Revelstoke Timber Supply Area
Timber Supply Review #4

Data Package

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1.0 Introduction

This document outlines the basic information and assumptions that are proposed for use in the provincial Timber Supply Review (TSR) process currently underway in the Revelstoke Timber Supply Area (TSA). The purpose of the review is to examine the short- and long-term effects of current forest management practices on the availability of timber for harvesting in the TSA. A review of this type is completed at least once every five years in order to capture changes in data, practices, policy, or legislation influencing forest management in the TSA. The previous review (TSR3) was completed in September 2004 with a final Annual Allowable Cut (AAC) determination on September 1, 2005. The current review (TSR4) is therefore working toward a new AAC determination to be in place by August 1, 2010.

This timber supply review will focus on a single forest management scenario that reflects current management practices in the TSA. Thus, the analysis goal is to model "what-is", and not "what-if". In addition to this current management or "Base Case" scenario, an assessment of how results might be affected by uncertainties is completed using a number of sensitivity analyses. Together, the sensitivity analyses and the Base Case form a solid foundation for discussions among government and stakeholders about appropriate timber harvesting levels.

It is recognized that ongoing treaty negotiations with First Nations have the potential to impact timber supply in the TSA. However, "current management" is the underlying assumption for the analysis and no settlement has yet been reached. The final results from treaty negotiations will be modeled in subsequent timber supply reviews that have the benefit of legal direction in this area.

This report is the first of three documents that will be released during the TSR4 process for Revelstoke TSA. This document provides detailed technical information on the upcoming analysis. A separate document called the Analysis Report will summarize the results of the timber supply analysis and will provide a focus for public discussion. The final document will outline the Chief Forester's harvest level decision and the reasoning behind it.

Additional copies of this document are available on the web at www.forsite.ca/RevelstokeTSR4/ or can be requested using the email address below.

If you have any questions or would like more information, please contact Cam Brown, RPF at (250) 832-3366 or cbrown@forsite.ca.

1.1 Purpose of the data package

The purpose of this data package is to:

- provide a detailed account of the land base, growth and yield, and management assumptions related to timber supply that the Chief Forester must consider under the *Forest Act* when determining an allowable annual cut (AAC) for the Revelstoke TSA and how these will be applied and modeled in the timber supply analysis;
- provide the evidentiary basis for the information used in the analysis;

1.2 Roles and Responsibilities

The Revelstoke TSA licencee / BCTS group chose to take on the responsibility of leading the Revelstoke TSR4 process in 2008. The group consists of Downie Street Sawmills Ltd., Stella-Jones Canada Inc., and British Columbia Timber Sales (BCTS, Okanagan Columbia). They have chosen to take on the responsibilities of assessing timber supply with the knowledge that the Forest Investment Account is currently funding the initiatives. To deliver on this commitment, the planning and analysis work associated with the TSR was tendered and subsequently awarded to Forsite Consultants Ltd.

Government agencies still play a key role in this TSR process – they set and enforce standards and are responsible for approval of the final Data Package and Analysis Reports. The Ministry of Forests and Range (MFR) provides technical support, facilitates resolution of issues, and validate technical information. Various resource specialists in the Ministries of Agriculture and Lands (MoAL) and Environment (MoE) contribute their knowledge and experience. The following table shows the general roles and responsibilities associated with the timber supply analysis leading to an AAC determination.

Table 1. Roles and responsibilities

LICENSEE-BCTS GROUP Obligations	Government Obligations	
	Forest Analysis Branch	**District And Regional Staff**
Compile data needed for the timber supply analysis, including forest cover and other data related to forest and land characteristics, administration and management regimes. Provide a summary of the data, management assumptions, and modeling methods to be applied in the timber supply analysis in a Data Package document.	Set standards for the data package	Provide data, information, and knowledge of current practices in the TSA.
Provide information to the public and First Nations and summarize comments received for government.		
Make any necessary changes to the data package and submit for government approval.	Review and accept the data package (focus on how data is to be applied in Timber supply analysis).	Review and accept the data package (focus on confirming current practice).
Perform and document a timber supply analysis according to standards provided by the Ministry of Forests and Range.	Provide technical advice and set standards for the analysis and reporting.	
Submit an Analysis Report and digital file containing the complete dataset used in the timber supply analysis.	Review and accept (together with the chief forester) the analysis report.	Review the analysis report to ensure local issues and current practices are adequately reflected.
Provide information to the public and First Nations and summarize comments received for government.		Formal consultation obligations.
Provide additional information as required by the chief forester.	Compile and prepare information for presentation to the chief forester at the determination meetings.	Assist in compiling and preparing information for presentation to the chief forester at the determination meetings.

1.3 Description of the Land Base

The Revelstoke Timber Supply Area (TSA) is in southeastern British Columbia and falls within the Southern Interior Forest Region. It is administered from the Columbia Forest District office in Revelstoke. It is bounded by the Monashee Mountains to the west and the Selkirk Mountains to the east, and straddles the Columbia River valley from the Mica Dam in the north to Monashee Provincial Park and Arrowhead in the south. The Trans-Canada Highway passes through the southern part of the area, providing easy access to an area of outstanding mountain scenery. Nearby are Mount Revelstoke National Park, a portion of Glacier National Park, and several smaller provincial parks (Figure 1). There are three TFL's that remove significant area from the TSA.

The Revelstoke TSA is just over 527,000 hectares in size once the TFL's and other non TSA ownership classes are removed. Approximately 55% of this area is non-forested land (alpine, lakes, swamp, brush, rock, etc) and only 10% is currently suitable to support timber harvesting activities. The forests of the Revelstoke TSA are dominated by two main biogeoclimatic zones; the Interior Western Hemlock (ICH) at lower elevations and the Engelmann Spruce Subalpine Fir (ESSF) at higher elevations (Figure 1). These ecosystems are dominated by stands of western hemlock, western red cedar, Engelmann spruce, and subalpine fir. To a lesser extent, stands contain Douglas-fir, western white pine, lodgepole pine, larch, cottonwood, birch and aspen.

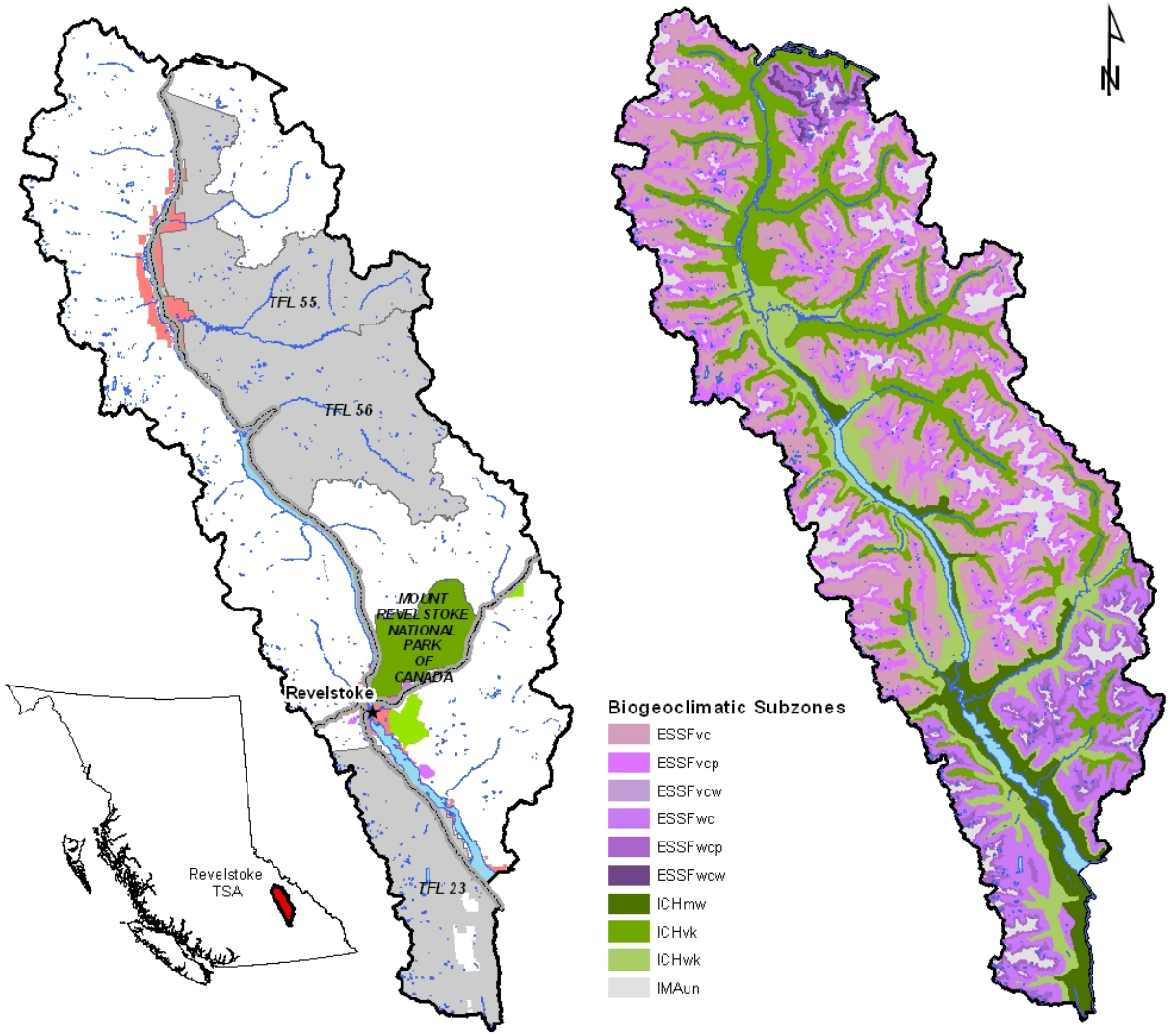


Figure 1. Revelstoke Timber Supply Area and Associated Biogeoclimatic Subzones

1.4 History of the Annual Allowable Cut

The history of the Annual Allowable Cut (AAC) for the Revelstoke TSA is summarized below.

- In 1981, an analysis was completed which resulted in a determination of an allowable annual cut (AAC) of 130,000 m³/yr.
- The timber supply was re-visited in 1985 after additional area, previously in TFL 23, was included in the TSA. The AAC was set at 269,000 m³/yr and remained unchanged until 1995.
- In 1995, the AAC was set at 230,000 m³/yr and has remained unchanged through two subsequent reviews, one in 1999 and one in 2005.

1.5 Current Practice

Within the general TSR process, current management practices are primarily defined by:

- Forest and Range Practices Act (FRPA) and its Regulations (FPPR, etc)
- Higher Level Plan Orders (e.g. Revelstoke Higher Level Plan Order),
- Government Action Regulation Orders (e.g. WHA's, Visuals, UWR, Caribou),
- Standards used to approve or reject Forest Stewardship Plans,
- Other approved BC Forest Service and joint agency forest management practices and policy,
- Current practices of forest tenure holders.

2.0 Thematic Data

2.1 Data Sources

Several resource inventories are used in the modeling process and are summarized in Table 2.

Table 2. Data inputs

Issue or Data	Description, Source	Coverage Name	Version or Date Stamp
Administrative Line Work			
Landscape Units	Landscape Unit Boundaries, LRDW	rtsa_lu	2008
Operability	Operability Line finalized in 2008 by Licensees & Forest District staff	oper_dec08	2008
Ownership	Ownership, KSDP updated by Forsite and Columbia District	owner_feb09	2008
Inventories			
BEC Variants	Biogeoclimatic Variants, Version 7, MFR research branch	rtsa_bgc	2008
NDT Types	Natural Disturbance Types in BGC file, LRDW	rtsa_bgc	2008
BEO	Biodiversity Emphasis Options, KSDP ftp – 2002	rtsa_beo	2002
Slope Classes	0-60%, 60–80%, and >=80% slope classes, Forsite Derived	rtsa_slp_cls	2009
Forest Cover / VEG	Forest Cover Composite Polygons and Rank 1 Layer, LRDW (VDYP7)	rtsa_veg_r1	2009
Terrain Classification	Terrain Classification, compiled by Forsite	rtsa_terrain	2009
ESA's	Environmentally Sensitive Areas, KSDP ftp	rtsa_esa	2005
RESULTS – Growth Intercept	RESULTS FC Inventory, LRDW	rtsa_GI_SI	2009
Management Guidelines			
Community Watersheds	Community Watersheds, LRDW	rtsa_cws	2008
Ungulate Winter Range	Approved UWR (U-4-001), LRDW	rtsa_uwr	2007
Caribou	Approved UWR (U-3-005), MoE FTP	rtsa_caribou	2009
Visual Quality Objectives	Recreational Visual Quality Objectives, LRDW	rtsa_vli	2007
Riparian Buffers	Rivers, wetlands buffered according to classification see details in data package, Forsite	rtsa_rip_buf	2009
Transportation Network	Roads and Railways buffered see details in data package, Forsite	roads_buffer	2009
OGMA	Old growth management areas (non-legal), LRDW	rtsa_ogma	2008
MOGMA	Mature-Old growth Management areas, MoE FTP	rtsa_amog	2007
Other / Special			
Forest Fires	Forest Fires, Forest Analysis and Inventory Branch	rtsa_fires	2008

2.2 Forest Cover Inventory

The forest cover inventory is a key component to the timber supply review of the TSA. The history of the forest cover inventory in the Revelstoke TSA can be summarized briefly as follows:

- The inventory data is based on 1991-1992 photography and is currently in a FIP Rollover format.
- A single flat file was obtained from the LRDW in Feb 2009 that includes only Rank 1 stand information. Attributes were projected to January 1, 2008 using VDYP7. This file also had RESULTS information (depletions and stand attributes) incorporated through the VRIMS process.
- Disturbances from harvesting and fire will be further updated in the GIS resultant to March 2008 using additional datasets supplied by licensees and the MFR.
- Ground sampling (Phase 2 work) is currently underway to assess the accuracy of the inventory attributes but is unlikely to be ready for this analysis.
- Using the Revelstoke Predictive Ecosystem Mapping (PEM) [1], site index adjustments will be applied to generate managed stand site index values in the ICH only - based on based on advice from MFR Regional Ecologists[2]. Existing inventory site indices have been used for natural stands yield projections.

2.2.1 Missing Inventory Information

There were approximately 11,770 ha in the forest cover inventory that was missing inventory attribute information (e.g. species, age, height, site index). These areas were typically associated with historical fires or logged areas that had their attributes removed when the forest cover was depleted to reflect the disturbance. It was necessary to populate these areas with species and site index information for assigning stands to analysis units and to ensure they were not excluded from the productive forest.

Species information was populated using the following hierarchy:

- RESULTS information was used to populate species composition.
- Species listed as the reference for site index was used (if available)
- Application of BEC variant based rules. For example if the dominant species in the ICHmw3 is Hemlock, it was used.

Missing site index information was filled in using the any estimated site index data in the inventory file and then for any remaining areas, a site index of 15.4 was assigned because it was the average site index of the timber harvesting land base prior to the update.

[1] Jones. C., Stehle, K., and E.Valdal. Silvatech. 2006. Revelstoke Predictive Ecosystem Mapping Final Report (BAPID #4316). Prepared for Mount Revelstoke National Park, Revelstoke Community Forest Corporation and BC Ministry of Forests and Range – Small Business Program

[2] Deb MacKillop / Del Meidenger's email approving the use of the Revelstoke PEM to adjust ICH stands. (Title: Accuracy Assessment of the Revelstoke PEM for use in TSR. Sent: November 18, 2008 by Deb Mackillop)

3.0 Timber Harvesting Land Base

3.1 Land Base Definitions

The Crown Forested Land Base (CFLB) is the area of productive forest under crown ownership. This is the land base that contributes to landscape level objectives for biodiversity and resource management. The crown forested land base excludes non-crown land, woodlots, non-forest and non-productive areas.

The Timber Harvesting Land Base (THLB) is the portion of the TSA where forest licensees under license to the province of BC are expected to harvest timber. The THLB excludes areas that are inoperable or uneconomic for timber harvesting, or are otherwise off-limits to timber harvesting. The THLB is a subset of the CFLB. Table 3 summarizes the land base for the Revelstoke TSA.

Table 3. Timber harvesting land base area netdown summary

Land Base Element	Total area (ha)	Effective Netdown* Area (ha)	% of TSA	% of Crown forest
Total area	**833,444**			
Less:				
Tree Farm Licenses		283,006		
Private Land, Woodlots, etc		23,433		
Total TSA Area		**527,005**	**100.0%**	
Less:				
Non-forest / Non-productive forest	286,995	286,995	54.5%	
Non-Commercial Brush	108	108	0.0%	
Unclassified existing roads, trails and landings	9,806	3,777	0.7%	
Total Crown Forested Land Base (CFLB)		**236,126**	**44.8%**	**100.0%**
Less:	In CFLB:			
Parks and Reserves	31,094	19,310	3.7%	8.2%
Specific Geographically Defined Areas	635	635	0.1%	0.3%
Inoperable/Inaccessible	144,715	127,252	24.1%	53.9%
Unstable Terrain	57,892	2,265	0.4%	1.0%
Environmentally Sensitive Areas	23,772	944	0.2%	0.4%
Non-Merchantable	2,764	1,923	0.4%	0.8%
Low Sites	46,539	4,197	0.8%	1.8%
Riparian Management Areas	3,129	1,616	0.3%	0.7%
Community Watersheds	4,449	255	0.0%	0.1%
Drinking Water Intakes	59	25	0.0%	0.0%
Wildlife Habitat Areas	6	4	0.0%	0.0%
Permanent Sample Plots	264	179	0.0%	0.1%
Backlog NSR	412	300	0.1%	0.1%
Cultural Heritage	0	0	0.0%	0.0%
Mountain Caribou Reserves	66,098	18,909	3.6%	8.0%
Existing Wildlife Tree Patches	690	404	0.1%	0.2%
Timber Harvesting Land Base –THLB (ha)		**57,908**	**11.0%**	**24.5%**
Less Temporary Reserves:				
Spatial OGMA's and MOGMA's	84,405	5,549	1.1%	2.4%
Effective Timber Harvesting Land Base –THLB (ha)		**52,358**	**9.9%**	**22.2%**
Volume Reductions:				
Future Wildlife Tree Patches (%)		215	0.0%	0.1%
Future roads, trails and landings		1,100	0.2%	0.5%
Long-term Timber Harvesting Land Base (ha)		**51,044**	**9.7%**	**21.6%**

* Effective netdown area represents the area that was actually removed as a result of a given factor. Removals are applied in the order shown above, thus areas removed lower on the list do not contain areas that overlap with factors that occur higher on the list. For example, the parks netdown does not include any non forested area.

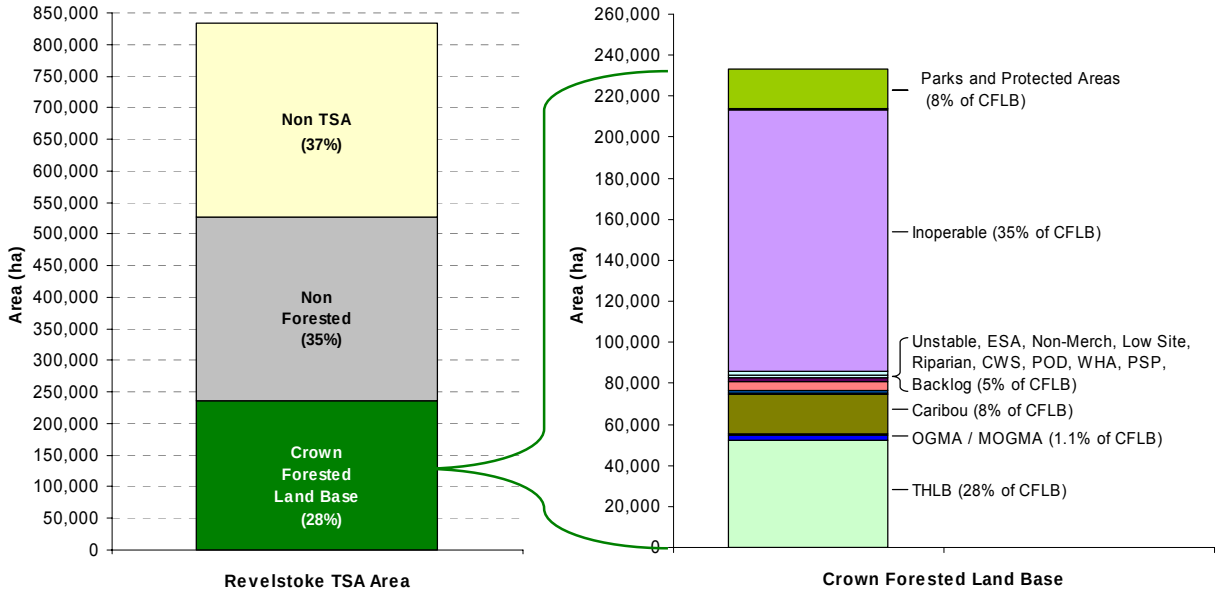


Figure 2. Revelstoke TSA Land Base Summary

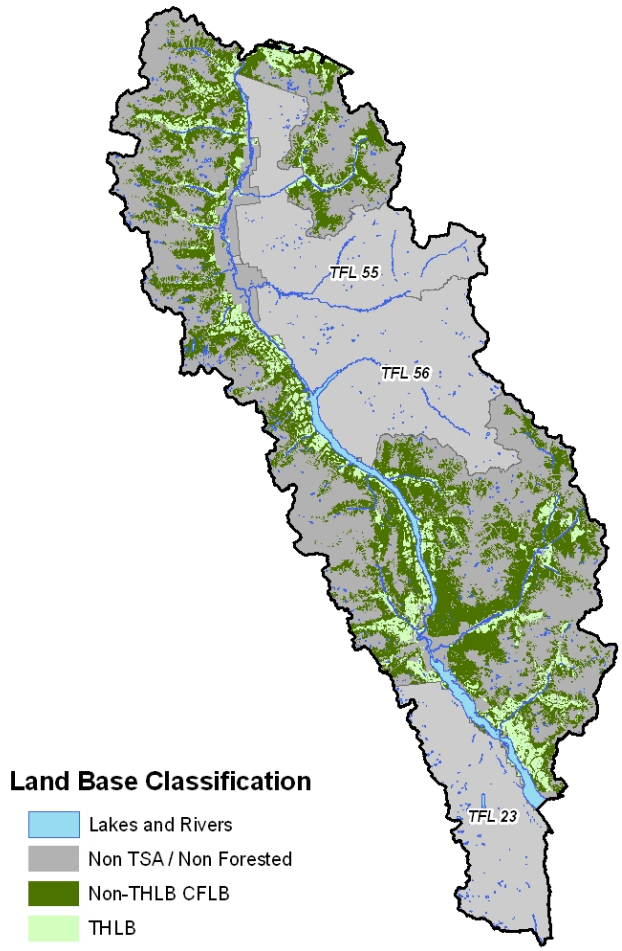


Figure 3. Revelstoke TSA Land Base Definition Map

3.2 Exclusions from the Crown Forested Land Base

3.2.1 Ownership classes not part of the TSA

The area of the Revelstoke Timber Supply Area is divided into ownership classes that describe the nature of ownership of a particular parcel of land. For forest management in the Revelstoke TSA, only those lands that are under crown ownership will contribute to forest management objectives, like landscape level biodiversity. For the purpose of this analysis, Mount Revelstoke National Park is included in the crown forested land base.

Table 4 describes the various ownership codes in the Revelstoke TSA and their contribution to the Crown Forest Land Base, the Timber Harvesting Land Base, or both. Parks and protected areas are described in more detail in Section 3.3.1.

Table 4. Ownership classes not part of the TSA

Ownership Description	Percent Contribution to Crown Forested Land base	Percent Contribution to Timber Harvesting Land base	Total area (ha)
Woodlot Licenses	0%	0%	1,809
Tree Farm Licence (TFL)	0%	0%	283,006
Private	0%	0%	21,624
		Total	**306,439**

The current ownership layer was obtained from the Kootenay Spatial Data Partnership website and updated by Forsite and MFR geomatics staff (Robyn Begley). The ownership is considered current to 2009. Edits were made to the ownership file for TSR4 as follows:

- Woodlot expansions were captured by adding the forest tenure managed license layer to the ownership file.
- Controlled Recreation Areas (Revelstoke Mountain Resort) were confirmed to be excluded from the timber harvesting land base. Expansion areas were specifically excluded from the THLB.
- The Canadian Pacific Railway (CPR) Moratorium area was added to the ownership file and treated as a miscellaneous reserve.

More detail on how the Revelstoke Mountain Resort and the CPR Moratorium are dealt with can be found in Section 3.3.1 and 3.3.2, respectively.

3.2.2 Non-forest and non-productive forest

All land classified as non-forest, non-productive (lakes, swamps, rock, alpine, *etc*.), or non-typed in the forest cover files were excluded from the timber harvesting land base. The non-forest and non-productive areas and codes used in the netdown process are listed in Table 5.

Table 5. Non-forest and non-productive area

Description	Percent Reduction	Total area (ha)	Netdown Area (ha)
Alpine	100%	209,410	209,410
Alpine forest	100%	22,090	22,090
Clearing	100%	54	54
Gravel bar	100%	86	86
Gravel pit	100%	18	18
Lake	100%	18,618	18,618
Meadow	100%	92	92
Non-productive	100%	19,940	19,939

Description	Percent Reduction	Total area (ha)	Netdown Area (ha)
Non-productive brush	100%	9,453	9,453
Non-productive burn	100%	437	437
No Typing Available	100%	97	97
Open range	100%	7	7
Rock	100%	3,000	3,000
River	100%	1,445	1,445
Swamp	100%	237	237
Urban	100%	2,011	2,011
	Total	**286,995**	**286,995**

3.2.3 Non-commercial cover

Non-commercial cover is productive forest land that is otherwise occupied by non-commercial tree or shrub species. This area of land does not currently grow commercial tree species, and is not expected to do so without intervention. This area was therefore excluded from the crown forested land base.

Table 6. Non-commercial cover

Description	Percent Reduction	Total Area (ha)	Netdown Area (ha)
Non-Commercial Brush (NFOR_Desc=NCBr)	100%	108	108

3.2.4 Roads, trails, and landings

Quantifying the area that is, and will be, disturbed by roads, trails, landings (RTLs) and other access features in the TSA is an important part of determining the THLB. Area expected to remain non-productive was removed from the working land base as outlined below.

3.2.4.1 Existing classified roads

Classified roads are those roads identified in the forest cover inventory. These are frequently large roads or highways with a wide right-of-way and are netted out in Table 5.

3.2.4.2 Existing unclassified roads, trails, and landings

Roads not represented in the forest cover data are considered unclassified. A consolidated dataset was compiled by Forsite in November 2008 by adding recently constructed roads to an existing roads dataset (TRIM). The widths associated with these road features were estimated by members of the Revelstoke TSR technical committee and applied as buffers to these line features (Table 7). The buffered areas are considered unproductive and are netted out of the crown forested land base.

Table 7. Access feature classification

Access feature / class	Road length (km's)	Road width (m)	Percent Reduction	Total Area (ha)*	Netdown Area (ha)
Highway	427	28.0	100%	1,165	56
Operational (Logging Roads & Spurs)	4,246	20.1	100%	8,450	3,718
Railway	82	28.0	100%	191	2
			Total	**9,806**	**3,777**

* This gross area is less than the area obtained by multiplying road lengths and widths. This is because the GIS coverage does not double count overlaps between feature types or the buffer overlaps that occurs at all intersections.

In order to account for in-block trails and landings (3% of all logged areas), buffers were enlarged on existing logging roads so that the equivalent area (e.g. 3.0% * logged area [43,921 ha] = 1317 ha) was added to the buffer.

3.3 Exclusions from the Timber Harvesting Land base

3.3.1 Parks and Protected Areas

Provincial / National parks and other protected areas in the Revelstoke TSA are excluded for the timber harvesting land base (Table 8). Although the Revelstoke Mountain Resort (RMR) does not carry an official park status, it was included here because it will be treated as if it were a park in the analysis.

Table 8. Parks and Protected Areas in Revelstoke TSA

Description	Percent Reduction	Productive Forest Area (ha)	Netdown Area (ha)
Mount Revelstoke National Park of Canada	100%	26,332	15,609
Martha Creek Provincial Park	100%	397	172
Blanket Creek Provincial Park	100%		
Goose Grass Ecological Reserve	100%		
Revelstoke Mountain Resort (RMR)	100%	4,365	3,528
	Total	**31,094**	**19,310**

The areas shown here are able to contribute toward meeting non timber objectives. However, most non-timber objectives in the Revelstoke TSA must be met separately above and below the operability line (i.e. landscape level biodiversity objectives). Since the Mount Revelstoke National Park is considered inoperable, it does not contribute toward meeting biodiversity objectives.

3.3.2 Specific Geographically Defined Areas

A moratorium on development exists on an area near the Canadian Pacific railway just East of Albert Canyon and therefore it was completely excluded from the timber harvesting land base (Table 9). The Downie Slide Moratorium area is another geographically defined area to be excluded from the THLB but is entirely outside the operability line and was therefore left to be addressed using that data source. The CPR moratorium area is also almost entirely outside the operable landbase. Because both these areas are considered inoperable, they cannot contribute to biodiversity objectives applied to the operable land base.

Table 9. Land base reductions for specific, geographically defined areas.

Description	Percent Reduction	Productive Forest Area (ha)	Netdown Area (ha)
CPR Moratorium	100%	635	635

3.3.3 Inoperable/inaccessible

Inoperable areas are areas that are not available for timber harvesting because of adverse terrain characteristics such as steep slopes, unfeasible road access or uneconomic yarding or flight distance. In the Revelstoke TSA, operability was updated in 2008 by forest licensees and approved by MFR District staff.

Table 10. Land base reductions for inoperable areas

Criteria	Percent Reduction	Productive Forest Area (ha)	Netdown Area (ha)
Physically and economically inaccessible with current technology (oper = I, or X)	100%	144,715	127,252

3.3.4 Unstable Terrain

Historically, terrain stability mapping was completed in a variety of projects to various intensities of mapping (Level B, C, and D), largely to satisfy operational and regulatory requirements. Terrain mapping datasets from numerous projects were appended together into a single spatial dataset. The stability attribute from all the separate inventories were compiled into a 'Final_Class' attribute, where the stability class from the most intensive mapping was given precedence over the least intensive mapping when overlaps occurred. As this data is considered more accurate than ESA mapping, it eliminates the need for ESA soils mapping (described below).

There is an acknowledgement that slope stability attributes found in terrain mapping require further refinement in the field during cutting permit development. For example, a portion of the areas mapped as "unstable" or "partially unstable" are typically confirmed to be acceptable for timber harvesting in the field. These mapped attributes best serve as a red flag for field operations and do not automatically exclude these areas from harvest.

In order to determine the appropriate land base reduction to apply to mapped Unstable (U) and Potentially Unstable (P) areas, several factors were considered:

- Harvest performance analysis (Forsite unpublished, 2009) – The proportion of the operable/eligible landbase designated as U or P was compared to the proportion of harvested areas (previous 5 yrs) designated as U or P. The results indicated no avoidance of P areas and slight avoidance of U areas relative to their profile on the land base.
- Harvest performance analysis (Downie unpublished, 2009) – 29 harvested blocks were selected and overlaid with Level D terrain mapping and Level A terrain mapping to determine the areas within each terrain class. The analysis indicated there was significant harvest performance in U and P terrain. It also indicated that about 5% of all the area in the blocks was considered unstable (Level A class V) enough to prevent harvest from occurring. These areas were typically left as WTP's. Because only harvested blocks were assessed, extrapolation to the entire landbase was not possible.
- Approach used in neighboring interior wet-Belt management units – TFL 56, TFL 55, Golden TSA, Kootenay Lake TSA. A detailed review of terrain mapping (polygon by polygon) within TFL 56 was conducted by Terratech staff in 2000. As a result of this assessment, 49% of all the U polygons below the operability line were netted out and 0% of the P polygons were netted out. Since TFL 56 is embedded within the TSA and has nearly identical terrain features, netdown factors applied in this TFL were felt to be representative of conditions experienced throughout the TSA.
- Professional opinion from Joe Alcock and Peter Jordan.

For purposes of modeling, netdowns were performed as per Table 11 – 50% of all polygons below the operability line that were labeled as U was removed on a steepest first basis. This subset of terrain polygons resulted in a netdown of area believed to be consistent with field operations. No netdown was applied to P polygons because experience in TFL 56 as well as the Forsite harvest performance analysis showed no avoidance of harvesting in this terrain stability class. Another factor that was considered was that leave areas that result from field assessments can almost always be accommodated within the stand level netdown budget. Where no terrain mapping existed, the ESA soils designation was used as described in Table 12 below.

Table 11. Land base reductions for unstable terrain

Mapped Terrain Class	Percent Reduction	Productive Forest Area (ha)	Netdown Area (ha)
U (unstable terrain) from Level D mapping	50%	23,424	2,265
P (potentially unstable) from Level D mapping	0%	34,469	0
	Total	**57,892**	**2,265**

3.3.5 Environmentally sensitive areas

Environmentally sensitive sites and areas of significant value for other resource uses have been delineated within the forest cover inventory as Environmentally Sensitive Areas (ESA's). ESA's are attributes assigned to forest cover polygons to indicate sensitivity for unstable soils (E1s), forest regeneration problems (E1p), snow avalanche risk (E1a), and high water values (E1h). As discussed in the previous section, terrain stability mapping provides a better estimate of unstable soils than the E1s mapping, so E1s mapping was only used when no terrain mapping was available. ESA netdown percentages are identical to those used in TSR3 (see Table 12).

Table 12. Land base reductions for Environmentally Sensitive Areas

ESA category	ESA description	Percent reduction	Productive Forest Area (ha)	Netdown Area (ha)
E1a	Severe snow avalanching	**100%**	27	0
E1s (where no terrain mapping exists)	Sensitive / unstable soils >= 60% slope	**100%**	12,261	591
	Sensitive / unstable soils < 60% slope	**25%**	11,484	353
		Total	**23,772**	**944**

3.3.6 Non-merchantable forest types

Non-merchantable forest types are stands that contain tree species not currently utilized, or timber of low quality, small size and/or low volume. Non-merchantable types are entirely excluded from the timber harvesting land base. In defining non-merchantable forest types for TSR4 the following stand types were considered for potential exclusion:

- Predominantly Balsam Stands (>80% B)
- Balsam leading with hemlock as secondary
- Predominantly Hemlock Stands (>80% Hw)
- Hemlock leading with deciduous as secondary
- Deciduous leading ≥30 years

Harvest performance over the past 5 years was assessed on the first three stand types listed and it was found that harvest has occurred consistent with each of the stands type profiles on the operable/eligible land base. As a result, these stand types remained in the land base while the Hw/Deciduous and deciduous leading stands were removed. Thus, non-merchantable forest types for use in TSR4 were the same as TSR3. Table 13 shows the non-merchantable forest types removed from the land base.

Table 13. Land base reductions for Non-merchantable forest types

Species	Inventory type group	Age (years)	Percent Reduction	Productive Forest Area (ha)	Netdown Area (ha)
Deciduous leading	35-42	>30	100 %	2,753	1,923
Hw Leading & Decid.	17	>140	100 %	10	0
			Total	**2,764**	**1,923**

Minimum ages were used to avoid removing young deciduous stands under the assumption that these stands will produce a conifer crop consistent with licensee obligations.

3.3.7 Low productivity sites

Low productivity sites are areas that are not suitable for timber harvesting due to low timber growing potential. These stands have suitable species for timber harvesting but are not expected to contribute to the THLB because they take too long to grow a commercial crop of trees. Low site cutoffs were re-visited in the development of this data package and resulted in no change from TSR3. The site index cutoffs did not apply to stands that have been previously logged.

Table 14. Land base reductions for Low sites

Leading species	Inventory Type Group Number	Site index	Percent Reduction	Productive Forest Area (ha)	Netdown Area (ha)
Douglas-fir	1-8	<9	100	185	31
Cedar	9-11	<9	100	4,941	2,015
Hemlock	12-17	<8	100	14,335	843
Balsam	18,19	<8	100	23,410	921
Spruce	20-26	<8	100	3,507	387
White Pine	27	<8	100	0	0
Lodgepole Pine	28-31	<9	100	25	0
Ponderosa pine	32	<9	100	0	0
Larch	33,34	<9	100	0	0
Deciduous	35-42	<9	100	136	0
			Total	**46,539**	**4,197**

3.3.8 Riparian reserves and management zones

Riparian reserve areas around lakes, wetlands, and streams in the Revelstoke TSA are excluded from the timber harvesting land base and are based on the *Forest Practices and Planning Regulation* (FPPR Sec. 47-52) defaults. Management practices within riparian management zones also resulted in areas excluded from the timber harvesting land base. In the analysis, this has been represented by an additional buffer width that will be 100% excluded. When the reserve zones and the representative portions of the management zones are added together, an "effective" buffer width is defined and ultimately used in the model.

3.3.8.1 Streams

Riparian reserve strategies were implemented in the model by establishing effective reserve buffers around the riparian features inventories (streams, wetlands, lakes) using GIS. See Table 15 for a description of the riparian management netdown assumptions.

Table 15. Land base reductions for riparian reserve and management zones — streams

Stream class*	Reserve Zone (RRZ) (m)	Management zone width (RMZ) (m)	RMZ Basal Area Retention (%)	Effective Buffer Width (m)** (each side)	Productive Forest Area (ha)	Netdown Area (ha)
S1a	0	100	20	20	28	20
S1b	50	20	20	54	1,018	577
S2	30	20	20	34	1,150	606
S3	20	20	20	24	655	261
S4	0	30	10	3	51	23
S5	0	30	10	3	227	93
S6	0	20	0	0	0	0
				Total	**3,129**	**1,579**

* Stream classes are defined in the Riparian Management Guidebook. S1-S4 are fish bearing or in a community watershed, while S5-S6 are non fish bearing.

** Effective width is calculated as Reserve Width (m) + (Management Zone Width x Management Zone Retention)

3.3.8.2 Lakes and Wetlands

Lakes and wetlands in the Revelstoke TSA were obtained from the LRDW, and classified in accordance with the *Riparian Management Area Guidebook* and the *Regional Lake Classification and Lakeshore Management Guidebook*. Similar to the riparian reserves around streams, a buffer around each lake / wetland was created to represent the area deducted from the THLB. Table 16 shows the effective buffer width around each class of lake or wetland.

Table 16. Land base reductions for riparian reserve and management zones — wetlands and lakes

Riparian class*	Reserve width (m)	Management zone width (m)	Management Zone Retention (%)	Effective Buffer Width (m)**	Productive Forest Area (ha)	Netdown Area (ha)
L1 Lakes <= 1000 ha	10	0	10	10	7	1
L3 lakes	0	30	10	3	7	1
W1 wetlands	10	40	10	14	16	4
W3 wetlands	0	30	10	3	38	18
W5 Wetlands	10	40	10	14	29	12
				Total	**96**	**37**

* The table only includes the wetland classes that occur in the TSA.
** Effective width is calculated as Reserve Width (m) + (Management Zone Width x Management Zone Retention).

3.3.9 Community Watersheds

Community watersheds are watersheds that supply communities with domestic water. Within the Revelstoke TSA there are 4 designated community watersheds: Hamilton, Greeley, Bridge, and Dolan Creek. Licencees have avoided and continue to avoid these areas and thus have been completely excluded from the THLB.

Table 17. Land base reductions for community watersheds

Description	Percent reduction	Productive Forest Area (ha)	Netdown Area (ha)
Community Watersheds	100%	4,449	255

3.3.10 Drinking Water Intakes

In order to protect drinking water resources, drinking water intakes or points of diversion (POD's) were buffered by 100 m and completely removed from the timber harvesting land base.

Table 18. Land base reductions for drinking water intakes

Description	Percent reduction	Productive Forest Area (ha)	Netdown Area (ha)
Buffered Drinking Water Intakes (100 m)	100%	59	25

3.3.11 Wildlife Habitat Areas

The provincial *Identified Wildlife Management Strategy* provides for the creation of wildlife habitat areas (WHAs), to protect key habitat features of listed wildlife species. Since the last TSR, five WHAs have been spatially established within the Revelstoke TSA and were therefore excluded from the timber harvesting land base.

Table 19. Land base reductions for Identified Wildlife

Description	Percent reduction	Productive Forest Area (ha)	Netdown Area (ha)
Wildlife Habitat Areas (WHAs)	100%	6	4

3.3.12 Permanent Sample Plots

Permanent sample plots (PSPs) are established throughout the province in order to provide long-term, local data on growth of existing forests. They provide information on rates of growth, mortality, and changes in stand structure from stand establishments to maturity. For this reason, it is important that established permanent sample plots are not disturbed. Therefore, all PSP core areas were removed from the THLB (Table 20).

Table 20. Land base reductions for Permanent Sample Plots

Description	Percent reduction	Productive Forest Area (ha)	Netdown Area (ha)
Permanent Sample Plots	100%	264	179

3.3.13 Backlog NSR

Backlog areas are those harvested prior to October 1987 and are not yet sufficiently stocked according to standards (MFR, 2008). District staff (Barb Wadey) used RESULTS information to identify approximately 412 ha within the Revelstoke TSA that meets this criteria. Backlog NSR areas are identified at the Standards Unit (SU) level which is not reflected spatially in the forest cover. In order to get to an equivalent backlog NSR area, 412 ha were chosen randomly from the Backlog NSR population of openings (Table 21). These backlog areas were 100% removed because it is unclear what volumes will be achieved on these sites and any volume that does materialize can be used to offset the reduced volumes coming from impeded or otherwise lower volume stand from that same era.

Table 21. Land base reductions for Backlog NSR

Description	Percent reduction	Productive Forest Area (ha)	Netdown Area (ha)
Backlog NSR	100%	412	300

3.3.14 Cultural Heritage Resources

A cultural heritage resource is defined in the Forest Act as, "an object, site, or location of a traditional societal practice that is of historical, cultural or archaeological significance to the province, a community, or an aboriginal people". Cultural heritage resources include archaeological sites, structural features, heritage landscape features and traditional use sites.

Archaeological Heritage Resources

The *Heritage Conservation Act* provides for the protection of British Columbia's archaeological sites predating 1846. In accordance with the *Act* (Section 13(2)), archaeological sites may not be damaged, excavated or altered without a permit issued by the Minister or designate. As such, any registered Archaeological site will be 100% excluded from the THLB (Table 22).

Table 22. Land base reductions for Registered Archaeological Sites

Description	Percent reduction	Productive Forest Area (ha)	Netdown Area (ha)
Registered Archeological Sites	100%	0.2	0

Other Cultural Heritage Resources and Values

Other cultural heritage resources and values may be present within the Revelstoke Timber Supply Area. These resources and/or values associated with a land base or forest operation may not have any legal designation. As such they have not been modeled in the base case timber supply analysis. However, such resources and values can be brought forward to the Chief Forester as information to consider in his AAC determination.

3.3.15 Mountain Caribou

Spatial reserves to protect mountain caribou (*Rangifer tarandus caribou*) habitat have been established (GAR Order #U-3-005) and have been in effect since February 12, 2009. Mountain caribou guidelines were amended out of the Revelstoke Higher Level Plan to avoid conflicts with the GAR order. These spatial reserves were therefore completely removed from the THLB in the Base Case.

Table 23. Land base reductions for Mountain Caribou

Description	Percent reduction	Productive Forest Area (ha)	Netdown Area (ha)
Caribou Reserves (GAR UWR 3-005)	100%	66,098	18,909

3.3.16 Existing Wildlife Tree Patches

Existing wildlife tree patches have been excluded from current timber harvesting activities, and are expected to remain on the landscape for a least one rotation. An equivalent area of mature forest is expected to always exist in WTPs so this area was removed from the timber harvesting land base (Table 24). A layer of existing WTPs was compiled from TSA licencee data.

Table 24. Land base reductions for Existing Wildlife Tree Patches

Description	Percent reduction	Productive Forest Area (ha)	Netdown Area (ha)
Existing Wildlife Tree Patches	100%	690	404

3.3.17 Old Growth and Mature+Old Management Areas

The Revelstoke Higher Level Plan Order specifies the percentage requirements of old seral and mature-plus-old seral that must be retained within each LU and BEC combination. The equivalent area of both the old and the mature-plus-old seral has been mapped be ILMB staff. These areas are called OGMA's (old growth management areas) and MOGMA's (mature old growth management areas). They are treated as "no-harvest' zones for the first 80 years of the planning horizon, after which they are released and aspatial cover constraints are applied to satisfy the requirements. Refer to Section 8.5.1 on Page 41 for more detail on biodiversity requirements were handled in the model.

Table 25. Temporary land base reductions for Spatial OGMA's and MOGMA's

Biodiversity Reserve Type	Percent reduction	Productive Forest Area (ha)	Netdown Area (ha)
Old growth management area (OGMA)	100%	36,320	3,249
Mature plus old management area (MOGMA)	100%	48,086	2,301
	Total	**84,405**	**5,549**

3.3.18 Future Land Base Reductions

3.3.18.1 Future wildlife tree retention areas

The licensees' Forest Stewardship Plans are based on retaining the default 7% of each cutblock as wildlife tree retention (WTR) areas. When possible, WTR is placed within existing non-THLB stands, so only a portion of the 7% is an incremental landbase reduction. Wildlife tree retention areas are typically managed so they are a maximum distance of 500 meters apart. Based on these two factors (7.0% of the THLB reserved when beyond the 500m maximum distance spacing) the area of future wildlife tree retention areas (Table 26) was estimated using the following procedure.

- Within the THLB (Table 26, column 1) apply a 250m buffer around all productive, non-THLB that is older than 80 yrs old (column 2);
- The area outside the buffer is the area that requires additional wildlife tree retention (column 3);
- Apply a 7% retention rate to this area to estimate the equivalent area of future wildlife tree retention (column 4);
- Calculate the equivalent, blended rate of retention across the whole THLB (the developed area plus the un-developed area), which is 0.41 % of the THLB (column 5);
- Apply that percentage as a yield curve reduction against all the future managed stand yield curves.

Table 26. Estimate of future wildlife tree retention areas

(1) THLB Area (ha)	(2) THLB Area within 500 meters of Forested Non-THLB (%)	(3) THLB Area requiring additional WT retention (%)	(4) Equivalent THLB Retention Assuming 7% Retention (ha) (7%) X (column 3)	(5) Future THLB Reduction (4) / (1) (%)
52,358	49,289	3,069	215	0.41%

A very small amount of THLB was further than 500m from existing retention because the THLB is geographically fragmented by geography and spatial reserves for OGMA, MOGMA, Caribou, and other netdowns.

3.3.18.2 Future roads, trails and landings

Deductions for future roads are necessary to account for the unproductive area created as new roads, trails and landings are built. A first logging entry into any unroaded area in the TSA will capture all of the timber volume available in that stand. Any subsequent entries will harvest less area, recognizing the unproductive area that would then exist as roads, trails and landings.

TSR3 used a yield reduction of 6.0% to model area lost to future roads, trails, and landings. For this analysis, the same percentage (6.0%) has been used but applied only to areas of the THLB that were at least 300 m from currently existing roads and stands older than 30 yrs old. The area within 300 m can currently be accessed from the existing roads and the 30 yr age is designed to eliminate currently logged blocks (i.e. heli blocks) from having this netdown applied.

Deductions for future roads, trails and landings were applied as a volume reduction to the yield tables of all future managed stand analysis units (200 series AU's). The THLB area meeting the criteria described above (11,995 ha) was multiplied by 6.0% to get an effective area reduction (751 ha). This area was then calculated as percentage of the total area of the future managed stand yield curves (34,644 ha) and implemented as a volume reduction (**2.1%**) on these curves. This percentage is lower than 6.0% because a portion of the area on 200 series AUs can already be serviced by the existing road infrastructure (i.e. within 300 m).

3.4 Changes from TSR3

Since TSR3, several input datasets and assumptions have changed, and result in differences in the size of the timber harvesting land base. A summary of these changes is provided below:

- New caribou management guidelines (GAR Order #U-3-005) provide for spatially explicit reserves that include incremental reserves beyond what was previously required under the Revelstoke Higher Level Plan. Excluding these reserves from the THLB causes a very significant reduction in THLB area relative to TSR3 although only the incremental reserves are likely to result in true timber supply impacts. Without the caribou reserves, the THLB in this analysis would have been within ~1000 ha of the TSR3 THLB area.
- Operable area for the TSA was reviewed in 2008 to confirm the physical operability. A new operable area was identified after areas were both removed and added to the old operability line. The net impact on THLB is dependant on how additions and subtractions are dealt with in the netdown process.
- Where terrain stability mapping (Level B or Level D mapping) is complete in the TSA, it was used in place of the older Environmentally Sensitive Area (ESA) soils mapping. ESA soils mapping was used in only 26% of the operable CFLB land base. This approach was less constraining than the approach used in TSR3.
- Use of spatially explicit Old Growth and Mature Management Areas (OGMAs and MOGMAs) to satisfy Old and Mature requirements set out in the Revelstoke Higher Level Plan for the first 80 years. TSR3 used percentage targets to meet the same objective.
- Wildlife Habitat Areas (WHAs) have been designated (no species listed).
- Boundaries for the Revelstoke Mountain Resort have been established and excluded.
- Ownership has changed slightly - Woodlots have been expanded.
- Recognition and protection of active Permanent Sample Plots (PSPs).
- Exclusions for drinking water intakes.
- Management of riparian area retention to FPPR defaults resulting in smaller effective riparian buffers.
- Removal of mapped registered archeological sites.
- Timber License areas no longer exist and are part of the TSA from the start of the planning horizon.

The THLB determined in TSR3 was 78,018 ha. As a result of the listed differences from TSR3, the THLB area used here dropped by 25,660 ha (32.9%). Spatial Caribou reserves make up the vast majority of the difference followed by the use of spatial OGMAs and MOGMAs to satisfy biodiversity requirements. The scale of this change will not translate proportionately into timber supply impacts because both HLP caribou and OGMA/MOGMA were modeled in TSR3 as constraints. They have simply been made spatial and removed from the THLB for this analysis.

Other non-THLB related changes since TSR3 include:

- Forest Cover attributes (ht, volume, age) have all been projected using VDYP7. The Forest Cover for the previous TSR was projected with VDYP v.6.5a. This appears to results in less standing volume in the TSA.
- Predictive Ecosystem Mapping (PEM) has been completed for the TSA. Managed stand site index values have been adjusted in the Base Case using SIBEC relationships in ICH variants.
- Biogeoclimatic mapping has been updated (Version 7).
- Revision of regeneration assumptions including:

  - Minor changes in species composition.
  - Inclusion of select seed gains for Spruce, Larch, and Douglas-fir.
- A new UWR GAR order for Mule Deer and Moose (U-4-001) exists and requires from 10-40% of the habitat in each Management Unit (MU) to be >60-100 yrs old and Maximum 40% <21 years old at any time. TSR3 required a minimum of 40% > 120 yrs old and maximum of 25% <2m so the current version appears to be less constraining.
- Visual Quality Objectives (VQO's) were legally established for the TSA in 2000. Additional updates were made in 2007. Assumptions for managing for visuals have also been revised.
- Revision of assumptions for modeling disturbance in the inoperable.
- Revision of assumptions for future wildlife tree retention – 0.27% reduction applied to all yield curves.
- Revision of assumptions to account for future roads trails and landings (RTLs). The same percentage was used to account for future RTLs however, it was only applied to the areas of the THLB that were at least 300 m away from currently existing roads and only applied to stands >30 years old. This area was then calculated as percentage of the total area of the future managed stand yield curves and implemented as a volume reduction on these curves.
- Use of Forest Planning Studio (FPS-ATLAS) to conduct timber supply modeling.

4.0 Growth and Yield

This section describes the information/data sources, assumptions, and methods for generating growth and yield estimates for both existing and future stands, under both unmanaged and managed conditions.

4.1 Analysis units

To reduce the complexity and volume of information in the timber supply analysis, individual stands were aggregated into 'Analysis Units' based on dominant tree species (inventory type group), timber growing capability (site index), and silvicultural management regimes. For example, all spruce/balsam stands on moderate growing sites with a clearcut silviculture regime are grouped into a single analysis unit. Each analysis unit has an associated yield table that provides the model with the net merchantable volume available for harvest at various stand ages. Three *sets* of analysis units are created to reflect the level of forest management associated with various time frames:

Existing Natural Stands (100 series – 34,772 ha of THLB)

Stands where forest management (planting/spacing) has been generally absent. This was defined as stands greater than 30 years old with no record of planting or spacing in the forest inventory files.

Existing Managed Stands (500 series – 23,185 ha of THLB)

Stands where forest management (e.g. planting/spacing) has had a positive impact on the regeneration/growth of the stand. This was defined as stands harvested on or after 1979 (≤ 30 yrs old . This set of analysis units is meant to capture past regeneration practices in the TSA that should provide at least a modest improvement over natural stands volumes. Once harvested, these stands will be grown with similar expectations to the future managed stands described below.

Future Managed Stands (200 / 600 series)

Stands harvested from today forward. Once existing natural stands are harvested in the model, they will be assigned to one of these analysis units. They are meant to capture the management/regeneration practices occurring in the TSA today. The 100 series AUs regenerate into the 200 series AUs. The 500 series AUs regenerate into the 600 series AUs.

These broad groups are further sub-divided by criteria of:

- leading species
- Site Index - In order to differentiate the regeneration and growth characteristics.
- Age Range

Table 27. Analysis Unit Descriptions

Analysis Unit Description	Existing Natural Stands AU #	Future Managed Stands* AU#	THLB Area (ha)	SI Inv. Wtd. Avg.	SI Adj Wtd. Avg.	Variable used to define analysis unit		
						Leading Species	Site index range	Age Range (yrs)
Existing Natural Stands								
Fir Larch Pine – Good <141	101	201	1,354	23.3	23.4	Fd, Lw, Pl	≥21	<141
Fir Larch Pine – Good +141	102	201	93	21.9	23.1		≥21	≥141
Fir Larch Pine – Medium <141	103	202	4,406	18.0	20.2		≥15 and <21	<141
Fir Larch Pine – Medium +141	104	202	663	17.2	18.2		≥15 and <21	≥141
Fir Larch Pine – Poor <141	105	203	1,123	13.4	19.3		<15	<141
Fir Larch Pine – Poor +141	106	203	99	12.1	19.8		<15	≥141
Cedar – Good <141	107	204	1,615	19.5	18.6	Cw	≥17.5	<141
Cedar – Good +141	108	204	172	20.1	20.1		≥17.5	≥141
Cedar – Medium <141	109	205	531	15.7	17.7		≥14.5 and <17.5	<141
Cedar – Medium +141	110	205	519	15.8	18.5		≥14.5 and <17.5	≥141
Cedar – Poor <141	111	206	512	11.8	17.9		<15	<141
Cedar – Poor +141	112	206	3,618	11.7	17.6		<15	≥141
Hemlock – Good <141	113	207	2,116	19.9	18.7	Hw	≥18	<141
Hemlock – Good +141	114	207	682	20.0	19.2		≥18	≥141
Hemlock – Medium <141	115	208	2,401	14.8	17.6		≥12 and <18	<141
Hemlock – Medium +141	116	208	4,276	14.4	16.5		≥12 and <18	≥141
Hemlock – Poor <141	117	209	308	10.8	15.4		<12	<141
Hemlock – Poor +141	118	209	1,706	10.4	14.2		<12	≥141
Balsam Spruce – Good <141	119	210	89	18.7	18.7	Bl	≥18	<141
Balsam Spruce – Good +141	120	210	48	18.6	18.6		≥18	≥141
Balsam Spruce – Medium <141	121	211	349	14.9	15.3		≥13 and <18	<141
Balsam Spruce – Medium +141	122	211	426	14.5	14.7		≥13 and <18	≥141
Balsam Spruce – Poor <141	123	212	406	11.3	12.1		<13	<141
Balsam Spruce – Poor +141	124	212	805	10.4	10.7		<13	≥141
Spruce Mix – Good <141	125	213	506	20.9	20.8	Sx	≥18	<141
Spruce Mix – Good +141	126	213	1,490	21.7	22.2		≥18	≥141
Spruce Mix – Medium <141	127	214	710	15.5	20.4		≥14 and <18	<141
Spruce Mix – Medium +141	128	214	1,079	15.9	18.8		≥14 and <18	≥141
Spruce Mix – Poor <141	129	215	361	11.8	14.5		<14	<141
Spruce Mix – Poor +141	130	215	2,259	11.6	14.1		<14	≥141
Natural Subtotal			**34,722**	**15.6**	**17.9**			
Existing Managed Stands*								
Fir Larch Pine – Good	501	601	370	23.5	23.4	Fd, Lw, Pl	≥21	<30
Fir Larch Pine – Med	502	602	2,605	17.2	21.8		≥15 and <21	<30
Fir Larch Pine – Poor	503	603	444	12.4	19.7		<15	<30
Cedar – Good	504	604	3,144	19.6	19.5	Cw	≥17.5	<30
Cedar – Med	505	605	1,704	15.7	17.6		≥14.5 and <17.5	<30
Cedar – Poor	506	606	1,140	11.8	17.3		<15	<30
Hemlock – Good	507	607	703	19.7	18.9	Hw	≥18	<30
Hemlock – Med	508	608	1,037	14.7	16.5		≥12 and <18	<30
Hemlock – Poor	509	609	115	9.0	14.2		<12	<30
Balsam – Good	510	610	91	18.5	18.7	Bl	≥18	<30
Balsam – Med	511	611	432	14.6	14.9		≥13 and <18	<30
Balsam – Poor	512	612	90	10.2	10.2		<13	<30
Spruce Mix – Good	513	613	3,339	20.5	22.2	Sx	≥18	<30
Spruce Mix – Med	514	614	6,126	15.2	19.5		≥14 and <18	<30
Spruce Mix – Poor	515	615	1,845	11.6	16.4		<14	<30
Managed Subtotal			**23,185**	**16.5**	**19.4**			
Total THLB			**57,908**	**16.0**	**18.5**			

* Inventory SI provided only for comparison – Adjusted SI's are used to model these AU's from time zero.

4.2 Site index

Estimates of site productivity are required to predict the rate of growth that will occur on each site throughout the TSA. The height of a "site" tree at age 50 (measured at breast height) is one measure of site productivity and is commonly referred to as "site index".

4.2.1 Site curves

For each tree species, site curves are available to illustrate the relationship between stand height and age for a range of site indices. In all cases, this analysis used the standard site curves recommended by the BC Ministry of Forests and Range as identified in the *Site Tools* software. They are as follows:

Table 28. Site index sources

Species	Source
Douglas Fir (Fdi)	Thrower and Goudie (1992)
Lodgepole Pine (Pli)	Thrower (1994)
Western White Pine (Pw)	Curtis, Diaz, and Clendenen (1990)
Western Red Cedar (Cw)	Nigh (2000)
Western Hemlock (Hwi)	Nigh (1998)
Engelmann Spruce (Se) & Subapline fir (Bl)	Chen and Klinka (2000)
Western Larch (Lw)	Brisco, Klinka, and Nigh 2002
White Spruce (Sw)	Goudie (1984)

4.2.2 Site index adjustments

The Base Case will include adjusted inventory site index values for managed stands (TIPSY curves) in recognition that existing inventory site indexes often do not adequately reflect the potential stand growth experienced by second growth stands. The site index sources used to derive the new estimates are listed by priority below.

1. Growth Intercept from regeneration surveys (0.7% of THLB area),
2. SIBEC 2nd approximation estimates (10.2% of THLB area),
3. SIBEC 1st approximation estimates (45.7% of THLB area),
4. Forest Cover Inventory estimates (43.3% of THLB area).

SIBEC estimates come from the MFR Research Branch's SIBEC project that links productivity estimates to ecological classifications. It is based on the assumption that sites with similar soil moisture and nutrient regimes will have similar rates of productivity. SIBEC adjustments using the Predictive Ecosystem Mapping (PEM) completed for the TSA in March 2006 (Jones, C. et. al., 2008) that identifies ecosystems at the site series level. This PEM has had an accuracy assessment completed in 2007-08 (Timberline, 2008) and as a result only the ICH variants have been approved for use in adjusting site index estimates in the Base Case[3]. The ESSF variants were not approved because they did not meet the minimum requirement for sample size and accuracy as set out by the Forest Analysis and Inventory Branch.

When PEM based site series data is combined with forest cover data, SIBEC relationships can be used to provide updated site index estimates for each stand in the forest cover file. A SIBEC crosswalk table provided by the regional research ecologist (Deb MacKillop) was used to link ecosystems in the SIBEC database (2005 classifications) to ecosystems in the PEM (2007 classifications).

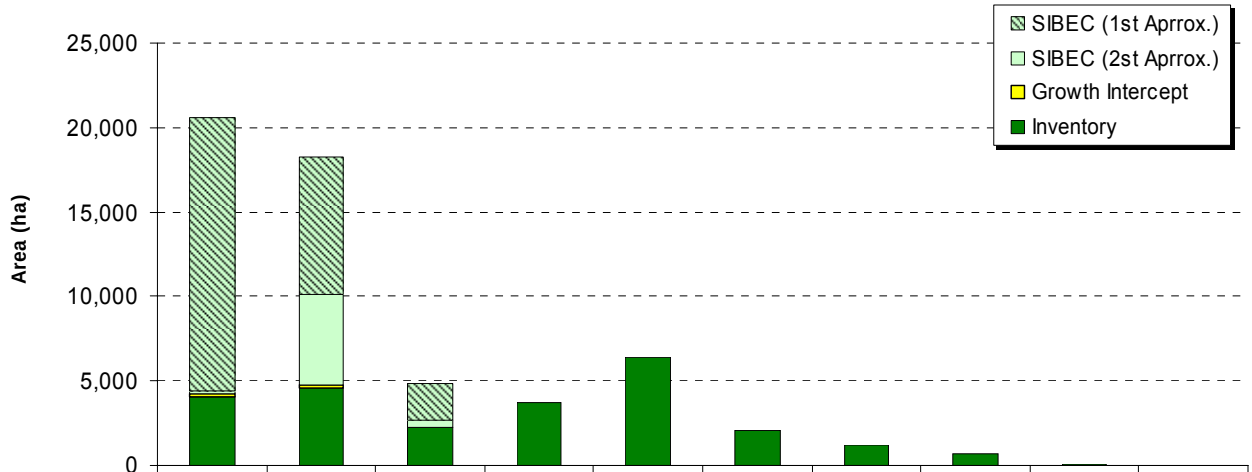
These new estimates will be used to build managed stand yield curves only. Harvest volumes for existing natural stands or site indexes used to define netdowns remain unchanged.

[3] Deb MacKillop / Del Meidenger's email approving the use of the Revelstoke PEM to adjust ICH stands. (Title: Accuracy Assessment of the Revelstoke PEM for use in TSR. Sent: November 18, 2008 by Deb Mackillop)

SIBEC Application Results

Weighted average site index values for each AU (Inventory and SIBEC influenced) can be found in Table 27. In general, the lower site index AU's had the largest increase, while the higher site index AU's remained the same or fell slightly. Overall, the average site index for the THLB area increased by 2.5 m from 16.0 m to 18.5 m (+15.8%).

The site index sources used to derive the new estimates are listed by priority below and are summarized by BEC variant in Figure 4.



	ICH vk 1	ICH wk 1	ICH mw 3	ICH mw 2	ESSFvc	ESSFwc 1	ESSFwc 4	ESSFwc 2	ESSFwcw	ESSFwcp
SIBEC (1st Aprrox.)	16,167	8,181	2,124	0	0	0	0	0	0	0
SIBEC (2st Aprrox.)	110	5,373	449	0	0	0	0	0	0	0
Growth Intercept	240	112	43	0	0	13	0	0	0	0
Inventory	4,031	4,625	2,220	3,704	6,384	2,104	1,239	725	61	3

Figure 4. Site index data sources by BEC variant and THLB area

4.3 Utilization level

Utilization levels define the maximum height of stumps that may be left on harvested areas, the minimum top diameter (inside bark), and the minimum diameter at breast height (dbh) of stems that must be removed from harvested areas. These factors are needed to calculate merchantable stand volume for use in the analysis.

Table 29. Utilization levels

	Utilization		
Species	**Minimum dbh[1] (cm)**	**Maximum stump height (cm)**	**Minimum top dib[2] (cm)**
Pl	12.5	30	10
All Others	17.5	30	10

[1] Diameter breast height
[2] Diameter inside bark

4.4 Decay, waste and breakage for unmanaged stands

Decay, waste and breakage (DWB) factors are applied to natural stand yield tables (VDYP7) to obtain net harvest volumes per hectare. Initial net volume estimates were generated using the adjusted inventory attribute values (age, height, basal area, site index) in VDYP7 with the default decay, waste and breakage factors applied. This work was completed by Forest Analysis and Inventory Branch and supplied to Forsite for inclusion in the analysis.

4.5 Operational adjustment factors for managed stands

Operational Adjustment Factors (OAF's) were applied in order to adjust potential yields generated by the TIPSY growth and yield model down to net operational volumes. This included reductions for such things as gaps in stands, decay/waste/breakage, and endemic forest health losses.

There were two types of OAF's used in the TIPSY model. OAF 1 is a constant percentage reduction to account for openings in stands, distribution of stems or clumpiness, endemic pests and diseases, and other risks to potential yield. OAF 2 is an increasing percentage reduction that can be applied to account for decay, waste and breakage. OAF 2 is applied after OAF 1 and increases linearly over time from 0 percent at age 0 to the specified percentage at 100 years of age.

Standard operational adjustment factors (OAF) were used to model managed stands. OAF1 was set to 0.85 (15% reduction) and OAF2 was set to 0.95 (5% reduction).

4.6 Deciduous Volume reductions

Deciduous volumes are not currently utilized in the Revelstoke TSA. Thus, deciduous leading stands have been removed from the THLB (see Table 13) and any deciduous volumes in coniferous leading stands have been ignored during the compilation of yield curves. Recently logged blocks (<30 yrs old) with a deciduous leading inventory label were allowed to remain in the analysis because licensees have an obligation to ensure a commercially acceptable crop is regenerated and the coniferous stems are likely to overtop the deciduous stems and form the next crop. Deciduous stems in future managed stands were treated as 'holes' in the stand and are addressed by the application of the OAF1 reduction.

4.7 Natural Stand Volume Projections

Yield tables will be derived for existing natural stands using VDYP 7 Batch by staff from the Ministry of Forest and Range – Forest Analysis and Inventory Branch. A yield table will be generated for each polygon and then provided to Forsite for aggregated into one table for each Analysis Unit (AU) using area weighted averages. The yield tables used during modeling are provided in Appendix 2.

The use of VDYP7 in this analysis has resulted in generally lower site index values and volumes for existing natural stands – especially for Cw stands. One of the primary causes is the use of updated site index curves in VDYP7. This issue will be fully quantified in the analysis report but initial indications are that inventory volumes have dropped by ~5% because of the use of VDYP7.

4.8 Managed Stand Yield Tables

All future managed stand AU's have an associated existing stand AU from which it will inherit stands when they are logged in the model. These future managed stand AU's used the area weighted adjusted site indexes for each AU (Table 27) and the regeneration assumption outlined in this document (Section 5.0). These values were input into Batch TIPSY 4.1d to generate a yield curve for each AU.

Existing managed stand yields were also derived using the adjusted site index (Table 27) and the regeneration assumptions outlined in Section 5.0. Existing managed stands are those that currently under 30 (est. 1979) years of age.

The regeneration assumptions required to model managed stands in TIPSY consist of:

- Species composition (See Section 5.1);
- Initial density (See Section 5.1);
- Regeneration method (See Section 5.1);
- Area-weighted average site index (See Section 5.1);
- Area-weighted genetic gains (See Section 5.4);
- Operational adjustment factors (See Section 4.5); and
- Regeneration delay (See Section 5.3).

Once merchantable stand yields were obtained from TIPSY, yield estimates were further reduced to reflect the area lost to future roads and wildlife tree retention (see section 3.3.18). These 'effective' yield tables were used during modelling and are provided in Appendix 2.

4.9 Existing Timber Volume Check

To verify that no errors were made in natural stand yield table aggregation and that no significant aggregation bias exists, the total volume of the current (starting) inventory using polygon-specific inventory volumes was compared to the volume derived using analysis unit yield tables. The results for existing natural (VDYP7) AU's are shown in Table 30 by AU and in Table 31 by age class.

Table 30. Existing timber volume check

AU	THLB Area (ha)	Volume derived from:		Difference	
		Inventory	Yield tables (AU)*	m^3	%
101	1,354	513,246	508,248	-4,998	-1.0%
102	93	49,554	49,696	143	0.3%
103	4,406	888,436	848,155	-40,281	-4.7%
104	663	227,756	230,810	3,054	1.3%
105	1,123	127,555	115,760	-11,795	-10.2%
106	99	26,556	26,529	-27	-0.1%
107	1,615	142,060	116,195	-25,866	-22.3%
108	172	109,818	114,478	4,660	4.1%
109	531	45,752	43,016	-2,736	-6.4%
110	519	283,318	289,014	5,695	2.0%
111	512	23,738	17,467	-6,270	-35.9%
112	3,618	1,722,638	1,763,900	41,262	2.3%
113	2,116	417,351	365,567	-51,784	-14.2%
114	682	337,717	342,981	5,264	1.5%
115	2,401	289,162	255,788	-33,375	-13.0%
116	4,276	1,746,399	1,759,492	13,093	0.7%
117	308	16,951	16,298	-654	-4.0%
118	1,706	582,021	584,816	2,795	0.5%
119	89	11,593	13,461	1,868	13.9%
120	48	19,981	20,165	183	0.9%
121	349	53,036	48,033	-5,003	-10.4%
122	426	144,877	145,968	1,091	0.7%
123	406	50,475	49,666	-809	-1.6%
124	805	197,212	198,674	1,462	0.7%
125	506	85,666	79,825	-5,841	-7.3%
126	1,490	728,821	764,183	35,361	4.6%
127	710	74,288	50,917	-23,371	-45.9%
128	1,079	423,966	439,690	15,724	3.6%
129	361	38,918	33,883	-5,035	-14.9%
130	2,259	729,863	744,448	14,585	2.0%
All VDYP	**34,722**	**10,108,725**	**10,037,122**	**-71,604**	**-0.7%**

Table 31. Existing timber volume check by Age Class

Age Class	THLB Area (ha)	Volume derived from:		Difference	
		Yield tables (AU)	Inventory	m^3	%
0-20	0	0	0	0	0
21-40	4,063	27,067	47,547	20,480	43.1%
41-60	1,608	71,070	83,247	12,177	14.6%
61-80	2,134	301,628	279,875	-21,753	-7.8%
81-100	3,610	746,550	683,459	-63,091	-9.2%
101-120	3,501	1,041,458	921,692	-119,765	-13.0%
121-140	1,872	590,455	546,459	-43,996	-8.1%
141-250	8,951	3,258,892	3,686,709	427,817	11.6%
250+	8,983	4,071,606	3,788,134	-283,472	-7.5%
All VDYP	**34,722**	**10,108,725**	**10,037,122**	**-71,604**	**-0.7%**

Although there is some differences in the timing of volume growth overall, the volumes being generated from the AU yield tables correlate well with the inventory (<1% difference).

5.0 Silviculture

5.1 Silviculture management regimes

Silviculture systems implemented in the Revelstoke TSA are predominately clearcut and clearcut-with-reserves, with less than 10% of harvest coming from alternate silvicultural systems. The latter consists primarily of primarily patchcut / group selection systems (small openings) and are generally treated as even-aged stands. These alternate silvicultural systems are employed primarily within visual landscapes, UWR, and important caribou habitat areas. Due to the relatively small percentage of alternate systems employed in the TSA, which are generally managed as even-aged, it was deemed too minor to model separately. Even age stand management dominates in the TSA.

5.2 Regeneration Assumptions

After harvest, stands in the TSA follow various silvicultural management regimes depending on originating stand type. This section of the data package summarizes the silvicultural management inputs used in the TIPSY growth and yield model for each managed stand AU. Current practices are reflected in the Future Managed Stand AU's (200 series) found in Table 32, while average historical regeneration practices are reflected in the Existing Managed Stand AU's (500 series) in Table 33. When existing managed stands are harvested, they will move onto an additional set of future managed stand AU's (600 series) that are identical to the 500 series but reflect the genetic gains for future managed stands. Species mixes and regeneration assumptions have been reviewed and updated by MFR Columbia District staff (Barb Wadey) to reflect current regeneration practices.

Table 32. Regeneration and growth and yield assumptions by analysis unit – future managed stands

Existing AU#	Regen AU #	Description	Regen Method	Regen Species and Weighting (%)	Avg. SI	Initial Competing Density* (stems/ha)	OAF's	Regen Delay (yrs)
101/102	201/202	Douglas fir, larch, pine good	Plant $_{100}$	$Fdi_{40}Sx_{20}Lw_{20}Cw_{10}Pw_{10}$	22.1 / 21.3	2000	15/5	2
103/104	203/204	Douglas fir, larch, pine medium	Plant $_{100}$	$Fdi_{40}Sx_{20}Lw_{20}Pw_{15}Cw_{05}$	19.4 / 18	2000	15/5	2
105/106	205/206	Douglas fir, larch, pine fir poor	Plant $_{100}$	$Fdi_{50}Cw_{30}Pw_{20}$	17.9 / 17.6	2000	15/5	2
107/108	207/208	Cedar good	Plant $_{100}$	$Cw_{50}Sx_{30}Fdi_{10}Hw_{10}$	16.2 / 19.5	2000	15/5	2
109/110	209/210	Cedar medium	Plant $_{100}$	$Cw_{50}Sx_{30}Fdi_{10}Hw_{10}$	15.9 / 17	2000	15/5	2
111/112	211/212	Cedar poor	Plant $_{100}$	$Cw_{50}Sx_{30}Fdi_{10}Hw_{10}$	15.5 / 16.3	2000	15/5	2
113/114	213/214	Hemlock good	Plant $_{100}$	$Sx_{40}Cw_{30}Fdi_{20}Hw_{10}$	17 / 18.1	2000	15/5	2
115/116	215/216	Hemlock medium	Plant $_{100}$	$Sx_{40}Cw_{30}Fdi_{20}Hw_{10}$	16 / 15.3	2000	15/5	2
117/118	217/218	Hemlock poor	Plant $_{100}$	$Sx_{40}Fdi_{30}Cw_{20}Hw_{10}$	12.9 / 13.4	2000	15/5	2
119/120	219/220	Balsam, spruce good	Plant $_{100}$	$Sx_{90}Bl_{10}$	17.3 / 18.6	2000	15/5	2
121/122	221/222	Balsam, spruce medium	Plant $_{100}$	$Sx_{90}Bl_{10}$	14.4 / 14.4	2000	15/5	2
123/124	223/224	Balsam, spruce poor	Plant $_{100}$	$Sx_{90}Bl_{10}$	11.5 / 10.6	2000	15/5	2
125/126	225/226	Spruce (mixed) good	Plant $_{100}$	$Sx_{60}Cw_{40}$	19 / 19.5	2000	15/5	2
127/128	227/228	Spruce (mixed) medium	Plant $_{100}$	$Sx_{60}Cw_{30}Fdi_{10}$	18.4 / 16.5	2000	15/5	2
129/130	229/230	Spruce (mixed) poor	Plant $_{100}$	$Sx_{50}Cw_{40}Hw_{10}$	12.9 / 13.7	2000	15/5	2

Table 33. Growth and yield assumptions by analysis unit – existing managed stands

Existing AU#	Regen AU #	Description	Regen Method	Regen Species and Weighting (%)	Avg SI	Initial Competing Density* (stems/ha)	OAF's	Regen Delay (yrs)
501	601	Douglas fir, larch, pine good	Plant $_{100}$	$Fd_{50}Cw_{20}Sx_{20}Lw_{10}$	22.6	2000	15/5	2
502	602	Douglas fir, larch, pine medium	Plant $_{100}$	$Fd_{50}Cw_{20}Sx_{20}Lw_{10}$	20.4	2000	15/5	2
503	603	Douglas fir, larch, pine fir poor	Plant $_{100}$	$Fd_{50}Cw_{20}Sx_{20}Lw_{10}$	18.6	2000	15/5	2
504	604	Cedar good	Plant $_{100}$	$Cw_{40}Sx_{40}Hw_{10}Fd_{10}$	18.1	2000	15/5	2
505	605	Cedar medium	Plant $_{100}$	$Cw_{40}Sx_{40}Hw_{10}Fd_{10}$	16.4	2000	15/5	2
506	606	Cedar poor	Plant $_{100}$	$Cw_{40}Sx_{40}Hw_{10}Fd_{10}$	15.8	2000	15/5	2
507	607	Hemlock good	Plant $_{100}$	$Sx_{30}Cw_{30}Hw_{30}Fd_{10}$	17.1	2000	15/5	2
508	608	Hemlock medium	Plant $_{100}$	$Sx_{30}Cw_{30}Hw_{30}Fd_{10}$	15.4	2000	15/5	2
509	609	Hemlock poor	Plant $_{100}$	$Sx_{30}Cw_{30}Hw_{30}Fd_{10}$	13.9	2000	15/5	2
510	610	Balsam, spruce good	Plant $_{100}$	$Sx_{90}Bl_{10}$	17.6	2000	15/5	2
511	611	Balsam, spruce medium	Plant $_{100}$	$Sx_{80}Bl_{10}Hm_{10}$	14.4	2000	15/5	2
512	612	Balsam, spruce poor	Plant $_{100}$	$Sx_{80}Bl_{10}Hm_{10}$	10.2	2000	15/5	2
513	613	Spruce (mixed) good	Plant $_{100}$	$Sx_{50}Cw_{30}Hw_{10}Fd_{10}$	20.4	2000	15/5	2
514	614	Spruce (mixed) medium	Plant $_{100}$	$Sx_{50}Cw_{30}Hw_{10}Fd_{10}$	18.2	2000	15/5	2
515	615	Spruce (mixed) poor	Plant $_{100}$	$Sx_{50}Cw_{30}Hw_{10}Fd_{10}$	15.3	2000	15/5	2

5.3 Regeneration delay

Regeneration delay is the time between harvesting and when a new stand is established. The delay incorporates both the time taken to establish a stand, and the age of seedling stock planted, if applicable. For this analysis, a regeneration delay was estimated based on local knowledge of the licensees' silviculture staff.

Existing managed stands:

For existing managed stands, regeneration delay was addressed through the use of actual stand age in the forest inventory file. This age represents the actual age of the stand and not the time since harvesting. For example, a stand may have been harvested 15 years ago but the current stand age is 12 – this implies a 3 year regeneration delay. The use of actual ages eliminated the need to estimate an average regeneration delay for these stands.

Future managed Stands:
A regeneration delay of 2 years was estimated based on the local knowledge of the licensees' silviculture staff. Regeneration delays for future managed stands were input into TISPY and are therefore embedded in the published yield curves.

5.4 Gene resources — use of select seed

Where it is available, licensees use select seed for regeneration purposes because of its superior volume production. This section describes the yield adjustments used to account for the use of select seed (i.e., orchard & superior provenance seed with a known genetic gain as measured by Genetic Worth [GW]).

Historical use of select seed was obtained from the Ministry of Forests Seed Planning & Registry system (SPAR) and the Reporting Silviculture Updates and Landstatus Tracking System (RESULTS), as provided by M. LeRoy (2009) and B. Wadey (2009). This information was used to derive estimates of net genetic gain (Net GW) at the species level for species planted from 1980 to 2007. Table 34 illustrates the weighted average GW for each species [A], the percent improved (class A and B) seed use for each species in the TSA [B], and the

estimated Net GW for each species [C]. The Net GW was calculated by multiplying [A] x [B] and is graphed in Figure 5.

Table 34. Calculation of net genetic worth of species planted over the last 27 years

	Wt Avg* GW by Species (Class A) [A]			% Class A of Total Seedlings Planted [B]			Net GW by Species [C]		
Year	**Lw**	**Sx**		**Lw**	**Sx**		**Lw**	**Sx**	
1980	0.0%	0.0%		0.0%	0.0%		0.0%	0.0%	
1981	0.0%	0.0%		0.0%	0.0%		0.0%	0.0%	
1982	0.0%	0.0%		0.0%	0.0%		0.0%	0.0%	
1983	0.0%	0.0%		0.0%	0.0%		0.0%	0.0%	
1984	0.0%	0.0%		0.0%	0.0%		0.0%	0.0%	
1985	0.0%	0.0%		0.0%	0.0%		0.0%	0.0%	
1986	0.0%	0.0%		0.0%	0.0%		0.0%	0.0%	
1987	0.0%	0.0%		0.0%	0.0%		0.0%	0.0%	
1988	0.0%	0.0%		0.0%	0.0%		0.0%	0.0%	
1989	0.0%	0.0%		0.0%	0.0%		0.0%	0.0%	
1990	0.0%	0.0%		0.0%	0.0%		0.0%	0.0%	
1991	0.0%	0.0%		0.0%	0.0%		0.0%	0.0%	
1992	0.0%	0.0%		0.0%	0.0%		0.0%	0.0%	
1993	0.0%	2.0%		0.0%	2.3%		0.0%	0.0%	
1994	0.0%	8.0%		0.0%	18.0%		0.0%	1.4%	
1995	0.0%	6.0%		0.0%	13.1%		0.0%	0.8%	
1996	0.0%	9.0%		82.6%	43.0%		0.0%	3.9%	
1997	0.0%	8.0%		82.6%	57.6%		0.0%	4.6%	
1998	0.0%	10.0%		82.6%	57.6%		0.0%	5.8%	
1999	0.0%	13.0%		82.6%	57.6%		0.0%	7.5%	
2000	0.0%	17.0%		82.6%	57.6%		0.0%	9.8%	
2001	4.0%	10.0%		82.6%	57.6%		3.3%	5.8%	
2002	9.0%	5.0%		82.6%	57.6%		7.4%	2.9%	
2003	9.0%	5.0%		82.6%	57.6%		7.4%	2.9%	
2004	13.0%	8.0%		82.6%	57.6%		10.7%	4.6%	
2005	21.0%	9.0%		82.6%	57.6%		17.3%	5.2%	
2006	21.0%	10.0%		82.6%	57.6%		17.3%	5.8%	
2007	16.0%	8.0%		82.6%	57.6%		13.2%	4.6%	
11 yr Avg	8.5%	9.4%		82.6%	57.6%		7.0%	5.4%	
28 yr Avg	3.3%	4.6%		32.5%	25.4%		**2.7%**	**2.3%**	

* Weighted average is based on the amount of seed requested from each class “A” SPU occurring in the TSA and its genetic worth (SeedMap Genetic Gain: Report 1 – Genetic Gain of Seedlings Requested by Species and SPZ.) provided by Matthew LeRoy, 2008

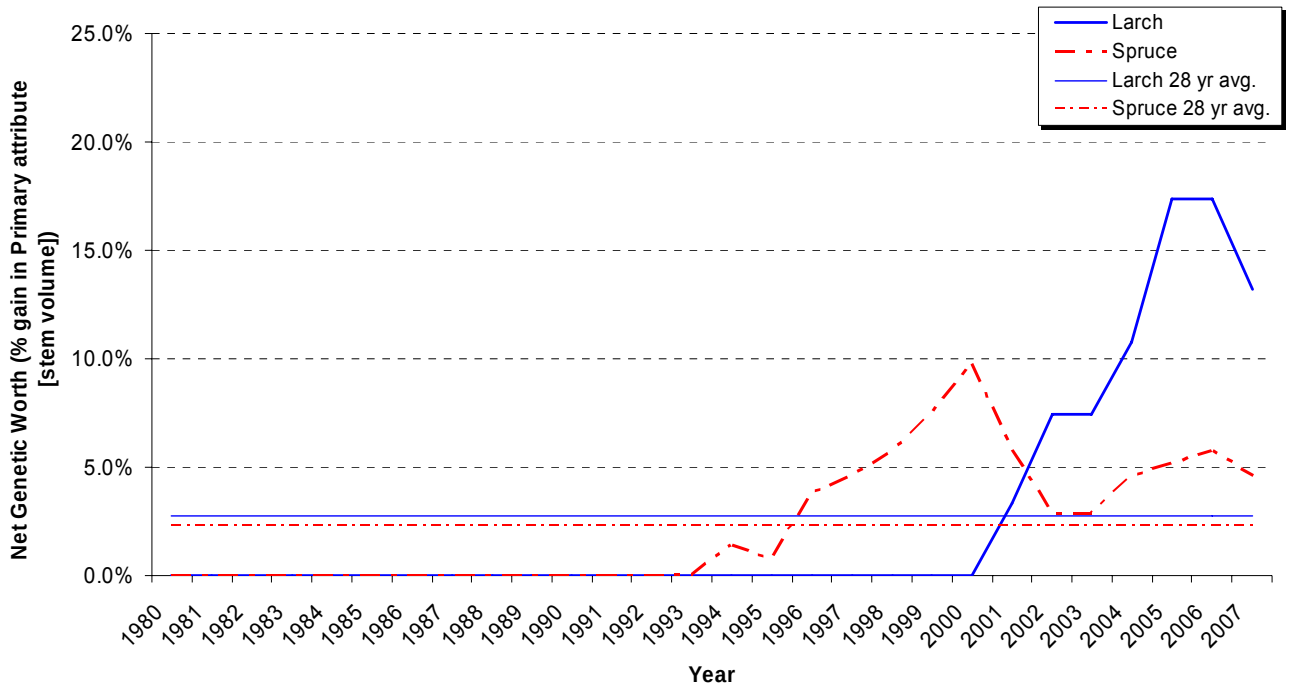


Figure 5. Net Genetic Worth for All Seedlings by Species - Revelstoke TSA

The 28 year average gains shown are suitable for use in generating existing managed stand yields as they reflect a prorated gain associated with 18 years of planting seedlings with no gains followed by 10 years of planting with gains. Genetic gains of 2.7% will be applied to Lw, and 2.1% to Sx. Other species with genetic gains have been planted on the TSA however, they have been planted in such low amounts that it was not worth including.

Seed planning units (SPU's) are polygon features that geographically delineate the appropriate area of seedling use for stock originating from specific seed orchards throughout the province. Each SPU identifies the area and elevation range in which seedlings of a given orchard may be used in regeneration. The SPU's relevant in the Revelstoke TSA are shown in Table 35. Estimates of future genetic worth and seedling availability are provided at the SPU level in Table 36.

Table 35. Seed Planning Units (2008) within the Revelstoke TSA (Class A seed)

Species	Genetic Class "A" Seed Planning Zone	Elevation Band
Interior Douglas-fir	Nelson Low	400-1000
Interior Douglas-fir	Nelson High	1000-1600
Western Larch	Nelson High	700-1400
Spruce	Nelson Mid	1000-1500
Spruce	Nelson High	1500-1900

Table 36. Seed Planning Units (Class A Seed) genetic worth and seed availability

SPU	THLB Area (ha)*	Percent of Total THLB	Genetic Worth Achieved (2008 SPAR)	Percent Class A Seedlings (2008 SPAR)	Planned GW for 2009	Planned Class A Seed Availability for 2009	Projected Future Genetic Worth % (2019)	Projected Class A Seed Availability (2019)
#21 Fdi NE low	21,706	41.5%	27%	43.8%	25%	34.8%	25%	100%
#22 Fdi NE high	27,904	53.3%			29%	28.1%	32%	100%
#37 Fdi QL low	4,103	7.8%			25%	55.5%	28%	100%
#13 Lw NE low	9,317	17.8%	N/A	0%	28%	100%	32%	100%
#44 Sx NE low	13,406	25.6%	6%	100%	20%	100%	26%	100%
# 4 Sx NE mid	40,333	77.0%			11%	100%	15%	100%
# 5 Sx NE high	4,164	8.0%			12%	100%	15%	100%

*The sum of this column is greater than the total THLB area because of overlaps that occur for SPU's of different species.

Table 37. Calculation of net genetic worth by species for future managed stands in Revelstoke

Year	Wtd. Avg GW by Species (Class A) [A]			Anticipated % Class A Available [B]			Net GW by Species [C]		
	Fdi	Lw	Sx	Fdi	Lw	Sx	Fdi	Lw	Sx
2009	27.1%	28.0%	13.2%	32.9%	100%	100%	8.9%	28.0%	13.2%
2019	28.9%	32.0%	17.5%	100%	100%	100%	28.9%	32.0%	17.5%

The application of this data in the timber supply model is summarized in Table 38, and is included in Table 32 and Table 33 for existing and future managed AU, respectively.

Table 38. Net genetic worth by species to be applied in timber supply model

Time Horizon in Model (decades)	Species	2009 Genetic Gains applied in TIPSY for Base Case		2019 Genetic Gains applied in TIPSY for Sensitivity Analysis	
		Existing Managed Stands	Future Managed Stands	Existing Managed Stands	Future Managed Stands
1-25	Fd	0%	8.9	0%	28.9
1-25	Lw	2.7%	28.0	2.7%	32.0
1-25	Sx	2.3%	13.2	2.3%	17.5

In summary, the 28-year historical average from Table 33 will be applied when modeling existing managed stands because this best corresponds with the criteria used to define these stands. When generating the AU yields in TIPSY for these stands, larch will have a 2.7% GW applied while spruce will have a 2.1% GW applied. These values are lower than those applied to future managed stands because the GW realized on present day stock is watered down by historical use of stock with no genetic gain. Future managed stands will have the 2009 Net GW's for Fdi (8.9%), Lw (28.0%), and Sx (13.2%) used in the Base Case.

No adjustment of genetic gains is scheduled during the planning horizon.

A sensitivity analysis is planned to explore the implication of applying forecasted 2019 GW's based on projected orchard gains and projected seed availability (orchard production) for Fd, Lw, and Sx. The projected Net GW for each species will be based on the values shown in Table 38 (prorated by THLB area) and will consider select seed availability as projected in the SPU timelines provided by Tree Improvement Branch. Genetic gains associated with existing managed stands will be unchanged in the sensitivity analysis.

Genetic gains will be incorporated into the growth and yield curves through TIPSY model functionality. When a species identified in Table 38 is included in a managed stand AU, its associated Net GW will be input into TIPSY. This Net GW reflects the genetic gain associated with all seedlings of a given species planted in a typical year. Where surrogate species are used in TIPSY, the GW employed is prorated to reflect the relative GW's of the original species (Sx used for Bl but Sx Gw not applied to Bl proportion).

5.5 Silviculture history (defining existing managed stands)

As discussed in the Analysis Units section above, existing managed stands are defined as those stands regenerated from 1980 forward (currently ≤ 30 yrs old). The 1980 date corresponds with the time period where silvicultural management regimes were regularly utilized in the TSA or management regimes were applied to clean up earlier harvesting (Industry outstanding stands were addressed).

5.6 Backlog and current not satisfactorily restocked areas (NSR)

Backlog NSR is any area not yet fully stocked that was denuded prior to 1987 when basic silviculture became the obligation of licensees. Not satisfactorily restocked (NSR) areas were determined using RESULTS data. NSR areas include both old burns and past harvesting. Current NSR (779 ha) and backlog NSR (412 ha) is summarized in Table 39.

Table 39. Backlog and Current NSR

NSR Type	Total Area (ha)	Netdown Area (ha)
Current NSR	779	0
Backlog NSR	412	412
Totals	1190	412

Backlog NSR was discussed with District silviculture and planning staff. To account for the full breath of these lower productivity sites currently on the landbase (backlog NSR, previously NSR but accepted at lower stocking, and impeded stands), these stands were taken out of the land base as a land base netdown (Section 3.3.13). Current NSR was assigned to standard analysis units and any delay in restocking these sites was reflected in the regeneration delays assigned to these analysis units. These sites have either been reforested but are not yet confirmed in the inventory file, or will be reforested because licencees are under legal obligation to do so.

6.0 Timber harvesting

6.1 Minimum harvestable age / merchantability standards

In order for a stand within the timber supply model to be considered for harvesting, it must achieve a minimum harvest age that ensures it meets reasonable economic criteria and emulates what is generally current practice by forest licensees. Note that these are minimum criteria, not the actual ages at which stands are forecast for harvest. Some stands may be harvested at the minimum thresholds to meet forest-level objectives while other stands may be not be harvested until well past their "optimal" timber production ages due to management objectives for other resource values such as requirements for the retention of older forest, or ungulate winter range.

For this analysis, minimum harvestable ages will be defined by the following economic criteria:

Existing Natural Stands:

- minimum volume per hectare (200 m³/ha for Hw and Cw, 150 m³/ha for all other species), and
- the age at which 95% of the culmination of the mean annual increment (CMAI) is achieved.

Existing Managed and Future Managed Stands:

- minimum volume per hectare (200 m³/ha for Hw and Cw, 150 m³/ha for all other species), and
- minimum piece size (25 cm mean prime DBH [250 largest trees]), and
- the age at which 95% of the culmination of the mean annual increment (CMAI) is achieved.

The minimum harvest age to be utilized for each analysis unit is defined in Table 40. For a detailed description of all analysis unit definitions, see Table 27.

Table 40. Minimum harvest ages

Analysis unit (AU)	AU #	Minimum harvest age (years)		Age to achieve min volume (yrs)		Age to achieve min diameter (yrs)		Age to 95% of Maximum MAI (yrs)	
		Natural	Managed	Natural	Managed	Natural	Managed	Natural	Managed
Natural Stands and Associated Future Managed Stands									
Fir Larch Pine – Good <141	101, 201	**89**	**65**	56	42	N/A	42	89	65
Fir Larch Pine – Good +141	102, 202	**85**	**65**	56	42	N/A	43	85	65
Fir Larch Pine – Medium <141	103, 203	**101**	**75**	86	51	N/A	51	101	75
Fir Larch Pine – Medium +141	104, 204	**106**	**83**	86	59	N/A	59	106	83
Fir Larch Pine – Poor <141	105, 205	**115**	**89**	115	56	N/A	57	114	89
Fir Larch Pine – Poor +141	106, 206	**119**	**88**	106	55	N/A	55	119	88
Cedar – Good <141	107, 207	**87**	**81**	76	57	N/A	52	87	81
Cedar – Good +141	108, 208	**82**	**76**	57	52	N/A	47	82	76
Cedar – Medium <141	109, 209	**103**	**86**	86	60	N/A	55	103	86
Cedar – Medium +141	110, 210	**100**	**82**	77	57	N/A	52	100	82
Cedar – Poor <141	111, 211	**135**	**86**	135	60	N/A	54	120	86
Cedar – Poor +141	112, 212	**124**	**87**	97	61	N/A	55	124	87
Hemlock – Good <141	113, 213	**83**	**78**	76	58	N/A	52	83	78
Hemlock – Good +141	114, 214	**84**	**76**	67	56	N/A	50	84	76
Hemlock – Medium <141	115, 215	**112**	**83**	106	62	N/A	56	112	83
Hemlock – Medium +141	116, 216	**109**	**88**	86	67	N/A	59	109	88
Hemlock – Poor <141	117, 217	**175**	**92**	175	74	N/A	66	141	92
Hemlock – Poor +141	118, 218	**133**	**100**	116	81	N/A	72	133	100
Balsam Spruce – Good <141	119, 219	**85**	**70**	66	51	N/A	48	85	70
Balsam Spruce – Good +141	120, 220	**84**	**72**	66	52	N/A	49	84	72
Balsam Spruce – Medium <141	121, 221	**106**	**88**	86	64	N/A	60	106	88
Balsam Spruce – Medium +141	122, 222	**105**	**92**	86	67	N/A	63	105	92
Balsam Spruce – Poor <141	123, 223	**125**	**113**	115	82	N/A	77	125	113

		Minimum harvest age (years)		Age to achieve min volume (yrs)		Age to achieve min diameter (yrs)		Age to 95% of Maximum MAI (yrs)	
Balsam Spruce – Poor +141	124, 224	**133**	**127**	115	93	N/A	87	133	127
Spruce Mix – Good <141	125, 225	**85**	**67**	66	45	N/A	44	85	67
Spruce Mix – Good +141	126, 226	**78**	**63**	57	41	N/A	41	78	63
Spruce Mix – Medium <141	127, 227	**112**	**67**	95	46	N/A	46	112	67
Spruce Mix – Medium +141	128, 228	**99**	**74**	76	51	N/A	50	99	74
Spruce Mix – Poor <141	129, 229	**129**	**99**	115	67	N/A	66	129	99
Spruce Mix – Poor +141	130, 230	**126**	**102**	96	69	N/A	68	126	102
Existing Managed Stands and Associated Future Managed Stands									
Fir Larch Pine – Good	501, 601	**68**	**65**	44	41	44	42	68	65
Fir Larch Pine – Med	502, 602	**74**	**69**	48	45	48	45	74	69
Fir Larch Pine – Poor	503, 603	**81**	**77**	55	52	55	52	81	77
Cedar – Good	504, 604	**78**	**75**	56	54	50	49	78	75
Cedar – Med	505, 605	**87**	**84**	63	61	56	55	87	84
Cedar – Poor	506, 606	**88**	**85**	64	62	57	56	88	85
Hemlock – Good	507, 607	**80**	**78**	58	56	52	51	80	78
Hemlock – Med	508, 608	**92**	**89**	67	66	60	59	92	89
Hemlock – Poor	509, 609	**107**	**104**	80	79	71	70	107	104
Balsam – Good	510, 610	**76**	**70**	55	51	52	49	76	70
Balsam – Med	511, 611	**98**	**93**	69	66	66	63	98	93
Balsam – Poor	512, 612	**140**	**134**	100	97	95	91	140	134
Spruce Mix – Good	513, 613	**67**	**64**	44	42	43	42	67	64
Spruce Mix – Med	514, 614	**76**	**73**	51	49	50	48	76	73
Spruce Mix – Poor	515, 615	**91**	**87**	62	60	61	59	91	87

6.2 Initial harvest rate

The base case harvest forecast will use the following initial harvest rates in the forecast.
Initial Harvest: Current AAC (230,000 m^3/yr) + Unsalvaged losses (6,550 m^3/yr) = 236,550 m^3/yr.

6.3 Harvest Priorities

Stands within currently planned cutting permits were given first priority for the first decade of the analysis horizon. The remaining stands were harvested according to an oldest first harvest priority for the entire planning horizon.

7.0 Natural Forest Disturbance

It is inevitable that natural disturbances will occur within the forests of the Revelstoke TSA and the implications of these disturbances on forest age classes and volumes are recognized in the timber supply analysis process. Natural disturbances are events caused by factors such as wildfire, wind, snow press, insects, disease and other forest health considerations. Two approaches to addressing these issues are used during modeling; one on the THLB and one on the remainder of the forested area of the TSA.

7.1 Unsalvaged Losses on the THLB

The purpose of this section is to quantify the average annual volume of timber that, in the future, will be damaged or killed on the THLB and not salvaged or accounted for by other factors. This factor is meant to capture catastrophic natural events like the fires that occurred in the Revelstoke TSA in 2003. Endemic pest losses are dealt with through factors applied in the growth and yield models as noted below:

TIPSY: Operational Adjustment Factors reduces gross volumes to account for losses toward maturity such as decay, and endemic forest health issues like minor infestations.
VDYP: The model predicts actual average yields from appropriate inventory ground plots. Endemic losses are inherently recognized in the model data.

The annual unsalvaged losses determined in TSR3 are still considered valid and were used in this analysis with the exception of losses related to fires and broadcast burning. Subsequent to the completion of the TSR3 analysis, district staff reviewed the unsalvaged losses for fires and felt that unsalvaged losses attributable to fires should be 2,500 m³/yr greater. Therefore, these additional losses were included in this analysis. Additionally, broadcast burning for site preparation is no longer used as extensively as in the past (only 146 ha in the past 5 years) so it was felt that NRL's associated with this factor are no longer relevant and were not applied.

Unsalvaged losses in TSR3 were applicable to the THLB area at that time. Since then, several factors have changed that have resulted in a smaller THLB. To account for this change, the TSR3 NRL values were proportionally reduced as follows:

TSR4 NRL (m³/yr) =

TSR4 Effective THLB Area (52,358 ha) * Adjusted TSR3 NRL (9,760 m³/yr) / TSR3 THLB (78,018 ha)

Expected non-recoverable losses for TSR4 are summarized in Table 41. This volume was added to the annual harvest target in order to remove this volume from the land base and cause an appropriate amount of stand area to have its age set to zero. The unsalvaged loss volumes will not be included in reported harvest levels for the TSA.

Table 41. Unsalvaged losses

Description	TSR3 Unsalvaged Loss (hectares/year)	TSR3 Average Volume (m³/ha)	TSR3 Annual unsalvaged volume in the THLB (m³/year)	TSR4 Adjusted Unsalvaged Losses
Wildfires	42.1	209	8800*	5,906
Total Fire	42.1	209	8800	**5,906**
Hemlock Looper	1.5	300	450	302
Spruce Bark Beetle	0	0		0
Douglas-fir bark beetle	0.6	350	210	141
Total Pest / Insects	2.1	650	660	**443**
Windthrow / Blowdown	0.7	328	230	154
Avalanche	0.2	350	70	47
Total Loss	**45**	**1,537**	**9,760**	**6,550**

* TSR3 value of 6,300 m³/yr + 2,500 m³/yr added in Chief Foresters 2005 AAC rationale.

7.2 Disturbance in the non-THLB

As forested stands in the non-THLB contribute toward several forest cover objectives (i.e., landscape level biodiversity, visuals, etc.), it is important that the age class distributions in these stands remain consistent with natural processes. By implementing disturbance in these stands, a natural age class distribution can be maintained in the model and a realistic contribution toward seral goals ensured.

A constant area was disturbed annually in each LU/NDT combination. The amount of disturbance in each LU/NDT combination was based on the BEC variants present and their associated natural disturbance intervals and old seral definitions as outlined in the *Biodiversity Guidebook* (September 1995) and Table 42 below.

Table 42. Calculation of area to be disturbed annually in forested non-THLB by LU/NDT

BEC	NDT	Disturbance Interval (yrs)	"OLD" Defn (yrs)	% Area > OLD*	Effective Rotation Age (yrs)*	Contributing Non-THLB Area (ha)	Annual Area Disturbed (ha) (area/rot age)
ESSF	1	350	250	49%	490	103,666	212
ICH	1	250	250	37%	395	62,844	159
ICH	2	200	250	29%	350	11,804	34
					Total	**178,315**	**405**

* % area old = exp (-[old age / disturbance interval]), Effective rotation age = old age / (1 – % area old)

Using the negative exponential equation, the proportion of the forest that would typically occur as old seral forest can be calculated based on the disturbance interval (% area old = exp(-[old age / interval]). Using this % area in old, the calculation of an effective rotation age associated with this seral distribution was possible (Effective rotation age = old age / (1 – proportion old)). The effective rotation age can then be used to define an annual area of disturbance. For example, ICH variants in NDT2 have a disturbance interval of 200 yrs and an old definition of 250 yrs. This translates into a typical age class distribution where 29% of the area is "old" (>250 yrs) and the oldest stands are around 350 years old. Thus $1/350^{h}$ of the area needs to be disturbed each year to maintain this age class distribution.
The base case includes annual disturbance of the contributing Non-THLB area in each LU/NDT. The area target was achieved by randomly selecting stands (without replacement) to be disturbed in each period and then hardwiring this into the model. Stands of all ages had equal opportunity to be disturbed.

This method is a simplification of Option 4 in *Modeling Options for Disturbance Outside the THLB - Working Paper* (MoF, June 2003). Modeling of disturbance at the LU/BEC variant level was simplified to the LU/NDT level in order to minimize the number of modeled zones while ensuring that each zone would have a single, old seral age. No minimum amount of old was implemented because disturbance was selected randomly - independent of modeled harvest priority.

The disturbance is implemented in the model using a random uniform probability. Each NDT is 'turned over' once during a period equal to its effective rotation age and then once again over the next effective rotation age, etc. There is no guarantee that any particular portion of the landbase will actually be disturbed in any one year. Across the NCLB, approximately 440 ha is disturbed each year (0.23%), resulting in an average 'turning over' of the landbase every ~ 447 years (range is 350 to 490 years).

8.0 Integrated Resource Management

This section of the document describes the range of timber and non-timber management objectives that occur within the Revelstoke TSA and how they will be addressed in the timber supply model. The most common method of inclusion is through the application of forest cover requirements.

Forest cover requirements can:

- Limit disturbance in an area by limiting the amount of forest that can be younger than a specific age (or shorter than a specific height);
- Maintain specific stand types on the land base by ensuring that at least a specified amount of forest older than a specific age (or taller than a certain height) is retained at all times;

Forest cover requirements from several different resource objectives can occur in a common area and result in overlapping constraints within the TSA (e.g. visual constraints inside a community watershed). Each requirement is evaluated independently to ensure that the harvesting of a specific stand does not violate any forest cover requirements.[4]

A summary of all non-timber management issues and modeling approaches is provided in Table 43 and Figure 6 below. Detail on each can be found in either the netdown section of this document (Section 3.3) or in the remainder of this section.

Table 43. Summary of Management Issues and Modelling Assumptions

Resource Issue	Modeling Approach	CFLB Area (ha)	THLB Area (ha)
Green-up /Adjacency	Maximum of 25% < 2m tall. Applied to the CFLB below the operability line within each LU.	90,656	57,404
Visuals	Maximum disturbance limit defined by VQO and VAC. VEG height defined by avg slope of VQO polygon. Modeled as a disturbance limit (i.e. max 15% < 6m tall) on the CFLB portion of each VQO polygon.	40,257	16,222
Community Watersheds	Applied as a spatial netdown - see Section 3.3.9.	4,449	N/A
Mountain Caribou Habitat	GAR (UWR U-3-005) reserves applied as a Spatial Netdown – see Section 3.3.14	66,098	N/A
Mule Deer	Minimum of 40% ≥101 yrs old depending on BEC Subzones and maximum of 40% <21 years old at any time. To be met within the CFLB of the mapped habitat areas in each MU as per GAR U-4-001	4,755	2,343
Moose	Minimum of 20% ≥61 years and maximum of 40% <21 years old at any time as per GAR U-4-001.	999	752
Ungulate Forage Area	Minimum of 10% ≥81 years old at any time as per GAR U-4-001. To be met on the CFLB portion of the identified area.	243	123
Identified Wildlife	Applied as a spatial netdown – see Section 3.3.11 (WHA's)	6	N/A
Landscape Level Biodiversity	Spatial Old Growth Management Areas (OGMA's) and Mature + Old Management Area (MOGMA's) applied as a spatial netdown for the first 80 years. From 80 years onward applied as forest cover constraints based on requirements set out in Revelstoke HLPO.	48,272	5,549
Stand Level Biodiversity – Wildlife trees and wildlife tree patches	Current and planned Wildlife tree patches applied as a spatial Netdown (see Section 3.3.16). Future WTP's applied as a yield curve reduction (See Section 3.3.18.1).	690	215

[4] Where a minimum amount of forest is required and does not exist, some harvesting may still occur if there are any stands old enough for harvest once the oldest available stands have been set aside to meet the objective.

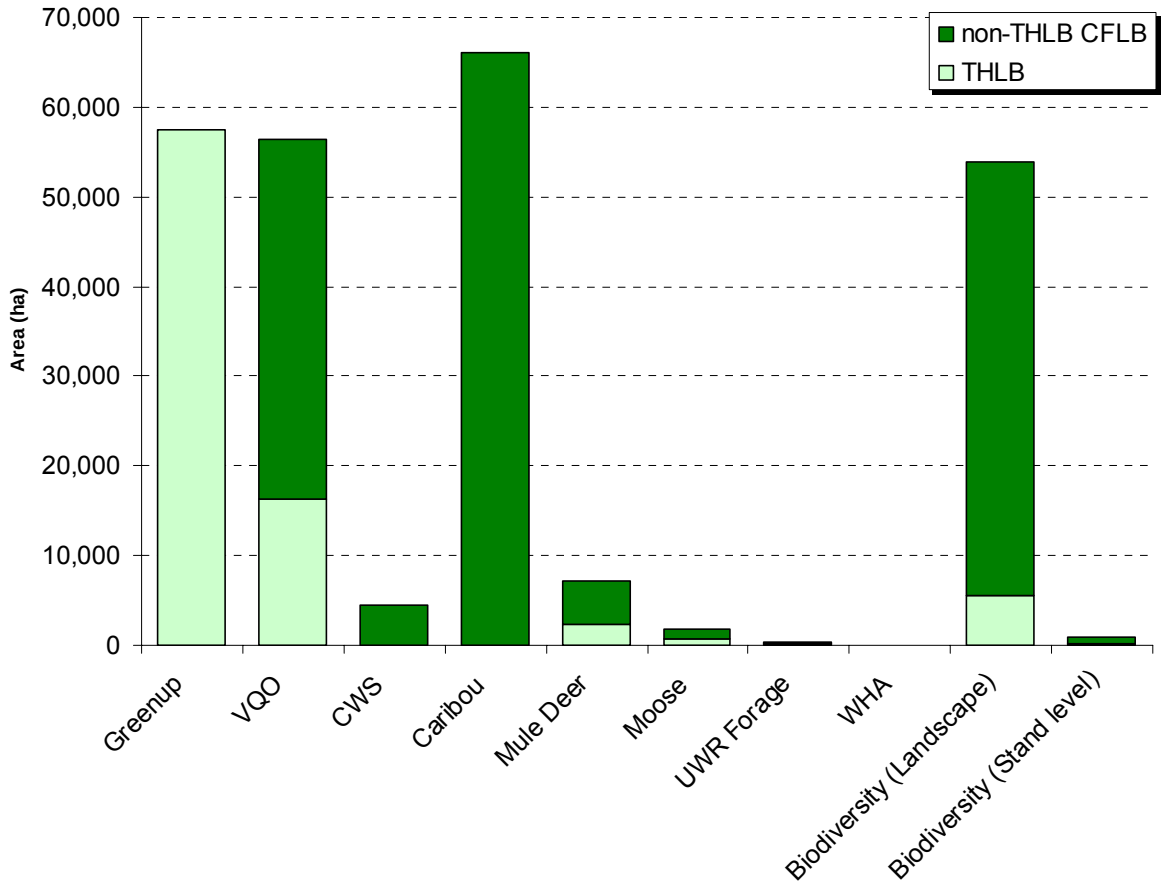


Figure 6. Summary of Management issues by land base classification

8.1 Green-up/adjacency

Green-up requirements specify that a logged block must achieve a specific condition called green-up before adjacent areas can be logged. Green-up refers to the average height of the regenerating forest reaching a specified target. Green-up requirements can often be waived if licensees manage for patch size distributions consistent with biodiversity objectives as described in the Landscape Unit Planning Guide (MoF/MoE 1999). Modeling of green-up requirements was done using forest level objectives, as opposed to block specific objectives, because this was consistent with the operational flexibility afforded by patch size management.

The amount of THLB area less than 2m in height was limited to 25% within each landscape unit (refer to Table 44). This is consistent with the objective applied in TSR 3.

Table 44. Green-up requirements

Management Zone	Green-up Requirement	Modeled Green-up Constraint	Area to which it applies
All TSA THLB	2 m tall trees	Max 25% < 2m in each LU	THLB area within each LU

A document[5] produced in 2000, compared actual silviculture data on the age to greenup heights to those produced by Site Tools for several regions of British Columbia. This data is considered to be a more accurate reflection of the actual age to green-up and has been recommended to be used in Timber Supply projects over the Site Tools method.

[5] B.C. Ministry of Forests. 2000. Age to Green-up Height: Using Regeneration Survey Data by Region, Species and Site Index. Available at:: http://www.for.gov.bc.ca/hre/pubs/docs/age-to-greenup.pdf

Using the Nelson Region species specific estimates from the report, green up ages were localized to the Revelstoke TSA using the planted species proportions over the past 5 years (2003-2007) and pro-rating the greenup age (Table 45). The document provides age to green-up heights from establishment and planted stock typically one year old so a net regeneration delay of one year was added to the greenup agesyr delay -1 yr old stock =1 year effective delay). The pro-rated result is a 13 Greenup age.

Table 45. Proration of Age to Green-up heights for Green-up Ages Sensitivity.

	[A]	[B]	[C]	[D] ([B]+[C])	[E] ([A]*[D])
SPECIES	**5 year Historical proportion planted (2003-2007)**	**Age to greenup***	**Net Regeneration delay**	**Total Age to Greenup**	**Pro-rated green up age**
BL	2.0	14	2	16	0.3
Cw	32.0	10	2	12	3.5
Fdi	12.0	11	2	13	1.4
Hw	2.0	9	2	11	0.2
Lw	2.0	9	2	11	0.2
Sx	50.0	12	2	14	6.5
	100				**13**

*Based on *Age to Green-up height: Using Regeneration data by Region, Species, and Site Index*. Nelson Region tables using SI=18 (Average Revelstoke TSA managed SI=18.5) + 1 year for net regeneration delay

8.2 Visual resources

The District Manger of the Columbia Forest District established new Visual Quality Objectives (VQO's) for the Revelstoke TSA with a letter to licensees on January 31, 2007 (GAR s.7) in addition to those established on October 23, 2000 (GAR s.17). Forest cover requirements aimed at meeting these objectives will be applied so that the amount of younger stands that can occur in visually sensitive areas is limited.

There are 175 VQO polygons within the Revelstoke TSA CFLB (341 in total) with some having as little as 0.2 ha and as much as 2009 ha of CFLB area. The average CFLB area with each polygon is 230 ha. All VQO polygons had maximum planimetric percent disturbance values assigned based on VQO class and visual absorption capability (VAC).

Table 46. Visually sensitive areas: Maximum planimetric disturbance %'s

VQO	**Visual Absorption Capability**								
	Low			**Mod**			**High**		
	Max. Planimetric Disturbance	**CFLB Area (ha)**	**THLB Area (ha)**	**Max. Planimetric Disturbance**	**CFLB Area (ha**	**THLB Area (ha)**	**Max. Planimetric Disturbance**	**CFLB Area (ha)**	**THLB Area (ha)**
Preservation	0%	0	0	0.5%	0	0	1%	0	0
Retention	1%	828	73	3%	3,065	201	5%	1,298	598
Partial Retention	5%	2,177	662	10%	12,102	3,892	15%	1,967	810
Modification	15%	2,441	1,210	20%	15,949	8,646	25%	430	129
Total		**5,446**	**1,945**		**31,116**	**12,739**		**3,695**	**1,537**

Each VQO polygon had the area weighted average slope calculated and an associated "visually effective green-up" (VEG) height calculated according to Table 47; extracted from *Procedures for Factoring Visual Resources into Timber Supply Analyses (MFR 1998)*.

Table 47. Tree heights required for meeting visually effective green-up by percent slope

	Slope Class (%)											
	0-5	6-10	11-15	16-20	21-25	26-30	31-35	36-45	46-50	51-55	56-60	60+
Tree Height (m)	3.0	3.5	4.0	4.5	5.0	5.5	6.0	6.5	7.0	7.5	8.3	8.5

1. Each VQO polygon will have the resulting forest cover objective applied to its crown forested area in the model. For example, a VQO of Retention with a VAC of High and an average slope of 32% would have the following objective: No more than 5% of the crown forested area in the VQO polygon can be less than 6m tall.

The visually effective green-up heights for each polygon were translated into green-up ages for use during modeling. Age to green-up was calculated in SiteTools (v3.3) using a weighted average stand type for each VQO. A comparison of the SiteTools method and the results of the "Age to Green-up Height" report referenced in Section 8.1 showed that greenup ages from the report were approximately 5 less than the SiteTools method for deriving greenup ages. Therefore, all the derived VEG ages from SiteTools were reduced by 4 years.

8.3 Community Watersheds

Community watersheds are watersheds that supply communities with domestic water. Within the Revelstoke TSA there are 4 designated community watersheds: Hamilton, Greeley, Bridge, and Dolan Creek. Licencees have avoided and continue to avoid these areas were therefore completely excluded from the timber harvesting land base. See Section 3.3.9 for more information.

8.4 Wildlife

8.4.1 Mountain Caribou

Spatial reserves to protect mountain caribou (*Rangifer tarandus caribou*) habitat have been established (GAR Order #U-3-005) and have been in effect since February 12, 2009. Mountain caribou guidelines were amended out of the Revelstoke Higher Level Plan to avoid conflicts with the GAR order. These reserves were completely removed from the timber harvesting land base. See Section 3.3.14 for more information.

8.4.2 Grizzly Bear

The Revelstoke Higher Level Plan requires management for grizzly bear through the retention of forest cover adjacent to high value habitat (avalanche chutes). These 50 m buffers on one side of key avalanche chutes have not been explicitly modeled here because the high value habitat areas have not been identified spatially and the impact of these areas is meant to be captured in the old and mature seral retention impacts.

8.4.3 Ungulate winter range – Mule Deer and Moose

In February 2007, an ungulate winter range GAR order was introduced that set general wildlife measures for Mule Deer, and Moose in the Revelstoke TSA (U-4-001). Since these cover requirements reflect current management of UWR in this TSA, they were applied on the CFLB portion of each MU as cover constraints in the model. See Table 48 for details.

Table 48. UWR Cover requirements (GAR #U-4-001) UWR forest cover requirements

UWR Attribute	Species	BEC Subzones	Forest cover objective*
Snow interception Cover	Mule Deer	ICHmw	Min. 40% ≥ 101 yrs in the CFLB of each MU
	Moose	All Subzones	Min. 20% ≥ 61 yrs in the CFLB of each MU
Forage Area	Both Species	All Subzones	Min. 10% ≥ 81 yrs in the CFLB
Forest Cover	Both Species	All Subzones	Max. 40% <21 yrs in the CFLB of each MU

* Order also specifies requirements for evergreen crown closure. However, it is not feasible to assess crown closure as part of constraints in the model so it was ignored for the purpose of this analysis.

8.4.4 Identified Wildlife

The provincial *Identified Wildlife Management Strategy* provides for the creation of wildlife habitat areas (WHAs), to protect key habitat features of listed wildlife species. Since the last TSR, five data sensitive WHAs have been spatially established within the Revelstoke TSA, all of which were removed from the THLB (see Section 3.3.11).

8.5 Biodiversity

Biodiversity is managed at both landscape and stand levels. The primary mechanism for landscape-level management is retention of old and mature seral forest. Stand-level biodiversity is protected through retention of wildlife trees and wildlife patches. The following sections outline how retention of old and mature forest and wildlife trees/patches will be modeled.

8.5.1 Landscape-level biodiversity

Part 1, Section 1 and 2 of the Revelstoke Higher Level Plan Order (March 2005) specify the amount of old and mature forest that must be maintained within each BEC variant inside each Landscape Unit (LU). The requirement must be met independently above and below the operability line, so only the operable portion has been modeled here as it is the only area influenced by forest management. The RHLPO does not indicate the

vintage for the operability line to be used for old seral requirements therefore, the most recent operability will be used (December 2008). Landscape Units have been legally established along with Biodiversity Emphasis Option (BEO) assignments that guide the target level of old/mature forest in each BEC variant. The achievement of the old seral retention targets will be accomplished by using spatial OGMA's for the first 10 years of the planning horizon after which spatial cover constraints will be applied.

Old seral requirements for each BEC/BEO combinations are provided in Table 49. These will be applied as constraints in the model after 10 years so that harvest will be limited in specific LU/BEC/BEO combinations if the cover requirements are not met. Specific LU/BEC BEO management zones are provided in Appendix 1. Any forested area below the operability line including forested non-contributing area (NHLB) such as GAR caribou reserves (pers. comm. Frank Wilmer, 2009) will be allowed to contribute to meeting targets as long as they meet the criteria outlined in Table 8.

Spatial Old Growth Management Areas (OGMA's) and Mature + Old Management Area (MOGMA's) have been developed by MoAL – Integrated Land Management Bureau (ILMB)[6]. These areas will be reserved from harvest in the model for the first 10 years to meet the objectives of the RHLPO requirements. The areas associated with these spatial OGMA's and MOGMA's are included in Appendix 1. Overall, there is a 5.1% deficit in reserved OGMA/MOGMA area relative to target biodiversity requirements. This deficit is largely due to the fact that spatial OGMA's and MOGMA's were developed with the premise that the ICHmw3 variant belonged to NDT3. However, since then ICHmw3 has been re-classified to belong to NDT2, which has an older 'old' seral age definition, lower old seral retention requirements, and higher mature + old requirements, there is not enough mature+old area identified. Therefore, percent constraints will be applied to manage for mature + old requirements in the ICHmw3 for the entire planning horizon.

Table 49. Old and mature forest cover requirements for landscape level biodiversity objectives

BEC Zone	NDT	Mature Age (yrs)	Old Age (yrs)	MATURE + OLD Seral Requirements			OLD Seral Requirements		
				Low	Inter	High	Low	Inter	High
ESSF	1	>120	>250	19	36	54	19	19	28
ICH	1	>100	>250	17	34	51	13	13	19
ICH	2	>100	>250	15	31	46	9	9	13

Summary of Modeling Approach to be used in the Base Case

First 80 Years	81-250 Years in Future
Prevent harvest of old and mature retention areas. (seral requirements are turned off – except for ICHmw3)	Release retention areas and apply aspatial seral cover requirements based.

The RHLPO does not allow for the drawdown of old seral targets in low BEO areas like in other areas of the province. Also, mature+old targets are required in all BEC/BEO units.

8.5.2 Stand-level biodiversity — Wildlife Tree Retention

Wildlife tree retention is one of the primary methods to address stand level biodiversity objectives. The Revelstoke Licensees' FSP's are based on Section 66 (1) of the Forest Planning and Practices Regulation (FPPR). Licensees are retaining, on an area basis, 7% of the total area of their cutblocks. When possible, retention is within non-THLB areas. Existing, mapped WTRA's are removed from the THLB as landbase netdowns (Section 3.3.16). These are within or adjacent to existing cutblocks. The estimate of future WTRA's was described in section 3.3.18.1.

[6] Wilmer, F. 2007. Revelstoke Timber Supply Area Old Growth Management Areas Report. Integrated Land Management Bureau. Ministry of Agriculture and Lands.

9.0 Timber Supply Forecasting

9.1 Timber supply model

Forest Planning Studio (FPS) version 6.0.2.0 will be used to complete the timber supply analysis. FPS was developed by Dr. John Nelson at the University of British Columbia (UBC) and is a spatially explicit forest estate simulation model. All events in the model are directly linked to stand level polygons or harvest units and thus allow tracking of individual stand attributes and spatial relationships through time. Each polygon belongs to a specific stand type (Analysis Unit) and has attributes such as age, harvest system, and land base status (THLB or Non THLB). Results are typically aggregated for reporting at higher levels (i.e. harvest flow for the entire unit).

A wide range of constraints can be modeled on the land base: harvest exclusion, spatial adjacency/maximum cutblock size, maximum disturbance/young seral, minimum mature/old seral, and equivalent clearcut area (ECA) limits. Constraints are applied to groups of polygons (cliques) and harvest is restricted if a constraint is not satisfied. A single polygon can belong to many overlapping cliques and each of them must be satisfied in order to allow harvest of the polygon. Where a mature or old cover constraint is not met, harvesting may still occur if there are any eligible stands remaining after the oldest stands are reserved to meet the constraint.

Harvest is implemented using a set of priorities to queue stands for harvest. In each period, the model harvests the highest priority eligible stands until it reaches the harvest target or exhausts the list of opportunities. Harvest can be implemented in single years, multiple year periods or a combination of these. Where periods are used, the midpoint of the period is typically used as the point where harvest opportunity is evaluated because it is a good balance between the start of the period (pessimistic) and the end of the period (optimistic).

9.2 Harvest Flow Objectives

Harvest flow objectives used during analysis are consistent with MFR policy[7]. The primary objective is to gradually adjust harvest levels, if required, to arrive at the long-term harvest level (LTHL) for the TSA. A wide range of harvest flows are possible but ideally the flows will:

- Achieve an acceptable short-term harvest level beginning at the current AAC whenever possible;
- Where harvest level changes are required, make steps no larger than 10%;
- Do not permit the mid-term harvest level to fall below a level reflecting the productive capacity of the TSA (based on VDYP yield estimates); and
- Achieve a maximum long-term stable harvest level over a 300-year time horizon reflecting the productive capacity of the TSA (based on TIPSY yield estimates). One indicator of a stable long-term harvest level will be a constant long-term total inventory (growing stock on the THLB).

9.3 Sensitivity Analyses

The data and assumptions used in timber supply analysis are often subject to uncertainty. To provide a perspective on the impacts to timber supply of uncertainty in the data or assumptions, sensitivity analyses are commonly performed. Usually only one variable (data or assumption) from the information used in the base case is changed in order to explore the sensitivity of that variable.

Sensitivity analyses are a key component of any Timber Supply Review process. Sensitivity analyses permit the determinant (the Chief Forester) to gauge the potential impact of uncertainty around assumptions and data that make up the base case. Sensitivity analyses help to frame the potential impacts of uncertainty by analyzing scenarios that are more pessimistic and more optimistic than the base case.

Selecting sensitivities to run within the analysis is important, since the sensitivities need to be relevant to the management unit and meaningful to the determination. In the previous TSR, the many of the sensitivities listed

[7] B.C. Ministry of Forests. 2003. Harvest Flow Considerations for The Timber Supply Review: Draft Working Paper. Forest Analysis Branch. http://www.llbc.leg.bc.ca/public/PubDocs/bcdocs/365082/DFAM_harvest_flow_options.pdf

below were critical to the Revelstoke TSA and it will be critical to explore them in this analysis to provide perspective to the Chief Forester for the AAC determination. Additional sensitivities have been added to reflect pending changes in practices or data uncertainties specific to this analysis.

Table 50. Planned sensitivity analyses

Sensitivity analysis	Zone/ group / analysis unit subject to uncertainty	Magnitude of change	# of Runs
Size of Timber Harvesting Land base	Timber Harvesting Land Base (THLB)	The timber harvesting land base will be increased and decreased by +/– 10%.	2
Managed Stand Yields	Managed Stands	The volume associated with managed stands will be increased and decreased by +/- 10%	2
PEM site Indices in ESSF	Managed Stands in ESSF	Apply SIBEC correlations to ESSF based on current PEM site series classifications	1
Natural Stand Yields	Natural Stands	The volume associated with natural stands will be increased and decreased by +/- 10%	2
VDYP6	Natural Stands	Compare initial growing stock (on THLB) between VDYP 6 and VDYP 7 projected inventory.	1
Minimum Harvest Ages	All Stands	Minimum Harvest ages will be increased and decreased by +/- 10 years.	2
Armillaria Root rot	Managed Stands	TIPSY low severity *Armillaria* OAF 2 applied to Douglas-fir in the ICH	1
2019 Genetic Gains	Future Managed Stands	The genetic gains projected for 2019 (10 years out) will be applied to all future managed stands.	1
VQO's	Visuals	Shift disturbance allowance up by one class	1
Exclude Hw stands(>79% volume)	All stands	Remove all Hw stands (>79% volume) from the THLB	1
Total			14

10.0 References

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11.0 Glossary

Allowable annual cut (AAC)	The rate of timber harvest permitted each year from a specified area of land, usually expressed as cubic meters of wood per year.
Analysis unit	A grouping of types of forest — for example, by species, site productivity, silvicultural treatment, age, and or location — done to simplify analysis and generation of timber yield tables.
Base case harvest forecast	The timber supply forecast which illustrates the effect of current forest management practices on the timber supply using the best available information, and which forms the reference point for sensitivity analysis.
Biodiversity (biological diversity)	The diversity of plants, animals and other living organisms in all their forms and levels of organization, including the diversity of genes, species and ecosystems, as well as the evolutionary and functional processes that link them.
Biogeoclimatic (BEC) variant	A subdivision of a biogeoclimatic subzone. Variants reflect further differences in regional climate and are generally recognized for areas slightly drier, wetter, snowier, warmer or colder than other areas in the subzone.
Biogeoclimatic zones	A large geographic area with broadly homogeneous climate and similar dominant tree species.
Coniferous	Coniferous trees have needles or scale-like leaves and are usually 'evergreen'.
Cutblock	A specific area, with defined boundaries, authorized for harvest.
Cutblock adjacency	The spatial relationship among cutblocks. Most adjacency restrictions require that recently harvested areas must achieve a desired condition (green-up) before nearby or adjacent areas can be harvested. Specifications for the maximum allowable proportion of a forested landscape that does not meet green-up requirements are used to approximate the timber supply impacts of adjacency restrictions.
Deciduous	Deciduous trees shed their leaves annually and commonly have broad-leaves.
Environmentally sensitive areas (ESA)	Areas with significant non-timber values, fragile or unstable soils, impediments to establishing a new tree crop, or high risk of avalanches.
Forest cover objectives	Specify desired distributions of areas by age or size class groupings. These objectives can be used to reflect desired conditions for wildlife, watershed protection, visual quality and other integrated resource management objectives. General adjacency and green-up guidelines are also specified using forest cover objectives (see **Cutblock adjacency and Green–up**).
Forest inventory	An assessment of British Columbia's timber resources. It includes computerized maps, a database describing the location and nature of forest cover, including size, age, timber volume, and species composition, and a description of other forest values such as recreation and visual quality.
Forest and Range Practices Act (FRPA)	Legislation that govern forest practices and planning, with a focus on ensuring management for all forest values.
Forest type	The classification or label given to a forest stand, usually based on its tree species composition. Pure spruce stands and spruce-balsam mixed stands are two examples.
Free-growing	An established seedling of an acceptable commercial species that is free from growth-inhibiting brush, weed and excessive tree competition.
Green-up	The time needed after harvesting for a stand of trees to reach a desired condition (usually a specific height) — to ensure maintenance of water quality, wildlife habitat, soil stability or aesthetics — before harvesting is permitted in adjacent areas.
Growing stock	The volume estimate for all standing timber at a particular time.
Harvest forecast	The flow of potential timber harvests over time. A harvest forecast is usually a measure of the maximum timber supply that can be realized over time for a specified land base and set of management practices. It is a result of forest planning models and is affected by the size and productivity of the land base, the current growing stock, and management objectives, constraints and assumptions.
Higher level plans	Higher level plans establish the broader, strategic context for operational plans, providing objectives that determine the mix of forest resources to be managed in a given area.

Inoperable areas	Areas defined as unavailable for harvest for terrain-related or economic reasons. Operability can change over time as a function of changing harvesting technology and economics.
Integrated resource management (IRM)	The identification and consideration of all resource values, including social, economic and environmental needs, in resource planning and decision-making.
Landscape-level biodiversity	The *Landscape Unit Planning Guide* provides objectives for maintaining biodiversity at both the landscape level and the stand level. At the landscape level, guidelines are provided for the maintenance of seral stage distribution, patch size distribution and landscape connectivity.
Landscape unit	A planning area based on topographic or geographic features, that is appropriately sized (up to 100 000 hectares), and designed for application of landscape-level biodiversity objectives.
Long-term harvest level	A harvest level that can be maintained indefinitely given a particular forest management regime (which defines the timber harvesting land base, and objectives and guidelines for non-timber values) and estimates of timber growth and yield.
Mature seral	Forest stands with trees between 80 and 120 years old, depending on species, site conditions and biogeoclimatic zone.
Management assumptions	Approximations of management objectives, priorities, constraints and other conditions needed to represent forest management actions in a forest planning model. These include, for example, the criteria for determining the timber harvesting land base, the specification of minimum harvestable ages, utilization levels, integrated resource guidelines and silviculture and pest management programs.
Mean annual increment (MAI)	Stand volume divided by stand age. The age at which average stand growth, or MAI, reaches its maximum is called the culmination age (CMAI). Harvesting all stands at this age results in a maximum average harvest over the long term.
Minimum harvestable age (MHA)	The age at which a stand of trees is expected to achieve a merchantable condition. The minimum harvestable age could be defined based on maximize average productivity (culmination of mean annual increment), minimum stand volume, or product objectives (usually related to average tree diameter).
Model	An abstraction and simplification of reality constructed to help understand an actual system or problem. Forest managers and planners have made extensive use of models, such as maps, classification systems and yield projections, to help direct management activities.
Natural disturbance type (NDT)	An area that is characterized by a natural disturbance regime, such as wildfires, which affects the natural distribution of seral stages. For example areas subject to less frequent stand-initiating disturbances usually have more older forests.
Not satisfactorily restocked (NSR)	An area not covered by a sufficient number of well-spaced trees of desirable species. Stocking standards are set by the B.C. Forest Service. Areas harvested prior to October 1987 and not yet sufficiently stocked according to standards are classified as backlog NSR. Areas harvested or otherwise disturbed since October 1987 are classified as current NSR.
Operational Adjustment Factor (OAF)	OAF1 and OAF2 are TIPSY input parameters that reduce predicted yield to account for factors such as non-productive areas within stands, disease and insects, non-commercial cover, stocking gaps, decay, waste, and breakage.
Operability	Classification of an area considered available for timber harvesting. Operability is determined using the terrain characteristics of the area as well as the quality and quantity of timber on the area.
Crown forest land base (CFLB)	All forested crown land in a management unit. Used to support the management of non timber resources. The THLB is a subset of this land base.
Protected area	A designation for areas of land and water set aside to protect natural heritage, cultural heritage or recreational values (may include national park, provincial park, or ecological reserve designations).
Riparian area	Areas of land adjacent to wetlands or bodies of water such as swamps, streams, rivers or lakes.
Scenic area	Any visually sensitive area or scenic landscape identified through a visual landscape inventory or planning process carried out or approved by a district manager.

Sensitivity analysis	A process used to examine how uncertainties about data and management practices could affect timber supply. Inputs to an analysis are changed, and the results are compared to a baseline or base case.
Seral stages	Sequential stages in the development of plant communities that successively occupy a site and replace each other over time.
Site index	A measure of site productivity. The indices are reported as the average height, in meters, that the tallest trees in a stand are expected to achieve at 50 years (age is measured at 1.3 meters above the ground). Site index curves have been developed for British Columbia's major commercial tree species.
Stand-level biodiversity	A stand is a relatively localized and homogeneous land unit that can be managed using a single set of treatments. In stands, objectives for biodiversity are met by maintaining specified stand structure (wildlife trees or patches), vegetation species composition and coarse woody debris levels.
Stocking	The proportion of an area occupied by trees, measured by the degree to which the crowns of adjacent trees touch, and the number of trees per hectare.
Table Interpolation Program for Stand Yields (TIPSY)	A B.C. Forest Service computer program used to generate yield projections for managed stands based on interpolating from yield tables of a model (TASS) that simulates the growth of individual trees based on internal growth processes, crown competition, environmental factors and silvicultural practices.
Timber harvesting land base (THLB)	Crown forest land within the timber supply area where timber harvesting is considered both acceptable and economically feasible, given objectives for all relevant forest values, existing timber quality, market values and applicable technology.
Timber supply	The amount of timber that is forecast to be available for harvesting over a specified time period, under a particular management regime.
Timber supply area (TSA)	An integrated resource management unit established in accordance with *Section 7* of the *Forest Act*.
Tree farm license (TFL)	Provides rights to harvest timber, and outlines responsibilities for forest management, in a particular area.
Ungulate	A hoofed herbivore, such as deer.
Unsalvaged losses	The volume of timber killed or damaged annually by natural causes (e.g., fire, wind, insects and disease) that is not harvested.
Variable Density Yield Prediction (VDYP)	An empirical yield prediction system, supported by the Ministry of Forests and Range, designed to predict average yields and provide forest inventory updates over large areas (i.e., Timber Supply Areas). It is intended for use in unmanaged natural stands of pure or mixed species composition.
Vegetation Resources Inventory (VRI)	An assessment of British Columbia's vegetation resources. It includes computerized maps, a database describing the location and nature of forest information, including timber size, stand age, timber volume, tree species composition, and shrub, herb, and bryoid information. It replaces the older forest inventory.
Visual quality objective (VQO)	Defines a level of acceptable landscape alteration resulting from timber harvesting and other activities. A number of visual quality classes have been defined on the basis of the maximum amount of alteration permitted.
Volume estimates	Estimates of yields from forest stands over time. Yield projections can be developed for stand volume, stand diameter or specific products, and for empirical (average stocking), normal (optimal stocking) or managed stands.
Yield projections	See volume estimates
Watershed	An area drained by a stream or river. A large watershed may contain several smaller watersheds.
Wildlife tree	A standing live or dead tree with special characteristics that provide valuable habitat for conservation or enhancement of wildlife.
Woodlot licence	An agreement entered into under the *Forest Act*. It allows for small-scale forestry to be practised in a described area (Crown and private) on a sustained yield basis.

12.0 Acronyms

AAC	Allowable Annual Cut
Analysis	Timber Supply Analysis
AU	Analysis Unit
BCTS	British Columbia Timber Sales
BEC	Biogeoclimatic Ecosystem Classification
BEO	Biodiversity Emphasis Option
CF	Chief Forester
CPR	Canadian Pacific Railway
DFO	Department of Fisheries and Oceans
DM	District Manager
DP	Data Package
ESA	Environmentally Sensitive Area
FAIB	Forest Analysis and Inventory Branch
FIZ	Forest Inventory Zone
FPC	Forest Practices Code
FPPR	Forest Planning and Practices Regulation
FSP	Forest Stewardship Plan
GAR	Government Action Regulation
GIS	Geographic Information System
HLP	Higher Level Plan
ILMB	Integrated Land Management Bureau (Ministry of Agriculture and Lands)
IRM	Integrated Resource Management
LRMP	Land and Resource Management Plan
LU	Landscape Unit
MHA	Minimum Harvestable Age
MOE	Ministry of Environment
MOGMA	Mature + Old Growth Management Area
MFR	Ministry of Forests and Range
MO	Ministerial Order
NCC	Non-Commercial Cover
NDT	Natural Disturbance Type
NRL	Non-Recoverable Losses
NSR	Not Satisfactorily Restocked
OAF	Operational Adjustment Factor
OGMA	Old Growth Management Area
PSP	Permanent Sample Plot
CFLB	Crown Forest Land Base
PSYU	Public Sustained Yield Unit
RMR	Revelstoke Mountain Resort
RMZ	Riparian Management Zone
RRZ	Riparian Reserve Zone
RVQC	Recommended Visual Quality Class
SI	Site Index
TFL	Tree Farm License
THLB	Timber harvesting land base
VAC	Visual Absorption Capability
VQO	Visual Quality Objective
WHA	Wildlife habitat area
UWR	Ungulate winter range

Appendix 1 – THLB / CFLB Operable Areas by BEO/BEC

Landscape Unit	Biodiversity Emphasis	Biogeoclimatic Variant	Operable CFLB Area (ha)	THLB Area (ha)	Percent Mature + Old Requirement	Percent Old Requirement	Percent Reserved as MOGMA	Percent Reserved as OGMA
Akolkolex	Intermediate	ESSFwc 1	2	2	36%	19%	0.0%	0.0%
		ICH mw 2	1,871	1,579	31%	9%	31.6%	9.0%
		ICH mw 3	1,244	760	31%	9%	23.2%	14.0%
		ICH wk 1	13	12	34%	13%	35.2%	21.5%
	Low	ESSFwc 1	1,752	1,304	19%	19%	14.2%	14.2%
		ESSFwc 4	965	579	19%	19%	18.8%	18.8%
		ICH mw 2	2,262	2,124	15%	9%	15.0%	9.0%
		ICH mw 3	2,060	887	15%	9%	14.1%	14.1%
		ICH vk 1	2,351	1,946	17%	13%	16.1%	12.2%
		ICH wk 1	2,804	2,156	17%	13%	16.5%	12.8%
Big Eddy	High	ESSFvc	44	26	54%	28%	55.8%	29.1%
		ICH vk 1	99	76	51%	19%	52.4%	19.8%
		ICH wk 1	1,350	923	51%	19%	51.4%	19.0%
	Low	ESSFvc	511	321	19%	19%	19.3%	19.3%
		ICH vk 1	1,147	848	17%	13%	18.4%	12.7%
		ICH wk 1	697	503	17%	13%	17.3%	13.2%
Bigmouth	Low	ESSFvc	847	120	19%	19%	17.7%	17.7%
		ICH vk 1	3,418	2,531	17%	13%	16.6%	12.5%
Cranberry	Intermediate	ICH mw 3	358	270	31%	9%	0.0%	0.0%
	Low	ESSFwc 1	3	3	19%	19%	0.0%	0.0%
		ESSFwc 4	3	3	19%	19%	0.0%	0.0%
		ICH mw 3	89	78	15%	9%	0.0%	0.0%
		ICH wk 1	399	323	17%	13%	0.0%	0.0%
Downie	Intermediate	ICH mw 3	166	137	31%	9%	0.0%	14.5%
		ICH wk 1	10	10	34%	13%	0.0%	0.0%
	Low	ICH mw 3	1	1	15%	9%	0.0%	51.4%
		ICH wk 1	53	53	17%	13%	0.0%	0.0%
Frisby Ridge	High	ICH mw 3	73	49	46%	13%	36.7%	26.6%
		ICH wk 1	1,445	889	51%	19%	51.3%	19.2%

Landscape Unit	Biodiversity Emphasis	Biogeoclimatic Variant	Operable CFLB Area (ha)	THLB Area (ha)	Percent Mature + Old Requirement	Percent Old Requirement	Percent Reserved as MOGMA	Percent Reserved as OGMA
	Low	ESSFvc	898	628	19%	19%	17.6%	17.6%
		ICH vk 1	540	139	17%	13%	17.3%	13.3%
		ICH wk 1	3,522	1,968	17%	13%	17.1%	13.1%
Goldstream	Intermediate	ICH mw 3	51	19	31%	9%	0.0%	34.2%
		ICH wk 1	29	25	34%	13%	0.0%	11.4%
	Low	ICH wk 1	17	17	17%	13%	0.0%	0.0%
Horne	High	ESSFvc	144	68	54%	28%	54.8%	28.1%
		ICH vk 1	2,027	829	51%	19%	51.3%	19.2%
		ICH wk 1	182	87	51%	19%	62.6%	19.7%
	Intermediate	ESSFvc	601	221	36%	19%	33.3%	18.6%
		ICH vk 1	711	323	34%	13%	32.8%	13.0%
		ICH wk 1	295	188	34%	13%	38.1%	13.3%
	Low	ESSFvc	81	32	19%	19%	20.4%	20.4%
		ICH vk 1	1,377	873	17%	13%	16.9%	13.2%
		ICH wk 1	367	321	17%	13%	18.4%	13.3%
Illecillewaet	Intermediate	ICH mw 3	353	119	31%	9%	27.3%	17.2%
		ICH vk 1	599	229	34%	13%	35.0%	13.3%
		ICH wk 1	104	22	34%	13%	35.7%	14.7%
	Low	ESSFvc	419	240	19%	19%	21.4%	21.4%
		ESSFwc 1	676	503	19%	19%	19.8%	19.8%
		ESSFwc 4	502	221	19%	19%	27.8%	27.8%
		ICH mw 3	257	63	15%	9%	14.1%	13.8%
		ICH vk 1	1,746	1,124	17%	13%	17.0%	12.9%
		ICH wk 1	4,383	3,265	17%	13%	17.0%	13.0%
Jordan	High	ICH mw 3	92	70	46%	13%	34.2%	20.5%
		ICH wk 1	0	0	51%	19%	0.0%	0.0%
	Intermediate	ICH mw 3	1,007	831	31%	9%	23.3%	11.9%
		ICH wk 1	130	113	34%	13%	25.2%	16.9%
	Low	ESSFvc	747	533	19%	19%	19.1%	19.1%
		ESSFwc 1	8	3	19%	19%	20.4%	20.4%
		ICH mw 3	534	382	15%	9%	15.4%	15.4%
		ICH vk 1	1,245	854	17%	13%	17.0%	13.0%
		ICH wk 1	2,704	2,281	17%	13%	17.4%	13.3%

Landscape Unit	Biodiversity Emphasis	Biogeoclimatic Variant	Operable CFLB Area (ha)	THLB Area (ha)	Percent Mature + Old Requirement	Percent Old Requirement	Percent Reserved as MOGMA	Percent Reserved as OGMA
LaForme	Intermediate	ESSFvc	1	0	36%	19%	0.0%	0.0%
		ICH mw 3	1,668	884	31%	9%	23.1%	14.0%
		ICH vk 1	3	1	34%	13%	59.8%	59.8%
		ICH wk 1	1,033	464	34%	13%	34.1%	13.0%
	Low	ESSFvc	1,788	878	19%	19%	17.2%	17.2%
		ICH mw 3	49	9	15%	9%	85.2%	85.2%
		ICH vk 1	1,837	871	17%	13%	17.7%	13.4%
		ICH wk 1	803	409	17%	13%	16.8%	13.3%
Liberty	High	ESSFvc	804	233	54%	28%	54.4%	28.0%
		ICH mw 3	2	2	46%	13%	0.0%	0.0%
		ICH vk 1	1,485	733	51%	19%	48.3%	18.1%
		ICH wk 1	2,876	1,526	51%	19%	48.4%	18.2%
	Intermediate	ESSFvc	1,746	1,042	36%	19%	35.4%	18.5%
		ICH vk 1	2,237	1,134	34%	13%	30.1%	11.5%
		ICH wk 1	1,284	577	34%	13%	28.4%	11.3%
	Low	ESSFvc	754	437	19%	19%	21.9%	21.9%
		ICH vk 1	1,454	834	17%	13%	15.3%	11.5%
		ICH wk 1	306	236	17%	13%	15.6%	13.5%
Mica	Intermediate	ICH vk 1	318	287	34%	13%	0.0%	3.2%
	Low	ICH vk 1	4	2	17%	13%	0.0%	28.8%
Mulvehill	Intermediate	ICH mw 3	184	30	31%	9%	0.0%	0.0%
		ICH wk 1	0	0	34%	13%	0.0%	0.0%
Pingston	Low	ESSFwc 1	358	267	19%	19%	0.0%	0.0%
		ESSFwc 4	366	359	19%	19%	0.0%	0.0%
		ICH wk 1	1,566	1,260	17%	13%	0.0%	0.0%
Redrock	Intermediate	ICH vk 1	1,671	1,347	34%	13%	34.2%	13.1%
		ICH wk 1	173	111	34%	13%	38.3%	11.8%
	Low	ESSFwc 2	1,130	725	19%	19%	21.3%	21.3%
		ESSFwcw	123	61	19%	19%	2.5%	22.8%
		ICH vk 1	2,283	1,887	17%	13%	13.3%	11.7%
Soards	High	ESSFvc	2	0	54%	28%	84.0%	84.0%
		ICH vk 1	1,198	594	51%	19%	50.9%	18.9%
		ICH wk 1	77	45	51%	19%	51.3%	20.7%

Landscape Unit	Biodiversity Emphasis	Biogeoclimatic Variant	Operable CFLB Area (ha)	THLB Area (ha)	Percent Mature + Old Requirement	Percent Old Requirement	Percent Reserved as MOGMA	Percent Reserved as OGMA
	Intermediate	ESSFvc	76	25	36%	19%	39.1%	19.4%
		ICH vk 1	238	108	34%	13%	35.0%	13.2%
		ICH wk 1	109	42	34%	13%	33.8%	13.8%
	Low	ESSFvc	3,308	1,579	19%	19%	19.2%	19.2%
		ICH vk 1	4,439	2,887	17%	13%	16.6%	12.8%
		ICH wk 1	207	148	17%	13%	17.6%	13.2%

Notes: OGMA's and MOGMA's were developed with the premise that the ICHmw3 variant belonged to NDT3. However, since then ICHmw3 has been re-classified to belong to NDT2, which has a different old seral age definition, lower old seral retention requirements, and higher mature + old requirements.

Appendix 2 – Analysis Unit Volumes

	Existing Natural Yields (VDYP7)														
Age	**101**	**102**	**103**	**104**	**105**	**106**	**107**	**108**	**109**	**110**	**111**	**112**	**113**	**114**	**115**
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10	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
30	17	16	3	1	0	0	11	13	0	0	0	0	14	12	0
40	54	52	19	16	3	3	40	60	17	17	3	0	46	46	10
50	108	106	43	37	15	9	82	134	46	54	14	13	89	101	29
60	171	168	75	68	32	19	133	225	86	106	31	40	139	170	55
70	233	231	110	104	52	46	184	316	133	171	53	80	187	243	85
80	290	289	145	142	76	74	232	396	180	239	76	131	232	311	117
90	343	342	178	179	99	104	276	466	226	302	100	188	272	371	147
100	393	388	209	214	121	136	315	526	267	359	124	244	308	420	176
110	439	430	237	246	141	168	350	577	305	409	147	298	340	461	204
120	479	467	263	275	160	198	381	621	339	454	167	348	369	493	229
130	515	499	286	301	177	221	408	657	369	492	187	393	394	519	254
140	544	526	306	323	192	241	430	686	396	525	205	434	416	539	275
150	567	546	321	340	205	257	447	705	417	550	220	466	433	552	293
160	580	557	332	350	214	266	457	714	431	565	231	486	444	559	306
170	588	565	338	357	220	271	464	717	440	573	239	499	451	561	315
180	593	568	342	361	224	274	467	715	445	576	243	507	455	560	321
190	594	568	345	362	226	275	468	713	448	576	246	510	456	557	324
200	594	567	346	363	228	276	468	709	450	575	248	510	456	552	326
210	591	563	344	362	228	275	465	703	447	571	247	507	452	544	324
220	587	559	342	360	227	274	462	698	444	566	246	504	447	537	322
230	583	555	340	359	226	273	459	692	442	562	244	500	443	529	319
240	580	552	338	358	226	271	456	687	439	558	243	497	439	522	317
250	577	548	336	356	225	270	452	681	436	554	242	493	434	515	315
260	573	545	334	355	224	269	449	675	433	549	240	490	430	507	312
270	570	542	332	353	223	268	446	669	430	545	239	486	426	500	310
280	567	538	330	352	222	267	442	662	427	541	237	483	421	492	307
290	564	535	328	350	221	266	439	656	424	537	235	479	417	485	305
300	561	532	326	349	220	264	435	649	421	533	234	476	412	478	302

	Existing Natural Yields (VDYP7) continued														
Age	**116**	**117**	**118**	**119**	**120**	**121**	**122**	**123**	**124**	**125**	**126**	**127**	**128**	**129**	**130**
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10	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
30	0	0	0	0	0	0	0	0	0	2	2	0	0	0	0
40	8	0	0	20	17	2	1	0	0	20	29	1	3	0	0
50	31	2	0	58	60	17	16	0	0	63	100	12	21	2	1
60	64	11	13	107	120	44	45	11	6	121	193	34	61	12	12
70	107	25	34	157	183	79	86	30	20	181	279	64	119	29	34
80	156	40	63	203	238	116	130	53	42	234	350	97	179	52	68
90	206	57	99	243	284	152	173	80	68	280	406	128	233	76	109
100	253	75	138	275	320	184	212	108	98	319	449	157	279	102	152
110	296	94	179	302	350	213	245	134	128	350	483	184	318	126	192
120	334	112	219	324	373	239	274	159	156	377	508	207	350	148	228
130	366	131	256	343	393	260	297	180	183	399	528	229	376	168	261
140	393	150	290	358	409	277	317	199	206	416	543	248	397	187	289
150	413	167	316	368	421	291	332	214	225	429	552	263	412	203	310
160	425	181	334	376	427	300	342	225	238	437	555	274	421	215	323
170	432	192	346	381	429	305	347	232	245	441	553	281	425	224	331
180	436	199	353	385	429	309	349	238	250	443	550	286	426	229	336
190	437	204	357	387	429	311	349	241	252	443	544	288	424	233	338
200	436	208	359	389	428	313	349	244	253	443	538	290	422	235	339
210	431	208	357	389	426	313	347	244	251	440	531	289	417	235	337
220	427	207	354	389	424	312	346	243	250	437	524	287	413	234	334
230	423	207	353	389	422	312	344	243	249	435	518	286	409	233	332
240	419	206	350	389	421	311	343	243	248	432	513	284	406	232	330
250	415	205	347	388	420	311	341	243	247	430	507	283	403	231	329
260	411	205	345	388	418	310	340	243	246	427	503	282	400	230	327
270	406	204	342	388	416	310	339	243	245	425	498	281	397	229	325
280	402	203	339	388	415	310	337	243	244	423	494	279	394	228	324
290	398	202	336	388	413	309	336	242	243	421	489	278	391	227	322
300	394	201	334	388	412	309	335	242	243	419	485	277	389	227	321

	Future Managed Yields (BatchTIPSY 4.1)														
Age	**201**	**202**	**203**	**204**	**205**	**206**	**207**	**208**	**209**	**210**	**211**	**212**	**213**	**214**	**215**
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10	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
30	31	29	6	2	1	1	1	4	0	1	0	0	1	2	0
40	126	120	54	24	26	31	39	68	23	37	24	21	38	48	22
50	235	229	134	82	93	105	131	176	103	126	106	100	124	138	94
60	324	317	215	150	178	193	228	281	195	223	198	191	213	230	178
70	401	393	284	215	246	262	312	365	279	306	283	276	293	309	256
80	468	460	345	271	317	335	385	443	348	379	352	344	360	376	321
90	518	510	396	321	380	400	451	511	415	445	419	411	417	434	379
100	563	555	439	363	438	458	509	566	472	503	476	468	465	481	428
110	599	592	475	399	486	507	556	612	522	551	526	518	505	521	470
120	599	620	504	430	531	554	596	662	562	590	566	559	539	555	487
130	599	618	528	456	573	597	640	704	597	632	603	594	573	590	502
140	599	617	550	479	610	632	678	738	638	671	644	634	601	617	517
150	599	615	567	496	640	662	709	766	673	703	678	668	624	638	530
160	599	613	580	510	667	688	734	791	701	728	704	697	643	657	540
170	599	612	591	523	689	711	758	814	723	751	727	720	660	675	549
180	599	610	600	535	710	731	778	835	744	761	748	740	676	691	556
190	599	610	600	545	727	748	796	853	762	771	766	758	690	703	563
200	599	610	600	552	744	763	813	868	771	779	784	776	701	715	569
210	599	610	600	559	757	777	828	868	779	787	799	791	711	725	575
220	599	610	600	564	769	789	840	868	785	793	812	805	721	734	580
230	599	610	600	569	780	799	851	868	791	799	824	816	728	738	584
240	599	610	600	574	790	809	861	868	796	803	834	826	735	738	588
250	599	610	600	577	799	818	869	868	800	808	843	835	740	738	591
260	599	610	600	581	807	826	869	868	804	812	851	844	740	738	593
270	599	610	600	584	814	834	869	868	808	812	857	850	740	738	596
280	599	610	600	584	820	841	869	868	811	812	863	857	740	738	598
290	599	610	600	584	826	847	869	868	814	812	869	862	740	738	599
300	599	610	600	584	826	847	869	868	814	812	869	862	740	738	599
310	599	610	600	584	826	847	869	868	814	812	869	862	740	738	599
320	599	610	600	584	826	847	869	868	814	812	869	862	740	738	599
330	599	610	600	584	826	847	869	868	814	812	869	862	740	738	599
340	599	610	600	584	826	847	869	868	814	812	869	862	740	738	599
350	599	610	600	584	826	847	869	868	814	812	869	862	740	738	599

	Future Managed Yields (BatchTIPSY 4.1) continued														
Age	**216**	**217**	**218**	**219**	**220**	**221**	**222**	**223**	**224**	**225**	**226**	**227**	**228**	**229**	**230**
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10	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
30	0	0	0	1	1	0	0	0	0	7	16	7	1	0	0
40	11	5	1	45	43	7	3	0	0	91	129	78	44	2	1
50	68	42	22	136	132	50	39	7	1	209	255	187	137	31	21
60	145	105	71	221	216	120	100	35	13	316	362	287	230	94	80
70	219	170	131	306	299	187	167	81	45	403	449	371	314	166	150
80	285	229	188	368	364	247	225	136	86	472	517	435	382	235	216
90	340	283	239	408	404	309	283	184	135	528	568	488	436	297	277
100	391	328	284	437	434	354	331	228	176	571	613	528	481	348	331
110	432	367	324	458	455	386	368	273	215	611	650	562	517	397	379
120	468	400	358	473	471	409	394	313	252	643	679	594	545	438	421
130	498	429	388	484	482	428	414	344	290	669	704	617	577	474	457
140	525	453	414	487	486	442	429	368	321	691	724	635	598	506	489
150	551	475	435	488	487	453	442	386	347	709	742	652	615	530	515
160	576	495	454	489	487	461	451	400	365	726	758	666	630	553	538
170	595	514	471	489	488	468	459	413	380	739	758	679	643	574	558
180	611	531	488	489	489	473	465	422	392	752	758	689	655	597	580
190	624	544	504	489	489	473	469	430	403	762	758	697	664	617	601
200	635	554	518	489	489	473	470	437	411	762	758	697	673	634	619
210	647	563	529	489	489	473	470	442	418	762	758	697	680	646	634
220	657	571	538	489	489	473	470	446	424	762	758	697	686	656	645
230	666	579	545	489	489	473	470	449	429	762	758	697	691	666	654
240	675	586	551	489	489	473	470	451	433	762	758	697	696	675	663
250	682	592	558	489	489	473	470	453	437	762	758	697	696	682	671
260	687	598	562	489	489	473	470	454	438	762	758	697	696	689	678
270	692	602	568	489	489	473	470	454	440	762	758	697	696	696	685
280	697	607	572	489	489	473	470	454	442	762	758	697	696	702	691
290	700	611	576	489	489	473	470	454	443	762	758	697	696	707	696
300	700	611	576	489	489	473	470	454	443	762	758	697	696	707	696
310	700	611	576	489	489	473	470	454	443	762	758	697	696	707	696
320	700	611	576	489	489	473	470	454	443	762	758	697	696	707	696
330	700	611	576	489	489	473	470	454	443	762	758	697	696	707	696
340	700	611	576	489	489	473	470	454	443	762	758	697	696	707	696
350	700	611	576	489	489	473	470	454	443	762	758	697	696	707	696

	Existing Managed Yields (BatchTIPSY 4.1)														
Age	**501**	**502**	**503**	**504**	**505**	**506**	**507**	**508**	**509**	**510**	**511**	**512**	**513**	**514**	**515**
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10	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
30	18	6	1	2	0	0	1	0	0	1	0	0	10	2	0
40	108	72	35	48	16	12	42	8	1	30	2	0	103	47	8
50	217	172	110	144	89	83	129	64	17	108	29	0	221	140	59
60	309	259	194	244	178	169	223	142	71	195	87	5	323	237	135
70	391	337	263	326	260	251	302	219	135	271	156	25	414	318	211
80	463	405	328	405	329	319	376	285	198	343	215	60	484	393	277
90	523	464	384	470	396	386	441	345	255	392	273	101	538	453	339
100	576	515	433	523	453	442	495	401	303	425	331	148	588	500	393
110	623	560	474	566	500	490	538	448	350	449	375	187	633	540	438
120	659	599	514	609	538	528	578	489	393	467	408	224	664	577	475
130	689	632	549	650	572	561	618	522	430	480	436	258	690	612	506
140	689	658	576	682	608	596	653	552	463	491	457	295	714	639	532
150	689	681	601	707	640	628	680	583	490	495	476	328	735	659	559
160	689	700	623	728	667	657	703	611	514	495	491	354	753	676	583
170	689	700	641	748	686	677	723	636	534	495	504	377	768	693	605
180	689	700	657	767	703	695	743	656	558	495	514	394	768	707	622
190	689	700	670	782	719	710	761	671	579	496	522	409	768	719	635
200	689	700	682	796	734	724	776	686	598	496	530	422	768	731	646
210	689	700	692	808	747	737	789	699	614	496	533	433	768	740	655
220	689	700	700	818	759	750	801	712	628	496	536	443	768	748	665
230	689	700	700	828	769	755	811	723	640	496	537	451	768	755	674
240	689	700	700	835	778	759	821	733	650	496	539	459	768	761	681
250	689	700	700	842	785	763	829	742	658	496	539	464	768	766	688
260	689	700	700	842	792	767	836	750	666	496	540	471	768	766	694
270	689	700	700	842	797	770	842	756	674	496	540	475	768	766	699
280	689	700	700	842	802	772	842	762	681	496	540	478	768	766	703
290	689	700	700	842	807	774	842	767	686	496	540	480	768	766	706
300	689	700	700	842	807	774	842	767	686	496	540	480	768	766	706
310	689	700	700	842	807	774	842	767	686	496	540	480	768	766	706
320	689	700	700	842	807	774	842	767	686	496	540	480	768	766	706
330	689	700	700	842	807	774	842	767	686	496	540	480	768	766	706
340	689	700	700	842	807	774	842	767	686	496	540	480	768	766	706
350	689	700	700	842	807	774	842	767	686	496	540	480	768	766	706

	Future Managed Yields (BatchTIPSY 4.1) - Previously Existing Managed														
Age	**601**	**602**	**603**	**604**	**605**	**606**	**607**	**608**	**609**	**610**	**611**	**612**	**613**	**614**	**615**
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10	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
30	29	13	3	3	0	0	2	0	0	1	0	0	15	3	0
40	133	95	50	58	22	18	47	11	1	46	5	0	122	59	11
50	248	200	133	159	102	94	140	73	22	139	41	1	244	159	71
60	341	287	220	261	192	183	235	153	78	226	108	9	347	257	152
70	422	366	289	345	277	267	318	230	145	311	178	35	433	341	229
80	494	434	354	419	346	336	388	299	208	375	241	74	501	410	299
90	548	492	408	482	410	399	451	357	266	416	303	120	554	467	357
100	602	538	457	535	464	454	503	411	315	446	356	165	600	515	408
110	644	582	497	577	510	500	547	457	361	468	396	204	638	553	450
120	678	620	534	618	548	538	586	497	401	483	426	242	669	588	487
130	678	649	565	655	580	571	625	530	438	495	451	280	696	618	517
140	678	674	593	686	615	604	657	558	469	498	472	317	719	642	542
150	678	674	616	710	645	635	683	589	496	498	489	345	738	662	567
160	678	674	636	732	670	660	706	616	520	499	504	371	755	680	591
170	678	674	652	752	689	679	727	639	540	500	514	390	755	696	610
180	678	674	666	770	706	697	746	657	562	500	522	406	755	710	625
190	678	674	678	785	722	713	763	673	583	500	530	420	755	722	637
200	678	674	689	798	736	720	777	688	602	500	533	431	755	732	648
210	678	674	689	810	749	726	790	701	618	500	535	442	755	742	658
220	678	674	689	820	761	732	802	714	630	500	537	451	755	750	668
230	678	674	689	820	770	737	812	724	641	500	539	459	755	750	676
240	678	674	689	820	779	741	822	735	650	500	540	465	755	750	683
250	678	674	689	820	786	745	819	743	659	500	541	471	755	750	690
260	678	674	689	820	792	748	817	751	667	500	541	476	755	750	695
270	678	674	689	820	798	751	815	757	674	500	542	479	755	750	700
280	678	674	689	820	803	754	812	763	681	500	542	481	755	750	703
290	678	674	689	820	807	756	810	768	687	500	542	484	755	750	706
300	678	674	689	820	807	756	810	768	687	500	542	484	755	750	706
310	678	674	689	820	807	756	810	768	687	500	542	484	755	750	706
320	678	674	689	820	807	756	810	768	687	500	542	484	755	750	706
330	678	674	689	820	807	756	810	768	687	500	542	484	755	750	706
340	678	674	689	820	807	756	810	768	687	500	542	484	755	750	706
350	678	674	689	820	807	756	810	768	687	500	542	484	755	750	706