TFL 6
Tree Farm License

Incremental Silviculture Strategy Type 2
Appendix 1

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1.0 Introduction

This appendix documents the procedures, assumptions, data and model used in the TFL Type 2 Incremental Silviculture Strategy for TFL 6 (March, 2002).

2.0 Definition of the CMO for the TSA for MP 9

The current management option assumes the following (reproduced from MP 9):

1) Implementation of the Forest Practices Code and the Vancouver Island Land Use Plan including:
    - removal of new parks
    - 40 ha maximum opening size
    - application of VQO's to known scenic areas
    - riparian management areas
    - wildlife tree patch retention
    - old seral stage target based on expected 10% high and 45% intermediate and low designations is used to defer old forest in each landscape unit
    - retaining old (not grandparented) Deer Winter Ranges as modeling surrogates for OGMA's and WHA's
2) Minimum harvest size for good, medium and poor sites set to 42 cm, 37 cm and 35 cm quadratic mean stand diameter at breast height respectively
3) Harvesting to inventory and operability profile.
4) Gradual conversion of older alder leading stands to conifer leading stands through normal forest succession with no utilization of the alder component
5) Planting of most harvested sites.
6) Broadcast fertilization of cedar-salal sites to achieve crown closure and improve long-term productivity
7) Spacing of 300 ha per year of primarily hemlock-leading stands is assumed subject to the availability of suitable stands
8) Tree improvement gains were modeled to be up to 5% for stock planted currently and rising to 15% for western hemlock, Douglas fir and yellow cedar after the next decade.
9) Yield table priority then minimize growth loss
10) Compartment balancing

3.0 Stand Level Analysis

3.1 DR Establishment Management Strategies

Site characteristics:

Site Series vm1(MOF):	Lewis Units:	SI
09, 10 High, med. bench	S3 (alluv floodplain)	37
05, 07	(S1HA)	31 to 35
01 (3-4[moist]/C[nutr.])	S1HA, (S12HA)	26 to 29

And slopes<50%, soils>50cm deep, forest floor <15cm

Management Regimes:

Regime Names*	**Intensive**	**Intermediate**	**Low**
Treatments	For best sites (quality, access)		For moderate sites (quality) and less accessible
Site prep	Logging disturbance and (Chemical)?	Logging disturbance and (Chemical)?	Logging disturbance
Planting Density	1600	1600	1100
Brushing-times	0-1	0-1	0-1
PCT	To 800-900 @ 10-11yrs	To 600-800 @ 10-11yrs	None
CT	To 250-300 @ 15-20yrs	None	None
Harvest Time	@35 to 40yrs	@35 to 40yrs	@40 to 60yrs
Harvest Outturn	80% HG, 10% SL	60% HG, 20% SL	50% HG, 30% SL

*Based on Weyerhaeuser's strategies in Washington State

3.2 WFP Timber Supply Analysis Stand-Level Inputs

For this information, refer to the *Timber Supply Analysis Information Package in Preparation of Management Plan 9 for Tree Farm License 6* produced by WFP.

3.3 TASS and Tipsy Stand-level Inputs for the Type 2 Project

3.3.1 Alder Inputs

Run	Total # Planted	Sp Planted	Sp Site Index	PCT Density	PCT Age	Com Thin Density	Com Thin Age
1	1600	Dr	37				
2	1600	Dr	37	850	10		
3	1600	Dr	37	850	10	275	15
4	1600	Dr	33				
5	1600	Dr	33	850	10		
6	1600	Dr	33	850	10	275	15
7	1600	Dr	28				
8	1600	Dr	28	850	10		
9	1600	Dr	28	850	10	275	15
10	1600	Dr	37	700	10		
11	1600	Dr	33	700	10		
12	1600	Dr	28	700	10		
13	1100	Dr	37				
14	1100	Dr	33				
15	1100	Dr	28				

3.3.2 Conifer Inputs

Summary of Tass/Tipsy* Inputs for Existing and Future Coniferous Stands - Type 2 Analysis

Run	Sp1 Planted %	Sp1 Site Index **	Sp2 Planted %	Sp2 Site Index	Total # Planted	Planted Genetic Worth	Sp Natural	Total Natural Infill	PCT	PCT Density	Fert
1					0		Hw	2000			
2					0		Hw	2000	yes	600	
3					0		Hw	2000	yes	850	
4					0		Hw	2000	yes	1000	
5					0		Hw	4000			
6					0		Hw	4000	yes	600	
7					0		Hw	4000	yes	850	
8					0		Hw	4000	yes	1000	
9					0		Hw	6000			
10					0		Hw	6000	yes	600	
11					0		Hw	6000	yes	850	
12					0		Hw	6000	yes	1000	
13					0		Hw	8000			
14					0		Hw	8000	yes	600	
15					0		Hw	8000	yes	850	
16					0		Hw	8000	yes	1000	
17					0		Hw	10000			
18					0		Hw	10000	yes	600	
19					0		Hw	10000	yes	850	
20					0		Hw	10000	yes	1000	
21	Hw 100	28			1100	low	Hw	2000			
22	Hw 100	28			1100	low	Hw	2000	yes	600	
23	Hw 100	28			1100	low	Hw	2000	yes	850	
24	Hw 100	28			1100	low	Hw	2000	yes	1000	
25	Hw 100	28			1100	low	Hw	4000			
26	Hw 100	28			1100	low	Hw	4000	yes	600	
27	Hw 100	28			1100	low	Hw	4000	yes	850	
28	Hw 100	28			1100	low	Hw	4000	yes	1000	
29	Hw 100	28			1100	low	Hw	6000			
30	Hw 100	28			1100	low	Hw	6000	yes	600	
31	Hw 100	28			1100	low	Hw	6000	yes	850	
32	Hw 100	28			1100	low	Hw	6000	yes	1000	
33	Hw 100	28			1100	low	Hw	8000			
34	Hw 100	28			1100	low	Hw	8000	yes	600	
35	Hw 100	28			1100	low	Hw	8000	yes	850	
36	Hw 100	28			1100	low	Hw	8000	yes	1000	
37	Hw 100	28			1100	low	Hw	10000			
38	Hw 100	28			1100	low	Hw	10000	yes	600	
39	Hw 100	28			1100	low	Hw	10000	yes	850	

Summary of Tass/Tipsy* Inputs for Existing and Future Coniferous Stands - Type 2 Analysis											
Run	**Sp1 Planted %**	**Sp1 Site Index ****	**Sp2 Planted %**	**Sp2 Site Index**	**Total # Planted**	**Planted Genetic Worth**	**Sp Natural**	**Total Natural Infill**	**PCT**	**PCT Density**	**Fert**
40	Hw 100	28			1100	low	Hw	10000	yes	1000	
41	Hw 100	28			1100	high	Hw	2000			
42	Hw 100	28			1100	high	Hw	2000	yes	600	
43	Hw 100	28			1100	high	Hw	2000	yes	850	
44	Hw 100	28			1100	high	Hw	2000	yes	1000	
45	Hw 100	28			1100	high	Hw	4000			
46	Hw 100	28			1100	high	Hw	4000	yes	600	
47	Hw 100	28			1100	high	Hw	4000	yes	850	
48	Hw 100	28			1100	high	Hw	4000	yes	1000	
49	Hw 100	28			1100	high	Hw	6000			
50	Hw 100	28			1100	high	Hw	6000	yes	600	
51	Hw 100	28			1100	high	Hw	6000	yes	850	
52	Hw 100	28			1100	high	Hw	6000	yes	1000	
53	Hw 100	28			1100	high	Hw	8000			
54	Hw 100	28			1100	high	Hw	8000	yes	600	
55	Hw 100	28			1100	high	Hw	8000	yes	850	
56	Hw 100	28			1100	high	Hw	8000	yes	1000	
57	Hw 100	28			1100	high	Hw	10000			
58	Hw 100	28			1100	high	Hw	10000	yes	600	
59	Hw 100	28			1100	high	Hw	10000	yes	850	
60	Hw 100	28			1100	high	Hw	10000	yes	1000	
61	Hw 50	28	Ss 50	31	1100	low	Hw	2000			
62	Hw 50	28	Ss 50	31	1100	low	Hw	2000	yes	600	
63	Hw 50	28	Ss 50	31	1100	low	Hw	2000	yes	850	
64	Hw 50	28	Ss 50	31	1100	low	Hw	2000	yes	1000	
65	Hw 50	28	Ss 50	31	1100	low	Hw	4000			
66	Hw 50	28	Ss 50	31	1100	low	Hw	4000	yes	600	
67	Hw 50	28	Ss 50	31	1100	low	Hw	4000	yes	850	
68	Hw 50	28	Ss 50	31	1100	low	Hw	4000	yes	1000	
69	Hw 50	28	Ss 50	31	1100	low	Hw	6000			
70	Hw 50	28	Ss 50	31	1100	low	Hw	6000	yes	600	
71	Hw 50	28	Ss 50	31	1100	low	Hw	6000	yes	850	
72	Hw 50	28	Ss 50	31	1100	low	Hw	6000	yes	1000	
73	Hw 50	28	Ss 50	31	1100	low	Hw	8000			
74	Hw 50	28	Ss 50	31	1100	low	Hw	8000	yes	600	
75	Hw 50	28	Ss 50	31	1100	low	Hw	8000	yes	850	
76	Hw 50	28	Ss 50	31	1100	low	Hw	8000	yes	1000	
77	Hw 50	28	Ss 50	31	1100	low	Hw	10000			
78	Hw 50	28	Ss 50	31	1100	low	Hw	10000	yes	600	
79	Hw 50	28	Ss 50	31	1100	low	Hw	10000	yes	850	
80	Hw 50	28	Ss 50	31	1100	low	Hw	10000	yes	1000	

Summary of Tass/Tipsy* Inputs for Existing and Future Coniferous Stands - Type 2 Analysis

Run	Sp1 Planted %	Sp1 Site Index **	Sp2 Planted %	Sp2 Site Index	Total # Planted	Planted Genetic Worth	Sp Natural	Total Natural Infill	PCT	PCT Density	Fert
81	Hw 50	28	Cw 50	24	1100	low	Hw	2000			
82	Hw 50	28	Cw 50	24	1100	low	Hw	2000	yes	600	
83	Hw 50	28	Cw 50	24	1100	low	Hw	2000	yes	850	
84	Hw 50	28	Cw 50	24	1100	low	Hw	2000	yes	1000	
85	Hw 50	28	Cw 50	24	1100	low	Hw	4000			
86	Hw 50	28	Cw 50	24	1100	low	Hw	4000	yes	600	
87	Hw 50	28	Cw 50	24	1100	low	Hw	4000	yes	850	
88	Hw 50	28	Cw 50	24	1100	low	Hw	4000	yes	1000	
89	Hw 50	28	Cw 50	24	1100	low	Hw	6000			
90	Hw 50	28	Cw 50	24	1100	low	Hw	6000	yes	600	
91	Hw 50	28	Cw 50	24	1100	low	Hw	6000	yes	850	
92	Hw 50	28	Cw 50	24	1100	low	Hw	6000	yes	1000	
93	Hw 50	28	Cw 50	24	1100	low	Hw	8000			
94	Hw 50	28	Cw 50	24	1100	low	Hw	8000	yes	600	
95	Hw 50	28	Cw 50	24	1100	low	Hw	8000	yes	850	
96	Hw 50	28	Cw 50	24	1100	low	Hw	8000	yes	1000	
97	Hw 50	28	Cw 50	24	1100	low	Hw	10000			
98	Hw 50	28	Cw 50	24	1100	low	Hw	10000	yes	600	
99	Hw 50	28	Cw 50	24	1100	low	Hw	10000	yes	850	
100	Hw 50	28	Cw 50	24	1100	low	Hw	10000	yes	1000	
101	Cw 100	24			1100	low	Hw	2000			
102	Cw 100	24			1100	low	Hw	2000	yes	600	
103	Cw 100	24			1100	low	Hw	2000	yes	850	
104	Cw 100	24			1100	low	Hw	2000	yes	1000	
105	Cw 100	24			1100	low	Hw	4000			
106	Cw 100	24			1100	low	Hw	4000	yes	600	
107	Cw 100	24			1100	low	Hw	4000	yes	850	
108	Cw 100	24			1100	low	Hw	4000	yes	1000	
109	Cw 100	24			1100	low	Hw	6000			
110	Cw 100	24			1100	low	Hw	6000	yes	600	
111	Cw 100	24			1100	low	Hw	6000	yes	850	
112	Cw 100	24			1100	low	Hw	6000	yes	1000	
113	Cw 100	24			1100	low	Hw	8000			
114	Cw 100	24			1100	low	Hw	8000	yes	600	
115	Cw 100	24			1100	low	Hw	8000	yes	850	
116	Cw 100	24			1100	low	Hw	8000	yes	1000	
117	Cw 100	24			1100	low	Hw	10000			
118	Cw 100	24			1100	low	Hw	10000	yes	600	
119	Cw 100	24			1100	low	Hw	10000	yes	850	
120	Cw 100	24			1100	low	Hw	10000	yes	1000	
121	Fd 100	31			1100	low	Hw	2000			

Summary of Tass/Tipsy* Inputs for Existing and Future Coniferous Stands - Type 2 Analysis

Run	Sp1 Planted %	Sp1 Site Index **	Sp2 Planted %	Sp2 Site Index	Total # Planted	Planted Genetic Worth	Sp Natural	Total Natural Infill	PCT	PCT Density	Fert
122	Fd 100	31			1100	low	Hw	2000	yes	600	
123	Fd 100	31			1100	low	Hw	2000	yes	850	
124	Fd 100	31			1100	low	Hw	2000	yes	1000	
125	Fd 100	31			1100	low	Hw	4000			
126	Fd 100	31			1100	low	Hw	4000	yes	600	
127	Fd 100	31			1100	low	Hw	4000	yes	850	
128	Fd 100	31			1100	low	Hw	4000	yes	1000	
129	Fd 100	31			1100	low	Hw	6000			
130	Fd 100	31			1100	low	Hw	6000	yes	600	
131	Fd 100	31			1100	low	Hw	6000	yes	850	
132	Fd 100	31			1100	low	Hw	6000	yes	1000	
133	Fd 100	31			1100	low	Hw	8000			
134	Fd 100	31			1100	low	Hw	8000	yes	600	
135	Fd 100	31			1100	low	Hw	8000	yes	850	
136	Fd 100	31			1100	low	Hw	8000	yes	1000	
137	Fd 100	31			1100	low	Hw	10000			
138	Fd 100	31			1100	low	Hw	10000	yes	600	
139	Fd 100	31			1100	low	Hw	10000	yes	850	
140	Fd 100	31			1100	low	Hw	10000	yes	1000	
141	Cw 100	19			1400	low					
142	Cw 100	24			1400	low					yes
143	Cw 100	19			1600	low					
144	Cw 100	24			1600	low					yes
145	Cw 100	19			1600	low			yes	1000	
146	Cw 100	24			1600	low					yes
147	Cw 100	19			1800	low					
148	Cw 100	24			1800	low					yes
149	Cw 100	19			1800	low			yes	1000	
150	Cw 100	24			1800	low					yes

* Runs 141-150 are done with TIPSY

** All Ecosystem Class, S1HA

	Notes and Assumptions
1	For all planted trees use square spacing.
2	Assume planting occurs in year 1, with 1 year old stock. Year 0 is time of harvest.
3	Assume all natural fill-in is randomly distributed.
4	Assume all PCT is done at the default height (6m) and is from below.
5	Assume OAF 1 is 10% and OAF is 5%.
6	One age distribution is used for the naturals. The default used in Tipsy (truncated Normal (mean=2, SD= 1.5)).

3.4 TASS and Tipsy Stand-level Outputs for the Type 2 Project

3.4.1 Alder Outputs

TASS outputs for Alder are withheld as the model is still in an experimental stage.

3.4.2 Conifer Outputs

TASS and Tipsy outputs for Conifer stands are provided electronically in the file named 'Electronic Appendices Submission/TASS run outputs for conifer species.zip'.

4.0 Log Grades and Values

4.1 Applicable Coniferous Second Growth Log Grades for all Species

(Source; BC MOF Scaling Manual)

Species	**Fd**	**All others**
Grade*	Key Grade Requirements	Key Grade Requirements
F (clear) G (clear) for Ss	>60cm top diam. >5m length quality restrictions including >=6 annual rings/2cm of diam.**; contains >25% clear cuttings	>50cm top diam.*** >5m length*** quality restrictions including >=6 annual rings/2cm of diam.**; contains >25% clear cuttings
C (peeler)	>38cm top diam. >5.2m length quality restrictions including >=6 annual rings/2cm of diam.	N/A
H (merch)	>38cm top diam. >5m length quality restrictions including >=5 annual rings/2cm of diam.	>38cm top diam. >5m length quality restrictions including >=5 annual rings/2cm of diam. (except for Cw, Yc)
I (merch)	>38cm top diam. >3.8m length	>38cm top diam. >3.8m length
J (merch)	16 to 38cm top diam. >5m length	16 to 38cm top diam. >5m length
U (merch)	10 to 16cm top diam. >5m length	10 to 16cm top diam. >5m length
X and Y (pulp)	Grade lower than U and higher than firmwood reject	Grade lower than U and higher than firmwood reject

*all merch. sawlog grades assume logs are sound and straight enough to make a high proportion of merchantable lumber.

**larger clear sawlog grades have at least this rate of growth restriction (some Ss clear grades require >=12 annual rings/2cm of diam).

***Ss grades are slightly different

4.1.2 Average Coastal Domestic Log Prices (1999-2000) for Selected Species

Species		HB	Cw	Yc	Fd	Ss	Dr
Grade							
F (G for Ss)*	**AVG AMV[1]**	**$ 120.00**	**$ 280.00**	**$ 440.00**	**$ 270.00**	**$ 260.00**	
H	**AVG AMV**	**$ 88.53**	**$ 189.20**	**$ 248.24**	**$ 156.88**	**$ 131.30**	
	STD[2] AMV	$ 8.53	$ 14.58	$ 47.99	$ 17.44	$ 29.33	
I	**AVG AMV**	**$ 69.62**	**$ 133.27**	**$ 155.86**	**$ 112.22**	**$ 84.10**	
	STD AMV	$ 7.46	$ 13.99	$ 34.67	$ 13.46	$ 16.91	
J	**AVG AMV**	**$ 59.69**	**$ 121.41**	**$ 103.97**	**$ 87.21**	**$ 70.04**	
	STD AMV	$ 2.27	$ 15.37	$ 21.31	$ 5.49	$ 8.17	
U	**AVG AMV**	**$ 45.41**	**$ 62.69**	**$ 64.60**	**$ 46.16**	**$ 48.03**	
	STD AMV	$ 2.08	$ 11.45	$ 17.09	$ 7.04	$ 7.90	
X	**AVG AMV**	**$ 43.94**	**$ 37.50**	**$ 29.88**	**$ 29.31**	**$ 43.72**	**$ 58.43**
	STD AMV	$ 2.43	$ 8.23	$ 10.04	$ 7.90	$ 5.01	$ 5.77
Y	**AVG AMV**	**$ 47.28**	**$ 16.20**	**$ 21.09**	**$ 26.26**	**$ 43.14**	**$ 46.60**
	STD AMV	$ 27.29	$ 5.25	$ 9.05	$ 7.74	$ 3.76	$ 13.11

*Clear prices are estimates.

4.1.3 Coniferous Log Values Used in the TFL 6 Type 2 Stand Level Analysis

The following tables present 'Base', 'Steep' and 'Flat' log prices for each of the species used in the analysis. 'Base' prices approximately represent the average current prices. 'Steep' prices assume future higher premiums for larger logs (H, I grades). 'Flat' prices assume less than current premiums for larger logs. For analysis H and I grades were combined as TIPSY and TASS have difficulty in accurately differentiating between these grades. For simplicity X and Y grades were combined and called pulp.

Hemlock

Sort	Set 1 ($/m3) "Base"	Set 2 ($/m3) "Steep"	Set 3 ($/m3) "Flat"
H + I	79	115	65
J	60	60	60
U	45	42	45
Pulp	35	32	35

Cedar

Sort	Set 1 ($/m3) "Base"	Set 2 ($/m3) "Steep"	Set 3 ($/m3) "Flat"
H + I	150	218	120
J	110	110	110
U	64	60	64
Pulp	30	28	30

[1] AVG= Average; AMV= Average Market Value
[2] STD= Standard Deviation

Douglas-fir

Sort	Set 1 ($/m3) "Base"	Set 2 ($/m3) "Steep"	Set 3 ($/m3) "Flat"
H + I	130	190	110
J	70	70	70
U	48	45	48
Pulp	25	23	25

Spruce

Sort	Set 1 ($/m3) "Base"	Set 2 ($/m3) "Steep"	Set 3 ($/m3) "Flat"
H + I	95	140	75
J	70	70	70
U	55	53	55
Pulp	35	32	35

4.2 Applicable Alder Log Grades and Prices

(Source; Modified from Weyerhaeuser Ltd; ex: Coast Mountain Hardwoods)

Grade	**High Grade S/L**		**Mid Grade S/L**		**Pulp**
Specs	Big	Small	Big	Small	Any merch wood remaining
Grd Code	HGBig	HGSm	SLBig	SLSm	P
Top Diam (cm)	>30	20-30	>30	20-30	
Length(m)	5	5	5	5	
Price ($/m3)	85-90	65-75	60	45-55	20-25

4.2.1 Alder Log Values Used in the TFL 6 Type 2 Stand Level Analysis

Sort	Set 1 ($/m3) "Base"	Set 2 ($/m3) "Steep"	Set 3 ($/m3) "Flat"
Sawlog A	68	74	90
Sawlog B	56	60	60
Pulp	25	25	25

5.0 Silviculture Treatment Costs and Employment Assumptions

Silviculture Treatment	Cost ($) Low		Cost ($) Base		Cost ($) High		Employment (days/ha)
	$/ha	$/unit	$/ha	$/unit	$/ha	$/unit	
Site Preparation	500	-	750	-	1000	-	1 to 2.3
Planting (seedlings and planting)		0.77		0.80		1.20	0.8 to 1
Fill Planting (including seedlings)	500	-	750	-	1000	-	1 to 2
Brushing	500	-	750	-	1000	-	1 to 2.3
SCHIRP Fertilization (2 applications)	750	-	900	-	1100	-	0.4
Juvenile Spacing							4 to 7
To 600 sph	1700	-	1900	-	2200	-	
To 850 sph	1500	-	1700	-	2000	-	
To 1000 sph	1300	-	1500	-	1800	-	
Pruning 2 lifts:							6 to 10
First lift	-	2/tree	-	2.3/tre	-	2.6/tre	
Second lift	-	3/tree	-	4/tree	-	5.4/tre	
Commercial thinning		25/m3		30/m3		35/m3	8 to 12

6.0 Harvesting and Milling Employment Assumptions

Harvesting and milling employment is assumed to be about 1.4 jobs per 1000m3/year harvested (Coast Forest and Lumber Association, 2000).

7.0 Stand Level Financial Analysis

7.1 Determination of Net Present Values

The net present value of a treatment scenario is simply the sum of its discounted revenues minus the sum of its discounted costs. By calculating NPVs, treatment scenarios, which have costs and revenues at different points in time, can be compared.
Assumptions used in determining NPVs in this study include:

- The forest management objective was maximization of timber value.
- All revenues and costs were measured in constant 2002 dollars
- The time of stand establishment was used as the base year (year 0) in all net present value calculations
- Merchantable volume was defined as a 12.5 cm dbh limit, 10 cm top and 30 cm stump.
- Road development costs were assigned to a stand only once per rotation. This was done at the time of commercial thinning for thinned stands and at final harvest for unthinned stands.
- Planting costs were assumed to occur in year 0 and be carried until final harvest.
- The timing of juvenile spacing was fixed at 12 years.
- The timing of pruning to 1st lift was fixed at 15 years while the timing of pruning to 2nd lift was fixed at 21 years.
- All stands were assumed to be clearcut at final harvest.

7.1.1 NPV of a single rotation

If the objective is to maximize the returns from a single rotation with no regard for the future use of the land after final harvest then NPV can be calculated as follows:

[1] $$NPV_1 = \sum_{y=0}^{H} \frac{R_y}{(1+r)^y} - \sum_{y=0}^{H} \frac{C_y}{(1+r)^y} = \sum_{y=0}^{H} \frac{(R_y - C_y)}{(1+r)^y}$$

where R_y = revenue received in year y
C_y = cost incurred in year y
r = discount rate
H = final harvest age

and the present is time 0.
Revenues include:

- revenue from the sale of logs from commercial thinning
- revenue from the sale of logs from final harvest

Costs include:

- basic silviculture costs (site prep, planting, fill planting, brushing)
- juvenile spacing costs
- pruning costs
- road building costs
- harvesting costs

What this NPV calculation does not include is a term that accounts for the benefits derived from future rotations, and, at the same time, the cost of foregoing the revenues obtained from future rotations.

7.1.2 Site Value

Site value is the present value of all cash flows produced by an infinite series of identically managed rotations, with rotation age H. It is the value one would be willing to pay for bare ground if the intent was to manage an infinite series of rotations under an assumed management regime. This is why site value is also often referred to as bare land value, soil expectation value, or land expectation value.
When starting with bare ground and comparing alternative management regimes, the regime that has the highest site value is considered the most economically efficient choice.

[2] $$SV = \frac{\sum_{y=0}^{H} \left(R_y - C_y\right)(1+r)^{(H-y)}}{(1+r)^H - 1} = \frac{NPV_1 (1+r)^H}{(1+r)^H - 1}$$

all terms as defined above.
Note that the general equation for the present value (V_0) of an infinite series of periodic payments of size X made every n years is:

[3] $$V_0 = \frac{X}{(1+r)^n - 1}$$

In equation [2] the numerator represents the net value of the rotation at harvest age H. So the site value equation assumes that one is starting with bare ground and will manage the land infinitely under identical management regimes, with the first “payment” being received in H years at the time of the first final harvest and then every H years thereafter.

When considering management options for established stands, NPVs which include a site value term, are compared (e.g. Stone 1993).

[4] $$NPV = \sum_{y=a}^{H} \frac{(R_y - C_y)}{(1+r)^y} + \frac{NPV_1(1+r)^H}{[(1+r)^H - 1](1+r)^{(H-a)}}$$

The first term in equation [4] is equivalent to NPV_1 as described in equation [1] above except for the fact that in an established stand discounted costs and revenues are those which occur in the future to the established stand and the present time is assumed to be at the age of the established stand (a). The second term represent a discounted site value, as bare ground will not be obtained until after the end of the first rotation (H-a years from now.)
If the above equation is used for bare ground then a = 0 and equation [4] reduces to:

[5] $$NPV = \sum_{y=0}^{H} \frac{(R_y - C_y)}{(1+r)^y} + \frac{NPV_1(1+r)^H}{[(1+r)^H - 1](1+r)^H}$$

$$= NPV_1 + \frac{NPV_1}{(1+r)^H - 1}$$

$$= \frac{NPV_1(1+r)^H}{(1+r)^H - 1} = SV$$

This means that site value is equivalent to the NPV of a single rotation starting from bare ground plus site value discounted back from the end of the rotation when bare land again becomes available. This assumes an infinite series of identical management regimes. For some this is an easier way to think about site value as it shows that it is largely made up of the NPV of the first rotation. By including the discounted site value term the cost of prolonging the time to the start of the next rotation is recognized.
For the remainder of this document the term NPV will refer to values calculated with equation [5]. The term NPV1 will refer to the NPV of a single rotation calculated as in equation [1], or equivalently, the first term of equation [5]. The phrase discounted site value will refer to the second term in equation [5].

7.2 Harvesting Costs

7.2.1 Ground-based Harvesting Systems

CONSTANT + (3.34 SS%/100) + (4.24*SLOPE%/100) – (5.41 * VOLHA/1000) + (.7*VOLHA/VOLTREE/1000) + (.43 * GVOL) + (3.61*BD%/100) + (2.85 * DPCUT2 - PCCUT2/100) + (.67*SUPP2/100) + (1.26*SUPP3/100)

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. This was set to 0.
PCCUT2	Volume removed	As defined in the commercial thinning schedule. This was set to 0.
DS	Distance to support centre	This was set at 50km
SUPP2	Distance to support	0 if DS [50km
SUPP3	Distance to support	0 if DS [150km

7.2.2 Cable-based Harvesting Systems

CONSTANT +(4.58*SLOPE%/100) – (2.01 * VOLHA/VOLTREE/1000) – (2.12*GVOL) +(.2*GVOLSQR) + (2.08 * CDPCUT) + (.7*SUPP2/100)

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

7.2.3 Hauling

Truck hauling costs were based on the equation in the B.C. Ministry of Forests Coast Appraisal Manual.
The hauling cost were calculated as $/m3 = 3.092 + 0.1100 (D)
Where D = the weighted average one-way haul distance in kilometers
For the purposes of this study D was set to 50km. Therefore truck hauling costs were set at $8.59/m3.

7.2.4 Transportation

Transportation is primarily by towing and barging. For these activities the current costs from the Coast Appraisal Manual vary from $2.75 to ~$6.00 /m3. For example, logs from Jeune Landing and Quatsino Sound are assumed to be barged to Alberni Inlet for $5.80 to 6.00/m3. Logs from Port McNeill are assumed to be towed to Howe Sound for $2.75/m3. For this analysis two thirds of the volume was assumed to be barged and the rest towed. Therefore costs of $4.80 were used.

7.2.5 Dump, Boom, Sort and Scale

A standard cost of $9.84 was applied (Coast Appraisal Manual) assuming that two thirds of the volume is barged and the rest towed.

7.2.6 Road Construction

Low = $0.00 Base = $1,000.00 High = $2,000.00
Because this analysis dealt with second growth timber, it could be assumed that a road network is already in place. As a result, for this analysis the ‘low’ road cost estimate assumed no road construction costs. The ‘base’ estimate assumed that a small amount of re-construction was required and the ‘high’ estimate assumed that a moderate amount of re-construction was required.

7.2.7 Routine Road Maintenance and Deactivation

A standard cost of $2.30 was applied (Coast Appraisal Manual)

7.2.8 Administration

A standard cost of $13.70 was applied (Coast Appraisal Manual)

7.2.9 Basic Silviculture

A standard cost of $2.23 was applied (Coast Appraisal Manual)

7.3 Spreadsheet Formulas and Instructions for Use

The costs and formulas described in sections 6.2 and 6.3 have been incorporated into a spreadsheet that calculates net present value. TASS input and output information is entered into the left hand side of the spreadsheet and the right hand side calculates the relevant costs and net present values for the runs. The spreadsheet is provided electronically in the file 'Electronic Appendices Submission\MASTER_Net Present Value.zip'. Within the zip file there are three spreadsheets:

- MASTERNPV- Contains the working spreadsheet where TASS/Tipsy information is input and NPV is calculated. The spreadsheet contains links to two cost worksheets, the information from which is used in the formulas.
- MASTERcosts – the primary cost worksheet, which includes values used in the ground-based harvesting formula, silviculture costs, discount rate and log values.
- MASTERcablecosts – this cost worksheet contains the values used in the cable-harvesting formula.

The MASTERNPV file contains a README worksheet with instructions on how to input information and manipulate cost values.

8.0 Results of Stand-level Analysis

Yield graphs were produced for all scenarios. These include graphs of MerchVolume, MaxMAI and DBHq. Yield graphs for each scenario are provided electronically. Cost analysis using the MASTERNPV was performed only on specific scenarios and is referenced to an electronic file where applicable.

8.1 Scenario #1 – Evaluation of CMO Stand-level Assumptions

Yield graphs made are Mvol, MaxMAI and DBHq (Provided electronically in the file 'Electronic Appendices Submission**Scenario Yield Graphs**\ Scenario 1_Evaluation of CMO stand-level assumption')
No cost analysis
AU 121 (5% GI)
AU 121 (15% GI)
Graphed with TASS runs of varying levels of infill
Runs: 21,33 with AU 121 5% GI (No trt; low infill)
41,53 with AU 121 15% GI (No trt; low infill)
27,35 with AU 121 5% GI (JS 850; high infill)
47,55 with AU 121 15% GI (JS 850, high infill)

Summary of Tass/Tipsy* Inputs for Existing and Future Coniferous Stands - Type 2 Analysis

Run	Sp1 Planted %	Sp1 Site Index **	Sp2 Planted %	Sp2 Site Index	Total # Planted	Planted Genetic Worth	Sp Natural	Total Natural Infill	PCT	PCT Density	Fert
21	Hw 100	28			1100	low	Hw	2000			
27	Hw 100	28			1100	low	Hw	4000	yes	850	
33	Hw 100	28			1100	low	Hw	8000			
35	Hw 100	28			1100	low	Hw	8000	yes	850	
41	Hw 100	28			1100	high	Hw	2000			
47	Hw 100	28			1100	high	Hw	4000	yes	850	
53	Hw 100	28			1100	high	Hw	8000			
55	Hw 100	28			1100	high	Hw	8000	yes	850	
** All Ecosystem Class, S1HA											

Analysis Unit	Productivity Group	Ecosystem Class.	Treatment	Estab. Density	Resid. Density	Spc 1	%	Spc 2	%	Spc 3	%	Site Index[1]	Planted/ Natural
121	2	S1HA	No treatment	1050		H	80	B	20			28	P

* Run through Tipsy at both 5% and 15% genetic worth

8.2 Scenario #3 – Impacts of Juvenile Spacing

Yield graphs made are Mvol, MaxMAI and DBHq (Provided electronically in the file 'Electronic Appendices Submission**Scenario Yield Graphs**\ Scenario 3_Impacts of Juvenile Spacing')
Cost analysis was performed on four out of the six sets of runs compared. The NPV spreadsheets for the base case are provided electronically in the file: 'Electronic Appendices Submission\ **Scenario Cost Spreadsheets**\Scenario 3_Impacts of Juvenile Spacing'.
Densities and residual densities with controls
2 medium density, 2 high density
Runs: 25, 26, 27, 28 (4000 sph) Low genetic gain
29, 30, 31, 32 (6000 sph) Low genetic gain
33, 34, 35, 36 (8000 sph) Low genetic gain
37, 38, 39, 40 (10000 sph) Low genetic gain
5, 6, 7, 8 (4000 sph) No genetic gain, natural regen (No Cost analysis)
13, 14, 15, 16 (8000 sph) No genetic gain, natural regen (No Cost analysis)
Base case: Low JS and Base Log value (NPV and $/m3)
Variations: NPV (Any other variations)

1. Low JS costs and Steep log value
2. High JS and Base Log Value

Summary of Tass/Tipsy* Inputs for Existing and Future Coniferous Stands - Type 2 Analysis											
Run	**Sp1 Planted %**	**Sp1 Site Index ****	**Sp2 Planted %**	**Sp2 Site Index**	**Total # Planted**	**Planted Genetic Worth**	**Sp Natural**	**Total Natural Infill**	**PCT**	**PCT Density**	**Fert**
5					0		Hw	4000			
6					0		Hw	4000	yes	600	
7					0		Hw	4000	yes	850	
8					0		Hw	4000	yes	1000	
13					0		Hw	8000			
14					0		Hw	8000	yes	600	
15					0		Hw	8000	yes	850	
16					0		Hw	8000	yes	1000	
25	Hw 100	28			1100	low	Hw	4000			
26	Hw 100	28			1100	low	Hw	4000	yes	600	
27	Hw 100	28			1100	low	Hw	4000	yes	850	
28	Hw 100	28			1100	low	Hw	4000	yes	1000	
29	Hw 100	28			1100	low	Hw	6000			
30	Hw 100	28			1100	low	Hw	6000	yes	600	
31	Hw 100	28			1100	low	Hw	6000	yes	850	
32	Hw 100	28			1100	low	Hw	6000	yes	1000	
33	Hw 100	28			1100	low	Hw	8000			
34	Hw 100	28			1100	low	Hw	8000	yes	600	
35	Hw 100	28			1100	low	Hw	8000	yes	850	
36	Hw 100	28			1100	low	Hw	8000	yes	1000	
37	Hw 100	28			1100	low	Hw	10000			
38	Hw 100	28			1100	low	Hw	10000	yes	600	
39	Hw 100	28			1100	low	Hw	10000	yes	850	
40	Hw 100	28			1100	low	Hw	10000	yes	1000	
** All Ecosystem Class, S1HA											

8.3 Scenario #4 – Pruning

Cost analysis only. NPV spreadsheets for the base case are provided electronically in the file: 'Electronic Appendices Submission\ **Scenario Cost Spreadsheets**\Scenario 4_pruning'.
Run: 27
Base case for cost sheet: No costs except pruning. 1st lift prune to 560 at medium cost, 2nd lift prune to 350 at medium cost.
Variation 1: 1st lift prune to 560 at high cost, 2nd lift prune to 350 at high cost.

Summary of Tass/Tipsy* Inputs for Existing and Future Coniferous Stands - Type 2 Analysis											
Run	**Sp1 Planted %**	**Sp1 Site Index ****	**Sp2 Planted %**	**Sp2 Site Index**	**Total # Planted**	**Planted Genetic Worth**	**Sp Natural**	**Total Natural Infill**	**PCT**	**PCT Density**	**Fert**
27	Hw 100	28			1100	low	Hw	4000	yes	850	
** All Ecosystem Class, S1HA											

8.4 Scenario #5 – Cw vs Hemlock

Yield graphs made are Mvol, MaxMAI and DBHq (Provided electronically in the file 'Electronic Appendices Submission**Scenario Yield Graphs**\ Scenario 5_Cw.vs.Hw graphs')
Cost analysis was performed on the base case. The NPV spreadsheets for the base case are provided electronically in the file: 'Electronic Appendices Submission\ **Scenario Cost Spreadsheets**\Scenario 5_Cw.vs.Hw'.
Runs: 25, 105, 108, 151
Base case: No costs, log prices base, 105=50%Hw, 108 50%Hw
Variation 1: Add medium spacing cost to run 108
Graph 3: Graph 108 50% Hw (base) with 75% Hw
Graph 4: Graph 105 50% Hw (base) with 75% Hw

Summary of Tass/Tipsy* Inputs for Existing and Future Coniferous Stands - Type 2 Analysis

Run	Sp1 Planted %	Sp1 Site Index **	Sp2 Planted %	Sp2 Site Index	Total # Planted	Planted Genetic Worth	Sp Natural	Total Natural Infill	PCT	PCT Density	Fert
25	Hw 100	28			1100	low	Hw	4000			
105	Cw 100	24			1100	low	Hw	4000			
108	Cw 100	24			1100	low	Hw	4000	yes	1000	
151	Cw 100	24			1800	low			yes	1000	
* Runs 141-151 are done with TIPSY											
** All Ecosystem Class, S1HA											
* 105 and 108 are analysed for costs as a mixed Cedar/hemlock stands											

8.5 Scenario #6 – Spruce vs Hemlock

Yield graphs made are Mvol, MaxMAI and DBHq (Provided electronically in the file 'Electronic Appendices Submission**Scenario Yield Graphs**\ Scenario 6_SS.vs.Hw graphs')
Cost analysis was performed on the base case. The NPV spreadsheets for the base case are provided electronically in the file: 'Electronic Appendices Submission\ **Scenario Cost Spreadsheets**\Scenario 6_Cw.vs.Hw'.
Runs: 65 (spruce/hemlock), 25 (hemlock)
Base case for cost sheet: No costs, log prices base, 65 = 75% spruce
Variation 1: 65 = 50% spruce

Summary of Tass/Tipsy* Inputs for Existing and Future Coniferous Stands - Type 2 Analysis											
Run	**Sp1 Planted %**	**Sp1 Site Index ****	**Sp2 Planted %**	**Sp2 Site Index**	**Total # Planted**	**Planted Genetic Worth**	**Sp Natural**	**Total Natural Infill**	**PCT**	**PCT Density**	**Fert**
25	Hw 100	28			1100	low	Hw	4000			
65	Hw 50	28	Ss 50	31	1100	low	Hw	4000			
* 65 is analysed for costs as a mixed spruce/hemlock stand											
** All Ecosystem Class, S1HA											

8.6 Scenario #7 – Fir vs Hemlock

Yield graphs made are Mvol, MaxMAI and DBHq (Provided electronically in the file 'Electronic Appendices Submission**Scenario Yield Graphs**\ Scenario 7_Fd.vs.Hw graphs')
Cost analysis was performed on the base case. The NPV spreadsheets for the base case are provided electronically in the file: 'Electronic Appendices Submission\ **Scenario Cost Spreadsheets**\Scenario 7_Fd.vs.Hw'.
Runs: 25 (hemlock), 125 (Fir/hemlock)
Base case: No costs, log prices base, 125=75% fir
Variation 1: 125 = 50% fir

Summary of Tass/Tipsy* Inputs for Existing and Future Coniferous Stands - Type 2 Analysis

Run	Sp1 Planted %	Sp1 Site Index **	Sp2 Planted %	Sp2 Site Index	Total # Planted	Planted Genetic Worth	Sp Natural	Total Natural Infill	PCT	PCT Density	Fert
25	Hw 100	28			1100	low	Hw	4000			
125	Fd 100	31			1100	low	Hw	4000			
* 125 is analysed for costs as a mixed Douglas-fir/hemlock stand											
** All Ecosystem Class, S1HA											

8.6 Scenario # 8 – Alder vs Hw

Cost analysis is not provided as the establishment of Alder is experimental.
Yield graphs are not relevant for this comparison.
Runs: 21, alder 14
Base case: no costs

Runs: 23 vs. Alder 5,6
Base case: site prep on 5 and 6, commercial thinning on 6, JS costs med on all runs
Variation 1: vary log prices to steep

Summary of Tass Inputs for Future Alder Stands-Type 2 Analysis

Run	Total # Planted	Sp Planted	Sp Site Index	PCT Density	PCT Age	Com Thin Density	Com Thin Age
5	1600	Dr	33	850	10		
6	1600	Dr	33	850	10	275	15
14	1100	Dr	33				

Summary of Tass/Tipsy* Inputs for Existing and Future Coniferous Stands - Type 2 Analysis

Run	Sp1 Planted %	Sp1 Site Index **	Sp2 Planted %	Sp2 Site Index	Total # Planted	Planted Genetic Worth	Sp Natural	Total Natural Infill	PCT	PCT Density	Fert
21	Hw 100	28			1100	low	Hw	2000			
23	Hw 100	28			1100	low	Hw	2000	yes	850	
** All Ecosystem Class, S1HA											

8.7 Scenario #9 – Natural Regen vs Planting

Yield graphs made are Mvol, MaxMAI and DBHq (Provided electronically in the file 'Electronic Appendices Submission**Scenario Yield Graphs**\ Scenario 9_Natural Regen.vs.Planting graphs')
Cost analysis was performed on the base case. The NPV spreadsheets for the base case are provided electronically in the file: 'Electronic Appendices Submission\ **Scenario Cost Spreadsheets**\Scenario 9_Natural Regen.vs.Planting '.
Runs: 5, 25 (low cost planting), 45 (medium cost planting)
Base case for cost sheet: planting costs on always
Variation 1: Run 5, Pr fill plant medium, Cost of fill plant low
Variation 2: Run 5, as with variation 1 but add low cost of brushing and medium pr of brushing
Set 2
Impact of GI/Density at low and high densities (Yield graphs only- no cost analysis)
High density
Runs: 33, 35, 53, 55, 13, 15
Low density
Runs: 21, 23, 41, 43, 1, 3

Summary of Tass/Tipsy* Inputs for Existing and Future Coniferous Stands - Type 2 Analysis

Run	Sp1 Planted %	Sp1 Site Index **	Sp2 Planted %	Sp2 Site Index	Total # Planted	Planted Genetic Worth	Sp Natural	Total Natural Infill	PCT	PCT Density	Fert
1					0		Hw	2000			
3					0		Hw	2000	yes	850	
5					0		Hw	4000			
13					0		Hw	8000			
15					0		Hw	8000	yes	850	
21	Hw 100	28			1100	low	Hw	2000			
23	Hw 100	28			1100	low	Hw	2000	yes	850	
25	Hw 100	28			1100	low	Hw	4000			
33	Hw 100	28			1100	low	Hw	8000			
35	Hw 100	28			1100	low	Hw	8000	yes	850	
41	Hw 100	28			1100	high	Hw	2000			
43	Hw 100	28			1100	high	Hw	2000	yes	850	
45	Hw 100	28			1100	high	Hw	4000			
53	Hw 100	28			1100	high	Hw	8000			
54	Hw 100	28			1100	high	Hw	8000	yes	600	
55	Hw 100	28			1100	high	Hw	8000	yes	850	
** All Ecosystem Class, S1HA											

9.0 Opportunity Area Determination for Selected Reforestation Species Strategies

Queries were done on the TFL database based on the following algorithms:

- Current stand ages of 30 to 150 years and,

9.1 Scenario #6 – Spruce vs Hemlock

- Primary ecosystem unit = S1Ha, S12Ha, S13, S3 and,
- Not where variant = vm2 and,
- Yc or Cw are not in Spp1, Spp2 or Spp3

9.2 Scenario #7 – Fir vs Hemlock

- Primary ecosystem unit = S1Ha and,
- Not where variant = vm2 or vh1and,
- Yc or Cw are not in Spp1, Spp2 or Spp3 and,
- Terrain is colluvial or morainal

9.3 Scenario # 8 – Alder vs Hw

- Primary ecosystem unit = S3, S1Ha, S12Ha and,
- Dr is in Spp1, Spp2 or Spp3