TYPE II
FOREST LEVEL
SILVICULTURE STRATEGY

NORTH COAST
TIMBER SUPPLY AREA

DATA PACKAGE

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1.0 INTRODUCTION

This Data Package was prepared for the North Coast TSA as a source document for the North Coast TSA Type II Forest Level Silviculture Strategy. The following tables and discussion outline the methods and inputs used for both the base case and silviculture scenario analyses for this project.

This project was scheduled such that the North Coast LRMP (the LRMP) analysis could be used as a benchmark for this project. Consequently, the majority of information found in this report comes directly from the *Timber Supply Analysis for the North Coast TSA – North Coast LRMP Project (May 16, 2002)* (the LRMP data package). The LRMP Base Case scenario assumptions will be used as the base case of this project. These assumptions are described below.

Sections 2.0, 3.0 and 4.0 describe the inputs and assumptions used in the base case analysis. Section 5.0 and Section 6.0 describe the assumptions specific to the silviculture scenarios and any variations from the base case. These assumptions have been developed through research and in consultation with numerous stakeholders and other experts.

1.1 PROJECT OBJECTIVE

The objective of this project is to determine the level, type and scheduling of discretionary silviculture expenditures that maximize the financial return on the North Coast TSA.

1.2 THE PROCESS

This document was developed based on a variety of sources and through collaboration with a number of key stakeholders. Following is brief synopsis of the process:

1) Preparation of the *Preliminary Information Report – Stakeholder Workshop (December 2001).* This document contains a description of the project objectives, land base summaries as per TSR II, and a list of potential scenarios for analysis.
2) Workshop #1 was held at the Prince Rupert District Office on December 12, 2001. Input was solicited from the attendees representing Industry and Government. A complete list of attendees and meeting agenda is included in Appendix I.
3) Input from the workshop and the results of further collaboration is summarized in the *North Coast TSA – Type II Forest Level Silviculture Strategy – Consensus Document (July 2002).* The document was sent to workshop participants for further review and comment. The assumptions contained within the *Consensus Document* have been incorporated into this Data Package.
4) This Data Package was submitted to MoF staff for approval.

1.3 ACKNOWLEDGEMENTS

Integrated Silviculture Services Ltd. and Timberline Forest Inventory Consultants Ltd. were jointly selected by the MoF undertake this project. This project was administered by Lou Tromp and was funded by Forest Renewal BC (FRBC).

2.0 FOREST ESTATE MODEL

The forest estate model Woodstock will be used for the silviculture analysis portion of the project. This model, developed by Remsoft, provides functionality in modelling and utilizes optimization technology to provide a wide range of modelling capabilities.

Woodstock's capabilities allow for the incorporation of product class, revenue and cost information into an optimized harvest schedule based on the maximization of net revenue.

Financial return will be used to evaluate silviculture treatments. The objective of the model will be to maximize the net present value (NPV) of the net revenue generated from the land base over the planning horizon. Various silviculture scenarios will be tested and evaluated based on their contribution towards this objective.

Benchmarking to the North Coast LRMP analysis will be conducted using FSSIM version 4.1. This is the model used to develop the LRMP base case.

3.0 LAND BASE SUMMARY

3.1 INVENTORY INFORMATION

Table 1: Inventory Information.

Data	Source	Vintage	Update	Scale
Forest cover inventory	MoF	1957/1997	01/05/08 – MSRM	1:20 000
Operability	MoF	2001	01/11/23 - MSRM	1:100 000
North Coast TSA boundary	MoF		01/05/05 - MSRM	1:20 000
Nisgaa settlement area	MoF	1997	01/06/11 - MSRM	1:250 000
North Coast LRMP Boundary	LUCO		01/10/05 - MSRM	1:250 000
Nass Partition	MoF		01/08/19 - MSRM	1:20 000
CCLRMP Zoning	LUCO		02/04/04 - MSRM	1:20 000
Visual Landscape Inventory	MoF		02/04/19 - MSRM	1:20 000
Scenic Areas	MoF	1995	01/09/14 - MSRM	1:20 000
Ownership	MoF		01/05/08 - MSRM	1:20 000
Biogeoclimatic ecosystem classification (BEC)	MoF	1995	02/04/17 - MSRM	1:250 000
Recommended landscape unit boundaries	MoF	1997	01/06/11 - MSRM	1:20 000
Existing Protected Areas	BC Parks		01/07/09 - MSRM	1:20 000
Visual Quality Objectives	MoF		01/07/09 - MSRM	1:250 000
Current Management Visual Quality Objectives	MoF		01/08/03 - MSRM	1:20 000
Community Watersheds	WALP		00/08/18 - WALP	1:20 000
Khutzeymateen GBPU/no hunting zone	WALP		01/04/10 - WALP	1:250 000
Settlement Areas	MSRM		01/09/24 - MSRM	1:20 000
Broad ecosystem inventory (BEI)	MSRM		01/11/16 - MSRM	1:250 000
Roads	MoF		00/02/29 - MoF	1:20 000
3rd order watersheds	MSRM		00/08/18 - MSRM	1:50 000
LRMP management zones	MSRM		01/11/16 - MSRM	Variable

3.2 INVENTORY ORGANIZATION

3.2.1 MANAGEMENT ZONES AND OBJECTIVES

Management zones are used in this analysis to differentiate areas within the North Coast TSA that have different management emphasis or objectives. An outline of the objectives to be tracked is provided in Table 2. Section 3.1, *Inventory Information* provides the sources of the inventories referenced below.

Table 2: Objectives To Be Tracked.

Objectives	Inventory definition
Landscape unit biodiversity	Recommended landscape unit boundaries and biogeoclimatic classification and natural disturbance type.
Visual quality objectives in scenic areas	Visual quality objectives by scenic area zone.
North of the Nass River	Identified boundary
Princess Royal Island	Forest cover inventory (within North Coast TSA, outside of North Coast LRMP)
Marginally Operable areas (cedar in the stand) – **Conventional Zone**	Defined in the operability layer
Marginally Operable areas (cedar-leading stands) – **Helicopter Zone**	Defined in the operability layer
Cutblock adjacency in Integrated Resource Management (IRM) areas	Forest outside of scenic zones.
LRMP	Forest cover inventory

3.2.2 ANALYSIS UNIT DEFINITION

Analysis units (AU) are formed in order to track growth characteristics of similar stands. Stands with similar species composition, age and site productivity are grouped into AU.

Yield tables, consisting of growth and yield, as well as product value information are created for each AU. Yield tables relate stand-level information to stand age and allow the model to project stands characteristics through time.

Analysis unit definition and yield table development is broken down into natural, existing managed and future managed stands. Table 3 shows the criteria used to define base case analysis units.

Table 3: Definition of Analysis Units.

Analysis Unit	Description	Inventory Type Groups	Site Index Range
1	Cedar, Hemlock / Cedar: High	9, 10, 11, 14	> 22
2	Cedar, Hemlock / Cedar: Med.	9, 10, 11, 14	15-22
3	Cedar, Hemlock / Cedar: Low	9, 10, 11, 14	< 15
4	Hemlock, Balsam: High	12, 13, 15 - 20	> 22
105	Hemlock, Balsam: High w thinning	12, 13, 15 - 20	> 22
6	Hemlock, Balsam: Med.	12, 13, 15 - 20	15-22
107	Hemlock, Balsam: Med. w thinning	12, 13, 15 - 20	15-22
8	Hemlock, Balsam: Low	12, 13, 15 - 20	< 15
9	Spruce: High	21 - 26	> 22
10	Spruce: Med.	21 - 26	15-22
11	Spruce: Low	21 - 26	< 15
12	Cottonwood	AC ~ 35, 36	All
23	Cedar, Hemlock / Cedar: Low	9, 10, 11, 14	< 15
26	Hemlock, Balsam: Med.	12, 13, 15 - 20	15-22
28	Hemlock, Balsam: Low	12, 13, 15 - 20	< 15
30	Spruce: Med.	21 - 26	15-22
42	Cedar, Hemlock / Cedar: Med.	9, 10, 11, 14	15-22
43	Cedar, Hemlock / Cedar: Low	9, 10, 11, 14	< 15

Analysis units 23, 26, 28, and 30 are essentially the same as analysis units 3, 6, 8, and 10 except that they occur in marginally operable areas (see definition in Section 3.3.5) where conventional timber harvesting is expected to occur.

Analysis units 42 and 43 are essentially the same as analysis units 2 and 3, except that they occur in marginally operable areas (see definition in Section 3.3.5) where timber harvesting by helicopter is expected to occur.

The area of some analysis units in marginally operable areas is very small. These analysis units are aggregated with other analysis units. Specifically, analysis units 21, 22, and 23 became analysis unit 23; analysis units 24, 26, and 27 became analysis unit 26; analysis units 29, 30, and 31 became analysis unit 30; analysis unit 32 became analysis unit 12; analysis units 41, 44, 46, 48, 49, 50, and 51 became analysis unit 42.

Analysis units 5 and 7 do not exist because they were managed through juvenile spacing. As such, they were grown on managed stand yield curves (105 and 107 respectively). Analysis units for existing, natural stands are incremented by 100 when regenerated i.e., analysis unit 1 becomes analysis unit 101 once regenerated.

Table 4 shows the current distribution of analysis units in terms of gross forested and THLB area.

Table 4: Current Analysis Unit Area (LRMP BaseCase).

Analysis Unit	Gross Forested Area (ha)	THLB Area (ha)
none	24,112	0
1	638	421
2	22,654	11,332
3	553,725	24,201
4	3,717	2,656
6	37,680	21,824
8	177,696	27,220
9	2,750	1,370
10	5,735	3,632
11	8,060	2,482
12	1,120	355
23	14,440	9,291
26	683	542
28	8,158	3,867
30	430	160
42	2,687	1,979
43	9,615	7,139
101	977	879
102	1,362	1,072
103	186	131
104	4,065	3,504
105	193	174
106	9,026	7,939
107	1,601	1,438
108	1,650	1,417
109	874	765
110	1,309	1,200
111	285	242
112	137	90
TOTAL	**895,568**	**137,323**

3.3 TIMBER HARVESTING LAND BASE DETERMINATION

Land base information was assembled and processed into a resultant database by the Skeena Region of the Ministry of Sustainable Resource Management in 2002. This database contains information on forested and non-forested land base within the North Coast TSA. Non-forested land and other areas where timber harvesting is not expected to occur (e.g., land set aside for parks, land needed to protect riparian habitat, and right-of-ways for highways) is included in the land base because it contributes to other land base objectives such as biodiversity requirements. The timber harvesting land base (THLB) represents Crown forested land within the timber supply area that is currently considered feasible and economical for timber harvesting.

Table 5 presents the results of the THLB determination process and identifies areas excluded from the timber harvesting land base. The following sections describe the process by which area was removed from the THLB for each category.

Table 5: Timber Harvesting Land Base for the North Coast Timber Supply Area.

Land base Classification	Land Base Reduction (ha)	Land Base Area (ha)
North Coast TSA		**1,875,334**
Not managed by MoF	191,104	
Non-forest	833,436	
Productive Forest Managed by the MoF		**850,794**
Non-commercial cover	335	
ESA	233,590	
Low growth potential	281,131	
Problem forest types	14,046	
Inoperable	171,554	
Existing roads	1,697	
Riparian reserve zones	11,118	
Timber Harvesting Land Base		**137,323**

3.3.1 LAND NOT ADMINISTERED BY THE BRITISH COLUMBIA FOREST SERVICE

The ownership (OWNER and OWNR_CH) codes on the inventory file were used to determine areas not managed by the B.C. Forest Service for timber supply. This category may include parks, ecological reserves, private land and various special use permit areas. Only those forests with ownership codes 62 C (forest management unit), 69 C (forest reserve) and 61 (UREP) contribute to the timber supply. From this area, the Kitasoo Spirit Bear proposed protected area is assumed to not contribute to the timber supply.

3.3.2 NON-PRODUCTIVE FOREST AND NON-FOREST LAND

Non-forest and non-productive forest (TYPID_PR = 6) and non-typed (TYPID_PR = 8) areas do not contribute to the timber harvesting land base. These categories include areas covered by such things as sparse alpine forest, ice, swamps, water, and rock.

3.3.3 NON-COMMERCIAL (BRUSH) FOREST COVER

Non-commercial brush types (TYPID_PR = 5) do not contribute to the timber harvesting land base.

3.3.4 ENVIRONMENTALLY SENSITIVE AREAS

Some forest lands are environmentally sensitive and/or significantly valuable for other resources to warrant their exclusion from timber harvesting. These areas are identified and delineated during a forest inventory and are called environmentally sensitive areas (ESA). The ESA system employs the following categories: soil (Es), forest regeneration problems (Ep), snow avalanche (Ea), recreation (Er), wildlife (Ew), water (Eh). Two ESA classes are recognized within each category: high (1) and moderately sensitive (2).

Table 6 lists the per cent of the area classified that does not contribute to the timber harvesting land base.

Table 6: Environmentally Sensitive Areas Unavailable for Timber Harvesting.

ESA category	ESA description	Area Reduction (%)
Es 1	High soil sensitivity	100
Es 2	Moderate soil sensitivity	25
Ep 1	High regeneration problems	100
Ep 2	Moderate regeneration problems	50
Eh 1	High water quality	100
Eh 2	Moderate water quality	100
Ea	Snow avalanche hazard	100

No reductions were made for Ew, as wildlife habitat requirements are met in areas outside of the timber harvesting land base in wildlife tree patches and riparian reserve zones.

No reductions are made for recreation areas, as visual landscape management requirements apply to these areas.

Areas identified as Ep 1 are difficult to reforest due to wildlife browsing on seedlings and brush competition. Areas identified as Ep 2 may have problems associated with natural tree density and brush, which is controllable on about one-half of the area.

Reductions of 100% are applied to areas identified with Eh and Ea, since areas with important water quality considerations and avalanche hazard sensitivity are not harvested.

3.3.5 DESCRIPTION OF OPERABLE AREAS

In October 2001, staff from the Ministry of Forests, the Ministry of Sustainable Resource Management and licencees updated the 1994 operability maps. This new operability presents a much more realistic view of where harvesting actually occurs. Following is the three-phase method they used to determine which stands are operable. All stands coded as inoperable (I) are not included in the timber harvesting land base.

PHASE 1

Physical operability limits identify a road development plan and a helicopter zoning plan for undeveloped drainages. The road development plan includes log dumps, mainlines and log handling/storage areas. The helicopter zoning plan includes heli-drop zones, flight distance and log handling/storage areas.

PHASE 2

Cutblock configurations from logging over the past 9 years were overlayed onto the forest cover maps to identify a timber inventory profile. The profile was then separated into six categories that were used to build the new operability map. The six categories are:

Conv_Log	Areas previously harvested under conventional harvesting systems.
Conv_4	All tree species >=400m^3/ha within a conventional zone, on slopes<60% and height class>=4 (>=28.5m).
Conv_marg	Combination Western red cedar stands >=250m^3/ha within a conventional zone, on slopes <60% and height class >=3 (>=19.5m).
Heli_Log	Areas previously harvested under non-conventional harvest systems.
Heli_350	All tree species with leading volume >=350 m^3/ha within a helicopter zone, on slopes >=60% and height class >=4.
Heli_CW_250	Leading Western Redcedar stands with leading volume>=250 m^3/ha within a helicopter zone, on slopes >=60% and height class >=3.

There is some uncertainty in the reliability of the information used to determine whether a stand would be harvested conventionally or by helicopter in the future. However, no distinction is made in this analysis for the timber harvesting land base between harvesting methods. A stand was either operable or inoperable.

PHASE 3

There were 32 operable areas that were considered unlikely to be harvested under any market condition, but still met the criteria according to the forest cover inventory. These areas, totalling 1,320 hectares, were further reviewed using air photos. This comparison found that errors in the forest cover file and/or TRIM data resulted in the delineation of these areas as operable. Twenty-seven of these areas (1,112 hectares) were manually coded as inoperable.

3.3.6 SITES WITH LOW TIMBER GROWING POTENTIAL

Sites may have low productivity because of inherent site factors (e.g., exposure, nutrient availability, excessive moisture), or because they are not fully occupied by commercial tree species. All stands with site index estimates of less than 10 metres at a breast height age of 50 years are excluded from the timber harvesting land base. As well, all age class 5 stands (81-100 years) that have not attained a height greater than height class 2 (10.5 - 19.4 metres) are excluded.

Table 7: Sites with Low Timber Growing Potential.

Characteristics	Area Reduction (%)
SI < 10	100
Age class >= 5 AND Height class <= 2	100

In some cases, stands with site index < 10 are more productive than their inventory SI is reporting, but because of competition, are unable to utilize the productivity of the site. The climax species on the coast often grow in an understory condition, limiting height growth. These young stands can grow in a suppressed state for many years until the overstory is removed. Some of these stands may express a fairly good SI if grown in a managed state. Section 4.4, *Site Productivity Estimates for Managed Stands* attempts to address this.

3.3.7 PROBLEM FOREST TYPES

Problem forest types are stands that are physically operable and exceed low site criteria, but are not currently utilized or have marginal merchantability. These types do not contribute to the timber harvesting land base.

Table 8: Problem Forest Types.

Inventory Type Group	Age (years)	Stocking Code	Crown Closure (%)	Area Reduction (%)
All		> 1		100
All	> 60		< 36	100
Pine-leading (27-32)				100
Broad-leaved except cottonwood (37-42)				100

Pine and broad-leaved trees other than cottonwood are species not currently utilized in the North Coast TSA. Stands that have low stocking or are close to mature ages and do not have closed canopies are generally not economic to harvest.

3.3.8 EXISTING AND FUTURE UNCLASSIFIED ROADS, TRAILS AND LANDINGS

Road, trail and landing estimates only account for the area that is permanently removed from the timber harvesting land base only apply to unclassified areas. All highways and larger municipal roads are of a sufficient size to be mapped as polygons and are classified as non-forest areas in the forest inventory.

EXISTING

To account for existing unclassified roads, trails and landings a total of 1,697 hectares (current to July 2001) is excluded from forest stands less than 50 years of age on conventionally operable stands, and from previously harvested, conventionally operable stands. This estimate was revised from the December 1996 figure used in TSR II (1,430 ha) to account for an additional 174 km of road built since then. The calculations used to arrive at this figure is described below.

The average disturbed width of a Class 5 (single lane) forest road based on measurements taken from the toe of the fill slope to the top of the cut is 13.5 metres horizontal distance. The total area lost due to landings, pullouts, and borrow pits (average 3/km) is 0.18 ha/km. Therefore, the estimated loss of site due to existing unclassified roads, trails and landings is 1.53 ha/km of road:

$$(13.5 \text{ m} \times 1{,}000 \text{ m}/10{,}000\text{m}^2) + 0.18 \text{ ha/km} = 1.53 \text{ ha/km}$$

The total existing unclassified roads, trails and landings to July 2001 is:

$$(1.53 \text{ ha/km} \times 1{,}109 \text{ km of road built}) = 1{,}697 \text{ hectares}$$

FUTURE

All future road, trail and landing development is accounted for by applying an area reduction of 8.4% to existing, natural, conventionally operable stands after harvest.

From several planning documents, district staff estimate the length of road required per conventionally harvested cubic metre to be 0.09 metres. Using the district average of 607 m^3/ha, and the estimate of 1.53 ha/km of road constructed calculated for existing roads, trails and landings:

$$\frac{607 \text{ m}^3\text{/ha} \times 0.09 \text{ m/m}^3 \times 1.53 \text{ ha/km}}{1{,}000 \text{ m}} = 8.4\%$$

The *North Coast Timber Supply Area Timber Supply Review Data Package* (February 1998) provides a more detailed description of how the area in roads, trails and landings was estimated.

3.3.9 RIPARIAN MANAGEMENT AREAS (RIPARIAN RESERVE ZONE COMPONENT ONLY) AND WILDLIFE TREE PATCHES

Riparian areas occur next to the banks of streams, lakes, and wetlands and include both the area dominated by continuous high moisture content and the adjacent upland vegetation that exerts an influence on it. Riparian ecosystems contain many of the highest value non-timber resources in the natural forest.

Riparian management areas consist of a riparian management zone (RMZ) and a riparian reserve zone (RRZ). Within the management zone, constraints to forest practices were applied (see Section 3.3.9).

Within the reserve zones, the timber harvesting land base is reduced by 7.49% after all the previously discussed exclusions were made. This figure is based on the *North Coast Riparian Classification Inventory, September 2001*, which examines eleven representative watersheds in the North Coast Forest District. An inventory of streams within these watersheds was completed, and the riparian reserve zone area within the operable area was measured using the *Forest Practices Code Riparian Management Area Guidebook*. The percent area excluded from the timber harvesting land base is calculated by dividing the riparian reserve zone area by the operable area (from TSR II data) for these 11 watersheds:

RRZ / Operable area = Total net loss (%)

Note that the operable area used in the calculation is from the TSR II land base, and not on the new operability lines produced in 2001.

Stand-level biodiversity is managed in part by retaining reserves of mature timber or wildlife trees (WT) and patches (WTP) within cutblocks and in adjacent inoperable and other retained areas to provide structural diversity and wildlife habitat. Cutblocks in the North Coast TSA tend to be linear, relatively small and generally proximal to a number of streams. These characteristics mean that most of the (WTP) requirements can be fulfilled by locating the WTP within riparian reserve zones. As such, there are no further reductions made to the timber harvesting land base specific to wildlife trees or patches.

3.3.10 TIMBER LICENCE REVERSIONS

There are no Timber Licences in the North Coast TSA.

3.3.11 WOODLOT LICENCES

The *Forest Act* requires that AAC determined for TSA be exclusive of the areas and timber volumes allocated to woodlot licences. One woodlot licence was awarded in March 1998 in the TSA. It is approximately 400 hectares in size, and has an AAC of 776 m^3/year. This area is excluded from the timber harvesting land base.

4.0 FOREST MANAGEMENT ASSUMPTIONS

4.1 UTILIZATION LEVELS

Utilization levels define the maximum stump height, minimum top diameter inside bark (dib), and minimum diameter at breast height (dbh) used to calculate merchantable volume. Table 9 reflects expectations that second-growth managed stands will be subject to closer utilization than existing stands.

Table 9: Utilization Levels.

Stand types	Utilization		
	Minimum dbh (cm)	Maximum stump height (cm)	Minimum top dib (cm)
Managed	12.5	30	10
Existing	17.5	30	10

The North Coast TSA utilization standards specify a 15 cm minimum top diameter and a 30 cm maximum stump height with a 17.5 cm minimum dbh for old growth stands (> 120 years). However, the volume estimates are only available for a 10 cm top diameter inside bark (dib). The Ministry of Forests' Resources Inventory Branch staff have conducted research that shows the difference in volume between a 10 cm and a 15 cm top is less than 1%. In younger second-growth stands a minimum top diameter of 10 cm (dib) and 12.5 cm minimum dbh is specified.

4.2 VOLUME EXCLUSIONS FOR MIXED SPECIES STANDS

All broad-leaved species except cottonwood are excluded from the estimation of volume in coniferous-leading mixed species stands. All stands dominated by deciduous species, except for cottonwood stands, do not contribute to the timber harvesting land base (see Section 3.3.7, *Problem Forest Types*).

4.3 MINIMUM HARVESTABLE AGES

The minimum harvestable age (MHA) is the time required for a stand to grow to a harvestable size. While harvesting may occur in stands at the minimum age to meet forest level objectives (e.g. maintaining overall harvest levels for a short period of time, or avoiding large changes in harvest levels), most stands will not be harvested until past their MHA.

In the North Coast TSA, stands other than those in marginally operable areas must meet three criteria before being eligible for harvest:

1) A minimum average diameter of 35 cm for the 250 largest trees.
2) Achievement of 95% of culmination of mean annual increment (CMAI).
3) A minimum standing volume of 375 m^3/ha.

Note that the diameter criterion is not applicable to natural stands.

For natural stands in marginally operable areas, only a minimum standing volume of 250 m^3/ha is required. Once these stands are harvested, the same three criteria as for the other areas must be met before these stands can be harvested again. Table 10 and Table 11 identify the ages when these criteria are met.

Table 10: Minimum Harvestable Ages by Analysis Unit.

Analysis Unit	Description	SI	Age Range (years)	Management	Age (years)			
					Prime 250 Diam. >= 35 cm	95% CMAI	>=375 m^3/ha	Minimum Harvest Age
1	Cedar, Hemlock / Cedar: High	> 22	>=24	natural	N/A	60	70	70
2	Cedar, Hemlock / Cedar: Med.	15-22	>=24	natural	N/A	80	120	120
3	Cedar, Hemlock / Cedar: Low	< 15	>=24	natural	N/A	90	180	180
4	Hemlock, Balsam: High	> 22	>=24	natural	N/A	60	60	60
6	Hemlock, Balsam: Med.	15-22	>=24	natural	N/A	70	90	90
8	Hemlock, Balsam: Low	< 15	>=24	natural	N/A	90	150	150
9	Spruce: High	> 22	>=24	natural	N/A	50	60	60
10	Spruce: Med.	15-22	>=24	natural	N/A	70	80	80
11	Spruce: Low	< 15	>=24	natural	N/A	90	110	110
12	Cottonwood	All	All	natural	N/A	N/A	N/A	50
101	Cedar, Hemlock / Cedar: High	>22	<24	managed	70	80	60	80
102	Cedar, Hemlock / Cedar: Med.	15-22	<24	managed	120	100	90	120
103	Cedar, Hemlock / Cedar: Low	<15	<24	managed	180	110	130	180
104	Hemlock, Balsam: High	>22	<24	managed	70	70	60	70
105	Hemlock, Balsam: High w thinning	>22		managed	50	90	60	90
106	Hemlock, Balsam: Med	15-22	<24	managed	110	100	90	110
107	Hemlock, Balsam: Med. w thinning	15-22		managed	70	100	70	100
108	Hemlock, Balsam: Low	<15	<24	managed	190	120	130	190
109	Spruce: High	>22	<24	managed	50	80	60	80
110	Spruce: Med.	15-22	<24	managed	90	90	70	90
111	Spruce: Low	<15	<24	managed	130	120	110	130
112	Cottonwood	all	all	natural	N/A	N/A	N/A	50

Table 11: Minimum Harvestable Ages by Analysis Unit for Marginally Operable Areas.

Analysis Unit	Description	SI	Age Range (years)	Management	Age (years) Prime 250 diam. >= 35 cm	95% CMAI	>=250 m³/ha	Minimum Harvest Age
23	Cedar, Hemlock / Cedar: Low	all	>=24	natural	N/A	N/A	140	140
26	Hemlock, Balsam: Med.	>=15	>=24	natural	N/A	N/A	60	60
28	Hemlock, Balsam: Low	<15	>=24	natural	N/A	N/A	130	130
30	Spruce: Med.	all	>=24	natural	N/A	N/A	60	60
42	Cedar, Hemlock / Cedar: Med.	>=15	>=24	natural	N/A	N/A	90	90
43	Cedar, Hemlock / Cedar: Low	<15	>=24	natural	N/A	N/A	130	130
							>=375 m³/ha	
123	Cedar, Hemlock / Cedar: Low	all	<24	managed	240	130	170	240
126	Hemlock, Balsam: Med.	>=15	<24	managed	100	90	80	100
128	Hemlock, Balsam: Low	<15	<24	managed	270	140	190	270
130	Spruce: Med.	all	<24	managed	90	90	70	90
142	Cedar, Hemlock / Cedar: Med.	>=15	<24	managed	120	100	100	120
143	Cedar, Hemlock / Cedar: Low	<15	<24	managed	190	120	150	190

For the marginally operable helicopter units (142-143), the western red cedar component of the stand must meet the minimum volume requirement of 375 cubic metres/ha.

Because the existing (natural) stands in the North Coast TSA are very old, they are harvested well beyond the stated minimum harvestable ages in the tables.

4.4 SITE PRODUCTIVITY ESTIMATES FOR MANAGED STANDS

Yield analysis uses site index (SI) as a measure of site productivity. Site index is an estimate of potential height growth on a site over a fixed period of time. In BC, we use SI_{50}, or height at breast height age of 50 years.

The productivity of a site largely determines how quickly trees grow and thus volume production and merchantable/rotation age. In recent years, extensive site index sampling of second growth stands (less than 120 years in age) has indicated that site productivity estimates from forest cover inventory underestimate actual site productivity of regenerated stands. Second growth forest stands tend to grow faster than projected by inventory-based site index estimates from old-growth stands (Olivotto and Meidinger 2001, Bnigh 1998, Nussbaum 1998).

Site index is tied closely to ecological site factors such as soil moisture and nutrient regime. Within the Biogeoclimatic Ecosystem Classification (BEC) system the site series expresses soil moisture and nutrient regime. The Site Index – BEC Project (SIBEC) has produced a database summarizing site index estimates (from second growth field data) by site series for coniferous tree species in BC and “look-up site index tables” have been produced for most biogeoclimatic subzones/variants in BC (Site Productivity Working Group, 1998).

Where terrestrial ecosystem mapping (TEM) exists, SIBEC site index estimates can be assigned to site series polygons in order to generate yield estimates for growth of regenerated stands. Detailed TEM mapping of large areas such as TSA is prohibitively expensive, but predictive ecosystem mapping (PEM) approaches using forest cover and TRIM inventories have been recently developed within BC (Meidinger et al. 2000). PEM is much more cost effective than TEM and provides the required level of detail for landscape-level analyses such as yield analysis.

EcoGen is a PEM approach being developed by the Ministry of Forests. An EcoYield module has also been developed to produce an ecologically-based yield analysis from the EcoGen mapping; a pilot has recently been completed in the North Coast Forest District (Meidinger et al. 2001). EcoGen mapping for the entire North Coast District is planned for completion by September 2002, at which time all maps will be available for use in a timber supply analysis. Currently, five mapsheets have been completed and gone through a quality assurance process.

Because of uncertainty regarding the application of PEM – site index – TSR analysis unit relationships from five mapsheets to the entire TSA, for the base case analysis, the site index data from the forest cover inventory is used to develop yield estimates. The LRMP analysis explores the use of SIBEC site index estimates in sensitivity analysis[1]. Due to this uncertainty and the current status of the PEM project for the North Coast TSA, forest cover estimates of site productivity (site index) are used in all scenarios for this Type II Silviculture Strategy Analysis.

Table 12 provides a comparison of estimates of site index applied in the base case analysis from the forest cover to managed and regenerated stands, with estimates applied in the sensitivity analysis from the EcoGen/SIBEC data for managed and regenerated stands for the TSA.

[1] Refer to the North Coast LRMP Timber Supply Analysis Data Package and Analysis Report for a more detailed description of PEM/SIBEC and the results of the sensitivity analysis.

Table 12: Inventory SI vs. EcoGen / SIBEC Predicted SI.

Analysis Unit	Description	THLB Area (ha)	Inventory SI	EcoGen / SIBEC Predicted SI
1	Cedar, Hemlock / Cedar: High	1,300	24.8	22.8
2	Cedar, Hemlock / Cedar: Med.	12,404	16.6	22.5
3	Cedar, Hemlock / Cedar: Low	24,331	13.1	19.8
4	Hemlock, Balsam: High	6,160	25.3	25.1
105	Hemlock, Balsam: High w thinning	174	26.6	25.5
6	Hemlock, Balsam: Med.	29,764	17.5	23.4
107	Hemlock, Balsam: Med. w thinning	1,438	22.0	23.4
8	Hemlock, Balsam: Low	28,637	13.1	22.3
9	Spruce: High	2,135	26.5	29.9
10	Spruce: Med.	4,831	18.7	28.8
11	Spruce: Low	2,724	12.9	28.0
12	Cottonwood	445	36.6	N/A
23	Cedar, Hemlock / Cedar: Low	9,291	11.9	19.8
26	Hemlock, Balsam: Med.	543	19.1	23.4
28	Hemlock, Balsam: Low	3,867	10.9	22.3
30	Spruce: Med.	160	18.5	28.8
42	Cedar, Hemlock / Cedar: Med.	1,979	16.5	22.5
43	Cedar, Hemlock / Cedar: Low	7,140	12.9	19.8
	TOTAL	137,323		

The site indices applied to the regenerated and managed stands in the base case were calculated averages from the existing analysis unit. For example, the mean site index of analysis unit 1 was applied to analysis unit 101, which is simply analysis unit 1 which has been regenerated or managed.

4.5 HARVESTING SCHEDULING PRIORITY

FSSIM is used for benchmarking this analysis to the LRMP analysis. For this analysis, the harvest priority was highest for stands that were the oldest relative to the applicable minimum harvestable age. This is termed a "relative oldest first" harvest rule.

The majority of the analysis for this project utilizes the optimization modelling tool Woodstock which does not require the specification of a harvest schedule priority rule. Priority for stand harvest is based on the modelling objective (maximize revenue) within the bounds of the management constraints (MHA, land base requirements, etc.)

4.6 SILVICULTURE SYSTEMS

The timber supply analysis assumes that all harvesting is by clearcut. Although some partial harvesting is occurring in the TSA, it is limited.

4.7 UNSALVAGED LOSSES

Unsalvaged volume losses due to epidemics of fire and wind damage are deducted prior to reporting volume harvested in the analysis report, for a total of 10,084 cubic metres per year**.**

Average annual unsalvaged losses due to fire are estimated at 2,034 cubic metres per year. These losses are based on a 20-year average loss of timber.

In 1998, a report estimating blowdown losses in the North Coast TSA was completed. This study estimates that annual unsalvaged losses to wind are 13,417 cubic metres on the operable land base. Ministry of Forests staff reviewed this report, and adjusted the blowdown estimate to 8,050 cubic metres per year to reflect unsalvaged losses on the timber harvesting land base.

While porcupine damage is evident in some second-growth stands, the long-term effect on timber production is not fully understood. Possible effects include lengthened regeneration delays, lower stocking, and lower volume yields. Unsalvaged losses due to porcupine damage remain unquantified, and as such, no unsalvaged losses have been attributed to this pest.

Losses due to insects and other pests are endemic in nature. As such, they have been accounted for elsewhere by operational adjustment factors and by decay, waste and breakage factors.

4.8 REGENERATION ACTIVITIES IN MANAGED STANDS

Table 13 shows the regeneration assumptions by analysis unit. Regeneration delay reflects current operational practice and is defined as the time between harvest and planting or seed germination occurs. Regeneration delays are applied within the forest estate models, not in the TIPSY / TASS yield model.

Provincial average operational adjustment factor (OAF) values are applied to the managed stand yield curves as recommended by the Ministry of Forests, Research Branch — as no local values are available. OAF 1 reflects small stocking gaps in stands, while OAF 2 reflects an estimate for decay, waste and breakage that increases with age, passing through 5% at 100 years of age.

Yield estimates for current (< 24 years) and future managed stands for the LRMP Base Case are based on the Forest Service Table Interpolation Program for Stand Yields (TIPSY) growth and yield model. Because TIPSY does not include data for Cottonwood stands, yield estimates for these stands are based on a VDYP curve for existing, natural stands. As well, because densities of 10,000 trees/ha are not available for planted stands in TIPSY, 4,444 sph was used for the initial density for analysis units 10 and 30.

TIPSY lacks the functionality to model many silviculture treatments and the customized outputs required for financial analysis. Therefore the MoF Tree and Stand Simulator (TASS) is used to develop both existing and future managed stand yields.

While there is some planting in the TSA, there is often considerable ingress of existing species to cause regenerated stands to develop more like a natural stands. Analysis units are therefore assumed to regenerate to the same species composition as the existing analysis unit.

Table 13: Regeneration Assumptions by Analysis Unit.

Analysis Unit	Description	Regen. Delay (yrs)	OAF		Method	Density (sph)	
			1	2		Initial	Thinned
1	Cedar, Hemlock / Cedar: High	1	15	5	Natural	10,000+	
2	Cedar, Hemlock / Cedar: Med.	1	15	5	Natural	10,000+	
3	Cedar, Hemlock / Cedar: Low	1	15	5	Natural	10,000+	
4	Hemlock, Balsam: High	2	15	5	Natural	10,000+	
5	Hemlock, Balsam: High w thinning	2	15	5	Natural	10,000+	700
6	Hemlock, Balsam: Med.	2	15	5	Natural	10,000+	
7	Hemlock, Balsam: Med. w thinning	2	15	5	Natural	10,000+	700
8	Hemlock, Balsam: Low	2	15	5	Natural	10,000+	
9	Spruce: High	2	15	5	Plant	1,000	
10	Spruce: Med.	2	15	5	Plant	4,444	
11	Spruce: Low	2	15	5	Natural	10,000+	
23	Cedar, Hemlock / Cedar: Low	1	15	5	Natural	10,000+	
26	Hemlock, Balsam: Med.	2	15	5	Natural	10,000+	
28	Hemlock, Balsam: Low	2	15	5	Natural	10,000+	
30	Spruce: Med.	2	15	5	Plant	4,444	
42	Cedar, Hemlock / Cedar: Med.	1	15	5	Natural	10,000+	
43	Cedar, Hemlock / Cedar: Low	1	15	5	Natural	10,000+	

4.9 IMMATURE MANAGED STAND HISTORY

The purpose of this section is to identify areas of existing immature forest where density (stems per hectare) is controlled and therefore should be assigned to appropriate managed stand yield curves. All NSR and future harvested stand volume projections are based on managed stand yield curves.

A juvenile spacing program has treated 2,393 hectares of hemlock/balsam stands from 1985 to November 2001. To reflect this, hemlock and balsam stands on good and medium sites, with an activity code of 'J' assigned (analysis units 105 and 107), are grown on yield curves reflecting density management through thinning.

The expectation noted in TSR II that juvenile spacing would continue, is no longer valid, as funding is no longer available for spacing. However, those stands assigned to yield curves to reflect thinning will continue to grow on those curves. Sensitivity to this assumption will be tested in expanded juvenile spacing treatment scenarios.

4.10 NOT SATISFACTORILY RESTOCKED (NSR) AREAS

Land classified in the TSA inventory file as type identity 4 or 9 is included in the timber harvesting land base. These types correspond to non-satisfactorily restocked (NSR) areas. NSR area is expected to regenerate within the regeneration delays specified in the table of regeneration assumptions (Table 13, above).

The Integrated Silvicultural Information System (ISIS) records a total of 4,591 hectares of NSR as of October 5, 2001, while the forest inventory file records a total of 3,368 hectares of NSR, with 1,259 hectares within the timber harvesting land base. See Table 14 for details.

Table 14: NSR Areas from ISIS Database.

Description	NSR area (ha)	Comments
Total from ISIS	4,591	
Current NSR	1,856	Stocked on a 2 year regeneration delay cycle
Backlog NSR:	2,735	
Estimated stocked but not updated in ISIS	1,511	Needs to be reclassified in ISIS after a survey
Estimated to be stocked with mixed red alder and a low percent of conifers	526	Needs to be reclassified in ISIS after a survey. Also needs DNC decision to manage and accept red alder on appropriate sites.
Estimated to be non-productive	101	Needs to be reclassified in ISIS after a survey
Area estimated to never reach full site potential until next rotation	597	It is estimated that only 50 % site occupancy will be attained mostly under an alder canopy.

There is typically a discrepancy between these two databases; for a variety of reasons they are not directly reconcilable. Discrepancies in area of NSR between ISIS and forest inventory information can be attributed to: inaccuracies in both databases, lags in data entry and the potential for backlog areas recorded by ISIS to be classified as restocked or non-forest during re-inventory.

Because the amount of NSR is very small, the area of NSR recorded on the inventory file is used in the timber supply analysis. The inventory NSR is assigned to the timber harvesting land base according to the distribution of analysis units in the 1-20 year age class, based on species and site description. The NSR area outside the timber harvesting land base is regenerated to an inoperable analysis unit.

4.11 VISUAL QUALITY, INTEGRATED RESOURCE MANAGEMENT, AND WATER QUALITY

The following forest cover requirements are applied to each management emphasis within each landscape unit.

Table 15: Forest Cover Requirements for Integrated Resource Management (IRM), Water Quality, and Visual Quality Objectives (VQO).

Management emphasis	Zone or group	Maximum allowable disturbance (% area)	Green-up height
IRM	Integrated Resource Management areas	33	3 m
Water quality	Community Watershed	5	5 y
Visual resources	Inside Passage (1) — preservation	1	7 m
Visual resources	Inside Passage (1) — retention	5	7 m
Visual resources	Inside Passage (1) — partial retention	15	7 m
Visual resources	Skeena River Corridor (2) — preservation	1	7 m
Visual resources	Skeena River Corridor (2) — retention	5	7 m
Visual resources	Skeena River Corridor (2) — partial retention	15	7 m
Visual resources	Portland / Work Channel (3) — modification	25	4 m
Visual resources	Douglas / Gribbell (4) — modification	25	4 m

There are four different scenic area zones in the North Coast TSA:

1) Inside Passage,
2) Skeena River Corridor,
3) Portland/Work Channel, and
4) Douglas/Gribbell.

The VQO objectives vary between scenic zones to reflect differences in visual sensitivity and management techniques. The forest cover requirements are applied to the total productive forest area within each VQO area within each scenic zone and recommended landscape unit.

Although the recommended VQO for zones 3 and 4 are partial retention, they are managed as modification, and are modelled as such.

IRM requirements are applied to all areas outside of these four scenic zones by landscape unit. IRM objectives are specified as a proxy for adjacency constraints associated with maximum clearcut and patch size guidelines. The maximum allowable disturbance constraint for IRM areas is applied to the timber harvesting land base only.

All stand heights shown in Table 15 refer to top heights (inventory definition), not to average stand height. The report, *Age to Green-up Height: Using Regeneration Survey Data*, was used to derive green-up ages for each analysis unit. Where data was not available in the report, the SiteTools model supported by the BC Ministry of Forests Research Branch was used.

Where community watersheds occur, a maximum allowable disturbance from the *Forest Practices Code Community Watershed Guidebook* is applied to protect water quality. The constraint is applied to the timber harvesting land base only.

4.12 LANDSCAPE-LEVEL BIODIVERSITY

Operationally, low-biodiversity emphasis is assumed for all landscape units, as specified by the *Biodiversity Guidebook* when emphasis options have not yet been formally assigned. Although interim Biodiversity Emphasis Options (BEO) have been assigned to each recommended landscape unit, they have not been legally established. Therefore, they cannot be used for the base case analysis.

As it is unknown which landscape units will be assigned low, intermediate or high-biodiversity objectives, a single weighted constraint for the old-seral stage requirement is applied based on the anticipated distribution of 10% high, 45% intermediate and 45% low-emphasis. The values shown in Table 16 reflect weighted *Biodiversity Guidebook* values. They represent a phase-in of the cover requirement, with an initial requirement that one-third of the *Biodiversity Guidebook* old-seral stage percentage be met in the low-emphasis portions. As seen in the table, the cover requirements increase over time ensuring full minimum retention of old-seral forest by the end of three rotations.

It is assumed that the application of full requirements at the beginning of the third rotation (in decade 14), when it still may not be achieved, will ensure the required forest cover will be built up over that rotation.

Minimum retention objectives are applied to the productive forest land base in each recommended landscape unit / BEC variant combination.

Appendix 3 of the *Biodiversity Guidebook* notes all areas within the Prince Rupert Forest Region are in NDT 1 or 2. The Ministry of Forests' Research Branch staff clarified that essentially all of the CWHvh2 and CWHvm within the North Coast TSA should be considered to be NDT 1.

Table 16: Forest Cover Requirements for Landscape Level Biodiversity.

Biogeoclimatic Unit	NDT	Old-seral Stage Requirements			
		Minimum Age (year)	Minimum Retention By Decade (%)		
			1	7	14
CWHvh2	1	250	9.7	11.65	13.6
CWHvm	1	250	9.7	11.65	13.6
CWHvm1	1	250	9.7	11.65	13.6
CWHwm	1	250	9.7	11.65	13.6
CWHvm2	1	250	9.7	11.65	13.6
MHmm1	1	250	14.2	17.05	19.9
MHmm2	1	250	14.2	17.05	19.9
MHwh1	1	250	14.2	17.05	19.9
CWHws1	2	250	6.7	8.1	9.4
CWHws2	2	250	6.7	8.1	9.4

4.13 RIPARIAN MANAGEMENT AREAS (RIPARIAN MANAGEMENT ZONE COMPONENT ONLY)

Riparian areas occur next to the banks of streams, lakes, and wetlands and include both the area dominated by continuous high moisture content and the adjacent upland vegetation that exerts an influence on it. Riparian ecosystems contain many of the highest value non-timber resources in the natural forest.

Riparian management areas consist of a riparian management zone (RMZ) and a reserve zone (RRZ). Within the reserve zone, the timber harvesting land base is reduced by 7.49% (see Section 3.3.9, *Riparian Management Areas (Riparian Reserve Zone Component Only) and Wildlife Tree Patches*). This figure is based on the *North Coast Riparian Classification Inventory, September 2001.*

The appropriate method to account for the timber supply implications of riparian management practices within riparian management zones (RMZ) depends upon the management practices applied in these zones (e.g. harvest pattern) and the availability of inventory information.

To account for the timber volume left unharvested in riparian management zones, as specified under the *Forest Practices Code Riparian Management Area Guidebook*, all volume over age curves are reduced by 4.2%. This assumption is based on average stream density figures for the coast, as reported in the 1994 study by Wild Stone Resources.

4.14 IDENTIFIED WILDLIFE MANAGEMENT STRATEGY

Habitat for certain wildlife species is managed through implementation of the Identified Wildlife Management Strategy (IWMS). Currently, there are no wildlife habitat areas established under the IWMS within the North Coast TSA and no higher level plans that identify other wildlife management practices.

However, given the Province’s commitment to implementing the strategy, the policy decisions and projected maximum allowed one-percent impact and, noting the expected occurrence of identified wildlife in the TSA, all volume over age curves were reduced by 1%.

5.0 PRODUCT VALUE AND ECONOMIC ASSUPTIONS

In order to analyze the value of silviculture treatments that have no direct impact on volume and / or diameter (i.e. pruning) financial information is incorporated into the timber supply model. Therefore, product value and silviculture treatment and harvesting costs must be quantified. By incorporating revenue and cost information into the analysis we are also able to evaluate the financial implications of forest investment decisions and determine when and where silviculture investments must be made in order to maximize the return on investment.

5.1 PRODUCT VALUE

Average domestic coastal log selling prices are calculated using *Three-Month Average Domestic Log Selling Prices*[2] historical data from March 15,1999 to June 15, 2002. Average product values, to be used in the model are shown by grade and species in Table 17.

[2] Three-Month Average Domestic Log Selling Prices are published monthly by the Ministry of Forests – Economics and Trade Branch and are used to establish export fees in lieu of manufacture in the Province. They are arrived at by analysis of log sales through the collection of log sale invoices from the coastal logging industry. (http://www.for.gov.bc.ca/HET/Index.htm). Historical data can be found at the Revenue Branch web site (http://www.for.gov.bc.ca/REVENUE/timberp/amv.htm).

Table 17: Average Domestic Coastal Log Selling Prices.

Species	Average Log Prices ($/m³) by Log Grade and Species															
	B	C	D	E	F	G	H	I	J	K	L	M	U	X	Y	Z
Alder														60.02	54.36	
Cedar			360.10		315.16		188.53	134.71	125.26	162.97	141.04	96.67	62.92	36.75	16.50	
Cottonwood														37.87	35.72	
Hemlock / Balsam			203.02		137.32		89.77	70.59	59.99				45.61	44.65	43.93	
Pine			126.88		86.10		72.35	50.69	65.43				24.65	21.46	20.58	
Spruce			441.19	368.75	324.55	234.24	123.73	78.80	71.13				45.04	44.36	44.25	

Shaded species-grade grids represent log classes that cannot be harvested economically given the average logging cost assumptions. Average logging costs (primarily stumpage) may be adjusted to reflect lower value stands that we know are currently being harvested economically. These adjustments will be made based on TASS outputs.

These log values will be used to determine the relative priority for investment and harvest. Therefore, absolute value is less important than the relative difference between stand values as well as the relationship difference between treatment cost and harvest value. As we model the forest further into the future, absolute values become less meaningful. However, relative differences will remain relatively consistent, allowing us to make sound investment planning decisions for the future.

5.2 SILVICULTURE COSTS

The following silviculture treatment costs (Table 18) will be applied based on individual treatments.

Table 18: Treatment Cost Information.

Treatment	Cost
Juvenile Spacing	$ 1,900 / ha
Pruning	$ 2,000 / ha
Rehabilitation (NSR / PFT / Low Site)	$ 4,800 / ha
All found Reforestation Cost (includes planting, site prep and seedling costs)	$ 1,782 / ha
Natural Seed Cost	$ 0.009 / seedling
Genetically Improved Seed Cost	$ 0.040 / seedling

5.3 HARVESTING COSTS

To determine the net revenue from harvesting, harvesting costs are subtracted from gross harvest revenue. In a document titled *Silviculture Options in the Central Coast* (Pojar et. al. 1999), total average log cost is calculated for the Central Coast. These costs are shown in Table 19 and will be subtracted from the per metre revenue generated from timber harvesting. While this calculation represents a different geographic area than the North Coast TSA, it represents the most accurate and timely information readily available. It should be noted that these costs are included in the calculation in order to better reflect the net revenue generated through timber harvesting. Because the same average harvesting cost is applied to all stands, it will not influence how silviculture treatments are applied or when and where timber is harvested.

Table 19: Clearcut Log Cost by Phase.

	Phase	Central Coast ($/m³)
DEVELOPMENT	Roads	14.7
	Bridges	2.46
	Major culverts	0.00
	Reconstruction	0.21
TREE TO TRUCK	Conventional log	18.00
	Helicopter log	13.47
LOG TRANSPORT	Truck hauling	5.06
	Dumping, sorting, booming, scaling	10.91
	Barging	6.60
	Towing	0.58
	Road maintenance/deactivation	3.63
ADMINISTRATION	Overhead	22.45
	Crew transport	2.58
	Camp overhead	7.56
	Low volume additive	0.03
SPECIFIED OPERATIONS	Lake transport	3.54
	Blowdown	0.18
	Partial cut	0.00
	Skyline	0.01
	Towing to tie-up grounds	0.69
	Tree crown modification	0.00
	Basic silviculture	2.36
TOTAL LOG COST		**115.01**

Adapted from Pojar et. al. 1999.

A document entitled *Financial State of the Forest Industry and Delivered Wood Cost Drivers - April 1997*, commissioned by the MoF, reports a coastal average total log cost of $113.35/m^3. These values are reported for 1996 and include a $24.94/m^3 for stumpage. The more recent figures from the *Silviculture Options for the Central Coast* report are used for this analysis.

The figures in Table 19 do not include stumpage. Average stumpage for the North Coast TSA was calculated using average stumpage payments for the Prince Rupert

Region for the period January 1st, 1998 to June 30th, 2002[3]. The figures used in this calculation are shown in Table 20. The average value of $17.68/m^3 will be deducted from harvest revenue to account for stumpage.

Table 20: Stumpage Billings for the Prince Rupert Region (1998-2002).

	1st Quarter	2nd Quarter	3rd Quarter	4th Quarter	Total
1998					
Volume Billed (000's m^3)	2,983	911	1,633	1,995	7,522
Value Billed ($,000)	96,907	18,526	25,002	31,264	171,699
Average Rate ($/m^3)	32.49	20.34	15.31	15.67	22.83
1999					
Volume Billed (000's m^3)	2,963	1,361	1,857	2,189	8,370
Value Billed ($,000)	59,630	18,882	27,357	39,430	145,299
Average Rate ($/m^3)	20.13	13.87	14.73	18.01	17.36
2000					
Volume Billed (000's m^3)	3,582	1,419	1,531	2,221	8,753
Value Billed ($,000)	80,069	20,680	25,965	25,765	152,479
Average Rate ($/m^3)	22.35	14.57	16.96	11.60	17.42
2001					
Volume Billed (000's m^3)	3,140	1,440	1,888	1,155	7,623
Value Billed ($,000)	51,485	12,322	23,964	15,732	103,503
Average Rate ($/m^3)	16.40	8.56	12.69	13.63	13.58
2002					
Volume Billed (000's m^3)	2,374	1,044			3,418
Value Billed ($,000)	43,827	14,157			57,984
Average Rate ($/m^3)	18.46	13.56			16.96
TOTAL					
Volume Billed (000's m^3)					**35,686**
Value Billed ($,000)					**630,964**
Average Rate ($/m3)					**17.68**

Adapted from Stumpage Billing Reports [3].

Stumpage and harvesting costs may be adjusted based on the TASS outputs to ensure that economically operable stands are not deemed to be economically inoperable by the averaging process. These adjustments will be based on the log grade profile produced by TASS and the above averages.

[3] Average stumpage cost was calculated using *Summary of Stumpage Billings* reports from the MoF – Revenue Branch web site (http://www.for.gov.bc.ca/REVENUE/timberp/stumpagebillings/index.htm).

5.4 DISCOUNT RATE

The discount rate provides a mechanism to analyze the time between an investment and return on that investment in making investment decisions. There are many different factors that can influence the selection of a discount rate: opportunity cost of capital, accounting for risk, changes in the value of money over time and, *the social rate of time preference* (Pearse 1990). Because of the period of time involved in this analysis the results are very sensitive to the discount rate selected. According to Pearse, forestry investments are evaluated at relatively modest rates of interest.

In this analysis, the model will "choose" to make silviculture investment based on gaining a positive return from that investment. If the discount rate selected is too high then the model will choose to not make any investment. A discount rate of 4% will be used but may be adjusted based on preliminary analysis results.

6.0 SILVICULTURE SCENARIOS

The following treatment scenarios will be conducted for the development of a North Coast TSA Silviculture Strategy.

6.1 SCENARIO #1: GENETICALLY IMPROVED STOCK

This scenario will examine potential gains of using genetically improved stock for all planted stands. Most of blocks in the North Coast are planted however, Hw ingress leads these blocks to be modelled using high initial densities. All the above analysis units will experience hemlock competition. The resulting, free-growing stand at rotation will contain hemlock as a crop species in varying amounts.

Table 21 shows the typical planting regimes used in the North Coast TSA. The genetic improvement gains in Table 22 will be applied to all planted stems in this scenario. Ingress and mortality is modelled by TASS and will determine how many of the planted stems survive to be harvested. This will influence the degree to which genetic gains are realized at the time of harvest and help determine the forest-level benefits of using genetically improved stock.

Planting costs will be adjusted in this scenario to account for the higher cost of genetically improved seed (Table 18).

Table 21: Planting Regime by Analysis Unit.

Analysis Unit	Description	Candidate for Genetically Improved Stock? (Y/N)	Planting Regime (Species and SPH)
1	Cedar, Hemlock / Cedar: High	Y	Cw(700), Ss(100), Ba(100)
2	Cedar, Hemlock / Cedar: Med.	Y	Cw(700), Ss(100), Ba(100)
3	Cedar, Hemlock / Cedar: Low	Y	Cw(800), Cy(100)
4	Hemlock, Balsam: High	Y	Ba(315), Ss315), Cw(270)
5	Hemlock, Balsam: High w thinning	Y	Ba(315), Ss(315), Cw(270)
6	Hemlock, Balsam: Med.	Y	Ba(315), Cw315), Ss(270)
7	Hemlock, Balsam: Med. w thinning	Y	Ba(315), Cw315), Ss(270)
8	Hemlock, Balsam: Low	Y	Cw(500), Cy(100), Nat Hw(300)
9	Spruce: High	Y	Ss(540), Cw(180), Ba(180)
10	Spruce: Med.	Y	Ss(540), Cw(180),Ba(180)
11	Spruce: Low	Y	Ss(540), Cw(180), Ba(180)
23	Cedar, Hemlock / Cedar: Low	Y	Cw(800), Cy(100)
26	Hemlock, Balsam: Med.	Y	Ba(315), Cw315), Ss(270)
28	Hemlock, Balsam: Low	Y	Cw(500), Cy(100), Nat Hw(300)
30	Spruce: Med.	Y	Ss(540), Cw(180), Ba(180)
42	Cedar, Hemlock / Cedar: Med.	Y	Cw(700), Ss(100), Ba(100)
43	Cedar, Hemlock / Cedar: Low	Y	Cw(800), Cy(100)

Table 22: Current and Future Expected Genetic Gains by Species.

Species	Current Genetic Gains	Future Genetic Gains (20 years from now)
Hw	16%	16%
Ss	2%	15%
Cw	2%	5%

6.2 SCENARIO #2: JUVENILE SPACING

All Hw / Cw and Hw / Bl high and medium sites are spaced at age 20 to 700 sph. The cost for this treatment is $1,900 /ha. Table 23 shows the potential treatable area for this scenario. Treatment will be applied only where and when it produces a positive financial return.

Table 23: Juvenile Spacing Scenario - Treatable Area.

Analysis Unit	Initial Density (sph)	Final Density (sph)	Treatment Age (yrs)	Gross Forested Area (ha)	THLB Area (ha)
1	10,000+	700	20	638	421
2	10,000+	700	20	22,654	11,332
4	10,000+	700	20	3,717	2,656
6	10,000+	700	20	37,680	21,824
101	10,000+	700	20	977	879
102	10,000+	700	20	1,362	1,072
104	10,000+	700	20	4,065	3,504
105[1]	10,000+	700	20	193	174
106	10,000+	700	20	9,026	7,939
107[1]	10,000+	700	20	1,601	1,438
TOTAL				**81,913**	**51,239**

[1]these stands are also thinned in the base case scenario.

6.3 SCENARIO #3: JUVENILE SPACING / PRUNING

This scenario examines the benefits of Juvenile Spacing and Pruning. Pruning adds clear wood and gains in log value to a stand. Because pruning does not affect stand volume or diameter it is best represented using financial information. This scenario will examine the financial return from this treatment regime.

Table 24 show the treatable area for the Juvenile Spacing / Pruning treatment. The treatable area is the same as the Juvenile Spacing scenario. The cost for this treatment is $1,900 / ha for juvenile spacing and $2,000 / ha for pruning for a total treatment cost of $3,900 / ha. As with juvenile spacing, this treatment will only be applied by the model where it represents a positive financial return to the land base.

Table 24: Juvenile Spacing / Pruning Scenario - Treatable Area.

Analysis Unit	Initial Density (sph)	Final Density (sph)	Treatment Age (yrs)	Gross Forested Area (ha)	THLB Area (ha)
1	10,000+	700	20	638	421
2	10,000+	700	20	22,654	11,332
4	10,000+	700	20	3,717	2,656
6	10,000+	700	20	37,680	21,824
101	10,000+	700	20	977	879
102	10,000+	700	20	1,362	1,072
104	10,000+	700	20	4,065	3,504
105[1]	10,000+	700	20	193	174
106	10,000+	700	20	9,026	7,939
107[1]	10,000+	700	20	1,601	1,438
TOTAL				**81,913**	**51,239**

[1]these stands are also thinned in the base case scenario.

All stands will be pruned to a target height of 6m with a minimum prune height of 4m and a minimum live crown ratio of 40% following pruning.

6.4 SCENARIO #4: REHABILITATE CEDAR LOW PRODUCTIVITY SITES

This scenario tests the forest-level benefits of rehabilitating low site, cedar-leading stands. These stands are harvested and regenerated normally to the analysis unit 103 (Cedar, Hemlock/Cedar – Low). Because these sites generally have low inventory volumes, smaller piece size and lower quality logs, the majority of the initial harvesting operations will likely occur at a financial loss. However, it is expected that following harvest and regeneration, these stands will likely show a productivity increase. This scenario tests whether this initial investment (harvesting at a financial loss) pays off in the long run by increasing the timber harvesting land base.

Table 25 shows the area available for rehabilitation treatment. Areas defined as "marginally operable" (conventional or helicopter) (AU 23 and 43) in the LRMP analysis are not available for treatment.

Table 25: Low Site Reduction Area Available for Rehabilitation.

Leading Species	Analysis Unit	Low Site Reduction (ha)	Comment
Cedar	3	166,362	
Cedar	23	139	Marginally Operable - No Rehab.
Cedar	43	51	Marginally Operable - No Rehab.
TOTAL		**166,552**	

About 50% of the sites would benefit from a mounding / piling treatment however only half of those would be able to be treated. Mounding / piling treatment generally costs approximately $1,200 / ha. Therefore, inventory information does not allow us to identify stands candidate for mounding / piling, all rehabilitated stands will have a $300 / ha cost ($1,200 * 25%). It is assumed that this treatment occurs in conjunction with harvesting.

6.5 SCENARIO #5: RED ALDER UTILIZATION

This scenario examines red alder as commercially viable species. 1,941 ha of red alder stands (ITG 38) are removed from the THLB as a problem forest types (Table 26). This scenario will incorporate these stands into the THLB to determine the supply of red alder that can be sustained in the North Coast TSA. These stands will be managed for the production of red alder and will not be converted to other species.

Table 26: Red Alder Utilization Area.

Analysis Unit	Description	ITG	SI	Gross Forested Area (ha)	PFT Reduction (ha)
	Red Alder	38	24.4	2,422	1,941

6.6 PREFERRED MANAGEMENT SCENARIO

This scenario will combine the best individual treatments from above into one scenario based on the results. This scenario will show the cumulative effects of the various treatment regimes in terms of both harvest volume and financial return. Variations of this scenario will include various levels of incremental silviculture spending as well as alternate harvest flow policies.

7.0 REFERENCES

British Columbia Ministry of Forests. 1999. *North Coast Timber Supply Area Analysis Report*. Province of British Columbia, Victoria, B.C.

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Tanz, Jordan and Craig Farnden. 2000. *North Coast Timber Supply Area – Type 1 Silviculture Strategy.* Ministry of Forests, Prince Rupert Region.

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Pojar, Jim et al. 1999. *Silviculture Options in the Central Coast.* Province of British Columbia, Victoria, B.C.

7.1 LRMP DATA PACKAGE – ADDITIONAL CITATIONS

Meidinger, D. B. Enns, S. Reed, and G. Olivotto. 2001. *Pilot to Develop a Methodology for Ecologically-Based Yield Analysis.* Unpublished Final Report. Research Branch, B.C. Ministry of Forests, Victoria, B.C.

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Site Productivity Working Group. 1998. *Site Index Estimates by Site Series for Coniferous Tree Species in British Columbia.* B.C. Ministry of Forests, Victoria, B.C.

Appendix I – Stakeholder Workshop # 1 – Attendees and Meeting Agenda

Table A1 - 1: Agenda – Stakeholder Workshop.

AGENDA	
Introduction	9:00 – 9:25
Meeting to Order	
Introduction of the Participants Round Table	
Review and Adoption of the Agenda	
Background Information	
Workshop Objectives	
Project Objectives and Timelines	
Review of TSR II	9:25 – 9:55
Inventory Information	
Land Base Determination (Netdown)	
Base Case Assumptions and Harvest Forecast	
Sensitivity Analysis	
Chief Forester's AAC Rationale	
Review of North Coast TSA – Type I Analysis	9:55 – 10:30
Key Issues and Strategies	
Issues Requiring Investigation	
Coffee Break	10:30 – 10:45
Wildlife Habitat	10:45 – 11:15
TSR II Assumptions	
Additional Requirements for the Type II analysis	
Silviculture Profile of the North Coast TSA	11:15 – 11:35
Expected Outcome	
Silviculture Systems and Program	
Product Class Definition	11:35 – Noon
Definition of Premium Product	
TSA Objectives	
Lunch Break (Lunch is provided)	12:00 – 12:30
Type II Base Case (revised Base Case)	12:30 – 1:30
Changes from the TSR II base case	
Silviculture Regimes and Costs	
Silviculture Budget	
Scenarios	1:30 – 3:00
Basic Silviculture	
Basic Silviculture + Genetically Improved Seedlings	
Basic Silviculture + Partial Harvesting	
Basic Silviculture + Juvenile Spacing	
Basic Silviculture + Backlog NSR Rehab	
Basic Silviculture + Commercial Thinning	
Basic Silviculture + Fertilization	
Coffee Break	3:00 – 3:15
Rehabilitation of Low Productivity Sites	3:15 – 4:30
Rehabilitation of Deciduous	
Operational Adjustment Factors (OAF)	
Land Base Adjustment (Operability)	
Alternate Planting Densities and Species Selection	
Silviculture Budget Variations (+/- 50%, +/- 100%)	
Other Possible Scenarios	
Discussion on the Data Package Content and Format	4:30 – 4:40
Review Action Items and Deadlines	4:40 – 5:00

Table A1 - 2: Workshop Invitees.

Individuals and Organizations	Present at Workshop	Email
Triumph Timber Ltd.		
Shawn Kenmuir	yes	shawnk@monarch.net
Shannon Pearce	yes	
International Forest Products Ltd.		
Peter Scharf, Area Manager	yes	peter_scharf@interfor.com
Wade Balbirnie, Planner	yes	wade_balbirnie@interfor.com
Ministry of Forests – Prince Rupert		
Mike Grainger, Silviculture Officer	yes	Mike.Grainger@gems8.gov.bc.ca
Christian Shears, Planning Officer	yes	Christian.Shears@gems1.gov.bc.ca
Glenn Piggot, SB Silviculture Forester	yes	Glenn.Piggot@gems3.gov.bc.ca
Dorothy Wharton, Operations Manager	yes	Dorothy.Wharton@gems1.gov.bc.ca
Ministry of Forests – Smithers		
Lou Tromp, Stand Tending Forester	yes	Lou.Tromp@gems9.gov.bc.ca
Timberline Forest Inventory Consultants Ltd.		
Jay Greenfield, Resource Analyst	yes	jag@timberline.ca
Integrated Silviculture Services Ltd.		
Al Todd, Senior Consulting Silviculturist	yes	avanti@mag-net.com
Interpac Resources Ltd. - (Rep. for Thomson Industries Ltd and Boyle and Dean Logging Ltd.)		
Dave Andermatt	no	davea@interpacforest.com
Ministry of Sustainable Resource Management		
Davide Cuzner	no	Davide.cuzner@gems6.gov.bc.ca
Ministry of Water, Land and Air Protection		
Dionys Deleeuw	no	Dionys.Deleeuw@gems5.gov.bc.ca