Fort St John Timber Supply Area

Timber Supply Analysis Report
In support of the
Fort St. John Forest Practices Code Pilot Project

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Timber Supply Analysis Report

In Support of the

Fort St. John Sustainable Forest Management Plan

1.0 Introduction

In support of the *Forest Practices Code Act, Fort St. John Pilot Project Regulation* (December 2001), a Sustainable Forest Management Plan (SFMP) for the Fort St. John Timber Supply Area (TSA) was undertaken by four licensees and Fort St. John British Columbia Timber Sales (BCTS). The purpose of the SFMP is to test alternative methods of meeting the objectives of the Forest Practices Code while improving the regulatory framework. Improvements are initiated through a shift from prescriptive management to results-based management.

The purpose of this report is to evaluate and quantify the potential impact of some of the management initiatives being forwarded by the proponents of the Ft St. John SFMP. To assist in the evaluation of these initiatives, Industrial Forestry Service Ltd. was contracted to undertake a timber supply analysis of the Fort St. John TSA. The analysis is supported by the proponents of the SFMP which include Canadian Forest Products Ltd., Louisiana Pacific Canada Ltd., Slocan Forest Products Ltd. and the BCTS.

2.0 Information Preparation for the Timber Supply Analysis

This analysis was completed over a 2 month period. This was possible only through close familiarity with the Ministry of Forests' (MOF's) recently completed timber supply review (June 2002) and an acceptance by the contract proponents that, as a starting point, the timber harvesting land base (THLB) determination, yield assumptions and management assumptions followed the analysis developed by the MOF through the Timber Supply Review process. The Ministry of Forests Timber Supply Review (TSR) Base Case was the starting point. Following a re-determination of the Fort St. John TSR Base Case, the Code Pilot proponents have included, deleted, and modified analysis assumptions in recognition of the varied management initiatives that are being tabled under the SFMP.

Timber supply analyses generally require three principle sources of information that are integrated into one cohesive forest estate model. This information involves an identification of the land base inventory, timber growth and yield data, and management practices. These three factors, along with a brief description of the model, are described in the sections that follow.

The information contained in this analysis was prepared for the purpose of addressing five specific scenarios. As some of the scenarios utilized management data that was considerably different from the TSR2 Base Case, considerable preparatory processing was required prior to the start of the analysis.

The management scenarios that were modeled in this analysis are:

- **Scenario 1** is a remake of the MOF's TSR2 Base Case scenario. This scenario provides the benefit of both calibrating the model to match the original TSR2 Base Case, and evaluating the impact of moving away from some "traditional" management assumptions.
- **Scenario 2** is an NDU Enhanced Scenario. In this scenario several changes are made in a move away from managing according to the Base Case:

a. The deciduous land base is expanded to include some stands that were previously considered problem forest types,

b. The non-contributing land base was cycled for natural disturbances at a rate of 1,105 ha/year (versus 5,000 ha/year used in Scenario 1),

c. Deciduous stands are cycled when they reach their maximum ecological age. (This was not done in Scenario 1 where deciduous stands were assumed to age indefinitely if they were not harvested),

d. Forest cover constraints that were based upon the Forest Practices Code (FPC) Biodiversity Guidebook were dropped in favour of Natural Disturbance Units (NDU),

e. Approximately 15 percent of deciduous-leading stands were assigned a 4-year regeneration delay,

f. Minimum deciduous harvest ages are modified to better reflect the ability to harvest deciduous stands at 120 m^3/ha.

- **Scenario 3** builds on Scenario 2 through the inclusion of equivalent clear cut area (ECA) constraints on large and small spatially defined watersheds in the TSA,
- **Scenarios 4** builds on Scenario 3 but modifies the forest cover constraints that were applied to NDUs. This was done by increasing the old-growth targets from a minimum percent area over 140 years of age, to include mean and maximum targets based upon the biodiversity emphasis option (BEO) recommended for Fort St. John landscape units.
- **Scenario 5** builds on scenario 4 but modifies the harvest schedule and the THLB in recognition of the Graham River Integrated Resource Management Plan (IRMP).

2.1 Land Base Determination

The Fort St. John TSA is defined by a series of inventory coverages that spatially describe many industrial, political, legal, economic and ecological management concerns across the entire land base. Map inventories representing many of these concerns are merged with the forest inventory to provide a spatially explicit graphical and tabular data-base. An Arc-Info Geographic Information System (GIS) was used to link these spatial coverages to the forest inventory. The resource inventories were largely identical to the inventories used in the TSR Base Case. However, several key inventories have been modified as a result of the progressive nature of forest management across B.C. Revised inventories that include woodlot areas, newly legislated protected areas, range leases, and inaccessible areas are only a few of the many layers that have been merged with the Fort St. John land base inventory files. A listing of the old and new inventories is provided in Table A3 in Appendix I.

Industrial Forestry Service Ltd. updated the inventory files for this analysis in August 2003. The current dataset includes many revisions to the data base completed by the Ministry of Forests approximately 1½ years earlier. The predominant changes to the Fort St John TSA data base involve the inclusion of a vegetative resource inventory (VRI) for approximately 12 percent of the TSAs area. Furthermore, landscape units have been expanded in size and reduced in number, and two new administrative inventories have been included into the analysis (i.e., NDUs and watersheds).

Figure 1 depicts the location of the Fort St. John TSA within the province of British Columbia. Table 1 describes the net-down process for the Fort St. John TSA through which the THLB and the non-contributing land base (NCLB) are defined. Three different THLBs have been identified for the Fort St. John TSA in this timber supply analysis.

- THLB 1 describes a THLB utilizing as closely as possible the net-down assumptions developed by the MOF and described in the Fort St. John Timber Supply Analysis Report. This THLB was used in Scenario 1 and is representative of the MOFs TSR2 base case.

- THLB 2 describes an enhanced THLB that maintains the same net coniferous area but greatly expands the deciduous THLB area by including the Slocan-LP OSB Corp merchantable deciduous forest types. This THLB was used in Scenarios 2, 3 and 4.

- THLB 4 includes the enhanced deciduous THLB described above, but excludes area in the Graham River Valley that is outside the cut-block clusters and riparian reserves that have been spatially identified in the Graham IRMP. This THLB was used in scenario 5.

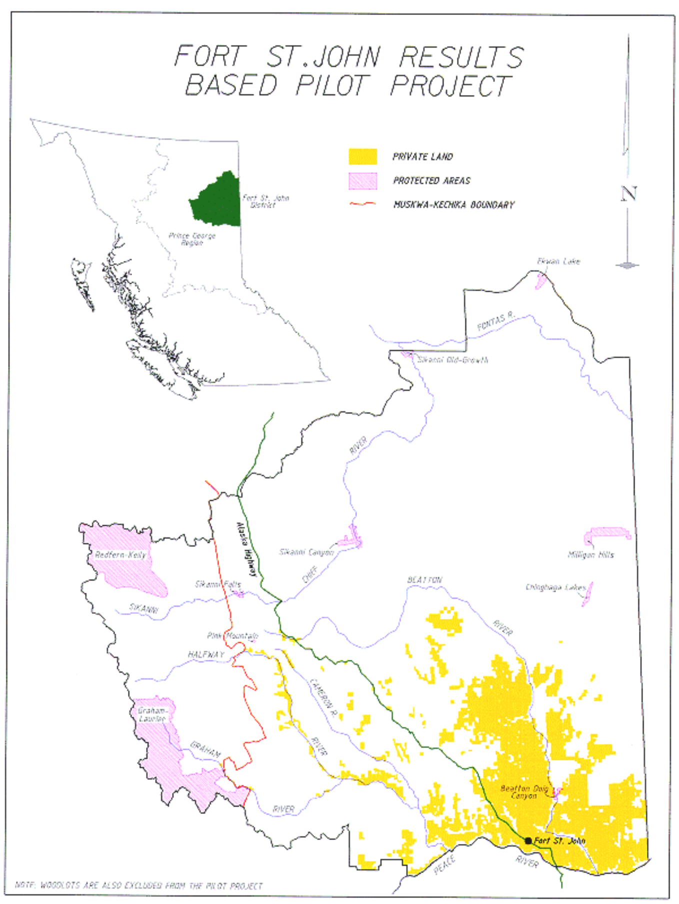

Figure 1 Map of the Fort St. John TSA

Table 1 Land Base Net Down

Classification	Gross Area (ha)	Net Area (ha)
Total TSA Area	**4,676,639**	
Non-forest	*2,018,108*	
Woodlots	*18,409*	*17,767*
Not Managed by BC For. Service	*555,181*	*215,596*
Non-commercial Cover	*173,065*	*148,977*
Area contributing to Forest Biodiversity		**2,276,190**
Range Leases	*13,388*	*9,370*
Parks and Reserves	*94,384*	*94,384*
Productive Forest Land Base		**2,172,436**
Reductions to Productive Forest		
Range and Wildlife Burn Areas	*30,795*	*30,623*
Inaccessible Areas	*24,297*	*15,691*
Inoperable	*20,356*	*18,347*
NonMerch Conifer	*344,063*	*339,100*
NonMerch Deciduous	*88,551*	*83,211*
Low Productivity Conifer	*554,305*	*328,261*
Low Productivity Deciduous	*171,228*	*149,174*
Recreation	*54,059*	*29,740*
ESA	*37,351*	*12,176*
WTP's	*95,586*	*52,921*
Reduction for NSR	*36,323*	*8,674*
Unclassified Roads,Trails and Landings	*14,348*	*9,351*
Lakes and Wetlands Riparian Areas	*15,087*	*7,181*
Streams Riparian Areas	*66,438*	*34,918*
Seismic Lines	*26,269*	*14,712*
Total Reductions		1,134,080
Timber Harvesting Land Base 1 **Coniferous - 733,206 hectares** **Deciduous - 305,150 hectares**		**1,038,356**
Deciduous Add-back		*124,289*
Timber Harvesting Land Base 2 **Coniferous - 733,206 hectares** **Deciduous - 429,439 hectares**		**1,162,645**
Reduction for Graham IRM Plan		*13,234*
Timber Harvesting Land Base 3 **Coniferous - 720,276 hectares** **Deciduous - 429,135 hectares**		**1,149,411**

2.1.1 Coniferous Land Base

Table 1 reveals that this net-down of the Fort St. John timber harvesting land base has resulted in a coniferous THLB that is almost the same size as the area determined by the MOF in TSR2. This coniferous THLB is utilized in all of the management scenarios but one. A small decline in the coniferous THLB occurs through the removal of merchantable areas inside the Graham River IRM Planning area.

Although only a very small difference in total coniferous area was determined through the net-down, the amount of area that was allocated to "small pine" versus the "traditional coniferous land base" has changed considerably. Approximately 18 percent of the area previously attributed to small pine has been redefined as traditional conifer. Approximately 6 percent of the coniferous land base now exists in the small pine THLB. Further detail in this regard is provided in Appendix I.

2.1.2 Deciduous Land Base

This analysis determined three deciduous THLBs. The first duplicates the net-down logic used in TSR2; the second defines an enhanced deciduous base; and the third marginally reduces the enhanced land base for the Graham IRMP. In this analysis, the first deciduous THLB is approximately 6 percent smaller than the land base derived in the MOF's analysis. An in-depth study into this discrepancy has not been carried out.

The second deciduous THLB is approximately 32 percent larger than the MOFs deciduous THLB. Slocan-LP OSB Corp has undertaken analysis that supports the inclusion of additional deciduous forest stands in an "enhanced deciduous THLB. This deciduous THLB adjustment is also partially supported by the MOF's own Phase II VRI analysis. The results of this analysis showed that deciduous volumes existing on the inventory files are believed to be underestimated in the Fort St. John TSA generally. Justification of this belief is not part of this analysis report.

The third and final deciduous THLB is reduced very slightly for deciduous stands within the Graham IRMP. This THLB was only used in Scenario 5.

The seral succession of deciduous-leading mixed-wood stands to coniferous-leading mixed-wood stands is not modeled in this analysis.

2.1.3 THLB Age Distribution

Figure 2 shows the current age class distribution of forested stands in the timber harvesting land base. Approximately 63 percent of the THLB is coniferous-leading stands. The remaining 37 percent are leading deciduous stands comprised of 'TSR2 defined' deciduous (26 percent) and stands previously defined as problem forest types (11 percent). The area in the Graham IRMP is mostly coniferous and makes up only 1 percent of the THLB area.

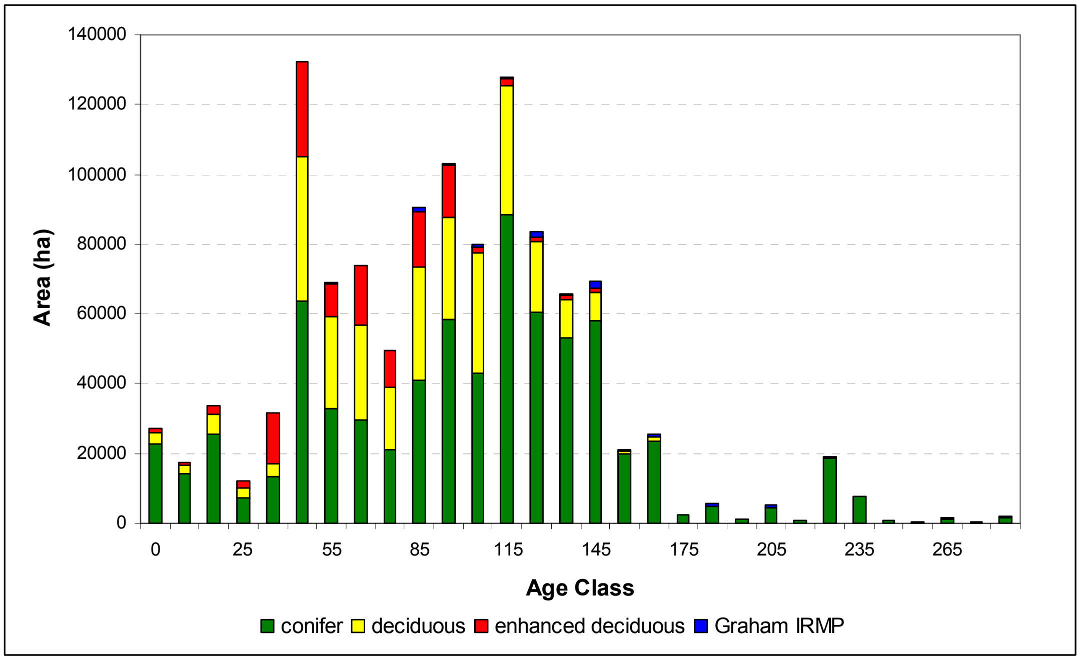

Figure 2 Fort St. John THLB Age Distribution

2.2 Growth and Yield

In this analysis, growth and yield relate to the rate at which stands increase in volume over time. Although the forest inventory for portions of the Fort St John timber harvesting land base was updated with the completion of a VRI, the analysis units and the yield tables representing each analysis unit remain largely unchanged from those developed and used by the MOF in the TSR2 analysis. The exception to this rule was the development of five additional analysis units and yield tables to represent the area and the growth and yield of the enhanced deciduous land base. Details on the amount of area in each analysis unit are provided in Appendix I, Table A19 .

The growth and yield of stands were determined by the MOF using two stand level models. Unmanaged stands were predicted using the VDYP model. Managed stands were predicted using the TIPSY model. It was assumed that deciduous-leading stands reverted back to an unmanaged state.

Figure 5 depicts the area-weighted average growth curve for deciduous stands and for unmanaged and managed coniferous stands.

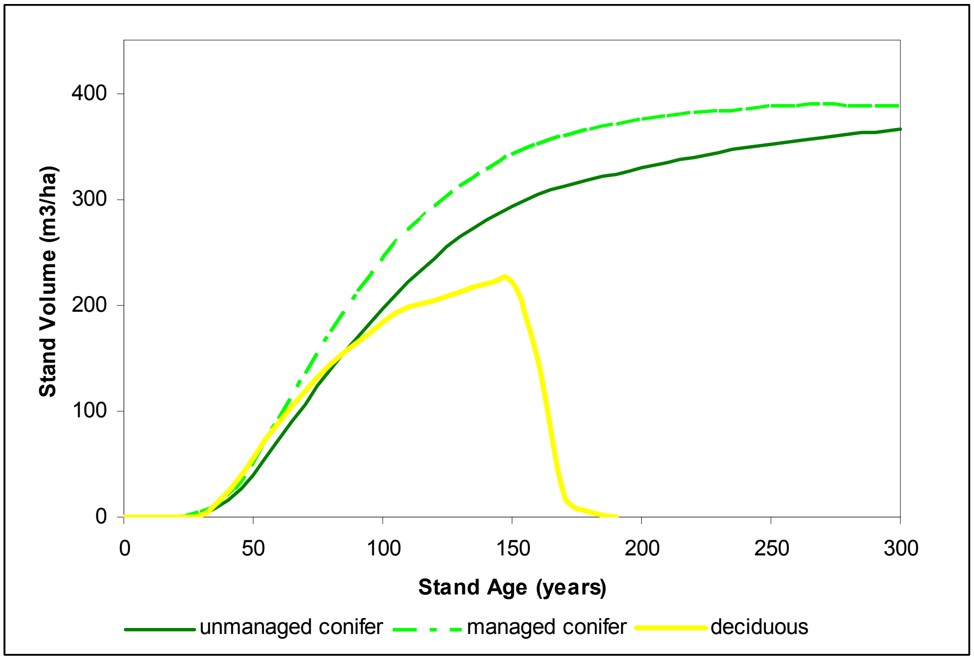

Figure 3 Average Yield Curves by Leading Species – Fort St. John TSA

2.2.1 Unmanaged Coniferous

Unmanaged conifer yield tables were unchanged from the yield tables used in TSR2. These unmanaged yield tables were produced using the MOF's Variable Density Yield Prediction model (VDYP). After harvesting, unmanaged coniferous stands convert to managed coniferous stands.

2.2.2 Managed Coniferous

Managed coniferous stands generally yield more volume per hectare than unmanaged stands. This is as a result of active forest management with respect to site preparation, seedling spacing, competition management, seedling quality and stand thinning. The managed stand coniferous yield tables used in this analysis remained unchanged from TSR2. Figure 5 shows that managed stands yield approximately 20 percent more volume than unmanaged stands after 100 years.

2.2.3 Deciduous

Deciduous yield tables remain largely unchanged from TSR2. However, two items are of note: 1) five new yield tables were added to the analysis to represent deciduous stands that were considered problem forest types. These stands were added back to an 'enhanced' deciduous land base. The analysis units representing these stands were only used in the scenarios (i.e., Scenarios 2-5) where an enhanced deciduous land base was modeled; 2) the yield tables of deciduous-leading stands were adjusted in Scenarios 2-5 such that after a certain age the merchantable volume fell to zero. The time at which this merchantable volume fall down occurs depended upon the leading species (i.e., 155 years for cottonwood and aspen, 115 years for birch). This was done to model the mortality and limited commercial and ecological life span of deciduous species. As a result of deciduous mortality, the average merchantable volume per hectare predicted for deciduous stands greater than 150 years age declines rapidly (see Figure 5). To minimize the loss of deciduous stands to mortality, a 'relative oldest-first' harvesting rule was applied in the model.

2.2.4 Mixed-wood

Mixed-wood stands were treated as per TSR2. The seral succession of deciduous-leading mixed-wood stands to coniferous-leading mixed-wood stands was not modeled. This omission occurred because growth and yield information on mixed-wood succession dynamics is lacking. Mixed-wood assumptions modeled in this analysis, presume that the total amount of mixed-wood area will remain relatively static. Figure 4 shows the amount of THLB by species composition. Roughly 27 percent of the THLB is comprised of mixed-wood stands.

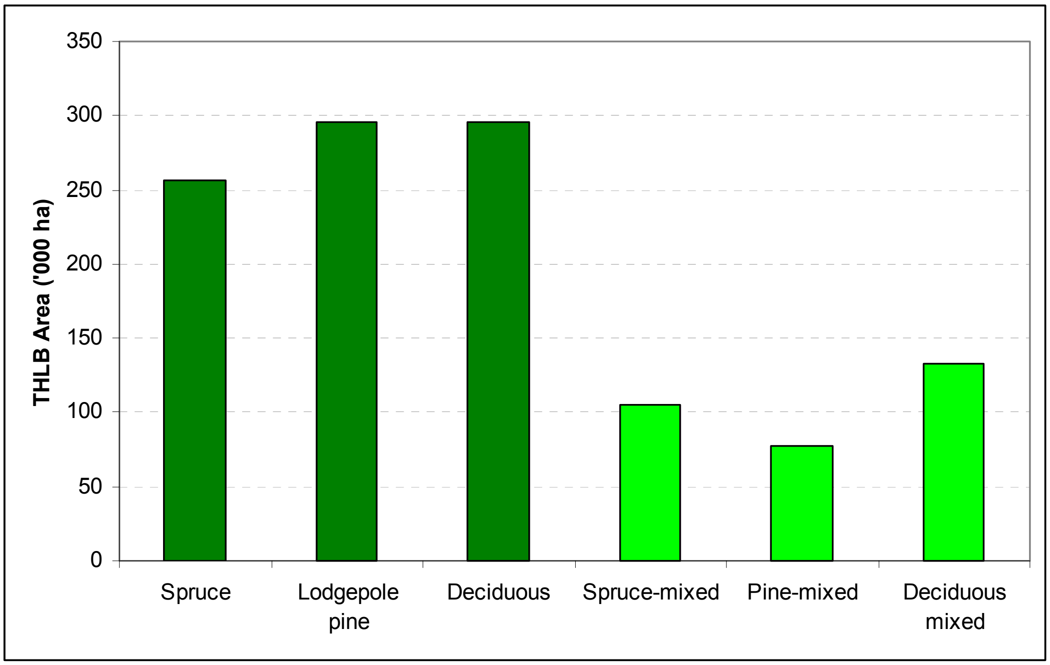

Figure 4 Species Distribution - Fort St. John TSA

2.3 Analysis Model

The forest estate model used in this analysis is the B.C. Ministry of Forest's forest estate model "FSSIM version 3.0". This is an aspatial model that harvests stands according to their availability and age, subject to varied resource management constraints. For the most part, stands are not selected for harvesting as a consequence of their location in the landscape.

In Scenario 5 (Graham IRMP), a degree of spatial integrity is maintained by spatially and temporally harvesting cut-block clusters. The area and timing of harvest was in reference to the design and harvest schedule proposed in the Graham River Integrated Resource Management Plan.

2.4 Management Practices

Management practices in the Fort St John TSA are largely guided by the Forest Practices Code of BC Act and associated regulations. The practices identified in this Act and Regulations that most directly influence short and long-term timber management is provided in Appendix I.

The scenarios examined in this analysis evaluate the change in some key management practices. A brief description of some of these key management assumptions follow:

- In all scenarios, three independent harvest forecast are modeled. One forecast for each of the traditional conifer land base, the deciduous land base and the small diameter pine land base.

- Silviculture management remains unchanged in all scenarios. Based upon TSR2 modeling assumptions, the treatment of stands pre and post-harvesting follows a system of clear-cutting with reserves, followed by stand re-establishment by either planting or natural regeneration.

- Forest health and unsalvaged losses remain the same in all scenarios. Losses are based upon the TSR2 expected average annual loss of 37,500 m^3/year of merchantable volume. This loss is applied only to the traditional coniferous land base and <u>all harvest flows graphed in this report are net of non recoverable losses.</u>

- Timber utilization remains unchanged in all scenarios and is based upon TSR2 assumptions regarding the size of trees and logs removed during harvest.

- Maintenance of scenic values occurs through an established visual landscape inventory and forest cover targets on this inventory. Visual quality objectives applicable to scenic areas remain unchanged in all scenarios.

- Cut-block adjacency was modeled in Scenario 1, by ensuring that the area within the IRM zone that does not meet green-up does not exceed a maximum of 40%. All other scenarios involved modeling according to natural disturbance units and have cut-block adjacency constraints removed.

- Caribou habitat values are maintained in all scenarios through forest cover targets (i.e., Kobes Creek, Graham and Hackney Hills) and through adjacency constraints (ie, Milligan Hills).

- Minimum harvest ages define the time it takes a stand to reach a merchantable condition with respect to volume/hectare. The minimum volume targets vary for coniferous based upon operability (e.g., licensees require 140 m^3/ha for operations on conventional ground and 250m^3/ha for operations on cable ground). Volume targets for deciduous are 120 m^3/ha. The minimum harvest ages used in this analysis remain unchanged between scenarios. The targets follow the values applied by the MOF in TSR2.

- Stand level biodiversity is maintained in all scenarios through a merchantable area reduction for wildlife tree patches (WTPs). WTP area reductions were applied based upon landscape unit name. This analysis utilizes far fewer landscape units then was used in TSR2. Hence the target values have been adjusted accordingly.

- Landscape level biodiversity is maintained through forest cover targets. This analysis diverges from the traditional FPC Act biodiversity guidebook's natural disturbance types (NDTs), and replaces those guidelines with recommended natural disturbance unit seral stage targets developed for the Prince George Forest Region. Only scenario 1 in this analysis utilizes NDTs. All other scenarios test the impact of managing for NDU landscape level old growth targets.

- The maintenance of water quality is managed by the establishment of a peak flow index applicable to defined watersheds. Each watershed has equivalent clear-cut area (ECA) forest cover targets. These watersheds and their associated targets are applied in Scenarios 3-5.

- Some forest lands are kept in an early seral stage through regular controlled burns for range and wildlife management. These areas do not contribute to timber supply, but can affect the amount of area outside burns required for old growth biodiversity.

- The Graham River Integrated Resource Plan was incorporated in Scenario 5. This IRMP spatially identified and scheduled cut-block clusters for harvesting over a very long planning horizon. THLB area adjacent to, but outside these clusters and associated riparian management zones, were excluded from any future harvesting opportunities.

2.4.1 Defined Management Areas

Management practices associated with several of the preceding bullets are summarized in the figures that follow. Additional information pertaining to the forest cover constraints applicable to each of these areas is provided in Appendix I. Figure 5 shows the area within management zones relative to the total productive forest. Note that defined management areas are not mutually exclusive of one another. Overlap between zones can exist.

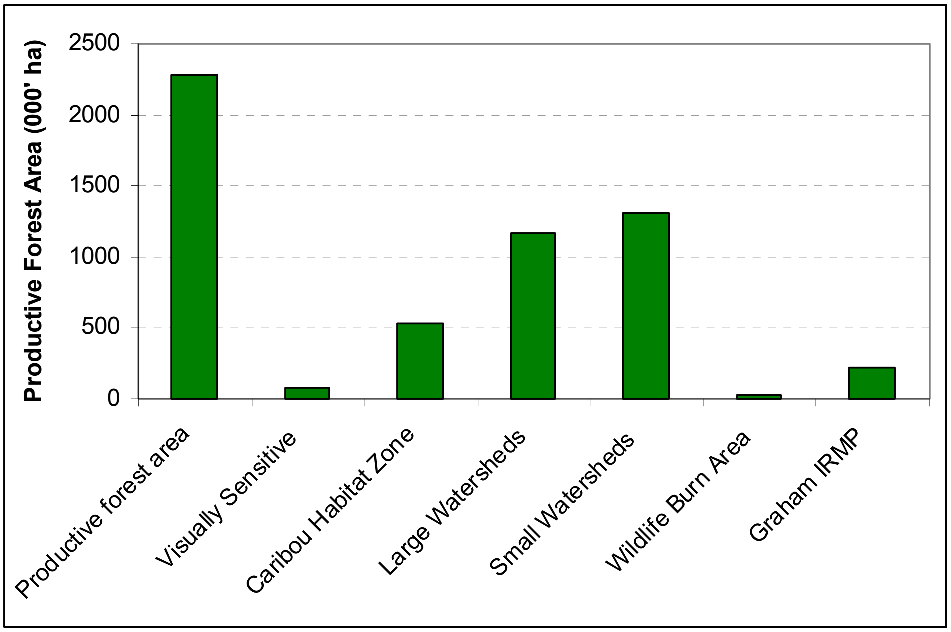

Figure 5 Defined Forest Management Areas

Visually Sensitive Areas

Visually sensitive areas cover only a very small portion (3.5 percent) of the TSA. These areas are classifications by their visual quality objectives (VQO), to which forest cover targets are applied. Figure 6 shows the relative distribution of VQO classifications across visually sensitive inventory area. Both the THLB and the non-contributing land base (NCLB) contribute to achieving visually quality objectives. Forest cover targets were applied at the VQO/landscape unit level.

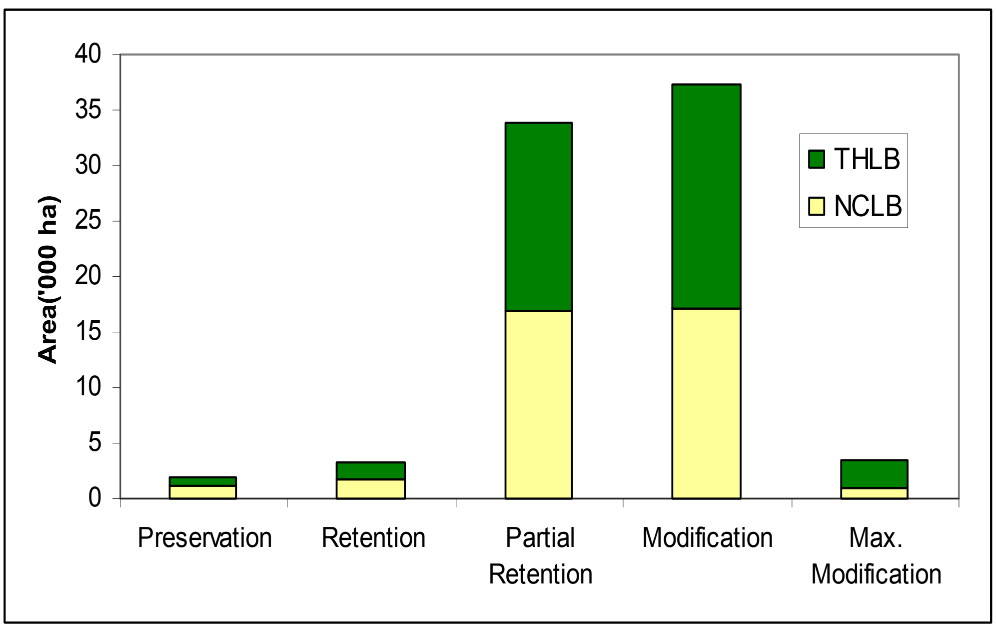

Figure 6 Visually Sensitive Areas

Caribou Habitat

Four caribou habitat zones have been spatially defined in this analysis. These zones cover approximately 24 percent of the TSA. Figure 7 describes these zones relative to one another. The Graham, Hackney Hills and Kobes Creek habitat areas are managed for old growth. The Milligan Hills area is managed for cut -block adjacency.

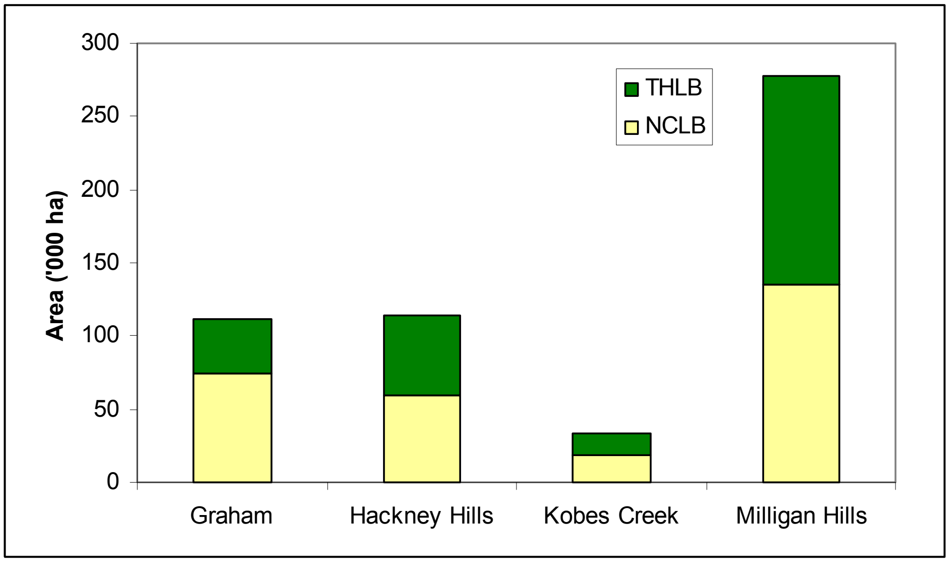

Figure 7 Caribou Habitat

BEC variants versus NDUs

A major change in management for biological diversity involves the incorporation of natural disturbance units as a planning tool across the Prince George Forest Region. NDUs are a relatively recent development in British Columbia's evolutionary progress to utilize best available information in the formulation of management planning guidelines. The Forest Practices Code biodiversity guidebook incorporated natural disturbance types utilizing biogeoclimatic ecosystem classifications for which old growth forest cover targets where determined. NDUs reflect a move towards the utilization of technically supportable guidelines utilizing spatially defined geographic areas and considerable research into natural disturbance patterns. This work was completed by the MOF at the Prince George Regional Office. The distribution of forested areas within NDTs and NDUs is shown in Figures 8 and 9.

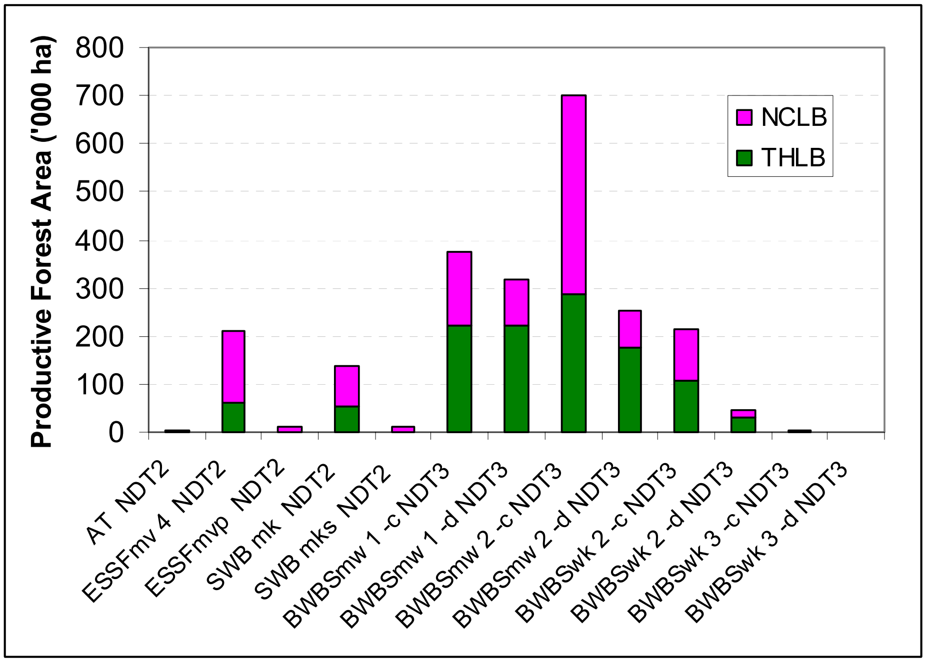

Figure 8 Forest Area by BEC, NDT - Fort St. John TSA

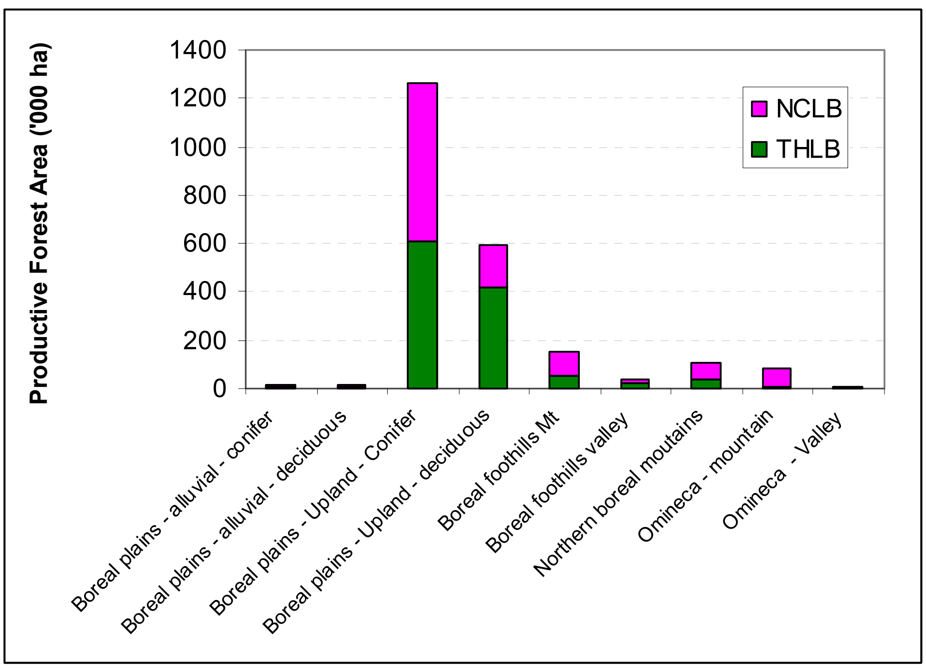

Figure 9 Forest Area by Natural Disturbance Unit – Fort St. John TSA

Watersheds and Equivalent Clear Cut Area (ECA)

As part of the Fort St. John SFMP project, watersheds have been delineated across most of the TSA. The watersheds vary in size from 900 hectares to over 170,000 hectares with many smaller watersheds existing within larger ones. Forest cover equivalent clear-cut area targets have been recommended for all of these watersheds. Figure 10 shows the broad extent to which watershed areas have been defined across the TSA.

Equivalent clear-cut area or "ECA" is used to estimate the average height required by plantations to achieve hydrologic recovery within a watershed. Most hydrologic impacts occur during periods of peak stream flow – usually during the springtime. After an area is harvested, both winter snow accumulation and spring melt rates' increase. As harvested areas are replanted and these plantations grow, the amount of snow accumulation and rate of snow melt are reduced. This reduction occurs as a result of the extent that the snow pack is exposed to solar radiation. The process is referred to as 'hydrologic recovery'. This analysis placed cumulative forest cover constraints on a watershed, thereby controlling the amount of forest land existing under a specified height. This should ensure that excessive timber harvesting in a watershed does not result in significant watershed damage.

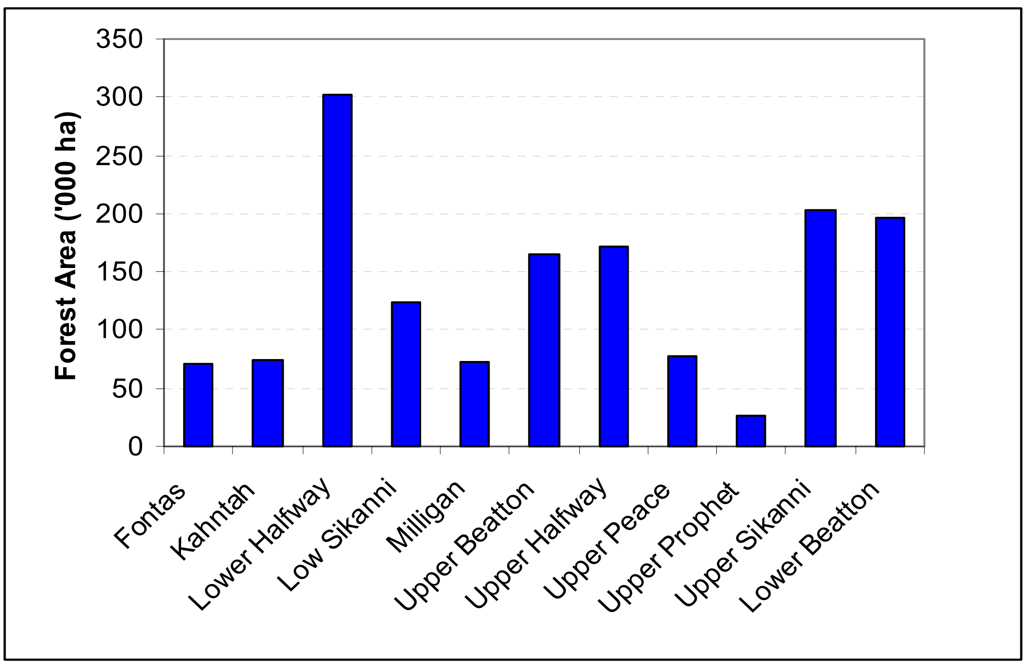

Figure 10 General Watershed Areas

Graham River Integrated Resource Plan

Forest management within the Graham River Valley has been refined for short and long-term management through a comprehensive integrated resource management plan. The acceptance of this plan by Graham River resource users led to the spatially explicit delineation of cut blocks and riparian corridors. A harvest schedule was proposed for these cut-blocks. Scenario 5 in this analysis incorporates this plan within the timber supply analysis. THLB area outside cut-blocks and riparian reserves were added to the non-contributing land base. The IRMP covers approximately 157,000 hectares in the TSA. From this area 24,022 hectares are identified in cut-block clusters or riparian areas as contributing to the THLB. The remaining area outside of clusters will not be harvested under this plan. Figure 11 defines this area and the associated harvest schedule.

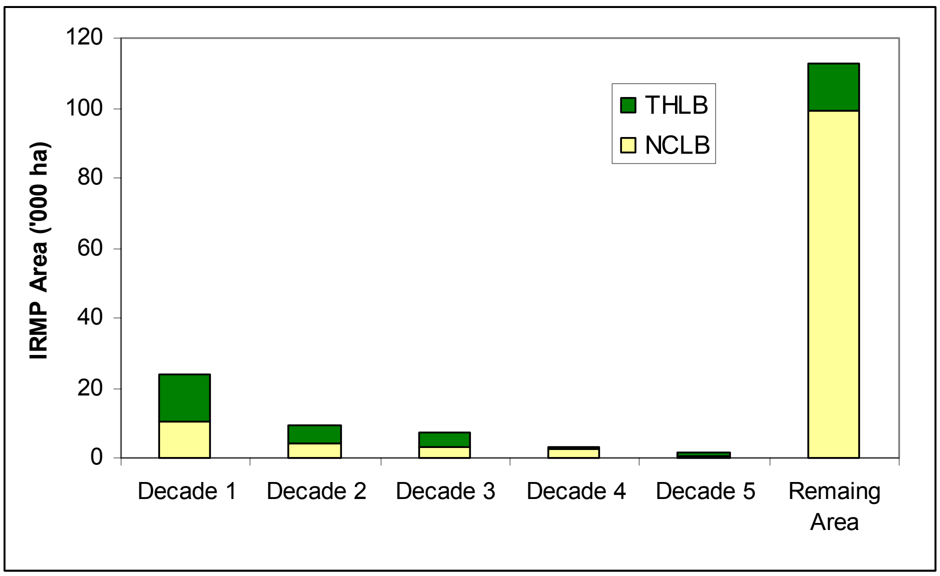

Figure 11 Graham River IRMP

3.0 Results

Five scenarios are examined in this analysis report. None of the scenarios are identified as a standard "Base Case", since the intent of this analysis was not to identify a sustainable harvest based upon current management practices, but to evaluate different management alternatives in support of a Sustainable Forest Management Plan.

3.1 Harvest flow

Harvest flow describes the sustainable harvest level for the TSA for the short, mid and long-term. The harvest flows shown in this report are net of non-recoverable losses and are supportable for a 400-year period. In each scenario, three harvest flows were determined. These are:

- A flat line non-declining traditional coniferous harvest level;
- A small-diameter lodgepole pine harvest level; and
- A deciduous harvest level that begins above the long-term sustainable harvest flow, and is followed by a maximum 10% per decade step down to the non-declining harvest level.

In each case an area-based disturbance target was directed at stands outside the THLB. This was done to cycle a certain level of mortality in the forested non-contributing land base

3.1.1 Scenario 1 – TSR2 Mimic

Forest estate modeling assumptions incorporated in this scenario follow very closely the land base and related assumptions developed by the Ministry of Forests for the Fort St. John Timber Supply Review (June 2002) Base Case Scenario. The harvest flow in Figure 12 shows a total initial harvest level of 2,750,000m^3/year. This harvest level is only 31,000 m^3 or 1.1 percent greater than the MOF's TSR2 Base forecast. The closeness of the result provides sufficient comfort to conclude that the forest estate model re-constructed for this analysis is capable of replicating TSR2 results, in light of changes to some inventories and various management assumptions.

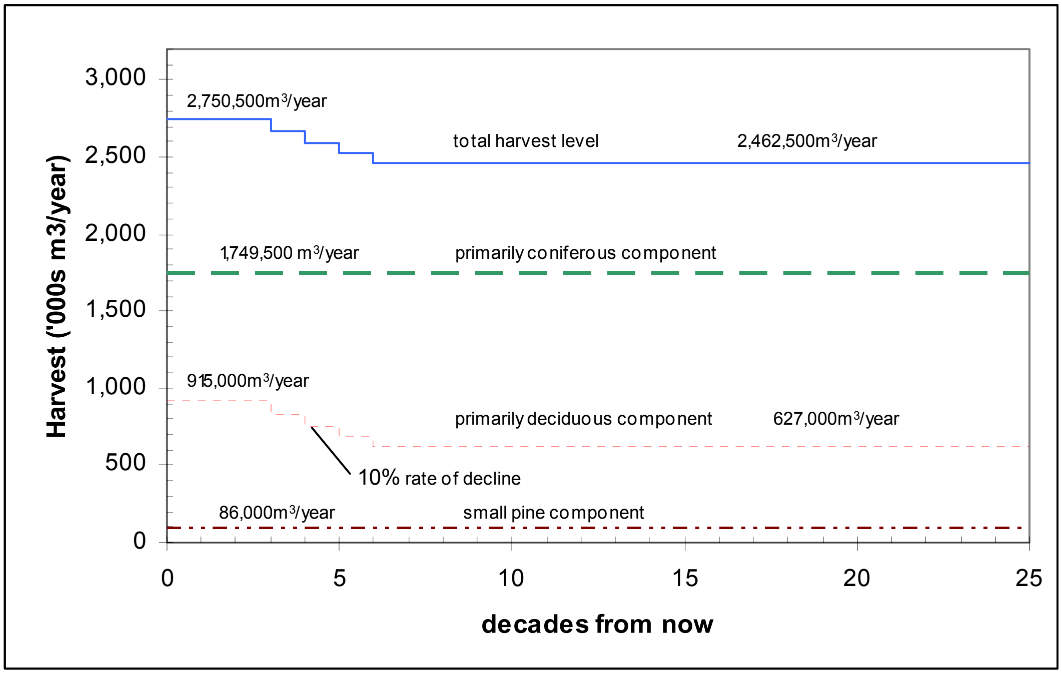

Figure 12 Scenario 1 harvest flow - TSR2 base case

Figure 12 also shows that the total TSA harvest has been apportioned to three defined land bases. The traditional coniferous land base can support a non-declining net harvest level of 1,749,500m^3/year. Although this is 3.3 percent greater than the harvest determined in TSR2, the difference can be generally explained by:

a) An increase in the traditional coniferous THLB by 1.5 percent (i.e., area has shifted from small pine to the traditional conifer THLB).

b) Grouping landscape units into larger contiguous management areas.

c) Small shifts in the amount of THLB associated with each analysis unit.

d) Use of a "relative oldest first" harvest rule in this analysis versus "random harvesting" in TSR2 (relative oldest first was used to better quantify the change in harvesting as a result of changes in management assumptions).

The small-pine harvest level has dropped significantly relative to the TSR2 results. A long-term harvest level of 86,000m^3/year is 22 percent less than the 110,000m^3/year reported in the TSR2 Report. A relatively significant portion of the area previously considered small-pine has shifted to the traditional conifer land base. The reason for the shift is a combination of the updated VRI forest inventory and slight variations in analysis unit programming logic.

The deciduous land base can continue to support an initial accelerated harvest of 915,000m^3/year for the next 30 years. This harvest then falls 10 percent per decade to the long-term harvest level of 627,000m^3/year (5,000m^3/year less than the TSR2 results). The difference in long-term harvest level is relatively small, in light of the 6 percent decrease in the deciduous THLB. Additional analysis, in regards to deciduous land base availability and yield and successional assumptions, needs to be undertaken; hence the results were deemed to be a reasonable representation of the sustainable deciduous harvest flow.

3.1.2 Scenario 2 NDU Analysis and an Enhanced Deciduous THLB

The participants of the Fort St. John results-based code pilot project have proposed a SFM plan that would manage forests according to a more natural range of variation then is currently advocated by the FPC biodiversity guidebook. The proposed plan would emulate patterns of natural disturbance at a landscape level, as opposed to management strategies directed at individual stands or cut-blocks. This scenario evaluates the move towards adopting natural disturbance indicators developed by the MOF's ecologist for the Prince George Region[1]. Several other changes to Scenario 1 were also incorporated in this scenario. To summarize these changes:

a) The deciduous land base was increased to include deciduous leading stands previously excluded from the THLB due to their being considered problem forest types. The inclusion of these stands increased the deciduous THLB by 41 percent (i.e., 124,290 ha) to 429,012.

b) Growth and yield from deciduous-leading stands was limited to a defined maximum age (155 years). Stands exceeding this age (if not harvested) reverted back to an immature unmanaged stand.

c) The non-contributing land base in both Scenario 1 and this scenario is cycled to reflect stand mortality from disturbance. Scenario 1 cycled the NCLB at a rate of 5,000 ha per year. Scenario 2 cycled stands based upon stand replacement disturbance cycles by NDU. Scenario 2 cycled the NCLB at a rate of approximately 1,105 ha per year.

d) The estimated loss to the THLB through the construction of future roads, trails and landings was increased from 0.6 percent in Scenario 1 to 6.4 percent.

Figure 13 shows the harvest flows that result from these changes. The initial TSA harvest level of 2,816,500m^3/year is 2.4 percent greater than in Scenario 1. Specifically, the traditional coniferous harvest has decreased from 1,749,500 to 1,693,500m^3/year; the small pine harvest has decreased from 86,000 to 83,000m^3/year; the deciduous allotment has increased from 915,000 to 1,040,000 m^3/year, and remains at this level for an additional 30 years before sinking to a long-term sustainable level.

Too many changes where made in the transition from Scenario 1 to Scenario 2 to fully analyze the incremental effect of each change. The increase in the deciduous THLB undoubtedly had a positive effect on the total deciduous harvest level. Increasing the estimated losses to future roads will have a negative effect on the long-term harvest level. The effect of managing for NDUs was unknown. Further analysis was undertaken. The stepwise change from NDT management to NDU management (i.e., whereby minimum NDU targets were applied to Scenario 1 in

[1] Natural Disturbance Units of the Prince George Forest Region: Guidance for Sustainable Forest Management, 2002. DeLong, Unpublished 2002

replace of NDT targets) revealed that this change had a very minor (e.g., <1%) positive impact on sustainable harvest levels.

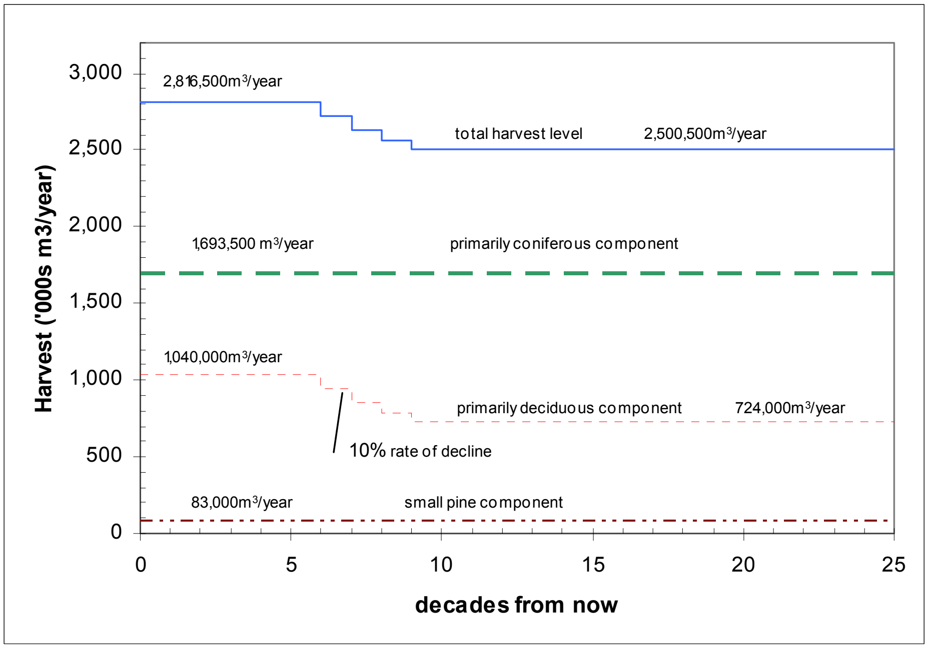

Figure 13 Scenario 2 harvest flow – Minimum NDUs

3.1.3 Scenario 3 – Watersheds

Incorporating watersheds into the harvest simulation was done incrementally by building on Scenario 2. Over 80 defined watersheds covering 1,564,164 hectares of forest land were modeled using equivalent clear cut area constraints. Greenup targets of 3, 5, 7 and 9 metres were applied to each watershed. Many of the watersheds were relatively small and overlapped with larger watersheds, thus more than one ECA target may have been applied to a forest stand. Further detailed information is provided in Appendix I, Section 2. The short and long-term timber supply impact of managing for watersheds using ECA is nil. The harvest flow described in Figure 13 is fully supportable, with the inclusion of watershed ECA targets in the timber supply model.

3.1.4 Scenario 4 – Biodiversity Emphasis Options

Previous to this point in the analysis, the constraints applied to the NDU/landscape unit areas were the minimum old growth targets (e.g., old growth is defined as stands ≥140 years) suggested in the Prince George Region natural disturbance unit document. The exception was deciduous leading stands in the Omineca NDU where the minimum NDU constraint was defined as the maintenance of 10% forest area above 120 years of age. This old growth target was determined through consultation with Craig Delong, the MOF's regional ecologist.

Biodiversity emphasis options (BEOs) have been proposed for landscape units within the TSA. The effect of these proposed BEOs was tested by applying the range of variability applicable to NDU old growth targets according to the biodiversity emphasis assigned to each landscape unit. High BEO landscape units were assigned the maximum old growth targets applicable for the NDU. Intermediate BEO landscape units were assigned mean old growth targets, and low BEO landscape units were assigned minimum NDU old growth targets.

The effect of this BEO assignment on the harvest flow is shown in Figure 14. BEOs have a very small effect on the TSA harvest levels. In the short-term the harvest flow falls only 0.2 percent. In the long-term the fall-down is slightly greater than 1 percent.

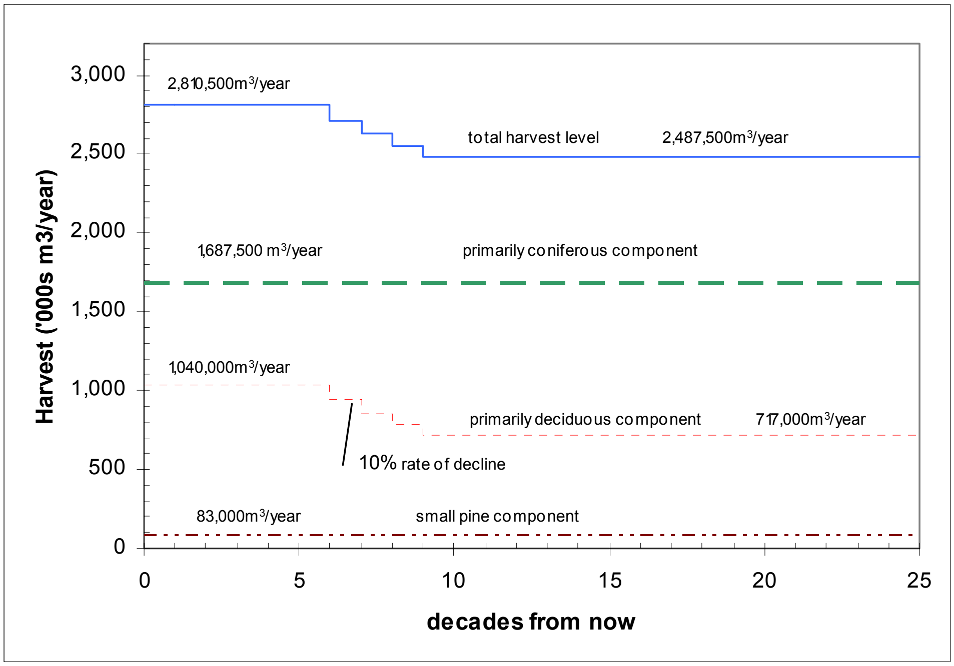

Figure 14 Scenario 4 harvest flow - Biodiversity Emphasis Options

3.1.5 Scenario 5 – Graham River Integrated Resource Management Plan

An integrated resource management plan (IRMP) was developed by Canfor for the Graham River Valley. A harvest plan was constructed with consideration given to scenic values, wildlife, recreation, hunting/fishing, and timber production. The geographic area is defined as the Crying Girl landscape unit and the Graham River landscape unit where it exists within the Omineca NDU. Within this area, clusters of cut-blocks were spatially delineated and a harvest schedule was prescribed. Riparian zones, inside and adjacent to clusters, were also defined. A maximum 10 percent of the area within riparian zones is considered available for harvest. All other area outside clusters and outside riparian zones was excluded from future harvesting.

The Graham IRM plan has a significant impact on the THLB for the entire TSA. The THLB was reduced by 13,234 ha (1.1%) for operable area adjacent to, but outside riparian areas and clusters.

The resultant harvest flow is provided in Figure 15. The initial net harvest level in for Scenario 15 is 2,769,500m^3/year for the TSA. This is sustainable for 60-years before beginning four declines of 10 percent per decade. In 90 years the long-term sustainable harvest level of 2,445,500m^3/year is achieved.

In Scenario 5, the coniferous and small pine harvest levels drop 2.2 and 5.1 percent respectively. This occurs primarily as a result of lost timber production opportunities in areas outside the IRMP harvest plan. The deciduous harvest level is not affected in the short or mid-term. A very small deciduous harvest reduction is forecast for the long-term. Very little of the Graham Valley has merchantable deciduous stands.

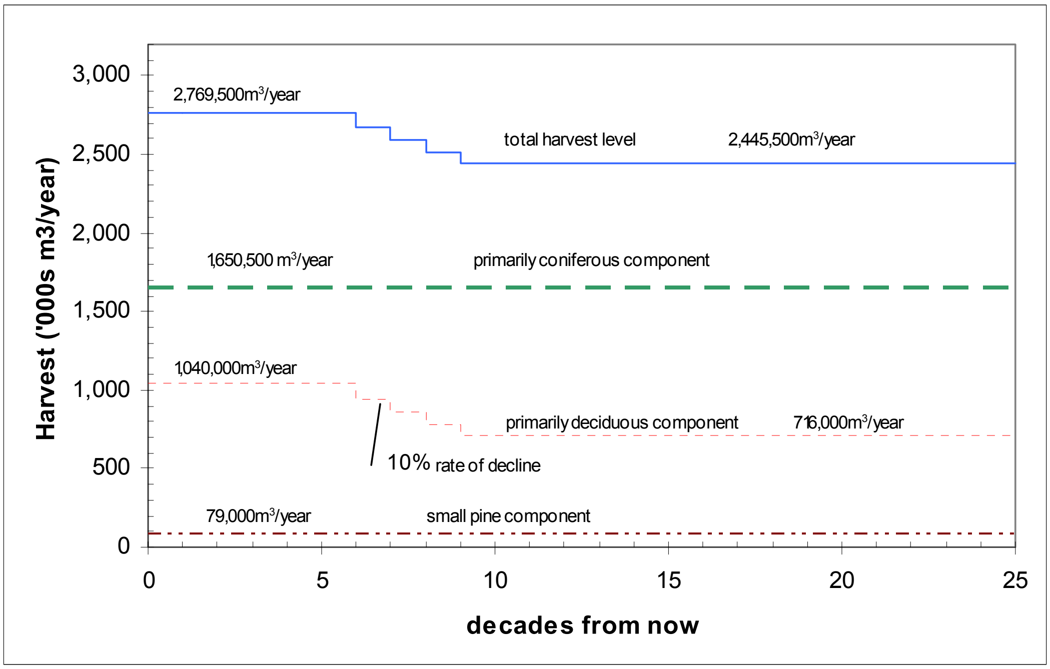

Figure 15 Scenario 5 harvest flow - Graham River IRMP

3.1.6 Scenario 5 - Additional Sensitivity Analysis

Additional sensitivity analysis was completed on Scenario 5. The sensitivity centered around 2 management assumptions:

a) All scenarios to this point included black spruce as contributing to biodiversity. Within the Fort St. John TSA, extensive areas of black spruce exist. These areas significantly mitigate the impact of forest cover constraints on the THLB. The timber supply impact of removing these expanses of black spruce from contributing to forest cover old growth targets was assessed.

b) All scenarios utilized a relative oldest first harvest rule. This was contrary to the TSR, which utilized a random harvest rule. The relative oldest first rule was chosen because it removed the possibility of a change in the analysis results, simply due to a change in the order of the input files.

The results for scenario 5(a) and scenario 5(b) are provided in Figures 20 and 21 respectively. Excluding black spruce (and range/wildlife burn areas) from contributing to biodiversity reduces the NCLB by 355,000 hectares or 32 percent. This has a significant impact on the timber that would otherwise contribute to biodiversity.

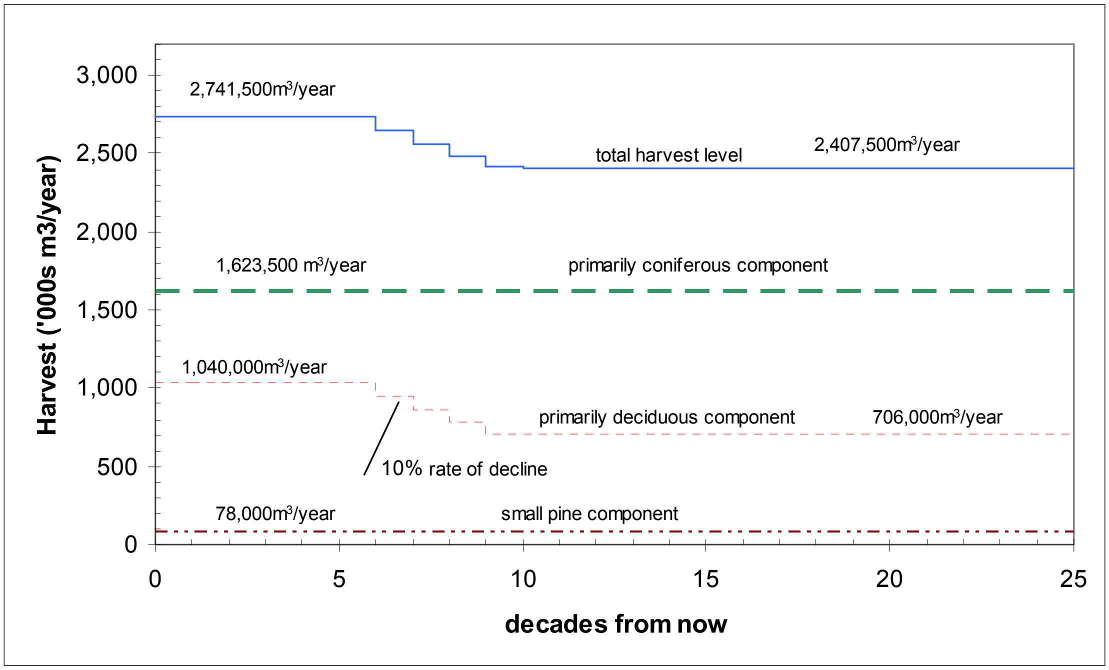

Figure 16 Scenario 5(a) harvest flow - Black Spruce Excluded from NCLB

A random harvest rule results in a very significant change to the sustainable harvest level for the TSA. Using this harvest rule, the total short-term harvest is sustainable for only 30 years, at a level of 2.38 million m^3/year. This is a 14 percent reduction from the original Scenario 5 which used a relative oldest first rule. After 7 decades, a long term harvest flow of 1.99 million m^3/year is reached..

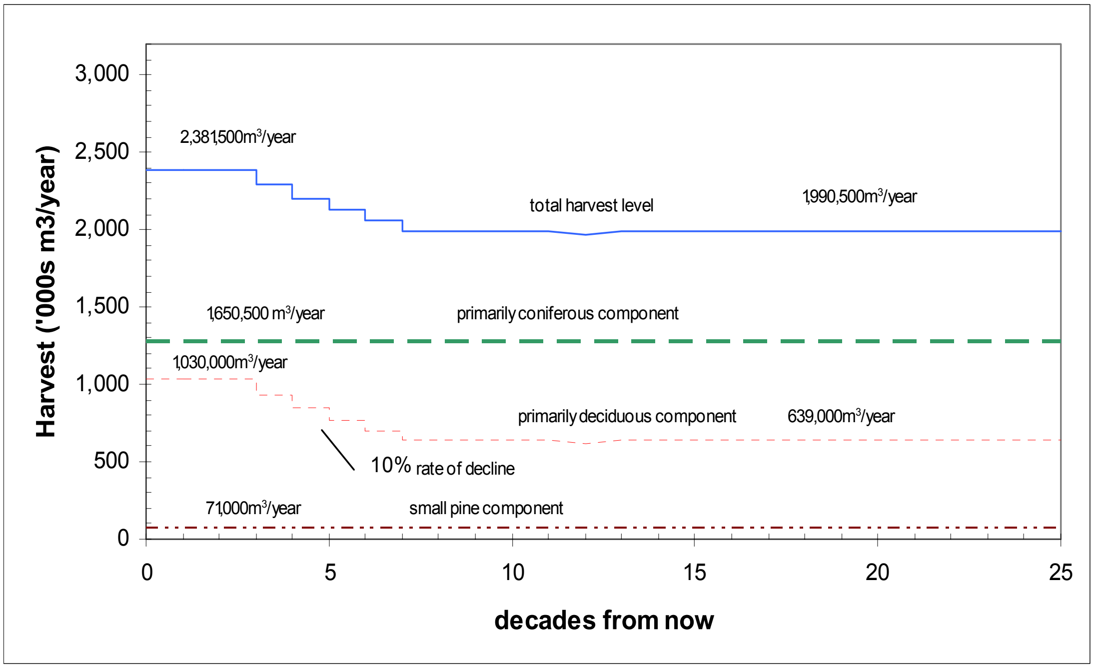

Figure 17 Scenario 5(b) harvest flow - Random Harvest Rule

3.1.7 Harvest flow summary information

Table 2 provides a tabular comparative summary of the harvest flow results for the preceding scenarios.

Table 2 Harvest flow results summary

Scenario	Description	THLB Area (ha)		Annual Harvest Levels (m3/year)					Percent change from S1 (short term)
				Leading Conifer	Leading Deciduous		Total		
		Conifer	Deciduous		Short Term	Long term	Short term	Long-term	
n/a	MOF TSR2	733,221	325,318	1,804,000	915,000	632,000	2,719,000	2,425,000	-1.15
S1	TSR2 mimic	733,206	305,150	1,835,500	915,000	627,000	2,750,500	2,462,500	0.00
S2	NDU	733,206	429,440	1,776,500	1,040,000	724,000	2,816,500	2,500,500	2.40
S3	Watersheds	733,206	429,440	1,776,500	1,040,000	724,000	2,816,500	2,500,500	2.40
S4	BEO	733,206	429,440	1,770,500	1,040,000	717,000	2,810,500	2,487,500	2.18
S5	Graham IRMP	720,267	429,144	1,729,500	1,040,000	716,000	2,769,500	2,445,500	-0.69
S5a	Graham – No Sb	720,267	429,144	1,701,500	1,040,000	706,000	2,741,500	2,407,500	-0.30
S5b	Graham - Random	720,267	429,144	1,721,500	1,030,000	639,000	2,751,500	2,360,500	0.00

The harvest flow results shown in Table 2 reveal that the Fort St. John TSA is very resilient to changes in management direction. This is a directed function of 2 overriding features: 1) the existing age class distribution indicates that approximately 73 percent of the THLB is merchantable and a large portion of this area can support both harvesting and old growth biodiversity; 2) the THLB includes only about 50% of the forested land base. Even with disturbance cycling, the non-contributing land base can support most of the short and long-term forest cover requirements that would otherwise constrain a harvest flow.

The sections following provide additional information about the consequences of harvest activities on the growing stock, and age class distributions across the TSA. For the sake of brevity, only the results for Scenario 5 are provided. Analysis of these results indicates that in most cases, only minor changes occur between the scenarios.

3.2 Growing Stock

For Scenario 5, Figure 18 shows the change in the THLB growing stock over time. Incorporating the expanded deciduous land base, the total THLB growing stock begins at about 180 million cubic metres and then declines rapidly over the next 10 decades. The THLB total growing stock stabilizes at about 95 million cubic metres. Most of this volume is coniferous. Figure 18 also shows the total growing stock for coniferous leading and deciduous leading stands. The TSA will eventually support a coniferous inventory of 73 million cubic metres and a deciduous inventory of 22 million cubic metres.

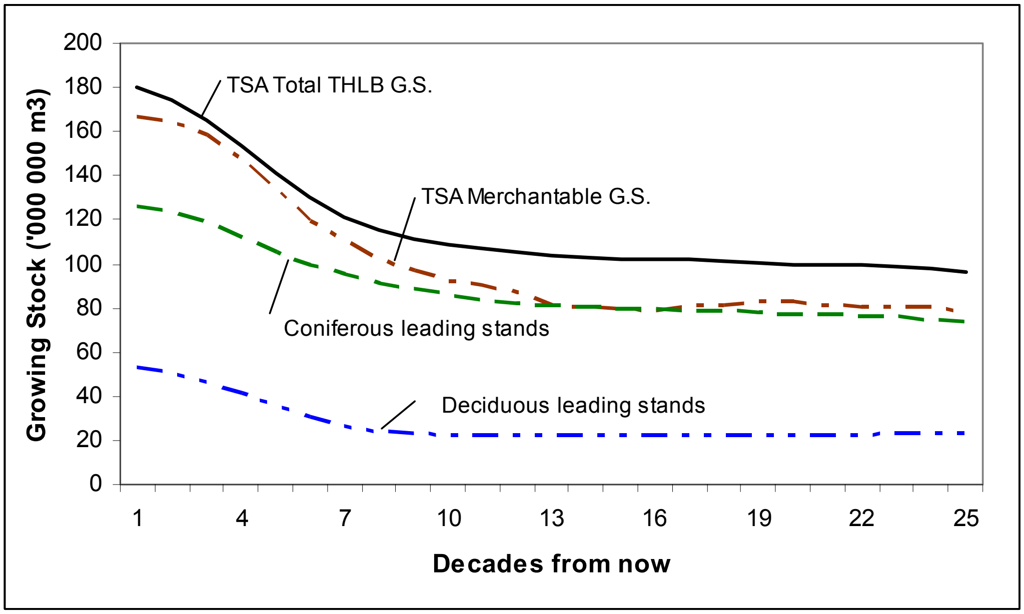

Figure 18 Change in growing stocks - Scenario 5 Fort St. John TSA

Yield tables for the non-contributing land base were not created in this analysis. However, when an area-weighted unmanaged stand yield table representing the THLB was applied to the NCLB, the result shown in Figure 19 is representative of the total expected change in the inventory for all productive forest stands in the TSA as-a-whole. Approximately 50 percent more growing stock exists across the TSA then is currently represented by the THLB. Although many of these stands are cycled (i.e., die through mortality and/or disturbance) the overall growing stock rises over time to about 500 million cubic metres. It is important to note that large catastrophic events are not modeled. Mortality equivalent to 1100 ha per year and periodic range and wildlife burns are modeled.

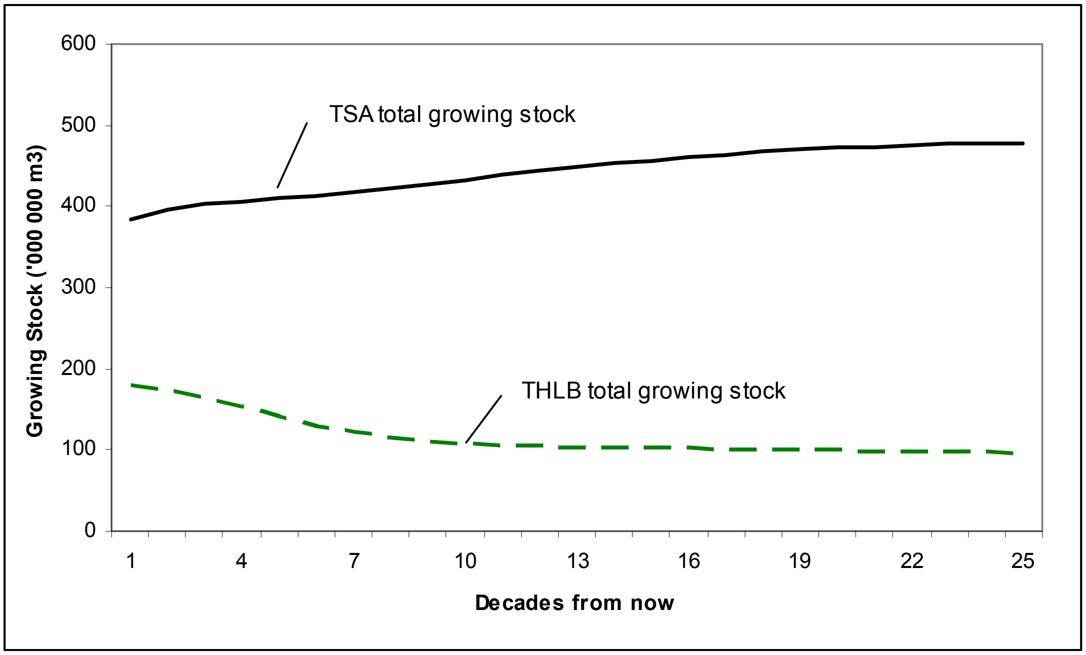

Figure 19 Total growing stock - Fort St. John TSA

3.3 Changing Age Class Distributions

Figure 20 plots the age class distribution of the timber harvesting land base over time. The graph reveals that harvesting transforms the THLB into a mostly normalized forest, with the majority of stands less than 120 years of age. The small amount of area in older age classes are representative of small, highly constrained areas (i.e., visually sensitive areas with a preservation or retention VQO) that hold area in reserve for other resource concerns.

Figure 21 also plots age class distribution over time, but is representative of the entire forested land base. Here, considerably more area is forecast to eventually exist in older age classes. Most of this area is representative of forests that do not contribute to the sustainable harvest levels.

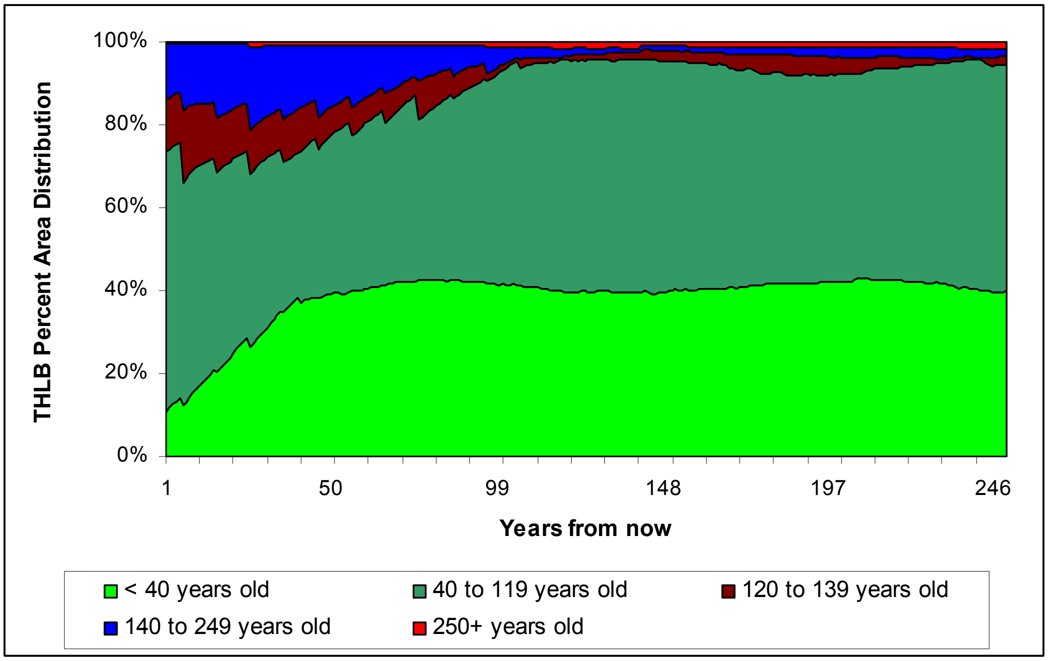

Figure 20 Age class distribution of the THLB over time

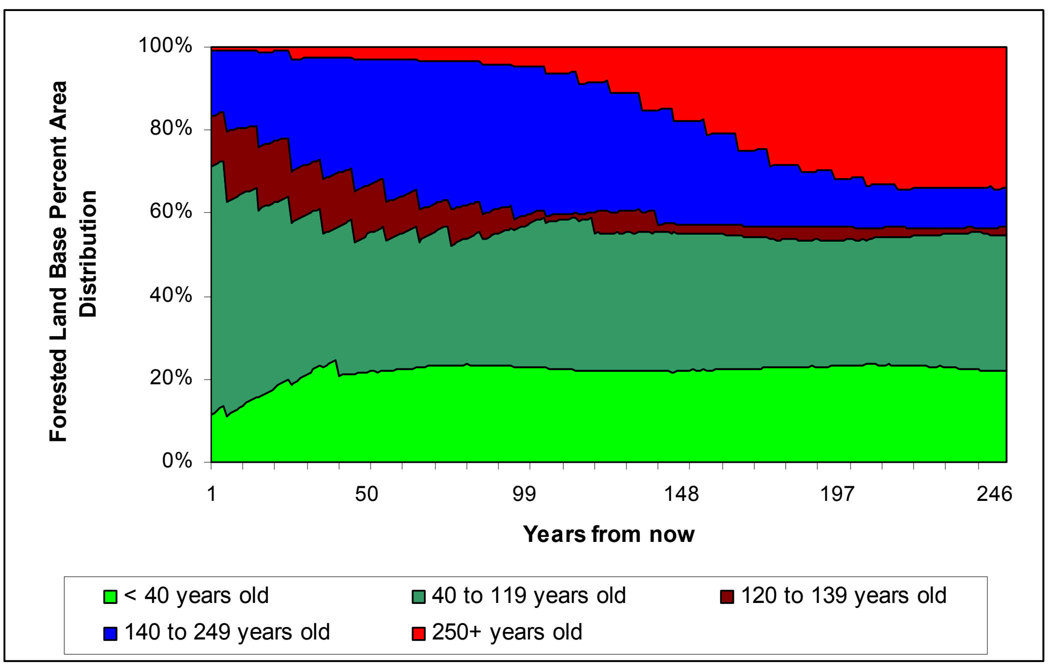

Figure 21 Age class distribution of the entire forested land base over time

3.4 Carbon Cycling

The timber supply model was not originally constructed to model the amount of carbon sequestration over time, for the forest stands within the TSA. Near the completion of this analysis, the desire to show the impact of forest management on carbon cycling became apparent. Carbon tables were created by Dr. Brad Seely (Forest Ecosystem Management Simulation Group, UBC) that described the amount of carbon in forest stands existing and forecast to exist in the Fort St. John TSA. These carbon tables were linked to the existing forest cover analysis units used in this project. The age class distributions of all analysis units, over a 400-year simulation period, were multiplied by the amount of carbon within each stand to describe the trend in carbon sequestration over time. Figures 22 and 23 show the total amount of ecosystem carbon over time and the rate of carbon sequestration.

- Line 1 is representative of the amount of carbon under the Scenario 5 harvest flow.
- Line 2 is representative of carbon under Scenario 5b, using a random harvest selection and the current apportioned allowable annual cut.
- Line 3 is representative of carbon sequestration if no harvesting occurred and the forest land base cycled naturally at a rate of approximately 20,000 hectares per year (based upon NDU disturbance rates).

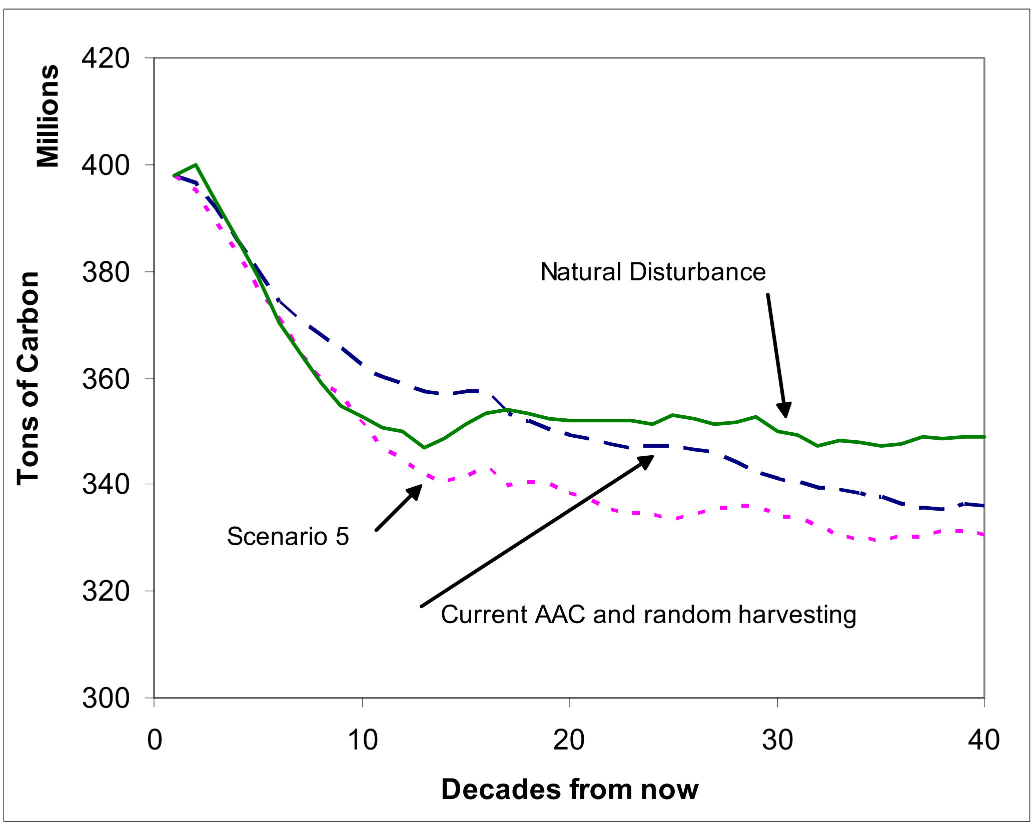

Figure 22 Total ecosystem carbon over time – Fort St. John TSA

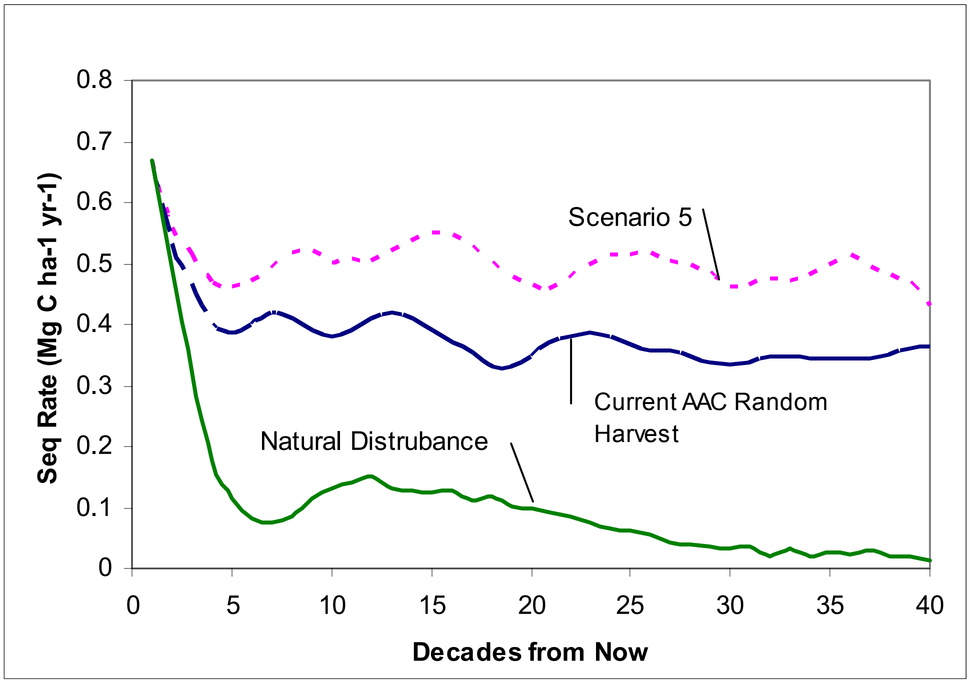

Figure 23 Rate of carbon sequestration – Fort St. John TSA

4.0 Summary and conclusions

A timber supply analysis was assessed for small pine, traditional conifer and deciduous leading stands in the Fort St. John TSA. The analysis began with the resurrection of the MOF's Base Case timber supply analysis scenario, but incorporated new inventories, revised landscape units and some small modifications to management assumptions. The results determined in a new base case (Scenario 1) were sufficiently close to the MOF's results to conclude that the forest estate model used for this report provided a reasonable representation of the TSR2 Base Case.

In support of the results-based code pilot project, for which a sustainable forest management plan has been created, additional analysis was conducted. Several changes to Base Case management assumptions were incrementally applied to quantify the impact of various management initiatives.

Considerable opportunity exists to increase deciduous harvest levels through the inclusion of stands that the Base Case considered deciduous-leading problem forest types. This opportunity is supported by the TSR2 report, which also suggested that deciduous-leading stand volumes may be underestimated by 27 percent. A 41 percent area increase in the deciduous-leading THLB can produce an immediate 14 percent increase in the deciduous harvest level, and keep this level sustainable for an additional 30 years.

The adoption of natural disturbance units in place of FPC natural disturbance types, utilizing minimum old growth targets, does not improve or constrain timber availability appreciably.

Watersheds have been defined for most of the TSA. For each watershed a peak flow index was used to establish equivalent clear-cut area (ECA) targets. The TSA contains sufficient forest area in the non-contributing land base to mitigate timber supply harvest reductions as a result of watershed management.

Biodiversity emphasis options have been proposed for landscape units within the TSA. Once again, the amount of forest area in the NCLB alleviates any significant impacts of harvest constraints in landscape units designated a high or intermediate BEO. A small (i.e., 0.5%) decrease in the TSA harvest was the simulation result.

The Graham River IRMP has spatially defined a THLB and a harvest schedule for a small resource sensitive portion of the TSA. Incorporation of this spatial plan into the analysis results in a small (1.7 %) decrease in the harvest forecast. This reduction is partly in response to the decrease in the THLB and partially in response to a harvest schedule that does not schedule according a harvest plan that better maximizes mean annual increment.

Appendix I

Data Package
in support of the
Fort St. John Result Base Code Pilot
Timber Supply Analysis

Data Package in Support of the Fort St John Code Pilot Project

The following data package was created in support of the Fort St. John Code Pilot timber supply analysis report. The information and logic using in the creation of this Data Package followed, to a great extent, the logic, yield assumptions, management assumptions and land base assumptions created for and used by the B.C. Ministry of Forests (MOF) in the timber supply review (TSR2) for the Fort St. John TSA completed in June 2002. The reader should be aware that several items have changed since the completion of the Ministries TSR Analysis. These changes include an updated land base inventory, watershed coverage, revised landscape units, and proposed natural disturbance unit (NDU) boundaries. The scenarios that investigated alternative management strategies incorporate most if not all these changes. This data package is divided into 3 sections.

1. Land base inventory
2. Management Assumptions
3. Growth and Yield

These three general topics form the basis under which a timber supply forest estate model can be constructed.

Section 1. Land Base Inventory

Table A3 describes the inventory coverage's used in the creation of an Arc-Info GIS semi-spatially explicit resultant data base. The resultant data base was used to formulate the inventor for the forest estate model.

Table A3 Inventory Coverage's

Inventory Coverage	Date	Scale
Forest Cover	1964-1989 Updated to 2003	1:20,000
Vegetation Resource Inventory	2000 updated to 2003	1:20,000
Landscape Units	2003	1:20,000
Biogeoclimatic ecosystem classification		
Range burns	1998	1:250,000
Wildlife burns	1999	1:50,000
Visual quality objectives	1997	1:50,000
Recreation	1998	1:20,000
Natural Disturbance Units	2003	
Graham IRMP cut-blocks and riparian	1998	1:20,000
Pulpwood Areas	1996	1:20,000
Protected Areas	2003	1:20,000
Caribou Management Zones	1989	1:50,000

Fort St. Kohn LRMP Resource	1996	1:20,000
Region / Compartment boundaries	1989	1:50,000
Watersheds		1:20,000

As closely as possible, the net down logic used to identify the timber harvesting land base (THLB) was conducted as per the TSR2 net down. To this end, the MOF's timber supply analyst was greatly supportive in assisting with programming logic. The following sections describe the net down used in the creation of the revised THLB in support of the Fort St. John SFMP analysis.

TSA Area

The Fort St. John TSA area was spatially identified. All area outside the perimeter of the TSA was excluded from the analysis. The total area of the Fort St. John TSA covers 4,676,639 ha.

Reduction for Non-Forest

Non-forest areas were excluded from the productive forest land base using the Type ID indicator codes on the forest inventory files. Type ID 6, 7, and 8 were removed from the productive forest land base.

Reductions for woodlots

Woodlots were removed from the inventory file, using a new inventory coverage that was not available for the TSR2 analysis. As a result considerably more area was removed in this analysis for woodlots. Forest area in woodlots is not used in support of biodiversity or other forest cover requirements.

Reductions for Ownership

Ownership refers to the forested and non-forested parts of the TSA for which the MOF has management jurisdiction. The MOF does not have jurisdiction over private lands, federal lands, Indian reserves and municipal areas that exist within the TSA. These areas are removed from the productive forest land base. The areas are identified on the inventory files by an ownership code. All ownership codes 1N, 40N, 52N, 61C, 61N were removed from this analysis. The remaining ownership codes (i.e., 60N, 62C, 63N, 67N, 69C, 69N, 72B, 76N, 77N) were not removed in this analysis. The total area in each ownership code is provided in Table A4.

Table A4 Land Ownership

Ownership	Schedule	Total Area
0		1.0
1	N	90.7
40	N	505,576.1
52	N	6,705.2
60	N	2,603.9

61	C	41,753.2
61	N	1,055.0
62	C	3,996,735.9
63	N	440.2
67	N	68.8
69	C	113,239.6
69	N	663.4
76	N	76.7
77	N	7,629.2
	Total	**4,676,639.0**

Reductions for Range Lease

Range lease areas were identified in the analysis using a non-standard inventory file. All areas identified as a "LEASE" were removed from the analysis area. These areas were deemed to have an agricultural value that precluded long-term timber supply planning.

Table A5 Range Classifications

Range type	Area (ha)
N/A	4,354,587.9
LEASE	13,388.2
PERMIT	308,662.9
Total	**4,676,639.0**

Reductions for Parks

Parks are identified as provincial parks, new parks, ecological reserves and recreation areas. These areas have been excluded from the timber harvesting land base, but the forests within these parks can contribute towards achieving old growth and biodiversity targets. The areas in parks are identified by ownership codes and by the non-standard inventory coverage associated with the Fort St. John Land and Resource Management Plan (LRMP). The logic used to defined parks is as follows:

1) if the ownership coded was 69N
2) if the resource management zone designation was "park" or "ecological reserve".

Wherever these conditions were met the area was classified as a park.

Reductions for Non-commercial cover

Non-commercial brush species are identified on the standard inventory files as Type ID #5. These areas are excluded from BOTH the timber harvesting land base and from contributing to the productive forest land base. A total of 192,035 ha are classified as Type ID #5 in the Fort St. John TSA.

Reductions for Unclassified roads trails and landings

In the MOF's process of completing the analysis for TSR2, existing unclassified roads and landings were spatially identified using a GIS. This spatial classification resulted in an incredibly large data-set due to the countless sliver polygons created by road buffers (as well as stream, wetland and lakeshore buffers). To simplify the analysis, the original data-set was used to determine the percent area in each polygon that should have area removed for roads (as well as in streams, wetlands and lake buffers). This percentage was then used in place of the GIS spatial reduction. These reduction values were obtained from the MOF and applied to the FIP portion of the inventory files. This information was not available for the newer VRI portion of the inventory files. To address unclassified roads in the VRI database, a TSA average reduction of 0.15156 percent was calculated using the TSR2 net-down summary table.

Reductions for Riparian Areas around Lakes and Wetlands

As with the reduction for unclassified roads and landings, a percent reduction was applied for riparian areas around lakes and wetlands. For the FIP portion of the inventory files, the reduction was polygon specific and matched the percent reduction used by the MOF. The VRI portion of the inventory file used a reduction factor of 0.34387 percent, as determined again from the TSR2 net-down table.

Reductions for Riparian Areas around Streams

Once again, in the reduction for unclassified roads and landings, a percent reduction was applied for riparian areas around single and double line streams. For the FIP portion of the inventory files, the percent reduction was polygon specific and matched the percent reduction used by the MOF. The VRI portion of the inventory file used a reduction factor of 1.66 percent as determined using the TSR2 net-down table.

Reductions for Seismic Lines

Finally, a percent reduction was applied for the corridors created by the construction of seismic lines, gas lines and hydro lines. For the FIP portion of the inventory files, the reduction was matched the percent reduction used by the MOF. The VRI portion of the inventory file used a reduction factor of 0.67004 percent as determined using the TSR2 net-down table.

Reductions for Range and Wildlife Burn Areas

Range and wildlife burn areas are managed for range and/or wildlife use. Prescribed burning is used to keep these areas in an early seral stage, and as such they do not contribute to the THLB, but are part of the productive forest. Range and wildlife burn areas were identified using a non-standard inventory file. There were 3,886 ha removed for wildlife burn areas and 27,563 ha removed for range burn areas for a total reduction of 31,449 ha.

Reductions for Inaccessible Areas

Inaccessible areas were identified in the TSR as region compartment numbers located too far from a timber processing facility to justify the hauling cost at the present time and in the foreseeable future. This analysis expands on this reduction to also include areas that would otherwise fall into the THLB, but existed in an area having a biogeoclimatic ecosystem classification of AT or ESSFmvp. There were 2,063.5 ha of AT and 12,491.0 ha of ESSF mvp for a total reduction of 14,554.5 ha.

The reductions for inaccessible areas are presented in Table A6.

Table A6 Reductions for Inaccessible Areas

Region	Compartment	Productive Forest Area (ha)
78	104	2,764
78	105	1,421
79	178	1,134
79	182	1,425
79	183	3,080
	Sub-Total	**9,824**
Biogeoclimatic Ecosystem Classification		**Productive Forest Area (ha)**
Alpine Forest (AT)		2,063.5
ESSF mvp (Alpine parkland)		12,491.0
	Sub-Total	**14,554.5**

Reductions for Inoperable Areas

Inoperable areas are sites that are deemed to be isolated, or areas with impassable physical barriers (e.g. steep slopes). Classified by air-photo interpretation, these areas are delineated in the FIP file by the operability code “I” for inoperable. There were 20,408.4 ha removed from the THLB for inoperability. The remaining operable areas, have been categorized into one of three other operability codes (“A” for conventional, “C” for cable or “H” for cable/aerial) based upon their slope, soil/parent material and harvest system. Table A7 lists the operability codes and their associated area classifications.

Table A7 Operability

Operability	Productive Forest	Timber Harvesting
(A) Conventional	2,169,650.1	1,026,392.5
(C) Cable	86,005.8	11,954.1
(H) Aerial (heli)	109.8	9.0
(I) Inoperable	20,408.4	0
Total	**2,276,174.1**	**1,038,355.6**

Reductions for Non-merchantable Coniferous Leading Species

Non-merchantable coniferous leading types are physically operable stands that exceed minimum site criteria, are not currently utilized or have marginal merchantability. The areas removed for black spruce, hemlock and cedar leading stands are presented in Table A8.

Table A8 Coniferous Problem Forest Types

Type Group	Description	Percent	Area (ha)
21 to 26	Remove all SB leading stands	100	342,664.4
10, 16	Remove all Hw and Cw	100	35.9
Total			**342,700.3**

Reductions for Non-merchantable Deciduous Leading Species

Non-merchantable deciduous leading types are physically operable stands that exceed minimum site criteria, and are not currently utilized or have marginal merchantability. The area removed for deciduous-leading stands is presented in Table A9.

Table A9 Deciduous Problem Forest Types

Type Group(s)	Description	Percent	Forest
33, 34	Remove all larch (Lx) leading stands	100	3,213.6
35 to 38	Remove all stands with Ac > 49% (not	100	20,896.3
35, 37, 41	Remove all stands with > 30% SB	100	0
40	Remove all stands with E or Ep leading	100	39,226.4
>=35 and <=42	Remove all stands with cmc_pct < 50	100	38,089.4
>=35 and <=42	Remove all stands with operability of C or	100	24,623.1
		Total	126,048.8

Reductions for Low Productivity Species

Stands that are considered to have low productivity do meet the minimum requirements for economic merchantability. Reasons such as poor nutrient availability, exposure, excessive moisture, and so forth may cause this lower yield. There are different criteria for identifying sites with low timber growing potential. The logic used to identify mature and immature low productivity sites is identical to the logic used in the TSR2 Report for the Fort St. John TSA Tables A-10 and A-11.

Reduction for Recreation Areas

Area reductions for recreation were carried out as per the logic identified in Table A-12 in the Fort St. John TSR2 Report.

Table A10 Recreation Reductions

Feature Significance	Management Class					
	Very Sensitive		Sensitive		Not Sensitive	
	% Red	Prod. For	%	Prod. For	% Red	Prod. For
Very High	100	492.1	50	0.0	0	0.0
High	100	1,889.7	50	77,923.5	0	0.0
Moderate	100	0.0	20	66,652.7	0	47,468.5
Low	0	0.0	0	781,844.1	0	282,311.5

Reduction for ESAs

Environmentally sensitive area reduction factors remained largely unchanged from TSR2. However, the VRI portion of the inventory no longer carries an ESA classification. The reduction factors were therefore only applied to the original FIP portion of the inventory. Table A11 describes these reductions and the forested area within each ESA classification.

Table A11 Environmental Sensitive Area Reductions

ESA	Reduction	Productive Forest
Es1	90.0	38,717.1
Es2	50.0	1,094.3
Ep1 Ep2	90.0	2,436.4
Ea	90.0	0.0
Ew1	90.0	814.5
Ew2	30.0	7,165.1

Total	50,227.4

Reduction for Wildlife Tree Patches

The Fort St. John TSR2 applied wildlife tree patch reductions based upon BEC, leading species and landscape unit. The landscape units have been changed (updated) in this analysis; hence the reduction for WTPs has been changed.

Table A12 WTP reductions by Landscape Unit

Landscape Unit	% reduction for WTPs
Lower Beatton	8.0
Milligan	4.0
Kahntah	4.0
Trutch	4.0
Tommy Lakes	3.0
Blueberry	5.0
Kobes	5.0
Crying Girl	6.0
Halfway	3.0
Graham	4.0
Sikanni	4.0

Reductions for non-productive burns areas

Reductions for non-productive burn areas no longer apply to the VRI portion of the inventory, as this information should be captured in the new inventory. However, this information remains a problem in the FIP portion of the inventory. To address the fact that large areas of the TSA have had wildfires that have been classified as NSR, the TSR2 Analysis reduced the amount of NSR that could be included in the THLB by 44.6 percent. This reduction was also applied to the FIP portion of this analysis.

Resultant net land base determination

The foregoing land base reductions resulted in the productive forest land base (i.e., 2,276,290 ha) being reduced to an initial timber harvesting land base of 1,038,355 hectares (THLB1). This THLB1 area was derived as a relative comparison to the THLB reported in the MOF's TSR2. It was used to benchmark the timber supply model to evaluate the relative change in modeling assumptions. The total area of 1,038,355 ha is divided into traditional conifer, small pine, and deciduous area as indicated in Table A13.

Table A13 THLB1 – TSR2 Assessment

Timber Harvesting Land Base 1	MOF's TSR2 Net Area	Net Area (ha)
Traditional conifer	676,523	686,656
Small Pine	56,698	46,977
Deciduous	325,318	304,722
Total		**1,038,355**

Revisions to the Timber Harvesting Land Base

This analysis included an evaluation of the effect of alternative management assumptions. These assumptions lead to the creation of 3 additional THLB's for which analysis was completed. These THLBs are:

THLB1 - As defined by the TSR2 logic

1. THLB2 – Adjust the TSR2 deciduous land base to include stands previously considered problem forest types (i.e., enhanced deciduous THLB)
2. THLB3 – As per THLB1 but remove areas outside the Graham River IRMP clusters and riparian areas from contributing to the timber harvesting land base. This THLB was not utilized in the analysis for the Fort St. John SFMP.
3. THLB4 – As per THLB3 but include the enhanced deciduous THLB

The assumptions leading to the creation of these additional timber harvesting land bases are described in the sections that follow.

Enhanced Deciduous Land Base

The enhanced deciduous land base involved an assessment of deciduous stands which in the TSR2 net-down were considered problem forest types or low productivity sites. This area was added back to the deciduous THLB after reductions for ESAs, riparian reserves, unclassified roads, etc. Table A14 shows the logic used to identify these stands.

Table A14 Deciduous Area Add-Back

AU# / Leading Species	Inventory type group	Stand characteristic where operability is conventional	Productive Forest Area (ha)	Net Area added to the Enhanced Deciduous THLB (ha)
602 - Birch	40	SI >= 14.0 & age <= 70	12,995.3	4550.3
603 - Birch	40	Age >70 & volume >120		6962.5
604 - Cottonwood	35, 36	Age <101 & SI>=9.6 & Ac% >= 49	11,377.2	12,493.1
		Age >=101 Ht>=17.5 vol >=120 Ac%>=49	14,175.9	
605 - Aspen with Conifer [1]	41	Age <101 and SI >=10.5 and <13.0	33,958.7	27,792.8
606 - Aspen with Deciduous	42	Age <101 and SI >=10.5 and <14.7	91917.1	72,491.1

AU# / Leading Species	Inventory type group	Stand characteristic where operability is conventional	Productive Forest Area (ha)	Net Area added to the Enhanced Deciduous THLB (ha)
			Total	**124,289.8**

The adjustment to the deciduous low site and problem forest type definition led to the creation of THLB2. This expanded the Deciduous THLB by 124,290 hectares (a 40% increase). The coniferous land base remained unchanged. The resultant enhanced timber harvesting land base for the TSA increased 12 percent to 1,162,645 ha.

Table A15 THLB2 - Deciduous Enhanced

Timber Harvesting Land Base 2	Net Area (ha)
Traditional conifer	686,656
Small Pine	46,977
Deciduous	429,012
Total	**1,162,645**

Graham River IRMP Adjustment

The SFMP is cognizant of the effort expended by Canfor on the development of the Graham River Integrated Resource Management Plan (IRMP). Through consultation with all stakeholders, a spatial long-term harvest plan was constructed and scheduled in a manner that met the concerns of other resource users. Cut-blocks were developed and "clustered" based upon the natural disturbance guidelines of the time. Riparian areas between the cut blocks were incorporated into the "clusters" and minimum extractions rules were applied. All areas outside the clusters, though merchantable under normal TSR net-down rules, were excluded from future harvest consideration. To incorporate this IRMP into the THLB for this analysis, the area outside defined riparian zones and clusters were identified and removed from the THLB. This was done first as an adjustment to THLB1 and created THLB3. It was then also applied to the enhanced deciduous land base and created a final THLB4. Table A16 describes the adjustment to the net-down logic and the area affected by the adjustment.

Table A16 Graham IRMP Area Adjustment

IRMP Area	Location	Reduction	THLB1	THLB2 Area
Inside Clusters	Graham LU and Omineca NDU or Crying Girl LU	0%	3505.4	3446.5
Defined Riparian Area outside clusters		0%	869.5	889.2
Outside clusters and riparian		100%	8514.5	8627.6
		Total	**12889.4**	**12963.3**

As a result of these adjustments, the THLB1 area was reduced by 8514.5 hectares to create THLB3 (IRMP adjusted), and the THLB2 (enhanced deciduous) land base was reduced by 8627.6 ha to create THLB4 (enhanced deciduous, IRMP adjusted).

The changes to the THLB as a result of the Graham River IRMP led to the definition of two additional THLB determinations. The area for each land base is described in Tables A17 and A18.

Table A17 TSR2 THLB adjusted for Graham IRMP

Timber Harvesting Land Base 3	Net Area (ha)
Traditional conifer	674,025.9
Small Pine	46,668.4
Deciduous	304,564.3
Total	**1,025,258.6**

Table A18 TSR2 THLB Adjusted for Enhanced Deciduous and the Graham IRMP

Timber Harvesting Land Base 4	Net Area (ha)
Traditional conifer	674,025.9
Small Pine	46,668.4
Deciduous	428,716.8
Total	**1,149,411.1**

These four timber harvesting land bases set the stage upon which several management alternatives were assessed.

Future Roads Trails and landings

A loss to future roads trails and landings of 0.6 percent was applied to all unmanaged stands in Scenario 1. This assumption matched the reduction used in the TSR2 Base Case. In scenarios 2 -5 the percent reduction was changed to 6.39 percent of all unmanaged stands greater than 30 years age.

Section 2 Management Assumptions

Management assumptions are used to tell the computer when it is allowed to first consider an area eligible for harvesting and then to harvest an area. The assumptions also explicitly define what happens to an area after it is harvested.

Analysis Units

The analysis units used in this report are the same as was used in TSR2. However, because of the inclusion of a new inventory on over 12 percent of the land base, and slight differences in the programming logic used to define the analysis units, the area within each analysis unit differs from the areas reported in TSR2.

Five new analysis units were also developed. These analysis units were devised to represent the area added-back to the deciduous THLB and described the enhanced deciduous land base. The definition for these 5 analysis units was provided in Table A14. The definition for the remaining analysis units is provided in Table A19. The area in each analysis unit (applicable to THLB4) is shown in Table A20.

The conversion of unmanaged stand analysis units to managed stand analysis units is the same in all scenarios. The conversion matches the TSR2 Report.

Table A19 Definition of Analysis Units

AU#	Name	ITG	1st	1st	2nd	site	Age	height	harvest	logging
11	Sw g old	18-21	n/a	n/a	n/a	>14	>140	n/a	A	none
12	Sw m old	18-21	n/a	n/a	n/a	>9.7 &	>140	n/a	A	none
13	Sw p old	18-21	n/a	n/a	n/a	<= 9.7	>140	n/a	A	none
14	Sw g y/t	18-21	n/a	n/a	n/a	>15.5	<=140	n/a	A	none
15	Sw m y/t	18-21	n/a	n/a	n/a	>9.7 &	<=140	n/a	A	none
16	Sw p y/t	18-21	n/a	n/a	n/a	<= 9.7	<=140	n/a	A	none
21	Pl all old	28	n/a	n/a	n/a	n/a	>140	>=19.4	A	none
24	Pl g thrifty	28	n/a	n/a	n/a	>18.5	>30	>=19.4	A	none
25	Pl m thrifty	28	n/a	n/a	n/a	>15.5 &	>30	>=19.4	A	none
26	Pl p thrifty	28	n/a	n/a	n/a	<=15.5	>30	>=19.4	A	none
28	Pl gm young	28	n/a	n/a	n/a	>14	<=30	n/a	A	none
29	Pl p young	28	n/a	n/a	n/a	<=14	<=30	n/a	A	none
31	Small Pl All old	28	n/a	n/a	n/a	n/a	>140	>=17.7	A	none
34	Small Pl good	28	n/a	n/a	n/a	>12.5	> 80 and	>=17.7	A	none
35	Small Pl	28	n/a	n/a	n/a	<=12.5	> 80 and	>=17.7	A	none
51	Aspen g all	42,41	n/a	> 80	n/a	>21	n/a	n/a	A	none
52	Aspen m all	42,41	n/a	> 80	n/a	>15.5 &	n/a	n/a	A	none
53	Aspen p all	42,41	n/a	> 80	n/a	<=15.5	n/a	n/a	A	none
61	Sw/At g old	22-26	n/a	n/a	AT	>14.5	>140	n/a	A	none
62	Sw/At m old	22-26	n/a	n/a	AT	<=14.5	>140	n/a	A	none
64	Sw/At g yt	22-26	n/a	n/a	AT	>18	<=140	n/a	A	none
65	Sw/At m yt	22-26	n/a	n/a	AT	>14.5 &	<=140	n/a	A	none
66	Sw/At p yt	22-26	n/a	n/a	AT	<=14.5	<=140	n/a	A	none
71	Sw/other g old	22-26	n/a	n/a	not= AT	>14	>140	n/a	A	none
72	Sw/other m old	22-26	n/a	n/a	not= AT	>9.9	>140	n/a	A	none
73	Sw/other p old	22-26	n/a	n/a	not= AT	<=9.9	>140	n/a	A	none
74	Sw/other g yt	22-26	n/a	n/a	not= AT	>18	<=140	n/a	A	none
75	Sw/other m yt	22-26	n/a	n/a	not= AT	>14.5 &	<=140	n/a	A	none
76	Sw/other p yt	22-26	n/a	n/a	Not= AT	<=14.5	<=140	n/a	A	none
81	Pl/At all old	29-31	n/a	n/a	AT		>140	n/a	A	none
84	Pl/At g yt	29-31	n/a	n/a	AT	>20	<=140	n/a	A	none
85	Pl/At medium	29-31	n/a	n/a	AT	>16 &	<=140	n/a	A	none
86	Pl/At p yt	29-31	n/a	n/a	AT	<=16	<=140	n/a	A	none
91	Pl/other gm old	29-31	n/a	n/a	not= AT	>13.8	>140	n/a	A	None
93	Pl/other p old	29-31	n/a	n/a	not= AT	<=13.8	>140	n/a	A	none
94	Pl/other good	29-31	n/a	n/a	not= AT	>17	>30	n/a	A	none
				1st	2nd	site			harvest	logging

AU#	Name	ITG	1st	1st	2nd	site	Age	height	harvest	logging
95	Pl/other	29-31	n/a	n/a	not= AT	>13.8 &	>30	n/a	A	none
96	Pl/other poor	29-31	n/a	n/a	not= AT	<=13.8	>30	n/a	A	none
97	Pl/other all y	29-31	n/a	n/a	not= AT		<=30	n/a	A	none
101	At/Sw good all	41	n/a	<= 80	S	>19	n/a	n/a	A	none
102	At/Sw medium	41	n/a	<= 80	S	>15 &	n/a	n/a	A	none
103	At/Sw poor all	41	n/a	<= 80	S	<=15	n/a	n/a	A	none
111	At/Pl good all	41	n/a	<= 80	PL	>19.5	n/a	n/a	A	none
112	At/Pl medium	41	n/a	<= 80	PL	>15 &	n/a	n/a	A	none
113	At/Pl poor all	41	n/a	<= 80	PL	<=15	n/a	n/a	A	none
121	At/Mix good all	35, 36	n/a	n/a	n/a	>19.5	n/a	n/a	A	n/a
		41, 42	n/a	<= 80	not= PL	>19.5	n/a	n/a	A	n/a
122	At/Mix medium all	35, 36	n/a	n/a	n/a	>15 &	n/a	n/a	A	n/a
		41, 42	n/a	<= 80	not= PL	>15 &	n/a	n/a	A	n/a
123	At/Mix poor all	35, 36	n/a	n/a	n/a	<=15	n/a	n/a	A	n/a
		41, 42	n/a	<= 80	not= PL	<=15	n/a	n/a	A	n/a
511	Sw all old	18-21	n/a	n/a	n/a	n/a	>140	n/a	C /H	none
514	Sw all thrifty/y	18-21	n/a	n/a	n/a	n/a	<=140	n/a	C /H	none
521	Pl/Mix all all	28,29,	n/a	n/a	n/a	n/a	n/a	n/a	C /H	none
561	Sw/Mix all all	22-26	n/a	n/a	n/a	n/a	n/a	n/a	C /H	none
1001	Managed Sw	18-21	n/a	n/a	n/a	n/a	n/a	n/a	A	L
1002	Managed Pl	28	n/a	n/a	n/a	n/a	n/a	n/a	A	L
1006	Managed Sw/At	22-26	n/a	n/a	AT	n/a	n/a	n/a	A	L
1007	Mngd Sw/other	22-26	n/a	n/a	not= AT	n/a	n/a	n/a	A	L
1008	Managed Pl/At	29-31	n/a	n/a	AT	n/a	n/a	n/a	A	L
1009	Mngd Pl/other	29-31	n/a	n/a	not= AT	n/a	n/a	n/a	A	L
1551	M unconv Sw	18-21	n/a	n/a	n/a	n/a	n/a	n/a	C / H	L
1552	M unconv	28-31	n/a	n/a		n/a	n/a	n/a	C / H	L
1556	M unconv	22-26	n/a	n/a		n/a	n/a	n/a	C / H	L

Table A20 Analysis Unit Area

AU#	Species	THLB4 Area (ha)	AU#	Species	THLB4 Area (ha)
11	Sw g old	16,287	91	Pl/other gm old	4,801
12	Sw m old	17,902	93	Pl/other p old	8,465
13	Sw p old	34,957	94	Pl/other good thrifty	12,583
14	Sw g y/t	35,656	95	Pl/other medium thrifty	43,346
15	Sw m y/t	36,270	96	Pl/other poor thrifty	56,398
16	Sw p y/t	4,938	97	Pl/other all y	670
21	Pl all old	4,374	101	At/Sw good all	15,314
24	Pl g thrifty	22,420	102	At/Sw medium all	32,981
25	Pl m thrifty	43,032	103	At/Sw poor all	9,639
26	Pl p thrifty	25,713	111	At/Pl good all	12,702
28	Pl gm young	11,533	112	At/Pl medium all	24,942
29	Pl p young	400	113	At/Pl poor all	5,866
31	Small Pl All old	1,805	121	At/Mix good all	7,210
34	Small Pl good thrifty	25,181	122	At/Mix medium all	18,689
35	Small Pl medium poor thrifty	19,682	123	At/Mix poor all	3,676
51	Aspen g all	20,323	511	Sw all old	2,728
52	Aspen m all	131,037	514	Sw all thrifty/y	2,463
53	Aspen p all	22,185	521	Pl/Mix all all	1,380
61	Sw/At g old	8,878	561	Sw/Mix all all	4,226
62	Sw/At m old	6,742	602	Birch medium	4,550
64	Sw/At g yt	12,763	603	Birch good	6,962
65	Sw/At m yt	25,086	604	Cottonwood	12,493
66	Sw/At p yt	13,820	605	Aspen-conifer PFT	27,712
71	Sw/other g old	6,573	606	Aspen - PFT	72,435
72	Sw/other m old	8,585	1001	Managed Sw	18,135
73	Sw/other p old	14,807	1002	Managed Pl	8,940
74	Sw/other g yt	8,580	1006	Managed Sw/At	9,067
75	Sw/other m yt	16,683	1007	Mngd Sw/other	13,531
76	Sw/other p yt	32,230	1008	Managed Pl/At	2,656
81	Pl/At all old	4,633	1009	Mngd Pl/other	2,892
84	Pl/At g yt	8,348	1551	M unconv Sw	75
85	Pl/At medium young/thrifty	32,816	1552	M unconv Pl/mix	22
86	Pl/At p yt	27,500	1556	M unconv Sw/mix	121
				Total Area All Analysis Units in THLB4	**1,149,411**

Notes:
Quality: g = good, m = medium, p = poor
Age: y or yt = young,
PFT = previously defined as a problem forest type

Forest Cover Constraints

Forest cover constraints are used in the timber supply analysis to constrain harvesting within certain spatially defined geographic areas. Constraints are used when consideration is being given to other resource values. Generally there are two types of forest cover constraints.

- Group 1 constraints restrict harvesting when a specified percent of the area is less than a prescribed green up age or height. Harvesting is not allowed to take place when a Group 1 constraint is broken in an area.

- Group 2 constraints are used to ensure that a specified minimum amount of area is greater than a target age. These are typically old growth constraints used for thermal cover or biodiversity. Harvesting can take place in a specified zone if this constraint is not currently met. An appropriate amount of the oldest stands closest to the target age is reserved from harvesting in order to eventually meet this management objective. If sufficient merchantable area exists above the minimum harvest age and is not required for the old growth objective, then this area is available to harvest.

The forest cover constraints for the Base Case and for all scenarios with respect to visually sensitive areas and caribou habitat remain unchanged from TSR2. These constraints are described in Tables A-22, A-23 and A-25 of the TSR2 Fort St. John TSA Analysis Report June 2002.

This analysis utilizes new forest cover requirements with regard to natural disturbance units and watersheds. When modeling according to NDU guidelines, the adjacency constraint for the IRM zone is removed for the analysis. Table A21 shows the forest cover constraints by NDU.

Scenario 1 in this analysis used FPC Biodiversity NDT targets as per the TSR2 Report. Scenarios 2 and 3 used NDU constraints and a low BEO. Scenarios 4 and 5 used NDU constraints and a BEO as per Table A21 and A22.

Table A21 NDU Forest Cover Constraints

NDU Classification	Minimum % Area ≥ 140 years		
	Low BEO	Inter BEO	High BEO
Boreal foothills Mt	33	41	49
Boreal foothills valley	23	32	40
Boreal plains - alluvial - conifer	44	51	57
Boreal plains - Upland - Conifer	17	25	33
Northern boreal mountains	37	49	60
Omineca - mountain	58	64	69
Omineca - Valley	23	32	40
Boreal plains - alluvial - deciduous	10	15	20
Boreal plains - Upland - deciduous	10	15	20

Table A22 Landscape Unit BEOs

Landscape Unit Name	Recommended Biodiversity Emphasis Option	Landscape Unit Name	Recommended Biodiversity Emphasis Option
Graham	High	Milligan	Intermediate
Halfway	Low	Trutch	Intermediate
Sikanni	High	Blueberry	Low
Crying Girl	Intermediate	Lower Beatton	Intermediate
Kahntah	Intermediate	Tommy Lakes	Low
Kobes	Low		

Minimum Harvest Ages

Table A23 provides the minimum harvest ages used for all scenarios in this analysis. The logic used to determine these minimum harvest ages follows the information provided in the TSR2 Report.

Table A23 Minimum Harvest Ages

AU	MHA	AU	MHA	AU	MHA	AU	MHA
11	72	75	79	1005	114	2076	98
12	97	76	102	1006	81	2081	73
13	169	81	83	1007	81	2084	51
14	67	84	53	1008	78	2085	59
15	93	85	67	1009	78	2081	73
16	127	86	83	1051	58	2093	98
21	74	91	67	1052	78	2097	88
24	51	93	109	1053	114	2101	51
25	64	94	55	1056	71	2102	64
26	74	95	71	1551	90	2103	85
28	66	96	103	1552	136	2511	108
29	104	97	69	1556	94	2514	76
31	120	101	55	2011	61	2521	78
34	88	102	68	2012	85	2561	69
35	105	103	83	2013	151	602	71
51	53	111	54	2014	56	603	61
52	69	112	67	2021	69	604	56
53	114	113	93	2024	51	605	100
61	81	121	56	2025	51	606	90
62	108	122	70	2026	62	888	61
64	66	123	90	2029	103	887	61
65	79	511	147	2031	118	886	61
66	102	514	98	2034	75	2602	71
71	79	521	98	2035	96	2603	61
72	100	561	110	2061	69	2604	56
73	153	1001	71	2064	53	2605	100
74	63	1002	68	2073	148	2606	90

Watersheds

ECA constraints on a watershed are typically applied incrementally with varying targets applied to varying tree heights. As a plantation grows the hydrologic recovery of the watershed increases as a consequent. If an ECA target is placed on a watershed, then the maximum area that can be in a denuded state is that target number. However, as portions of the harvested area regenerate into plantations of varying height, the amount of total area with less than 100% hydrologic recovery increases. It is estimated in the Code Interior Watershed Assessment Procedure Guidebook that with each 3-metre increase in plantation height, hydrologic recovery improves by 25 percent. This then can be translated into a 25% increase in the Group 1 constraint in the Forest Estate Model FSSIM.

The following table shows the guidelines used in the application of ECA constraints in the Fort St. John TSA. When reference is made in this document to an ECA constraint, the maximum amount of forest area below three metres is the target number referred to. Additional constraints increasing by 25 percent increments every three metres to a regenerated stand height of nine metres is inferred, and was applied in all of the applicable harvest scenarios examined.

Table A24 Calculating ECA Targets (example)

Average Height (m)	"Trigger Height"	Average Age to Achieve Height (years)	Hydrologic Recovery (IWAP) (%)	Maximum ECA Constraint		
				30%	20%	10%
0 - < 3 m	0	0	0%	n/a	n/a	n/a
3 - < 5m	3	16	25%	30% < 16 yrs	20% < 16 yrs	10% < 16 yrs
5 - < 7 m	5	24	50%	37.5% < 24 yrs	25% < 24 yrs	12.5% < 24 yrs
7 - < 9 m	7	30	75%	45% < 30 yrs	30% < 30 yrs	15% < 30 yrs
9 m +	9	35	90%	52.5% < 35 yrs	35% < 35 yrs	17.5% < 35 yrs

In this analysis watersheds were identified using a three string code. The first character denotes the ECA target. The second character, the watershed region and the third character denoted the watershed number or drainage. Table A25 describes the code logic. Table A26 describes the area in each watershed.

Table A25 Watershed code

ECA	Watershed Group	Watershed number
25 = 2	FONT = F	L1 = Z
30 = 3	KAHN = K	L2 = Y
35 = 8	LHAF = L	L3 = X
40 = 4	LSIK = S	S1 = 1
50 = 5	MILL = M	S2 = 2
	UBTN = B	S3=3
	UHAF = H	S4=4
	UPRO = P	S5=5
	USIK = U	S6=6
	UPCE = E	S7=7
	None =N	S8=8
		S9=9
		S10=A
		S11=B
		S12=C
		S13=D
		S0=0

Table A26 Forested Area by Watershed

Watershed	Forest Area (ha)	Watershed	Forest Area (ha)	Watershed	Forest Area (ha)
3H1	14,529	4FY	5,434	5S6	25,644
3H2	17,443	4FZ	13,984	8B1	10,595
3H3	11,635	4K2	12,628	8BA	2,678
3H5	21,072	4K4	12,182	8EO	31,338
3H6	17,131	4KY	16,962	8HX	31,097
3H8	5,916	4L8	23,900	8L1	16,396
3HY	25,518	4M2	16,290	8L2	23,308
3HZ	26,593	4M4	13,940	8L3	19,440
3L7	28,955	4MZ	15,241	8L4	35,255
3LY	48,806	4N0	66,400	8L5	9,979
3P2	3,262	4NZ	80,739	8L9	14,272
3P5	4,726	4S1	16,032	8LA	30,360
3PY	5,726	4S4	2,259	8LB	9,413
4B2	22,526	4S5	18,748	8LC	16,556
4B4	25,233	4S7	3,925	8LZ	26,050
4B5	13,001	4S8	2,582	8N0	172,111
4B6	32,115	4S9	6,370	8P3	7,549
4B7	9,297	4SX	16,104	8PZ	5,428
4B8	27,399	4SY	21,688	8S2	10,389
4B9	5,055	4UA	9,207	8U1	16,533
4BB	16,520	4UD	25,399	8U2	6,712
4F1	1,638	5K5	3,092	8U4	4,173
4F2	4,043	5KI	5,298	8U5	17,242
4F3	5,395	5KZ	24,829	8U6	12,056

Watershed	Forest Area (ha)	Watershed	Forest Area (ha)	Watershed	Forest Area (ha)
4F4	6,461	5M1	926	8U8	11,283
4F5	4,309	5M3	15,125	8U9	15,882
4F7	4,228	5M5	4,044	8UB	14,594
4F8	11,461	5M6	6,555	8UC	51,572
4FX	13,949	5N0	3,391	8UZ	19,046

Forest cover constraints were determined for each watershed area. The area-weighted site index in each watershed group was used to calculate the average years to green-up for all species at green-up heights of 3, 5, 7, and 9 metres. These green-up ages are provided in Table A27. The rate of hydrologic recovery is shown in Table A28.

Table A27 Years to Greenup by Watershed Group

# of Years to Green up				
H2O Group	**3m**	**5m**	**7m**	**9m**
Upper Beatton	16	24	32	41
Upper Peace	13	19	25	31
Fontas	16	22	29	36
Halfway	23	32	41	50
Kahntah	12	18	23	29
Lower Halfway	15	21	28	34
Milligan	12	16	24	30
Lower Peace	13	18	23	29
Upper Prophet	23	33	43	53
Lower Sikanni	12	18	23	29
Upper Sikanni	19	27	36	46

Table A28 Rate of Hydrologic Recovery by ECA

	Average Ht (m)	3	5	7	9
ECA %	**Hydrologic recovery %**	**0%**	**25%**	**50%**	**75%**
25		25	31	37	44
30		30	38	45	52
35		35	44	53	61
40		40	50	60	70
50		50	62	75	88

Graham River IRMP

Cut block clusters in the Graham IRMP were scheduled for harvest according to the timing shown in Table A29. Defined riparian areas within the IRMP were given a forest cover adjacency constraint such that during any harvest period there as a maximum of 10 percent of the forest area less than 40 years age.

Table A29 Graham River Clusters

Cluster #	Harvest decade	Forest Area (ha)	THLB (ha)
1	1	1,891.3	1,183.8
2	1	2,137.5	824.7
3	1	2,333.7	590.7
4	1	3,793.6	1,263.4
5	1	2,206.1	1,338.8
17	1	622.9	216.2
6a	1	2,420.9	1,017.4
6b	1	812.5	594.7
6c	1	691.5	367.8
sub-total		16,910.2	7,397.5
7	2	1,840.1	638.2
9	2	914.9	577.7
10	2	821.7	486.9
11	2	1,737.9	810.9
8a	2	1,769.1	974.3
8b	2	2,031.4	1,267.0
sub-total		9,115.1	4,755.1
12	3	3,299.5	2,261.6
13	3	2,340.7	1,375.3
14	3	2,640.4	1,919.2
15	3	3,012.3	1,850.0
sub-total		11,293.0	7,406.1
16	4	1,970.7	1,083.5
18	4	1,241.0	703.1
19	4	2,923.2	1,825.4
sub-total		6,134.8	3,611.9
20	5	1,301.4	852.6
	Total	**44,754.4**	**24,023.2**

Cycling the NCLB

In Scenario 1, the NCLB was cycled according to the TSR2 analysis, which cycled 5,000 ha per year. In all other scenarios the NCLB was cycled according to the rates show in Table A30. These vales were derived using the report: Natural Disturbance Units of the Prince George Forest Region: Guidance for Sustainable Forest Management, 2002. DeLong, Unpublished 2002.

Table A30 NDU Area in NCLB cycled annually

NDU	Area cycled per year (ha)
Omineca - Valley	72
Omineca - mountain	23
Northern boreal moutains	55
Boreal foothills valley	16
Boreal foothills Mt	99
Boreal plains - Upland - deciduous	177
Boreal plains - Upland - Conifer	657
Boreal plains - alluvial - deciduous	3
Boreal plains - alluvial - conifer	3
Total	**1105**

Wildlife and Range Burn Areas

Range and wildlife burn areas have been spatially identified on the inventory file. During the running of all simulations, the stand ages in these areas were re-assigned to age 20 over the first 30-year period. Thereafter, every stand that reached the age of 60 was reassigned an age of 20

There are 31,449 hectares of forest land that does not contribute to the THLB and is cycled on a 60-year rotation for wildlife and range burns.

Section 3 Growth and Yield

Yield tables for most analysis units are identical to the tables used in Tables A-27 and A-28 in the Fort St. John TSR2 Analysis Report. Only the yield tables for previously excluded deciduous stands were created using VDYP. These yield tables are provided in Table A31 following.

Deciduous Yield Tables

Scenarios 2-5 in the analysis changed the longevity of deciduous leading stands. As Table A31 shows, birch stands (AU#s 602 and 603) were assumed to yield merchantable volume until 110 years of age. All other deciduous stands were assumed to yield merchantable volume until 150 years of age. The logic for this is in current age class distributions for deciduous stands, wherein almost no area exists in deciduous stands greater than 140 years of age. Deciduous stands that reached an age of 150 years without being harvested were transferred to immature deciduous stands having a reversion age of 5 years.

Table A31 Enhanced deciduous land base yield tables

Age	602	603	604	605	606
0	0	0	0	0	0
10	0	0	0	0	0
20	0	0	0	0	0
30	0	0	1	0	0
40	27	35.1	25	0	14
50	61	79.3	89	11	39
60	91	118.3	141	37	64
70	118	153.4	186	62	85
80	141	183.3	224	84	103
90	163	211.9	257	104	119
100	182	236.6	285	121	132
110	199	258.7	310	137	142
120	0	0	331	151	149
130	0	0	350	162	156
140	0	0	365	171	162
150	0	0	379	178	164
160	0	0	0	0	0

Carbon Cycling

Volume tables that reflect carbon cycling were created using the FORECAST model by Brad Seely. These tables were used to predict the total amount of carbon in the TSA over time and the rate of carbon sequestration. Carbon volume tables were created for the TSA and matched to existing analysis units. The age class distribution for each analysis unit in each period was then multiplied by the corresponding carbon volume in the appropriate carbon table and age class.

The relationship between analysis units and carbon table identifiers is shown in Table A32. Carbon for the NCLB was apportioned according to the proportions identified in the last column of Table A32.

Table A33 shows the total amount of ecosystem carbon (Mg C ha-1) and the carbon sequestration rate (Mg C ha-1 yr-1) for each carbon identified table.

Table A32 Carbon table ID versus AU# associations

Carbon Table	Analysis unit	Carbon Table	Analysis unit	Carbon Table	NCLB Analysis unit	Proportion
1	13,16,511	25	101	15	886 & 888	0.0402911
2	12,15	26	113, 913	30	886 & 888	0.2411666
3	11,14,514	27	112,914	11	886 & 888	0.0335798
4	21, 26, 29, 31, 34, 35	28	111	10	886 & 888	0.0190432
5	25,28	29	915	18	886 & 888	0.0485414
6	24	30	902, 887	31	886 & 888	0.2278847
7	53, 123, 602, 605, 606, 909, 910	31	906	21	886 & 888	0.0365591
8	52, 122,604	32	2013, 2511, 2073	20	886 & 888	0.0241764
9	51, 121,603	33	2012	7	886 & 888	0.0550105
10	62, 66,904	34	2011, 2014, 2514, 1001, 2551, 1551	8	886 & 888	0.1495651
11	61,65, 903	35	2021, 2026, 2029, 2031, 2034, 2035	23	886 & 888	0.0114413
12	64	36	2025, 1002	24	886 & 888	0.0283407
13	73	37	2024	26	886 & 888	0.013997
14	72, 561	38	2076	27	886 & 888	0.0194131
15	71, 901	39	2061, 1056, 1006, 1007, 1556, 2521	29	886 & 888	0.0509898
16	74	40	2064			
17	76,93,96	41	2561, 2093,2081			
18	75, 91, 95, 97, 905	42	1008, 1009, 2097			
19	94	43	2084, 2085, 1552, 2552			
20	81,86,908	44	1053			
21	521,907	45	1052			
22	84,85	46	1051			
23	103, 911	47	2103			
24	102, 912	48	2102			
		49	2101			

Table A33 Ecosystem Carbon and Sequestration Rate by Carbon ID

Year	1	1	2	2	3	3	4	4	5	5	6	6	7	7	8	8	9	9	10	10
1	117.0	0.0	170.1	0.0	199.9	0.0	151.3	0.0	234.2	0.0	225.5	0.0	151.0	0.0	234.2	0.0	225.7	0.0	151.1	0.0
10	98.2	-1.9	145.0	-2.5	174.5	-2.5	125.5	-2.6	200.5	-3.4	203.1	-2.2	124.6	-2.6	201.8	-3.2	206.5	-1.9	123.3	-2.8
20	85.2	-1.3	127.2	-1.8	156.8	-1.8	113.0	-1.2	184.9	-1.6	205.1	0.2	111.9	-1.3	189.2	-1.3	213.9	0.7	104.8	-1.8
30	75.6	-1.0	114.4	-1.3	142.8	-1.4	112.5	-0.1	179.3	-0.6	225.1	2.0	110.9	-0.1	182.8	-0.6	226.8	1.3	98.6	-0.6
40	69.3	-0.6	105.5	-0.9	132.6	-1.0	117.9	0.5	184.6	0.5	244.5	1.9	117.1	0.6	186.7	0.4	240.5	1.4	100.2	0.2
50	67.1	-0.2	101.6	-0.4	127.8	-0.5	129.8	1.2	198.8	1.4	267.2	2.3	130.2	1.3	200.7	1.4	255.0	1.5	109.2	0.9
60	70.0	0.3	104.0	0.2	130.9	0.3	145.8	1.6	219.8	2.1	289.3	2.2	146.5	1.6	216.6	1.6	269.0	1.4	123.3	1.4
70	77.5	0.7	112.6	0.9	141.6	1.1	161.5	1.6	240.3	2.0	308.4	1.9	160.9	1.4	231.7	1.5	280.1	1.1	139.2	1.6
80	87.6	1.0	125.8	1.3	158.0	1.6	174.1	1.3	255.1	1.5	320.1	1.2	171.3	1.0	244.2	1.3	287.0	0.7	153.7	1.5
90	97.9	1.0	139.7	1.4	175.7	1.8	185.0	1.1	266.1	1.1	327.8	0.8	178.4	0.7	253.0	0.9	291.8	0.5	166.5	1.3
100	107.6	1.0	152.8	1.3	192.3	1.7	195.9	1.1	276.2	1.0	335.4	0.8	182.2	0.4	256.1	0.3	292.9	0.1	176.4	1.0
110	116.7	0.9	164.7	1.2	207.2	1.5	205.8	1.0	285.2	0.9	342.6	0.7	184.1	0.2	255.0	-0.1	290.9	-0.2	184.5	0.8
120	125.4	0.9	175.9	1.1	220.8	1.4	212.2	0.6	291.5	0.6	347.0	0.4	186.9	0.3	255.9	0.1	290.5	0.0	192.2	0.8
130	133.5	0.8	185.9	1.0	233.0	1.2	211.8	0.0	290.2	-0.1	343.3	-0.4	189.5	0.3	258.1	0.2	290.6	0.0	199.3	0.7
140	141.1	0.8	195.1	0.9	244.0	1.1	207.6	-0.4	285.4	-0.5	335.7	-0.8	192.4	0.3	261.4	0.3	292.1	0.2	206.0	0.7
150	148.3	0.7	203.6	0.8	253.9	1.0	202.2	-0.5	279.5	-0.6	327.2	-0.9	194.9	0.2	265.6	0.4	294.7	0.3	212.3	0.6
160	154.6	0.6	210.8	0.7	262.0	0.8	196.2	-0.6	272.5	-0.7	317.7	-0.9							217.9	0.6
170	158.9	0.4	215.9	0.5	267.3	0.5	189.2	-0.7	264.6	-0.8	307.4	-1.0							221.8	0.4
180	162.3	0.3	219.7	0.4	271.0	0.4	181.6	-0.8	256.0	-0.9	296.5	-1.1							224.9	0.3
190	165.6	0.3	223.3	0.4	274.7	0.4	173.5	-0.8	247.3	-0.9	285.3	-1.1							228.0	0.3
200	168.8	0.3	226.7	0.3	278.4	0.4	167.6	-0.6	242.6	-0.5	278.2	-0.7							231.0	0.3
Year	11	11	12	12	13	13	14	14	15	15	16	16	17	17	18	18	19	19	20	20
1	234.0	0.0	224.9	0.0	116.9	0.0	151.1	0.0	233.9	0.0	225.0	0.0	151.2	0.0	234.0	0.0	225.3	0.0	151.2	0.0
10	196.0	-3.8	196.6	-2.8	98.2	-1.9	122.1	-2.9	194.4	-3.9	194.7	-3.0	123.6	-2.8	197.1	-3.7	199.9	-2.5	125.2	-2.6
20	170.2	-2.6	186.9	-1.0	85.2	-1.3	100.4	-2.2	164.5	-3.0	177.4	-1.7	105.9	-1.8	173.4	-2.4	194.6	-0.5	112.7	-1.3
30	156.9	-1.3	195.7	0.9	76.0	-0.9	88.4	-1.2	146.2	-1.8	171.6	-0.6	100.3	-0.6	162.4	-1.1	206.1	1.2	112.1	-0.1
40	154.4	-0.3	210.6	1.5	70.4	-0.6	83.3	-0.5	138.3	-0.8	175.3	0.4	101.6	0.1	162.3	0.0	224.7	1.9	117.9	0.6
50	163.2	0.9	224.0	1.3	68.9	-0.2	85.0	0.2	142.6	0.4	190.0	1.5	110.1	0.8	172.8	1.0	243.8	1.9	130.6	1.3
60	178.5	1.5	234.1	1.0	72.9	0.4	92.3	0.7	153.6	1.1	199.4	0.9	123.9	1.4	190.6	1.8	261.6	1.8	147.4	1.7
70	199.6	2.1	241.4	0.7	81.0	0.8	102.4	1.0	170.3	1.7	213.1	1.4	138.5	1.5	211.7	2.1	275.0	1.3	163.9	1.7
80	221.0	2.1	243.3	0.2	91.3	1.0	113.2	1.1	190.9	2.1	228.7	1.6	151.2	1.3	230.8	1.9	285.9	1.1	177.3	1.3
90	239.9	1.9	246.7	0.3	101.5	1.0	124.2	1.1	213.9	2.3	243.8	1.5	163.1	1.2	247.9	1.7	298.0	1.2	188.1	1.1
100	255.2	1.5	258.7	1.2	111.5	1.0	135.0	1.1	234.4	2.0	261.1	1.7	174.7	1.2	263.5	1.6	308.7	1.1	196.6	0.8
110	267.7	1.3	271.4	1.3	120.9	0.9	145.1	1.0	251.9	1.8	276.3	1.5	185.6	1.1	277.0	1.3	317.1	0.8	202.2	0.6
120	279.3	1.2	284.9	1.3	129.7	0.9	154.4	0.9	267.7	1.6	289.3	1.3	195.1	0.9	288.7	1.2	324.8	0.8	207.2	0.5
130	289.6	1.0	297.3	1.2	137.3	0.8	162.1	0.8	281.2	1.4	300.9	1.2	200.5	0.5	295.8	0.7	331.5	0.7	209.6	0.2
140	297.9	0.8	309.7	1.2	144.2	0.7	168.7	0.7	292.8	1.2	313.4	1.3	203.7	0.3	300.5	0.5	332.5	0.1	210.4	0.1
150	304.5	0.7	315.1	0.5	150.6	0.6	174.7	0.6	302.5	1.0	316.8	0.3	206.1	0.2	304.9	0.4	329.9	-0.3	210.4	0.0
160	309.7	0.5	317.1	0.2	155.8	0.5	179.5	0.5	309.4	0.7	317.6	0.1	207.4	0.1	308.9	0.4	325.6	-0.4	209.7	-0.1
170	294.7	-1.5	316.3	-0.1	159.2	0.3	182.4	0.3	312.0	0.3	315.9	-0.2	207.7	0.0	309.0	0.0	319.6	-0.6	208.9	-0.1
180	291.2	-0.4	314.6	-0.2	161.5	0.2	184.3	0.2	312.6	0.1	313.6	-0.2	207.4	0.0	304.0	-0.5	313.1	-0.6	207.7	-0.1
190	286.5	-0.5	314.1	-0.1	163.9	0.2	186.2	0.2	313.5	0.1	312.3	-0.1	207.2	0.0	298.0	-0.6	307.3	-0.6	205.0	-0.3
200	283.1	-0.3	314.5	0.0	166.7	0.3	188.2	0.2	309.4	-0.4	311.9	0.0	206.9	0.0	291.3	-0.7	301.9	-0.5	202.4	-0.3

Year	21	21	22	22	23	23	24	24	25	25	26	26	27	27	28	28	29	29	30
1	151.2	0.0	225.4	0.0	151.1	0.0	234.0	0.0	225.2	0.0	151.1	0.0	234.1	0.0	225.5	0.0	46.1	0.0	116.9
10	125.2	-2.6	202.5	-2.3	124.5	-2.7	198.4	-3.6	199.6	-2.6	125.6	-2.6	200.8	-3.3	203.0	-2.2	38.8	-0.7	98.2
20	112.7	-1.3	205.4	0.3	110.8	-1.4	180.0	-1.8	198.6	-0.1	114.8	-1.1	186.7	-1.4	208.0	0.5	36.6	-0.2	85.2
30	112.1	-0.1	223.7	1.8	109.2	-0.2	171.2	-0.9	212.6	1.4	114.3	0.0	180.6	-0.6	223.3	1.5	37.2	0.1	76.0
40	117.9	0.6	243.3	2.0	114.5	0.5	173.6	0.2	226.9	1.4	120.5	0.6	185.3	0.5	239.8	1.7	39.3	0.2	70.4
50	130.6	1.3	265.2	2.2	127.0	1.2	187.9	1.4	243.1	1.6	133.3	1.3	201.0	1.6	258.0	1.8	42.6	0.3	68.9
60	147.4	1.7	286.7	2.2	143.1	1.6	208.5	2.1	259.6	1.6	149.6	1.6	222.2	2.1	276.2	1.8	48.7	0.6	72.9
70	163.9	1.7	304.1	1.7	158.6	1.6	229.1	2.1	275.1	1.6	164.9	1.5	241.4	1.9	290.7	1.5	55.9	0.7	81.0
80	177.3	1.3	313.8	1.0	170.3	1.2	244.4	1.5	287.3	1.2	175.9	1.1	255.0	1.4	299.0	0.8	62.8	0.7	91.3
90	188.1	1.1	319.2	0.5	178.5	0.8	255.0	1.1	297.4	1.0	183.5	0.8	263.6	0.9	303.3	0.4	69.1	0.6	101.5
100	196.6	0.8	323.6	0.4	182.5	0.4	261.5	0.6	302.2	0.5	187.0	0.3	266.5	0.3	303.6	0.0	74.9	0.6	111.5
110	202.2	0.6	326.6	0.3	184.3	0.2	266.8	0.5	302.1	0.0	188.2	0.1	265.9	-0.1	301.5	-0.2	79.7	0.5	120.9
120	207.2	0.5	326.9	0.0	188.1	0.4	270.8	0.4	302.1	0.0	191.0	0.3	266.2	0.0	301.0	-0.1	83.9	0.4	129.7
130	209.6	0.2	319.8	-0.7	192.3	0.4	270.2	-0.1	299.2	-0.3	193.6	0.3	265.1	-0.1	298.8	-0.2	87.6	0.4	137.3
140	210.4	0.1	309.9	-1.0	196.3	0.4	264.4	-0.6	292.7	-0.7	195.8	0.2	264.0	-0.1	296.4	-0.2	91.0	0.3	144.2
150	210.4	0.0	300.2	-1.0	200.0	0.4	255.6	-0.9	284.1	-0.9	197.0	0.1	263.8	0.0	294.8	-0.2	94.2	0.3	150.6
160	209.7	-0.1	290.8	-0.9	203.3	0.3	246.3	-0.9	275.9	-0.8	197.3	0.0	264.7	0.1	294.3	0.0	96.9	0.3	155.8
170	208.9	-0.1	281.8	-0.9	206.1	0.3	237.5	-0.9	269.4	-0.7	197.0	0.0	266.7	0.2	295.1	0.1	98.6	0.2	159.2
180	207.7	-0.1	273.3	-0.9	207.8	0.2	230.1	-0.7	264.8	-0.5	195.3	-0.2	269.6	0.3	297.0	0.2	99.6	0.1	161.5
190	205.0	-0.3	265.6	-0.8	209.2	0.1	224.5	-0.6	262.1	-0.3	193.1	-0.2	273.1	0.3	299.6	0.3	101.0	0.1	163.9
200	202.4	-0.3	263.2	-0.2	210.2	0.1	219.9	-0.5	260.4	-0.2	192.5	-0.1	278.2	0.5	304.2	0.5	102.5	0.2	166.7
Year	31	31	32	32	33	33	34	34	35	35	36	36	37	37	38	38	39	39	40
1	117.0	0.0	75.8	0.0	99.5	0.0	120.2	0.0	105.0	0.0	143.6	0.0	173.8	0.0	97.5	0.0	134.5	0.0	158.8
10	98.7	-1.8	61.5	-1.4	81.8	-1.8	99.9	-2.0	83.6	-2.1	117.4	-2.6	139.7	-3.4	76.1	-2.1	106.9	-2.8	125.6
20	87.1	-1.2	56.7	-0.5	74.8	-0.7	92.7	-0.7	78.5	-0.5	111.0	-0.6	132.8	-0.7	70.6	-0.6	101.9	-0.5	120.1
30	79.5	-0.8	59.2	0.3	75.8	0.1	94.8	0.2	85.6	0.7	120.5	0.9	147.1	1.4	77.0	0.6	116.4	1.4	139.7
40	75.5	-0.4	66.9	0.8	82.2	0.6	103.6	0.9	97.1	1.1	141.2	2.1	176.3	2.9	88.6	1.2	135.3	1.9	164.6
50	75.2	0.0	75.7	0.9	92.5	1.0	115.5	1.2	109.9	1.3	165.0	2.4	207.4	3.1	103.6	1.5	157.8	2.3	191.5
60	81.7	0.7	85.5	1.0	104.4	1.2	129.5	1.4	124.3	1.4	191.3	2.6	239.4	3.2	120.6	1.7	176.4	1.9	215.1
70	92.9	1.1	96.0	1.1	117.7	1.3	145.4	1.6	137.9	1.4	214.8	2.4	267.0	2.8	137.2	1.7	192.1	1.6	233.9
80	104.1	1.1	106.4	1.0	131.0	1.3	161.7	1.6	149.8	1.2	233.7	1.9	288.7	2.2	152.2	1.5	203.4	1.1	241.9
90	115.0	1.1	116.9	1.0	144.1	1.3	178.2	1.6	161.0	1.1	250.1	1.6	306.4	1.8	165.0	1.3	212.7	0.9	241.8
100	126.1	1.1	126.7	1.0	156.1	1.2	193.1	1.5	171.8	1.1	265.3	1.5	321.9	1.6	175.5	1.0	221.3	0.9	239.8
110	136.3	1.0	135.9	0.9	167.1	1.1	206.8	1.4	182.0	1.0	278.9	1.4	335.1	1.3	183.0	0.7	229.9	0.9	246.6
120	144.5	0.8	144.3	0.8	177.4	1.0	219.3	1.2	190.6	0.9	289.5	1.1	344.5	0.9	189.1	0.6	238.7	0.9	257.9
130	149.2	0.5	151.7	0.7	186.6	0.9	230.1	1.1	196.0	0.5	294.4	0.5	346.3	0.2	194.8	0.6	247.1	0.8	269.3
140	152.1	0.3	158.6	0.7	195.2	0.9	240.0	1.0	199.6	0.4	295.1	0.1	344.2	-0.2	200.4	0.6	254.8	0.8	278.6
150	154.3	0.2	165.0	0.6	203.2	0.8	249.1	0.9	202.5	0.3	293.7	-0.1	340.6	-0.4	205.4	0.5	261.3	0.7	283.2
160	155.6	0.1	170.2	0.5	210.0	0.7	256.4	0.7	204.4	0.2	290.5	-0.3	335.3	-0.5	209.7	0.4	265.3	0.4	284.3
170	155.9	0.0	173.8	0.4	214.8	0.5	260.7	0.4	204.5	0.0	286.0	-0.5	328.6	-0.7	213.0	0.3	268.6	0.3	282.8
180	155.7	0.0	176.7	0.3	218.9	0.4	263.6	0.3	203.9	-0.1	280.8	-0.5	321.0	-0.8	216.0	0.3	267.8	-0.1	281.3
190	156.0	0.0	179.7	0.3	222.9	0.4	266.4	0.3	203.3	-0.1	275.5	-0.5	313.3	-0.8	219.0	0.3	267.2	-0.1	280.5
200	158.7	0.3	182.9	0.3	226.8	0.4	269.2	0.3	202.8	-0.1	272.1	-0.3	308.1	-0.5	222.0	0.3	265.8	-0.1	280.3

40	41	41	42	42	43	43	44	44	45	45	46	46	47	47	48	48	49	49
0.0	101.9	0.0	140.4	0.0	167.9	0.0	99.2	0.0	131.8	0.0	156.0	0.0	97.8	0.0	134.0	0.0	156.4	0.0
-3.3	81.5	-2.0	114.5	-2.6	135.6	-3.2	81.6	-1.8	115.8	-1.6	138.1	-1.8	81.9	-1.6	117.8	-1.6	136.6	-2.0
-0.5	78.8	-0.3	110.2	-0.4	129.0	-0.7	81.2	0.0	126.5	1.1	151.1	1.3	84.0	0.2	127.8	1.0	147.1	1.1
2.0	88.6	1.0	125.4	1.5	148.4	1.9	94.3	1.3	149.8	2.3	176.5	2.5	98.1	1.4	150.7	2.3	174.3	2.7
2.5	101.0	1.2	147.9	2.3	181.2	3.3	111.3	1.7	177.1	2.7	204.8	2.8	115.6	1.7	175.9	2.5	202.4	2.8
2.7	116.4	1.5	174.3	2.6	214.7	3.4	133.0	2.2	206.0	2.9	234.1	2.9	136.0	2.0	202.8	2.7	231.5	2.9
2.4	134.3	1.8	201.8	2.8	247.6	3.3	154.0	2.1	232.3	2.6	259.4	2.5	155.8	2.0	226.7	2.4	257.6	2.6
1.9	151.6	1.7	226.2	2.4	275.2	2.8	173.0	1.9	253.2	2.1	279.6	2.0	173.9	1.8	245.1	1.8	278.4	2.1
0.8	166.5	1.5	245.5	1.9	294.6	1.9	187.8	1.5	267.0	1.4	293.2	1.4	188.5	1.5	256.9	1.2	293.3	1.5
0.0	178.9	1.2	260.4	1.5	307.5	1.3	198.2	1.0	275.5	0.8	300.7	0.8	200.2	1.2	262.9	0.6	303.5	1.0
-0.2	189.7	1.1	272.8	1.2	317.2	1.0	202.2	0.4	276.9	0.1	300.7	0.0	207.3	0.7	259.8	-0.3	303.2	0.0
0.7	197.5	0.8	281.2	0.8	323.1	0.6	201.2	-0.1	273.2	-0.4	295.3	-0.5	211.3	0.4	254.6	-0.5	293.0	-1.0
1.1	203.2	0.6	286.4	0.5	325.1	0.2	201.7	0.0	272.6	-0.1	293.2	-0.2	215.9	0.5	251.0	-0.4	280.2	-1.3
1.1	207.5	0.4	287.0	0.1	320.6	-0.5	202.6	0.1	274.0	0.1	293.4	0.0	220.3	0.4	246.6	-0.4	267.6	-1.3
0.9	211.0	0.3	284.2	-0.3	313.6	-0.7	203.3	0.1	276.1	0.2	294.3	0.1	224.5	0.4	240.7	-0.6	257.1	-1.0
0.5	213.9	0.3	278.5	-0.6	306.5	-0.7	202.5	-0.1	278.2	0.2	295.2	0.1	228.3	0.4	233.5	-0.7	248.7	-0.8
0.1	216.0	0.2	270.9	-0.8	299.1	-0.7							231.7	0.3	225.9	-0.8	241.9	-0.7
-0.1	217.6	0.2	263.3	-0.8	291.8	-0.7							234.6	0.3	218.6	-0.7	236.4	-0.6
-0.2	219.2	0.2	257.5	-0.6	284.3	-0.7							237.3	0.3	212.6	-0.6	232.5	-0.4
-0.1	220.5	0.1	253.8	-0.4	277.2	-0.7							239.1	0.2	208.0	-0.5	229.8	-0.3
0.0	221.6	0.1	253.4	0.0	273.1	-0.4							239.9	0.1	204.4	-0.4	228.0	-0.2