad scale. It cannot be used to determine absence of a specific fish species.
8. The data for the Lower Dunedin study was collected and mapped to the TRIM 1 base.

[26] Review of stream riparian classification and reduction for Fort Nelson TSR analysis by Lynn Blouw and David Tesch received by email March 9, 2004.

Appendix 2: Yield curves

Table 56: Secondary analysis unit yield tables (m^3/hectare) for existing natural stands VRI Rolled Over (enr) using VDYP

Age (years)	Spruce			Spruce/Pine			Spruce/Deciduous			Aspen/Coniferous			Aspen/Deciduous			Pine			Pine/Deciduous			Cottonwood/Coniferous		
	011 enr	012 enr	013 enr	021 enr	022 enr	023 enr	031 enr	032 enr	033 enr	041 enr	042 enr	043 enr	051 enr	052 enr	053 enr	061 enr	062 enr	063 enr	071 enr	072 enr	073 enr	081 enr	082 enr	083 enr
10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3
30	0	0	0	0	0	1	0	0	0	0	3	17	0	8	36	0	1	27	0	0	14	0	4	52
40	0	0	8	0	1	23	0	0	11	12	39	74	16	45	90	0	33	83	0	18	56	4	41	125
50	0	13	66	0	6	82	0	4	55	45	84	127	45	84	144	16	74	134	10	49	101	48	90	179
60	10	64	126	1	42	144	1	33	113	80	125	176	75	123	194	44	111	179	31	82	140	88	129	222
70	41	112	179	19	87	200	19	76	166	112	163	222	104	159	241	71	145	218	56	112	175	121	161	257
80	79	155	224	57	130	249	52	117	212	140	195	257	128	188	277	96	175	253	78	138	206	150	188	284
90	113	192	262	93	169	292	83	153	252	163	222	287	148	212	307	119	202	285	100	162	233	176	211	306
100	143	225	294	128	205	330	111	184	284	184	244	311	165	232	331	141	227	315	119	183	257	198	231	324
110	171	253	321	161	237	364	137	211	311	200	262	330	178	247	349	161	250	342	137	203	279	217	248	339
120	196	277	344	193	267	393	162	235	334	213	276	343	187	257	360	181	272	367	154	220	298	234	262	352
130	218	299	364	222	294	418	184	255	352	224	286	352	192	263	366	199	292	391	170	236	315	248	274	362
140	239	318	381	248	315	437	202	273	368	233	296	362	198	270	374	212	305	406	182	246	326	261	284	371
150	257	335	397	270	334	453	219	289	382	241	304	370	204	277	381	223	316	418	191	255	334	273	293	379
160	273	349	409	289	349	466	230	299	390	245	308	373	204	277	382	231	324	426	198	260	339	276	296	380
170	288	362	420	305	361	476	240	308	397	249	311	375	204	277	382	237	329	431	202	264	342	279	298	382
180	301	374	430	318	371	484	249	316	404	252	313	377	204	278	382	240	331	432	205	265	343	281	299	383
190	313	384	438	329	379	489	257	323	409	254	315	378	204	278	382	241	331	430	205	264	342	283	301	384
200	324	393	446	341	388	496	265	329	414	256	317	380	205	278	382	244	333	432	208	266	343	285	302	385
210	334	401	452	351	396	501	272	335	418	258	319	381	205	278	383	247	336	435	210	268	344	286	303	386
220	343	409	458	361	403	506	278	340	422	260	320	382	205	278	383	251	339	438	213	270	346	288	305	387
230	351	415	463	370	409	511	283	344	425	261	322	383	205	278	383	254	342	441	215	271	348	289	306	387
240	358	421	468	379	415	515	288	348	428	263	323	384	205	278	383	256	344	443	217	273	350	291	306	388
250	365	426	471	387	420	519	293	352	431	264	324	385	205	279	383	259	347	446	219	275	351	292	307	388
260	371	431	475	394	425	522	297	355	433	266	325	385	205	279	383	261	349	449	221	276	353	293	308	389
270	376	435	477	400	429	525	301	358	435	267	326	386	205	279	383	264	351	451	223	278	355	293	308	389
280	381	438	479	406	433	528	305	361	437	268	327	386	205	279	383	266	353	454	224	279	356	294	309	389
290	385	441	481	412	436	530	308	363	438	269	328	387	205	279	383	267	355	456	226	280	357	295	309	390
300	389	444	483	417	439	532	311	366	439	269	329	387	205	279	383	269	357	458	227	282	358	296	310	390

Table 56 continued: Secondary analysis unit yield tables (m^3/hectare) for existing natural stands VRI Rolled Over (enr) using VDYP

Age (years)	Cottonwood/Deciduous			Spruce/Larch			Subalpine Fir			Birch		
	091 enr	092 enr	093 enr	101 enr	102 enr	103 enr	111 enr	112 enr	113 enr	121 enr	122 enr	123 enr
10	0	0	0	0	0	0	0	0	0	0	0	0
20	0	0	0	0	0	0	0	0	0	0	0	0
30	0	1	39	0	0	1	0	0	4	0	3	22
40	0	28	107	0	0	65	0	9	29	1	39	73
50	29	74	158	0	7	139	2	28	69	10	78	118
60	68	116	198	8	42	204	6	54	108	28	112	158
70	103	151	230	31	77	259	19	85	147	47	142	193
80	134	180	254	61	109	305	35	110	181	65	169	222
90	161	205	274	90	138	344	47	131	211	80	192	247
100	185	226	290	118	164	376	61	150	238	95	213	270
110	205	244	303	144	187	404	74	168	262	108	232	289
120	223	259	313	168	208	427	85	184	285	121	248	305
130	238	272	322	190	225	447	97	201	308	129	258	315
140	251	283	329	210	241	463	109	217	327	133	263	319
150	263	292	335	226	253	476	120	232	345	136	268	323
160	263	292	335	239	264	485	130	247	360	139	270	325
170	264	293	336	250	272	492	140	260	374	141	272	327
180	264	293	336	259	280	498	150	273	387	142	274	329
190	264	293	336	267	286	503	159	286	398	144	275	330
200	265	293	336	274	292	508	168	297	410	145	276	331
210	265	294	336	281	297	512	176	308	421	146	278	332
220	265	294	336	287	302	516	185	319	431	147	279	333
230	266	294	336	292	306	519	193	329	442	149	280	334
240	266	294	336	297	310	522	200	339	451	150	281	334
250	266	294	336	302	313	524	208	349	461	151	282	335
260	266	294	336	306	316	526	209	350	464	151	282	335
270	266	294	337	309	319	528	211	352	467	152	283	336
280	267	295	337	312	321	529	212	353	469	153	283	336
290	267	295	337	315	323	531	214	355	472	154	284	336
300	267	295	337	318	325	532	215	356	474	154	284	337

Table 57: Secondary analysis unit yield tables (m^3/hectare) for existing natural stands VRI Phase II (en2) using VDYP

Age (years)	Spruce			Spruce/Pine			Spruce/Deciduous			Aspen/Coniferous			Aspen/Deciduous			Pine			Pine/Deciduous			Cottonwood/Coniferous		
	011 en2	012 en2	013 en2	021 en2	022 en2	023 en2	031 en2	032 en2	033 en2	041 en2	042 en2	043 en2	051 en2	052 en2	053 en2	061 en2	062 en2	063 en2	071 en2	072 en2	073 en2	081 en2	082 en2	083 en2
10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6
30	0	0	0	0	0	1	0	0	0	0	6	26	0	12	38	0	2	26	0	1	19	0	5	86
40	0	0	12	0	1	12	0	0	12	20	53	95	24	59	101	3	36	82	3	25	67	6	51	169
50	0	16	74	2	7	59	0	8	58	62	106	160	62	108	162	26	78	133	22	61	113	57	111	232
60	15	67	135	9	38	117	4	42	116	102	155	219	99	155	220	56	116	177	49	95	154	103	159	280
70	54	114	188	40	82	170	30	87	169	139	201	274	134	199	273	84	150	216	75	127	191	143	200	317
80	92	157	234	77	124	218	66	128	215	170	238	316	162	234	314	110	180	250	99	154	222	177	234	347
90	127	194	272	112	162	261	99	165	255	197	269	352	186	263	349	134	208	280	120	178	250	207	263	371
100	158	227	305	145	197	298	130	197	289	219	294	380	206	286	376	156	233	308	140	200	275	234	288	390
110	186	255	332	176	229	331	158	225	316	237	314	402	221	304	397	176	256	332	157	220	296	256	309	405
120	211	279	355	205	258	360	183	250	339	251	329	418	232	316	410	196	277	354	173	238	316	276	326	418
130	234	301	375	231	284	385	206	271	358	262	340	428	238	322	417	213	296	375	188	253	332	294	341	429
140	254	320	393	254	306	405	225	288	374	271	350	439	245	330	426	226	309	388	198	264	344	308	354	438
150	273	337	408	274	325	421	242	304	387	280	359	449	251	337	435	237	320	399	207	272	352	322	366	446
160	288	351	421	290	340	434	254	314	396	283	363	453	251	338	436	245	327	406	212	278	357	325	368	448
170	303	363	432	304	352	444	266	324	404	287	366	456	252	339	436	250	332	411	216	281	360	328	371	449
180	315	375	441	316	362	452	276	332	411	289	369	458	253	339	437	253	334	412	217	282	361	331	372	450
190	327	385	450	326	371	458	285	339	416	291	371	460	253	340	437	254	334	411	217	281	359	334	374	451
200	337	393	457	336	379	464	293	346	422	293	373	462	253	340	437	257	336	413	219	283	361	336	376	452
210	347	401	464	346	387	471	300	352	426	295	374	463	254	340	438	260	339	415	221	285	362	338	377	453
220	355	408	469	354	395	476	307	357	430	297	376	465	254	341	438	263	342	418	223	287	364	340	378	454
230	363	415	475	362	401	481	313	362	434	298	377	466	255	341	438	266	344	421	225	288	366	341	379	455
240	370	421	479	370	407	485	319	366	437	300	379	467	255	341	438	269	347	423	227	290	367	343	380	455
250	377	426	483	376	413	489	324	370	440	301	380	468	255	341	438	271	349	425	229	292	369	344	381	456
260	382	430	486	383	418	493	329	374	442	302	381	469	255	342	439	274	351	427	230	293	371	345	382	456
270	388	435	489	388	422	496	333	377	444	303	382	470	256	342	439	276	353	429	231	295	372	346	382	456
280	393	438	492	393	426	499	337	380	446	304	383	470	256	342	439	278	355	431	233	296	373	347	383	457
290	397	442	494	398	430	502	341	382	448	305	383	471	256	342	439	279	357	433	234	297	375	348	384	457
300	401	445	496	402	433	504	344	385	450	306	384	472	256	342	439	281	359	435	235	298	376	349	384	457

Table 57 continued: Secondary analysis unit yield tables (m^3/hectare) for existing natural stands VRI Phase II (en2) using VDYP

Age (years)	Cottonwood/Deciduous			Spruce/Larch			Subalpine Fir			Birch		
	091 en2	092 en2	093 en2	101 en2	102 en2	103 en2	111 en2	112 en2	113 en2	121 en2	122 en2	123 en2
10	0	0	0	0	0	0	0	0	0			
20	0	0	6	0	0	0	0	0	0	0	0	0
30	0	2	94	0	0	0	0	0	6	0	3	25
40	0	36	180	0	0	24	0	5	32	9	48	88
50	25	88	244	0	13	85	2	19	73	34	97	145
60	65	136	292	10	57	143	12	46	112	62	140	195
70	103	176	329	42	99	194	33	76	150	90	179	239
80	136	211	357	76	137	239	52	101	182	115	212	276
90	166	240	379	107	171	277	70	124	210	138	242	310
100	192	264	397	136	202	310	86	146	234	159	269	339
110	215	285	411	163	229	339	101	165	256	177	292	365
120	235	303	423	187	253	363	114	183	275	194	313	388
130	252	317	432	209	274	385	128	199	297	205	325	400
140	265	329	440	228	292	403	141	212	317	210	330	405
150	278	340	446	244	307	416	154	226	337	214	335	410
160	279	340	446	257	319	426	166	236	355	217	338	412
170	280	341	447	267	328	434	178	246	372	219	340	414
180	281	342	447	276	336	440	189	255	389	221	341	415
190	282	342	447	285	344	446	199	264	405	223	343	417
200	282	343	447	292	350	451	210	273	419	225	344	418
210	283	343	447	299	356	455	220	281	434	226	346	419
220	284	343	447	304	361	459	229	289	447	227	347	420
230	284	344	448	310	366	463	238	297	460	229	348	421
240	285	344	448	315	370	466	247	304	473	230	349	422
250	285	344	448	319	373	469	256	311	485	231	350	422
260	286	345	448	323	377	471	258	312	487	232	350	423
270	286	345	448	327	380	473	260	313	488	233	351	424
280	286	345	448	330	382	475	262	314	490	234	352	424
290	287	345	448	333	384	476	264	315	492	234	352	424
300	287	345	448	335	386	478	266	315	493	235	353	425

Table 58: Secondary analysis unit yield tables (m^3/hectare) for existing managed stands VRI "roll over" (emr) using TIPSY

Age (years)	Spruce	Pine	
	012 emr	062 emr	063 emr
10	0	0	0
20	0	0	1
30	0	15	43
40	0	67	123
50	14	129	197
60	64	182	255
70	131	226	304
80	191	262	339
90	246	292	369
100	303	314	394
110	350	333	416
120	385	349	434
130	412	363	446
140	431	374	453
150	449	384	459
160	460	393	465
170	473	397	470
180	480	405	472
190	488	407	471
200	495	413	472
210	499	416	472
220	499	419	472
230	497	417	472
240	494	417	473
250	493	414	473
260	493	413	473
270	488	411	474
280	484	411	474
290	484	411	474
300	485	410	474

Note: there are no existing managed stands in the THLB that contained VRI Phase II inventory.

Table 59: Secondary analysis unit yield tables (m^3/hectare) for current/future managed stands VRI "roll over" (cfmr) and Phase 2 (cfm2) using TIPSY

Age (years)	VRI "roll over"									VRI Phase 2								
	Spruce			Spruce/Pine			Pine			Spruce			Spruce/Pine			Pine		
	011 cfmr	012 cfmr	013 cfmr	021 cfmr	022 cfmr	023 cfmr	061 cfmr	062 cfmr	063 cfmr	011 cfm2	012 cfm2	013 cfm2	021 cfm2	022 cfm2	023 cfm2	061 cfm2	062 cfm2	063 cfm2
10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
20	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	2
30	0	0	0	0	0	1	0	11	52	0	0	0	0	0	0	0	11	54
40	0	1	20	0	0	48	4	54	136	0	1	24	0	0	19	9	55	138
50	1	22	98	0	14	151	23	109	208	1	25	107	1	11	97	34	112	212
60	13	82	189	5	63	244	51	158	267	18	86	198	13	53	188	66	161	270
70	47	151	265	29	126	337	81	198	313	63	157	281	47	114	265	97	200	316
80	94	211	344	69	187	402	108	232	346	114	218	354	94	175	344	127	236	350
90	146	269	398	114	240	446	132	261	376	167	274	407	146	227	399	152	265	378
100	190	328	433	161	294	476	153	286	401	211	333	445	191	278	434	174	290	403
110	232	370	462	200	343	500	171	302	420	254	377	470	233	329	461	191	307	423
120	272	400	483	238	380	517	185	319	439	300	404	489	273	367	483	206	321	440
130	314	425	497	276	404	525	200	332	449	339	430	506	315	395	498	220	335	450
140	346	443	511	313	426	524	211	341	456	368	446	517	347	417	511	231	344	458
150	374	458	519	341	442	524	220	350	463	391	462	521	374	435	517	241	353	463
160	392	471	517	368	456	525	229	357	467	409	475	519	392	447	516	249	360	467
170	409	481	518	385	467	523	236	365	471	424	485	516	409	460	516	256	367	469
180	423	491	514	401	478	520	241	370	472	434	492	518	422	471	515	262	372	470
190	433	496	514	414	484	519	245	374	471	445	499	515	433	478	514	268	377	469
200	440	500	514	424	491	515	249	376	472	452	502	515	442	484	512	273	378	470
210	450	502	513	433	495	513	255	378	472	461	502	513	450	490	513	278	380	470
220	456	500	509	440	497	512	259	380	472	468	500	507	457	494	510	280	383	470
230	461	498	506	447	497	512	261	382	472	472	500	507	463	493	507	281	384	470
240	468	498	503	454	494	512	265	382	473	475	496	502	468	493	503	282	386	471
250	471	493	500	456	493	512	268	383	473	479	493	499	471	490	500	282	387	471
260	474	491	498	463	492	512	270	384	473	482	490	496	474	490	498	284	387	471
270	476	488	497	466	489	512	271	385	474	482	491	496	476	489	495	284	388	471
280	478	490	493	467	487	512	270	385	474	479	490	496	479	486	493	283	390	472
290	476	488	493	469	481	512	270	385	474	478	487	496	476	483	493	286	391	472
300	476	484	493	471	480	512	267	387	474	478	484	496	475	480	493	285	392	472

Appendix 3: Landscape Unit and Biodiversity Emphasis Options

Landscape Unit	BEO	AT %	BWBS %	SWB %	Landscape Unit	BEO	AT %	BWBS %	SWB %
Akue	I	0	100	0	Klua	I	0	100	0
Big Beaver	I	0	100	0	Kwokullie	I	0	100	0
Boreal	I	26	16	58	Kyklo	L	0	100	0
Bunch	L	0	88	12	La Biche	I	0	100	0
Capot Blanc	I	0	100	0	Liard Hot Springs	I	0	70	30
Catkin	I	0	100	0	Liard River A	I	0	98	2
Chee	I	0	34	66	Liard River B	I	0	100	0
Coal	L	0	94	6	Liard River C	H	0	100	0
Crehan	I	33	8	59	MacDonald	I	25	6	68
Crow	I	0	99	1	Major Hart	I	19	23	58
Crusty	I	0	71	29	Matulka	I	9	18	73
D Easum	L	0	100	0	Minaker	I	0	95	5
Dilly	L	0	100	0	Moose	I	58	0	42
Dunedin	I	0	94	6	Moule	L	0	75	25
Eight Mile	L	9	13	78	Muncho	L	28	10	62
Elleh	L	0	100	0	Muskwa River A	L	0	89	11
Eskai	L	0	100	0	Muskwa River B	L	0	100	0
Etane	I	0	100	0	Netson	I	32	8	60
Falk	I	0	71	29	Ootta	I	0	100	0
Forcier	L	4	43	53	Otelsas	I	54	0	46
Fort Nelson River A	L	0	100	0	Patry	I	0	100	0
Fort Nelson River B	L	0	100	0	Petitot River	I	0	100	0
Gammer	I	0	76	24	Pouce	L	0	100	0
Gathto	L	50	2	48	Prophet River	L	0	100	0
Gemini	I	0	98	2	Rabbit	L	0	76	24
Graybank	L	0	91	9	Racing	L	67	0	33
Grayling	L	4	33	63	Ram	L	6	31	64
Gundahoo	I	20	5	75	Redpott	I	4	18	78
Hay River	I	0	100	0	Richards	L	14	6	80
Hewer	I	28	6	66	Sahtaneh	L	0	100	0
Hoffard	I	0	100	0	Sandy	I	0	100	0
Holden	L	0	79	21	Scatter	I	4	60	36
Hossitl	L	0	100	0	Sharktooth	L	46	9	45
Irene East	I	0	100	0	Shekilie	L	0	100	0
Irene West	H	0	100	0	Smith	I	0	85	15
Jackknife	L	0	100	0	Snake	I	0	100	0
July Lake	L	0	100	0	Stanolind	L	0	100	0
Kechika River	H	0	91	9	Sulpher	L	7	44	49
Kitza	I	0	96	4	Tentsi	I	34	12	54
Kiwigana	I	0	100	0	Tetsa	L	40	0	60
Kledo	I	0	100	0	Timberwolf	I	0	100	0
Klowee	I	0	100	0	Tuchodi	L	42	3	55
Klua	I	0	100	0	Vents	L	0	64	36

Appendix 4: Minimum Harvest Ages

Table 60: Minimum harvest age based on minimum volume (140m^3/ha) and 95% of maximum MAI for existing natural stands

Species Group	Secondary Analysis Unit	VRI "Rolled Over"		VRI Phase II	
		Age at 95% Max. MAI	Age at 140 m^3/ha	Age at 95% Max. MAI	Age at 140 m^3/ha
Spruce	011	143	100	138	95
	012	114	80	114	80
	013	95	65	95	65
Spruce/Pine	021	152	105	143	100
	022	124	85	128	85
	023	100	60	105	65
Spruce/Deciduous	031	143	115	143	105
	032	119	90	119	85
	033	95	70	100	65
Aspen/Coniferous	041	95	85	90	75
	042	86	65	81	60
	043	76	55	76	50
Aspen/Deciduous	051	90	90	90	75
	052	81	65	81	60
	053	71	50	71	50
Pine	061	124	100	124	95
	062	100	70	100	70
	063	81	55	76	55
Pine/Deciduous	071	124	115	119	105
	072	105	85	100	75
	073	86	65	81	60
Cottonwood/Coniferous	081	100	80	100	70
	082	81	65	81	60
	083	57	45	52	40
Cottonwood/Deciduous	091	105	85	114	85
	092	86	70	86	65
	093	62	50	52	35
Spruce/Larch	101	143	110	138	105
	102	119	95	119	85
	103	81	55	95	60
Subalpine Fir	111	200	170	181	140
	112	138	95	119	100
	113	105	70	95	70

Table 61: Minimum harvest age based on minimum harvest volume (140m^3/ha) and 95% of maximum MAI for Existing Managed Stands

Species Group	Secondary Analysis Unit	VRI "Rolled Over"	
		Age at 95% Max. MAI	Age at 140 m^3/ha
Spruce	012	103	75
Pine	062	65	55
	063	55	45

Table 62: Minimum harvest age based on minimum harvest volume (140m^3/ha) and 95% of maximum MAI for Future Managed Stands

Species Group	Secondary Analysis Unit	VRI "Rolled Over"		VRI Phase II	
		Age at 95% Max. MAI	Age at 140 m^3/ha	Age at 95% Max. MAI	Age at 140 m^3/ha
Spruce	011	125	90	120	85
	012	98	70	96	70
	013	78	55	75	55
Spruce/Pine	021	136	95	125	90
	022	102	75	105	75
	023	70	50	78	55
Pine	061	95	95	86	90
	062	65	60	68	60
	063	55	45	55	45