

Type 2 Strategic Silviculture Analysis Analysis Information Package

Ministry of Forests Prince Rupert Forest Region Kalum Forest District

In Conjunction with

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Type 2 Strategic Silviculture Analysis Analysis Information Package November 2001

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1 INTRODUCTION

The Ministry of Forests (Prince Rupert Forest Region) has initiated the development of a Type 2 Forest Level Silviculture Strategy for the Kalum TSA. This information package documents the procedures, assumptions, data and model used in the analysis. Forest Ecosystem Solutions Ltd. (FESL), formerly Hugh Hamilton Limited was engaged to prepare the information package and conduct the Type 2 analysis on behalf of the MoF. While not as detailed as an information package for a timber supply analysis, this package will utilize where appropriate format and requirements within the *Provincial Guide for the Submission of Timber Supply Information Packages for Tree Farm Licences, Version 3*.

The purpose of this information package is to:

- Provide a mechanism for communication of technical analysis issues (land base net down, analysis assumptions and analysis scenarios) between the participants (FESL, MoF, licencees) prior to undertaking the Type 2 analysis;
- Provide an opportunity for the MoF and participants to review those technical issues and assumptions that will be used in the preparation of the Type 2 analysis;
- Create a dynamic document which, over time, will ensure that all relevant information is accounted for appropriately in the Type 2 analysis; and
- Increase the efficiency of the Type 2 analysis process by reducing the risk of having analyses discarded due to inappropriate content.

Base data for this analysis will come from the 1999 Timber Supply Review (TSR) and the Kalum Land and Resource Management Plan (LRMP).

Appropriate yield tables will be generated with Variable Density Yield Prediction (VDYP) model for natural growth stands and the Table Interpolation Program for Stand Yields (TIPSY) for managed stands. Special incremental silviculture treatments will have yield tables generated through TASS (Tree and Stand Simulator).

All data summarized in this package used spatial GIS data and forest inventory polygon (FIP) labels, allowing all **FSOS** analyses to be spatially and temporally referenced. **FSOS** (Forest Simulation Optimization System) will be used to determine a long-term silviculture strategy, based on various silviculture assumptions over a 200-year planning horizon.

Upon review by the Prince Rupert Forest Region, the assumptions used in this information package will be used to guide the development of the strategic silviculture analysis. During the analysis, sensitivity analyses and management options will be tested to determine the influence of various factors on timber flow levels.

2 PROCESS

The Contract Officer and local stakeholders direct this analysis through the Request for Proposal. This information package will be included as an Appendix in the Analysis Report.

The background information that guided the assumptions and processes employed in this information package includes but is not limited to the following reports:

- *Achieving Acceptable Biodiversity Timber Impacts*
- *Forest Practices Code Guidebooks:*
 - Biodiversity Guidebook*
 - Community Watershed Guidebook*
 - Riparian Guidebook*
- *Incorporating Biodiversity and Landscape Units in the Timber Supply Review*
- *Site Index Adjustments for Old-Growth Stands Based on Veteran Trees (Working Paper 36, 1998)*
- *Timber Supply Review Base Case Modelling Assumptions for Biodiversity and Landscape Units*
- *Tree Farm Licence Information Package Guidelines*

2.1 Growth and Yield

The growth and yield data will be generated using the following models:

- VDYP, Version 6.4, for unmanaged stands;
- TIPSYP, Version 2.1e, for existing and future managed stands; and

Research Branch using TASS Version 2.07.12 will develop growth and yield information for the intensive silviculture regimes.

2.2 Data Preparation and Data Quality

The Ministry of Environment, Lands and Parks provided a resultant spatial dataset in ARC/INFO format, which was the result of its LRMP planning process. Extensive re-processing and manual correction were required to prepare the LRMP dataset for a fully spatial analysis, which delayed project progression. The new resultant ARC/INFO coverage contains about 60,000 polygons with a unique and sequential polygon identity. This coverage was converted into shape format, which is then loaded into MS Access for database management and analysis and into Arc/View for mapping purposes.

Additional data, such as data from the provincial silvicultural database ISIS, was linked to the new resultant dataset using MS Access. The resulting database environment created in MS Access is fully spatial, and was used to generate all required netdown values.

After assessing the LRMP dataset, FESL felt that the dataset needed to be reworked to bring it in line with the Ministry of Forests standards for LUP Data Preparation. The LRMP dataset presented some unique challenges, such as strips of data along neatlines with missing attribute data for some database items. In some places, ARC/INFO's universal polygon extended into the Kalum TSA area, creating linear gaps between adjoining mapsheets approximately 100 to 200 meters wide.

All corrections are likely a very close approximation of the actual landscape. Wherever missing data was added to the LRMP dataset based on the attributes or shape of neighbour polygons, errors and misinterpretation might locally distort the model; however, any errors created through this adjustment process are small as compared to not making adjustments at all.

3 SCENARIOS AND SENSITIVITY ANALYSIS

3.1 *Analysis Methods*

The objective of the Type 2 analysis is to identify the forest level benefits of intensive silviculture activities.

Through forest level modeling using **FSOS** (Forest Simulation Optimization System), the variety of treatments can be considered in light of their ability to satisfy forest level objectives. A single treatment at the stand level may result in a yield improvement. However, at the forest level this treatment may be a poor investment when considered together with all other investments, budgets, and objectives. Conversely, a treatment at the stand level that does not represent a significant benefit may in fact be an important action and satisfy an objective at the forest level.

Stand management options or treatment regimes describe a series of silviculture actions that are possible for a given stand type. Each treatment within the regime occurs in sequential order and has an associated set of costs, values, employment levels, and timber quality and quantity effects at a given point in time.

FSOS will determine the appropriate management regime for each stand following harvest or for those stands that are currently harvested and treatable. Each regime provides a timeframe of treatments, including harvesting, and stand development. Following harvest, the stand may follow the same treatment regime or transform to another regime or receive no treatment at all based on decisions of costs, values and overall satisfaction of objectives.

A number of forest level scenarios will be developed and analyzed. These scenarios will eventually lead to the preferred option. This approach presents a sequential and iterative process of analysis with each step providing insight, understanding and direction for the next.

3.2 *Scenarios*

The development of a strategic silviculture plan is not an easy process. A variety of stand and forest level objectives or desired future outcomes, elaborate stand treatment regimes and long time horizons create complexity in forest dynamics making understanding difficult and complicating the development of an incremental silviculture plan.

Scenario planning helps to understand those significant issues that control future outcomes related to the stated objectives by simplifying the complex interactions. Scenarios are developed as sensitivity analyses or to investigate individual management interests and questions.

Each scenario plan or result describes the silvicultural and forest-level outcome given the management approach defined in that scenario. The scenarios are assessed individually

for the development of the preferred option. The actual final silvicultural strategy may be composed of constituents of some or all of the other scenarios. The scenarios provide an incremental process of understanding the minimum and maximum values of future forest conditions and possibilities. Key items that are assessed within each scenario are the response of important indicators (i.e. timber supply), similar trends across scenarios, tradeoffs between scenarios, and short- and long-term variations.

Both simulation and optimization analysis techniques will be used in the Kalum TSA analysis. Table 1 provides a summary of different analysis scenarios.

Table 1: Summary of Scenarios

Scenario	Title	Scenario Description
1	FESL Base Case	Re-creation of the TSR II Base Case Scenario to calibrate model and to test model reliability.
2	Base Case – No Spacing	Base Case without spacing unless specified in forest cover information.
3	Revised Base Case	Base Case with new yield curves for OGSi and SIBEC adjustments.
4	Genetic Improvement	Scenario 3 with genetic improvement.
5	Nisga’a Lands Removed	The FESL Base Case with Nisga’a Lands removed as non-ownership.
6	Silviculture Strategy Base Case	Deciduous conversion. Existing 0-40 year-old stands on TASS curves. Goat out. Nisga’a Lands out. Kitimat SRMZ added. No future treatments incorporated.
7	Timber Volume Scenarios	A scenario, which applies an unlimited silviculture budget and determines the impact on volume. Focus is on increasing mid-term flows.
8	Timber Value Scenarios	A set of scenarios varying annual investment budgets. Intent is to apply treatments that maximize value across certain budget levels.
9	Preferred Option	All preferred management options combined.

3.2.1 FESL Base Case (Scenario 1)

Re-creating the TSRII base case will allow us to evaluate the model’s performance as well as monitor differences between our analysis and TSRII. Any differences between the base cases will be useful in understanding volume differences in the simulations.

3.2.2 Base Case – No Spacing (Scenario 2)

This scenario modifies the FESL Base Case to exclude spacing treatments. New TIPSy curves were generated to represent the no spacing option where appropriate. However,

where the forest cover information indicated that previous spacing had occurred, the spacing treatment was maintained.

3.2.3 Revised Base Case (Scenario 3)

This scenario is the base case revised to incorporate TASS curves with SIBEC and OGSi adjustments. Site index adjustments are listed in Table 10. Spacing treatments, elimination of backlog NSR, and the management of existing and managed stands are modeled as in the base case.

3.2.4 Genetic Improvement (Scenario 4)

This scenario is identical to Scenario 3 with the exception of a 2% increase in softwood yield volumes to account for planting of genetically improved stock. This increase is a generally accepted adjustment level for softwood species.

3.2.5 Nisga'a Lands Removed (Scenario 5)

This scenario is identical to Scenario 1 with the exception that the Nisga'a lands are considered non-ownership, meaning they are removed from the productive forest and no longer contribute to seral objectives.

3.2.6 Silviculture Strategy Base Case (Scenario 6)

This scenario introduces all management assumptions to be used in the silviculture strategy analyses. These are as follows:

- All past silvicultural activities recognized.
- Genetic improvements incorporated.
- All deciduous stands older than 10 years present in the Kalum THLB will be converted to softwood after the first rotation, while deciduous stands less than 10 years old convert on the same schedule as existing backlog NSR.
- Managed stands, which are defined as stands up to 40 years of age, and stands between 40 and 100 years, have both value and product information added to their respective yield curves. Stands in both categories are available for commercial thinning when appropriate.
- All mountain goat habitat areas are reserved.
- A Kitimat Special Management Resource Zone (SRMZ) was added to control age structure development in the Kitimat Valley. In the Kitimat SRMZ, an early disturbance requirement of allowing a maximum of 15% of the THLB to be less than 15 years old was set to ensure a smooth transition to an even-age structure. Also, a goal was set to have at least 20% of the THLB covered by stands 80 years in age or older.
- Nisga'a Lands were removed from the THLB.
- No future incremental silviculture treatments are incorporated.
- A 5% tolerance was applied around some are class targets to allow flexibility for transition strategies.

3.2.7 Timber Volume Scenarios (Scenario 7)

This scenario uses an unlimited annual investment budget and incorporates multiple transition options, including commercial thinning. The intent is to determine the increases in timber quantity associated with silviculture investment.

- No timber value or harvest costs yet incorporated.
- Schedule from scenario 6 provides the starting point from which solutions are improved.
- Investment levels are \$0 (Scenario 6) and unlimited.

3.2.8 Timber Value Scenarios (Scenario 8)

This is a set of scenarios which vary the annual investment budget and incorporate multiple transition options, including commercial thinning. The intent is to determine increases in timber quality.

- Investment levels are \$0, \$500,000, \$1,000,000/year, and \$2,500,000/year.
- Includes economic scenarios assessing the feasibility of different silvicultural investments at a forest level. Also, compares dollar values between the different silvicultural scenarios and the silviculture strategy base case.

3.2.9 Preferred Scenario (Scenario 9)

Based on the results of all previous scenarios, scenario 9 is the ‘best’ option that attempts to balance all preferred management outcomes. Map output will be limited to the presentation of all treatments in the first 10-year period based on the ‘optimized’ silviculture treatment schedule.

3.3 Assumptions

To ensure understanding of the strategic silviculture analysis the readers and reviewers must have a thorough comprehension of the assumptions that were used to prepare the data and represent analysis parameters.

3.3.1 Analysis Assumptions

1. “Normal” market conditions will prevail for demand and prices for timber and fibre.
2. A status quo THLB will be used in the TSR II base case and any modifications will be utilized in the “revised base case”. The Nisga’a lands are removed for the silviculture strategy base case.
3. All current FPC requirements will be utilized and maintained in the analysis.
4. MoF timber supply concepts and harvest flow rules will be followed (maintain current harvest as long as possible; declines, where necessary do not exceed 10%/decade). No patch objectives will be applied to this analysis on seral requirements.
5. Specific levels of precision to be used in the optimization analysis are as follows:
 - +/- 10% change in timber flow between decades.

- Silviculture investment not to exceed maximum budget level by more than 5%.
- Maximum 5% tolerance around age-class targets specified in TSRII for optimization to allow for smooth transition strategies to be achieved without impacting timber flows.

4 MODELS

The following software was used in the preparation of the strategic silviculture analysis and data package for the Kalum TSA:

- **FSOS** (Forest Simulation Optimization System) time-step simulation model and **FSOS** forest estate optimization model;
- MoF Variable Density Yield Program (VDYP);
- MoF Table Interpolation Program for Stand Yields for Microsoft Windows (WinTIPSY).
- MoF Tree and Stand Simulator (TASS)

4.1 Landscape Design Model - FSOS

Model Name:	FSOS
Model Developer:	Guoliang Liu
Model Development:	Hugh Hamilton Limited, Forest Ecosystem solutions Ltd and UBC
Model Type:	Landscape Design Model

Description:

Forest Ecosystem Solutions Ltd. combines the power of advanced computer modeling techniques and GIS tools with expert professional experience. At the centre is a landscape optimization model called **FSOS** (Forest Simulation Optimization System). The model uses C++ programming language and can be run with both Windows '98 and Windows NT operating systems. The model interfaces directly with Microsoft Access for data management. The Timber Supply Branch of the MoF accepted the use of FSOS for timber supply analysis in August 1998. **FSOS** uses dynamic heuristic and simulation techniques to schedule harvest units based on 1) patch and seral objectives defined by non-timber (e.g. old-growth, biodiversity, visuals, habitat, watershed, etc.) resource values and 2) timber management objectives (e.g. even flow, volume levels, opening size distribution, species quotas). Harvest and approximate cut block shape and size over the planning horizon are an output of the model. Modeling of strict adjacency and seral constraints is accomplished using simulation modeling. The data structure is identical for both heuristic and simulation models, which prevents extensive data loading procedures when switching between techniques.

FSOS uses the multiple resultant polygons created by GIS overlay as the basic model unit, allowing great flexibility in creating a variety of potential harvest unit configurations by amalgamating these resultant polygons. Amalgamations of the harvest units through time create early seral openings and mature and old growth patches consistent with planned patch management strategies defined by higher level plans. Managing for specific patch size distributions within each seral class is also inherent within the model framework and is an extremely effective way to meet long-term biodiversity objectives. High weightings can be applied to relatively important resource objectives or objectives which are difficult to achieve. The objective function (evaluation equation) provides the means to evaluate the relative “success” between differing

solutions. For each iteration, the model calculates a “penalty” based on the deviation of a given solution from the target values. Optimal solutions achieve targets quickly for highly weighted parameters in order to minimize the total "penalty" over the planning horizon. With optimization, “constraints” can be violated. As all resource values are tracked throughout the planning horizon, where and when this occurs is part of the model output.

The initial inventory data represents the gross land base, which includes both operable and inoperable areas and the contributing and non-contributing timber harvesting land base. This is required, as inoperable and other reserve areas contribute to the achievement of non-timber objectives. From GIS overlay, the land base is divided into resultant polygons, each with a unique set of attributes. Treatments are applied to each polygon based on these attributes. Analysis unit, forest type, forest age, silvicultural treatment, user allocation, site index, non-timber resource objectives or any other parameter can define treatment type and regime.

FSOS uses individual stand ages to project the current age structure of stands in the analysis area. As stands age, they move into and out of age classes established as a basis for meeting target objectives. For example, age classes may be established as ≤ 40 yrs, 41-120 yrs, 121-250 yrs, and >250 yrs.

The planning horizon length can vary as required. **FSOS** can produce spatially and temporally explicit plans over 20 years or for multiple rotations. A unique feature of **FSOS** is its ability to integrate strategic, tactical and operational planning phases into one process. Analysis runs include harvest timing and location for each period, as well as long-term, sustainable harvest levels.

Harvest rules that are used in **FSOS** are:

- Minimum stand age before a stand can be harvested;
- Maximum stand age, at which the stand is scheduled for cutting within a certain number of years (i.e. 10); and
- Green-up period required before adjacent patches can be harvested (this is not between openings but between patches. Patch size in early seral can reflect desired cut block size distributions).

A range of priorities can also be applied to include the following:

- Stands at risk from fire, disease or insects;
- Species preferences to meet mill requirements;
- Opening size distribution;
- Piece size requirements;
- Silviculture investment;
- Even volume flow; and
- Minimize transportation costs.

All possible regeneration alternatives and treatment regimes can be incorporated into the model. Adjusting growth curves or harvesting percentages of the block at specified intervals incorporates complex harvest systems (i.e. partial cutting) and silvicultural treatments. **FSOS** can also account for re-entry delays. **FSOS** can apply multiple regeneration assumptions.

The reporting functions of **FSOS** are extensive. The data for each period is easily accessible for any analysis unit, zone, polygon, landscape unit, etc. and gives an overview of the forest state at any point in time. Species compositions, age structure, patch distribution, harvest scheduling, treatment cost, product values and many other variables are tracked and reported by period. Reporting functions are highly effective for the direct comparison of sensitivity analysis and scenario options. **FSOS** is linked directly to the powerful ArcView environment for the easy production of high-quality map production.

Updates to the land base can be applied by two methods. Changes to applied netdowns occur in the database framework by reapplying netdown percentages. Changes to layer boundaries or additions or subtractions from the land base require the data be altered in the G.I.S. environment.

Cover targets are usually applied by age as a surrogate for height. Using patch and age class distribution indicators can achieve all cover targets. Age class distribution targets can be set as minimums, maximums, or desired levels. For example, wildlife habitat cover requirements may be achieved by having 70% of the management zone greater than 100 years of age.

Some other capabilities of **FSOS** include:

- Negative ages;
- Multiple constraints (guidelines) by unit, zone or group;
- Yearly age distribution;
- Volume and land Operational Adjustment Factors (OAFs);
- Spatial and temporal referencing of neighbouring polygons;
- Multi-species stands;
- No maximum planning horizon;
- Opening size distribution;
- Timber flow management;
- Landscape metrics options; and
- Economic indicators.

5 FOREST INVENTORY

The Ministry of Environment, Land and Parks provided all spatial information in ARC/INFO format through the release of its LRMP dataset. This dataset is a resultant dataset, which incorporates forest cover information provided by the Ministry of Forests. The forest cover inventory used for the LRMP had, for most of the mapsheets involved, been updated to January 1, 1995. For modelling purposes, FESL further updated the data to January 1, 2000. Volume projections were completed using VDYP.

All data is presented using the Albers projection, and it is controlled to the North American Datum (NAD) 83 base.

The adjacency file was set for a tolerance of 15 m. This means that the maximum distance between two polygons must be 15 m or less if the two polygons are to be considered adjacent. This distance affects polygon aggregation into harvest units and patches. Generating polygon adjacency at 15 m will prevent any small sliver polygons present in the database from being a barrier to adjacency.

6 DESCRIPTION OF LAND BASE

Determination of the timber harvesting land base (THLB) results from a sequential procedure where stands ineligible for harvest due to poor stand quality, non-merchantable species, specific geographical or management reductions, or site sensitivity are systematically removed from the land base. This section describes the procedures used in determining the THLB. Although portions of the land base are reserved from harvesting, their attributes within forested crown land still contribute to forest cover objectives.

6.1 Timber Harvesting Land Base

The net down procedure is an exclusionary process. Once an area has been removed, it cannot be deducted further along in the process. For this reason, the gross area removed is often greater than the net area removed, a result of overlapping resource issues.

6.2 Total Area

Table 2 represent the landbase netdowns made for Scenario 1 based on the modified LRMP dataset. The total land base in the Kalum TSA is 540,818 ha, with 198,883 ha of productive forest. Both numbers compare well to the numbers presented in the TSR II, with the difference amounting to less than a 1% difference in both cases.

The THLB that is reported in this analysis is approximately 3% lower than the area reported in the TSR II analysis. Differences are largely attributable to calculations for deciduous, environmentally sensitive areas (ESAs), and wildlife tree patches (WTPs). Also, some differences are likely due to neatline removal (lines between different map sheets), as forest cover attributes are often not consistent for polygons that are separated by mapsheet neatlines.

Table 2: Timber Harvesting Land Base Determination – Scenario1

	Silviculture Strategies Analysis	TSR II
Classification	Area Reductions (ha)	Area Reductions (ha)
Total Land Base:	540,818	539,319
Non-forest	306,973	305,698
Not directly managed by B.C. Forest Service	34,962	36,213
Total Productive Forest	198,883	197,408
Reductions to Total Productive Forest:		
Non-commercial	468	503
Inoperable	72,031	70,897
Humphrys reversion	827	906
Deciduous (Aspen, Birch, Alder)	5,584	4,041
Problem Forest Types (FTP)	6,840	7,090
Low productivity sites	831	808
Existing Roads, Trails and Landings	3,771	3,815
Environmentally Sensitive Areas	6,226	4,836
Riparian Management Areas	4,510	4,625
Wildlife Tree Patches	2,650	1,359
Exchamsiks	119	272
Total Reductions to Land Base	103,857	99,152
Current THLB	95,026	98,256
Includes 6,195 ha of NSR		
Future Reductions:		
Future Roads	3,413	4,076
Long-Term THLB	91,613	94,180

6.3 Non-Forest

All areas classified as Non-Forest are removed from the Productive Forest Area. These include all areas with a Projected Type ID of 6 or 8.

6.4 Non-Ownership

These land base reductions include areas of non-crown ownership as well as ownership areas, which are not part of the contributing land base such as parks and reserves, but still contribute to biodiversity objectives.

6.5 Non-Commercial Forest Cover

Non-commercial cover is removed from the Productive Forest Area and is identified in the forest inventory database information as TYPID_PR = 5.

6.6 Operability

Areas with operability criteria of I (Inoperable) or N (Not Classified/Reported) were removed from the Productive Forest Area.

6.7 *Humphrys Reversion (to TFL)*

A portion of the Humphrys Landscape Unit is being transferred to TFL 41. This area is completely removed from the Productive Forest Area.

6.8 *Deciduous Leading (Aspen, Birch, Alder)*

Inventory Type Groups 37 – 42 are mostly removed from the Productive Forest Area. These groups represent aspen, birch and alder leading stands.

6.9 *Problem Forest Types*

Problem forests types are stands that, though operable and exceeding low site criteria, are currently not utilized or that are of marginal merchantability.

6.10 *Low Productivity Sites*

Sites may have low timber growing potential because of inherent site factors (nutrient availability, saturated soils, rocky substrates, etc.) or because they are not fully occupied by commercial tree species. Stands falling into this category were identified and removed from the Productive Forest Area.

Table 3: Low Productivity Sites Reductions

Analysis Unit	FIZ	SI (ht in m at 50 yrs)	% Net down	Productive Forest Area (ha)	Net Down Area (ha)
Balsam	A	<6.5	100	0	0
Balsam	J	<6.5	100	795	0
Cedar	A	<8.5	100	358	0
Cedar	J	<9.0	100	0	0
Hemlock	A	<7.0	100	4,819	767
Hemlock	J	<7.5	100	3,527	0
Spruce	A	<3.0	100	6	0
Spruce	J	<5.0	100	110	3
Pine	A	<8.5	100	2	0
Pine	J	<9.5	100	105	40
Cottonwood	A	<8.0	100	65	21
Cottonwood	J	<7.0	100	3	0
Total				9,790	831

6.11 *Existing Roads, Trails and Landings*

Productive Forest Area is (for analysis purposes) permanently lost due to the construction roads, trails and landings. A non-spatial %-reduction of 7.5% was applied to all stands younger or equal to 35 years of age.

6.12 *Environmentally Sensitive Areas (ESA)*

ESA information was derived from forest cover polygon labels. A portion of the area within these polygons is excluded from harvesting based on the percentages in Table 6.3.

The reductions were established by the Ministry of Forests (MoF) in conjunction with MoELP.

Table 4: Environmentally Sensitive Areas Reductions

ESA Type	ESA Description	% Reduction	Productive Forest Area (ha)	Net Down Area (ha)
Es1	Soils - high	50	25,798	1,749
Es2	Soils - moderate	30	14,130	1,852
Er1	Recreation - high	100	2,504	1940
Ep1	Regeneration difficulty - high	100	4,508	537
Ep2	Regeneration difficulty – moderate	50	113	2
Ea1	Avalanche -high	100	1,621	146
Total			48,674	6,226

6.13 Riparian Management Areas

The THLB was reduced by a grand total 4,510 ha to account for riparian reserve and management zone retention. This reduction was by BEC variant as per TSR II.

6.14 Wildlife Tree Patches

Wildlife tree patches are retained in cutblocks to maintain stand structures beneficial for the conservation and enhancement of wildlife. Forest District staff has indicated that within the TSA, wildlife tree patches greater than 2 ha in size must be retained in perpetuity within a cutblock boundary.

It is assumed that 75% of all WTPs will be located in areas that are already deducted from the Productive Forest Area for other reasons (such as an ESA area). The remaining 25% of the area required for WTPs will have to be removed from the land base. This additional reduction was assumed to be located in the IRM and modification VQO, as other zones would inherently have adequate retention characteristics. Given the above assumptions, a percent reduction of the productive forest within the following biogeoclimatic variants was calculated as the net down area to be subtracted from the Productive Forest Area: 1.7% of the CWHvm variant, 3.1% of the CWHws variant, and 2.9% of the ICHmc variant. The total reduction for wildlife tree patches following other land base exclusions was 2,650 hectares.

6.15 Future Roads

Future Roads are subject to a 6.5% permanent land base reduction, to be applied *after* the first harvest.

6.16 Timber Licence Reversion

Timber licences (TL) are old tenure arrangements managed by the B.C. Forest Service that give a licensee exclusive rights to harvest Crown merchantable timber within the licence area and do not contribute to the TSA allowable cut. Once harvested and

regenerated to a free-to-grow status, the timber licence reverts to the T.S.A. All TL areas are anticipated to be harvested within the next 5 years.

6.17 Nisga'a Lands

Nisga'a lands were excluded from the sensitivity on the FESL Base Case (Scenario 5) and all silviculture strategies scenarios (Scenarios 6-10). The total THLB reduction was 5,598 ha.

7 INVENTORY AGGREGATION

Inventory aggregation is a process of simplifying the landscape into like units and identifies management zones or resource emphasis areas for the application of unique forest cover and spatial structure requirements as well as the application of growth and yield information. The aggregation must recognize both the similarities and differences in forest stand productivity as well as management objectives and prescriptions. This section describes the criteria and rationale behind the aggregation.

7.1 Management Zones

Management zones are geographically referenced areas that require unique management considerations. Areas requiring the same management regime or the same forest cover requirements are grouped into management zones. Table 5 lists the management zones in the Kalum TSA and the rationale used to define these zones.

Multiple resource issues may be present on the same forest area. For example, the watershed management zone may also have areas, which are visually sensitive and require an old growth objective. **FSOS** can accommodate multiple overlapping resource layers. This is done by establishing target levels for each layer. The model then schedules harvest units which best meet the target levels for all resource layers as a whole.

Table 5: Management Zones

Management Zone	Net Area (Productive Area) (ha)	Criteria used to Delineate Zone	Rationale/Comment
Integrated Resource Management Zone	85,167 (182,855)	The area of the TSA that is outside the community watersheds or VQO (PR) management zones described.	The timber harvesting land base, which is considered to be free of extraneous constraints.
Watershed Zone Deep Creek	569 (1,132)	The boundary of the watershed was delineated by height of land and the within the boundaries of TSA.	Because of low slope in the watershed the target is not too restrictive
BEC Variants	CWH vm 8,603 (28,183) MH mm2 5,720 (28,274) MH mm1 0 (1,249) CWH ws1 56,480 (86,014) CWH ws2 19,203 (43,599) ICH mc1 849 (1,447) ICH mc2 4,146 (7,771) ESSF mk (no targets) 0 (1,891) AT p (no targets) 0 (408)	Defined in the Biodiversity Guidebook, determine the natural disturbance regime, and old growth objectives within these zones. Full biodiversity percentages were applied from year 0 and a 45/45/10 rule was applied to each landscape unit.	Old growth objectives will be applied by landscape unit and by variant to ensure representation within each unit.
Thunderbird Resource Zone	7,398 (9,492)	The area under the Thunderbird integrated resource management area (IRMP)	
Kitimat Special Resource Management Zone (latter scenarios only)	27,336 (37,840)	LUs in the Kitimat Valley. Does not include areas in the Thunderbird SRMZ.	THLB area based on adjusted land base. Management objectives include even age class distribution and some extended rotations.
Visual Sensitivity	PR 1,671 (2,650) R 2,010 (3,926)		Visually sensitivity applied by classification on a landscape unit basis.

7.2 Analysis Units

Table 6 lists the principal criteria used in the aggregation of stands with similar biological characteristics into larger homogenous units called analysis units (AUs). This aggregation provides the mechanism for application of stand level modeling and reporting. Each forest cover polygon will be assigned an AU based on the criteria in Table 6 Site index, leading species and biogeoclimatic variant were the dominant criteria for creating the AUs.

Table 6: Existing Analysis Units

AU	Leading Species		Inventory Type Group	SI ₅₀ Range	MHA
1	Western Hemlock - Coast	Coast	12-17	8-18	110
2	Hemlock/Balsam/Cedar/Spruce	Coast	9-27	>18	60
3	Hemlock/Balsam/Cedar/Spruce	Coast	9-27	<=18	120
4	Lodgepole Pine	Coast	28-31	>=8.5	100
5	Cottonwood	Coast	35-36	>=8	70
6	Hemlock/Balsam/Cedar/Spruce	Interior	9-27	>18	90
7	Hemlock/Balsam/Cedar/Spruce	Interior	9-27	13-18	140
8	Hemlock/Balsam/Cedar/Spruce	Interior	9-27	<13	110
9	Lodgepole Pine	Interior	9-27	>=9.5	60
10	Cottonwood	Interior	28-31	>7	50
11	Hemlock/Balsam – Comm. Thin initial Curve	All	>12-20	>24	40 (for CT)
12	Hemlock/Balsam – Comm. Thin second curve	All	>12-20	>24	60

8 REGENERATION ASSUMPTIONS

Within the strategic silviculture analysis there are two levels to regeneration assumptions. The first level is regeneration trends consistent with the TSR II analysis. These assumptions deal with age of regenerating trees, NSR regeneration assumptions, regeneration distributions, site index adjustments etc. The second level, the strategic silviculture level, addresses transition options for regenerating stands.

8.1 Yields for Base Case Managed Stands

This section describes the current regeneration regimes for the TSA Base Case identifying managed stand conditions for each analysis unit. The operational adjustment factor (OAF) for all regeneration AUs is 15% for OAF 1 and 5% for OAF 2. All conifer-leading stands are planted. Cottonwood naturally regenerates along a VDYP curve.

Table 7: Existing and Future Managed TIPSy Curves - Planted and Spaced

Analysis Unit ^a	Location	SI	Regen Delay ^a	MHA
21 - H/B/C/S - SI adjusted	Coastal	23.5	3	50
22 - H/B/C/S	Coastal	22.1	3	55
23 - H/B/C/S	Coastal	13.3	3	110
24 - PI	Coastal	17.9	6	100
26 - H/B/C/S	Interior	18.6	3	70
27 - H/B/C/S	Interior	15.4	3	90
28 - H/B/C/S	Interior	11.5	3	130
29 - PI	Interior	16.8	6	110
31- H/B thinning (original regen)	All	27.6	3	40
32 - H/B thinning (post treatment)	All	27.6	3	55
36 - Spruce (early rotation) Kitimat Valley	All	23.8	3	60

^a Cottonwood naturally regenerates along the VDYP curve

In the TSR II Base Case, most stands assume some degree of planting and spacing (see TSR II for assumptions). In the strategic silviculture analysis base case (scenario 6), a natural density of 4000 stems was used for all future regeneration curves. This is used to approximate the average stand density within the analysis units given the majority of stems will be ingress at free-to-grow. Analysis units are assumed to regenerate to the leading species of the respective analysis unit with the exception of Sitka spruce, which will be regenerated to hemlock.

8.1.1 Genetic Gain Allowances

No genetic gain was assumed in the base case.

A sensitivity analysis will apply a 2% genetic improvement to approximately 75% of stands. The most productive stands were selected first for a 2% genetic improvement until 75% of the net forested area was represented.

8.1.2 Existing Managed Immature

Table 8 provides information for the areas of existing immature forest where the density has been controlled. The stands are assigned to a managed stand yield tables.

Table 8: Existing Managed Immature by Age Class

Analysis Unit	Area Managed (%)			
	Age 1-10	Age 11-20	Age 21-30	Age 31-40
All Types	100	100	70	30

8.2 Not Satisfactorily Restocked

In *FSOS*, NSR is modeled using negative ages, which are applied to reflect the NSR restocking schedule. Current NSR is assumed to regenerate within the regeneration delays shown in Table 7. Backlog NSR is assumed to regenerate within the next 20 years.

8.3 TASS Curves

The strategic silviculture analysis focuses on determining the optimal timing and treatments to be applied given certain forest cover objectives, employment objectives, budgeting, timber flow criteria, timber volumes, costs of treatment, etc. The TASS curves provide a range of treatment regimes for regenerating stands. From these treatment options, a ‘good’ treatment option for each stand can be determined. The treatment regimes are shown in Table 9.

Table 9: STRATEGIC SILVICULTURE ANALYSIS - KALUM TSA, TREATMENT REGIMES AND RULES, OAF 1 = .85 OAF 2 = .95

Regime Number	MHA	Sp	Workshop SI	Density Range	Model SI	Model Density	Treatment Regime			Spacing
KHG1	92	Hw	<20	<1500	18	350	Do nothing			
KHG2	80	Hw	<20	<1500	18	600	Do nothing			
KHG3	73	Hw	<20	<1500	18	850	Do nothing			
KHG4	95	Hw	<20	<1500	18	850	Ct			
KHG5	100	Hw	<20	<1500	18	850	Ct1	Ct2		
KHG6	93	Hw	<20	1500 - 3500	18	2125	Do nothing			
KHG7	73	Hw	<20	1500 - 3500	18	2125	Space			600 sph @ 20 Yrs
KHG8	72	Hw	<20	1500 - 3500	18	2125	Space			800 sph @ 20 Yrs
KHG9	80	Hw	<20	1500 - 3500	18	2125	Space			1000 sph @ 20 Yrs
KHG10	84	Hw	<20	1500 - 3500	18	2125	Space			1200 sph @ 20 Yrs
KHG11	90	Hw	<20	1500 - 3500	18	2125	Space			1400 sph @ 20 Yrs
KHG12	84	Hw	<20	1500 - 3500	18	2125	Space	Ct		1000 sph @ 20 Yrs
KHG13	120	Hw	<20	1500 - 3500	18	2125	Space	Ct1	Ct2	1200 sph @ 20 Yrs
KHG14	100	Hw	<20	1500 - 3500	18	2125	Ct			
KHG15	120	Hw	<20	1500 - 3500	18	2125	Ct1	Ct2		
KHG16	104	Hw	<20	3500-5000	18	4250	Do nothing			
KHG17	71	Hw	<20	3500-5000	18	4250	Space			600 sph @ 20 yrs
KHG18	71	Hw	<20	3500-5000	18	4250	Space			800 sph @ 20 yrs
KHG19	80	Hw	<20	3500-5000	18	4250	Space			1000 sph @ 20 Yrs
KHG20	83	Hw	<20	3500-5000	18	4250	Space			1200 sph @ 20 Yrs
KHG21	90	Hw	<20	3500-5000	18	4250	Space			1400 sph @ 20 Yrs
KHG22	104	Hw	<20	3500-5000	18	4250	Space			1600 sph @ 20 Yrs
KHG23	108	Hw	<20	3500-5000	18	4250	Space	Ct		600 sph @ 20 Yrs
KHG24	90	Hw	<20	3500-5000	18	4250	Space	Ct		750 sph @ 20 Yrs
KHG25	90	Hw	<20	3500-5000	18	4250	Space	Ct		1000 sph @ 20 Yrs
KHG26	110	Hw	<20	3500-5000	18	4250	Space	Ct1	Ct2	1200 sph @ 20 Yrs
KHG27	120	Hw	<20	3500-5000	18	4250	Ct			
KHG28	140	Hw	<20	3500-5000	18	4250	Ct1	Ct2		
KHG29	110	Hw	<20	5000-10000	18	5950	Do nothing			
KHG30	71	Hw	<20	5000-10000	18	5950	Space			600 sph @ 20 yrs
KHG31	71	Hw	<20	5000-10000	18	5950	Space			800 sph @ 20 yrs
KHG32	75	Hw	<20	5000-10000	18	5950	Space			1000 sph @ 20 Yrs
KHG33	84	Hw	<20	5000-10000	18	5950	Space			1200 sph @ 20 Yrs
KHG34	90	Hw	<20	5000-10000	18	5950	Space			1400 sph @ 20 Yrs
KHG35	95	Hw	<20	5000-10000	18	5950	Space			1600 sph @ 20 Yrs
KHG36	111	Hw	<20	5000-10000	18	5950	Space	Ct		600 sph @ 20 Yrs
KHG37	91	Hw	<20	5000-10000	18	5950	Space	Ct		750 sph @ 20 Yrs
KHG38	90	Hw	<20	5000-10000	18	5950	Space	Ct		1000 sph @ 20 Yrs

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Regime Number	MHA	Sp	Workshop SI	Density Range	Model SI	Model Density	Treatment Regime			Spacing
KHG39	110	Hw	<20	5000-10000	18	5950	Space	Ct1	Ct2	1200 sph @ 20 Yrs
KHG40	120	Hw	<20	5000-10000	18	5950	Ct			
KHG41	140	Hw	<20	5000-10000	18	5950	Ct1	Ct2		
KHG42	68	Hw	20-24	<1500	22	350	Do nothing			
KHG43	60	Hw	20-24	<1500	22	600	Do nothing			
KHG44	56	Hw	20-24	<1500	22	850	Do nothing			
KHG45	70	Hw	20-24	<1500	22	850	Ct			
KHG46	90	Hw	20-24	<1500	22	850	Ct1	Ct2		
KHG47	70	Hw	20-24	1500-3500	22	2125	Do nothing			
KHG48	55	Hw	20-24	1500-3500	22	2125	Space			600 sph @ 20 Yrs
KHG49	55	Hw	20-24	1500-3500	22	2125	Space			800 sph @ 20 Yrs
KHG50	59	Hw	20-24	1500-3500	22	2125	Space			1000 sph @ 20 Yrs
KHG51	64	Hw	20-24	1500-3500	22	2125	Space			1200 sph @ 20 Yrs
KHG52	70	Hw	20-24	1500-3500	22	2125	Space			1400 sph @ 20 Yrs
KHG53	60	Hw	20-24	1500-3500	22	2125	Space	Prune 2 lifts		600 sph @ 20 Yrs
KHG54	65	Hw	20-24	1500-3500	22	2125	Space	Prune 2 lifts		800 sph @ 20 Yrs
KHG55	70	Hw	20-24	1500-3500	22	2125	Space	Ct		1000 sph @ 20 Yrs
KHG56	100	Hw	20-24	1500-3500	22	2125	Space	Ct1	Ct2	1200 sph @ 20 Yrs
KHG57	80	Hw	20-24	1500-3500	22	2125	Ct			
KHG58	100	Hw	20-24	1500-3500	22	2125	Ct1	Ct2		
KHG59	77	Hw	20-24	3500-5000	22	4250	Do nothing			
KHG60	53	Hw	20-24	3500-5000	22	4250	Space			600 sph @ 20 Yrs
KHG61	54	Hw	20-24	3500-5000	22	4250	Space			800 sph @ 20 Yrs
KHG62	59	Hw	20-24	3500-5000	22	4250	Space			1000 sph @ 20 Yrs
KHG63	63	Hw	20-24	3500-5000	22	4250	Space			1200 sph @ 20 Yrs
KHG64	67	Hw	20-24	3500-5000	22	4250	Space			1400 sph @ 20 Yrs
KHG65	71	Hw	20-24	3500-5000	22	4250	Space			1600 sph @ 20 Yrs
KHG66	54	Hw	20-24	3500-5000	22	4250	Space	Prune 2 lifts		600 sph @ 20 Yrs
KHG67	54	Hw	20-24	3500-5000	22	4250	Space	Prune 2 lifts		800 sph @ 20 Yrs
KHG68	75	Hw	20-24	3500-5000	22	4250	Space	Ct		600 sph @ 20 Yrs
KHG69	66	Hw	20-24	3500-5000	22	4250	Space	Ct		750 sph @ 20 Yrs
KHG70	70	Hw	20-24	3500-5000	22	4250	Space	Ct		1000 sph @ 20 Yrs
KHG71	100	Hw	20-24	3500-5000	22	4250	Space	Ct1	Ct2	1200 sph @ 20 Yrs
KHG72	90	Hw	20-24	3500-5000	22	4250	Ct			
KHG73	110	Hw	20-24	3500-5000	22	4250	Ct1	Ct2		
KHG74	82	Hw	20-24	5000-10000	22	5950	Do nothing			
KHG75	54	Hw	20-24	5000-10000	22	5950	Space			600 sph @ 20 Yrs
KHG76	54	Hw	20-24	5000-10000	22	5950	Space			800 sph @ 20 Yrs
KHG77	54	Hw	20-24	5000-10000	22	5950	Space			1000 sph @ 20 Yrs
KHG78	64	Hw	20-24	5000-10000	22	5950	Space			1200 sph @ 20 Yrs

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Regime Number	MHA	Sp	Workshop SI	Density Range	Model SI	Model Density	Treatment Regime			Spacing
KHG79	70	Hw	20-24	5000-10000	22	5950	Space			1400 sph @ 20 Yrs
KHG80	70	Hw	20-24	5000-10000	22	5950	Space			1600 sph @ 20 Yrs
KHG81	54	Hw	20-24	5000-10000	22	5950	Space	Prune 2 lifts		600 sph @ 20 Yrs
KHG82	54	Hw	20-24	5000-10000	22	5950	Space	Prune 2 lifts		800 sph @ 20 Yrs
KHG83	79	Hw	20-24	5000-10000	22	5950	Space	Ct		600 sph @ 20 Yrs
KHG84	66	Hw	20-24	5000-10000	22	5950	Space	Ct		750 sph @ 20 Yrs
KHG85	70	Hw	20-24	5000-10000	22	5950	Space	Ct		1000 sph @ 20 Yrs
KHG86	100	Hw	20-24	5000-10000	22	5950	Space	Ct1	Ct2	1200 sph @ 20 Yrs
KHG87	90	Hw	20-24	5000-10000	22	5950	Ct			
KHG88	110	Hw	20-24	5000-10000	22	5950	Ct1	Ct2		
KHG89	54	Hw	24-28	<1500	26	350	Do nothing			
KHG90	48	Hw	24-28	<1500	26	600	Do nothing			
KHG91	44	Hw	24-28	<1500	26	850	Do nothing			
KHG92	60	Hw	24-28	<1500	26	850	Ct			
KHG93	80	Hw	24-28	<1500	26	850	Ct1	Ct2		
KHG94	55	Hw	24-28	1500-3500	26	2125	Do nothing			
KHG95	44	Hw	24-28	1500-3500	26	2125	Space			600 sph @ 20 Yrs
KHG96	44	Hw	24-28	1500-3500	26	2125	Space			800 sph @ 20 Yrs
KHG97	48	Hw	24-28	1500-3500	26	2125	Space			1000 sph @ 20 Yrs
KHG98	52	Hw	24-28	1500-3500	26	2125	Space			1200 sph @ 20 Yrs
KHG99	53	Hw	24-28	1500-3500	26	2125	Space			1400 sph @ 20 Yrs
KHG100	44	Hw	24-28	1500-3500	26	2125	Space	Prune 2 lifts		600 sph @ 20 Yrs
KHG101	44	Hw	24-28	1500-3500	26	2125	Space	Prune 2 lifts		800 sph @ 20 Yrs
KHG102	48	Hw	24-28	1500-3500	26	2125	Space	Prune 2 lifts		1000 sph @ 20 Yrs
KHG103	61	Hw	24-28	1500-3500	26	2125	Space	Ct		600 sph @ 20 Yrs
KHG104	60	Hw	24-28	1500-3500	26	2125	Space	Ct		750 sph @ 20 Yrs
KHG105	60	Hw	24-28	1500-3500	26	2125	Space	Ct		1000 sph @ 20 Yrs
KHG106	80	Hw	24-28	1500-3500	26	2125	Space	Ct1	Ct 2	1200 sph @ 20 Yrs
KHG107	70	Hw	24-28	1500-3500	26	2125	Ct			
KHG108	90	Hw	24-28	1500-3500	26	2125	Ct1	Ct2		
KHG109	60	Hw	24-28	3500-5000	26	4250	Do nothing			
KHG110	43	Hw	24-28	3500-5000	26	4250	Space			600 sph @ 20 Yrs
KHG111	43	Hw	24-28	3500-5000	26	4250	Space			800 sph @ 20 Yrs
KHG112	47	Hw	24-28	3500-5000	26	4250	Space			1000 sph @ 20 Yrs
KHG113	50	Hw	24-28	3500-5000	26	4250	Space			1200 sph @ 20 Yrs
KHG114	53	Hw	24-28	3500-5000	26	4250	Space			1400 sph @ 20 Yrs
KHG115	57	Hw	24-28	3500-5000	26	4250	Space			1600 sph @ 20 Yrs
KHG116	43	Hw	24-28	3500-5000	26	4250	Space	Prune 2 lifts		600 sph @ 20 Yrs
KHG117	45	Hw	24-28	3500-5000	26	4250	Space	Prune 2 lifts		800 sph @ 20 Yrs

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Regime Number	MHA	Sp	Workshop SI	Density Range	Model SI	Model Density	Treatment Regime			Spacing
KHG118	49	Hw	24-28	3500-5000	26	4250	Space	Prune 2 lifts		1000 sph @ 20 Yrs
KHG119	60	Hw	24-28	3500-5000	26	4250	Space	Ct		600 sph @ 20 Yrs
KHG120	60	Hw	24-28	3500-5000	26	4250	Space	Ct		750 sph @ 20 Yrs
KHG121	60	Hw	24-28	3500-5000	26	4250	Space	Ct		1000 sph @ 20 Yrs
KHG122	80	Hw	24-28	3500-5000	26	4250	Space	Ct1	Ct 2	1200 sph @ 20 Yrs
KHG123	70	Hw	24-28	3500-5000	26	4250	Ct			
KHG124	90	Hw	24-28	>3500	26	4250	Ct1	Ct2		
KHG125	38	Hw	>28	<1500	30	850	Do nothing			
KHG126	60	Hw	>28	<1500	30	850	Ct			
KHG127	70	Hw	>28	<1500	30	850	Ct1	Ct2		
KHG128	46	Hw	>28	1500-3500	30	2125	Do nothing			
KHG129	37	Hw	>28	1500-3500	30	2125	Space			600 sph @ 20 Yrs
KHG130	37	Hw	>28	1500-3500	30	2125	Space			800 sph @ 20 Yrs
KHG131	40	Hw	>28	1500-3500	30	2125	Space			1000 sph @ 20 Yrs
KHG132	43	Hw	>28	1500-3500	30	2125	Space			1200 sph @ 20 Yrs
KHG133	44	Hw	>28	1500-3500	30	2125	Space			1400 sph @ 20 Yrs
KHG134	37	Hw	>28	1500-3500	30	2125	Space	Prune 2 lifts		600 sph @ 20 Yrs
KHG135	38	Hw	>28	1500-3500	30	2125	Space	Prune 2 lifts		800 sph @ 20 Yrs
KHG136	42	Hw	>28	1500-3500	30	2125	Space	Prune 2 lifts		1000 sph @ 20 Yrs
KHG137	60	Hw	>28	1500-3500	30	2125	Space	Ct		1000 sph @ 20 Yrs
KHG138	60	Hw	>28	1500-3500	30	2125	Space	Ct		1000 sph @ 20 Yrs
KHG139	60	Hw	>28	1500-3500	30	2125	Space	Ct		1000 sph @ 20 Yrs
KHG140	80	Hw	>28	1500-3500	30	2125	Space	Ct1	Ct2	1200 sph @ 20 Yrs
KHG141	60	Hw	>28	1500-3500	30	2125	Ct			
KHG142	80	Hw	>28	1500-3500	30	2125	Ct1	Ct2		
KHG143	48	Hw	>28	3500-5000	30	4250	Do nothing			
KHG144	37	Hw	>28	3500-5000	30	4250	Space			600 sph @ 20 Yrs
KHG145	37	Hw	>28	3500-5000	30	4250	Space			800 sph @ 20 Yrs
KHG146	40	Hw	>28	3500-5000	30	4250	Space			1000 sph @ 20 Yrs
KHG147	43	Hw	>28	3500-5000	30	4250	Space			1200 sph @ 20 Yrs
KHG148	44	Hw	>28	3500-5000	30	4250	Space			1400 sph @ 20 Yrs
KHG149	47	Hw	>28	3500-5000	30	4250	Space			1600 sph @ 20 Yrs
KHG150	37	Hw	>28	3500-5000	30	4250	Space	Prune 2 lifts		600 sph @ 20 Yrs
KHG151	37	Hw	>28	3500-5000	30	4250	Space	Prune 2 lifts		800 sph @ 20 Yrs
KHG152	41	Hw	>28	3500-5000	30	4250	Space	Prune 2 lifts		1000 sph @ 20 Yrs
KHG153	60	Hw	>28	3500-5000	30	4250	Space	Ct		600 sph @ 20 Yrs
KHG154	60	Hw	>28	3500-5000	30	4250	Space	Ct		750 sph @ 20 Yrs
KHG155	60	Hw	>28	3500-5000	30	4250	Space	Ct		1000 sph @ 20 Yrs
KHG156	80	Hw	>28	3500-5000	30	4250	Space	Ct 1	Ct2	1200 sph @ 20 Yrs

Kalum Timber Supply Area Strategic Silviculture Analysis
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Regime Number	MHA	Sp	Workshop SI	Density Range	Model SI	Model Density	Treatment Regime			Spacing
KHG157	60	Hw	>28	3500-5000	30	4250	Ct			
KHG158	80	Hw	>28	3500-5000	30	4250	Ct1	Ct2		
KHG159	51	Hw	>28	5000-10000	30	5950	Do nothing			
KHG160	37	Hw	>28	5000-10000	30	5950	Space			600 sph @ 20 Yrs
KHG161	37	Hw	>28	5000-10000	30	5950	Space			800 sph @ 20 Yrs
KHG162	41	Hw	>28	5000-10000	30	5950	Space			1000 sph @ 20 Yrs
KHG163	43	Hw	>28	5000-10000	30	5950	Space			1200 sph @ 20 Yrs
KHG164	45	Hw	>28	5000-10000	30	5950	Space			1400 sph @ 20 Yrs
KHG165	47	Hw	>28	5000-10000	30	5950	Space			1600 sph @ 20 Yrs
KHG166	37	Hw	>28	5000-10000	30	5950	Space	Prune 2 lifts		600 sph @ 20 Yrs
KHG167	38	Hw	>28	5000-10000	30	5950	Space	Prune 2 lifts		800 sph @ 20 Yrs
KHG168	42	Hw	>28	5000-10000	30	5950	Space	Prune 2 lifts		1000 sph @ 20 Yrs
KHG169	60	Hw	>28	5000-10000	30	5950	Space	Ct		600 sph @ 20 Yrs
KHG170	60	Hw	>28	5000-10000	30	5950	Space	Ct		750 sph @ 20 Yrs
KHG171	60	Hw	>28	5000-10000	30	5950	Space	Ct		1000 sph @ 20 Yrs
KHG172	80	Hw	>28	5000-10000	30	5950	Space	Ct1	Ct2	1200 sph @ 20 Yrs
KHG173	60	Hw	>28	5000-10000	30	5950	Ct			
KHG174	80	Hw	>28	5000-10000	30	5950	Ct1	Ct2		
KPA1	80	PI	All	All	22	4250	Do nothing			
KPA2	57	PI	All	All	22	4250	Space			800 sph @ 20 yrs
KPA3	65	PI	All	All	22	4250	Space			1000 sph @ 20 yrs
KPA4	73	PI	All	All	22	4250	Space			1200 sph @ 20 yrs
KPA5	75	PI	All	All	22	4250	Space			1400 sph @ 20 yrs
KPA6	77	PI	All	All	22	4250	Space			1600 sph @ 20 yrs
KPA7	57	PI	All	All	22	4250	Space	Prune 2 lifts		600 sph @ 20 yrs
KPA8	59	PI	All	All	22	4250	Space	Prune 2 lifts		800 sph @ 20 yrs
KPA9	75	PI	All	All	22	4250	Space	Prune 2 lifts	Fert	600 sph @ 20 yrs
KPA10	75	PI	All	All	22	4250	Space	Prune 2 lifts	Fert	800 sph @ 20 yrs
KPA11	75	PI	All	All	22	4250	Space	Fert		800 sph @ 20 yrs
KPA12	75	PI	All	All	22	4250	Space	Fert		1000 sph @ 20 yrs
KPA13	75	PI	All	All	22	4250	Space	Fert		1200 sph @ 20 yrs
KPA14	80	PI	All	All	22	4250	Space	Fert	Ct	1000 sph @ 20 yrs
KPA15	90	PI	All	All	22	4250	Space	Fert	Ct	1600 sph @ 20 yrs
KPA16	80	PI	All	All	22	4250	Space	Ct		1000 sph @ 20 yrs
KPA17	90	PI	All	All	22	4250	Space	Ct		1600 sph @ 20 yrs
KPA18	90	PI	All	All	22	4250	Ct			

Parameters:

- First commercial thinning removed a maximum of 35% of the stand volume at a mean stand dbh of 25 cm. A minimum volume of 100 m³ per hectare was removed.
- Second commercial thinning removed a maximum of 35% of the stand volume at a mean stand dbh of 30 cm. A minimum volume of 100 m³ per hectare was removed. The second commercial thinning occurred a minimum of 20 years after the first one.
- The first lift of pruning occurred at the mean height of 7 meters. The stems were pruned up to 3 meters in height.
- The second lift of pruning occurred at the mean height of 10 meters. The stems were pruned up to 5 meters in height.

For each site index (hemlock stands) there are 4 density classes in TASS:

1. Density class 850 less than 1,500 stems/ha;
 This class was further divided to 4 sub-classes.
2. Density class 2,125 1,500-3,500 stems/ha;
3. Density class 4,250 3,500-5,000 stems/ha;
4. Density class 5,950 greater than 5,000 stems/ha.

These classes represent different levels of yield, i.e., the yield is somewhat dependent on the density. All unmanaged stands and stands without density information were assumed to regenerate to the 4,250 density class. For managed stands, if the density was known, the appropriate density class was used. If the density was not known the analysis used the 4,250 density curve. After regeneration all yields were assumed to follow 4,250 density yield curves. It was felt that this default density best represented general conditions in the Kalum TSA, including natural ingress.

8.3.1 Minimum Harvest Age Criteria

For TASS yield curves, the following criteria were used to determine the minimum harvest age (MHA).

All Analysis Units:

- Stand height 22 meters
- Merchantable log volume 250 m³
- Average dbh 25 cm

Stands must meet all three criteria before they are eligible for harvest, except for cottonwood. The minimum harvest age for cottonwood was 60.

For stands that were commercially thinned the harvest must occur at least 10 years after commercial thinning.

8.3.2 Site Index Adjustments

The TSR 2 base case utilized site indices from the forest inventory file with an upward OGSi adjustment for regenerated hemlock stands of 10 m. The Kalum TSA group felt that the site indices in the forest inventory file as well as the more recent SIBEC site indices might not be accurate. For this reason, it was decided that the site indices for the silviculture analysis should be adjusted.

The Kalum TSA group provided the adjustments for the existing forest inventory site indices. The adjustments for the SIBEC site indices were based on a site index review, within the Kalum TSA. Two hundred and thirty-six openings were chosen from the Integrated Silviculture Information System (ISIS). The selected openings met the following criteria:

- They were selected at random,
- Growth intercept methodology was used to determine the site index,
- Stands were 15 to 40 years old, and
- The site index survey of each opening was done between 1995 and 2000.

The chosen openings were located in three biogeoclimatic subzones: CWH ws, CWH vm, and ICH mc. The site index of each opening (from ISIS) was summed and the weighted average was generated. This weighted average site index was then compared to the SIBEC site index. The difference of these two site indices was used as an adjustment factor. Table 10 illustrates the site index adjustments used in this analysis.

Table 10 – Site index adjustments

Species	SI Adjustment Elevate FC SI by	SI Adjustment Elevate SIBEC by
Hw/S/B/C	8	4
Pine	0	0
Ac	0	0

8.3.3 ISIS Integration

The linkage from ISIS to the forest cover is not a 1 to 1 relationship. Currently, an opening number is used to link the two databases; however, within each opening the forest cover may have many forest cover polygons, and the ISIS would have several treatment units. The number of sub components in the opening may or may not be equal between ISIS and the forest cover information.

Where a 1 to 1 relationship existed, the FIP database was updated with ISIS data based on the leading species within each opening. Where the ISIS database contained 1 or more sub component, the data was checked to see if NP was present in the ISIS database and not in the forest cover. If this was the case, then the FIP data was updated as described above.

8.3.4 TASS – Regeneration Delay

The silviculture strategies analyses used an assumption of a 3-year-regeneration delay.

8.3.5 TASS Modeling of Species

TASS does not model balsam (*Abies* spp). Western hemlock will be used as a surrogate for balsam for this analysis. Furthermore, for modelling purposes, all spruce and cedar stands will continue to be aggregated with balsam and hemlock in the generation of yield curves. There was some concern expressed in the workshop that hemlock does not adequately represent the bole shape, treatment response or value potential of the other species; however, given that the vast majority of stands are hemlock leading or contain a hemlock component, this assumption was considered to have very little overall impact on the volume and product information.

9 PROTECTION

9.1 Unsalvaged Losses

Unsalvaged losses are losses due to natural events that are non-recoverable and result in a decrease in the productivity of the TSA. These losses focus on the epidemic losses, such as losses due to fire, insects and diseases that are not salvaged whereby the endemic losses are accounted for through operational adjustments and net down reductions. The analysis uses the values and rationale from the TSRII report. The losses for fire (2,500 m³/year) and wind (7,000 m³/year) total 9,500 m³/year.

Volumes are removed from the modeled harvest levels to represent net available volume.

10 INTEGRATED RESOURCE MANAGEMENT

The intent of this section is to provide details on how modeling methodology will integrate non-timber resource values with timber objectives.

10.1 Forest Cover Requirements

Table 11 sets out the forest cover objectives for the Kalum TSA, by management zone for maintaining non-timber values. Forest cover objectives are applied to model biodiversity values, hydrological recovery, and visual quality objectives by placing maximum and/or minimum boundaries on specific age distributions mainly focusing on young age forests and old age forests.

By applying Forest Ecosystem Solutions Ltd's analysis approach, **FSOS**, forest cover objectives can be viewed as either targets or constraints. In simulation mode, forest cover constraints can be applied that must coincide with harvesting actions. In the optimization approach, targets will be set which will attempt to develop and schedule harvest units to best achieve age class and timber flow objectives. Some trade-offs between objectives may occur.

Table 11: Management Zones and Forest Cover Objectives – Base Case Scenario

Resource	Zone	THLB Area (ha)	Prod Area (ha)	Cover Requirement			
				Age 1	Max % < age 1	Age 2 (years)	Min % > Age 3
IRM^a	(area includes Kitimat SRMZ IRMs)	85,167	182,855	20	35	-	-
Water Supply	Watershed Zone Deep Creek	569	1,132	23	30	-	-
BEC Variants^a	CWH vm	8,603	28,183	--	--	250	13.9
	MH mm2	5,720	28,274	--	--	250	19.9
	MH mm1	0	1,249	--	--	250	19.9
	CWH ws1	56,480	86,014	--	--	250	9.4
	CWH ws	19,203	43,599	--	--	250	9.4
	ICH mc1	849	1,447	--	--	250	9.4
	ICH mc2	4,146	7,771	--	--	250	9.4
	ESSF mk (no targets)	0	1,891	--	--	250	--
Thunderbird Resource Zone		7,398	9,492	--	--	140	12
Kitimat SRMZ	Kitimat Valley LUs	27,336	37,840	15	15	80	20
Visual Quality	Partial Retention Modification	1,671	2,650	16	15	--	--
		2,010	3,926	16	25	--	--

^a Applied by individual landscape unit

10.2 Spatial Forest Objectives

Simulation analysis will not use cutblocks but schedule individual polygons in order to more closely reflect the TSRII aspatial analysis. Adjacency constraints will be applied as a cover constraint only.

11 TIMBER OBJECTIVES

11.1 Timber Values

Timber values used within the analysis are based on a series of piece size groupings - similar to industrial grading - for each species. The analysis is based on average log diameter, taper, knot size and rings per inch. Logs will be bucked to provide optimal lengths for value.

The product selling prices for the analysis were derived using MoF second growth coastal log survey data with all incidental volumes removed from the database. The data is based on indexed monthly averages for the seven years ending December 15, 1999. The indexing is by the British Columbia consumer price index. The second growth selling prices are summarized in Table 12. Figure 1 depicts per cubic meter pricing for different grades by incremental top diameter.

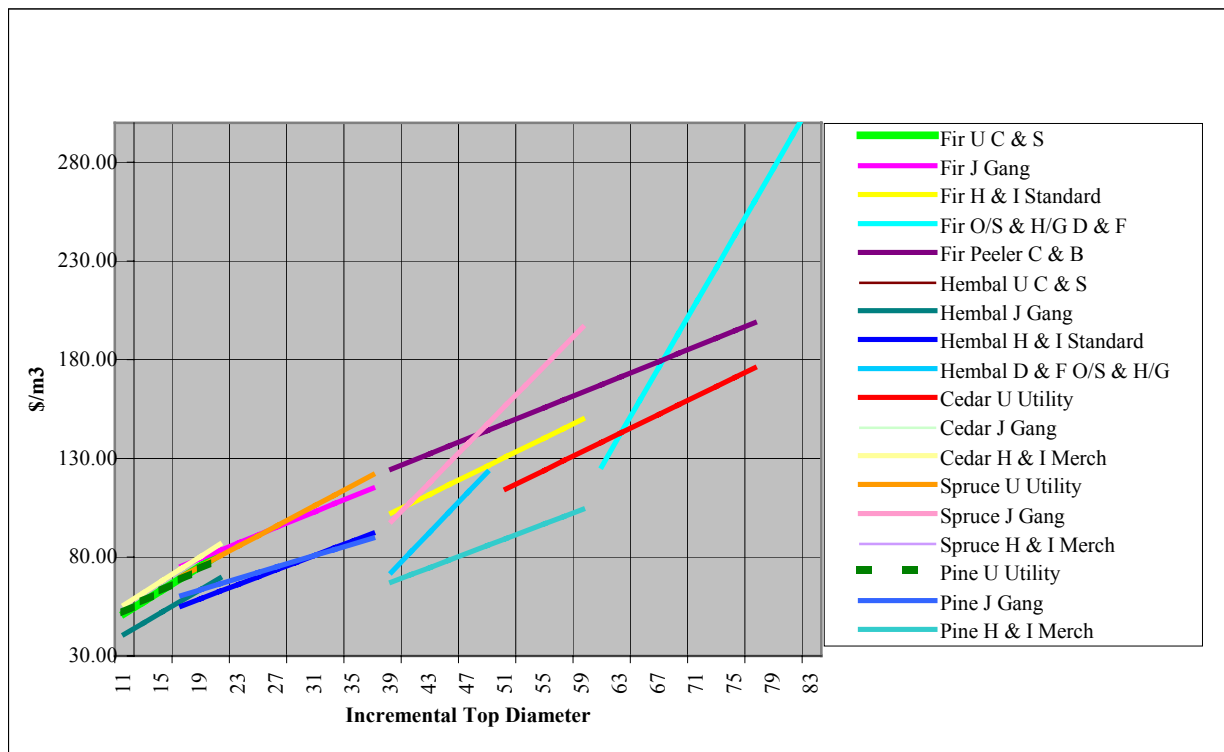


Figure 1: Second Growth Timber Value by Species Grade; Sort at Howe Sound

All timber values are based on domestic pricing, regardless of whether export opportunities for the wood exist.

11.2 Harvesting Costs

Two harvest systems are being proposed for the Kalum TSA, a ground based and cable based system.

Harvesting costs will be determined by the utilizing the Coast Appraisal Manual costing allowances. Harvesting Cost Estimation is used in conjunction with the log values to provide ranking criteria for various treatment regimes. The costs need to be reasonable, but as they are not being used in any legal context, do not need to be exact. To determine harvesting operating costs we are looking for a methodology with the following criteria:

- Must represent marginal increases in piece size gained through treatment
- Should be based on a single harvesting system for each polygon, with basic separating criteria
- Should be defensible as to data source and methodology

The Stumpage Appraisal system was chosen to provide costing, as it is based on operator survey data, is defensible to the MoF and stakeholders. The harvesting cost systems will not be accurate for every cutblock, because of the operational ability to blend harvesting systems, rather is a method to allow different regimes to be ranked against each other.

For the purpose of this analysis, log values were determined at Gambier Island, Howe Sound. To properly calibrate costs, towing costs from Kitimat to Howe Sound were included as well as hauling to Kitimat. It is understood that this doesn't match reality, but it allows true values to be matched with applicable costs.

11.2.1 Tree to Truck

The Tree to Truck section of the Interior Appraisal Manual was chosen to develop the tree to truck costs. A GIS analysis was done on the dataset and divided the area at the 40% slope grade. Below 40% slope will use the ground-based tree to truck costing method, while those polygons greater than 40% will use the cable based harvest system.

Data from three FERIC studies:

- Partial Cutting in Mountainous Old-Growth Forests in Coastal British Columbia: Harvesting Productivity and Cost, and Residual Stand Impacts; Bennett, December 1997;
- Harvesting Sensitive Sites with a Long Distance Cableway System: Productivity and Costs; Bennett, January 1996;
- Shelterwood Harvesting in Coastal Second Growth Douglas-Fir; Hedin, October 1994;

were reviewed, but did not provide a superior methodology to provide a tree to truck cost. The information from the report was used to validate and modify the Interior Appraisal Manual Methodology.

For Tree to Truck harvest cost estimation the following equations are used:

Ground Based Harvesting Systems

$$\text{Cost} = \text{CONSTANT} + (3.34 * \text{SS\%/100}) + (4.24 * \text{SLOPE\%/100}) - (5.41 * \text{VOLHA/1000}) + (.7 * \text{VOLHA/VOLTREE/1000}) + (.43 * \text{GVOL}) + (3.61 * \text{BD\%/100}) + (2.85 * \text{DPCUT2}) - (2.76 * \text{PCCUT2/100}) + (.67 * \text{SUPP2/100}) + (1.26 * \text{SUPP3/100})$$

Table 13: Tree to truck cost calculation parameters for ground based harvesting systems.

Variable	Definition	Assumption or Application
CONSTANT		Set at 17.10
SS%	Sensitive Site	Assumed to be 0
SLOPE	Ground Slope	Set at 20%
VOLHA	Net Volume per ha	Defined as the merch vol/ha on the TASS curves
VOLTREE	Net Volume per tree	Defined as the Merch vol/ha divided by stems/ha in TASS
GVOL	Gross Volume per tree	Defined as Total Vol/ha divided by stems/ha in TASS
BD	Blow Down	Assumed to be 0
DPCUT2	Partial Cut	If commercial thinning = 1, else = 0
PCCUT2	Volume removed	As defined in the commercial thinning schedule
SUPP2	Distance to support	Ignored for this calculation
SUPP3	Distance to support	Ignored for this calculation

The distance to support centre has been ignored, because the tree to truck costs have been attached to the yield curves and can occur throughout the TSA. A distance to support centre cost will be attached to the hauling costs, which are spatially based.

Cable Based Harvesting Systems

$$\text{Cost} = \text{CONSTANT} + (4.58 * \text{SLOPE\%/100}) - (2.01 * \text{VOLHA/VOLTREE/1000}) - (2.12 * \text{GVOL}) + (.2 * \text{GVOLSQR}) + (2.08 * \text{CDPCUT}) + (.7 * \text{SUPP2/100})$$

Table 14: Tree to truck cost calculation parameters for cable harvesting systems.

Variable	Definition	Assumption or Application
CONSTANT		Assumed to be 29.04
SLOPE	Ground Slope	Assumed to be 40%
VOLHA	Net Volume per ha	Defined as the merch vol/ha on the TASS curves
VOLTREE	Net Volume per tree	Defined as the Merch vol/ha divided by stems/ha in TASS
GVOL	Gross Volume per tree	Defined as Total Vol/ha divided by stems/ha in TASS
GVOLSQR	Gross Vol/tree squared	
CDPCUT	Partial Cut	Partial Cut =1 else =0
SUPP2	Distance to support	Ignored for this calculation

The distance to support centre has been ignored, because the tree to truck costs have been attached to the yield curves and can occur throughout the TSA. A distance to support centre cost will be attached to the hauling costs, which are spatially based.

It is assumed that no incremental silviculture treatments will occur on helicopter blocks, therefore, helicopter harvesting costs are not required.

11.2.2 Hauling

The Coast Appraisal Manual will be used to determine hauling cost. In the Interior Appraisal Manual, haul distance is based on cycle time, which cannot be calculated within this analysis. The Coast Appraisal Manual uses haul distance in its calculation as measured from the centre of the cut block(s). For this analysis, we will determine an average haul cost for each landscape unit, a spatial overlay for every polygon. In addition, harvest premiums can be included for individual landscape units to represent local conditions.

The hauling cost will be calculated as $3.092 + 0.1100$ (One way distance; Coast Appraisal Manual).

11.2.3 Towing

All log prices were assumed to be set at Centre Bay, Gambier Island. The towing price from Kitimat to Gambier Island is \$9.40 (Coast Appraisal Manual).

11.2.4 Dump, Boom, Sort and Scale

A standard cost of \$8.10 is applied. (Coast Appraisal Manual).

11.2.5 Road Construction

Because this analysis is only viewing the values achieved from second growth timber, it is assumed that all wood has been roaded. A standard cost of \$5.00 is applied to account for road reconstruction. A standard road maintenance cost of \$1.74 is applied (Interior Appraisal Manual).

11.2.6 Administration

A standard cost of \$5.99 is applied (Interior Appraisal Manual).

11.2.7 Basic Silviculture

A standard cost of \$2.10 (Coast Appraisal Manual)

Table 15: Kalum TSA – Landscape Unit Attributable Harvest Costs per m³

Landscape Unit	Distance (km)	Measured to	Hauling Cost	Tow	DBSS	Rd Const	Rd Mtce	Admin	Basic Silv	LU Premium	LU Cost
Beaver	152	Kitimat	19.812	9.4	10.31	5	1.74	5.99	2.1	8	62.352
Clore	108	Kitimat	14.972	9.4	10.31	5	1.74	5.99	2.1	8	57.512
Exchamsiks	132	Kitimat	17.612	9.4	10.31	5	1.74	5.99	2.1	8	60.152
Exstew	112	Kitimat	15.412	9.4	10.31	5	1.74	5.99	2.1	8	57.952
Greenwille	200	Kitimat	25.092	9.4	10.31	5	1.74	5.99	2.1	12	71.632
Hirsch	14	Kitimat	4.632	9.4	10.31	5	1.74	5.99	2.1	4	43.172
Hot Springs	48	Kitimat	8.372	9.4	10.31	5	1.74	5.99	2.1	4	46.912
Jesse-Bish	16	Kitimat	4.852	9.4	10.31	5	1.74	5.99	2.1	4	43.392
Kalum	88	Kitimat	12.772	9.4	10.31	5	1.74	5.99	2.1	4	51.312
Kasiks	136	Kitimat	18.052	9.4	10.31	5	1.74	5.99	2.1	8	60.592
Kiteen	148	Kitimat	19.372	9.4	10.31	5	1.74	5.99	2.1	8	61.912
Kitimat	32	Kitimat	6.612	9.4	10.31	5	1.74	5.99	2.1	4	45.152
Kleanza-Treasure	112	Kitimat	15.412	9.4	10.31	5	1.74	5.99	2.1	8	57.952
Ksedin	172	Kitimat	22.012	9.4	10.31	5	1.74	5.99	2.1	12	68.552
Lakelse River	68	Kitimat	10.572	9.4	10.31	5	1.74	5.99	2.1	4	49.112
Nass River Kalum	204	Kitimat	25.532	9.4	10.31	5	1.74	5.99	2.1	12	72.072
Nelson Fiddler	132	Kitimat	17.612	9.4	10.31	5	1.74	5.99	2.1	8	60.152
Skeena River Kalum	88	Kitimat	12.772	9.4	10.31	5	1.74	5.99	2.1	4	51.312
Tseax	90	Kitimat	12.992	9.4	10.31	5	1.74	5.99	2.1	12	59.532
Wedeeene	14	Kitimat	4.632	9.4	10.31	5	1.74	5.99	2.1	4	43.172
Williams	68	Kitimat	10.572	9.4	10.31	5	1.74	5.99	2.1	8	53.112

Table 15 depicts the harvesting costs by landscape unit for the Kalum TSA.

11.3 Treatment Costs

Treatment costs for the analysis are based on MoF and industry information obtained at the pre-analysis workshop. Table 16 shows the treatment costs used in the analysis.

Table 16: Treatment Costs

Treatment	Cost	Person Days
Spacing (per ha)	\$1400	5.55
Pruning 1 st lift (per ha)	\$1600	5.55
Pruning 2 nd lift (per ha)	\$2000	7.14
Fertilization – Fd/B (per ha)	\$300	0.1
1 st Commercial Thin (per ha)	Variable	5.0
2 nd Commercial Thin (per ha)	Variable	5.0

11.4 Commercial Thinning

It is anticipated that commercial thinning will provide a significant supply of logs for the Kalum TSA in the near future.

For ground based blocks, and this does not preclude using a cable-based system, it is assumed that minimal stand requirements are 250 m³/ha, with an average stem dbh of 25 cm.

For cable-based blocks, minimum stand requirements are 300 m³/ha, with an average stem dbh of 25 cm.

11.5 Fertilization

Fertilization in scenarios 7-10 is applied at age 80. This is intended to represent fertilization approximately 10-15 years prior to harvesting, though the actual application in the model may differ slightly from the intent if harvest is delayed beyond 100 years.

11.6 Stand Density Determination

Stand density information was used where available. For stands without density information, a probability analysis was used to determine that the most likely regeneration class would be between 3500-5000 sph. This is consistent with density information in TSR II for regenerating stands. An analysis using correlation between site and stand characteristics (age, crown closure, species, and height or biogeoclimatic zone) was attempted but proved inconclusive for determining stand density in the Kalum TSA.

11.7 Value Analysis

In the analysis, all costs and revenues were aggregated at the forest level for each period. The difference was brought back to today's dollars using a 4% discount rate. The model

was then used to find a solution that would maximize the forest level difference between costs and revenues over the planning horizon.

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