WOOD SUPPLY ANALYSIS REPORT
FOR
FOREST MANAGEMENT UNIT 13 AND 14

Forestry Branch

Manitoba Conservation

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EXECUTIVE SUMMARY

As part of the provincial wood supply determination program, the Forestry Branch has completed a new Wood Supply Analysis (WSA) for two Forest Management Units, (FMU) in the Mountain Forest Section. This WSA is based on a recently completed $2.2 million forest lands inventory for the Duck Mountain Provincial Park and Forest (FMU 13) and the Porcupine Provincial Forest (FMU 14) developed in partnership with Louisiana-Pacific Canada Ltd (LP).

The Forestry Branch has adopted new methods and forest modeling tools to evaluate provincial forest resources and to determine wood supply that account for complex issues associated with managing Provincial forest resources in a sustainable way. As a result, this WSA differs significantly from the process and methodology used in the early 1980's to determine harvest levels for the same area.

The new WSA process includes additional operating constraints, reflects actual timber utilization standards and forest management activities currently practiced in this area, and accounts for changes to the landbase due to Treaty Land Entitlement Selections, Heritage Resource sites, proposed Ecological Reserves and the Protected Area Initiative. In 2002 a technical advisory committee was established to guide the WSA. The technical advisory committee comprised of representatives from the forest industry, the Western region Integrated Resource Management Team and other branches within Manitoba Conservation provided critical review throughout the process.

The WSA resulted in a new "Base Case" wood supply for FMU's 13 & 14. The "Base Case" wood supply may be modified to reflect operational and management strategies proposed by Louisiana-Pacific and identified in the company's long term Forest Management Plan. Annual allowable cut modifications may, for example, be the result of changes that Louisiana-Pacific proposes to forest planning and operating practices such as, emulating for natural disturbances. Any proposed change to the "Base Case" wood supply will require the approval of Manitoba Conservation.

The wood supply area covers approximately 492,806 hectares of productive forested land in west-central Manitoba. Approximately 312,133 ha. of the forested Crown land in FMU 13 are considered productive and through a series of landbase netdowns, 69.9% of total productive area is available to support forest management activities. There are approximately 180,673 ha of productive forest land in FMU 14 and 65.5% and of this total is available to support forest management activities. The wood supply analysis has determined the total sustainable volume that can be harvested from the timber supply area to be 724,305 m^3/year comprised of 256,302 m^3/year softwood and 468,003 m^3/year of hardwood volumes. Harvest levels are subject to change due to unplanned events such as fire, insect and disease infestations and/or significant changes to forest management practices.

The WSA shows that the total hardwood and softwood harvest levels from FMU's 13 & 14 have decreased from calculations completed in the early 1980's. This reduction is the result of many factors, including timber utilization standards practiced by the industry, reduction of the total operable landbase (Protected Area Initiative, steep slopes, Treaty Land Entitlement selections etc.), incorporating operating constraints such as wildlife tree retention, harvest block greenup requirements and maximum harvest block size into the analysis.

This "Base Case" analysis and the accompanying input/output files will be the benchmark against which all resource activities and management plans will be measured and considered for approval.

1. INTRODUCTION

The Forestry Branch of Manitoba Conservation has completed the wood supply analysis for FMU 13 and FMU 14. The analysis follows a new cost shared inventory and volume sampling program between Manitoba Conservation (MC) and Louisiana Pacific Canada Limited (LP). The previous inventory was undertaken 20 years ago and the annual allowable cut or sustainable harvest level determinations, based on the old inventory, required updating to reflect the sustained yield capacity of the present day forest. New technology and methodologies have been employed in this effort, along with a more consultative approach with the forest industry. The new Forest Lands Inventory (FLI) is a very comprehensive database identifying multi-storied forest structure with a strong ecological component that included a wetland classification, geological/soils layer and many other site and landform attributes. The information gathered in this effort served as the basis for landbase netdown, yield curve development and wood supply analysis detailed in this report.

2. PROVINCIAL POLICY AND MANDATE

The Forestry Branch of Manitoba Conservation is responsible for determining the sustainable harvest level or sustained yield capacity of the forests on Manitoba's forested land. Any allocations made to the forest industry, either through Forest Management License Agreement (FML), timber quota assignment or special allocation, are governed by the sustainable harvest level. Under the old system for determining sustainable harvest level the forest was re-inventoried every 15 to 20 years at which time a new determination was made and allocations were adjusted appropriately. Modern forest modelling technology and methods now allow us transition away from the old periodic determinations of harvest levels and adopt a new comprehensive long-term sustained yield approach in determining wood supply. The Forestry Branch has adopted a more open and consultative approach, jointly discussing key modelling inputs with the industry prior to inclusion into the analysis model. This more comprehensive approach includes more detailed input, particularly from forestry operations and practices.

3. WOOD SUPPLY ISSUES

FMU 13 (under license to LP) and FMU 14 are the primary source of softwood and hardwood fiber for the forest industry located within the Mountain Forest Section. Rising demand of the forest resources and increased pressure on the landbase for other use gave importance to re-inventorying the forests to determine the level of sustainable harvest levels which could be supported on this landbase. Since the last inventory new initiatives on the landbase included, Parklands reconfiguration and zonation, Protected Areas Initiative, Treaty Land Entitlement selections, new ecological reserves and changing operating standards and practices to name a few. Growing concerns on environmental issues such as wetland conservation and water quality protection needed to be better addressed through more comprehensive wood supply analysis.

4. NEW FOREST LANDS INVENTORY

The Forest Lands Inventory (FLI) was completed early in 2003 for FMU 13 and 14 using 1998 aerial photography for FMU 13 and 2000 aerial photography for FMU 14. The Forestry Corp., a consulting company, under the direction of Louisiana Pacific and Manitoba Conservation, undertook the photo interpretation, mapping and ecological sampling of the landbase in FMU 13 and 14. Forest stands were delineated from the aerial photographs and each stand was given forest and soil attributes based on photo interpretation and ground sampling. The standards for this FLI can be found in the document Forest Lands Inventory Specifications prepared for Louisiana-Pacific Canada Ltd. and Manitoba Conservation by The Forestry Corp. (March 31, 2003). Forest sampling methodologies and procedures are detailed in the document "Ecosystem Field Sampling Program Volume Sampling Summary" by the Forestry Corp. prepared for Louisiana Pacific Canada Ltd. and Manitoba Conservation Forestry Branch. The forest inventory and sampling program took two years to complete.

5. WOOD SUPPLY PROCESS

This analysis undertakes to determine the maximum sustainable harvest level that can be sustained on the landbase in FMU13 and FMU14. The determination of sustainable wood supply is undertaken in two parts. First, the strategic level wood supply is determined in accordance with the primary objective of this analysis; determine maximum harvest that can be sustained over the planning horizon. The sustainable harvest is calculated in consideration of forest management policies, such as uninterrupted fiber supply from the landbase (even flow) and operational constraints such as, for example, timber utilization standards, stream buffer widths, minimum harvest age and forest regeneration delay. Secondly, the tactical level wood supply is determined, whereby the harvest blocks and harvest schedules derived from the strategic level optimization analysis are further constrained with spatial considerations, such as greenup delay, harvest-block adjacency rules and maximum cutblock size.

The strategic and tactical level analysis was formulated to best reflect forest policy, operating guidelines and harvesting practices presently followed by the industry and is considered to be the Provincial "Base Case" wood supply analysis.

The forest resource planning software packages, developed by Remsoft Inc. were used in the analysis. The "Woodstock" forest planning model was used to determine the sustained yield harvest in accordance to stated objectives, actions and constraints. "Stanley" is a simulation model that was used to spatially locate the areas scheduled for harvest from the "Woodstock" harvest sequence file. The following sections of this report document the wood supply process detailing model inputs, outputs, structure and data preparation.

6. DATA PREPARATION FOR GIS PROCESSING

The wood supply analysis was undertaken for two separate areas in the Mountain Forest Section, Forest Management Unit 13 (Duck Mountain Provincial Park and Provincial Forest) and Forest Management Unit 14 (Porcupine Mountain Provincial Forest). A separate set of information was prepared for each Forest Management Unit (FMU).

6.1 MAP LAYERS

The information for the two FMU areas was collected and prepared as digital map layers using ESRI ArcInfo Geographic Information System (GIS) software.

The map layers are listed in the table below with a brief description and then described in detail after the table.

Table 1. Map layers prepared for Analysis in FMU 13 and FMU 14.

No.	Layer name	FMU13*	FMU14*	Description
1	Forest Lands Inventory	Yes	Yes	Forest Lands Inventory (FLI) polygons with land status and ownership information.
2	FMU Boundary	Yes	Yes	Boundary of Forest Management Unit.
3	Watershed	Yes	Yes	Fisheries watershed boundaries (area where all streams flow into one river).
4	Heritage Sites	Yes	Yes	Sites identified as being important to heritage (e.g. archaeological discovery)
5	Riparian Buffers	Yes	Yes	Buffers delineating riparian areas around lakes and rivers.
6	Road Buffers	Yes	Yes	Buffers delineating no-cut areas around provincial roads.
7	Harvest Depletion updates	Yes	Yes	Areas harvest after the forest inventory was done (i.e. harvested in 2000-2001)
8	Slope Classes	Yes	Yes	Slope of terrain classified into 5 slope classes.
9	Steep Slopes	Yes	Yes	Areas interpreted as having steep slopes that would restrict harvesting operations.
10	Protected Areas	No	Yes	Areas protected against harvested by Protected Area Initiative (PAI).
11	Treaty Land Entitlement (TLE)	No	Yes	Selection of lands by First Nations that have validated Treaty Land Entitlement claims.

* Indicates whether the map layer is included for FMU 13 or 14 (i.e. Yes or No)

6.1.1 Forest Lands Inventory

The FLI polygon attributes were combined with four other layers to get the final FLI layer. The four other layers are: Forest Management License (FML) boundary, ownership, land status and Forest Management Unit boundary. Combining the layers added additional attributes to the final FLI layer that allow determining which FML and FMU a polygon is located in and what the ownership and status of the polygon is.

The original FLI layer is stored in map tiles with each tile representing an area of about 10 km by 10 km. For the wood supply analysis, the FLI map tiles were appended together to make one FLI map for FMU 13, and one for FMU 14.

6.1.2 Forest Management Unit Boundary

An FMU boundary was needed for each FMU in order the set the geographic limits for the wood supply analysis. The FMU 13 and 14 boundaries (illustrated in Appendix I) were used to set the geographic limits for each of the other map layers.

6.1.3 Watershed Boundaries

The watershed boundaries were delineated by the Prairie Farm Rehabilitation Association (PFRA) and are used as official watershed boundaries by other agencies like the Federal Department of Fisheries and Oceans, Manitoba Conservation Water Branch and Fisheries Branch. A watershed boundary shows the area where all the water drains into one point on a river through a network of streams and rivers.

6.1.4 Heritage Sites

The heritage sites map layer consists of geographically located points that identify where a heritage value has been discovered. For example, archaeological sites are identified as heritage site. Heritage sites are protected from forest management operations so a 50-meter buffer was placed around each site. The site and buffer area were subsequently excluded from harvest consideration. The archaeological and other heritage sites were obtained from Manitoba Culture, Heritage and Tourism.

6.1.5 Riparian Buffers

The area immediately surrounding streams, lakes and other water features is known as a riparian area. This area provides certain values to wildlife and also provides protection to streams, rivers and lakes. Riparian areas are precluded from forest harvesting activities and must be identified so they may be removed from harvest consideration in the wood supply analysis. There are provincial guidelines on buffer widths around water features that are generally interpreted and applied at the regional level. In order to facilitate the netdown process for riparian buffers the Regional Integrated Resource Management Teams (IRMT) was consulted and a map prepared illustrating the buffer widths that are likely to be employed on the landbase. The results of this work were hard coded into the spatial database. Buffer widths employed for this analysis offer various degrees of protection depending on the regional assessment of protection needed. The widths range from 50 meters to 200 meters. The 100 and 200 meter buffers are applied on selected lakes, streams and rivers and 50 meter buffers are applied on all remaining water bodies. The buffers are illustrated on maps in Appendix I.

6.1.6 Road Buffers

For each FMU, provincial roads (i.e. a numbered highway) were identified and a map layer was created to establish 100 meter buffers adjacent highways. Road buffer management strategies and prescriptions are reviewed and if approved, timber volumes will be incremental to the established **annual allowable harvest** level.

6.1.7 Harvest Depletion Update

The Forest Land Inventory (FLI) was completed using 1998 aerial photography in FMU 13 and 2000 photography in FMU 14. The inventory was updated to reflect depletion information (1998-2001), establishing the base year for this wood supply analysis at 2002. The harvest depletion layer consists of polygons that represent areas where the forest has been harvested.

6.1.8 Slope Classification

This is a map layer of polygons that represent 5 different classes of slope in the terrain of FMU 13 and 14. Each slope class and corresponding percent slope range is presented in Table 2.

Table 2. Slope Classification

SLOPE CLASS	PERCENT SLOPE RANGE
1	0 -19%
2	20 - 29%
3	30 - 34%
4	35 - 39%
5	40% +

Polygons with slope class 5 (40%+) were considered to be inoperable and were excluded from harvest consideration in this wood supply analysis.

The slope class coverage was created using spot elevations and breakline elevation features that were supplied by Manitoba Conservation Geomatics Branch. The breaklines are river and lake line features that have been given elevation values. These spot elevations and breaklines were used to make a grid (raster) of elevation values for each FMU. The elevation grid (digital elevation model) was then used to make a grid of slope values. Slope values were then classified into the five slope classes and the classified grid was converted into slope class polygons for the final map layer.

6.1.9 Steep Slopes

A map of each FMU (13 and 14) was plotted showing 5-meter elevation contour lines along with other geographic features. These maps were then used to delineate areas that were considered inoperable because of steep slopes. Smaller distances between contour lines indicated the steeper slopes and, along with local knowledge of the area, this was used to delineate the inoperable steep slopes. These steep slope polygons were then digitized into a digital map layer to be excluded from harvest consideration in the wood supply landbase. Steep slope deductions are presented in Appendix I.

6.1.10 Protected Areas

The Protected Area Initiative identified areas in FMU 14 that are designated to be protected. A polygon map layer was created of the protected areas. The protected areas identified on this map layer for FMU 14 are:

- Bell/Steeprock Canyon protected Area

- Proposed Armit Ecological Reserve
- Proposed Birch River Ecological Reserve

These areas were identified for exclusion from harvest consideration. They are presented in Appendix I.

6.1.11 Treaty Land Entitlement Selection Area

The map layer of the Treaty Land Entitlement (TLE) selection area was received from the Crown Land Registry of Manitoba Conservation. The polygons in this map layer represent the selection of lands by First Nations that have validated Treaty Land Entitlement Claims [Crown Lands Act 5(1)(d)]. There are only TLE areas in FMU 14 and the map showing the location is presented in Appendix I.

7. LANDBASE NETDOWN PROCESS

All GIS processing was undertaken using ESRI ArcInfo and ARC-GIS software. The map layers described in Section 6 (Data Preparation for GIS Processing) were prepared as ArcInfo GIS coverage's. These coverages were overlaid on each FMU to facilitate the netdown of the landbase in preparation for wood supply analysis.

Overlaying GIS data involved combining 10 coverages for FMU 13 into one coverage and combining 11 coverages for FMU 14 into a single coverage. The final combined coverages are termed netdown files. Netdown is the process by which areas and associated volumes are identified for inclusion or exclusion. These netdown coverages are a combination of all the polygons from the combined map layers and are illustrated on maps in Appendix I. Attributes for the FMU 13 and FMU 14 netdown files are listed in Appendix II with information on which map layer they originated.

A separate FLI attribute database was developed and used to assign each forest stand a yield strata label that would be used to project growth in that stand (polygon). This yield strata label was brought into the database using the FLI polygon unique identifier as a link. New attributes for crown closure and year of origin were also joined to the database using the unique identifier link. Yield strata label assignment requires a polygon to have a valid forest type to be eligible. Those hectares without a valid forest type but with a clearcut modifier, indicating that they once were productive hectares, were further examined to determine whether or not they were planted. Planted hectares were assigned appropriate yield strata all others are considered to be non-productive forest for this "Base Case" analysis. Non-productive hectares will be adjusted and placed back into the productive landbase as forest renewal information becomes available. The valid forest type decision rules are presented in Appendix III.

There is a number of no-harvest or restricted harvest areas that have been identified on this landbase and in many instances these situations overlap. For example, a polygon that is within a riparian buffer may also be within a steep slope area and a protected area. The landbase netdown for wood supply was, therefore, done in a particular order and in a way that ensured that each polygon was accounted for only once. Table 3 illustrates the decisions to be made in removing area from harvest consideration and the order in which the areas supporting these volumes must be removed.

Table 3. Landbase Deductions

No.	Deductions for FMU 13	Deductions for FMU 14
1	non-merchantable or non-productive (no yield curve assigned)	non-merchantable or non-productive (no yield curve assigned)
2	land status not equal to agriculture	land status not equal to agriculture
3	50 meter buffer around heritage sites	50 meter buffer around heritage sites
4	100 meter buffer around provincial roads	100 meter buffer around provincial roads
5	buffers around lakes	buffers around lakes
6	buffers around rivers and streams	buffers around rivers and streams
7	slope >=40% (digital elev. model)	slope >= 40% (digital elev. model)
8	steep slopes interpreted from contour lines	steep slopes interpreted from contour lines
9	provincial park closed to resource management	treaty land entitlement selection
10		proposed ecological reserves
11		protected area

Starting at the top of the table the polygons for each type of deduction were queried from the database and then removed so that they would not be accounted for again by any deductions further down the table.

8. GROWTH AND YIELD

The yield curves for this analysis were developed from volume sampling data undertaken in 2001 and 2002 immediately following the new Forest Inventory. Louisiana Pacific, Manitoba Conservation and Forestry Corp. Consulting, jointly determined the sampling stratification and the number of sample plots to be established. Area weighted, randomized volume sampling was undertaken throughout FMU 13 and FMU 14. Forest stands in both units are considered to be similar in forest growth and yield allowing the volume data, derived from sampling in both FMUs, to be aggregated as one population in the process of constructing yield curves. Managed stands were not sampled in the volume sampling program and, as a result, all yield curves are natural stand yield curves.

8.1 SAMPLE PLOT DATABASE DEVELOPMENT

Following the preparation of the forest cover maps a volume sampling program was undertaken by Forestry Corp. to acquire information on forest productivity. To facilitate the sampling program, the forest profile was stratified into forest development types, similar in species composition and structure. All forest stands were aggregated under a development type definition. Species composition, crown closure and height primarily define the development types. All productive forest stand types were assigned to a total of 44 development type classes. Each class was then sampled for tree, stand and site attributes through an area weighted randomized sampling design; allowing stands occupying larger proportion of the landbase a greater probability of being selected for sampling. In total 936 plots were established across FMU 13 and 534 plots were established across FMU 14 for a total of 1470 plots or 490 polygons. The volume sampling program, methodology and field procedures are detailed in a separate report prepared by Forestry Corp., entitled "Ecosystem Field Sampling Program Volume Sampling Summary". The forest productivity information gathered at these plots facilitated the development of yield strata and the preparation of yield curves used in this analysis.

8.2 MERCHANTABLE VOLUME DETERMINTION

Kozak's variable exponent taper equation was used to determine merchantable tree volume. The taper equation and corresponding species coefficients are presented and discussed in detail in Appendix IV. The volume for each tree within the plot was determined using tree height and diameter at breast height. In some plots, not all trees received a height measurement. In these cases, heights, derived from a localized height/diameter model, were used to assign a height to the tree. The following utilization standards were used in the determination of merchantable tree volume.

MERCHANTABLE TREE LENGTH VOLUME

Minimum Diameter Breast Height (1.3 m.above ground) ……………… 11.0 cm
Minimum Top Diameter
softwood ………………………………………… 7.62 cm
hardwood DBH 11-20cm………..……………………… 10.16 cm
DBH 21-40cm……………………..………… 12.7 cm
DBH 41cm+……………………….…………15.24 cm
Stump height softwood and hardwood ………………………………...15.0 cm
Minimum Merchantable length to minimum top diameter ……………… 2.54 m

MERCHANTABLE LOG-LENGTH VOLUME

Minimum Diameter Breast Height (1.3m. above ground)………………. 11.0 cm
Minimum Top Diameter
softwood … . .……………………………………..………… 7.62 cm
hardwood DBH 11-20cm………..………..…………… 10.16 cm
DBH 21-40cm………………………………….. 12.7 cm
DBH 41cm+……………………..………….. 15.24 cm

Stump height softwood and hardwood …………………..…….……… 15.0 cm
Merchantable log-length = integer portion of merchantable length/2.54 m.

8.2.1 Merchantable Species

Only species currently utilized by the industry were considered to be commercially important and used in the aggregation of merchantable volume for softwood and hardwood. For softwood, jack pine, white spruce and black spruce were eligible. Hardwood species include trembling aspen, balsam poplar and white birch. All other hardwood and softwood species were considered to be commercially unimportant and while they are a component of total volume they are not included in the determination of merchantable softwood and hardwood volume per hectare used in sustainable harvest levels.

8.2.2 Cull Reductions

Merchantable tree volume was further reduced for cull (rot). Manitoba cull factors are based on species and age and are presented in Table 4.

Table 4. Percent Reduction for Cull

	SPECIES (all sites)							
AGE CLASS	WS	BS	JP	BF	TL	BA	TA	WB
10								
20								
30	-	-	-	-	-	0.5	-	-
40	0.5	-	-	5.7	-	1.8	0.8	
50	0.5	-	0.4	6.0	-	3.2	2.2	0.4
60	1.3	0.5	1.2	6.5	0.5	4.8	3.8	1.1
70	1.3	0.9	2.6	8.0	0.9	6.5	5.5	1.7
80	3.3	1.0	4.4	10.0	1.0	8.3	7.3	2.4
90	3.5	1.6	6.8	14.0	1.6	10.3	9.3	3.4
100	3.6	2.0	9.4	18.0	2.0	12.4	11.4	4.8
110	3.7	2.3	11.9	20.0	2.3	14.7	13.7	6.7
120	4.0	2.7	14.4	25.0	2.7	17.0	16.0	9.1
130	4.0	3.3	17.1	28.0	3.3	19.6	18.6	11.7
140	5.0	3.7	19.6	35.0	3.7	22.3	21.3	14.5
150	5.0	4.2	22.2	43.0	4.2	25.1	24.1	17.4
160	7.2	5.0	24.8	50.0	5.0	28.0	27.0	20.2

8.3 YIELD STRATA LABEL

Following the filed sampling program stands were re-assigned from development strata to yield strata. The yield strata are presented in Table 5.

Table 5. Yield Strata

STRATUM #	STRATUM NAME	DENSITY CLASS*	DEFINITION
1	PTA	1	Pure Trembling Aspen
		2	80-100% TA, 0-20% softwood
2	MDE	1	Mixed deciduous
		2	80-100% hardwood (TA,BP,WB), 0-20% softwood
3	PJP	1	Pure JackPine
		2	80-100% softwood, JP leading
4	UBS	1	Upland Black Spruce
		2	80-100% softwood, BS or TL leading, moisture class=D,F,M,V
5	LBS	all	Lowland Black Spruce
			80-100% softwood, BS or TL leading, moisture class=W
6	PWS	1	Pure White Spruce
		2	80-100% white spruce, WS or BF leading
7	MWS	1	Mixedwood, softwood dominant
		2	50-79% softwood, 21-50% hardwood, WS or BF or JP leading
8	NWS	1	Mixedwood, Hardwood dominant
		2	50-79% hardwood, 21-50% softwood, WS or BF or JP leading
9	MBS	1	Mixedwood, softwood dominant, Black spruce leading
		2	50-79% softwood, 21-50% hardwood, BS or TL leading
10	NBS	1	Mixedwood, Hardwood dominant
		2	50-79% hardwood, 21-50% softwood, BS or TL leading
11	PHW		Transitional stand, volume from PTA and MDE.

* Density class 1 <= 50% crown closure ; Density class 2 > 50% crown closure

Yield strata assignment grouped forested stands of similar productivity and growth. This provided the increased number of observations and distribution at the age class level that is needed for developing yield curves. The aggregation of species composition and density types into yield strata were also considerate of silvicultural characteristics of species and species associations. SAS programming was undertaken to populate the FLI polygon attribute table with the appropriate yield strata label.

8.4 YIELD CURVE PREPARATION

As outlined in "Pilot Project: Ecosystem Field Sampling Summary" (The Forestry Corp., 2001) the volume sampling program called for the establishment of three plots within a polygon or forest stand. These plots were then averaged to provide species specific stand level mean volume per hectare. The data was then aggregated for analysis under the appropriate strata. A two parameter non-linear model [equation 1] was used to construct yield curves. The SAS - PROC NLIN least squares procedure was used for this analysis work. The statistical analysis work generated yield curves that estimate yield at a given stand age (age of origin from the FLI) across the length of the planning period (200 years).

For each stratum, curves for total merchantable softwood volume and total merchantable hardwood volume using the log length utilization standard were developed. Presentation and detailed discussion on yield curves is presented in Appendix V.

[Equation 1] $$\textbf{Volume} = a * age^{b} * e^{-a*age}$$

Where:
Volume = Merchantable volume per hectare (m^3/ha)
Age = interpreted FRI stand age
a,b = coefficients
e = natural log

8.4.1 Balancing Yield Curves

Yield curves were examined and in some cases underwent minor modification to ensure that the sum of predicted softwood volume and hardwood volume within a stratum equaled the predicted total volume of the stratum at a given age. In many cases these adjustments were minor and only made to the subordinate volume curve. The adjustment factor and the adjusted softwood and hardwood volume are calculated as follows:

Adjustment Factor = (MSV + MHV) – TMV) / (MSV + MHV)
Where:
MSV = Merchantable Softwood Volume
MHV = Merchantable Hardwood Volume
TMV = Total Merchantable Volume

Calibrated MSV = MSV * (1- Adjustment Factor) for hardwood dominated stratum.
Calibrated MHV = MHV * (1- Adjustment Factor) for softwood dominated stratum.

8.4.2 Rotation/Operability Age

Rotation ages for each stratum have been determined through graphical and tabular examination of mean annual increment (MAI) and periodic annual increment (PAI) exhibited by growth curves. Table 6 shows the rotation ages that have been assigned to yield strata. The rotation age applies to all tree species within that yield stratum. Strata level rotation age particularly impacts mixed wood strata. In such cases, the MAI and PAI curves were closely examined to establish composite optimum rotation age for softwood and hardwood working group within each stratum. The curves were further examined to establish an operability window within which harvesting could occur without significantly compromising the combined potential productive capacity of softwood and hardwood species within the stratum. For hardwood leading strata the optimum rotation age and operating window took precedence over the optimum for softwood. However, the final choice reflects the overriding objective to minimize volume loss by both species. The procedure and graphical data is presented and discussed in Appendix VI.

Death age represents that point in time when the current forest stand structure collapses either due to fire or senescence. For this analysis the forest stand age is reset to zero at death and the growth cycle repeats. Death age is a reflection of age class presence (or lack of) as found within the volume sampling program as well as the fire history throughout the forest management unit. Death age and succession are discussed further in the Treatment and Response section (9.4).

Table 6. Rotation Ages

STRATUM	DENSITY CLASS	ROTATION AGE	OPERABILITY RANGE	DEATH
LBS	All	75 years	65 - 80 years	180 years
MBS	2	80 years	70 - 85 years	160 years
MBS	1	80 years	70 - 85 years	160 years
MDE	2	60 years	50 - 65 years	150 years
MDE	1	60 years	50 - 65 years	150 years
MWS	2	70 years	55 - 75 years	150 years
MWS	1	70 years	55 - 75 years	150 years
NWS	2	70 years	60 - 75 years	150 years
NWS	1	70 years	60 - 75 years	150 years
PJP	2	75 years	65 - 80 years	160 years
PJP	1	75 years	65 - 80 years	160 years
PTA	2	70 years	60 - 75 years	140 years
PTA	1	70 years	60 -75 years	140 years
PWS	2	85 years	75 - 90 years	150 years
PWS	1	80 years	70 - 85 years	150 years
UBS	2	65 years	55 – 70 years	180 years
UBS	1	75 years	70 - 85 years	180 years

9. WOOD SUPPLY MODEL AND STRUCTURE

The forest modeling structure was created within Woodstock, Spatial Woodstock and Stanley (Remsoft 2003) forest-modelling environment. The system is flexible and can produce models using both simulation and linear programming formulations.

Spatial Woodstock (an advance version of Woodstock) spatially represents Woodstock models and individual components of these models. All the activities and interventions, including, for example, harvesting, planting, silviculture and any combination of treatments can be portrayed spatially on Spatial Woodstock maps. Spatial Woodstock can also spatially show the change in these activities over time.

Stanley is a harvest block scheduling software that goes beyond the strategic level of long-term forest management planning to application of on-the-ground, blocked harvest schedules. Stanley automates the process of developing a spatial harvest plan. Stanley includes an integrated set of tools for generating stand (polygon) description lists, identifying adjacent stands, finding the best fit solutions. Stanley accounts for any regulation or constraint that may have to be addressed at the spatial level. It deals, for example, with greenup (adjacency) delays, limitations on opening size (clear cuts), and other sustainable forestry implementation guidelines.

The following forest modelling protocols were incorporated as a guide to structure the Woodstock "Base Case" optimization model. Woodstock input files, descriptions and coding are presented in Appendix VII.

9.1 AVAILABLE LANDBASE

FMU13 and 14 area reports were generated from the Forest Land Inventory (FLI) following the landbase netdown process described in previous sections. The netdown process identified 11 coverages outlined in Table 3. The model takes into account the entire forested landbase within the FMU boundaries. The productive forests are grown in accordance with the yield strata to which they belong. The netdown process identifies areas where harvesting will be precluded from harvest consideration. These hectares will, however, contribute to the overall total and merchantable volume on the landbase and assist in meeting the requirements of other resource values. The netdown area used in this analysis is presented in netdown summary Tables 9 and 11 and include, for example, stream and lake buffers, protected areas, provincial road buffers, steep slopes, and areas within Duck Maintain Provincial Park that are closed to harvesting.

9.2 HARVEST ELIGIBILITY

All hectares are not eligible for harvest. Eligibility depends on site conditions, operational limitations, productivity requirements, environmental constraints, land status and forest management policy/guidelines.

9.2.1 Strata Eligibility

The "other hardwood" stratum, which is dominated by non-commercial hardwood species, is not eligible for harvest regardless of the minimum volume and age of commercial species, which may be present within a particular stand.

The lowland black spruce stratum, owing to its small diameter distribution and low productivity has also been removed from harvest consideration.

9.2.2 Operability Requirements

The minimum operable volume constraint, identified jointly with industry, defines the minimum acceptable operable volume per hectare required before a stand is eligible for harvest. For stands within the pure softwood strata types or softwood leading mixed strata, the softwood volume must be greater than or equal to $50m^3$/ha. Hardwood and hardwood leading mixed-strata have a minimum hardwood volume per hectare constraint equal to 75 m^3/ha. A stand must meet these minimum volume requirements before the model will schedule them for harvest. In addition to the minimum operable volume per hectare constraint, harvesting can only occur if a stand meets the minimum operability range age requirement as determined in section (8.4.2).

9.2.3 Net Operable Landbase

The netdown process defines all hectares available for harvest. It identifies for example, the location of hectares associated with buffers, steep slopes, protected areas etc. This is termed the operable landbase upon which harvest eligibility is determined in accordance with the operability constraints. Operable hectares that satisfy the operability constraints are termed net operable landbase upon which harvesting activities are likely to occur. The net operable landbase accounts for areas further removed due to some imposed management and/or operating constraint, such as minimum age or volume per hectare requirement. The hectares contributing to net operable landbase and the associated operable volume change overtime as stands grow and move in and out of harvest eligibility.

9.3 LOG LENGTH UTILIZATION

In this analysis, merchantable log length utilization standard, outlined in section 8.3, is used. In previous calculations for periodic cut determination the provincial utilization standards where vastly different than the utilization standards and process used in this analysis. Stand stock tables have given way to yield curves and utilization standards now recognize log processing limitations and mill delivery specifications. The yield curves used in this model take into account current utilization practices that better reflect the recoverable (deliverable) volume at the tree level.

9.4 TREATMENT RESPONSES /SUCCESSION PATHWAY

Post harvest hectares were reassigned age and strata type based on an analysis of past regeneration survey results and the recommendations from a provincial technical advisory committee. In this wood supply analysis all pure hardwood stands with crown closure 31 - 50% were reassigned as a hardwood stand with crown closure 51 - 60% after harvest. The re-designation of density class is based on forest regeneration survey results that show a trend toward denser stands due to harvest induced suckering.

Hardwood stands (>80% hardwood species composition) with a minor softwood component were re-assigned to a new transitional strata with a yield curve equivalent to the total merchantable volume of the originating hardwood dominated strata. The curve effectively converts the harvested softwood component (if present) into hardwood. This rationale is based on the evidence that the less than 20% softwood component would not be regenerated and present for the second harvest.

Forest regeneration survey data, free to grow data, permanent sample plot data and temporary plot data were examined to determine whether or not trends in forest succession could be ascertained for aging natural stands. The results of this examination were inconclusive and therefore, for this analysis a death age has been assigned and aging strata hectares revert back to their original forest strata type upon death.

For stands depleted through harvesting the analysis of regeneration surveys and free to grow surveys revealed trends in stand development that warranted changing strata types after harvesting. Table 7 illustrates the post harvest transition pathways used in this wood supply analysis.

Table 7. Treatment and Response Pathways

Strata Harvested	Percent Change	Target Strata
PTA	100%	PHW
MDE	100%	PHW
PJP	80%	PJP
	20%	MWS
UBS	80%	UBS
	20%	MBS
LBS	100%	LBS
PWS	50%	PWS
	50%	NWS
MWS	50%	MWS
	25%	NWS
	25%	MDE
NWS	50%	NWS
	50%	PTA
MBS	50%	MBS
	25%	NBS
	25%	MDE
NBS	50%	NBS
	50%	MDE

9.5 MODEL CONTROL

The base year for this analysis is 2002 and the landbase has been updated with all outstanding spatial information (forest management activities) from year of photography to 2002. The updates, for example, include depletion due to harvesting, fires, plantations, land withdrawals, etc. The objective of this analysis is to maximize total merchantable volume under an even flow (consistent periodic harvest level) policy for softwood and hardwood volume. The model uses linear programming (XA solver, Sunset Software Technology) to optimize the objective over a 200 year planning horizon. The optimization was further constrained by a forest management policy that does not permit total operable growing stock to decline in the last 50 years of the planning horizon. A 5 year planning interval was chosen as best suited for operational planning and tracking change in the forest profile overtime.

9.5.1 Planning Horizon

For the "Base Case", a 200 year planning horizon was chosen as a period of time that would best measure the effects of present day harvest strategies, objectives and constraints on the future forest. It is also a suitable period to allow a reasonable risk assessment to be undertaken on many model assumptions, operational/planning constraints and productivity projections.

9.5.2 Even Flow

Even flow minimizes harvest fluctuations by being sensitive to the age class structure of the forest and the variable productivity rates across the landbase. This principle not only ensures that the demand and supply of wood resources from the landbase today can be maintained over a long period of time, but also ensures a constant wood flow to the processing facility and maintains economic/social stability for the surrounding rural communities. Such policy provides for stability and reliability in long term wood supply.

9.5.3 Non-Declining Yield

To assist in the assurance of sustainability, a non-declining, total operable growing stock constraint was introduced in the last 50 years of the planning period. The model objective, to maximize volume over the planning horizon, will attempt to harvest the forest down to this maximum production level at the end of the planning period. Such a scenario ignores any catastrophic events to supply such as fire or insect and disease outbreaks. It also undertakes this maximization based on some assumptions, which may or may not change. Considerations of unplanned events and future changes to land base need to be factored into the model to provide some insurance that the supply risks they pose are managed against the even flow policy. Non-declining operable growing stock is one constraint imposed in this "Base Case" that addresses these risks.

9.6 WOOD SUPPLY CONSTRAINT SUMMARY

In terms of wood supply generated by wood supply models, a number of factors must be taken into consideration.

9.6.1 FMU Amalgamation

The landbase, upon which this analysis was undertaken, is comprised of two FMUs, FMU 13 and FMU 14. The FMUs are separately administered, each with their own supply and licensing encumbrances. FMU13 is under license to LP and FMU 14 is an important wood supply area for the forest industry in the Mountain Forest Section. The Forestry Branch recognizes this distinction and therefore has analyzed each FMU separately.

9.6.2 No-Harvest Zones

The landbase netdown process identifies the map layers that were excluded from harvest consideration. They include non-merchantable or non-productive forested areas, heritage sites, water and road buffers, steep slopes, protected areas and areas within the Duck Mountain Provincial Park that are closed or restricted to harvesting. These areas have been identified as non-harvestable or non-operable landbase and although they contribute, in this analysis, to other resource values such as wildlife food and cover requirements their volumes are not part of the harvestable volumes and they are never scheduled for harvest.

9.6.3 Natural Disturbance

Depletion due to fire, insect and disease or other natural causes are not directly taken into account in this analysis. This is due to the inability to predict where and when such events will take place. As previously discussed, the model formulation manages this risk through other means. Harvest levels will be re-calculated when losses exceed 5% of the operable landbase.

9.6.4 Strategic Level, Non-Spatial Constraints

The main objective in the Woodstock model formulation focuses on maximizing total sustainable harvest level within the main management constraint of maintaining even flow of merchantable softwood and hardwood volume. Both commercial hardwood and softwood species are utilized by the forest industry.

9.6.4.1 Regeneration Lag

Depleted hectares in the softwood and softwood leading strata types undergo softwood renewal strategies and are, therefore, not added back into the productive landbase for 5 years to reflect an adequate establishment period for the softwood. Hardwood and hardwood leading strata, on the other hand, are added back into the productive landbase within one year of depletion. This reflects the findings that adequate hardwood regeneration is immediate while softwood requires 5 years (one planning period) to establish.

9.6.4.2 Minimum Allowable Harvest Age

Table 6 of this report presents the operability range for strata. The minimum age in this range is the earliest a stand can be harvested within the strata. As stated earlier the minimum operability age reflects the combined hardwood and softwood productivity.

9.6.4.3 Minimum Merchantable Volume per Hectare

This operability requirement reflects current operating practices by the License Holder and Quota Holder operations on the landbase considered in this analysis. Hardwood-dominated strata must have at least 75 m^3 per hectare of merchantable hardwood volume for it to be eligible for harvest. Softwood-dominated strata must have at least 50 per hectare of softwood volume before it is eligible for harvest. Merchantable stand volume is extrapolated from the merchantable volume yield curves that in turn reflect merchantability definitions outlined in this report.

9.6.4.5 Stand Breakup or Death

Death defines the natural break-up of a stratum. Death ages range from 140 to 180 years. For reasons presented in earlier sections, death, not succession, occurs on forested stands left to grow beyond their operability range. If left un-harvested, for any reason, a stand will age towards stand breakup or senescence at which time the age will reset to 0. Death age for each stratum is presented in Table 6. Detailed graphics illustrating the establishment of death age are presented in Appendix VI.

9.6.5 Tactical Level, Spatial Constraints

In addition to the non-spatial constraints at the strategic level there are spatial constraints imposed at the tactical level for this "Base Case" analysis. The strategic level analysis, undertaken by Woodstock, focuses on long-term planning objectives. The tactical, spatial analysis undertaken by Stanley best reflects spatially based operating/policy constraints on this landbase. The Stanley simulation exercise represents current reality in operational planning. It finds the hectares, sequenced by Woodstock, and schedules them for harvest under the following constraints.

9.6.5.1 Harvest Blocking Period

The first 25 years (5 periods) of the 200 year harvest sequence produced by Woodstock are scheduled by Stanley.

9.6.5.2 Greenup/adjacency/proximal distance

The greenup delay represents the amount of time (years) which must pass before the harvest of adjacent or proximal blocks can occur. The Greenup delay has been set at 10 years (two periods). This delay for harvested stands addresses wildlife food and cover requirements as outlined in the "Timber harvesting Practices for Forest Operations in Manitoba" and accompanying guidelines documents.

Adjacency is the distance within which a stand is considered to be adjacent to another stand. During the allocation phase, Stanley groups eligible, adjacent polygons into harvest units based on harvest timings specified in the harvest sequence file.

Proximal distance is the distance within which a polygon is considered proximate but not adjacent to another polygon. During the scheduling phase, Stanley checks proximate polygons for compliance with greenup delay. Both adjacent and proximal distances are expressed in linear units within the spatial data set. In this analysis, the preliminary target distances are set to zero distance for both adjacent and proximal distances. This may change in future forest management planning scenarios.

Stanley attempts to assign treatments to stands such that the deviations from the harvest schedule, provided by Woodstock, are minimized. A higher setting allows for greater flexibility in the allocation process but at the expense of a greater divergence from the goals and objectives reconciled in the strategic schedule. The tolerance level, defined as maximum deviation, allows Stanley to deviate from harvest block sequence file toward finding a solution is 10 years or 2 periods.

9.6.5.3 Cutblock Size

Provincial policy and harvesting guidelines stipulate the maximum cutblock size is to be 100 hectares. Cutblocks in excess of this size require approval from the Director of Forestry. The model formulation of Stanley in this analysis restricts cutblock size to a maximum of 100 hectares. Stanley attempts to allocate a block by using the target size goal of 40 hectares. However, Stanley is not constrained by this and may seek out more optimal sizes and configurations as it explores alternative block patterns. It should be noted that this goal is worked toward in consideration of greenup requirements which may significantly impact the optimum harvest schedule generated by Woodstock. Stanley reports the number of occurrences the target was violated.

9.6.5.4 Volume Reduction for Wildlife Trees

A global reduction of 5% of annual harvest is used to reflect tree retention for wildlife. The percentage reflects current operating practices followed by the industry operating on this landbase.

9.6.6 Resource Indicator Outputs

To facilitate assessments on the sustainability of harvest levels generated through this wood supply analysis, the following resource indicators were tracked at the strategic level:

- Total sustainable harvest level
- Softwood (SW) & hardwood (HW) sustainable harvest level
- Long run sustained yield average(LRSYA)
- Merchantable growing stock
- Merchantable net operable growing stock
- Area harvested
- Volume per ha by strata types
- Mortality (merchantable volume)
- Age class distribution
- Average harvest age
- Harvest volume and area by strata profile
- Wildlife habitat report for elk and moose

10. AREA REPORT

10.1 FMU 13

The total area of the landbase in FMU 13 is 376,259 hectares in size (see Table 8). A total of 6,356 hectares or 1.7% of the area is comprised of non-productive forests and 57,771 hectares or 15.4% is non-forested. The non-productive forest land includes forest stands with less than 5% of crown closure and stands that were previously harvested and remain untreated and un-forested. Non-forested lands are water, wetland, anthropogenic, grassland, shrub and agriculture land. All other land is productive forest land totaling 312,133 hectares or 83.0 % of the FMU.

Table 8. FMU 13 Area Summary

Classification	Area (ha)	Percent of total	Percent of Productive Forest
Non Forested			
water	16,981	4.5%	
wetland	34,959	9.3%	
Anthropogenic	1,912	0.5%	
Grass	1,334	0.3%	
Shrub	2,559	0.7%	
Agriculture	27	0.0%	
Subtotal	**57,771**	**15.4%**	
Non-productive Forest			
Crown closure < 5%	2,302	0.6%	
Shrub (previous depletion)	1,584	0.4%	
Veteran (previous depletion)	2,073	0.6%	
Grass (previous depletion)	396	0.1%	
Subtotal	**6,356**	**1.7%**	
Productive Forest			
Closed	38,825	10.3%	12.4%
Restricted	6,254	1.7%	2.0%
Open	267,054	71.0%	85.6%
Subtotal	**312,133**	**83.0%**	**100%**
TOTAL	**376,259**	**100.0%**	

Of the 312,133 hectares of productive forest land, Table 8 shows that 14.4% is in the closed and restricted land status primarily due to land use codes within the Duck Mountain Provincial Park. A series of deductions are applied to the remaining productive forest landbase as part of the process used to define the operable harvesting landbase in the wood supply analysis. These deductions account for the factors that effectively reduce the availability or suitability of the forested productive area for ecological, economical or social reasons. The remaining area deductions for buffers and steep slope areas result in a further landbase reduction of 9.4% of productive forests.

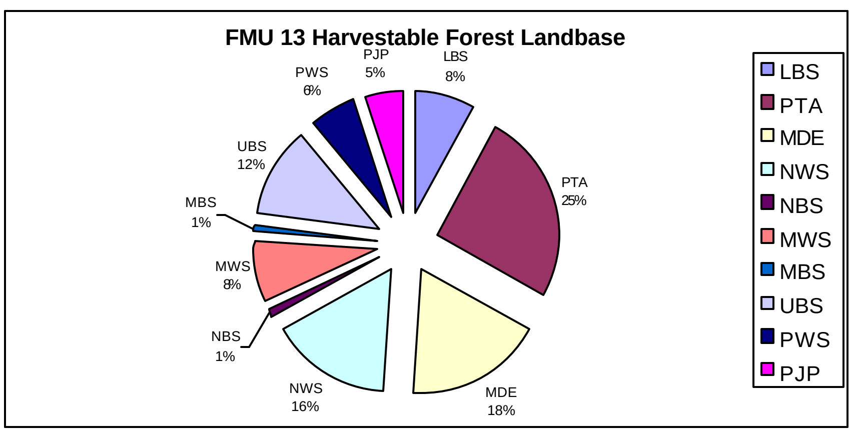
Table 9 illustrates the netdown summary of FMU 13. The total reduction of netdown on the productive forest landbase is 23.9%. In addition to the landbase netdown reductions, an operability issue with respect to lowland black spruce further reduces the harvestable landbase considered in this analysis by 5.2%. These reductions result in a total operable landbase of 218,255 hectares or 58% of the total landbase and 69.9% of total productive forest land within FMU13.

Table 9. FMU 13 Netdown Summary

Classification	Hectares (balance)	Deduction (ha)	Percent of total FMU	Percent of Productive Forest
Productive Forest Landbase	**312,133**		**83.0%**	**100%**
Netdown Deductions				
Closed to harvest (provincial park)		38,825	10.3%	12.4%
Restricted (provincial park - no harvest)		6,254	1.7%	2.0%
Heritage sites		11	0.0%	0.0%
Road buffers		1,809	0.5%	0.6%
Lake buffers		10,332	2.7%	3.4%
River buffer		15,310	4.1%	4.9%
Steep slope		1,926	0.5%	0.6%
Subtotal		**74,467**	**19.8%**	**23.9%**
Harvestable Forest Landbase	**237,666**			
Lowland Black Spruce		19,411	5.2%	6.2%
Total Deductions		**93,878**	**25.0%**	**30.1%**
Operable Forest Landbase	**218,255**		**58.0%**	**69.9%**

Chart 1 shows the forest strata distribution on the harvestable forest landbase within FMU 13 and the percentage of that distribution on the harvestable landbase.

Chart 1. FMU 13 Forest Strata Percent Distribution



10.2 FMU 14

The total area of the landbase in FMU 14 is 207,651 hectares in size (see Table 10). On this landbase 4,008 hectares or 1.9% of the area is comprised of non-productive forests and 22,970 hectares or 11.1% is non-forested. A balance of 180,673 hectares or 87.0 % of the FMU is productive forest land.

Table 10. FMU 14 Area Summary

Classification	Area (ha)	Percent of total	Percent of Productive Forest
Non Forested			
Water	11,207	5.4%	
Wetland	8,307	4.0%	
Anthropogenic	1,294	0.6%	
Grass	368	0.2%	
Shrub	1,592	0.8%	
Agriculture	202	0.1%	
Subtotal	**22,970**	**11.1%**	
Non-productive Forest			
Crown closure < 5%	705	0.3%	
Shrub (previous depletion)	1,170	0.6%	
Veteran (previous depletion)	1,007	0.5%	
Grass (previous depletion)	1,125	0.5%	
Subtotal	**4,008**	**1.9%**	
Productive Forest			
Local Gov. Dist.	57	0.0%	0.0%
Patent Land	38	0.0%	0.0%
Restricted	18	0.0%	0.0%
Open Forest	180,559	87.0%	100.0%
Subtotal	**180,673**	**87.0%**	**100.0%**
TOTAL	**207,651**	**100.0%**	

Table 11 shows the netdown summary for FMU 14.

Table 11. FMU 14 Netdown Summary

Classification	Hectares (balance)	Deduction (ha)	Percent of total FMU	Percent of Productive forest
Productive Forest Landbase	**180,673**		**87.0%**	**100%**
Netdown Deductions				
Local Gov. Dist.		57	0.0%	0.0%
Patent land		38	0.0%	0.0%
Restricted		18	0.0%	0.0%
Heritage sites		19	0.0%	0.0%
Road buffers		696	0.3%	0.4%
Lake buffers		5,612	2.7%	3.1%
River buffer		11,890	5.7%	6.6%
Steep slope		3,562	1.7%	2.0%
TLE		4,244	2.0%	2.3%
EcoReserve		274	0.1%	0.2%
Protected Area		8,178	3.9%	4.5%
Subtotal		**34,590**	**16.6%**	**19.1%**
Harvestable Forest Landbase	**146,083**			
Lowland Black Spruce		27,751	13.4%	15.4%
TOTAL DEDUCTIONS		**62,341**	**30.0%**	**34.5%**
Operable Forest Landbase	**118,332**		**57.0%**	**65.5%**

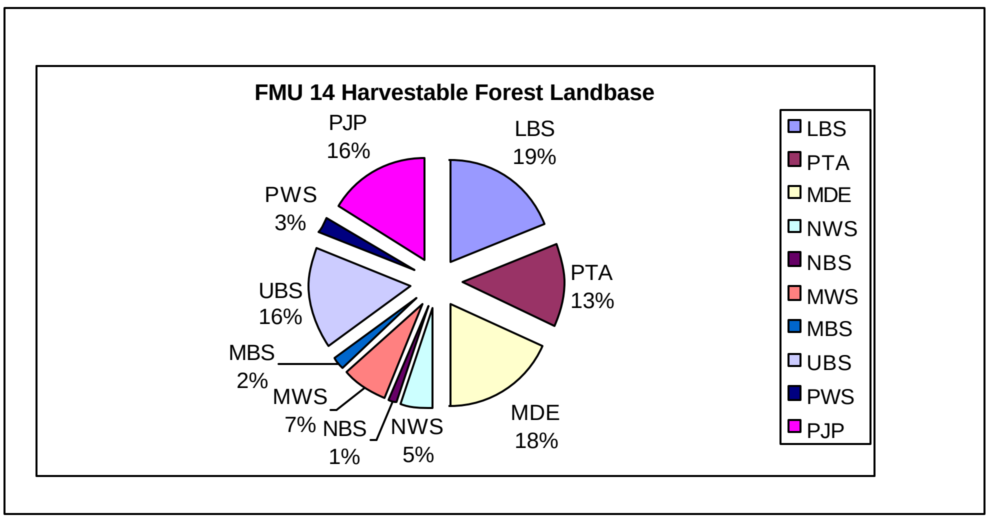
The summary shows only 113 hectares in the local government districts, patent land and restricted land status from FLI inventory. This is less than .01% of the 180,673 productive hectares.

In FMU 14, the protected areas and proposed TLE selections have been very important considerations in determining the harvestable landbase. Similar to FMU 13, a series of deductions are applied to the remaining productive forest landbase. These deductions account for the factors that effectively reduce the availability or suitability of the forested productive area for ecological, economical or social reasons. The remaining area deductions for buffers and steep slope areas result in a further reduction of 10.4% of total FMU area, or 12.1% of productive forests. In addition, TLE selections, proposed ecological reserves and protected areas together reduced the total FMU area by 6.0% and total productive forest area by 7.0%.

The netdown in this FMU results in a total reduction of 19.1% on the productive forest landbase. The inoperability of lowland black spruce further reduces the operable landbase by 15.4%. The reductions result in a total operable landbase of 118,322 hectares or 57% of the total landbase and 65.5% of total productive forest land within FMU 14.

Chart 2 illustrates the forest strata distribution on the productive forest landbase within FMU 14 and the percentage of that distribution on the harvestable landbase.

Chart 2. FMU 14 Forest Strata Percent Distribution



11. WOOD SUPPLY ANALYSIS RESULTS

This section presents the results of the wood supply analysis for the FMU 13 and FMU 14. The "Base Case" harvest forecast uses the most current information on landbase ownership and status, timber harvest, yield curves, tree utilization standards, regeneration survey reports, and forest management/practices. The model formulation and accompanying management policies and constraints were also developed to best represent current harvesting practices and policies for FMU 13 and FMU 14. This analysis should be considered as a baseline for further sensitivity analysis and utilization strategies as deemed necessary. In this analysis, piece size and socio/economics are not considered. This analysis has directed its efforts to determine the sustainable harvest level of wood fiber for hardwood, softwood and mixed-wood strata in FMU 13 and FMU 14.

11.1 STRATEGIC LEVEL RESULTS

The strategic level harvest forecasts, for each FMU, represent current management policies and constraints as described in previous sections of this report. The results presented in Tables 12 and 13 show gross long-term sustainable harvest levels over the next 200 years. FMU 13's total sustainable harvest of hardwood and softwood is 550,115 m^3/yr. while FMU 14's total sustainable harvest is 282,966 m^3/yr. In FMU 13 this total harvest represents 162,533 m^3/yr. of softwood and 387,582 m^3/yr. of hardwood. In FMU 14 the split is 135,830 m^3/yr. of softwood and 147,136 m^3/yr. of hardwood. Over the 200 year planning horizon, the sum of the minimum or maximum volumes for softwood and hardwood growing stock will not equal to the corresponding total because softwood and hardwood total growing stock does not happened at the same time. This phenomenon also exists in operable growing stock. In this analysis the regeneration lag causes subtle differences in the long run sustained yield average (LRSYA).

Table 12. Summary of Strategic Level Wood Supply Results for FMU13

	Over 200 Years			Year 1-100	Year 101-200
	Minimum	Maximum	Average	Average	Average
Harvest Softwood (m^3/yr)	162,533	162,533	162,533	162,533	162,533
Harvest Hardwood (m^3/yr)	387,582	387,582	387,582	387,582	387,582
Total Harvest volume (m^3/yr)	550,115	550,115	550,115	550,115	550,115
LRSYA (m^3/yr)	549,439	572,916	565,089	564,029	566,149
SW merchantable growing stock (000's m^3)	3,759	18,778	8,927	12,009	5,690
HW merchantable growing stock (000's m^3)	11,098	20,979	12,935	13,521	12,322
Total merchantable growing stock (000's m^3)	17,925	39,757	21,862	25,530	18,012
SW merchantable operable growing stock (000's m^3)	813	16,610	5,994	9,541	2,447
HW merchantable operable growing stock (000's m^3)	2,413	19,737	5,684	8,247	3,121
Total merchantable operable growing stock (000's m^3)	5,119	36,348	11,678	17,788	5,568

Table 13. Summary of Strategic Level Wood Supply Results for FMU 14

	Over 200 Years			Year 1-100	Year 101-200
	Minimum	Maximum	Average	Average	Average
Harvest Softwood (m^3/yr)	135,830	135,830	135,830	135,830	135,830
Harvest Hardwood (m^3/yr)	147,136	147,136	147,136	147,136	147,136
Total Harvest volume (m^3/yr)	282,966	282,966	282,966	282,966	282,966
LRSYA (m^3/yr)	300,251	315,766	310,488	310,179	310,798
SW merchantable growing stock (000's m^3)	3,140	8,434	6,435	7,883	4,914
HW merchantable growing stock (000's m^3)	4,787	8,306	6,091	5,249	6,976
Total merchantable growing stock (000's m^3)	11,445	14,360	12,526	13,132	11,890
SW merchantable operable stock (000's m^3)	679	6,093	3,283	4,620	1,945
HW merchantable operable stock (000's m^3)	1,184	5,182	2,947	2,425	3,470
Total merchantable operable stock (000's m^3)	5,061	11,274	6,230	7,045	5,415

The total even flow harvest or sustainable harvest level in FMU 13 is on average 2.6% less than LRSYA (illustrated in Figure 2). The average total, even flow harvest level in FMU 14 is 9.7% less than LRSYA. LRSY is the theoretically average sustainable harvest level the forest can support over the long run. This important indicator of sustainability in the evaluation of the sustainable harvest level is satisfied in this analysis.

A graphical illustration of the sustainable harvest levels in FMU 13 and 14 is presented in Appendix VIII, Figures 1 and 2.

11.1.1 Post Harvest Transitional Trends

Figures 3 and 4 in Appendix VIII illustrate transitional trends resulting from harvest operations in softwood and hardwood stands. The trends illustrate the transition from existing natural stands to second growth stands (previously depleted and regenerating). Harvesting at maximum sustainable levels in FMU 13 would result in hardwood harvesting operations moving into second growth stands in approximately 50 years. While the maximum sustainable harvest level for the softwood forest can be sustained for an additional 40 years before operations move into second growth softwood stands. Given that the current forest age class distribution in this FMU is primarily mature to over-mature with few young stands, any changes that affect the timing of transition (i.e. failure to meet reforestation requirements or not following harvest schedule generated by Woodstock) could significantly affect the harvest level in FMU 13. The timing of these transitional events is very similar in FMU 14.

11.1.2 Harvest Volume by Strata

Figures 5 and 6 in Appendix VIII illustrate volume harvested by forest strata type. The strata contribution to harvested volumes varies over time and reflects current forest age class distribution, strata size and the effects of transition pathways for depleted hectares. In FMU 13 the PTA, MDE strata make up the greatest proportion of the total harvested volume in first 40 years. The PHW strata (which is reflective of stand transition after harvest) begins to dominate and remain dominant until the end of the planning horizon. In FMU 14, the MDE and UBS strata make up the majority of harvesting in the first 50 years. The transition pathways in this FMU show the MDE stratum and PTA stratum transitioning to the PHW stratum over time. The PJP and UBS stratum dominate the softwood harvest (influence of the 1980 fire).

11.1.3 Growing Stock

Figures 7 and 8 in Appendix VIII show a projection of total harvestable growing stock available for harvest in FMU 13 and 14 respectively. These projections reflect the “Base Case” harvest scenario. Over the 200 year planning horizon the total growing stock on the harvestable landbase declines as the merchantable stands are harvested and replaced by younger and as yet unmerchantable, second growth stands. In FMU 13 the total growing stock declines from 39 million cubic meters to approximately 18 million cubic meters in the first 100 years of harvesting, reflective of the age class distribution. In FMU 14 the total growing stock declines slightly from 14 million to 12.5 million. This decline is significantly influenced by the initial age class distribution, particularly the hectares contributed by the 1980 fire.

The graphs show that toward the end of planning horizon, the hardwood growing stock increases while the softwood growing stock decreases in volume. The increase and decrease in volume is the result of post harvest stand transition, as the accumulated effects of the treatment responses, after harvest, begin to show.

It must be remembered that even though the growing stock becomes merchantable in time it may not be harvested due to harvest policy, constraints and operability limits. Net operable growing stock (Figures 9 and 10 in Appendix VIII) provide a better indication of available volume but only under the present tree utilization standards and operating constraints. Improvements in the level of utilization and harvesting practices can have a dramatic effect on net operable growing stock and move it closer to total merchantable growing stock volume.

11.1.4 Net Operable Growing Stock

Figures 9 and 10 in Appendix VIII depict the net operable growing stock or volume available in consideration of all netdowns, strata eligibility and operating constraints. As expected, the same general trends seen in the total harvestable growing stock appear in the net operable volume, but at a significantly reduced level. FMU 14 shows a considerable gain in net operable volume at 45 years. This is due to the mass maturing of stands from the 1980 fire.

The average total operable stock for the “Base Case” in FMU 13 is about 12 million cubic meters with a high of 36 million cubic meters at the beginning of the planning horizon to 5 million cubic meters at 150 years. In FMU 14 the average total operable stock is about 6 million cubic meters with a high of 11 million cubic meters at the beginning of the planning horizon to approximately 5 million cubic meters at 150 years.

11.1.5 Area Harvested

Figures 11 and 12 in Appendix VIII show the total area harvested, from the operable forest landbase in FMU 13 and 14. In order to optimize the management objectives, under an age class imbalance, the model concentrated harvesting on older aged hectares and hectares exhibiting low productivity in the early years of the planning horizon. The model chooses this harvest strategy to acquire the hectares needed to move toward a more balanced age class distribution and maximum even flow harvest across the planning period. In FMU 13 a harvest area of 3,540ha per year at the beginning of the planning horizon dropped to 2,430 hectares within 15 years of harvesting. In FMU 14 an annual harvest area of 1,745 ha. dropped to 1,343 ha. in the first 25 years of harvesting. This drop in area harvested reflects the model's choice of harvesting stands close to their optimum rotation ages. At 60 years (after first rotation) the harvest area increased to about 2,939 hectares per year in FMU 13 and 1,628 hectares per year in FMU 14. As shown in the graphs this harvest level is less that 2% of the forested area >20 years of age across the planning horizon.

11.1.6 Harvest Area by Strata Type

The annual harvest area fluctuates due to the volume per hectare contribution made by the different strata types harvested in a particular year. Figures 13 and 14 in Appendix VIII illustrate the strata harvest profile for FMU 13 and FMU 14 respectively. The annual average harvest area in FMU 13, accounts for approximately 1.3%, of the FMU’s open productive forest landbase. While in FMU 14 the annual average harvest area accounts for 1.1% of open productive forested landbase. For FMU 13 the average annual harvest area within density class 2 stands is 2,830 hectares and an average of 228 hectares per year comes from density class 1 stands. In FMU 14 harvesting averages 1,360 hectares per year from density class 2 stands and 146 hectares per year from density class 1 stands.

11.1.7 Mean Annual Volume per Hectare Harvested

Figures 15 and 16 in Appendix VIII illustrates the mean volume per hectare harvested across the planning horizon by leading species working groups, including the leading species volume per hectare for softwood stands (PJP, UBS and PWS), softwood leading mixedwood stands (MWS and MBS), hardwood leading mixedwood stands (NWS and NBS) and hardwood stands (PTA, MDE and PHW). The mean volume per hectare is the total harvest volume divided by total harvest area at each planning period and is an important indicator in evaluating operational productivity.

In order to optimize long-term harvest productivity, less area is harvested in higher volume per hectare strata and vice versa. It should be noted that in certain planning periods the model chooses not to harvest some strata types. The graphs also show that the minimum operable volume per hectare constraint has been met for the softwood and hardwood leading stands.

11.1.8 Average Harvest Age

Figures 17 and 18 in Appendix VIII show the stand ages by all harvested stand types over 200 year planning horizon. Each stratum is harvested within their operable and separate age range. To calculate the average harvest age by stand type the harvest age must be weighted by area harvested in each strata. For FMU 13, all harvested stand ages are above 100 years at the beginning of the planning period, gradually moving to about 60 years toward the end of the planning horizon. This trend exists in FMU 14, but there's an exception from year 141 to year 150 due to increased harvest in older softwood and mixedwood stands during that time.

11.1.9 Age Class Distribution

Age class distribution maps for each FMU can be found in Appendix VIII. The graphs (figures 19 and 20) illustrate the current and future age class distribution on both the total productive forest area and harvestable landbase. The graphs show the change in age structure overtime.

Under the current management scenario and in the absence of natural disturbances (fires), the age class distribution on the harvestable forest landbase becomes more evenly distributed. At 100 years into the future the harvestable-forested landbase becomes more populated by younger age classes, ranging in age from 0 years to optimum or near optimum rotation age. The loss of older age classes is largely attributable to the death of un-harvested lowland black spruce, aging strata within the protected areas and buffers.

11.1.10 Mortality

Figures 21 and 22 in Appendix VIII tracks the volume on stands not harvested and lost due to mortality in FMUs 13 and 14. The peaks reflect the present age class distribution of the forest whereby over-mature stands break up at those points in time. In FMU 13 the Closed/Restricted areas primarily account for the volumes lost to mortality followed by areas lost to harvesting through netdown activities. In FMU 14 the protected areas and buffers contribute the most volume to mortality followed by the harvestable area.

11.1.11 Habitat Suitability Indicies

Figures 23 and 24 in Appendix VIII illustrate the moose and elk food and cover suitability indices that result from this "Base Case" scenario.

The habitat suitability indices are derived from curves developed jointly with the Wildlife Branch. Food and cover habitat includes all available land area, including closed and restricted areas, buffer areas, steep slope areas, and protected areas that were removed from harvest consideration. These figures demonstrate the trend under the current forest management regime.

11.2 TACTICAL LEVEL RESULTS

As stated previously in the report, the spatial constraints are applied to the Woodstock harvest sequence to produce a 25-year tactical harvest schedule that is achievable under current operating practices.

Tactical output identifies the location and timing of hectares (blocks) to be harvested. The spatial constraints are applied using Stanley harvest simulation software, which undertakes a best-fit analysis through a series of passes. For FMU13 the tactical level analysis resulted in an additional 5% reduction of the sustainable harvest level produced in Woodstock, indicating that the optimum Woodstock harvest schedule could not be completely realized under additional spatial constraints.

In FMU 14 the optimal spatial harvest schedule is 86% of the Woodstock solution, demonstrating that the move from the strategic level analysis using Woodstock to the tactical level cutblock harvest schedule results in a 14% reduction to sustainable harvest levels in FMU 14. This larger deduction in FMU 14 is due to the greater age class gap in this FMU. The configuration of these gaps across the harvestable forest landscape constrains harvest choice to a small area where the adjacency constraint plays a significant role by restricting harvest choices.

The tactical level analysis also applied a reduction for wildlife tree retention. An additional 5% reduction was incorporated to account for wildlife trees that are left on harvested areas as per the company's operating guidelines. The 5% deduction for wildlife trees was agreed to by the industry as a reasonable deduction that reflects current operating practices. Operational logistics and terrain features could not model the application of the wildlife deduction at either the strategic or tactical level due to the randomness of application influence.

11.3 HARVEST LEVEL RESULTS SUMMARY

Table 14 provides a summary of the harvest levels. Based on the strategic level (200 years) and tactical level (25 years) analysis, the net total harvest levels for next 25 years are 495,103 m^3/yr for FMU 13, and 229,202 m^3/yr for FMU14 after the Stanley spatial constraints and wildlife tree deduction. The total net harvest level is 724,305 m^3/yr if two FMUs are added together. In this "Base Case" wood supply analysis, no attempt is made to forecast the Annual Operating Plan (AOP) and/or the long term Forest Management Plan (FMP) process. However, wood supply for the short term should be addressed in the AOP and 10 year FMP documents.

Table 14. Harvest Level Results Summary

FMU		Strategic Level Total Harvest Level Woodstock (m^3/yr)	Tactical Level Volume Deduction Stanley Constraints** %	Wildlife Tree %	Net* Harvest Volume (m^3/yr)
13	Total	550,115	5%	5%	495,103
	Softwood	162,533			146,280
	Hardwood	387,582			348,823
14	Total	282,966	14%	5%	229,202
	Softwood	135,830			110,022
	Hardwood	147,136			119,180
FMU 13 & 14					724,305

Note:
* The net harvest volume =(total harvest volume at strategic level) *(1-volume deduction from Stanley constraints & wildlife tree)
** Stanley constraints:
No adjacent and proximal distance, maximum block 100ha, target 40 ha, greenup delay 10 yr, maximum deviation 10 yr, maximum flow fluctuation 0%.

12. DISCUSSION AND CONCLUSIONS

This "Base Case" wood supply analysis was guided by provincial policy and operating guidelines in determining maximum sustainable harvest levels for FMU 13 and FMU 14. Although socio-economic objectives were not considered in this analysis, an even-flow constraint for volume available for harvest was adopted to ensure stability in a diverse forest industry relying on steady, long term supply of forest products from the landbase. A planning horizon of 200 years has been adopted to facilitate a thorough evaluation of the forest management practices and assumptions guiding forest development through two rotations of the forest. The province recognizes that predicting the state and composition of the forest, so far into the future, is very difficult owing to the many variables, assumptions and estimates imbedded within the analysis. However, the long planning horizon allows planners to test the sensitivity of results across, for example, the range or natural variation of a particular input.

The "Base Case" analysis shows considerable operable growing stock or volume eligible for harvest at the beginning of the planning horizon. The even flow constraint, imposed across the planning horizon, in conjunction with a preponderance of older age classes and a lack of young age classes, produces a "pinch point" in operable growing stock. This "pinch point" occurs at the end of the planning horizon and limits the sustained yield harvest level across the whole planning horizon (200 years). Stands eligible for harvest early in the planning horizon are left to age, producing diminished yields per hectare.

Non-declining yield of total operable growing stock in the last 50 years of the planning horizon was enforced to assist in ensuring that productivity estimates at the back end of the planning horizon did not overly influence the level of harvest across the entire planning horizon. As added insurance, the risk to timber supply by unplanned catastrophic events such as fire was addressed through this policy. Sensitivity analysis showed that the need for an additional constraint to account for unplanned events which may occur early in the planning horizon was not required due to the large amount of available operable growing stock relative to even flow harvest levels for softwood and hardwood.

In the development of model inputs and formulation a technical advisory committee undertook consultations with industry, regional Integrated Resource Management Teams and other branches within Manitoba Conservation. This was done to ensure that operating practices and environmental safeguards (such as utilization standards or stream buffers), were addressed by the model formulation at both the strategic and tactical level.

Of particular note is the stream and lake buffer assignment during the landbase netdown process. The regional IRMT assigned the buffer widths that were to be established on streams and lakes within the Forest Management Units. They also assisted in identifying slope areas where forest harvesting operations would not be approved.

Discussions with industry resulted in the withdrawal of the lowland black spruce strata from the harvestable landbase. At present lowland black spruce stands are not harvested and therefore should not contribute in the determination of periodic harvest levels. After netdown, lowland black spruce occupies 6.2% of the productive forest in FMU 13 and 15.4% of the productive forest land in FMU 14. Tamarack and balsam fir were not considered merchantable species in the determination of the sustainable softwood harvest level.

Prior to running the "Base Case" analysis, the FLI was updated for depletion activities occurring since the date of photography, upon which the current inventory is based. Non-forested stands, when identified through the forest interpretation process, indicating previous harvest or renewal activity, were assigned a Clear-Cut identifier. Such stands were crossed checked with planting records to insure that, if planted, they were assigned to a productive stratum. All other depleted non-forested hectares are considered to be potentially productive and were not assigned to a productive stratum. A total of 4,053 hectares in FMU 13 and 3,302 hectares in FMU 14 are classed as potentially productive. Further investigation of these potentially productive hectares could result in additional hectares being added back into the productive landbase.

Managed stands or stands which undergo some treatment regime i.e. planting and tending are generally believed to be more productive than naturally developing stands. Increasingly, genetically superior seed will be used to grow the planting stock for the plantations providing another reason to expect greater productivity per hectare on forest plantations. Managed stand yield curves should be developed to reflect this increase in productivity. However, for this analysis, there is not enough data from managed stands to use for the development of managed stand yield curves. Consequently this results in the use of natural stand yield curves for both managed and natural (unmanaged) stands. This suggests that the volume estimates for managed stands (generally harvested after the first rotation) may be conservative and the resulting long term wood supply less than what may be realized. However, until the growth dynamics of managed stands are determined, volume estimates from current natural stand yield curves will continue to reflect the productivity of both managed and unmanaged stands for the near future.

In determining rotation age or minimum harvest age, the only consideration given to tree size was that it had to be of merchantable size (minimum 11cm. diameter at breast height) as per the provincial utilization standards. Beyond that, tree size was not an important consideration in this wood supply analysis. If there are expectations or requirements by the forest industry on the average tree size delivered to mills then additional analysis work will be required. A tree size or piece size constraint would likely increase average harvest age which in turn would likely result in a reduction to wood supply.

Ideally in developing yield curves all age classes of the forest strata should be equally represented, with no one age class over-shadowing another. Over sampled age classes may unduly influence the slope of the yield curve during development. Consequently, additional sampling was done by Manitoba Conservation, targeting strata that needed improvement in the number of observations. However, more work still could be done to supplement the existing volume sample data used in the development of yield curves.

In this analysis, the only cull deduction to gross tree volume was a deduction for tree rot. Deductions for poor stem form were not considered or taken into account. Sawlog operations may wish to include further deductions, for example, log sweep, to reflect real volume loss for processing.

Another consideration for volume loss which was not taken into account is breakage. Depending on the logging systems and processing systems used, breakage may or may not be a significant deduction for some strata types. This deduction will require further investigation in future analysis work.

For this wood supply analysis the Provincial utilization standard for hardwood top diameter was replaced by a variable top standard. The variable top standard (ranging from 10.16cm to 15.24cm) reflects current harvesting practice that results in larger top diameters for larger trees. Improved level of utilization (chipping) could see a significant increase in recoverable volume at the stump and result in an increased hardwood supply.

Sensitivity analysis work showed that tree length harvesting operations will significantly increase deliverable volume over the log length utilization level currently used by the forest industry. Under tree length harvesting operations there would be an average 12 percent increase in hardwood and 6 percent increase in softwood supply (Table 15). A further increase in softwood volume is possible (2,500 m^3/yr-FMU 13 & 1,500 m^3/yr-FMU14) should balsam fir be managed and utilized effectively by the industry (Table 16).

Table 15. Comparison 3" Top Tree Length Harvest Level with "Base Case" at Tactical Level

FMU		"Base Case" (m^3/yr)	3" Top Tree Length (m^3/yr)	3" Top Tree Length of "Base Case" %
13	Total	495,103	544,405*	110.0%
	Softwood	146,280	155,239	106.1%
	Hardwood	348,823	389,166	111.6%
14	Total	229,202	251,823 *	109.7%
	Softwood	110,022	116,657	106.1%
	Hardwood	119,180	135,166	113.1%

Note:
* The "Base Case" tactical level volume deduction factor applied for each FMU.

Table 16. Balsam Fir Harvest Level at Strategic Level*

FMU		"Base Case" 200-Year Average (m^3/yr)	3" Top Tree Length 200-Year Average (m^3/yr)	3" Top Tree Length of "Base Case" %
13	Balsam Fir	2,457	2,527	102.8%
14	Balsam Fir	1,444	1,487	103.0%

Note:
* Calculated from 3%, 8% and 2% of PWS, MWS and MBS harvest volumes respectively at strategic level for each FMU.

In this analysis it is assumed that secondary and tertiary roads required for wood extraction will be reforested.

As previously mentioned the "Base Case" analysis undertakes a strategic level analysis as well as a tactical level analysis. The strategic level analysis produces a policy based harvest level which reflects estimates and assumptions on forest productivity, stand transition and a host of other inputs previously presented. The strategic level analysis also provides the companion harvest sequence profile that supports the harvest level. The harvest sequence profile which, if followed, will ensure that harvesting at the maximum level will be sustained over the planning horizon. The tactical level analysis examines the harvest sequence file and introduces the spatial constraints that were presented earlier in this document. The achievable harvest level is then further constrained by these spatial considerations. However, this is not to say that the harvest sequencing cannot be improved upon to minimize volume loss due to operational planning considerations. Or indeed to maximize other objectives which may be introduced at the spatial level. It must be remembered that this is the "Base Case" analysis which forms the basis for refinement, adjustment and sensitivity analysis of other forest management scenarios which may be proposed for this landbase.

Key outputs from this "Base Case" analysis are strata harvest levels, long run sustained yield average, net operable growing stock, average harvest age, age class distribution, strata area distribution and mortality.

Harvest levels were checked against the Long Run Sustained Yield Average (LRSYA) which is the maximum theoretical average harvest level. At the strategic level it shows that the harvest level is lower than average LRSYA, about 3% in FMU 13 and 10% in FMU 14. This ensures that the "Base Case" harvest levels do not violate LRSYA and are reasonable expectations within the mountain forest section.

The operable landbase is determined through the GIS landbase netdown process. Overtime the operable forest landbase moves to a more even distribution of age classes enhancing the biodiversity of the forest. The net operable growing stock on this landbase is calculated taking into consideration additional operational constraints such as strata eligibility and operability standards. Across the planning horizon the net operable growing stock drops gradually and levels off at 150 years into the future when the Non-Declining Yield constraint disallows any further decline. Toward the end of planning horizon, the hardwood growing stock increases while the softwood growing stock decreases in volume. The increase and decrease in volume is the result of post harvest stand transition, as the accumulated effects of the treatment responses, after harvest, begin to show. However the non-declining yield constraint on total net operable growing stock is maintained. Softwood under-storey protection is not a consideration in this analysis. If softwood under-story protection is successfully practised, net operable softwood growing stock would increase and may result in increased softwood harvest levels.

Net operable growing stock provides an indication of available volume but only under the present tree utilization standards and operating constraints. Improvements in the level of utilization and harvesting practices can have a dramatic effect on net operable growing stock and move it closer to total merchantable growing stock volume. Although fire and other events make it difficult to predict with certainty, forest profiles far into the future, the non-declining yield constraint in the last 50 years addresses this risk and provides a measure of insurance in order to preserve net operable growing stock available for the harvest.

In the first quarter of the planning horizon the average harvest age is approximately 100 years. The average harvest age of the whole forest then slowly reduces to 60 years (near rotation age) as the model optimizes harvest volumes. Examination of average harvest age by strata indicates that the minimum harvest age constraints have been met in the solution. There were no piece size constraints built into this analysis and as the average harvest age drops so does the average size of the trees being harvested.

In this analysis, death as opposed to succession is incorporated for un-harvested stands. Pathways for natural forest succession are difficult to ascertain in the absence of supporting data from long term permanent sample plots. Succession also has a very significant impact on growing stock. Slight changes in succession predictions can have a dramatic effect on the forest landscape and accompanying operable volumes. In view of the gaps in the supporting data the Department has chosen a more conservative approach in determining sustainable harvest levels in this "Base Case" analysis by adopting death and re-birth as a succession scenario for un-harvested stands. This approach was felt to be an acceptable one in light of the focus of the "Base Case" analysis. Certainly this area will need to be more closely examined in the future as biodiversity targets for plants and animals becomes incorporated into overall forest planning objectives. In this analysis tree mortality on harvestable land is minimal, occurring primarily in non-harvestable areas such as buffers.

Many inputs into this "Base Case" analysis are uncertain due in part to the variation within the data sets used. This is not unexpected as forest development dynamics and productivity across such a large landbase is very difficult to accurately predict. In this analysis a great effort was placed on managing the risk and efforts continue to reduce the level of risk through ongoing research and analysis.

For wood allocation, the hardwood harvest level is calculated from the operable landbase within the Porcupine Mountain Provincial Forest, Duck Mountain Provincial Park & Provincial Forest. Hardwood quota and special allocations that predate LP's environmental License can continue within the Park's resource management land use zone. To effectively manage the hardwood harvest level for FMU 13 the existing hardwood Quota Holder's should, over time, be located in the Resource Management zone within the Park.

Wood supply analysis systems, used in optimizing sustainable harvest levels are tools to assist forest managers and planners in determining the annual allowable cut. Many other considerations, such as socio-economic values which fall outside the model structure have to be carefully evaluated in setting the annual harvest levels. The Province maintains the responsibility of setting harvest levels for forest management units throughout the province. Therefore, any wood supply analysis work undertaken outside this "Base Case" analysis will require departmental approval. Inputs such as yield curves, operable forest area, forest transition pathways, etc. that differ from those used in the “Base Case” analysis will be examined closely for approval by the Department. The Forestry Branch is presently in the process of revising submission requirements for wood supply analysis work. This “Base Case” analysis and the accompanying input/output files will be the benchmark against which all resource activities and management plans will be measured and considered for approval.

13. REFERENCE

B.C. Ministry of Forests, 2002, Fort St. John Timber Supply Area Analysis Report

Forestry Corp., 2001, Pilot Project: Ecosystem Field Sampling Summary (unpublished)

Haddon, B.D. (editor), 1988, Forest Inventory Terms in Canada

KPMG Management Consulting, 1995, Manitoba’s Forest Plan-towards Ecosystems Based Management, Report to Manitoba Natural Resources

Manitoba Conservation Forestry Branch, 2001, Five-year Report on the Status of Forestry

Manitoba Conservation Forestry Branch, 1998, Provincial Forest Inventory Field Instructions Manual (unpublished)

Remsoft Inc. 2003, User’s manuals for Woodstock, Spatial Woodstock and Stanley

14. APPENDICES