TIMBER PRICING BRANCH

Cruise Compilation Manual

July 1, 2014

Includes Amendments	Effective Date
Amendment No. 1	July 1, 2016

BRITISH COLUMBIA

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Highlights

2016 *Cruise Compilation Manual* Changes

The *Cruise Compilation Manual* is available on the Internet at:

http://www2.gov.bc.ca/gov/content/industry/forestry/competitive-forest-industry/timber-pricing/timber-cruising/cruise-compilation-manual

Section	Description
2.1 - Input Data	New version number 2016.00.
Appendix 9.11 – Percentages within Spruce Grades	The Coast spruce high grade historic grade percentages are rolled up for April 1, 2014 to March 31, 2016 for use in the grade algorithm for loss factor cruises.
Appendix 9.12 – Percentages within Cedar Grades	The Coast cedar high grade historic grade percentages are rolled up for April 1, 2014 to March 31, 2016 for use in the grade algorithm for loss factor cruises.
Valid Compilation Versions Site	The valid compilation versions web site will be updated to indicate that the Claymore and IFS CruiseComp compilation programs are approved to compile Coast area cruises for FLNRO appraisal purposes. http://www2.gov.bc.ca/assets/gov/farming-natural-resources-and-industry/forestry/docs/timber-pricing/timber-cruising/valid_compilation_versions_amendment.pdf

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Introduction 1

This manual outlines the Ministry of Forests, Lands and Natural Resource Operations policy for compiling cruise data collected on British Columbia's Crown land. Any agency compiling cruise data for a licensee must adhere to these guidelines if the compilation is being submitted to the Ministry for stumpage appraisal.

The objective of this manual is to provide a comprehensive and organized set of instructions for system designers and programmers who are building or maintaining a Ministry-standard cruise compilation program.

The chapters are ordered logically as follows:

1. Standard Compilation Input - Chapter 2.

2. Standard Compilation Procedures - Chapter 3.

3. Special Compilation Input and Procedures - Chapters 4 - 7.

4. Report Definitions with Sample Calculations - Chapters 8 - 12.

References will be made to the Timber Pricing Branch's *Cruising Manual*, which outlines cruising field procedures and other pre-compilation requirements. This manual can be viewed on the Internet at http://www.for.gov.bc.ca/hva/manuals/cruising.htm.

Because there are different appraisal concerns for the Coast and Interior, the compilation program must provide different parameters depending on the type of compilation. A Coast compilation is referred to as compilation type 32, while an Interior compilation is type 03. The report definition chapters of this manual (8-14) will clearly state where differences occur between the Coast and Interior reports.

Each compiling agency is responsible for implementing its own solution. Programming techniques, platforms, data models, functional decompositions and other non-policy material will be determined independently for each implementation.

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Data Input and Edits 2

2.1 Input Data - Standard Compilation

Standard compilations are based on two input forms, the Map Area Statement (FS 121) and the Cruise Tally Sheet (FS 205). These two types of input are discussed in this chapter.

Two other input forms are used for non-standard compilations, the Stump Cruise Tally Sheet (FS 205S) and the Cruise Percent Reduction Worksheet (FS 221), which are described in Chapters 5 and 6.

A standard data input file is made up of a Map Area Statement and one or more Cruise Tally Sheets.

The Map Area Statement consists of one card type A, 1 or 2 card type Bs, 1 or more card type Cs, 1 or more card type Ds, 0 or more card type Es, 1 or more card type Fs and 1 card type G.

The Cruise Tally Sheet is 63 characters wide and consists of 1 card type 9, 1 or more card type 2s and 0 or more card type 3s.

The Cruise Tally Sheet and Map Area Statement are described in Chapters 6 and 7 of the *Cruising Manual*.

For each card type, a list or a range of the accepted values for each data input field will be given in tabular format. The following key defines acceptable data types:

1. "A" denotes an upper case letter.

2. "X" denotes an alphanumeric character {i.e., A-Z, 0-9}.

3. "9" denotes a digit.

4. "9(L, D)" denotes a number L digits long with D decimal places. The decimal places are implied and should not appear on the input file.

5. "YY" denotes a year.

6. "MM" denotes a month.

7. "{X, Y, Z}" means that only values 'X', 'Y', & 'Z' are permitted.

8. "{1-7}" means that only digits 1 through 7 are permitted.

Further, this chapter defines the data input requirements by specifying data dependency between different fields. For each card type, the list of data dependencies will be broken down by the severity of the error. Field names are capitalized.

The error message column describes the behavior of the system when the edit fails.

1. "I" - an informational message, the compilation will complete normally.
2. "W" - a warning, the compilation will complete but is suspect.
3. "F" - a fatal error, the compilation cannot be completed.
4. "N/A" - no error messages are generated for the field.

For a detailed explanation of the Cruise Tally Sheet and Map Area Statement fields refer to Chapters 6 and 7 of the *Cruising Manual*. The *Cruising Manual* is located on the Internet at URL

http://www2.gov.bc.ca/gov/content/industry/forestry/competitive-forest-industry/timber-pricing/timber-cruising/timber-cruising-manual

The input data must be submitted in ASCII format. Here is an example of an input file:

```
V2013.02
AA99999123001205B057000100C  00000020A          Road Fork   DEF       2
BA999991231 00003217503015010                          A
CA99999123  01          10
CA99999123  02          10
DA9999912300101M   10
DA9999912300102M   10
FA99999123 CC01   10
FA99999123 CC02   10
GA99999123A
9A999991230010101C012545M    25000F175         CC 640314
2A999991230010101C012500013555  7552  2      3301          MLG 8 -H13 -U99 -
2A999991230010101C012500025505 13503  4   3 4300         GMDF1398G1398H 898U99 -
2A999991230010101C012500035255 12401         5300          MLF1398H1398H  898U99 -
9A999991230010102C012554M    25000F175         CC 660314
2A999991230010102C012500015205 14071         6400         MLF13 -H13 -I 8 -U99 -
2A999991230010102C012500024875 11502   1     5300         MLF 8 -H1394I 8 -U99 -
2A999991230010102C012500034555  9508          4302         SLH13 -U99 –
2A999991230010102C012500045655 15982  1      6400         MLF1398G13 -H11 -U 8 -X99 -
2A999991230010102C012500056115 16331         5405         MLF13 -F13 -H13 -I 8 -Y99 -
9A999991230010103C012557M    25000F175         CC 240314
2A999991230010103C012500015645 145521        5300         MLF 8 -Y 650G13 -H11 -U 8 -X99 -
2A999991230010103C012500025845 15221         6400         MLF13 -F 8 -H13 -I 8 -U99 -
9A999991230010198C012540C    25000F175         CC  590314
2A999991230010198C01250001   S
2A999991230010198C01250002   S
2A999991230010198C01250003   S
2A999991230010198C01250004   S
2A999991230010198C01250005   S
```

Figure 2.1a Input File (page 1).

A version number will be placed at the top of the file above card type A. It will start with a V followed by the year, followed by a period followed by 2 digits. For example, the first version in a year would be V2016.00 the next version would be V2016.01. Refer to the 'Valid Compilation Versions' link in the *Cruise Compilation Manual* for the most recent version numbers and cruise compilation companies that are approved to compile cruises for appraisal purposes in British Columbia. The link is located at:

http://www2.gov.bc.ca/assets/gov/farming-natural-resources-and-industry/forestry/docs/timber-pricing/timber-cruising/valid_compilation_versions_amendment.pdf

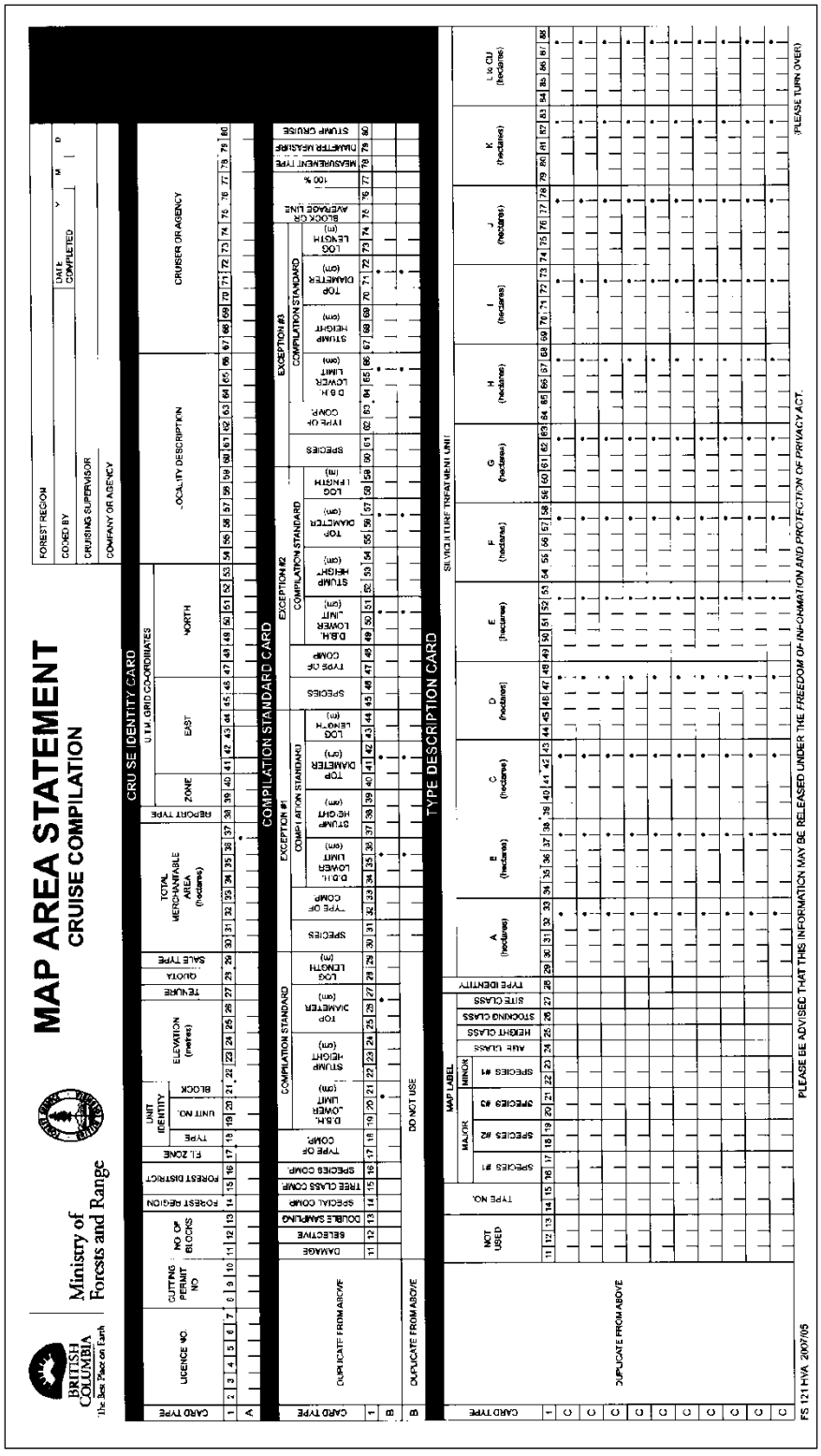

Figure 2.2a Sample Map Area Statement - Front Side.

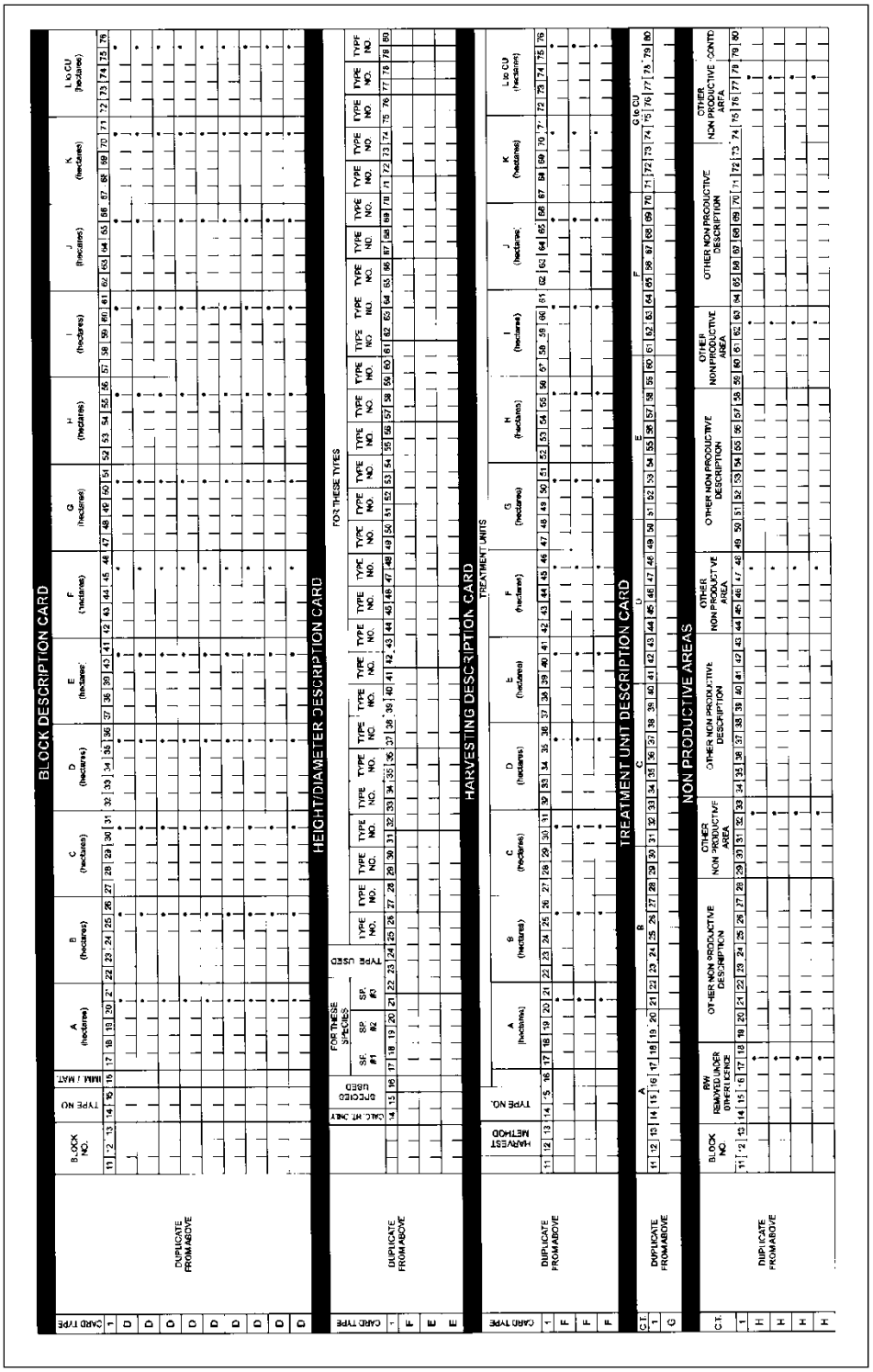

Figure 2.2b Sample Map Area Statement - Reverse Side.

2.2 Card type A

2.2.1 Table of Data Types

Column Position	Column Name	Accepted Values	Error Type
1	Card type	"A" - hard coded	F
2-7	License	Refer to *Cruising Manual*, Chapter 5	F
8-10	Cutting Permit	XXX	F
11-13	No. of Blocks	999	I
14	Forest Region	1-8	F
15-16	Forest District	Refer to Appendix 6 - Regions and Districts	F
17	F.I.Z.	A-L	F
18	Unit Type	0,1,2,3,5,7, B, C, E, G, K, L, M, P, S, T, W, blank	F
19-20	Unit No.	99	W
21	Block	9	F
22-26	Elevation	99999	I
27	Tenure	A, B, C, S, T, U, V, W, X, Y, 1-9	I
28	Quota	D, H, N, Q, R, S, T, blank	I
29	Sale Type	A-K, M, N, R	I
30-37	Total Merchantable Area	9 (8, 1)	F
38	Report Type	Blank, A	I
39-40	Zone	08-11	I
41-46	East	280,000-720,000	I
47-53	North	5,351,000-6,653,000	I
54-66	Locality Description	Any value is accepted	N/A
67-80	Cruiser or Agency	Any value is accepted	F

2.2.2 Fatal Errors

For Unit Type 'T', the Unit Numbers must come from the list of valid Tree Farming Licenses. All TFL's are listed in Table 17 of the *Cruising Manual*.

1. For Unit Type 'T', columns 6-7 must match columns 19-20.
2. If the Unit Type is blank and the Unit Number is 26 or 75 then the Unit Block must be coded.
3. If the Unit Type is 'A' and the Unit Number is 10, then the Unit Block must be coded 1 or 2.
4. If the Unit Number is one of {25, 39, 43, 45, 47 or 49}, then the Unit Block must be coded.
5. Unit identity does not agree with licence number.
6. Unit identity does not agree with allowable F.I.Z.
7. For Coast compilations, the Forest Inventory Zone must be A, B, C, or D.
8. Invalid District within Area. Refer to Appendix 6.

2.2.3 Warning

1. Unity identity column cannot be blank.

2.2.4 Messages

1. UTM co-ordinates and Zones must be valid for the specified Area. For a list of UTM co-ordinates refer to the following web site:

   http://a100.gov.bc.ca/pub/mascotw/

June 1, 2009 Amendment - allow FIZ H and I for the Babine PSYU.

June 15, 2011 Amendment – allow FIZ E and F for the Cranbrook PSYU.

June 1, 2012 Amendment - allow FIZ D and G for the Spallumcheen PSYU.

July 22, 2013 Amendment – allow FIZ L, special cruise number 265 for the Dawson Creek Special Sale Area (SSA).

July 1, 2014 – allow FIZ D for the Shuswap PSYU.

2.3 Card Type B - Compilation Standard

2.3.1 Table of Data Types

Column Position	Column Name	Accepted Values	Error Type
1	Card type	"B" - hard coded	F
2-10	N/A	Same as card type A	F
11	Damage	Yes for appraisal purposes	W
12	Selective Cut Ind.	Blank, C, L	F
13	Double Sampling	0, 1	F
14	Special Comp.	Blank for Coast, 1 or 2 for Interior	I
15	Tree Class Comp.	0, 1	F
16	Species Comp.	0, 1	F
17-18	Type of Comp.	03, 32	F
19-21	DBH lower limit	9 (3, 1)	I
22-24	Stump height	999	I
25-27	Top diameter	9 (3, 1)	I
28-39	Log length	99	I
30-31, 45-46, 60-61	Species Exceptions	Refer to Chapter 5 of the *Cruising Manual*	F
32-33, 47-48, 62-63	Type of Comp.	03, 32	F
34-36, 49-51, 64-66	DBH lower limit for species exceptions	Blank, 9 (3, 1)	I

Column Position	Column Name	Accepted Values	Error Type
37-39, 52-54, 67-69	Stump height for species exceptions	Blank, 999	I
40-42, 55-57, 70-72	Top diameter for species exceptions	Blank, 9 (3, 1)	I
43-44, 58-59, 73-74	Log length for species exceptions	Blank, 99	I
75	Block vs. Avg. line	A, B	F
76	Type of cruise	Blank for Loss Factors, C for CGNF compilation	N/A
77	100% cruise	Blank, A	N/A
78	Measurement type	C, R	N/A
79	Diameter measure	I	N/A
80	Stump cruise	Blank, S	N/A

2.3.2 Fatal Errors

1. For Interior compilations, the Special Compilation cannot be 0.
2. The DBH Lower Limit is less than or equal to the Top Diameter.
3. Columns 2-10 must be the same as card type A.

2.3.3 Warnings

1. Exception Log Lengths should be between 2 and 11 m.

2.3.4 Messages

1. If Tree Class Combination is coded 1, then mark all reports "Not for Appraisals".

2. For Interior compilations, if the Special Compilation is coded 1, then mark all reports "Sale is in the Wet Belt".

3. For Interior compilations, if the Special Compilation is coded 2, then mark all reports "Sale is in the Dry Belt".

4. If the standard merchantability requirements are not coded as outlined below, then mark all reports "Not for Appraisals":

Coast	Log length = 10.0 meters Mature: Minimum DBH = 17.5, Minimum Top Diameter = 15.0 Immature: Minimum DBH = 12.0, Minimum Top Diameter = 10.0 Exception: the coastal portion of the Coast Mountain Natural Resource District, must allow for Interior Standard Utilization Specifications
Interior	Log length = 5.0 meters Minimum DBH = 17.5, Minimum Top Diameter = 10.0 Exception 1: Lodgepole Pine, Minimum DBH = 12.5 Exception 2: Red Cedar Top Diameter = 15.0 if more than 50% of the Red Cedar net volume is over 140 years old

5. Coast and interior compilations for the Coast Mountain district using coast and interior Forest Inventory Zones & PSYUs are allowed. Compilations using FIZ D are allowed in Chilliwack district.

2.4 Card type C - Type Identity

2.4.1 Table of Data Types

Column Position	Column Name	Accepted Values	Error Type
1	Card type	"C" - hard coded	F
2-10	N/A	Same as card type A	F
11-13	N/A	N/A	N/A
14-15	Type number	99 or blanks	F
16-17	Major Species 1	Refer to the *Cruising Manual*, Appendices (Timber Typing)	W
18-19	Major Species 2	Same as above	W
20-21	Major Species 3	Same as above	W
22-23	Minor Species 1	Same as above	W
24	Age Class	1-9	W
25	Height Class	1-8	W
26	Stocking Class	0-3	W
27	Site Class	G, M, P, L	W
28	Type Identity	1-3	F
29-33, 34-38, Etc.	Treatment unit areas A-CU	9 (5, 1) or blanks	F

2.4.2 Fatal Errors

1. At least one STU area must be greater than 0.
2. There must be at least one timber type.
3. Columns 2-10 must be the same as card type A.

2.4.3 Warnings

1. The sum of the STU areas must equal the Total Area coded on card type A.

2.4.4 Messages

1. Type Identities greater than 3 are invalid or incorrect.
2. If the Type Number is blank, all the subsequent card type C fields should be blank.
3. Timber type numbers should appear only once on the card type Cs.

2.5 Card Type D - Block Description

2.5.1 Table of Data Types

Column Position	Column Name	Accepted Values	Error Type
1	Card type	"D" - hard coded	F
2-10	N/A	Same as card type A	F
11-13	Block number	XXX	N/A
14-15	Type number	99 or blanks	F
16	Block Maturity	Blank, I, M	I
17-21, 22-26, Etc.	Treatment unit areas A-CU	9 (5, 1) or blanks	F

2.5.2 Fatal Errors

1. A block must contain at least one timber type.
2. Columns 2-10 must be the same as card type A.
3. There must be the same number of blocks coded on card type Ds as is specified on card type A.
4. The sum of the type areas within blocks must be equal to the total type area on card type C.

2.5.3 Messages

1. Type Numbers must be coded on a preceding card type C.
2. If a Type Number is blank, then all of its Treatment Unit Areas should be blank.
3. For Coast compilations, if the Block Maturity is not coded, mark all reports "Not for Appraisals"
4. There should be at least one block.

2.6 Card Type E - Height/Diameter Description

2.6.1 Table of Data Types

Column Position	Column Name	Accepted Values	Error Type
1	Card type	"E" - hard coded	F
2-10	N/A	Same as card type A	F
11-13	N/A	Blanks	I
14	Calc. height only	Blank, 0, 1	F
15-16	Species used	Refer to *Cruising Manual*, Chapter 5	F
17-18, 19-20, 21-22	Species to be replaced 1, 2 & 3	Same as above	F
23-24	Type used	99 or blanks	I
24-25, 26-27… 79-80	Types to be replaced 1, 2, … 28	99 or blanks	I

2.6.2 Messages

1. There should be no blanks between the types coded in columns 25-80.
2. Type Numbers must be coded on a preceding card type C.

2.7 Card Type F - Harvesting Method Description

2.7.1 Table of Data Types

Column Position	Column Name	Accepted Values	Error Type
1	Card type	"F" - hard coded	F
2-10	N/A	Same as card type A	F
11	N/A	Blank	N/A
12-13	Harvesting method	Refer to Chapter 13 for valid harvesting method codes	F
14-15	Type number	99 or blanks	F
16		Blank	N/A
17-21, 22-26, Etc.	Treatment unit areas A-CU	9 (5, 1) or blanks	F

2.7.2 Fatal Errors

1. There must be at least 1 Harvesting Method.

2. The sum of the type areas within Harvesting Methods must be equal to the total type area on card type C.

2.7.3 Warnings

1. A Harvesting Method should appear only once on the card type Fs.

2. Type Numbers should be coded on a preceding card type C.

2.8 Card Type G - Treatment Unit Description

2.8.1 Table of Data Types

Column Position	Column Name	Accepted Values	Error Type
1	Card type	"G" - hard coded	F
2-10	N/A	Same as card type A	F
11-20, 21-30, Etc.	Silviculture Treatment Units A-CU	XXXXXXXXXX	N/A

2.8.2 Fatal Errors

1. There must be 1 card type G.

2. There must be an equal number of Treatment Unit Names specified in card type G as there are Treatment Unit Areas on card type C.

2.9 Card Type H – Non Productive Areas

2.9.1 Table of Data Types

Column Position	Column Name	Accepted Values	Error Type
1	Card type	"H" - hard coded	F
2-10	N/A	Same as card type A	F
11–13	Block No.	XXX	N/A
14–18	R/W Removed Under Other Licence	9 (5, 1) or blanks	F
19-28 34-43 49-58 Etc.	Other Non Productive Description	AAAAAAAAAA or blanks	N/A
29-33 44-48 59-63 Etc.	Other Non Productive Area	9 (5,1) or blanks	N/A

2.10 Cruise Tally Sheet Image

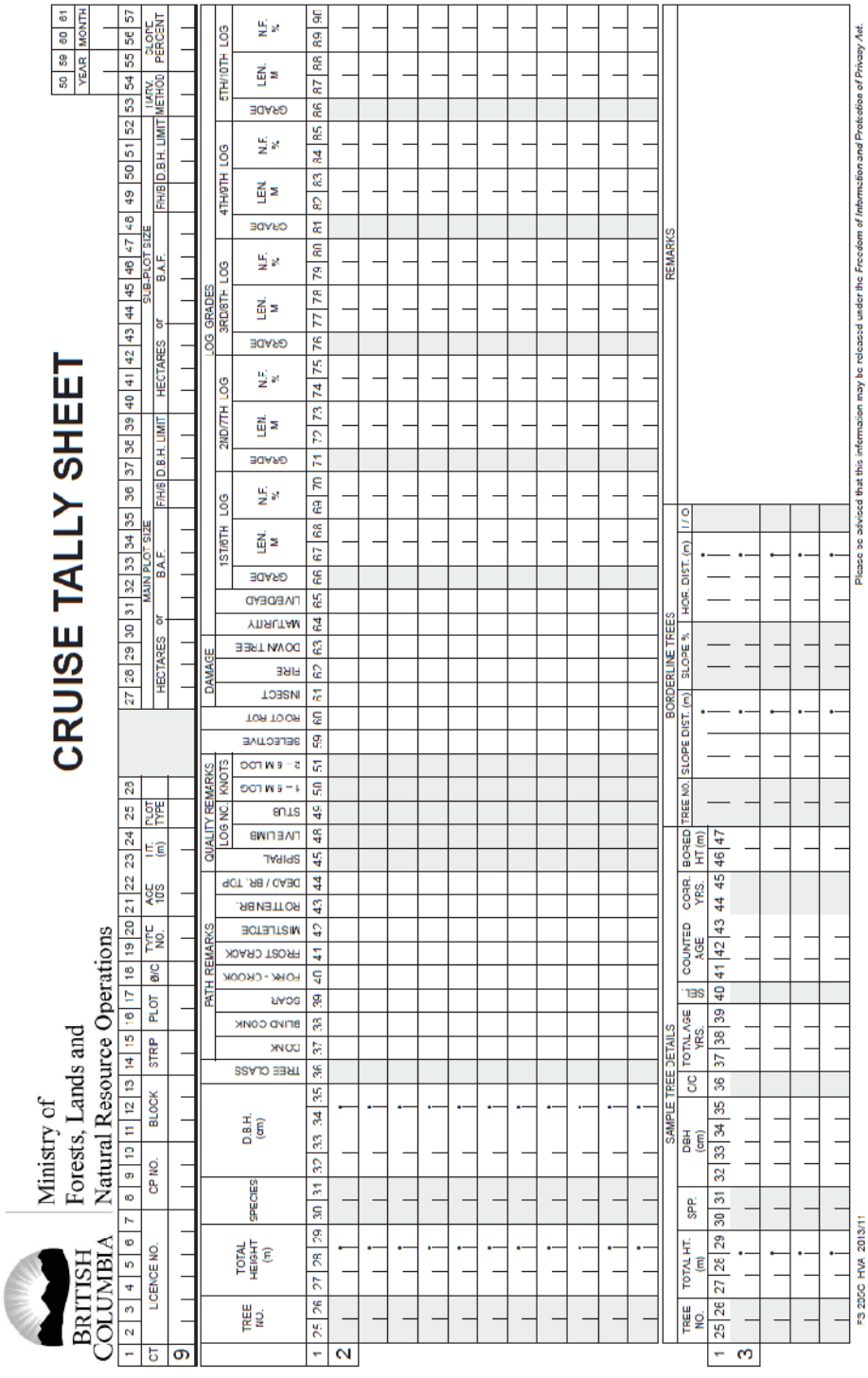

Figure 2.3a Interior Cruise Tally Sheet - Front Side.

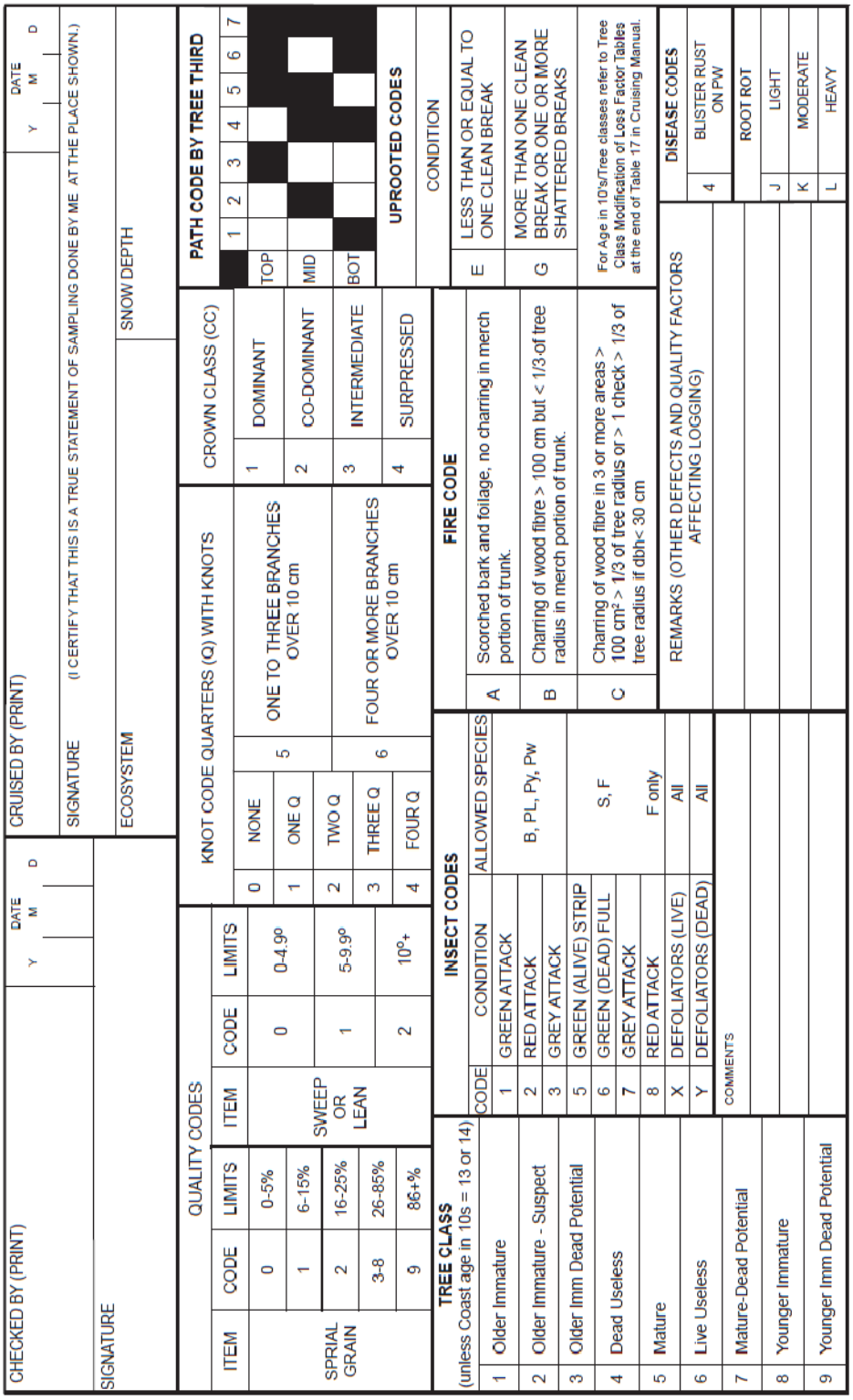

Figure 2.3b Cruise Tally Sheet - Reverse Side.

2.11 Card Type 9 - Plot Identity Information

2.11.1 Table of Data Types

Column Position	Column Name	Accepted Values	Error Type
1	Card type	"9" - hard coded	N/A
2-10	Same as card type A	Same as card type A	W
11-13	Block	XXX	F
14-15	Strip	XX	F
16-17	Plot	XX	F
18	Original or Check	O, C	F
19-20	Type number	99	F
21-22	Age in 10s	99	F
23-24	Height in 3m	Blanks or 99	F
25	Plot type	Blank, C, M, S	F
26	Plot card sequence	Blank - not used[1]	N/A
27-30	Hectares	Blanks or 9 (4, 3)	F
31-35	Basal area factor	Blanks or 9 (5, 3)	F
36	Plot sweep	F, B	F
37-39	DBH limit	9 (3, 1)	F
40-43	Sub-plot hectares	Blanks or 9 (4, 3)	F
44-48	Sub-plot BAF	Blanks or 9 (5, 3)	F
49	Sub-plot prism sweep	Blank or F, H, B	I
50-52	Sub-plot DBH limit	Blanks or 9 (3, 1)	F

Column Position	Column Name	Accepted Values	Error Type
53-54	Harvesting method	Refer to card type F, positions 12-13. Blanks are not permitted	F
55-57	Slope percent	999	F
58-61	Cruise date	YYMM	F

1 This field is used on stump cruise tally cards to indicate ordering of tally sheets when more than one tally sheet is required for a plot. It is not used in a compilation.

2.11.2 Fatal Errors

1. Timber Type must match a valid type from card type C.
2. Block must match a valid block from card type D.
3. Average height field is required for PSYUs Bowron, Longworth, Monkman, Purden and Robson, and for TFL 30.
4. Block/Strip/Plot combinations must be unique.
5. Both Hectares and BAF cannot be coded in a main/sub plot.
6. Count plots are not allowed for a fixed area compilation.
7. For count plots, the Prism Sweep must be full ('F').
8. For interior compilations the card type 9 Main/Sub Plot DBH must be the same as the lowest DBH limit for the cruise plot. Each tree in a count plot must have the DBH or DBH class recorded if the tree has a DBH smaller than the interior timber merchantability requirements.
9. For coast compilations, the card type 9 Main/Sub Plot DBH must be the same as the lowest DBH limit for the cruise plot. Each tree in a count plot must have the DBH or DBH class recorded if the tree has a DBH smaller than the Coast timber merchantability requirements.
10. Harvesting Method must occur on a card type F.
11. Harvesting Method/Timber Type combination must occur on a card type F.

12. Fixed plot areas must be the same for all plots in a type.

13. The date must be included on the tally card.

2.11.3 Warnings

1. Variable plot BAFs should be the same for all plots in a type.

2. There must be at least 2 plots per type for average line method compilations.

3. There must be at least 2 plots per type for each block for block method compilations.

2.11.4 Messages

1. The Sub Plot BAF/plot size are greater than the Main Plot BAF/plot size.

2. If the Sub Plot BAF/plot size are both blank, then the Sub Plot Sweep and DBH should also be blank.

3. Sweep in sub plot must be equal to Sweep in the main plot.

4. Main plot or sub plot DBH lower limit should not be less than the compilation standard or exception DBH lower limit, whichever is lower.

2.12 Card Type 2 - Tree Details

2.12.1 Table of Data Types

Column Position	Column Name	Accepted Values	Error Type
1	Card type	"2" - hard coded	F
2-24	N/A	Identical to card type 9	F
25-26	Tree number	01-99	F
27-29	Total height	9 (3, 1)	F
30-31	Species	Refer to *Cruising Manual*, Section 4.3.2.4	F
32-35	DBH	9 (4, 1)	F
36	Tree class	1-9	F
37	Conk	1-7, Blank	F
38	Blind conk	1-7, Blank	F
39	Scar	1-7, Blank	F
40	Fork or crook	1-7, Blank	F
41	Frost crack	1-7, Blank	F
42	Mistletoe	1-7, Blank	F
43	Rotten branch	1-7, Blank	F
44	Dead top	1-7, Blank	F
45	Spiral grain	0-9	F
46	Sweep	0, 1, 2, Blank (Coast)	F
47	Lean	0, 1, 2, Blank (Coast)	F
48	Log no. of 1st live limb	1-9	F

Column Position	Column Name	Accepted Values	Error Type
49	Log no. of 1st stub	1-9	F
50	Knots in 1st 5 m	0-6	F
51	Knots in 2nd 5 m	0-6	F
52-58	N/A	Not used at this time	N/A
59	Selective	Blank, C, L	F
60	Root rot	Blank 1 – 7, J, K, L	F
61	Insect and disease damage	1, 2, 3, 4, 5, 6, 7, 8, X, Y	W
62	Fire damage	A, B, C	W
63	Blowdown damage	E, G	W

2.12.2 Fatal Errors

1. Cut and leave trees coded in the selective cut column must have a full measure tree recorded, by species for each timber type.

2. For tree class 2, pathological codes are required.

2.12.3 Warnings

1. Insect damage code must be valid for species (refer to the *Cruising Manual*, Section A.6.1). Beetle codes 1, 2 and 3 are allowed in all species of the Pinus genus.

2. Damage codes must be valid for tree class.

Damage Code	1	2	3	4	Tree Class 5	6	7	8	9	Species
1	X	X			X			X		Pl,Py,Pw,B
2	X	X			X			X		Pl,Py,Pw,B
3			X				X		X	Pl,Py,Pw,B
4	X	X			X			X	X	Pw
5	X	X			X			X		S,F
6	X	X			X			X		S,F
7			X				X		X	S,F
8	X	X			X			X		F
X	X	X			X			X		All
Y	X	X	X		X		X	X	X	All
A	X	X	X		X		X	X	X	All
B	X	X	X		X		X	X	X	All
C	X	X	X		X		X	X	X	All
E	X	X	X		X		X	X	X	All
G	X	X	X		X		X	X	X	All

2.12.4 Messages

1. For interior compilations, if the tree DBH is less than the compilation standard DBH lower limit, then the tree will not be used.

2. For coast compilations, if the tree DBH is less than the compilation standard DBH lower limit OR the block maturity DBH lower limit, then the tree will not be used.

3. If the tree class is 4 or 6 and the Tree Class combination is not coded 1, then the tree will only contribute to the snag percent.

4. If the selective cut indicator does not match the card type B selective cut indicator then the tree will not be compiled.

5. A tree with a height less than 3 m will not be used.

6. A tree with no height and the species does not exist on a card type E will not be used.

7. No pathological codes are allowed for tree classes 1, 4, and 6.

8. For tree classes 4 and 6, do not code quality remarks.

2.13 Card Type 3 - Sample Tree Details

2.13.1 Table of Data Types

Column Position	Column Name	Accepted Values	Error Type
2-24	N/A	Identical to card type 9	F
36	Crown class	1-4	I
37-39	Total age	999	F

2.13.2 Messages

1. The tree height is not in range for species in Forest Inventory Zone - refer to Appendix 4.

2. The total age is not in range for species in Forest Inventory Zone - refer to Appendix 5.

2.14 Report 001A - Sample Listing (Partial)

Edit Error Report - Required.

```
FOREST REVENUE BRANCH - 2001.0       COMPUTED 2001-03-19  15:44:21
(001)  PAGE    1


11111111112222222222333333333344444444445555555556666666666777777777 8

12345678901234567890123456789012345678901234567890123456789012345678901234567890
     1     ATL7070001002106CE86000100BD 00000125A  0000000000000 TEST 2000   CRUISER B
                              REPORT DESIGNATOR - CC 38 - INFO MAYBE USED FOR APPRAISALS
                              UTM ZONE - CC 39-40 - IS INVALID
                               DISTRICT NAME = SOUTH ISLAND
                              PSYU VANCOUVER       -
                              UTM ZONE - CC 39-40 - IS INVALID CODE

     2     BTL7070001  00 13217503015010                                                A
N
                              THIS CRUISE WILL BE COMPILED USING AVERAGE LINE METHOD

     3     CTL7070001   01F H C Y 941M200050

     4     CTL7070001   02F B     440M20005000025

     5     DTL70700010010100025                          0200025                        M

     6     DTL70700010020100025                          020002500025                   M

     7     FTL7070001 SC0100050                          0200050

     8     FTL7070001 SS020000000025

     9     GTL7070001CLEARCUT  SELECTION

    10     9TL70700010010101O011342M     12000B175             SC0602010
                              PLOT AGE FOR CONIFEROUS - MATURE            - SEE TABLE 17
PAGE 11
    11     2TL70700010010101O011342014l0Y 11005  7    3   4300           F
```

Figure 2.4 Report 001A.

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Compilation Sequence 3

The compilation program is used to compute *quantitative* estimates for volume, basal area, average diameter and tree count statistics and other related data for a timber cruise. The estimates are reported for both stand total and 'per hectare' values. For example, the total volume and volume per hectare estimates are reported for the timber cruise. In the interior, estimates for lumber recovery and chip yield are also computed.

The estimates for these parameters are reported at the following levels:

1. Timber Type - a stratification of the cutting permit. Trees that belong to a certain type have similar characteristics with respect to species composition, age, size, quality and site index.
2. Cutting Permit - the whole cutting authority area that is compiled..
3. Block - a contiguous area within a cutting authority, made up of 1 or more Timber Types.
4. Harvesting Method - an area within a cutting authority area that is harvested by the same logging system.
5. Treatment Unit - an area of common treatment based on a silvicultural prescription.
6. Plot - an area where tree are sampled. These sampling points provide the estimates for the previous 5 levels.

For each report level, the data may be further broken down into *qualitative* categories such as species, risk group, maturity, damage type, and log grades. The reporting levels are specified in Chapters 8 - 14.

3.1 Compilation Sequence

3.1.1 Step-by-Step Compilation Instructions

Step 1 Perform Edits and Load Data - Inspect each input card from the input file and compare to the list of edits in Chapter 2. If a fatal error is found, stop the compilation and edit the input file. Remove un-compiled trees and load the data for use by subsequent processing. A sample data model relating the input data elements is given in Section 3.4.

Output - Edit Error Report (001a)
- Scattergram of card type 2s and 3s (001b)

Step 2 If there are any trees with no height, then determine the Height-Diameter curves from the sample trees and apply heights as outlined in Chapter 7.

Output - Regression coefficients (003a)
- Scattergram of predicted heights (003b)

Step 3 Calculate Volume - refer to Section 3.3.1 for step-by-step instructions on calculating volumes.

Step 4 Produce Reports - for each of the selected reports, refer to the specific Chapters 8 - 14, which defines the report.

3.1.2 Compilation Dataflow Diagram

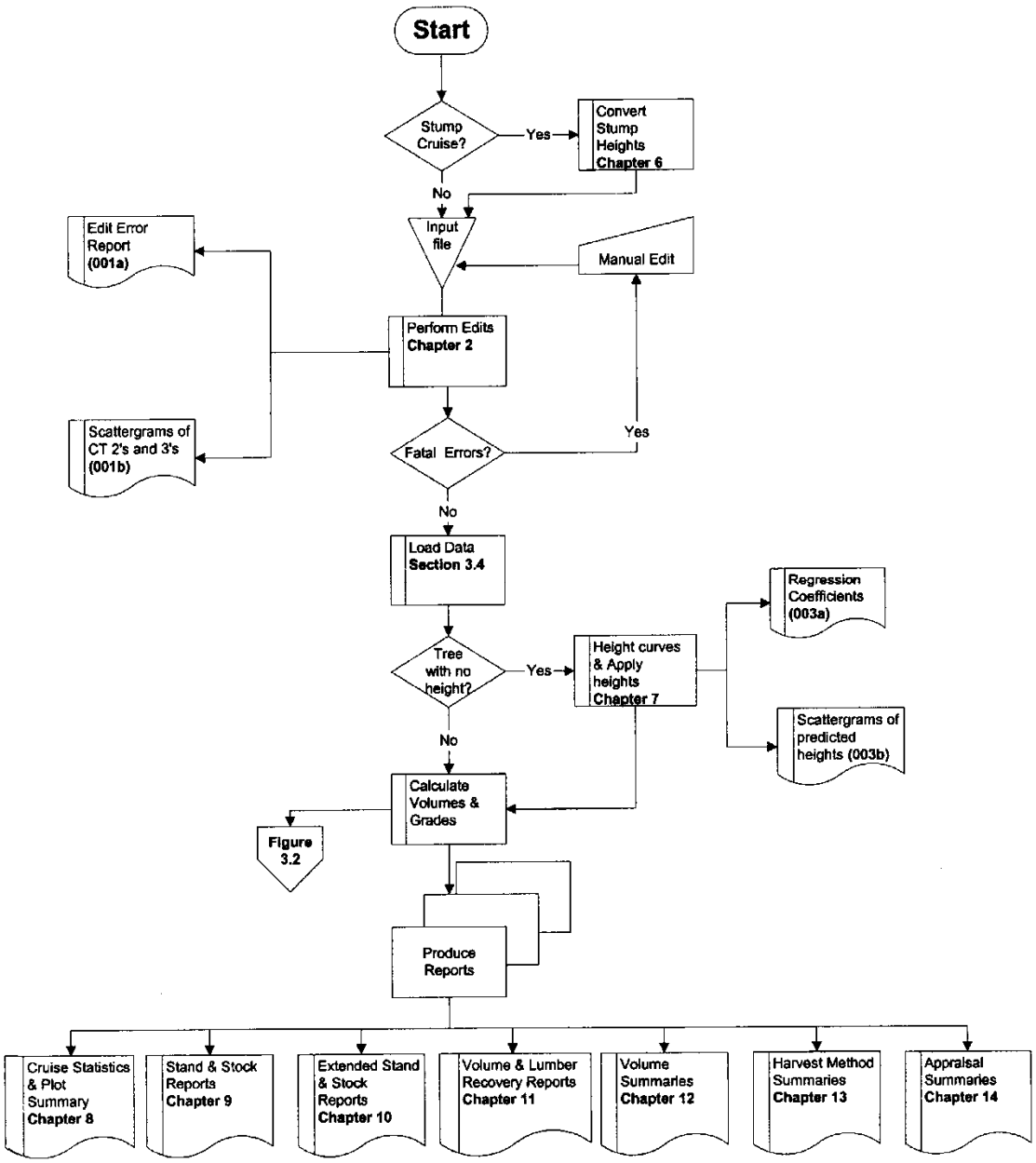


Figure 3.1 Cruise Compilation Sequence.

3.2 Log Volume Calculation - Overview

3.2.1 Step-by-Step Log Volume Calculation Instructions

Only compile the stem count for Western Yew.

Step 1 Set the parameters for calculating the volume of a tree. These are:

1. Forest Inventory Zone.
2. DBH - Diameter at breast height (1.3 m) outside bark in cm to the nearest tenth (e.g., 110.1).
3. Height - Total height in meters to the nearest tenth (e.g., 41.3).
4. Stump ht. - Stump height in meters to the nearest hundredth (e.g., 0.30).
5. Top diam. - Top diameter inside bark in cm to the nearest tenth (e.g., 12.5).
6. Log length - log length in meters to the nearest tenth (e.g., 5.0).

Step 2 Calculate tree volumes - taper equation and volume routine (see Appendix 13).

Use the taper equation and volume routine with the above-defined parameters. This routine will determine:

1. Number of logs in the tree.
2. Volumes for each log.
3. Top diameters for each log.
4. Length of top log.
5. Butt diameter for 1st log.
6. Gross merchantable volume - from stump height to top diameter.
7. Biological volume - from ground to top of tree.

Step 3 Determine loss factor table.

1. Use FIZ tables unless a local loss factor exists for the Unit. All local factors apply only to mature volumes (i.e., 121 years or greater). Refer to Table 17 of the *Cruising Manual*.

2. Determine maturity based on tree class and age. Refer to the Tree Class Modification of Loss Factors in Table 17 of the *Cruising Manual* at the above URL.

3. Determine Risk Group based on tree class and Section 3.5.6, pathological remarks, and damage.

   Tree Class - Tree classes 3, 4, 6, 7 & 9 automatically go to highest Risk Group. The exception being Tree Class 7 Lodgepole Pine in the Interior. These stems will be classed as Risk Group 2. Conk, Blind conk, fire code C and blowdown code G will move these stems into Risk Group 3.

   Pathological Indicators - Tree class 1, 2, 5 & 8 trees start at the lowest risk group and are then placed into a higher risk group, depending on pathological indicators. Refer to Table 18 in the *Cruising Manual*.

   Damage Codes - trees are further moved into higher risk groups depending on the damage codes associated with them.

   Insect Damage

   If the Risk Group is not 2 or 3, then increase the Risk Group by 1 for insect damage codes 1, 2, 3, 4, 6, 7 and 8.

   Fire Damage

   There is no change in Risk Group for fire damage code A.

   If the Risk Group is not 2 or 3, and the tree class is 1, 2, 5 or 8, then increase the Risk Group by 1 for fire damage code B. For other tree classes, use the highest Risk Group.

   Use the highest Risk Group for fire damage code C.

Blowdown Damage

There is no change in Risk Group for blowdown code E.

For blowdown damage code G, use the highest Risk Group.

For cedar loss factor table 296, the Risk Group is based on the average height from card type 9. If the average height <= 40, then the risk group is 2. Otherwise, the Risk Group is 1.

4. Determine diameter class, based on DBH. Refer to Appendix 14.

Step 4 Apply loss factors - refer to the "*Cruise Compilation Loss Factor Table Manual*", 1976, for the specific table. Reduce the tree volume by the specified percentages. Apply the loss factors individually and in the order {Decay → Waste → Breakage}.

For mature coast cottonwood, a flat rate of 15 percent is applied in lieu of the loss factors.

For interior Lodgepole Pine addition breakage factors are reduced from gross volume based on insect damage codes and/or tree classes.

The additional breakage factor for all risk group 3 stems is zero (0).

Tree Classes	Damage Code	Breakage Factor Add On
1, 2, 5, 8	No insect code	0
1, 2, 5, 8	1	0
1, 2, 5, 8	2	7.5
3, 7, 9	3	20.0
3, 7, 9	No insect code	20.0

Step 5 If count and measure plots have been tallied, calculate the double sampling ratios (DSR) for each tallied species. The DSR adjusts stem count, basal area, and volume estimates. When using the Average Line method, calculate a DSR for each Timber Type. When using the Block method, calculate a DSR for each Timber Type, each Timber Type within Block and each Timber Type within Harvesting Method.

For tree classes 4 & 6, use 1.0 (i.e., no adjustment in volume).

Use 1.0 for Western Yew (i.e., no adjustment in stem count).

Output - Double Sampling Ratios (004b)

Example: Fir DSR for a Timber Type

$$DSR(fir) = \frac{\#\ of\ meas\ plots.}{Total\ \#\ of\ plots} * \frac{(\#\ fir\ trees)*(avg.BAF\ \ all\ \ fir\ trees)}{(\#\ meas.\ fir\ trees)*(avg.BAF\ \ meas.\ fir)}$$

To calculate the average BAF , sum the basal area factors of all the trees in the type and divide by the number of trees in the type. Refer to Section 3.5 for a detailed explanation of the calculation of number of trees and basal area factors.

Example 3.4 - Double Sampling Ratio

Refer to Figure 3.4 for a sample Double Sampling Ratio Report.

In Block 2, Type 2 there are 2 measure plots and 2 count plots. One measure plot is a border plot and has a BAF of 8. The other measure plot is a full plot with a BAF of 10. Both count plots are full plots with BAFs of 8 and 10.

There was 1 cedar tallied in each of the plots. The cedar tallied in the border plot would count as 2.

The average basal area for all cedars is (8 + 8 + 8 + 10 + 10) / 5 = 8.8
The average basal area for all measured cedar is (8 + 8 + 10) / 3 = 8.66

$$DSR(cedar) = \frac{2}{4} * \frac{5*8.8}{3*8.66} = 0.84615373$$

Step 6 If a percent reduction is being compiled, determine whether there is an eligible reduction for the tree. Refer to Chapter 5 for Percent Reduction handling.

Step 7 Double the volume, basal area and tree count for border plots.

Step 8 Calculate grade percents (Appendices 9 and 10).

Each log is graded and the volume for that log is reported for that grade.

3.2.2 Calculate Volumes and Grades

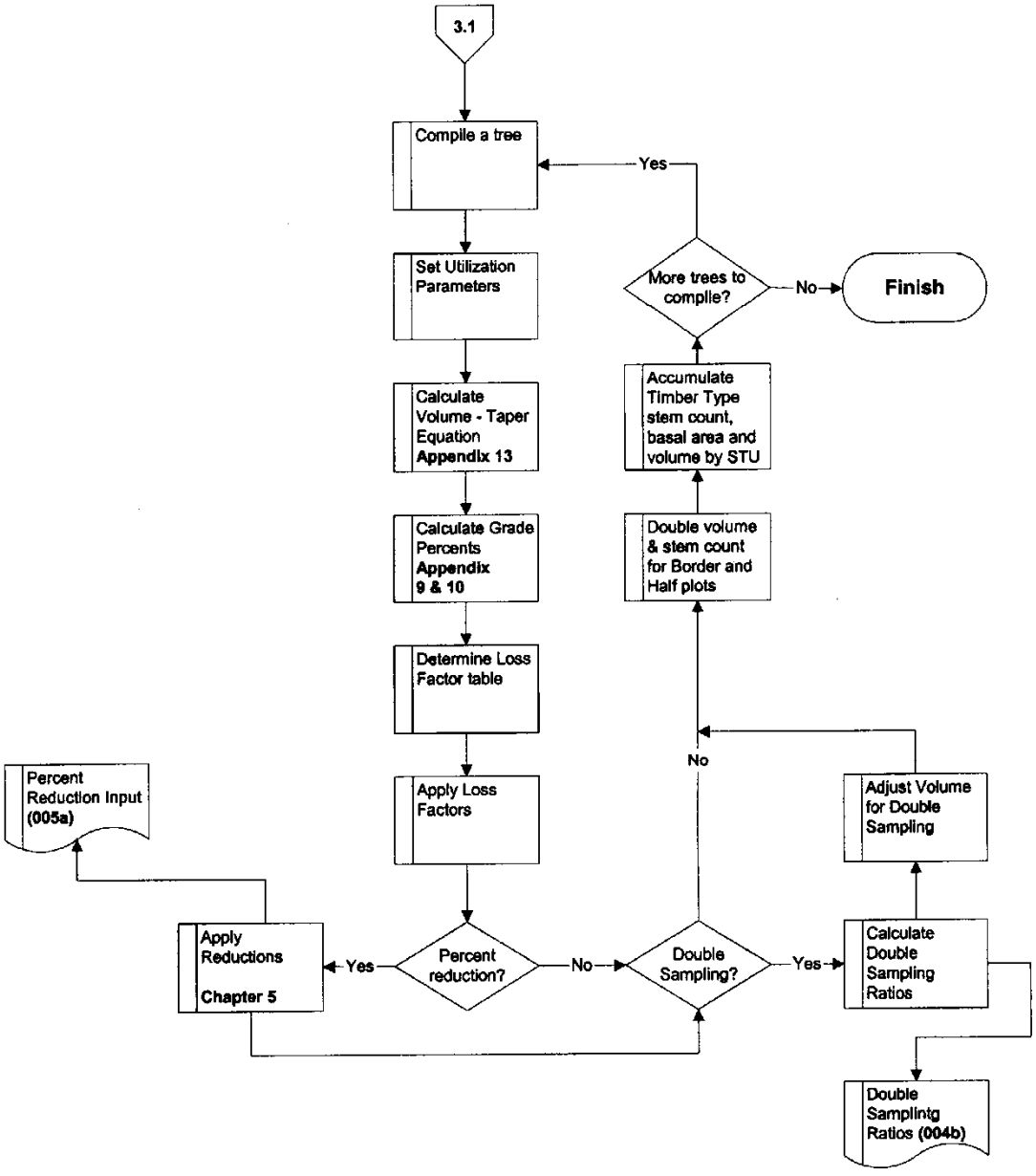


Figure 3.2 Log Volume Calculation.

3.3 Sample Data Model

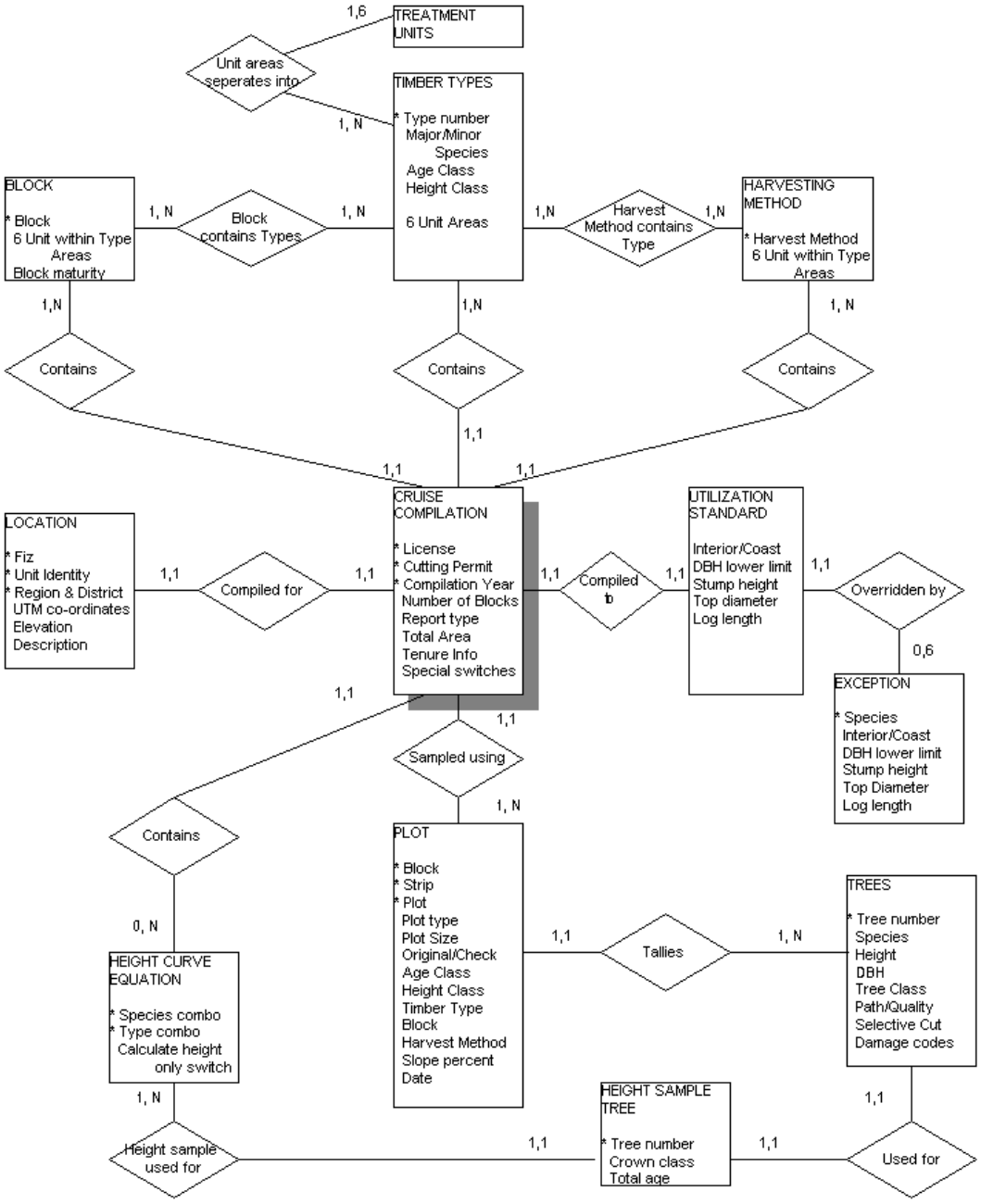


Figure 3.3 Input Data Relationships.

This diagram is only a sample of the input data relationships. Many different views would be required to perform all the reporting calculations.

Read the cardinality rules as: "1 Cruise Compilation CONTAINS 1 or many Harvesting Methods", "1 Tree can be USED FOR 1 Height Sample Tree" etc.

3.4 Plot Types

There are two methods of plot sampling, which correspond to the *type* of plot being cruised. The types of plots are fixed area plots and variable plots, also known as prism plots. Both of these plot types have associated methods for estimating the following quantitative values (as well as any other 'per hectare' value required for a compilation):

1. Volume per hectare.

2. Basal area per hectare.

3. Number of trees per hectare.

Further, each of the plot types can identify a sub-plot, which will alter the calculations of the above parameters for certain trees in the plot, depending on the specified DBH of the tree.

Generally speaking, the two types of sampling cannot be mixed. However, in a stratified stand with more than one Timber Type, it is permissible to use fixed area plots for one Type and prism plots for another Type.

3.4.1 Prism Plots

Prism plots are identified by the presence of a BAF in columns 32 - 35 of card type 9. The BAF may change between plots in a Timber Type.

A prism plot may be a measure plot or a count plot, as indicated by an "M" or a "C" in column 25 of card type 9. The presence of count plots indicates "double sampling" which requires a method of adjusting the plot estimates despite recording only the species of each tree. Plot estimates are adjusted using a factor called the Double Sampling Ratio, described in Section 3.3.1.

If a species is tallied in a count plot, it must also occur in a measure plot.

Count plots cannot be border plots.

Tree classes 4 and 6 are not permitted in count plots.

For count plots, the DBH lower limit specified in columns 37 - 39 of card type 9 must be the same as the DBH lower limit from card type B.

The plot sweep for prism plots may be "F" (full) or "B" (border) and is located in column 36 of card type 9. For border plots, each tree tallied will contribute double to the estimates of the plot parameters, i.e. volume, basal area and tree count.

Use the following methods for calculating the plot estimates. The tree class 4 and 6 trees (snags) will be estimated independently from the other trees (stems).

3.4.1.1 Number of Trees per Hectare

Each tree contributes:

$$S_t = \frac{BAF_t * 12732.39545}{DBH^2} * DSR_t * R_t$$

To the number of stems (or snags) per hectare. So,

$$S_p = \sum_{t=1}^{np} S_t$$

Example 3.1

Plot 1, Type 1 has two (2) Spruce trees in it. Spruce is reduced by 30 percent in all diameter classes. BAF = 10. Tree one has a DBH of 56.0 and tree two has a DBH of 51.1. The Double Sampling Ratio is 1.

Tree 1 $S_{t,1} = \frac{10 * 12732.39545}{56.0^2} * 1 * (1 \quad 30 / 100)$ = 28.4 stems per hectare

Tree 2 $S_{t,2} = \frac{10 * 12732.39545}{51.1^2} * 1 * (1 \quad 30 / 100)$ = 34.1 stems per hectare

$S_p = 28.4 + 34.1$ = 62.5 stems per hectare

Where:

S_t = Stems per hectare estimate for tree t.

S_p = Stems per hectare estimate for plot p.

n_p = Number of trees in plot p.

BAF_t = Basal area factor for tree t in plot p.

DBH_t = Diameter at 1.3 m outside bark for tree t.

DSR_t = Double Sampling Ratio for tree t (see Section 3.3.1).

R_t = Post-reduction percent for tree t (1 - reduction percent / 100).

Double this estimate if the plot is a border or a half plot.

3.4.1.2 Basal Area per Hectare

$$BA_p = \sum_{t=1}^{n_p} BAF_t * DSR_t * R_t$$

Where:

BA_p = Basal area/hectare estimate for plot p.

n_p = Number of trees in plot p.

BAF_t = Basal area factor for tree t in plot p.

DBH_t = Diameter at 1.3 m outside bark for tree t.

DSR_t = Double Sampling Ratio for tree t (see Section 3.3.1)

R_t = Post-reduction percent for tree t (see Example 5.5).

Double this estimate if the plot is a border plot.

3.4.1.3 Volume per Hectare

Each tree contributes:

$$V_t * \frac{BAF_t * 12732.39545}{DBH_t^2} * DSR_t * R_t$$

To the volume per hectare.

$$V_p = \sum_{t=1}^{n_p} V_t$$

Where:

V_p = Gross merchantable volume per hectare estimate for plot p.

n_p = Number of merchantable trees in plot p.

BAF_t = Basal area factor for tree t in plot p from card type 9.

DBH_t = Diameter at 1.3 m outside bark for tree t.

V_t = Gross merchantable volume for tree t (see Appendix 13).

DSR_t = Double Sampling Ratio for tree t (see Section 3.3.1).

R_t = Post-reduction percent for tree t (see Example 5.5).

The procedure for calculating the merchantable volume of a tree is described in Section 3.3.

Double this estimate if the plot is a border plot.

Sub-plots may be used for prism plots and are detected by the presence of a sub-plot basal area factor in columns 44-48 of card type 9, which differs from the main plot DBH. There will be a corresponding DBH lower limit for the sub-plot in columns 50-52, which will also differ from the main plot DBH lower limit.

If the sub-plot DBH is smaller than the main plot DBH, then the smaller trees in the plot will use the sub-plot BAF and plot sweep in the above calculations. Conversely, if the sub-plot DBH is larger than the main plot DBH, then the larger trees in the plot will use the sub-plot BAF and plot sweep.

For example, if the main plot DBH lower limit is 17.5 and the sub-plot DBH lower limit is 27.5, then trees with DBH between 17.5 and 27.4 would be processed using the main plot BAF and plot sweep. Trees with DBH of 27.5 or more would be processed using the sub-plot BAF and plot sweep. Together, the main plot and sub-plot count as 1 plot.

3.4.2 Fixed Area Plots

Fixed area plots are identified by the presence of a plot size, in hectares, in columns 27-30 of card type 9. The plot size must be the same for all plots in a timber type. Unlike prism plots, fixed area plots cannot be count plots.

The plot sweep for fixed area plots must be full or border.

Use the following methods for calculating the plot estimates. The tree class 4 and 6 trees (snags) will be estimated independently from the other trees (stems).

3.4.2.1 Number of Trees per Hectare

Each tree contributes: $$S_t = \frac{Area\ one\ hectare}{Plot\ Size} * R_t$$

Each species contributes: $$S_p = \sum_{t=1}^{np} S_t$$

Example 3.2

Plot 1, Type 1 has two (2) Spruce trees in it. Spruce is reduced by 30 percent in all diameter classes. The area of the plot is 400 m^2. Tree one has a DBH of 56.0 and tree two has a DBH of 51.1. There is no Double Sampling Ratio because count plots are not used with fixed area sampling.

Tree 1 $$S_{t,1} = \frac{10\ 000}{400} * (1 \quad 30 / 100)$$ = 17.5 stems per hectare

Tree 2 $$S_{t,2} = \frac{10\ 000}{400} * (1 \quad 30 / 100)$$ = 17.5 stems per hectare

$$S_p = 17.5 + 17.5$$ = 35.0 stems per hectare

Where:

S_p	=	Stems per hectare estimate for plot p.
n_p	=	Number of trees in plot p.
R_t	=	Post-reduction percent for tree t (1 - reduction percent / 100).
S_t	=	Number of trees per hectare tree t represents.
Area one hectare	=	10,000 m^2
plotsize	=	Area of plot from card type 9.

Double this estimate if the plot is a border plot.

3.4.2.2 Basal Area per Hectare

The basal area for each tree is calculated as pi (DBH/200)^2 (i.e., the area of a circle whose diameter is the DBH for the tree).

$$BA_p = \frac{\sum_{t=1}^{n_p} pi \left(DBH_t / 200 \right)^2}{plot\ size} * R_t$$

Where:

BA_p = Basal area (m^2) per hectare estimate for plot p.

n_p = Number of trees in plot p.

DBH_t = Diameter (cm) at 1.3 m outside bark for tree t.

pi = 3.14159

R_t = Post-reduction percent for tree t (1 - reduction percent / 100).

Double this estimate if the plot is a border plot.

3.4.2.3 Volume per Hectare

$$V_p = \sum_{t=1}^{n_p} S_t V_t$$

Where:

V_p = Gross merchantable volume per hectare estimate for plot p.

n_p = Number of trees in plot p.

V_t = Gross merchantable volume for tree t.

S_t = Number of trees per hectare that tree t represents.

Double this estimate if the plot is a border plot.

The procedure for calculating the volume of a tree is described in Section 3.3.

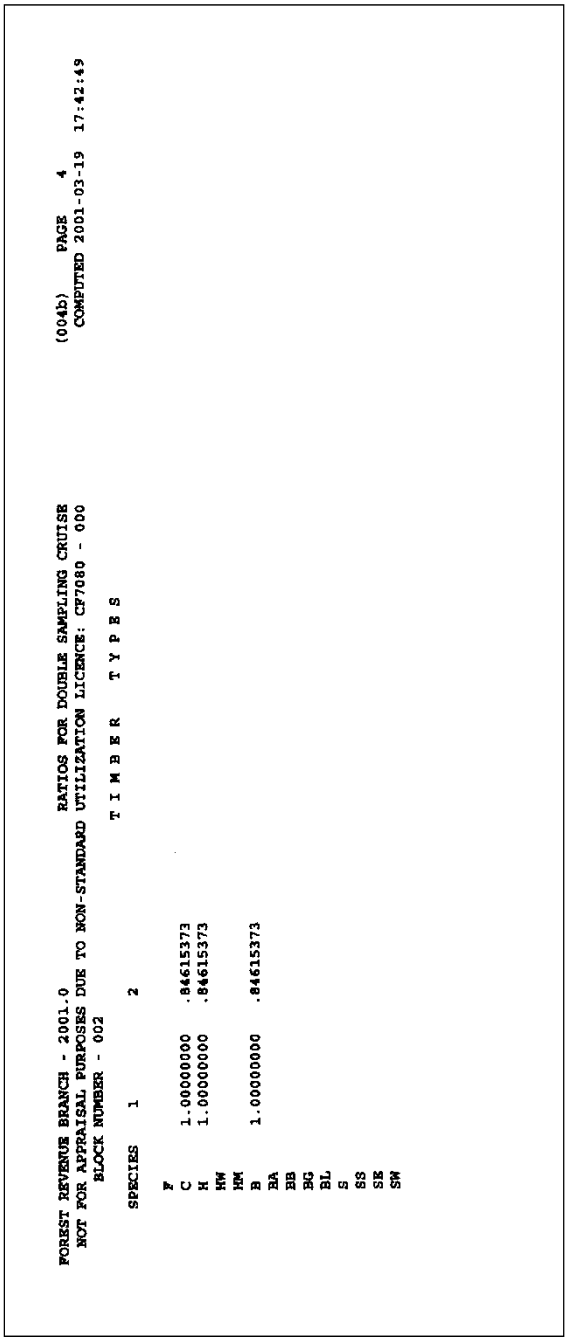
Sub plots are also permitted for fixed area plots and are detected by the presence of a sub-plot size in columns 40-43 of card type 9. There will be a corresponding DBH lower

limit in columns 50-52, which will also differ from the main plot DBH lower limit. Use the same logic as is used for prism plots to determine which trees use the sub-plot parameters and which trees use the main plot parameters.

3.5 Double Sampling Ratio - Sample Listing

Report 004b - Sample listing (partial).

Double Sampling Ratios - required.



```
FOREST REVENUE BRANCH - 2001.0                RATIOS FOR DOUBLE SAMPLING CRUISE                (004b)    PAGE   4
 NOT FOR APPRAISAL PURPOSES DUE TO NON-STANDARD UTILIZATION LICENCE: CF7080 - 000                COMPUTED 2001-03-19  17:42:49
      BLOCK NUMBER - 002
                                                T I M B E R   T Y P E S
 SPECIES   1          2

  F
  C      1.00000000   .84615373
  H      1.00000000   .84615373
  HW
  HM
  B      1.00000000   .84615373
  BA
  BB
  BG
  BL
  S
  SS
  SE
  SW
```

Figure 3.4 Report 004b.

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Damage Reports 4

Whenever the codes for Blowdown, Fire and/or Insect damage are detected on card type 2s, damage reports are produced in addition to the normal (non-damage related) output. These reports will segregate the reported volumes into separate damage types and/or codes, as indicated. Root rot damage is reported for block summaries only and is optional.

The damage reports will be the same as the normal output, only there will be a designation of species and damage type and damage codes on the report.

Damage Type	Code	Description	Species
Blowdown	E	Down trees	All Species
	G	Down and shattered trees	All Species
Fire	A	Light fire	All Species
	B	Medium fire	All Species
	C	Heavy fire	All Species
Insect/Disease	1	Green attack	Balsam, Pine
	2	Red attack	Balsam, Pine
	3	Grey attack	Balsam, Pine
	4	Blister rust	White Pine
	5	Green attack - alive	Spruce, Douglas Fir
	6	Green attack - dead	Spruce, Douglas Fir
	7	Grey attack - dead	Spruce, Douglas Fir

Damage Type	Code	Description	Species
	8	Red attack	Douglas Fir
	X	Defoliator G live cambium	All Species
	Y	Defoliator D dead cambium	All Species
Root Rot	J	Light	All Species
	K	Moderate	All Species
	L	Heavy	All Species

4.1 List of Damage Reports

The following damage reports are required for damage types Blowdown, Fire, and Insect:

1. 006 Extended Forest Type Stand and Stock Table, one page with all trees, one page with non-damaged trees, and one page for each Blowdown, Fire, or Insect damage code.

2. 007 Stand and Stock Tables, one page for each species and damage type containing each of the damage codes for that damage type.

    i 007a Block Stand Table.

    ii 007b Block Stock Table.

    iii 007c Block Basal Area.

    iv 007d Timber Type Stand Table.

    v 007e Timber Type Stock Table.

    vi 007f Timber Type Basal Area.

    vii 007g Cutting Permit Stand Table.

    viii 007h Cutting Permit Stock Table.

    ix 007i Cutting Permit Basal Area.

3. 009 Volume Summaries, one page for each species and damage type reporting each of the damage codes for that damage type.

    i 009a Timber Type Summary.

    ii 009b Block Summary.

    iii 009c Cutting Permit Summary.

    iv 009d Treatment Unit within Block Summary - Coast only.

4. 011 Plot Summary, damage code volumes segregated for each species.

5. 015 Harvesting Method Summary, percent net volumes will be segregated for each Harvesting Method under the headings Fire, Heavy Fire (Damage code C), Down trees, and Insect damage.

The following damage reports are optional:

1. 009b Root Rot Block Summary.

4.2 Damage Report Calculation

Trees with multiple damage codes will report each damage type in the *Damage Summary Reports*. The damage code or codes that will assign the highest risk group will be used in the calculation of the net volume for each of the damage types. If pathological indicator(s) move the risk group higher than the damage code(s) then use the risk group from the pathological indicator(s) to calculate the *Damage Summary Reports*.

Example

Cruise = 1 ha, 1 plot, 1.0 m^3 mature Lodgepole Pine tree that respresents 100 stems/ha with down tree code G, fire code B and insect 3:

Risk groups (RG) -Down Tree = RG3, Fire = RG2, Insect 3 = RG 2. Use RG 3 since it is the highest risk group.

Volume - Hypothetical loss factor DWB = 30% plus 20% for the grey attack breakage add-on = 50%.

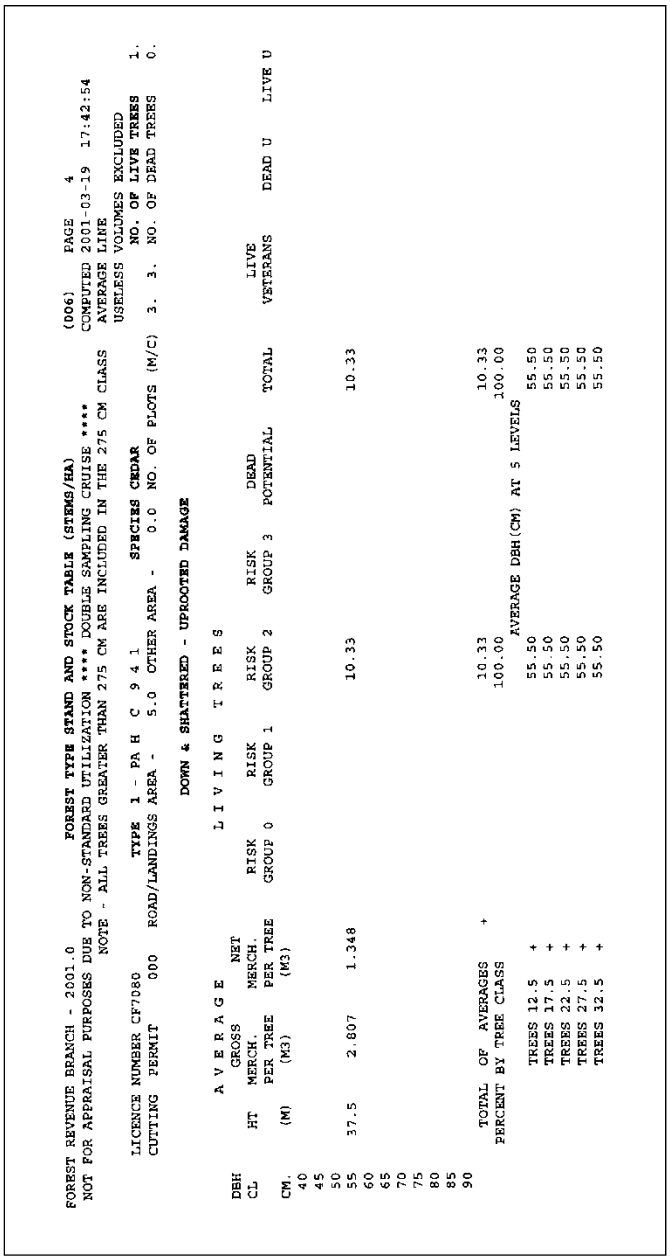
Tree = 1.0 m^3 - 0.5 m^3. Cruise volume per hectare = 0.5 * 100 stems = 50 m^3.

Damage reports -Type, Block and Cutting Permit Damage Report Net Volume = 50 m^3 for Lodgepole pine Down Tree (G), Fire (B) and Insect (3).

4.3 Sample Damage Report Listings

Some of the DBH classes have been removed from these sample listing.

4.3.1 Extended Forest Type Stand and Stock Damage Report - Sample Listing



FOREST REVENUE BRANCH - 2001.0 FOREST TYPE STAND AND STOCK TABLE (STEMS/HA) (D06) PAGE 4
NOT FOR APPRAISAL PURPOSES DUE TO NON-STANDARD UTILIZATION **** DOUBLE SAMPLING CRUISE **** COMPUTED 2001-03-19 17:42:54
NOTE - ALL TREES GREATER THAN 275 CM ARE INCLUDED IN THE 275 CM CLASS AVERAGE LIVE
USELESS VOLUMES EXCLUDED

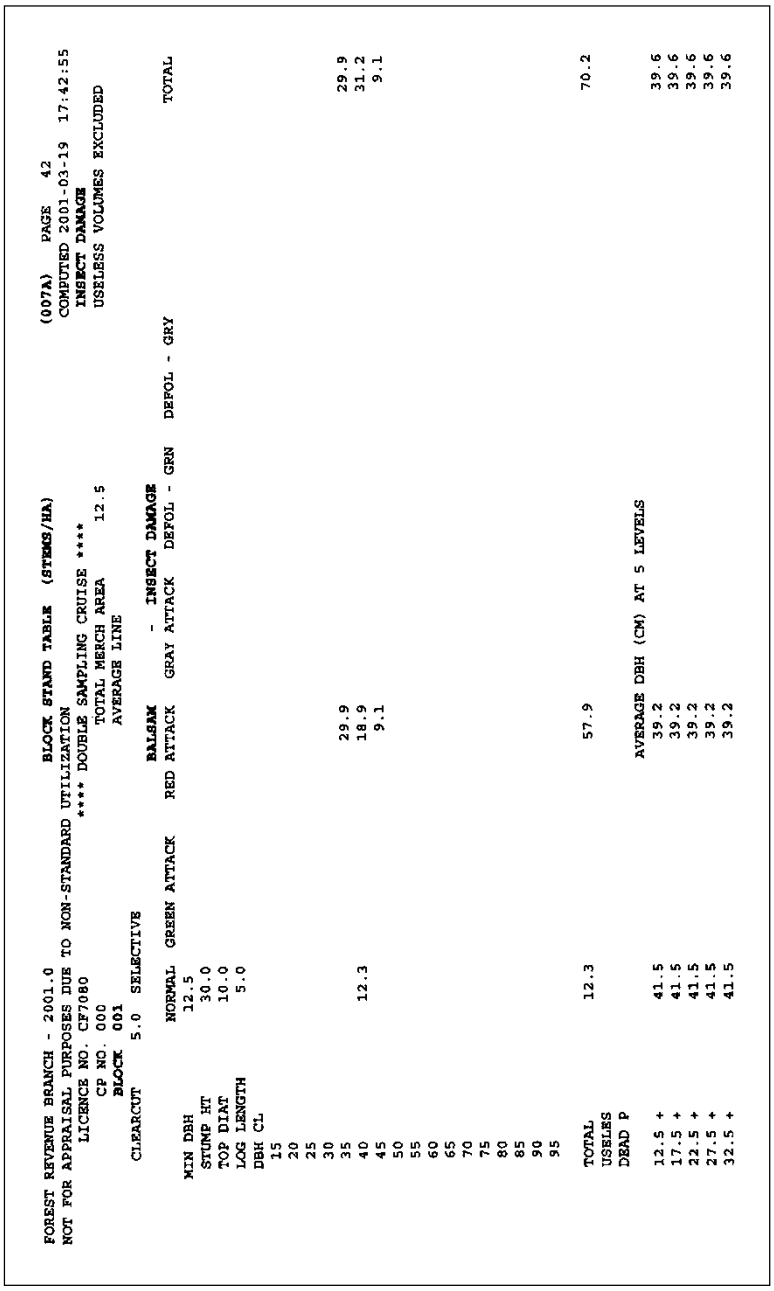
LICENCE NUMBER CF7080 TYPE 1 - PA H C 9 4 1 SPECIES CEDAR NO. OF LIVE TREES 1.
CUTTING PERMIT 000 ROAD/LANDINGS AREA - 5.0 OTHER AREA - 0.0 NO. OF PLOTS (M/C) 3. 3. NO. OF DEAD TREES 0.

DOWN & SHATTERED - UPROOTED DAMAGE

DBH CL	A V E R A G E HT	GROSS MERCH. PER TREE (M3)	NET MERCH. PER TREE (M3)	L I V I N G T R E E S RISK GROUP 0	RISK GROUP 1	RISK GROUP 2	RISK GROUP 3	DEAD POTENTIAL	TOTAL	LIVE VETERANS	DEAD U	LIVE U
CM.	(M)											
40												
45												
50												
55	37.5	2.807	1.348			10.33			10.33			
60												
65												
70												
75												
80												
85												
90												
TOTAL OF AVERAGES +						10.33			10.33			
PERCENT BY TREE CLASS						100.00			100.00			
						AVERAGE DBH(CM) AT 5 LEVELS						
TREES 12.5 +						55.50			55.50			
TREES 17.5 +						55.50			55.50			
TREES 22.5 +						55.50			55.50			
TREES 27.5 +						55.50			55.50			
TREES 32.5 +						55.50			55.50			

Figure 4.1 Extended Forest Type Stand and Stock Damage Report - Sample Listing (Partial).

4.3.2 Block Stand Damage Table - Sample Listing



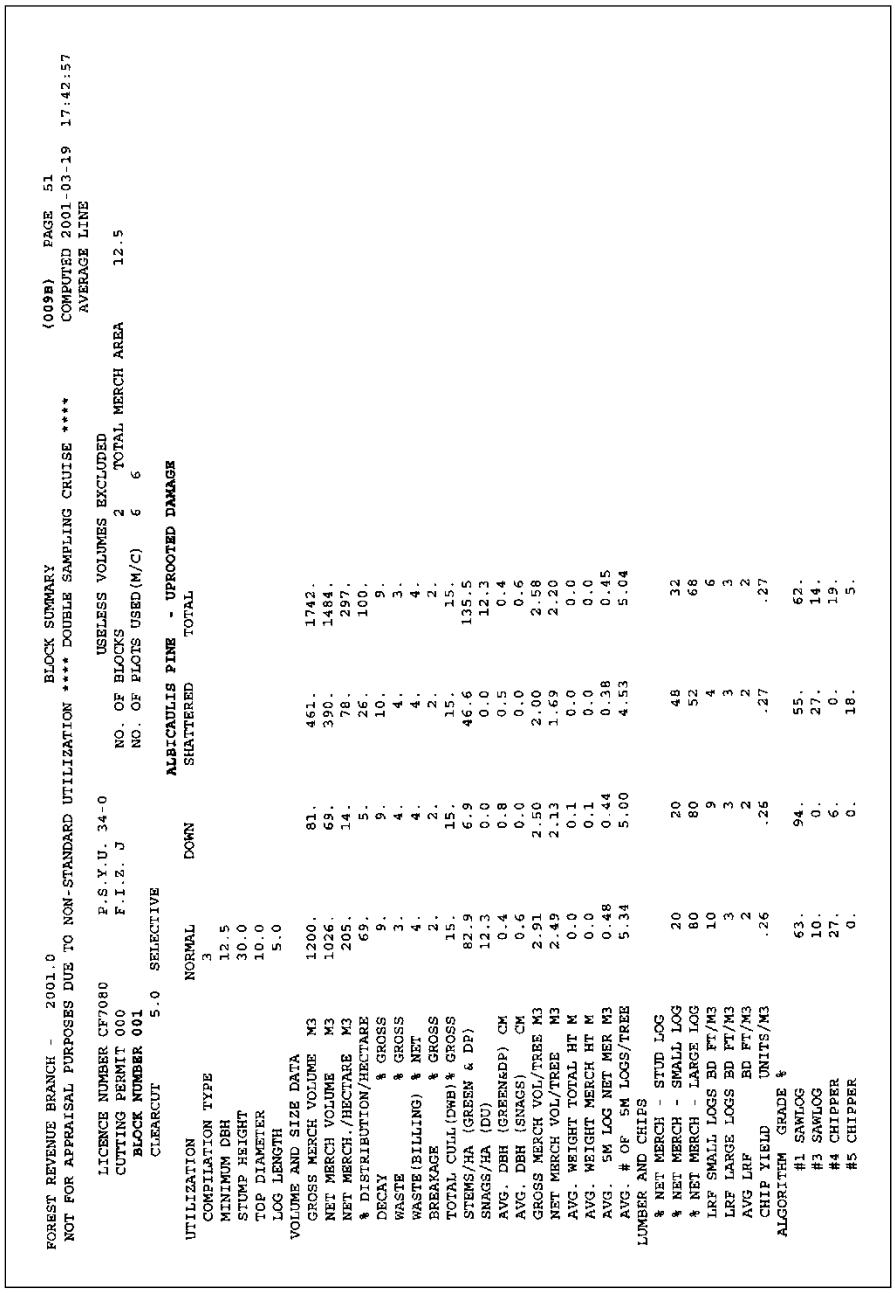
FOREST REVENUE BRANCH - 2001.0 BLOCK STAND TABLE (STEMS/HA) (007A) PAGE 42
NOT FOR APPRAISAL PURPOSES DUE TO NON-STANDARD UTILIZATION COMPUTED 2001-03-19 17:42:55
LICENCE NO. CF7080 **** DOUBLE SAMPLING CRUISE **** INSECT DAMAGE
CP NO. 000 TOTAL MERCH AREA 12.5 USELESS VOLUMES EXCLUDED
BLOCK 001 AVERAGE LINE
CLEARCUT 5.0 SELECTIVE 5.0

		BALSAM - INSECT DAMAGE				
	NORMAL	GREEN ATTACK	RED ATTACK	GRAY ATTACK	DEFOL - GRN	DEFOL - GRY	TOTAL
MIN DBH	12.5						
STUMP HT	30.0						
TOP DIAT	10.0						
LOG LENGTH	5.0						
DBH CL							
15							
20							
25							
30			29.9				29.9
35			18.9				31.2
40		12.3	9.1				9.1
45							
50							
55							
60							
65							
70							
75							
80							
85							
90							
95							
TOTAL	12.3		57.9				70.2
USELES							
DEAD P							

	AVERAGE DBH (CM) AT 5 LEVELS	
12.5 +	41.5	39.2	39.6
17.5 +	41.5	39.2	39.6
22.5 +	41.5	39.2	39.6
27.5 +	41.5	39.2	39.6
32.5 +	41.5	39.2	39.6

Figure 4.2 Block Stand Damage Table - Sample Listing (Partial).

4.3.3 Block Volume Summary Damage Report - Sample Listing



```
FOREST REVENUE BRANCH -   2001.0                          BLOCK SUMMARY                          (009B)   PAGE  51
 NOT FOR APPRAISAL PURPOSES DUE TO NON-STANDARD UTILIZATION **** DOUBLE SAMPLING CRUISE ****        COMPUTED 2001-03-19  17:42:57
                                                                                                     AVERAGE LINE
       LICENCE NUMBER CF7080       P.S.Y.U. 34-0              USELESS VOLUMES EXCLUDED
       CUTTING PERMIT 000          F.I.Z. J          NO. OF BLOCKS          2    TOTAL MERCH AREA      12.5
         BLOCK NUMBER 001                            NO. OF PLOTS USED(M/C)   6    6
         CLEARCUT       5.0  SELECTIVE
                                                  ALBICAULIS PINE  - UPROOTED DAMAGE
 UTILIZATION                  NORMAL       DOWN      SHATTERED     TOTAL
   COMPILATION TYPE             3
   MINIMUM DBH                  12.5
   STUMP HEIGHT                 30.0
   TOP DIAMETER                 10.0
   LOG LENGTH                    5.0
 VOLUME AND SIZE DATA
   GROSS MERCH VOLUME  M3      1200.         81.        461.       1742.
   NET MERCH VOLUME    M3      1026.         69.        390.       1484.
   NET MERCH./HECTARE  M3       205.         14.         78.        297.
   % DISTRIBUTION/HECTARE        69.          5.         26.        100.
   DECAY          % GROSS         9.          9.         10.          9.
   WASTE          % GROSS         3.          4.          4.          3.
   WASTE(BILLING) % NET           4.          4.          4.          4.
   BREAKAGE       % GROSS         2.          2.          2.          2.
   TOTAL CULL(DWB)% GROSS        15.         15.         15.         15.
   STEMS/HA (GREEN & DP)        82.9         6.9        46.6       135.5
   SNAGS/HA (DU)                12.3         0.0         0.0        12.3
   AVG. DBH (GREEN&DP) CM        0.4         0.8         0.5         0.4
   AVG. DBH (SNAGS)    CM        0.6         0.0         0.0         0.6
   GROSS MERCH VOL/TREE M3      2.91        2.50        2.00        2.58
   NET MERCH VOL/TREE   M3      2.49        2.13        1.69        2.20
   AVG. WEIGHT TOTAL HT M        0.0         0.1         0.0         0.0
   AVG. WEIGHT MERCH HT M        0.0         0.1         0.0         0.0
   AVG.  5M LOG NET MER M3      0.48        0.44        0.38        0.45
   AVG. # OF  5M LOGS/TREE      5.34        5.00        4.53        5.04
LUMBER AND CHIPS
   % NET MERCH - STUD LOG
   % NET MERCH - SMALL LOG        20          20          48          32
   % NET MERCH - LARGE LOG        80          80          52          68
   LRF SMALL LOGS BD FT/M3        10           9           4           6
   LRF LARGE LOGS BD FT/M3         3           3           3           3
   AVG LRF        BD FT/M3         2           2           2           2
   CHIP YIELD     UNITS/M3       .26         .26         .27         .27
 ALGORITHM  GRADE %
        #1 SAWLOG                63.         94.         55.         62.
        #3 SAWLOG                10.          0.         27.         14.
        #4 CHIPPER               27.          6.          0.         19.
        #5 CHIPPER                0.          0.         18.          5.
```

Figure 4.3 Block Volume Summary Damage Report - Sample Listing.

Reduction Compilations 5

5.1 Reduction Compilations - Overview

Reduction compilations use the Percent Reduction Worksheet form (FS 221 - Figure 5.1). This data is contained in a separate input file that must be submitted in ASCII format showing reductions by Treatment Unit when requested.

A version number will be placed on the top row of the ASCII file. It will start with a V followed by the year, followed by a decimal point, followed by two digits. For example, the first version in a year would be V2005.00 and the next version in the same year would be 2005.01.

Unique types should be used when a partial reduction is planned for a single block when the type being reduced extends across multiple blocks. Another use for unique types would be for Coastal mixed mature and immature block situations. The determination to use a unique type is the decision of the prescribing forest professional.

The FS 221 form allows for a reduction of the volumes and stem counts by 4 methods:

1. By species, timber type, risk group/tree class and treatment unit.

2. By species, timber type and treatment unit

3. By species, risk group/tree class and treatment unit.

4. By species and treatment unit.

When compiling a reduction, pre-reduction and post-reduction reports are required. Leave Tree summaries are also required with post-reduction reports (see Chapter 9).

The reduced volume would not be cut. The remaining reported volume is the cut volume. When coding the percentages on the FS 221 worksheet, the number coded is the net volume percent that will be left standing.

For each tree, determine whether there is an eligible reduction:

1. If a Timber Type is coded, then the reduction applies to trees in that Type.

2. If the Timber Type is blank, then the reduction applies to all types.

3. If Damage is coded B, F, I or R on the reduction card, then do not apply the reduction to trees that have been assigned a damage code of that type.

4. If Species is non-blank, then an exact species match has to apply for the tree to be eligible for reduction. Otherwise, if Species is blank, apply the reduction to all species.

5. If Risk Group/Tree Class is non-blank, then an exact Risk Group/Tree Class match has to apply for the tree to be eligible for reduction. Otherwise, if Risk Group/Tree

Class is blank, apply the reduction to all risk groups and tree classes. An "L" in column 13 indicates all live trees. A "D" in column 13 applies to all dead trees (except tree class 4 and 6).

When a tree is targeted for a reduction, then reduce the calculated volume by the percent value that is coded for the DBH class that the tree falls into. See Section 5.3 for example.

If the DBH class is blank, then do not apply a reduction for that tree.

5.2 Percent Reduction Worksheet Image

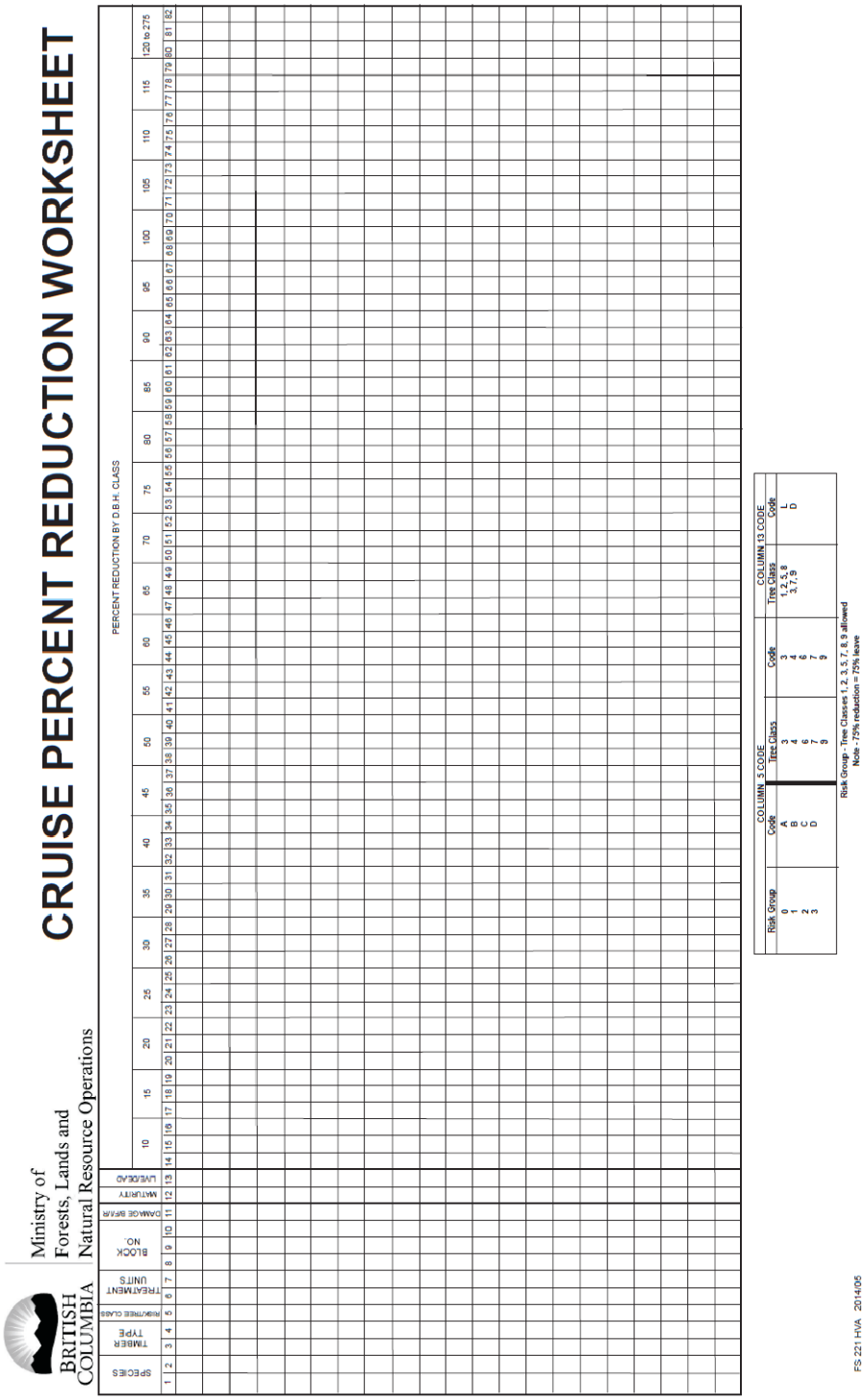


Figure 5.1 Sample Percent Reduction Worksheet.
View Cruise Percent Reduction Form

5.3 Reduction Examples

These examples use a 12.5 ha Cutting Permit with 2 types, 2 blocks and 2 harvesting methods. Cutting Permit details and pre-reduction volumes are as follows:

Type 1 has 5 ha in Silviculture Treatment Unit (STU) A
Type 2 has 5 ha in STU A & 2.5 ha in STU B

Block 1 has 2.5 ha of Type 1 (STU A) and 2.5 ha of Type 2 (STU A)
Block 2 has 2.5 ha of Type 1 (STU A) and 5 ha of Type 2 (2.5 ha of STU A & 2.5 ha of STU B)

Harvesting Method SC has 5 ha of Type 1 (STU A) and 5 ha of Type 2 (STU A)
Harvesting Method SS has 2.5 ha of Type 2 (STU B)

The Average Line Treatment Unit area factors for Block & Harvesting Method are defined as follows:

Numerator: The Treatment Unit area of the Type within Block or Harvesting Method.

Denominator: The total Treatment Unit Area for the Type.

Plots

The following plot information was used to determine the volume parameters:

Plot	Type	Block	Harvesting Method	Volume/ha estimate
1	1	1	Skid Clear	150
2	1	2	Skid Clear	230
3	1	1	Skid Clear	170
4	1	2	Skid Clear	250
5	2	1	Skid Clear	230
6	2	2	Skid Sel.	260
7	2	1	Skid Clear	210
8	2	2	Skid Sel.	260

5.3.1 Timber Type and Cutting Permit Reductions - Average Line Method

Refer to Section 3.1 for an explanation of the difference between Average Line and Block method calculations.

Average Line Method - Pre-reduction

All volume in Type 1 is in STU A because it is the only treatment unit in Type 1. Two-thirds of the volume in Type 2 is in STU A because two-thirds of the Type 2 area is in treatment unit A. One-third of the Type 2 volume in STU B because one-third of the Type 2 area is in treatment unit B.

Type 1 = ((150+230+170+250)/4) * 5.0ha = 1000 m^3 (1000 STU A)
Type 2 = ((230+260+210+260)/4) * 7.5ha =1800 m^3 (1200 STU A + 600 STU B)

The Cutting Permit volume is the sum of the type volumes.

Cutting Permit = 1000 + 1800 = 2800 m^3 (2200 STU A + 600 STU B)

By the average line method, the Block volumes are determined based on the entire Type volumes being pro-rated based on the Type areas *within* the Block. For example, there are 5 ha of STU A in Block 1, 2.5 ha from Type 1 and 2.5 ha from Type 2. Therefore, the STU A volume for Block 1 is calculated by adding 50 percent of the Type 1 volume for STU A and 50 percent of the Type 2 volume for STU A.

The Harvesting Method volumes are calculated the same way as the Block.

The full set of calculations for the Block and Harvesting Method volumes are shown below.

	Type 1	Type 2	
Block 1			
- STU A	= (2.5/5.0 * 1000)	+ (2.5/5.0 * 1200) = 500 + 600 =	1100 m^3
Block 2			
-STU A	= (2.5/5.0 * 1000)	+ (2.5/5.0 * 1200) = 500 + 600 =	1100 m^3
-STU B		= (2.5/2.5 * 600) =	600 m^3
			1700 m^3
Harvesting Method – SC			
-STU A	= (5.0/5.0 * 1000) +	(5.0/5.0 * 1200) = 1000 + 1200 =	2200 m^3
Harvesting Method – SS			
-STUB	= 0	+ (2.5/2.5 * 600) =	600 m^3

In the following examples, the reduced volumes will appear bold.

Example 5.1

Reducing the Type 2 volume by 30 percent in STU B:

Type 1 = 1000 m^3 (1000 STU A)

Type 2 = **1620 m^3** (1200 STU A + **420** STU B)

Type 2 has STU B, so the STU B volume was reduced by 30 percent.

Cutting Permit = 1000 + **1620** = **2620 m^3** (2200 STU A + **420** STU B)

Block 1

- STU A = (2.5/5.0 * 1000) + (2.5/5.0 * 1200) = 500 + 600 = 1100 m^3

Block 1 has no STU B, so its volume is not reduced.

Block 2

-STU A = (2.5/5.0 * 1000) + (2.5/5.0 * 1200) = 500 + 600 = 1100 m^3
-STU B = = (2.5/2.5 * **420**) = **420 m^3**
1520 m^3

Block 2 has STU B from Type 2, so its volume was reduced.

Harvesting Method – SC

-STU A = (5.0/5.0 * 1000) + (5.0/5.0 * 1200) = 1000 + 1200 = 2200 m^3

Harvesting Method - SC has no STU B, so its volume was not reduced.

Harvesting Method – SS

-STUB = 0 + (2.5/2.5 * **420**) = **420 m^3**

Harvesting Method - SS only has STU B, so its volume was reduced by 30 percent.

Example 5.2

Reducing the Cutting Permit volume by 10 percent in STU A:

Type 1 = **900 m^3** (**900** STU A: *1000 * 0.9*)

Type 2 = **1680 m^3** (**1080** STU A: *1200 * 0.9* + 600 STU B)

STU A was reduced by 10 percent for each Timber Type.

Cutting Permit = **900** + **1680** = **2580 m^3** (1980 STU A + 600 STU B)

	Type 1	Type 2
Block 1		
- STU A	= (2.5/5.0 * **900**)	+ (2.5/5.0 * **1080**) = 450 + 540 = **990 m^3**

Block 1 only has STU A, so its volume was reduced by 10 percent.

Block 2			
-STU A	= (2.5/5.0 * **900**)	+ (2.5/5.0 * **1080**) = 450 + 540 =	**990 m^3**
-STU B	= 0	= (2.5/2.5 * 600) = 0 + 600 =	600 m^3
			1590 m^3

Harvesting Method – SC			
-STU A	= (5.0/5.0 * **900**) +	(5.0/5.0 * **1080**) = 900 + 1080 =	**1980 m^3**

Harvesting Method - SC only has STU A, so its volume was reduced by 10 percent.

Harvesting Method – SS			
-STUB	= 0	+ (2.5/2.5 * 600) = 0 + 600 =	600 m^3

5.3.2 Block and Timber Type Reductions - Block Method

Refer to Section 3.1 for an explanation of the difference between Average Line and Block method calculations.

Block Method - Pre-reduction

Type 1 = 1000 m^3 (1000 STU A)

Type 2 = 1800 m^3 (1200 STU A + 600 STU B)

Cutting Permit = 1000 + 1800 = 2800 m^3 (2200 STU A + 600 STU B)

The Type and Cutting Permit volumes do not change for the Block method.

Type 1/Blk 1 = ((150+170)/2) * 2.5ha = 400 m^3 (400 STU A)
Type 1/Blk 2 = ((230+250)/2) * 2.5ha = 600 m^3 (600 STU A)
Type 2/Blk 1 = ((230+210)/2) * 2.5ha = 550 m^3 (550 STU A)
Type 2/Blk 2 = ((260+260)/2) * 5.0ha = 1300 m^3 (650 STU A + 650 STU B)

Type 1/SC = ((150+230+170+250)/4) * 5.0 ha = 1000 m^3 (1000 STU A)
Type 2/SC = ((230+210+)/2) * 5.0 ha = 1100 m^3 (1100 STU A)
Type 2/SS = ((260+260)/2) * 2.5 ha = 650 m^3 (650 STU B)

	Type 1	Type 2
Block 1		
	- STU A = 400	+ 550 = 950 m^3
Block 2		
	-STU A = 600	+ 650 = 1250 m^3
	-STU B = 0	+ 650 = 650 m^3
		1900 m^3
Harvesting Method - SC		
	-STU A = 1000	+ 1100 = 2100 m^3
Harvesting Method - SS		
	-STUB = 0	+ 650 = 650 m^3

In the following examples, the reduced volumes will appear bold.

Example 5.3

Reducing the volume by 20 percent of STU B in Block 2:

Type 1 = 1000 m^3 (1000 STU A)

Type 2 = **1680 m^3** (1200 STU A + **480** STU B)

Block 2 has STU B in Type 2, so Type 2 was reduced.

Cutting Permit = 1000 + 1680 = **2680 m^3**

Type 1/Blk 1 = 400 m^3 (400 STU A)
Type 1/Blk 2 = 600 m^3 (600 STU A)
Type 2/Blk 1 = 550 m^3 (500 STU A)
Type 2/Blk 2 = **1170 m^3** (650 STU A + **520** STU B)

Type 1/SC = 1000 m^3 (1000 STU A)
Type 2/SC = 1100 m^3 (1100 STU A)
Type 2/SS = **520 m^3** (**520** STU B)

	Type 1	Type 2
Block 1		
	- STU A = 400	+ 550 = 950 m^3
Block 2		
	-STU A = 600	+ 650 = 1250 m^3
	-STU B = 0	+ **520** = **520 m^3**
		1770 m^3

Block 2 has STU B, so its volume was reduced.

Harvesting Method - SC
-STU A = 1000 + 1100 = 2100 m^3

Harvesting Method - SS
-STUB = 0 + **520** = **520 m^3**

Block 2 has STU B in Harvesting Method - SS, so its volume was reduced.

Example 5.4

Reducing Type 2 volume by 50 percent in STU A results in:

Type 1 = 1000 m^3 (1000 STU A)

Type 2 = **1200 m^3** (**600** STU A + 600 STU B)

Type 2 has STU A, so its volume was reduced.

Cutting Permit = 1000 + **1200** = **2200 m^3**

Type 1/Blk 1 = 400 m^3 (400 STU A)
Type 1/Blk 2 = 600 m^3 (600 STU A)
Type 2/Blk 1 = **275 m^3** (**275** STU A)
Type 2/Blk 2 = **975 m^3** (**325** STU A + 650 STU B)

Type 1/SC = 1000 m^3 (1000 STU A)
Type 2/SC = **550 m^3** (**550** STU A)
Type 2/SS = 650 m^3 (650 STU B)

	Type 1	Type 2	
Block 1			
	- STU A = 400	+ **275** =	**675 m^3**

Block 1 has STU A in Type 2, so its volume was reduced.

Block 2

-STU A = 600	+ **325** =	**925 m^3**
-STU B = 0	+ 650 =	650 m^3
	=	1575 m^3

Block 2 has STU A in Type 2, so its volume was reduced.

Harvesting Method - SC
-STU A = 1000 **+ 550** = **1550 m^3**

Harvesting Method – SS
-STUB = 0 + 650 = 650 m^3

Harvesting Method - SS doesn't have STU A, so its volume was not reduced.

5.3.3 Single Tree Reduction

The previous 4 examples in this chapter demonstrated how the total volume for a Treatment Unit would be reduced if all the trees from a particular cross-section were reduced. However, reductions can be dependent on individual tree parameters such as DBH, Tree Class/Risk Group and Damage Type. The reductions are performed on a tree-by-tree basis as follows.

Example 5.5

The sample reduction input in Section 5.5 indicates a 20 percent reduction in Type 2 - Treatment Unit B for Yellow Cedar with a DBH up to 150 cm. All Risk Groups and Tree Classes are included, and no Damage Types are excluded from the reduction.

A Yellow Cedar was tallied in a plot from Type 2 within Block 2. Recall that Type 2/Block 2 has 2 Treatment Units, each having an area of 2.5 ha. Because the Treatment Unit cannot be coded on the Cruise Tally Sheet, the plot determines volume per hectare for both Treatment Units in Type 2 within Block 2.

The Yellow Cedar was tallied using a BAF of 12 in a full plot and the measured DBH was 55.6 cm. The calculated gross merchantable volume was 3.583566 m^3. Hence, the pre-reduction estimate for gross volume per hectare for both Treatment Units is:

(1)
$$V = \frac{(12\ 12732.39545) * (3.583566)}{55.6^2}$$
$$= \mathbf{177.12\ m^3\ per\ hectare}$$

The post-reduction estimate for Treatment Unit B is:

(2)
$$V = 177.12\ (1 - 0.2)$$
$$= \mathbf{141.69\ m^3\ per\ hectare}$$

The post-reduction estimate for the two combined Treatment Units is:

(3)
$$V = (2.5/5.0) * 177.12 + (2.5/5.0) * 141.69$$
$$= \mathbf{159.40\ m^3\ per\ hectare}$$

5.4 Percent Reduction Card Edits

5.4.1 Table of Data Types

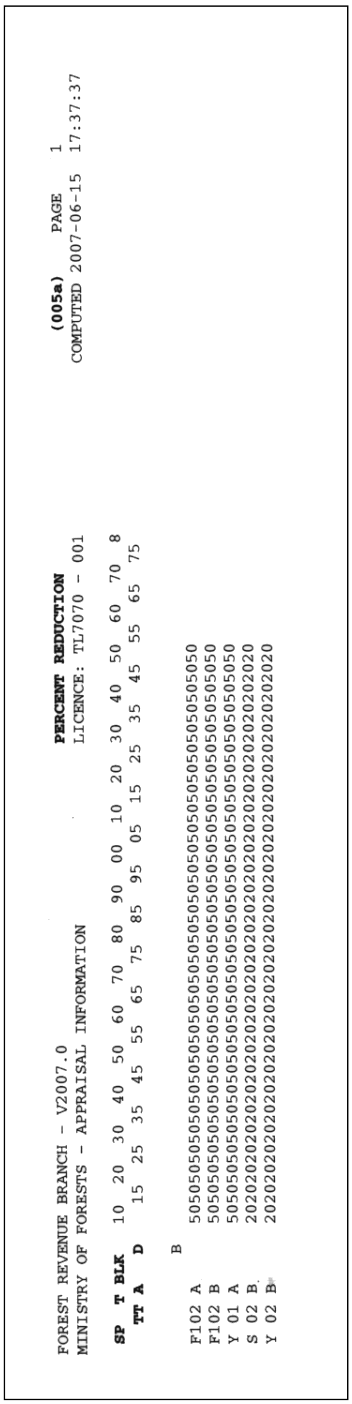
Column Position	Column Name	Accepted Values	Error Type
1-2	Species	Blank or valid species code (Refer to Appendix 3 for valid species codes)	F
3-4	Timber Type	Blank, 99	F
5	Risk Group/Tree Class	Blank, A, B, C, D, 1 - 9	F
6-7	Treatment Unit	A - CU, 1-99	F
8-10	Block	Blank	F
11	Damage type	Blank, B, F, I, R	F
12	Maturity	Blank, M or S for CGNF Cruises only	F
13	Live or Dead	Blank, L or D	F
14-15, 16-17, …, 80-81	Reduction percent for DBH class	Blank, 001 – 100	F

5.4.2 Fatal Errors

1. A tree can only qualify for one reduction.
2. Timber Type must be a valid Type from a card type C.
3. Block must be a valid Block from a card type D.

5.5 Percent Reduction Input Values - Sample Listing

Report 005a. This report is required for reduction compilations.



```
FOREST REVENUE BRANCH - V2007.0                          PERCENT REDUCTION                    (005a)     PAGE    1
MINISTRY OF FORESTS - APPRAISAL INFORMATION                LICENCE: TL7070 - 001          COMPUTED 2007-06-15  17:37:37

SP  T BLK   10  20  30  40  50  60  70  80  90  00  10  20  30  40  50  60  70  8
TT A   D    15  25  35  45  55  65  75  85  95  05  15  25  35  45  55  65  75

        B

F102 A     50505050505050505050505050505050505050505050505050505050505050
F102 B     50505050505050505050505050505050505050505050505050505050505050
Y 01 A     50505050505050505050505050505050505050505050505050505050505050
S 02 B     20202020202020202020202020202020202020202020202020202020202020
Y 02 B     20202020202020202020202020202020202020202020202020202020202020
```

Figure 5.2 Percent Reduction Input Values.

Stump Cruise Compilations 6

6.1 Stump Compilation - Overview

An "S" in column 80 of card type B identifies a stump cruise. Card type 2 Stump Diameters Inside Bark are converted to Diameter at 1.3 m (DBH) Outside Bark, and the resulting input file is compiled using the same merchantability requirements as normal compilations.

Stump cruises only use fixed area plots. Usually, the entire area is cruised, which eliminates the need for the statistical reports described in Chapter 8.

Stump cruise plots are recorded using the Stump Cruise Tally Sheet (Figure 6.1 and 6.2).

The species, stump height, stump diameter, tree class, and pathological remarks are entered for each stump in the plot.

No quality remarks or damage codes will be added.

The stump conversion is based on a measurement at stump height and can be recorded either in centimeters or rads, as specified in column 78 of card type B. If the measurement is made in rads, then double the measurement to obtain the stump diameter in centimeters (i.e., 1 rad = 2 cm).

For Coast compilations (F.I.Z A, B, or C), the age in 10s and tree class determine whether mature or immature conversion constants are used for Fir, Cedar, Hemlock, and Spruce:

Immature:	Tree class 8 and 9 are always immature.
	Tree classes 1, 2 and 3, are immature if Age in 10s < 13.
Mature:	Tree class 5 and 7 are always mature.
	Tree classes 1, 2, and 3 are mature if age in 10s > 12.

Tree class 4 and 6 are only included if the tree class combination from card type B is 1. In this case, set maturity using the above rules for tree classes 1, 2, and 3.

The stump diameter measurement is taken inside bark, and is recorded in centimeters to the nearest tenth. The conversion equation estimates the diameter at breast height outside bark.

$$DBH_o = DSH_i + b_0\, DSH_i\, (2.3 - SH) + b_1 DSH_i\, ln[(SH + 1) / 2.3]$$

Where:

DBH_o	=	Diameter at 1.3 m outside bark, in centimeters to the nearest tenth.
DSH_i	=	Diameter at stump height inside bark, in centimeters to the nearest tenth.
SH	=	Stump height in centimeters.
b_0, b_1	=	Diameter conversion constants, to 6 decimal places. Refer to *Cruising Manual* for the list of constants by Species, Forest Inventory Zone, and Maturity.
ln	=	Natural logarithm function.

Example 6.1

Unit of

Measurement:	Centimeters
F.I.Z.:	J
Stump height:	25 cm
Species:	Spruce
Diameter:	53 cm

DBH = 53.0 + 0.065728 * 53.0 * (2.3 - 0.25) + 0.575037 * 53.0 * *ln* [1.25/2.3]

= 53.0 + 7.14 – 18.58

= 41.6 cm

Once the DBHs have been assigned to the stumps, tree heights must be calculated using a height-diameter equation. Please see Chapter 7 for an explanation of the derivation and application of height-diameter equations.

6.2 Stump Cruise Tally Sheet Image

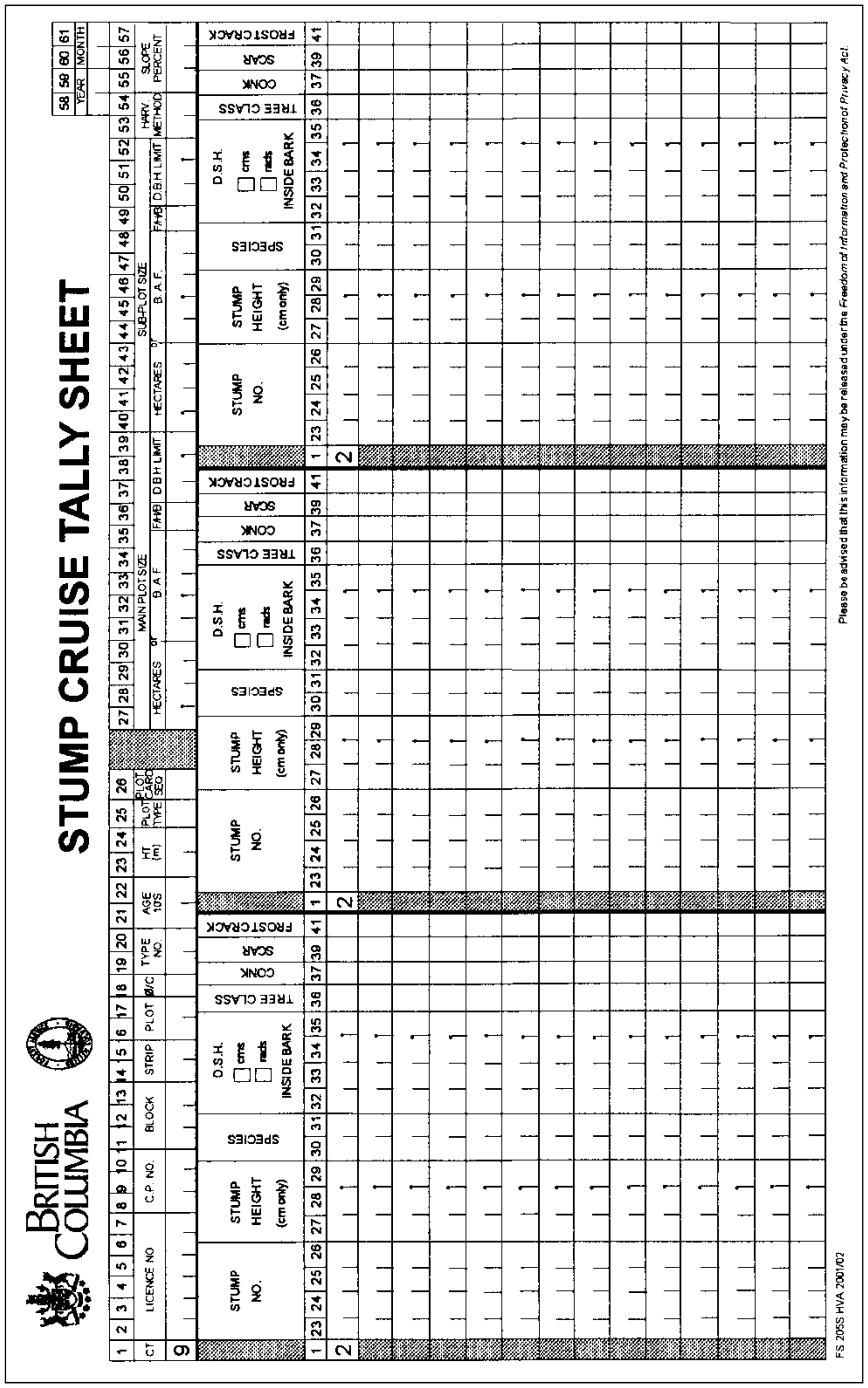


Figure 6.1 Stump Cruise Tally Sheet - Front Side.

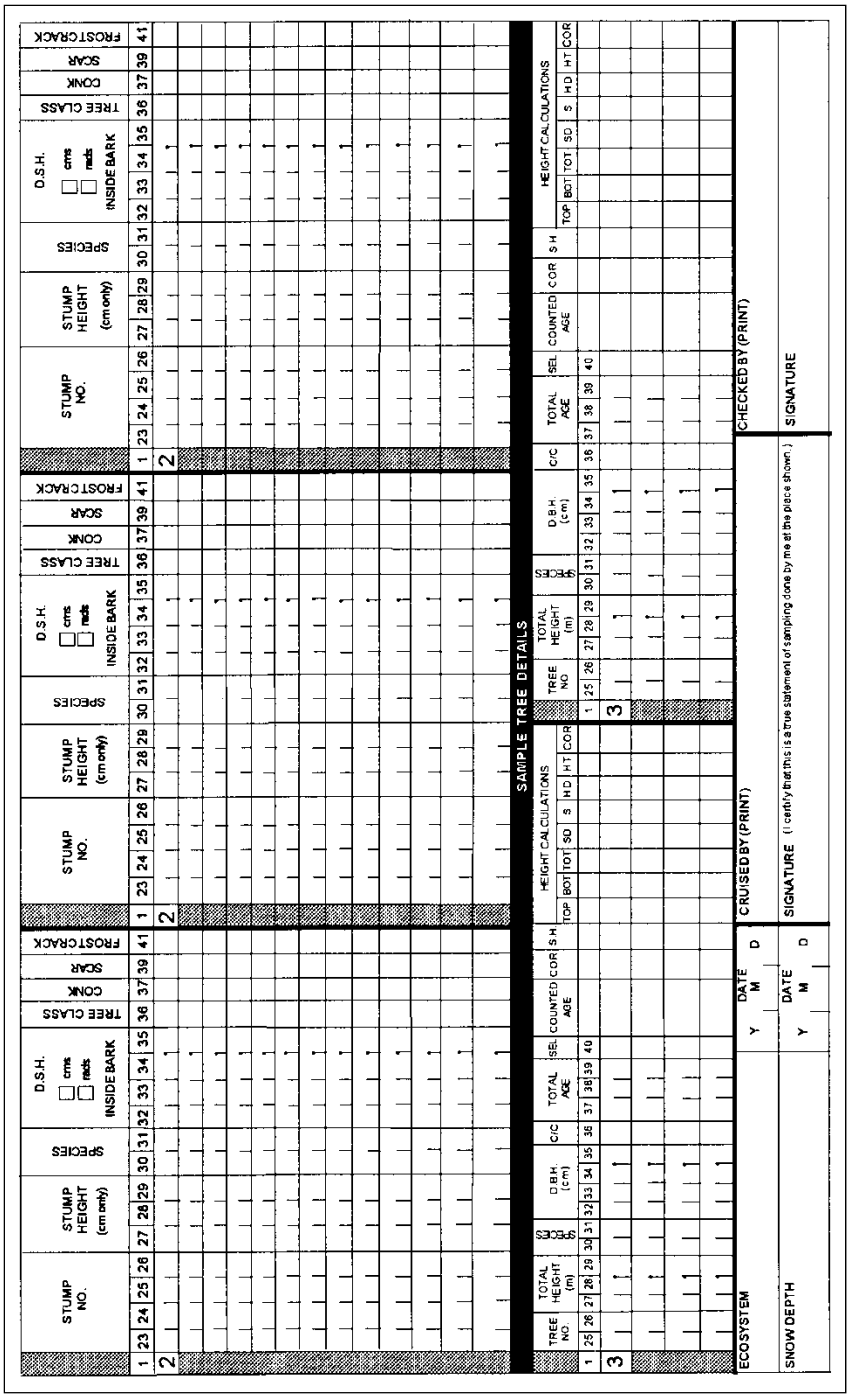


Figure 6.2 Stump Cruise Tally Sheet - Reverse Side.

6.3 Stump Cruise Tally Sheet Edits

6.3.1 Card Type 9 - Plot Identity Information

Same as Section 2.11.1

6.3.2 Card Type 2 - Stump Details

Column Position	Column Name	Accepted Values	Error Type
27-29	Stump height (cm)	9 (3, 1)	F
30-31	Species	Refer to *Cruising Manual*, Section 6.3.2	F
32-35	Diameter at stump height (cm)	9 (4, 1)	F
36	Tree Class	Same as Section 2.12.1	F
37	Conk	Same as Section 2.12.1	N/A
39	Scar	Same as Section 2.12.1	N/A
41	Frost Crack	Same as Section 2.12.1	N/A

6.3.3 Card Type 3 - Sample Tree Details

Column Position	Column Name	Accepted Values	Error Type
25-29	Tree Number	0 - 99	F
27-29	Total Height	999	F
30-31	Species	Refer to Appendix 2	F
32-35	DBH	9 (4, 1)	F
36	Crown Class	1 - 4	I
37-39	Total Age	999	F
40	Selective Cut	Blank	N/A

6.3.3.1 Messages

1. The tree height is not in range for species in Forest Inventory Zone - refer to Appendix 4.

2. The total age is not in range for species in Forest Inventory Zone - refer to Appendix 5.

3. Tree numbers should be unique or the preceding tree with the duplicate number will be ignored for the card type 3 cross-reference edit.

See Table 4 of the *Cruising Manual* Appendices for the FIZ A/QCI PSYU stump to DBH taper equations.

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Height-Diameter Equations 7

Tree heights are required for the calculation of volume, as explained in Chapter 3. When tree heights are not measured for each tree (e.g. – stump cruises) height-diameter equations, or curves, are derived from the sample trees.

Heights are assigned by substituting the DBH into the chosen equation. Each equation has a minimum value DBH_{min}, below which the equation predicts negative values. Each function also has an associated DBH_{max}. Heights cannot be calculated for DBHs greater than DBH_{max} or lower than DBH_{min}. Where a DBH does not fall into the acceptable range for the equation, the minimum or maximum DBH would be substituted, and a message would be indicated for that tree in report 004a (see Figure 7.2).

There are 6 possible equations available:

Parabola	H	=	$a + bD + cD^2$
Conditioned Parabola	H	=	$1.3 + bD + cD^2$
Hyperbola	H	=	$a + b/D + cD$
Conditioned Hyperbola	H	=	$1.3 – bD/(D+1) + cD$
Weibull	H	=	$a[1 - EXP(-bD^c)]$
Conditioned Weibull	H	=	$1.3 + a[1 – EXP(-bD^c)]$

Where:

H = Tree height in metres, to the nearest tenth.

D = Diameter at 1.3 m outside bark in centimeters, to the nearest tenth.

a, b, c = Regression coefficients.

EXP(x) = e^x, where *e* is the base of the natural logarithm function.

Use the following method to choose the suggested curve for assigning heights:

1. Reject any curves that compute a negative height for a DBH of 10 cm or lower.

2. If the *b* and *c* coefficients are positive for the Parabola, the Weibull function must not be used.

3. Of the remaining curves, choose the curve with the lowest standard error estimate (S.E.E.) based on volume. If the curve with the lowest SEE volume exceeds 3% over the range of DBHs, then another curve may be used in the compilation.

Regression equations are calculated for each species within a Timber Type. In order to produce regression coefficients, a minimum of 20 sample trees must be used. For minor species (less than twenty percent of the unauthorized timber harvest area gross volume) ten trees per curve is acceptable. If there are not enough sample trees for a species in a Timber Type, then samples may be grouped together for different species and types using card type E. Where more than one species contributes to a height curve, appropriate, to each species volume constants, as per Appendix 15 are to be applied when calculating the S.E.E. volume. Refer to Chapter 6 of the *Cruising Manual* for a description of the methods of grouping sample trees.

A height curve equation applies heights for all of the Species and Types listed in columns 15-80 of card type E.

If the column 14 of card type E is coded '1', then the sample trees used to derive the height curve are restricted to the Species and Type coded in the Species Used and the Type Used fields.

If column 14 is blank or 0, then the sample trees used to derive the height curve would be all of the Species and Types in columns 15-80 of card type E. Refer to Chapter 6 of the *Cruising Manual* for example card type E codes.

A good practice is to first plot the sample trees diameter vs. height. This provides a useful picture of the height-diameter relationship for the species and types that the equation generates heights for. It will also indicate outliers if they exist.

Next, find the regression coefficients for all six curves. To determine the S.E.E. volume, use the method described in Section 7.3. Choose the curve that yields the lowest S.E.E. for volume as the suggested curve that does not generate negative heights at 10 cm DBH or has a maximum/minimum DBH range insufficient for the card Type 2 requirements.

7.1 Regression Coefficients

In order to determine the regression coefficients, there are many statistical packages available which support the above equations. For the parabola and hyperbola equations, fit a linear least-squares regression with an intercept. For the Weibull functions, fit a non-linear least squares regression. For the conditioned forms of each equation type, change the dependent variable to H - 1.3, rather than H and fit the equation without an intercept.

A method for determining coefficients for the parabola and hyperbola is included for each equation listed below.

In the following examples, N = the number of sample trees used.

The Σ without upper and lower bound parameters in the regression coefficient formulas is a summation over all N of the sample trees.

7.1.1 Parabola

$$A = \sum HD^2 - \frac{\sum H \sum D^2}{N}$$

$$B = \sum D^2 - \frac{(\sum D)^2}{N}$$

$$C = \sum D^3 - \frac{\sum D^2 \sum D}{N}$$

$$D = \sum HD - \frac{\sum H \sum D}{N}$$

$$E = \sum D^4 - \frac{\left(\sum D^2\right)^2}{N}$$

$$F = \sum D$$

$$G = \sum H$$

$$H = \sum D^2$$

The parabola regression coefficients are calculated as follows:

$$c = \frac{AB - CD}{BE - CC}$$

$$b = \frac{D - cC}{B}$$

$$a = \frac{(G - bF - cH)}{N}$$

7.1.2 Conditioned Parabola

$$A = \sum (H - 1.3) D^2$$

$$B = \sum D^2$$

$$C = \sum D^3$$

$$D = \sum (H - 1.3) D$$

$$E = \sum D^4$$

The conditioned parabola regression coefficients are calculated as follows:

$$c = \frac{AB - CD}{BE - CC}$$

$$b = \frac{D - cC}{B}$$

$$a = 1.3$$

7.1.3 Hyperbola

$$A = \sum HD - \frac{\sum H \sum D}{N}$$

$$B = \sum \frac{1}{D^2} - \frac{\left(\sum 1/D\right)^2}{N}$$

$$C = N - \frac{\sum 1/D \sum D}{N}$$

$$D = \sum \frac{H}{D} - \frac{\sum H \sum 1/D}{N}$$

$$E = \sum D^2 - \frac{(\sum D)^2}{N}$$

$$F = \sum \frac{1}{D}$$

$$G = \sum H$$

$$H = \sum D$$

The hyperbola regression coefficients are calculated as follows:

$$c = \frac{AB - CD}{BE - CC}$$

$$b = \frac{D - cC}{B}$$

$$a = \frac{(G - bF - cH)}{N}$$

7.1.4 Conditioned Hyperbola

$$A = \sum (H - 1.3)D$$

$$B = \sum \frac{(-D)^2}{(D+1)^2}$$

$$C = \sum \frac{-(D^2)}{(D+1)}$$

$$D = \sum \frac{-D(H-1.3)}{(D+1)}$$

$$E = \sum D^2$$

The conditioned hyperbola regression coefficients are calculated as follows:

$$c = \frac{AB - CD}{BE - CC}$$

$$b = \frac{D - cC}{B}$$

$$a = 1.3$$

7.1.5 Weibull and Conditioned Weibull

The Weibull coefficients are not determined by matrix manipulation as the other two curves are. The calculations will not be provided here. Instead, use T. Kozak's subroutine - April, 1993. For the un-conditioned Weibull, the dependant variable would be the set of sample tree heights (H) and the independent variable would be the set of sample tree diameters (D). For the conditioned Weibull, the dependent variable would be the set of sample tree heights less 1.3 m (i.e., H-1.3).

When coefficients are determined through iteration the maximum number of iterations is 1 000.

7.2 Minimum and Maximum DBH

Heights can only be calculated for trees when their DBH is in the specified range for the height-diameter curve. When a tree falls outside of the DBH range, use either the height calculated for DBH_{max} or DBH_{min} for the selected curve.

7.2.1 Parabola and Conditioned Parabola

7.2.1.1 Minimum DBH

For the conditioned and un-conditioned parabola:

DBH_{min} = the root that is closest to 0:

$$DBH_{min} = \frac{-b \pm \sqrt{b^2 - 4ac}}{2c}$$

The root closest to zero of the two roots is selected.

When $b^2 - 4ac < 0$, then set $DBH_{min} = 0$.

Example 7.1

a = 1.3

b = 0.62079155

c = - 0.00307971

$Root_1$ = - 2.0728 ← DBH_{min}

$Root_2$ = 203.647

7.2.1.2 Maximum DBH

This method can solve either the minimum or maximum DBH depending on the values of the coefficients. If *b* is positive and *c* is negative there is a maximum height at a given DBH. If both *b* and *c* are positive there is a minimum height at a given DBH. A maximum DBH_{max} of 250 cm has been assigned.

DBH_{max} = Root of the derivative of the parabola

$H = a + bD + cD^2$

$H' = b + 2cD$

Setting derivative equal to zero, gives

$$DBH_{max} = \frac{-b}{2c}$$

Example 7.2

b = 0.62079155

c = - 0.00307971

$$DBH_{max} = 100.7873$$

7.2.2 Hyperbola and Conditioned Hyperbola

7.2.2.1 Minimum DBH

For the hyperbola, DBH_{min} = the root that is closest to 0 of the following quadratic equation.

$cD^2 + aD + b = 0$

$$DBH_{min} = \frac{-a \pm \sqrt{a^2 - 4cb}}{2c}$$

When $a^2 - 4cb < 0$, then set $DBH_{min} = 0$.

Example 7.3

a = 10.81912465

b = -9.74355472

c = 0.23902870

$Root_1$ = 0.8833 ← DBH_{min}

$Root_2$ = -46.1462

For the conditioned hyperbola, DBH_{min} = The root that is closest to 0 of the following quadratic equation

$cD^2 + (c-b+a)D + a = 0$

$$DBH_{min} = \frac{(b-a-c) \pm \sqrt{(c-b+a)^2 - 4ac}}{2c}$$

When $(c-b+a)^2 - 4cb < 0$, then set $DBH_{min} = 0$.

Example 7.4

a = 1.3

b = -9.48876491

c = 0.23935168

$Root_1$ = -0.1182 ← DBH_{min}

$Root_2$ = -45.9567

7.2.2.2 Maximum DBH

If *b* is negative and *c* is positive there is no maximum or minimum DBH.

If both *b* and *c* are negative then $DBH_{max} = (b/c)^{1/2}$

To estimate $DBH_{max,}$ calculate the height at increasing 0.5 cm intervals for DBH. Pick the diameter that yields the greatest height. The calculated heights will increase with increasing DBH, until the vertex (DBH_{max}) is passed. At that point, the heights will decrease with increasing DBH. Set D_{max} to the 0.5 cm interval before the calculated heights started to decrease. If the vertex is not passed before 250 cm, set DBH_{max} equal to 250 cm. In this case, the reported DBH_{max} is not a true maximum, but rather an arbitrarily assigned maximum.

Example 7.5

DBH	Height	
170	51.4	
170.5	51.5	
171	51.6	← DBH_{max}

Example 7.6

DBH	Height	
122	49.0	
122.5	49.1	← DBH_{max}
123	49.0	

7.2.3 Weibull and Conditioned Weibull

7.2.3.1 Minimum DBH

DBH_{min} for the Weibull function is 0.

7.2.3.2 Maximum DBH

DBH_{max} for the Weibull function is infinity, since *a* is the maximum height at infinity DBH. A maximum DBH_{max} of 250 cm has been assigned.

7.3 Standard Error of Estimate (S.E.E.) and Bias

Bias is a systematic distortion between the observed and calculated values. Because of the way the formula was created in statistics, if the calculated height were generally higher than the observed heights, the height bias would be negative. Likewise, if the calculated heights were systematically lower than the observed heights, the height bias would be positive.

Standard Error of Estimate is the measure of spread of the observed values around the regression line (estimated values).

7.3.1 Standard Error of Estimate - Height

7.3.1.1 Parabola

$$A = \sum HD^2 - \frac{\sum H \sum D^2}{N}$$

$$D = \sum HD - \frac{\sum H \sum D}{N}$$

$$I = \sum H^2 - \frac{(\sum H)^2}{N}$$

$$K = 3$$

7.3.1.2 Conditioned Parabola

$$A = \sum (H - 1.3)D^2$$

$$D = \sum (H - 1.3)D$$

$$I = \sum (H - 1.3)^2$$

$$K = 2$$

The parabola and conditioned parabola standard error estimate for height are calculated as follows:

$$SEE_h = \sqrt{\frac{I - bD - cA}{N - K}}$$

7.3.1.3 Hyperbola

$$A = \sum HD - \frac{\sum H \sum D}{N}$$

$$D = \sum \frac{H}{D} - \frac{\sum H \sum 1/D}{N}$$

$$I = \sum H^2 - \frac{(\sum H)^2}{N}$$

$$K = 3$$

7.3.1.4 Conditioned Hyperbola

$$A = \sum (H - 1.3)D$$

$$D = \sum \frac{-D(H - 1.3)}{(D + 1)}$$

$$I = \sum (H - 1.3)^2$$

$$K = 2$$

The hyperbola and conditioned hyperbola standard error estimate for height is calculated as follows:

$$SEE_h = \sqrt{\frac{I - bD - cA}{N - K}}$$

7.3.1.5 Weibull and Conditioned Weibull

7.3.1.5.1 Weibull

H = height of tree

H' = calculated height from regression equation

7.3.1.5.2 Conditioned Weibull

H = height of tree

H' = calculated height

$$SEE_h = \sqrt{\frac{\sum (H - H')^2}{N - 3}}$$

7.3.2 Bias - Height

Use the following calculation for all 6 height-diameter equations. The height bias should be zero for the Parabola and Hyperbola.

$$BIAS_h = \frac{\sum (H - H')}{N}$$

Where

H = Height of sample tree in metres, to the nearest tenth

H' = Calculated height in metres, to the nearest tenth

N = Number of sample trees used

7.3.3 Bias - Volume

Use the following calculation for all 6 height-diameter equations.

$$Bias_v = \frac{\sum (v_1 - v_2)}{N}$$

7.3.4 Standard Error Estimate - Volume*

Use the following calculation for all 6 height-diameter equations.

> * The equation with the lowest SEE_v will be labeled as the suggested curve.

$$SEE_v = \sqrt{\frac{\Sigma(v_1 - v_2)^2}{N - K}}$$

Where

v_1 = $10^a D_i^b H_i^c$

v_2 = $10^a D_i^b (H'_i)^c$

D_i = DBH of sample tree i

H_i = Height of sample tree i

H_i' = Calculated height of sample tree i

a = Volume constant A, from Appendix 15

b = Volume constant B, from Appendix 15

c = Volume constant C, from Appendix 15

N = Number of sample trees used

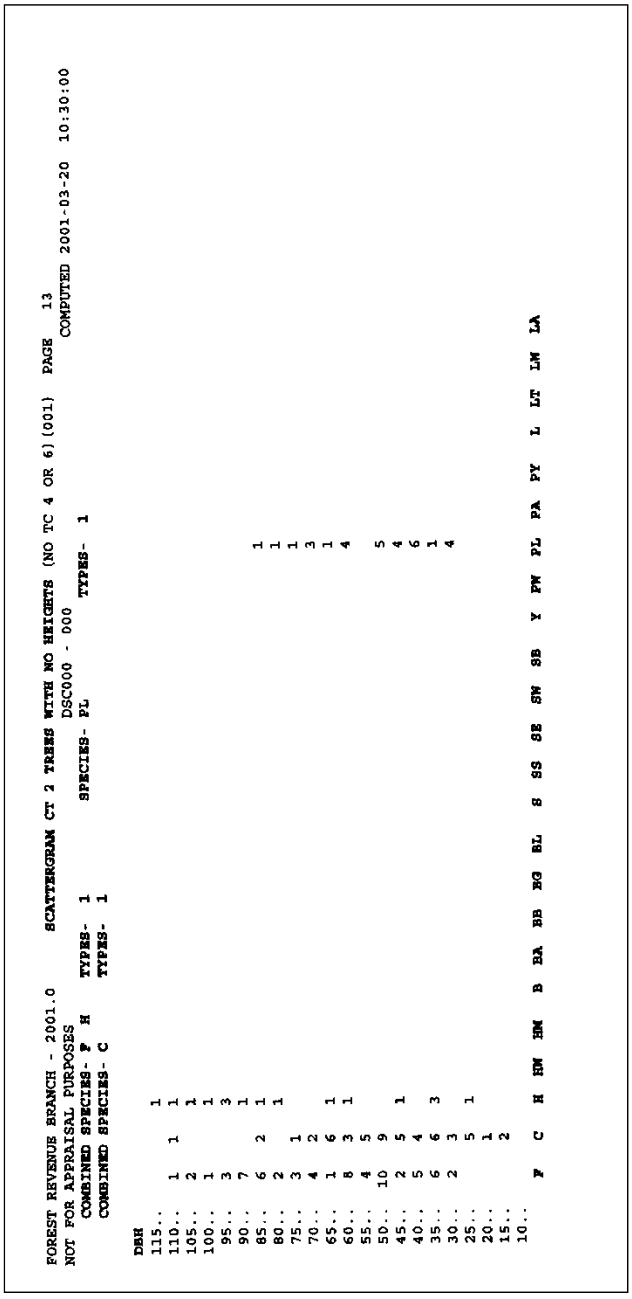
K = 2, for the conditioned parabola and conditioned hyperbola or

K = 3, for all other functions

7.4 Sample Report Listings

7.4.1 Report 001b - Sample Listing

Scattergram of card type 2 trees - required for stump cruises.

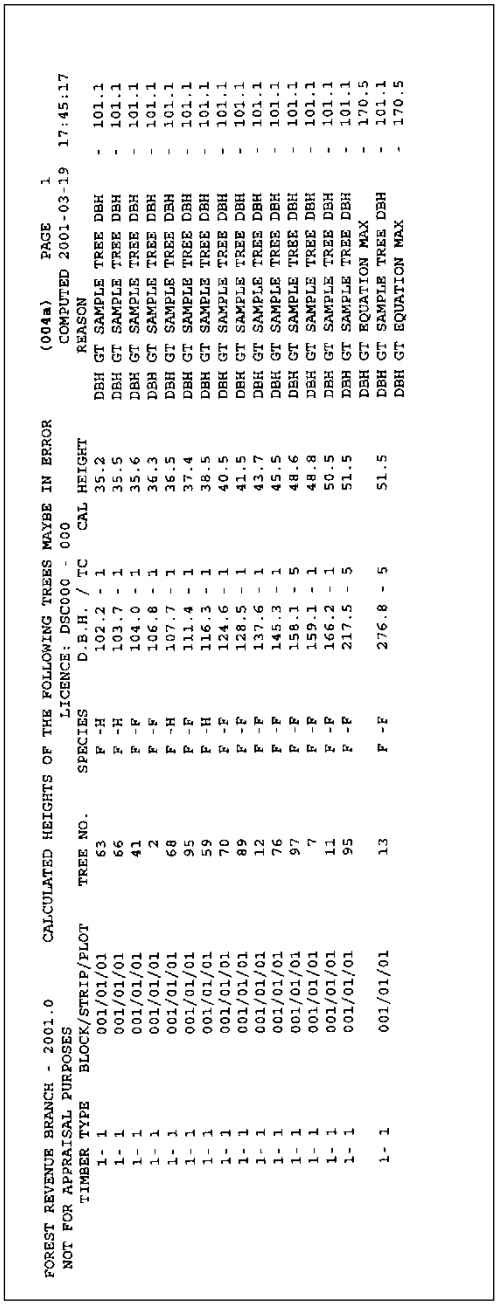


```
FOREST REVENUE BRANCH - 2001.0      SCATTERGRAM CT 2 TREES WITH NO HEIGHTS (NO TC 4 OR 6)(001)  PAGE   13
NOT FOR APPRAISAL PURPOSES                                                    COMPUTED 2001-03-20  10:30:00
     COMBINED SPECIES- F H    TYPES-  1        SPECIES- PL          TYPES-  1
     COMBINED SPECIES- C      TYPES-  1

 DBH
 115..                 1
 110..   1   1   1
 105..   2       1
 100..   1       1
  95..   3       3
  90..   7       1
  85..   6   2   1                                                
```

7.4.2 Report 004a - Sample Listing

Height curve edits - required for stump cruises.



FOREST REVENUE BRANCH - 2001.0 CALCULATED HEIGHTS OF THE FOLLOWING TREES MAYBE IN ERROR (004a) PAGE 1
NOT FOR APPRAISAL PURPOSES LICENCE: DSC000 - 000 COMPUTED 2001-03-19 17:45:17

TIMBER	TYPE	BLOCK/STRIP/PLOT	TREE NO.	SPECIES	D.B.H. / TC	CAL HEIGHT	REASON	
1	1	001/01/01	63	F -H	102.2 - 1	35.2	DBH GT SAMPLE TREE DBH	- 101.1
1	1	001/01/01	66	F -H	103.7 - 1	35.5	DBH GT SAMPLE TREE DBH	- 101.1
1	1	001/01/01	41	F -F	104.0 - 1	35.6	DBH GT SAMPLE TREE DBH	- 101.1
1	1	001/01/01	2	F -F	106.8 - 1	36.3	DBH GT SAMPLE TREE DBH	- 101.1
1	1	001/01/01	68	F -H	107.7 - 1	36.5	DBH GT SAMPLE TREE DBH	- 101.1
1	1	001/01/01	95	F -F	111.4 - 1	37.4	DBH GT SAMPLE TREE DBH	- 101.1
1	1	001/01/01	59	F -H	116.3 - 1	38.5	DBH GT SAMPLE TREE DBH	- 101.1
1	1	001/01/01	70	F -F	124.6 - 1	40.5	DBH GT SAMPLE TREE DBH	- 101.1
1	1	001/01/01	89	F -F	128.5 - 1	41.5	DBH GT SAMPLE TREE DBH	- 101.1
1	1	001/01/01	12	F -F	137.6 - 1	43.7	DBH GT SAMPLE TREE DBH	- 101.1
1	1	001/01/01	76	F -F	145.3 - 1	45.5	DBH GT SAMPLE TREE DBH	- 101.1
1	1	001/01/01	97	F -F	158.1 - 5	48.6	DBH GT SAMPLE TREE DBH	- 101.1
1	1	001/01/01	7	F -F	159.1 - 1	48.8	DBH GT SAMPLE TREE DBH	- 101.1
1	1	001/01/01	11	F -F	166.2 - 1	50.5	DBH GT SAMPLE TREE DBH	- 101.1
1	1	001/01/01	95	F -F	217.5 - 5	51.5	DBH GT SAMPLE TREE DBH	- 101.1
							DBH GT EQUATION MAX	- 170.5
1	1	001/01/01	13	F -F	276.8 - 5	51.5	DBH GT SAMPLE TREE DBH	- 101.1
							DBH GT EQUATION MAX	- 170.5

Figure 7.2 Height Curve Edits - Sample Listing (Partial).

7.4.3 Report 003 - Sample Listing

This report graphs the calculated height vs DBH.

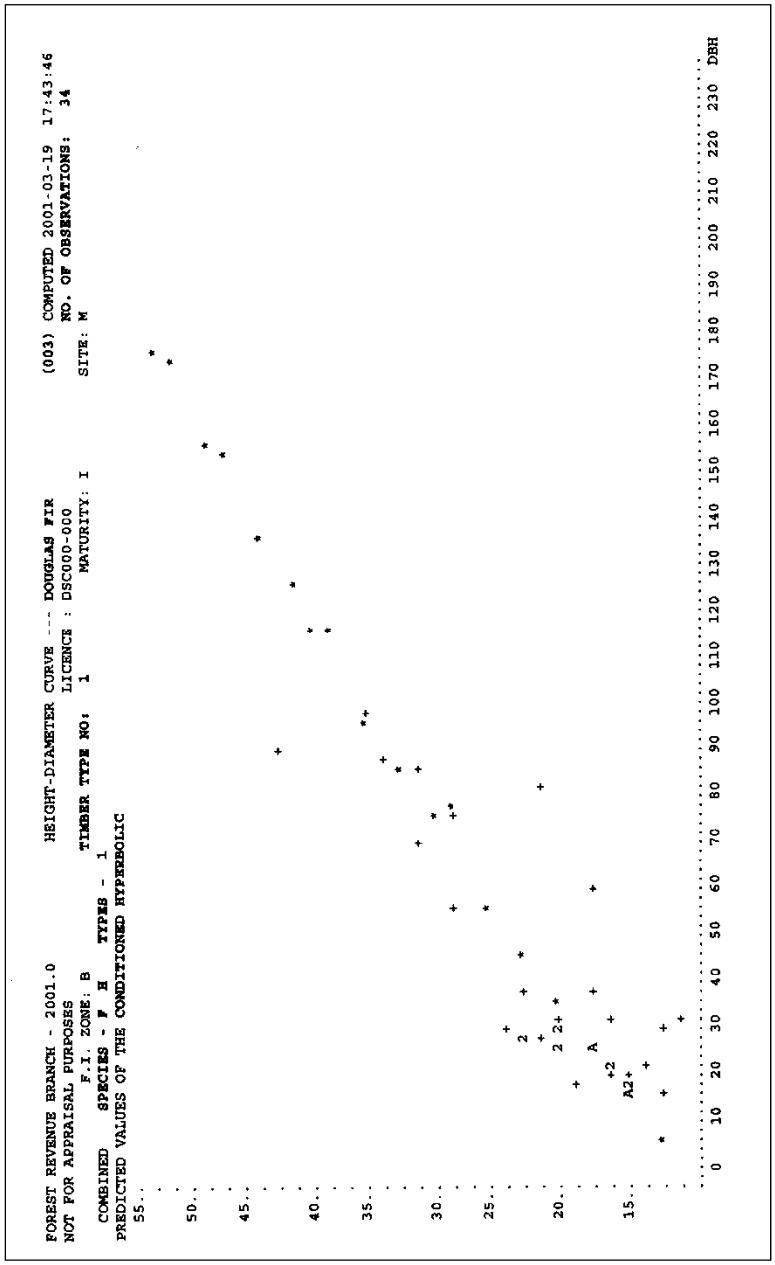
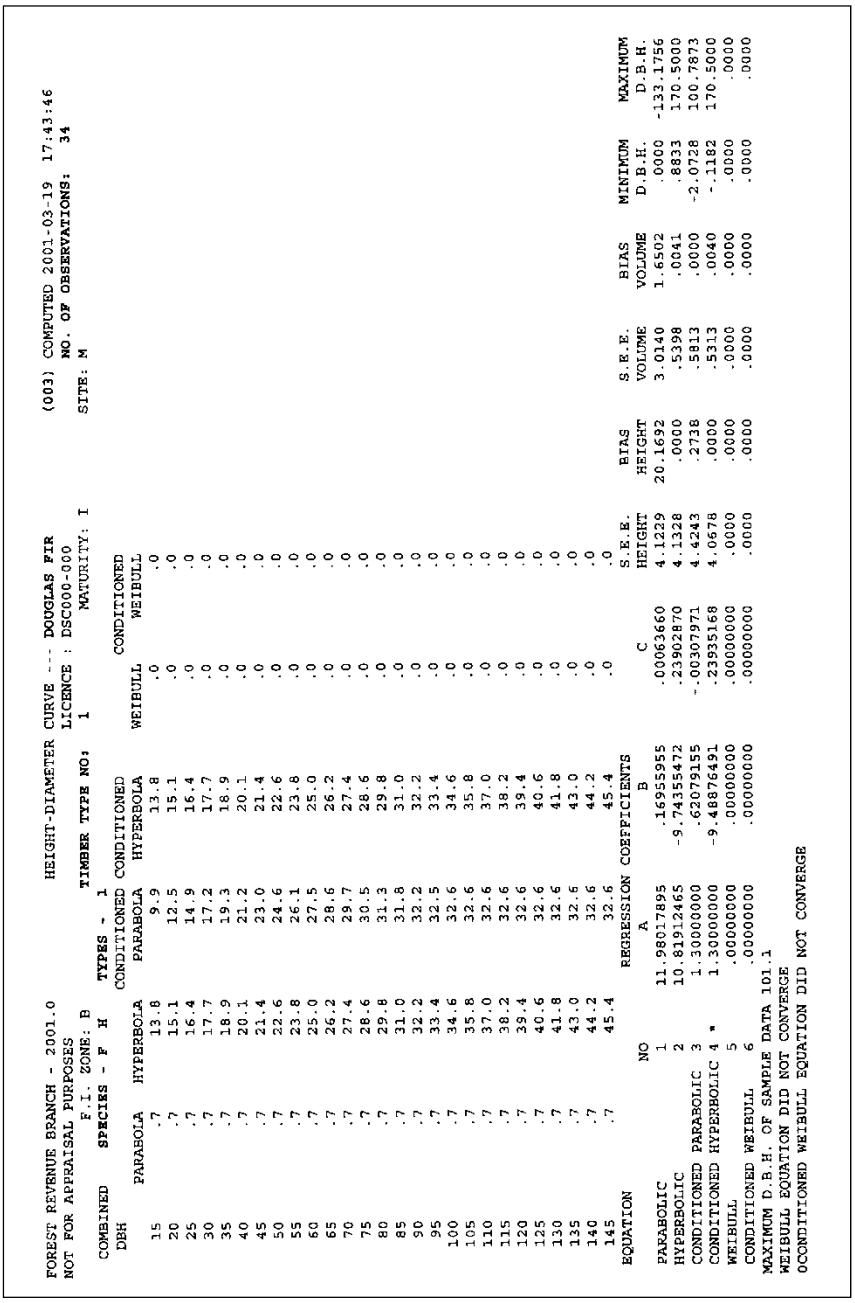


Figure 7.3 Regression Coefficients and Calculated Heights – Sample Listing (Partial).

This report shows the regression analysis and calculated heights for DBH levels.



```
FOREST REVENUE BRANCH - 2001.0          HEIGHT-DIAMETER CURVE --- DOUGLAS FIR          (003) COMPUTED 2001-03-19  17:43:46
NOT FOR APPRAISAL PURPOSES                                LICENCE : DSC000-000                NO. OF OBSERVATIONS:   34
                F.I. ZONE: B            TIMBER TYPE NO:   1          MATURITY: I          SITE: M
  COMBINED    SPECIES - F  H    TYPES -  1
   DBH                          CONDITIONED CONDITIONED            CONDITIONED
          PARABOLA   HYPERBOLA    PARABOLA   HYPERBOLA     WEIBULL     WEIBULL
    15          .7        13.8         9.9        13.8          .0          .0
    20          .7        15.1        12.5        15.1          .0          .0
    25          .7        16.4        14.9        16.4          .0          .0
    30          .7        17.7        17.2        17.7          .0          .0
    35          .7        18.9        19.3        18.9          .0          .0
    40          .7        20.1        21.2        20.1          .0          .0
    45          .7        21.4        23.0        21.4          .0          .0
    50          .7        22.6        24.6        22.6          .0          .0
    55          .7        23.8        26.1        23.8          .0          .0
    60          .7        25.0        27.5        25.0          .0          .0
    65          .7        26.2        28.6        26.2          .0          .0
    70          .7        27.4        29.7        27.4          .0          .0
    75          .7        28.6        30.5        28.6          .0          .0
    80          .7        29.8        31.3        29.8          .0          .0
    85          .7        31.0        31.8        31.0          .0          .0
    90          .7        32.2        32.2        32.2          .0          .0
    95          .7        33.4        32.5        33.4          .0          .0
   100          .7        34.6        32.6        34.6          .0          .0
   105          .7        35.8        32.6        35.8          .0          .0
   110          .7        37.0        32.6        37.0          .0          .0
   115          .7        38.2        32.6        38.2          .0          .0
   120          .7        39.4        32.6        39.4          .0          .0
   125          .7        40.6        32.6        40.6          .0          .0
   130          .7        41.8        32.6        41.8          .0          .0
   135          .7        43.0        32.6        43.0          .0          .0
   140          .7        44.2        32.6        44.2          .0          .0
   145          .7        45.4        32.6        45.4          .0          .0
  EQUATION                        REGRESSION COEFFICIENTS                  S.E.E.     BIAS     S.E.E.     BIAS    MINIMUM    MAXIMUM
                         NO           A             B             C        HEIGHT    HEIGHT    VOLUME    VOLUME    D.B.H.     D.B.H.
  PARABOLIC               1     11.98017895     .16955955     .00063660    4.1229   20.1692    3.0140    1.6502     .0000  -133.1756
  HYPERBOLIC              2     10.81912465   -9.74355472     .23902870    4.1328     .0000     .5398     .0041     .8833   170.5000
  CONDITIONED PARABOLIC   3      1.30000000     .62079155    -.00307971    4.4243     .2738     .5813     .0000   -2.0728   100.7873
  CONDITIONED HYPERBOLIC  4 *    1.30000000   -9.48876491     .23935168    4.0678     .0000     .5313     .0040    -.1182   170.5000
  WEIBULL                 5       .00000000     .00000000     .00000000     .0000     .0000     .0000     .0000     .0000      .0000
  CONDITIONED WEIBULL     6       .00000000     .00000000     .00000000     .0000     .0000     .0000     .0000     .0000      .0000
MAXIMUM D.B.H. OF SAMPLE DATA 101.1
WEIBULL EQUATION DID NOT CONVERGE
0CONDITIONED WEIBULL EQUATION DID NOT CONVERGE
```

Figure 7.4 Regression Coefficients and Calculated Heights - Sample Listing - Continued (Partial).

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Summary and Cruise Statistics 8

8.1 Plot Summary Report Overview

The Plot Summary reports number of stems, diameter, and merchantable volume information for the measured plots. The parameters are segregated by species within the plot. Each species is segregated by damage code for damage compilations. Refer to Appendix 1 for the list of species used.

Count plots are included in the plot summary.

Only include trees in a plot that meet the merchantability requirements from card type B.

Plots are sorted within Type, Block, and Strip.

Stems are trees with Tree Class coded 1, 2, 3, 5, 7, 8, or 9. Snags are trees with Tree Class coded either 4 or 6.

8.1.1 Header Information

1. License from card type A.

2. Cutting Permit from card type A.

3. Forest Inventory Zone from card type A.

4. Unit # and Block from card type A.

   - Report the actual name of the Unit/Block from Table 17 of the *Cruising Manual*.

5. Message indicating whether compilation is for appraisals or not.

6. Method of calculation (Average Line or Block).

7. Merchantability requirements from card type B.

8. Special compilation messages for:

   a. Reduction compilation.

   b. Stump cruise compilation.

   c. Tree class combination - useless volumes are included or excluded, depending on column 15 of card type B (0 or blank - snags excluded, 1 - snags included).

d. Selective cut indicator - which trees to compile depends on column 12 of card type B (blank - include all trees, 'C' - include cut-indicated and non-indicated trees, 'L' - include leave-indicated trees).

e. Wet/Dry belt indicator (Interior only) - sale is in the wet belt or dry belt, depending on column 14 of card type B (0 - no message, 1 - wet belt, 2 - dry belt).

9. Compiler program name and version.

10. Compile date and time.

11. Page number.

8.1.2 Plot Information

For each plot, report the following card type 9 information:

1. Type.

2. Block.

3. Strip.

4. Plot.

5. Plot size.

   - Report the plot area for fixed plots, or the basal area factor for prism plots.

   - If a sub-plot is being used, include the letter 'S' next to the plot size.

6. Plot sweep.

7. Slope percent.

8. Date.

8.1.3 Species Information

All summations in the following calculations are for the merchantable trees in a plot.

8.1.3.1 Number of Stems and Snags

Count the number of trees in the plot for the species. When compiling a reduction, apply the reduction.

If the plot is a border plot, double the number of stems and snags.

Round to the nearest whole number.

8.1.3.2 Number of Stems and Snags Per Hectare

Use the method outlined in Section 3.4 for calculating S_p for a specific species.

8.1.3.3 Average Diameter of Stems and Snags

The average diameter is derived from the basal area and stems per hectare estimates from the plot using the relationship Area = pi*radius^2. The multiplication by 100 is to convert from meters to centimeters.

$$\overline{D_p} = 100 * 2 * \sqrt{\frac{BA_p}{pi * S_p}}$$

Where:

$\overline{D_p}$ = Average diameter (cm) of stems (or snags) for plot p.

BA_p = Average basal area per hectare (m^2) for plot p (refer to Section 3.5).

S_p = Stems (or snags) per hectare for plot p (refer to Section 3.5).

pi = 3.14159265

Report to 2 decimal places.

Example 8.1

2 Fir stems were tallied in a full plot using a BAF of 12.000. PRF = 0.1443. Tree one has a DBH of 89.9 and tree two has a DBH of 78.8.

The basal area per hectare is:

BA = 2 * 12 = 24

The stems per hectare are:

$$S_p = \frac{12\,(12732.39545)}{89.9^2} + \frac{12\,(12732.39545)}{78.8^2} = 43.51$$

The average diameter is:

$$= 100 * 2 * \sqrt{\frac{24}{\text{pi} * 43.51}} = 83.80 \text{ cm}$$

8.1.3.3.1 Gross Merchantable Volume/hectare

Use the method outlined in Section 3.5 for calculating V_p for a specific species.

Report to 2 decimal places.

8.1.3.4 Less Decay

$$\text{Less Decay} = \sum_{t=1}^{n_p} S_t\,(1 - d_t)\,V_t$$

Where:

V_t = Gross merchantable volume of tree t.

d_t = Decay percent from Loss Factor Table.

Report to 2 decimal places.

8.1.3.5 Less Decay and Waste

$$\text{Less Decay/Waste} = \sum_{t=1}^{n_p} S_t\,(1 - d_t - w_t)\,V_t$$

Where

S_t = Number of trees per hectare that tree t represents.

V_t = Gross merchantable volume of tree t.

d_t = Decay percent from Loss factor table.

w_t = Waste percent from Loss factor table.

n_p = Number of trees in plot P.

Report to 2 decimal places.

8.1.3.6 Less Decay, Waste and Breakage - Net Merchantable Volume per Hectare

$$\text{Less DWB} = \sum_{t=1}^{n_p} S_t \ (1 - d_t - w_t - b_t) \ V_t$$

Where:

S_t = Number of trees per hectare that tree t represents.

V_t = Gross merchantable volume of tree t.

d_t = Decay percent from Loss factor table.

w_t = Waste percent from Loss factor table.

b_t = Breakage percent from Loss factor table.

n_p = Number of trees in plot P.

Report to 2 decimal places.

8.1.3.7 Loss Factor Table

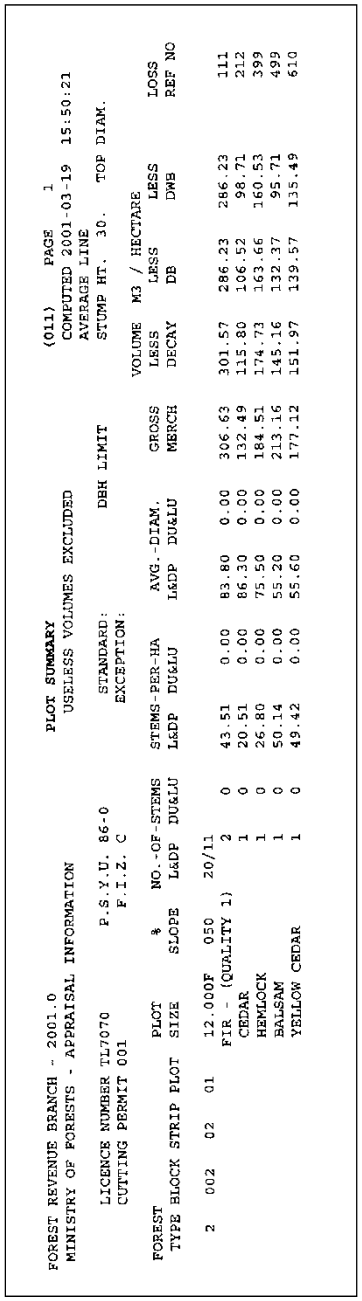
Refer to Section 3.3.1 Step #3 for instructions on determining the appropriate loss factor table.

8.1.4 Plot Frequency Report

At the end of the Plot summary report, list the number of measure plots and hectares per plot for each Type within Block and Type within cutting permit.

8.2 Plot Summary Listing

Report 011 - required.



```
FOREST REVENUE BRANCH - 2001.0                          PLOT SUMMARY                                  (011)   PAGE    1
MINISTRY OF FORESTS - APPRAISAL INFORMATION                USELESS VOLUMES EXCLUDED                   COMPUTED 2001-03-19  15:50:21
                                                                                                      AVERAGE LINE
     LICENCE NUMBER TL7070          P.S.Y.U. 86-0          STANDARD:                DBH LIMIT          STUMP HT.  30.   TOP DIAM.
     CUTTING PERMIT 001             F.I.Z. C               EXCEPTION:
                                                                                                   VOLUME  M3 / HECTARE
FOREST                PLOT      %    NO.-OF-STEMS   STEMS-PER-HA    AVG.-DIAM.     GROSS    LESS    LESS     LESS      LOSS
 TYPE BLOCK STRIP PLOT  SIZE    SLOPE   L&DP  DU&LU   L&DP  DU&LU    L&DP  DU&LU    MERCH    DECAY   DB       DWB       REF NO

  2   002   02   01   12.000F   050    20/11
                      FIR - (QUALITY 1)    2    0    43.51    0.00   83.80    0.00   306.63   301.57   286.23   286.23      111
                      CEDAR                1    0    20.51    0.00   86.30    0.00   132.49   115.80   106.52    98.71      212
                      HEMLOCK              1    0    26.80    0.00   75.50    0.00   184.51   174.73   163.66   160.53      399
                      BALSAM               1    0    50.14    0.00   55.20    0.00   213.16   145.16   132.37    95.71      499
                      YELLOW CEDAR         1    0    49.42    0.00   55.60    0.00   177.12   151.97   139.57   135.49      610
```

Figure 8.1 Plot Summary - Sample Listing.

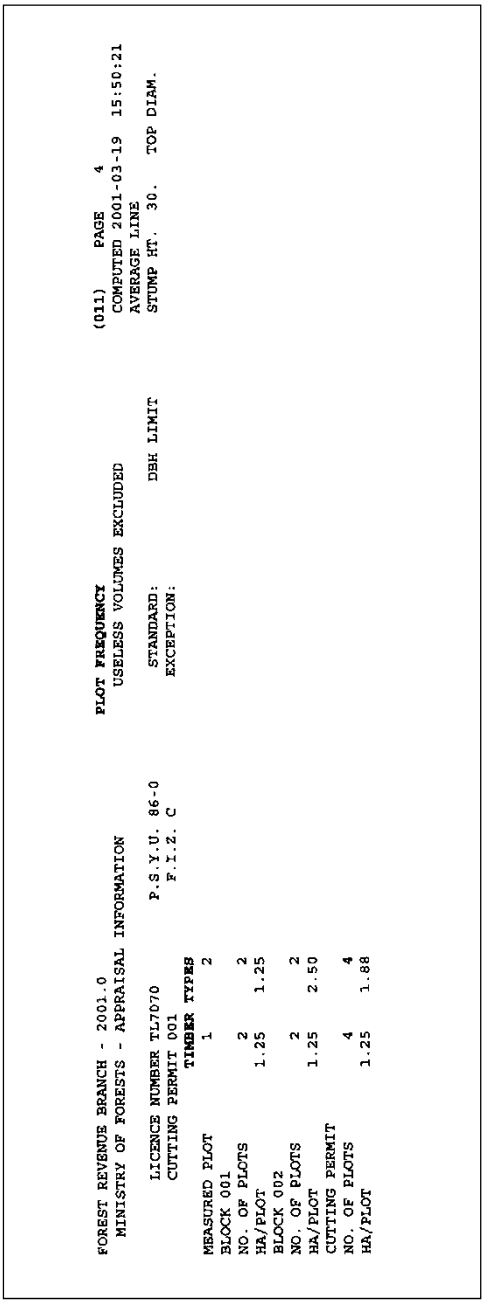


Figure 8.2 Plot Frequency - Sample Listing.

8.3 Plot Summary by Maturity Overview and Listing

This report is obsolete.

8.4 Cruise Statistics Overview

The Cruise Statistics summary reports volume and basal area statistics for each Timber Type in the compilation and for the entire Cutting Permit.

8.4.1 Header information

1. License from card type A.
2. Cutting Permit from card type A.
3. Forest Inventory Zone from card type A.
4. Unit # and Block from card type A.
5. Forest Region and District from card type A.
6. Merchantability requirements levels and exceptions from card type B.
7. Message indicating whether compilation is for appraisals or not.
8. Method of calculation (Average Line or Block)
9. Special compilation messages for:
    a. Reduction compilation.
    b. Stump cruise compilation.
    c. Tree class combination - useless volumes are included or excluded determined by column 15 of card type B (0 or blank - snags excluded, 1 - snags included).
    d. Selective cut indicator - which trees to compile depends on column 12 of card type B (blank - include all trees, 'C' - include cut-indicated and non-indicated trees, 'L' - include leave-indicated trees).
    e. Wet/Dry belt indicator - sale is in the wet belt or dry belt, depending on column 14 of card type B (0 - no message, 1 - wet belt, 2 - dry belt).
10. Compiler program name and version.
11. Compile date and time.
12. Page number.

8.4.2 Timber Type Information

For each Timber Type report.

8.4.2.1 Type Information

Report the Type number, Species composition, Age class, Height class, and Stocking Class from card type C.

8.4.2.2 Type of Plots

Either 'Fixed' or 'Prism' depending on the type of plots being compiled. If both fixed area and prism plots are used then report 'Mixed'.

8.4.2.3 Number of Potential Trees

Report the number of stems listed in plots from the Timber Type. If a percent reduction is being compiled, report the pre-reduction amount. If border plots are in the type, double the number of stems from those plots.

Report to the nearest whole number.

8.4.2.4 Number of Measured and Count Plots

Report the number of measured plots and count plots in the Timber Type.

8.4.2.5 Mean Net Volume per Hectare

Take the average of the estimates from the plots within the Timber Type.

$$\overline{V_i} = \frac{\sum_{p=1}^{m} V_p}{m}$$

Where

$\overline{V_i}$ = Timber Type i volume/hectare.

V_p = Volume/hectare estimate from plot p (refer to Section 3.4.2.3).

m = Number of measure plots in the Timber Type i.

Report to 1 decimal place.

Example 8.2

The subscripts in the above summation refer to the plots within the Type. 'P=1' means 'starting with the first plot in the Type' and 'm' means 'ending with the last plot in the Type'. In this example, there are 3 measure plots in Type 1. There are no count plots and no reductions being compiled. The average volume per hectare for the Type is:

$\overline{V_1}$ = (1048.47 + 828.07 + 726.08) / 3 = 867.54 m^3 per hectare

8.4.2.6 Mean Net Basal Area/hectare

For the basal area per hectare, include count plots in the summation instead of accommodating for count plots with the double sampling ratio.

$$\overline{b_i} = \frac{\sum_{p=1}^{m+c} BA_p}{m+c}$$

Where:

$\overline{b_i}$ = Timber Type basal area/hectare, corrected for double sampling.

BA_p = Basal area/hectare estimate from plot p (see Section 3.4.1.2 or 3.4.2.2).

m = Number of measure plots in the Timber Type.

c = Number of count plots in the Timber Type.

Report to 1 decimal place.

8.4.2.7 Standard Deviation for Volume - Measure Plots Only

$$SD_{vm} = \sqrt{\frac{\sum_{p=1}^{m} V_p^2 - \left(\sum_{p=1}^{m} V_p\right)^2 \Big/ m}{m-1}}$$

Where:

SD_{vm} = Standard Deviation for volume from measure plots only.

V_p = Volume/hectare estimate from measure plot p, not corrected for double sampling (i.e., do not apply DSR, see Section 3.4.1.3 or 3.4.2.3).

m = Number of measure plots in the Timber Type.

Report to 4 decimal places.

Example 8.3

Using the same plots as were used in Example 8.2:

$$\sum_{p=1}^{m} V_p^2 = 1048.47^2 + 828.07^2 + 726.08^2 = 2312181.432$$

$$\left(\sum_{p=1}^{m} V\,p \right)^2 = (1048.47 + 828.07 + 726.08)^2 = 6773630.864$$

$$SD_{vm} = \sqrt{\frac{2312181.432 - 6773630.864/3}{3-1}} = 164.7794$$

8.4.2.8 Standard Deviation for Basal Area - All Plots

Calculate the basal area standard deviation the same as the volume standard deviation, but include the count plots.

$$SD_b = \sqrt{\frac{\sum_{p=1}^{m+c} BA_p^2 - \left(\sum_{p=1}^{m+c} BA_p \right)^2 \Big/ m+c}{m+c-1}}$$

Where:

SD_b = Standard Deviation for basal area from measure and count plots.

BA_p = Basal area/hectare estimate from plot p (see Section 3.4.1.2 or 3.4.2.2).

m = Number of measure plots in the Timber Type.

c = Number of count plots in the Timber Type.

Report to 4 decimal places.

8.4.2.9 Coefficient of Variation for Volume - Measure Plots Only

The coefficient of variation is the standard deviation divided by the mean, expressed as a percent.

$$CV_v = \frac{SD_{vm}}{\overline{V_m}} * 100$$

Where

SD_{vm} = Standard Deviation for volume from measure plots only (defined above e).

$\overline{V_m}$ = The average volume per hectare from measure plots in the Timber Type, not corrected for double sampling (i.e., do not apply DSR, see Section 3.4.1.3 or 3.4.2.3)

$$= \frac{\sum_{p=1}^{m} V_p}{m}$$

Report to 1 decimal place.

Example 8.4

Using the volume per hectare and standard deviation from Examples 8.2 and 8.3, the coefficient of variation is calculated as:

CV_v = (164.7794 / 867.54) * 100 = 19.0

8.4.2.10 Coefficient of Variation for Basal Area

Calculate the basal area coefficient of variation the same as the volume coefficient of variation.

$$CV_b = \frac{SD_b}{\overline{b}} * 100\%$$

Where

SD_b = Standard Deviation for basal area from measure and count plots (defined above).

$\bar{b}$ The average basal area/hectare from measure and count plots in the Type (defined above).

Report to 1 decimal place.

8.4.2.11 Standard Error of the Mean Percent for Volume

$$SEM_v\% = \frac{SEM_v}{\overline{V}} * 100$$

Where:

$SEM_v\%$ = Standard error of the mean for volume expressed as a percent of the average volume.

SEM_v = $\sqrt{S_v^2} * FPC$

$$S_v^2 = \left[SD_{vm}^2 - 2\left(\frac{\overline{V}_m}{\overline{b}_m}\right) S_{vb} + \left(\frac{\overline{V}_m}{\overline{b}_m}\right)^2 SD_{bm}^2 \right]\left(\frac{1}{m} - \frac{1}{c+m}\right) + \frac{SD_{vm}^2}{c+m}$$

S_{vb} = Covariance between volume and basal area for measured plots only.

$$S_{vb} = \frac{\sum_{p=1}^{m} V_p BA_p - \left(\sum_{p=1}^{m} BA_p\right)\left(\sum_{p=1}^{m} V_p\right) \Big/ m}{m-1}$$

SD^2_{bm} = Variance of basal area a for measure plots only.

$$SD^2_{bm} = \frac{\sum_{p=1}^{m} BA_p^2 - \left(\sum_{p=1}^{m} BA_p\right)^2 \Big/ m}{m-1}$$

SD_{vm} = Standard deviation for volume from measured plots only (see Section 8.4.2.9).

$\overline{b_m}$ = $\frac{\sum_{i=1}^{m} BA_i}{m}$ = type average basal area/hectare from measure plots only.

$\overline{V_m}$ = Average volume/hectare from measured plots only (see Section 8.4.2.9).

FPC = 1.0 for Types sampled using variable plots, or

= $\sqrt{\frac{N-m}{N-1}}$ for Types sampled using fixed area plots.

N = Total number of possible plots in the type if 100% cruised.

m = Number of measure plots in the Timber Type.

c = Number of count plots in the Timber Type.

Report to 1 decimal place.

Example 8.5

Using the Type from Examples 8.2 and 8.3, assume that there are 3 count plots. The basal area per hectare estimates from the 3 measure plots are; 120, 80 and 90 respectively. The revised mean volume per hectare based on double sampling is 733.4.

S_{vb} = $\frac{257409.2 - 290 * 2602.62/3}{3-1}$ = 2911.3

SD^2_{bm} = $\frac{28900 - 84100/3}{3-1}$ = 433.33

S^2_v = $\left[27152.251 - 2\left(\frac{867.54}{96.67}\right)2911.3 + \left(\frac{867.54}{96.67}\right)^2 433.33\right]\left(\frac{1}{3} - \frac{1}{3+3}\right) + \frac{27152.251}{3+3}$

= [27152.25 – 52255.23 + 34901.78](1/6) + 4525.38 = 6158.51

FPC = 1.0

SEMv = $\sqrt{6158.51} * 1.0$ = 78.48

$SEM_v\%$ = 100 * (78.48 / 733.4) = 10.7

8.4.2.12 Standard Error of the Mean Percent for Basal Area

$SEM_b\% = \frac{SEM_b}{\bar{b}_i} * 100\%$

Where

$SEM_b\%$ = Standard error of the mean for volume expressed as a percent of the average basal area.

SEM_b = $\sqrt{\frac{SD_b^2}{m+c}} * FPC$

S_b^2 = Variance of Basal Area for all plots

= $\frac{\sum_{i=1}^{m+c} BA_p^2 - \left(\sum_{i=1}^{m+c} BA_p\right)^2 / (m+c)}{m+c-1}$

FPC = Finite population correction

= 1.0 when sampling using variable plots

= $\sqrt{\frac{N-n}{N-1}}$ when sampling using fixed area plots

N = Total number of possible plots in the type if 100% cruised.

n = Actual number of plots sampled

m = Number of measure plots in the Timber Type.

c = Number of count plots in the Timber Type.

Report to 1 decimal place.

8.4.2.13 % Confidence Interval for Volume

$95\%\ CI_v = \overline{V}_m \pm SEM_v\ \% * t_{m-1}$

Where:

t_{m-1} = t-value from Appendix 11 with m-1 degrees of freedom.

Report to 1 decimal place.

Example 8.6

Using the standard error of the mean for volume from Example 8.5, and the t-value from appendix 11 for 3-1=2 degrees of freedom, half of the 95 percent confidence interval for Type 1 is:

Half of the $95\%CI_v = 10.7 * 4.303 = 46.0$

8.4.2.14 % Confidence Interval for Basal Area

$$95\%CI_b = \overline{b_i} \pm SEM_b * t_{m+C-1}$$

Where

t_{m+c-1} = t-value from Appendix 11 with m+c-1 degrees of freedom.

Report to 1 decimal place.

8.4.3 Cutting Permit Information

8.4.3.1 Cutting Permit 95% Confidence Interval for Volume - All Plots

$$95\%CI_{vcp} = \pm 100 * \frac{\sqrt{\sum_{i=1}^{k} r_i^2 SEM_{vi}^2}}{\overline{V_{cp}}} * t_{(m+c)-k}$$

Where:

SEM_{vi} = SEM_v for Type i.

r_i = Proportional area of Type i.

$$r_i = \frac{A_i}{\sum_{i=1}^{k} A_k}$$

k = Number of Types.

m = Number of measure plots in the Cutting Permit.

C = Number of count plots in the Cutting Permit.

$t_{(m+c)-k}$ = t value from Appendix 11 with (m+c) - k degrees of freedom.

$\overline{V_{cp}}$ = Average volume/hectare for the Cutting Permit.

$$= \frac{\sum_{i=1}^{k} A_i \overline{V}_i}{\sum_{i=1}^{k} A_i}$$

Report to 1 decimal place.

Example 8.7

Say the Standard Error of the Mean is 78.5 for Type 1 and 45.0 for Type 2. Type 1 has 5 ha and Type 2 has 7.5 ha. The revised mean is 733.4 for Type 1 and 632.3 for Type 2. There are 3 measure plots in each Type.

$$95\%CI_{vcp} = \pm 100 * \frac{\sqrt{0.16 \text{ x } 6162.25 + 0.36 \text{ x } 2025}}{5 \text{ x } 733.4 + 7.5 * 632.3 / 12.5} \text{ x } 2.776 = \pm 17.1$$

8.4.3.2 Cutting Permit 95% Confidence Interval for Basal Area - All Plots

$$95\%CI_{cpb} = \pm 100 * \frac{\sqrt{\sum_{i=1}^{k} r_i^2 SEM_{bi}^2}}{\overline{b_{cp}}} * t_{(m+c) - k}$$

Where:

SEM_{bi} = Average volume/hectare for the Cutting Permit.

= SEM_b for Type i.

r_i = Proportional area of Type i.

$$r_i = \frac{A_i}{\sum_{i=1}^{k} A_k}$$

$\overline{b_{cp}}$ = Average basal area/hectare for the Cutting Permit.

$$= \frac{\sum_{i=1}^{k} A_i \overline{b_i}}{\sum_{i-1}^{k} A_i}$$

Report to 1 decimal place.

8.4.3.3 Cutting Permit 95% Confidence Interval for Volume - Measure Plots Only

$$95\%CI_{vmcp} = \pm 100 * \frac{\sqrt{\sum_{i=1}^{k} r_i^2 SEM_{vmi}^2}}{\overline{V_{cpm}}} * t_{m-k}$$

Where:

SEM_{vmi} = SEM_{vm} for Type i - measure plots only.

$$SEM_{vm} = \sqrt{\frac{SD_{vm}^2}{m}}$$

r_i = Proportional area of Type i.

$$r_i = \frac{A_i}{\sum_{i=1}^{k} A_k}$$

$\overline{V_{mcp}}$ = Average volume/hectare for the Cutting Permit - measure plots only.

$$= \frac{\sum_{i=1}^{m} A_i \overline{V_i}}{\sum_{i=1}^{k} A_i}$$

k = Number of timber types.

m = Number of measure plots in the cutting permit.

Report to 1 decimal place.

8.4.3.4 Cutting Permit 95% Confidence Interval for Basal Area - Measure Plots Only

$$95\%CI_{bcp} = \pm 100 * \frac{\sqrt{\sum_{i=1}^{k} r_i^2 SEM_{bmi}^2}}{\overline{b_{cpm}}} * t_{m-k}$$

Where:

SEM_{bmi} = SEM_{bm} for Type i, measured plots only.

$$SEM_{bm} = \sqrt{\frac{SD_{bm}^2}{m}}$$

$$r_i = \frac{A_i}{\sum_{i=1}^{k} A_k}$$

k = Number of timber types.

m = Number of measure plots in the cutting permit.

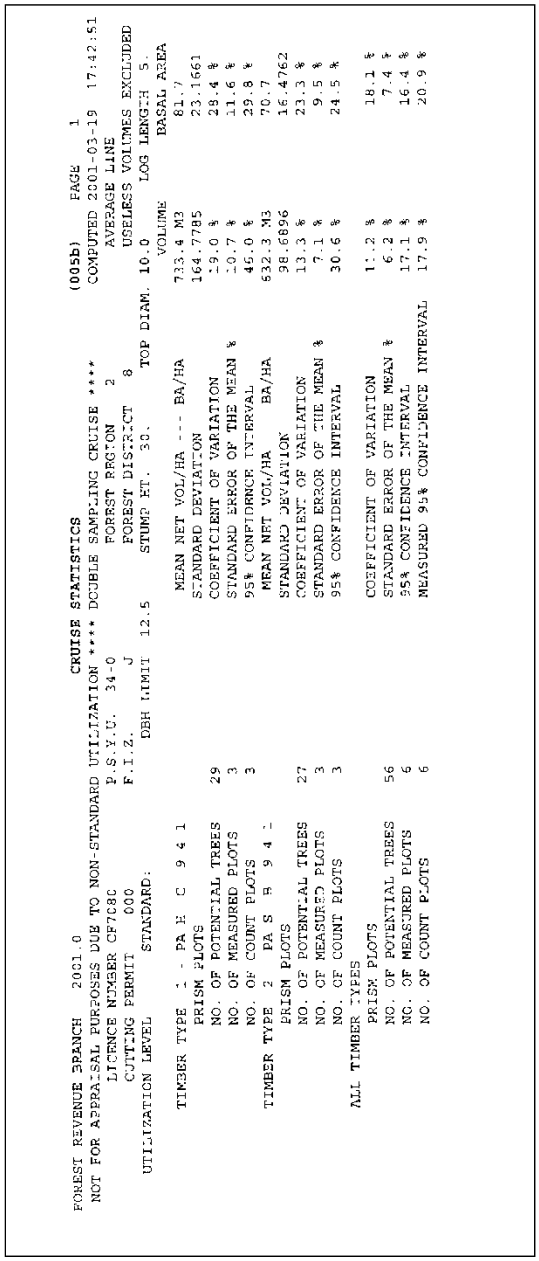
$\overline{b_{cpm}}$ = Average basal area/hectare for the Cutting Permit, measure plots only.

$$= \frac{\sum_{i=1}^{k} A_i \bar{b}_i}{\sum_{i=1}^{k} A_i}$$

Report to 1 decimal place.

8.5 Cruise Statistics Listing

Report 005b - required.



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Stand and Stock Reports 9

The stand and stock tables report stems per hectare, merchantable volume per hectare, and basal area per hectare by DBH class. The DBH classes are defined in Appendix 14.

Leave Tree tables will report the stems per hectare, merchantable volume per hectare, and basal area per hectare by DBH class of the stems not harvested in a reduction compilation. Please see chapter 5 for instructions on reduction compilations.

All species are to be included in columnar format, as depicted in the sample listings in Sections 9.1.2, 9.2.2, and 9.3.2.

Report the net merchantable volume based on merchantability. Some of the diameter classes have been removed from the sample listing (Figures 9.1, 9.2, and 9.3).

Each table except for a Leave Tree table is reported at the Block, Timber Type, and Cutting Permit levels. Leave Tree tables are reported at the Block and Treatment Unit within Block levels only.

Live stems are trees with tree class coded 1, 2, 5 or 8. *Snags* are trees with tree class coded either 4 or 6. *Dead potential stems* are trees with tree class coded 3, 7 or 9.

List of Reports

(007A) - Block Stand Table (stems/hectare).

(007B) - Block Stock Table (merchantable volume/hectare).

(007C) - Block Basal Area (basal area/hectare).

(007D) - Timber Type Stand Table (stems/hectare).

(007E) - Timber Type Stock Table (merchantable volume/hectare).

(007F) - Timber Type Basal Area (basal area/hectare).

(007G) - Cutting Permit Stand Table (stems/hectare).

(007H) - Cutting Permit Stock Table (merchantable volume/hectare).

(007I) - Cutting Permit Basal Area (basal area/hectare).

(007J) Block Leave Tree Stand Table (stems/hectare).

(007K) Block Leave Tree Stock Table (merchantable volume/hectare).

(007L) Block Leave Tree Basal Area (basal area/hectare).

For each of the reports listed above, there are six additional damage reports. For each of Blowdown, Fire, and Insect damage produce a Stand Table and a Stock Table at each of the three reporting levels. Basal area per hectare is not a required damage report. The damage reports are one species per table per damage type. Refer to Section 4.3 for a sample report format. Where multiple damage codes exist for a tree, its volume and basal area would only contribute to one damage type, as explained in Chapter 4.

No damage reports are required for the Leave Tree summaries.

Leave Tree summaries will have the words LEAVE TREE in upper case letters printed at the top.

9.1 Header Information - All Reports

Include the following header information on the stand, stock and basal area reports, including the damage reports. For damage reports, add the species and damage type, as shown in Chapter 4.

1. License from card type A.
2. Cutting Permit from card type A.
3. Block or Timber Type number, if the table is for a Block or Timber Type.
4. Silviculture Treatment Unit areas for the Block, Timber Type or Cutting Permit.
5. Message indicating whether compilation is for appraisals or not.
6. Method of calculation (Average Line or Block).
7. Merchantability requirements from card type B for each species on the report.
8. Special compilation messages for:
    a. reduction compilation,
    b. stump cruise compilation,
    c. tree class combination - useless volumes are included or excluded,
    d. from column 15 of card type B (0 or blank - snags excluded, 1 - snags included),
    e. selective cut indicator - which trees to compile depends on column 12 of card type B (blank - include all trees, 'C' - include cut-indicated and non-indicated trees, 'L' - include leave-indicated trees), and
    f. double sampling, if count plots are used
9. Compiler program name and version.
10. Compile date and time.
11. Page number.
12. Damage code - for damage reports only.

9.2 Stand Table

9.2.1 Stand Table - Detail Information

All of the stand table parameters described below are reported to 1 decimal place.

9.2.1.1 Live Stems per Hectare

The live stems per hectare calculations are based on trees for each species and for each diameter class. Use only tree classes 1, 2, 5, and 8.

9.2.1.1.1 Timber Type

The Type estimate is the average of the plot estimates from the Type.

$$S_{s,d,i} = \frac{\sum_{p=1}^{m_i} S_p}{m_i}$$, using tree classes 1, 2, 5 and 8 only

9.2.1.1.2 Block - Average Line method

The Type estimates are weighted based on area of the Type within the Block.

$$S_{s,d,j} = \frac{\sum_{i=1}^{I_j} S_{s,d,i} * A_{i,j}}{A_j}$$

9.2.1.1.3 Block - Treatment Unit "Leave Tree" Summary

Only report those species within the Treatment Unit within the Block that have a percent reduction applied to them.

$$SLT_{u,s,d,i,j} = S_{u,s,d,i,j} * (PR_{u,s,d,i,j} \div 100)$$

Where:

$SLT_{u,s,d,i,j}$ = Stems per hectare estimate for Treatment Unit u, Species s, Diameter class d, Type i and Block j for stems not to be harvested (Leave Trees).

$S_{u,s,d,i,j}$ = Pre reduction stems per hectare estimate for Treatment Unit u, Species s, Diameter class d, Type i and Block j.

$PR_{u,s,d,i,j}$ = Percent reduction value for Treatment Unit u, Species s, Diameter class d, Type I and Block j used in the Percent Reduction Worksheet (FS 221).

Example 9.1

The reduction value for Pine in the 20 cm class in Treatment Unit A is 45.

The Treatment Unit has 399.9 stems per hectare for Pine in the 20 cm class before reduction.

$SLT_{u,s,d,i,j}$ = $399.9 * (45 \div 100)$

= 179.9 stems per hectare

9.2.1.1.4 Block "Leave Tree" Summary

Weight the Treatment Unit Leave Tree stems per hectare by the area of the Treatment Unit within the Type within the Block, sum, divide by the area of the Block. For Treatment Units without a percent reduction the reduction value equals zero.

$$SLT_{s,d,j} = \frac{\sum_{u=1}^{U_j} SLT_{u,s,d,i,j} * A_{u,i,j}}{A_j}$$

Where:

$SLT_{s,d,j}$ = Stems per hectare estimate for Species s, Diameter class d and Block j for stems not harvested (Leave Trees).

A_j = Area of Block j.

$A_{u,i,j}$ = Area of Treatment Unit u within Type i within Block j.

U_j = Number of Treatment Units in Block j.

Example 9.2

There are 2 Treatment Units in Block X. The area of Block X is 10 hectares.

There are 2 types in the Block.

Treatment Unit A is 8 hectares, 7.5 hectares of Type 1 and .5 hectares of Type 2.

Treatment Unit B is 2.0 hectares, all in Type 2.

The reduction value for Pine in the 20 cm class in Type 1, Treatment Unit A is 45.

The reduction value for Pine in the 20 cm class in Type 2, Treatment Unit A is 35.

There is not a percent reduction for Pine in Treatment Unit B.

The Type 1 pre-reduction stand table for Pine shows 399.9 stems per hectare in the 20 cm class.

The Type 2 pre-reduction stand table for Pine shows 361.4 stems per hectare in the 20 cm class.

$SLT_{A,P,20,1,X} * A_{A,1,X}$ = 399.9 * .45 * 7.5 = 1349.66

$SLT_{A,P,20,2,X} * A_{A,2,X}$ = 361.4 * .35 * 0.5 = 63.25

$SLT_{B,P,20,2,X} * A_{B,2,X}$ = 361.4 * .00 * 2.0 = 0.00

$SLT_{P,20,X}$ = (1349.66 + 63.25 + 0) ÷ 10

= 141.3 stems per hectare

9.2.1.1.5 Block - Block method

The Type within Block estimates must be calculated and weighted based on area of the Type within the Block. The Type within Block estimates use the Block Double Sampling Ratio and the plots from the Type within the Block.

$$S_{s,d,i,j} = \frac{\sum_{p=1}^{m_{i,j}} S_p}{m_{i,j}}$$ - intermediate calculation - not reported

$$S_{s,d,j} = \frac{\sum_{i=1}^{I_j} S_{s,d,i,j} * A_{i,j}}{A_j}$$

9.2.1.2 Example 9.3

There are 2 Types in Block 1, each having 2.5 ha. In Block 1, there are 4 plots taken in Type 1 and 2 plots taken in Type 2.

The plot estimates for Cedar stems per hectare in Block 1 are:

Type 1	Type 2
50	40
0	40
25	
25	

(Assume these estimates are for a particular diameter class, d)

$S_{c,d,1,1}$ = (50 + 0 + 25 + 25) / 4 = 25

$S_{c,d,1,2}$ = (40 + 40) / 2 = 40

Then $S_{c,d,1} = \frac{2.5 * 25 + 2.5 * 40}{5.0 \text{ total hectares}} = 32.5$

9.2.1.2.1 Cutting Permit

The cutting permit estimate is the weighted average of the Type estimates based on the area of the Type within the Cutting Permit.

$$S_{s,d,cp} = \frac{\sum_{i=1}^{I} S_{s,d,i} * A_i}{A_{cp}}$$

Sum the Type, Block and Cutting Permit estimates by species and by diameter class (the examples below show the summations for the Timber Type only).

$$S_{s,i} = \sum_{d=1}^{34} S_{s,d,i}$$

$$S_{d,i} = \sum_{s=1}^{31} S_{s,d,i}$$

Sum either of the above estimates for the total stems per hectare for the Type, Block, and Cutting Permit (i.e., all Species and all Diameter Classes).

$$S_i = \sum_{d=1}^{34} S_{s,i}$$

Where:

$S_{s,d,i}$ = Stems per hectare estimate for species s, diameter class d and Timber Type i.

$S_{s,d,j}$ = Stems per hectare estimate for species s, diameter class d and Block j.

$S_{s,d,j,k}$ = Block method stems per hectare estimate for species s, diameter class d, Timber Type i within Block j - the Block method Double Sampling ratio would be used.

$S_{s,d,cp}$ = Stems per hectare estimate for species s and diameter class d for the Cutting Permit.

$S_{s,i}$ = Total stems per hectare for a species, all 34 diameter classes.

$S_{d,i}$ = Total stems per hectare for a diameter class, all species.

S_i = Total stems per hectare for the Timber Type.

S_p = Stems per hectare estimate for plot p (refer to Section 8.1.3).

$A_{i,j}$ = Area of Type i within Block j to 1 decimal place.

A_i = Area of Type i to 1 decimal place.

A_j = Area of Block j to 1 decimal place.

A_{cp} = Area of Cutting Permit to 1 decimal place.

I = Number of Types in the Cutting Permit.

I_j = Number of Types in Block j.

M_i = Number of measure plots in Timber Type i.

$m_{i,j}$ = Number of measure plots in Timber Type i within Block j.

D = Diameter Class (refer to Appendix 14).

9.2.1.3 Useless Stems (snags) per Hectare

The Useless stems per hectare estimate are by Species (all Diameter Classes) and by Diameter Class (all Species). Only use tree classes 4 and 6.

Leave Tree tables use the same methodology as outlined for Live Stems per Hectare (Section 9.1.1.1).

9.2.1.3.1 Timber Type

$$SU_{s,i} = \frac{\sum_{d=1}^{34}\left(\sum_{p=1}^{m_i} S_p\right)}{m_i}, \text{ tree classes 4 and 6 only}$$

$$SU_{s,i} = \frac{\sum_{d=1}^{34}\left(\sum_{p=1}^{m_i} S_p\right)}{m_i}, \text{ tree classes 4 and 6 only}$$

$$SU_{d,i} = \frac{\sum_{s=1}^{31}\left(\sum_{p=1}^{m_i} S_p\right)}{m_i}$$

Where:

$SU_{s,i}$ = Useless stems per hectare estimate for species s, Timber Type i.

$SU_{d,i}$ = Useless stems per hectare estimate for diameter class d, Timber Type i.

S_p = Stems per hectare estimate for plot p (refer to Section 8.1.3).

m_i = Number of measure plots in timber type i.

9.2.1.3.2 Block - Average Line Method

The Type estimates are weighted based on area of the Type within the Block. Use the same weighting method as for the live stems per hectare estimate.

The Type within Block estimates must be calculated and weighted based on area of the Type within the Block. The Type within Block estimates use the Block Double Sampling Ratio and the plots from the Type within the Block. Use the same weighting method as for the live stems per hectare estimate.

9.2.1.3.3 Cutting Permit

The cutting permit estimate is the weighted average of the Type estimates based on the area of the Type within the Cutting Permit. Use the same weighting method as for the live stems per hectare estimate.

9.2.1.4 Dead Potential Stems per Hectare

The Dead Potential Stems per hectare estimate are by Species (all Diameter Classes) and by Diameter Class (all Species). Only use tree classes 3, 7 and 9.

For Leave Tree tables use the same methodology as outlined for Live Stems per Hectare (Section 9.1.1.1).

9.2.1.4.1 Timber Type

$$SDP_{s,i} = \frac{\sum_{d=1}^{34} \left(\sum_{p=1}^{m_i} S_p \right)}{m_i} =, \text{ tree classes 3, 7 and 9 only}$$

$$SDP_{d,i} = \frac{\sum_{s=1}^{31} \left(\sum_{p=1}^{m_i} S_p \right)}{m_i} =, \text{ tree classes 3, 7 and 9 only}$$

Where

$SDP_{s,i}$ = Dead potential stems per hectare estimate for species s, Timber Type i.

S_p = Stems per hectare estimate for plot p (refer to Section 8.1.3).

m_i = Number of measure plots in timber type i.

9.2.1.5 Average DBH at Five Levels

The average DBH is also reported for five diameter levels:

Leave Tree summaries do not need to report these parameters.

1. DBH greater than 12.4 cm.
2. DBH greater than 17.4 cm.
3. DBH greater than 22.4 cm.
4. DBH greater than 27.4 cm.
5. DBH greater than 32.4 cm.

Separate trees by Tree Class (i.e., live trees, dead potential and useless) as above. Weight the parameters for Block and Cutting Permit as above.

9.2.1.5.1 Timber Type:

$$\overline{D}_{s,l,i} = 100 * 2 * \sqrt{\frac{BA_{s,l,i}}{pi * S_{s,l,i}}}$$

Where:

$\overline{D}_{s,l,i}$ = Avg. diam. (cm) of trees with DBH lower limit l for Species s and type i.

$BA_{s,l,i}$ = Average basal area per hectare estimate of trees with DBH lower limit l for Species s and Type i.

$S_{s,l,i}$ = Stems (or snags) per hectare estimate of trees with DBH lower limit l for Species s and Type i.

pi = 3.14159265.

9.2.1.6 Example 9.4

There are 2 plots in Type 1 each having 2 Hemlock stems. The BAF in each plot is 10.

DBH	
Plot 1	**Plot 2**
58.8	42.6
42.5	51.1

Plot 1
BA = 2 * 10 = 20

$$\text{SPH} = \frac{10\ (12732.39545)}{58.8^2} + \frac{10\ (12732.39545)}{42.5^2} = 107.32$$

Plot 2
BA = 2 * 10 = 20

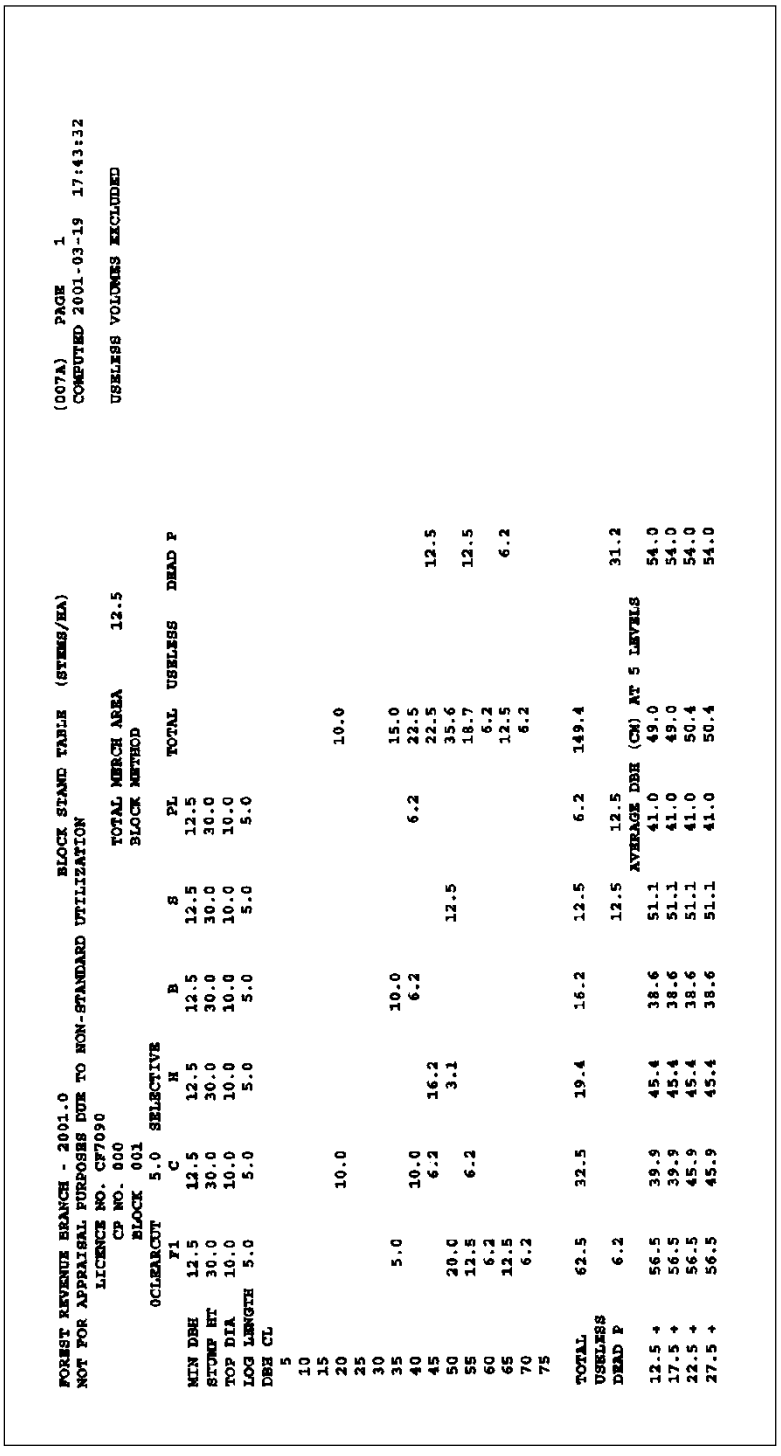
$$\text{SPH} = \frac{10\ (12732.39545)}{42.6^2} + \frac{10\ (12732.39545)}{51.1^2} = 118.92$$

Sum of SPH 107.32 + 118.92 = 226.24

Average Diameter Type 1 $100 * 2 * \sqrt{\frac{40}{PI * 226.24}} = 47.4$

9.2.2 Block Stand Table - Sample Listing - Block Method

Report 007A - required.



```
FOREST REVENUE BRANCH - 2001.0                    BLOCK STAND TABLE  (STEMS/HA)                    (007A)   PAGE    1
NOT FOR APPRAISAL PURPOSES DUE TO NON-STANDARD UTILIZATION                                          COMPUTED 2001-03-19  17:43:32
          LICENCE NO. CF7090
               CP NO. 000                                TOTAL MERCH AREA      12.5                  USELESS VOLUMES EXCLUDED
               BLOCK  001                                BLOCK METHOD
        0CLEARCUT    5.0  SELECTIVE
             F1       C       H       B       S       PL    TOTAL  USELESS   DEAD P
MIN DBH    12.5     12.5     12.5     12.5     12.5     12.5
STUMP HT   30.0     30.0     30.0     30.0     30.0     30.0
TOP DIA    10.0     10.0     10.0     10.0     10.0     10.0
LOG LENGTH  5.0      5.0      5.0      5.0      5.0      5.0
DBH CL
  5
 10
 15
 20                10.0                                        10.0
 25
 30
 35         5.0                      10.0                       15.0
 40                10.0              6.2                6.2     22.5
 45                 6.2     16.2                                22.5              12.5
 50        20.0              3.1              12.5              35.6
 55        12.5      6.2                                        18.7              12.5
 60         6.2                                                  6.2
 65        12.5                                                 12.5               6.2
 70         6.2                                                  6.2
 75

TOTAL      62.5     32.5     19.4     16.2     12.5      6.2    149.4
USELESS
DEAD P      6.2                              12.5     12.5                        31.2
                                                  AVERAGE DBH (CM) AT 5 LEVELS
12.5 +     56.5     39.9     45.4     38.6     51.1     41.0     49.0              54.0
17.5 +     56.5     39.9     45.4     38.6     51.1     41.0     49.0              54.0
22.5 +     56.5     45.9     45.4     38.6     51.1     41.0     50.4              54.0
27.5 +     56.5     45.9     45.4     38.6     51.1     41.0     50.4              54.0
```

Figure 9.1 Block Stand Table - Sample Listing (Partial).

9.3 Stock Table

9.3.1 Stock Table - Detail Information

All of the stock table parameters described below are reported to 1 decimal place.

Report net merchantable volumes (i.e., gross less decay, waste, breakage). Refer to Section 8.1.3.

9.3.1.1 Net Merchantable Volume per Hectare

The volume per hectare calculation segregates trees for each species and for each diameter class. Use only tree classes 1, 2, 5 and 8.

9.3.1.1.1 Timber Type

The Type estimate is the average of the plot estimates from the Type.

$$V_{s,d,i} = \frac{\sum_{p=1}^{m_i} V_{p,s,d,i}}{m_i}, \text{ tree classes 1, 2, 5 and 8 only}$$

> Refer to Example 9.4 for a sample Timber Type calculation.

9.3.1.1.2 Block - Average Line Method

The Type estimates are weighted based on area of the Type within the Block.

$$V_{s,d,j} = \frac{\sum_{i=1}^{I_j} V_{s,d,i} * A_{i,j}}{A_j}$$

9.3.1.1.3 Block Treatment Unit "Leave Tree" Summary

Only report those species within the Treatment Unit within the Block that have a percent reduction applied to them.

$$VLT_{u,s,d,i,j} = V_{u,s,d,i,j} * (PR_{u,s,d,i,j} \div 100)$$

Where:

$VLT_{u,s,d,i,j}$ = Net volume per hectare estimate for Treatment Unit u, Species s, Diameter class d, Type i and Block j for stems not to be harvested (Leave Trees).

$V_{u,s,d,i,j}$ = Pre reduction net volume per hectare estimate for Treatment Unit u, Species s, Diameter class d, Type i and Block j.

$PR_{u,s,d,i,j}$ = Percent reduction value for Treatment Unit u, Species s, Diameter class d, Type i and Block j used in the Percent Reduction Worksheet (FS 221).

Example 9.5

The reduction value for Pine in the 20 cm class in the Treatment Unit is 45.

The Treatment Unit net volume is 109.9 m^3 per hectare for Pine in the 20 cm class before reduction.

$$VLT_{u,s,d,i,j} = 109.9 * (45 \div 100)$$

$$= 49.5 \text{ } m^3 \text{ per hectare}$$

9.3.1.1.4 Block "Leave Tree" Summary

Weight the Treatment Unit Leave Tree net volume per hectare by the area of the Treatment Unit within the Type within the Block, sum, divide by the area of the Block. For Treatment Units without a percent reduction the reduction value equals zero.

$$VLT_{s,d,j} = \frac{\sum_{u=1}^{U_j} VLT_{u,s,d,i,j} * A_{u,i,j}}{A_j}$$

Where:

$VLT_{s,d,j}$ = Net volume per hectare estimate for Species s, Diameter class d and Block j for stems not harvested (Leave Trees).

A_j = Area of Block j.

$A_{u,i,j}$ = Area of Treatment Unit u within Type i within Block j.

Example 9.6

There are 2 Treatment Units in Block X. The area of Block X is 10 hectares.

There are 2 types in the Block.

Treatment Unit A is 8 hectares, 7.5 hectares of Type 1 and .5 hectares of Type 2.

Treatment Unit B is 2.0 hectares, all in Type 2.

The reduction value for Pine in the 20 cm class in Type 1, Treatment Unit A is 45.

The reduction value for Pine in the 20 cm class in Type 2, Treatment Unit A is 35.

There is not a percent reduction for Pine in Treatment Unit B.

The Type 1 pre reduction stock table for Pine shows 109.9 m^3 per hectare in the 20 cm class.

The Type 2 pre reduction stock table for Pine shows 84.0 m^3 per hectare in the 20 cm class.

$VLT_{A,P,20,1,X} * A_{A,1,X}$ = $109.9 * .45 * 7.5 = 370.91$

$VLT_{A,P,20,2,X} * A_{A,2,X}$ = $84.0 * .35 * 0.5 = 14.70$

$VLT_{B,P,20,2,X} * A_{B,2,X}$ = $84.0 * .00 * 2.0 = 0.00$

$VLT_{P,20,X}$ = $(370.91 + 14.70 + 0) \div 10$

= 38.6 m^3 per hectare

9.3.1.1.5 Block - Block Method

The Type within Block estimates must be calculated and weighted based on area of the Type within the Block. The Type within Block estimates use the Block Double Sampling Ratio, and the plots from the Type within the Block.

$$V_{s,d,i,j} = \frac{\sum_{p=1}^{m_{i,j}} V_{p,s,d,i,j}}{m_{i,j}}$$ - intermediate calculation - not reported

$$V_{s,d,j} = \frac{\sum_{i=1}^{I_j} V_{s,d,i,j} * A_{i,j}}{A_j}$$

> Refer to Example 9.3 for a sample Block calculation.

9.3.1.1.6 Cutting Permit

The cutting permit estimate is the weighted average of the Type estimates based on the area of the Type within the Cutting Permit.

$$V_{s,d,cp} = \frac{\sum_{i=1}^{I} V_{s,d,i} * A_i}{A_{cp}}$$

Report to two decimal places.

9.3.1.2 Example 9.7

There are two Types in the Cutting Permit. Type 1 has 5 ha and Type 2 has 7.5 ha. The Fir volume per hectare estimate in Type 1 is 238.18. The Fir volume per hectare estimate in Type 2 is 107.28.

$$V_{f,d,cp} = \frac{238.18 * 5 + 107.28 * 7.5}{12.5} = 159.64$$

Sum the Type, Block and Cutting Permit estimates by species and by diameter class (the examples below show the summations for the Timber Type only).

$$V_{s,i} = \sum_{d=1}^{34} V_{s,d,i}$$

$$V_{d,I} = \sum_{s=1}^{31} V_{s,d,i}$$

Sum either of the above estimates for the total volume per hectare for the Type, Block and Cutting Permit (i.e., all Species and all Diameter Classes).

$$V_{i} = \sum_{d=1}^{34} V_{s,i}$$

Where:

$V_{s,d,i}$ = Volume per hectare estimate for species s, diameter class d and Timber Type i.

$V_{s,d,j}$ = Volume per hectare estimate for species s, diameter class d and Block j.

$V_{s,d,i,j}$ = Block method volume per hectare estimate for species s, diameter class d, Timber Type i within Block j - the Block method Double Sampling ratio would be used.

$V_{s,d,cp}$ = Volume per hectare estimate for species s and diameter class d for the Cutting Permit.

$V_{s,i}$ = Total volume per hectare for a species, all 34 diameter classes.

$V_{d,i}$ = Total volume per hectare for a diameter class, all species.

V_{i} = Total volume per hectare for the Type i.

V_{p} = Volume per hectare estimate for plot p (refer to Section 8.1.3).

$A_{i,j}$ = Area of Type i within Block j to 1 decimal place.

A_{i} = Area of Type i to 1 decimal place.

A_{j} = Area of Block j to 1 decimal place.

A_{cp} = Area of Cutting Permit to 1 decimal place.

I = Number of Types in the Cutting Permit.

I_j = Number of Types in Block j.

m_i = Number of measure plots in Timber Type i.

$m_{i,j}$ = Number of measure plots in Timber Type i within Block j.

D = Diameter Class (refer to Appendix 14).

9.3.1.3 Useless Volume per Hectare

Only report useless volume per hectare if the Tree Class Combination coded on card type B is set to 1. The Useless Stems per hectare estimate are by Species (all Diameter Classes) and by Diameter Class (all Species). Only use tree classes 4 and 6.

For Leave Tree tables use the same methodology as outlined for Live Net Merchantable Volume per Hectare (Section 9.2.1.1).

9.3.1.3.1 Timber Type

$$VU_{s,i} = \frac{\sum_{d=1}^{34} \left(\sum_{p=1}^{m_i} S_p \right)}{m_i}, \text{ tree classes 4 and 6 only}$$

$$VU_{d,i} = \frac{\sum_{s=1}^{31} \left(\sum_{p=1}^{m_i} S_p \right)}{m_i}, \text{ tree classes 4 and 6 only}$$

Where:

$VU_{s,i}$ = Useless volume per hectare estimate for species s, Timber Type i.

$VU_{d,i}$ = Useless volume per hectare estimate for diameter class d, Timber Type i.

V_p = Volume per hectare estimate for plot p (refer to Section 8.1.3).

m_i = Number of measure plots in timber type i.

D = Diameter Class (refer to Appendix 14).

9.3.1.3.2 Block - Average Line Method

The Type estimates are weighted based on area of the Type within the Block. Use the same weighting method as for the volume per hectare estimate.

9.3.1.3.3 Block - Block Method

The Type within Block estimates must be calculated and weighted based on area of the Type within the Block. The Type within Block estimates use the Block Double Sampling Ratio, and the plots from the Type within the Block. Use the same weighting method as for the volume per hectare estimate.

9.3.1.3.4 Cutting Permit

The cutting permit estimate is the weighted average of the Type estimates based on the area of the Type within the Cutting Permit. Use the same weighting method as for the volume per hectare estimate.

9.3.1.4 Dead Potential Volume per Hectare

The Dead Potential volume per hectare estimates are segregated by Species (all Diameter Classes) and by Diameter Class (all Species). Only use tree classes 3, 7 and 9.

For Leave Tree tables use the same methodology as outlined for Live Net Merchantable Volume per Hectare (Section 9.2.1.1).

9.3.1.4.1 Timber Type

$$VDP_{s,i} = \frac{\sum_{d=1}^{34} \left(\sum_{p=1}^{m_i} V_{p,s,i} \right)}{m_i}$$, tree classes 3, 7 and 9 only

$$VDP_{d,i} = \frac{\sum_{s=1}^{31}\left(\sum_{p=1}^{m_i} V_p\right)}{m_i}, \text{ tree classes 3, 7 and 9 only}$$

Where

$VDP_{s,i}$ = Dead potential volume per hectare estimate for species s, Timber Type i.

V_p = Volume per hectare estimate for plot p (refer to Section 8.1.3).

m_i = Number of measure plots in timber type i.

d = Diameter Class.

9.3.1.5 Total Volume per Hectare at Seven Levels

The total volume per hectare is also reported for seven diameter levels:

Leave Tree summaries do not need to report these parameters.

1. DBH greater than 17.4 cm.
2. DBH greater than 22.4 cm.
3. DBH greater than 27.4 cm.
4. DBH greater than 32.4 cm.
5. DBH greater than 37.4 cm.
6. DBH greater than 42.4 cm.
7. DBH greater than 47.4 cm.

Separate trees by Tree Class (i.e., live trees, dead potential and useless) as above. Only report Useless volume if the Tree Class Combination from card type B is coded 1. Weight the parameters for Block and Cutting Permit as above.

9.3.1.5.1 Timber Type

$$VT_{s,l,i} = \sum_{d=l+2}^{34} V_{s,d,i}\, y$$

Where:

$VT_{s,l,i}$ = Total volume for Species s at level l in Timber Type i.

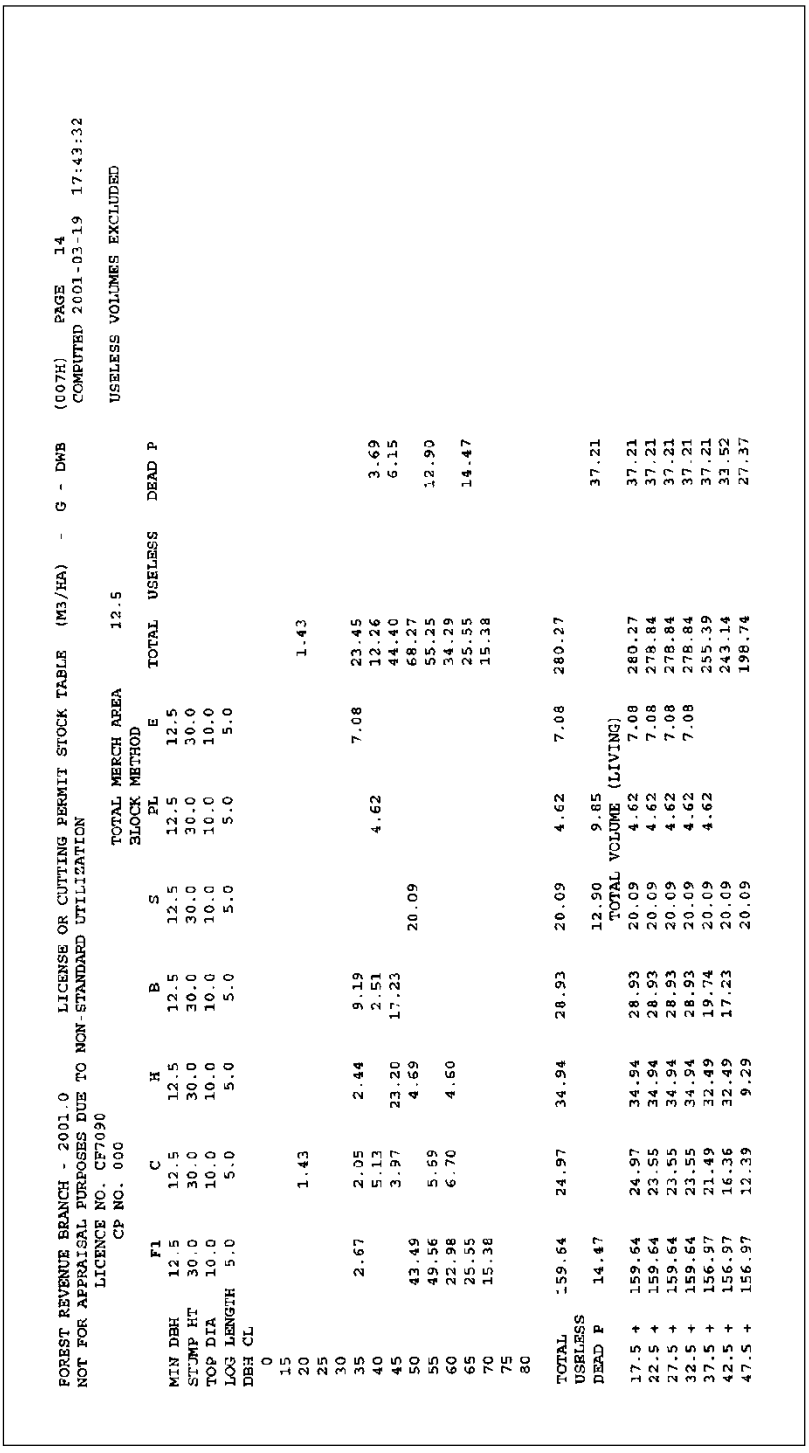
$V_{s,d,i}$ = Volume per hectare estimate for species s, diameter class d and Timber Type i.

l = DBH lower limit level (1-7).

d = Diameter Class (refer to Appendix 14).

9.3.2 Stock Table - Sample Listing - Cutting Permit Level

Report 007h - required.



FOREST REVENUE BRANCH - 2001.0 LICENSE OR CUTTING PERMIT STOCK TABLE (M3/HA) - G - DWB (C07H) PAGE 14
NOT FOR APPRAISAL PURPOSES DUE TO NON-STANDARD UTILIZATION COMPUTED 2001-03-19 17:43:32

LICENCE NO. CF7090 USELESS VOLUMES EXCLUDED
CP NO. 000

TOTAL MERCH AREA 12.5
BLOCK METHOD

	F1	C	H	B	S	PL	E	TOTAL	USELESS	DEAD P
MIN DBH	12.5	12.5	12.5	12.5	12.5	12.5	12.5			
STUMP HT	30.0	30.0	30.0	30.0	30.0	30.0	30.0			
TOP DIA	10.0	10.0	10.0	10.0	10.0	10.0	10.0			
LOG LENGTH	5.0	5.0	5.0	5.0	5.0	5.0	5.0			
DBH CL										
0										
15		1.43						1.43		
20										
25										
30										
35	2.67	2.05	2.44	9.19			7.08	23.45		3.69
40		5.13		2.51		4.62		12.26		6.15
45		3.97	23.20	17.23				44.40		
50	43.49		4.69		20.09			68.27		12.90
55	49.56	5.69						55.25		
60	22.98	6.70	4.60					34.29		14.47
65	25.55							25.55		
70	15.38							15.38		
75										
80										
TOTAL	159.64	24.97	34.94	28.93	20.09	4.62	7.08	280.27		
USELESS					12.90	9.85				
DEAD P	14.47				TOTAL	VOLUME (LIVING)				37.21
17.5 +	159.64	24.97	34.94	28.93	20.09	4.62	7.08	280.27		37.21
22.5 +	159.64	23.55	34.94	28.93	20.09	4.62	7.08	278.84		37.21
27.5 +	159.64	23.55	34.94	28.93	20.09	4.62	7.08	278.84		37.21
32.5 +	159.64	23.55	34.94	28.93	20.09	4.62	7.08	278.84		37.21
37.5 +	156.97	21.49	32.49	19.74	20.09	4.62		255.39		37.21
42.5 +	156.97	16.36	32.49	17.23	20.09			243.14		33.52
47.5 +	156.97	12.39	9.29		20.09			198.74		27.37

Figure 9.2 Cutting Permit Stock Table - Sample Listing (Partial).

9.4 Basal Area Table

9.4.1 Basal Area Table - Detail Information

All of the basal area table parameters described below are reported to one decimal place.

9.4.1.1 Basal Area per Hectare

The basal area per hectare calculations are segregated by species and diameter class. Use only tree classes 1, 2, 5 and 8.

9.4.1.1.1 Timber Type

The Type estimate is the average of the plot estimates from the Type.

$$BA_{s,d,i} = \frac{\sum_{p=1}^{m_i} BA_p}{m_i}, \text{ tree classes 1, 2, 5 and 8 only}$$

9.4.1.2 Example 9.8

There are 4 plots in Type 1. The basal area per hectare estimates from these plots are 20, 30, 30 and 50 respectively. Assume that the estimates are based on a particular diameter class, d.

$BA_{s,d,i} = (20 + 30 + 30 + 50) / 4 = 32.5$

9.4.1.2.1 Block - Average Line Method

The Type estimates are weighted based on area of the Type within the Block.

$$BA_{s,d,j} = \frac{\sum_{i=1}^{I_j} BA_{s,d,i} * A_{i,j}}{A_j}$$

9.4.1.2.2 Block - Treatment Unit "Leave Tree" Summary

Only report those species within the Treatment Unit within the Block that have a percent reduction applied to them.

$$BALT_{u,s,d,i,j} = BA_{u,s,d,i,j} * (PR_{u,s,d,i,j} \div 100)$$

Where:

$BALT_{u,s,d,i,j}$ = Basal Area per hectare estimate for Treatment Unit u, Species s, Diameter class d, Type i and Block j for stems not to be harvested (Leave Trees).

$BA_{u,s,d,i,j}$ = Pre reduction basal area per hectare estimate for Treatment Unit u, Species s, Diameter class d, Type i and Block j.

$PR_{u,s,d,i,j}$ = Percent reduction value for Treatment Unit u, Species s, Diameter class d, Type i and Block j used in the Percent Reduction Worksheet (FS 221).

Example 9.9

The reduction value for Pine in the 20 cm class in the Treatment Unit is 45.

The Treatment Unit has a basal area of 14.0 m^2 per hectare for Pine in the 20 cm class before reduction.

$$BALT_{u,s,d,i,j} = 14.0 * (45 \div 100)$$

$$= 6.3 \text{ } m^2 \text{ per hectare}$$

9.4.1.2.3 Block "Leave Tree" Summary

Weight the Treatment Unit "Leave Tree" basal area per hectare by the area of the Treatment Unit within the Type within the Block, sum, divide by the area of the Block. For Treatment Units without a percent reduction the reduction value equals zero.

$$BALT_{s,d,j} = \frac{\sum_{u=1}^{U} BALT_{u,s,d,i,j} * A_{u,i,j}}{A_j}$$

Where:

$BALT_{s,d,j}$ = Basal area per hectare estimate for Species s, Diameter class d and Block j for stems not harvested (Leave Trees).

A_j = Area of Block j.

$A_{u,i,j}$ = Area of Treatment Unit u within Type i within Block j.

Example 9.10

There are 2 Treatment Units in Block X. The area of Block X is 10 hectares.

There are 2 types in the Block.

Treatment Unit A is 8 hectares, 7.5 hectares of Type 1 and .5 hectares of Type 2.

Treatment Unit B is 2.0 hectares, all in Type 2.

The reduction value for Pine in the 20 cm class in Type 1, Treatment Unit A is 45.

The reduction value for Pine in the 20 cm class in Type 2, Treatment Unit A is 35.

There is not a percent reduction for Pine in Treatment Unit B.

The Type 1 pre reduction basal area table for Pine shows 14.0 m^2 per hectare in the 20 cm class.

The Type 2 pre reduction basal area table for Pine shows 10.5 m^2 per hectare in the 20 cm class.

$BALT_{A,P,20,1,X} * A_{A,1,X}$ = $14.0 * .45 * 7.5 = 47.25$

$BALT_{A,P,20,2,X} * A_{A,2,X}$ = $10.5 * .35 * 0.5 = 1.84$

$BALT_{B,P,20,2,X} * A_{B,2,X}$ = $10.5 * .00 * 2.0 = 0.00$

$BALT_{P,20,X}$ = $(47.25 + 1.84 + 0) \div 10$

= 4.9 m^2 per hectare

9.4.1.2.4 Block - Block method

The Type within Block estimates must be calculated and weighted based on area of the Type within the Block. The Type within Block estimates use the Block Double Sampling Ratio and the plots from the Type within the Block.

$$BA_{s,d,i,j} = \frac{\sum_{p=1}^{m_{i,j}} BA_p}{m_{i,j}}$$ - intermediate calculation - not reported

$$BA_{s,d,j} = \frac{\sum_{i=1}^{I_j} BA_{s,d,i,j} * A_{i,j}}{A_j}$$

> Refer to Example 9.3 for Block level calculations.

9.4.1.2.5 Cutting Permit

The cutting permit estimate is the weighted average of the Timber Type estimates in the cutting authority.

$$BA_{s,d,cp} = \frac{\sum_{i=1}^{I} BA_{s,d,i} * A_i}{A_{cp}}$$

Sum the Type, Block and Cutting Permit estimates by species and by diameter class (the examples below show the summations for the Timber Type only).

$$BA_{s,i} = \sum_{d=1}^{34} BA_{s,d,i}$$

$$BA_{d,i} = \sum_{s=1}^{31} BA_{s,d,i}$$

Refer to Example 9.7 for Cutting Permit level calculations.

Sum either of the above estimates for the total basal area per hectare for the Type, Block and Cutting Permit.

$$BA_i = \sum_{d=1}^{34} BA_{s,i}$$

Where:

$BA_{s,d,i}$ = Basal area per hectare estimate for species s, diameter class d and Timber Type i.

$S_{s,d,j}$ = Basal area per hectare estimate for species s, diameter class d & Block j.

$BA_{s,d,i,j}$ = Block method basal area per hectare estimate for species s, diameter class d, Timber Type i within Block j - the Block method Double Sampling ratio would be used.

$BA_{s,d,cp}$ = Basal area per hectare estimate for species s and diameter class d for the Cutting Permit.

$BA_{s,i}$ = Total basal area per hectare for a species, all 34 diameter classes.

$BA_{d,i}$ = Total basal area per hectare for a diameter class, all species.

BA_i = Total basal area per hectare for the Timber Type.

BA_p = Basal area per hectare estimate for plot p (refer to Section 8.1.3).

$A_{i,j}$ = Area of Type i within Block j to 1 decimal place.

A_i = Area of Type i to 1 decimal place.

A_j = Area of Block j to 1 decimal place.

A_{cp} = Area of Cutting Permit to 1 decimal place.

I = Number of Types in the Cutting Permit.

I_j = Number of Types in Block j.

m_i = Number of measure plots in Timber Type i.

$m_{i,j}$ = Number or measure plots in Timber Type i within Block j.

d = Diameter Class (refer to Appendix 14).

9.4.1.3 Useless Basal Area per Hectare

The Useless basal area per hectare estimates are by Species (all Diameter Classes) and by Diameter Class (all Species). Only use tree classes 4 and 6.

For Leave Tree tables use the same methodology as outlined for Live Net Merchantable Volume per Hectare (Section 9.3.1.1).

9.4.1.3.1 Timber Type

$$BAU_{s,i} = \frac{\sum_{d=1}^{34} \left(\sum_{p=1}^{m_i} BA_{p,s,i} \right)}{m_i}$$

$$BAU_{d,i} = \frac{\sum_{s=1}^{31} \left(\sum_{p=1}^{m_i} BA_{p,d,i} \right)}{m_i}$$

Where:

$BAU_{s,i}$ = Useless basal area per hectare estimate for species s, Timber Type i.

$BAU_{d,i}$ = Useless basal area per hectare estimate for diameter class d, Timber Type i.

BA_p = Basal area per hectare estimate for plot p (refer to Section 8.1.3).

m_i = Number of measure plots in timber type i.

d = Diameter class (refer to Appendix 14).

9.4.1.3.2 Block - Average Line Method

The Type estimates are weighted based on area of the Type within the Block. Use the same weighting method as for the basal area per hectare estimate.

9.4.1.3.3 Block - Block Method

The Type within Block estimates must be calculated and weighted based on area of the Type within the Block. The Type within Block estimates use the Block Double Sampling Ratio and the plots from the Type within the Block. Use the same weighting method as for the basal area per hectare estimate.

9.4.1.3.4 Cutting Permit

The cutting permit estimate is the weighted average of the Type estimates based on the area of the Type within the Cutting Permit. Use the same weighting method as for the basal area per hectare estimate.

9.4.1.4 Dead Potential Stems per Hectare

The Dead Potential Stems per hectare estimate are by Species (all Diameter Classes) and by Diameter Class (all Species). Only use tree classes 3, 7 and 9.

For Leave Tree tables use the same methodology as outlined for Live Net Merchantable Volume per Hectare (Section 9.3.1.1).

9.4.1.4.1 Timber Type

$$BADP_{s,i} = \frac{\sum_{d=1}^{34} \left(\sum_{p=1}^{m_i} BA_p \right)}{m_i}$$

$$BADP_{d,i} = \frac{\sum_{s=1}^{31} \left(\sum_{p=1}^{m_i} BA_p \right)}{m_i}$$

Where:

$BADP_{s,i}$ = Dead potential basal area per hectare estimate for species s, Timber Type i.

BA_p = Basal area per hectare estimate for plot p (refer to Section 8.1.3).

m_i = Number of measure plots in Timber Type i.

d = Diameter class (refer to Appendix 14)

9.4.1.5 Total Basal Area per Hectare at Five Levels

The total basal area per hectare is also reported for 5 diameter levels:

Leave Tree reports do not need to report these parameters.

1. DBH greater than 12.4 cm.
2. DBH greater than 17.4 cm.
3. DBH greater than 22.4 cm.
4. DBH greater than 27.4 cm.
5. DBH greater than 32.4 cm.

Separate trees by Tree Class (i.e., Live trees, Dead potential and Useless) as above. Weight the parameters for Block and Cutting Permit as above.

9.4.1.5.1 Timber Type

$$BAT_{s,l,i} = \sum_{d=l+2}^{34} BA_{s,d,i}$$

Where:

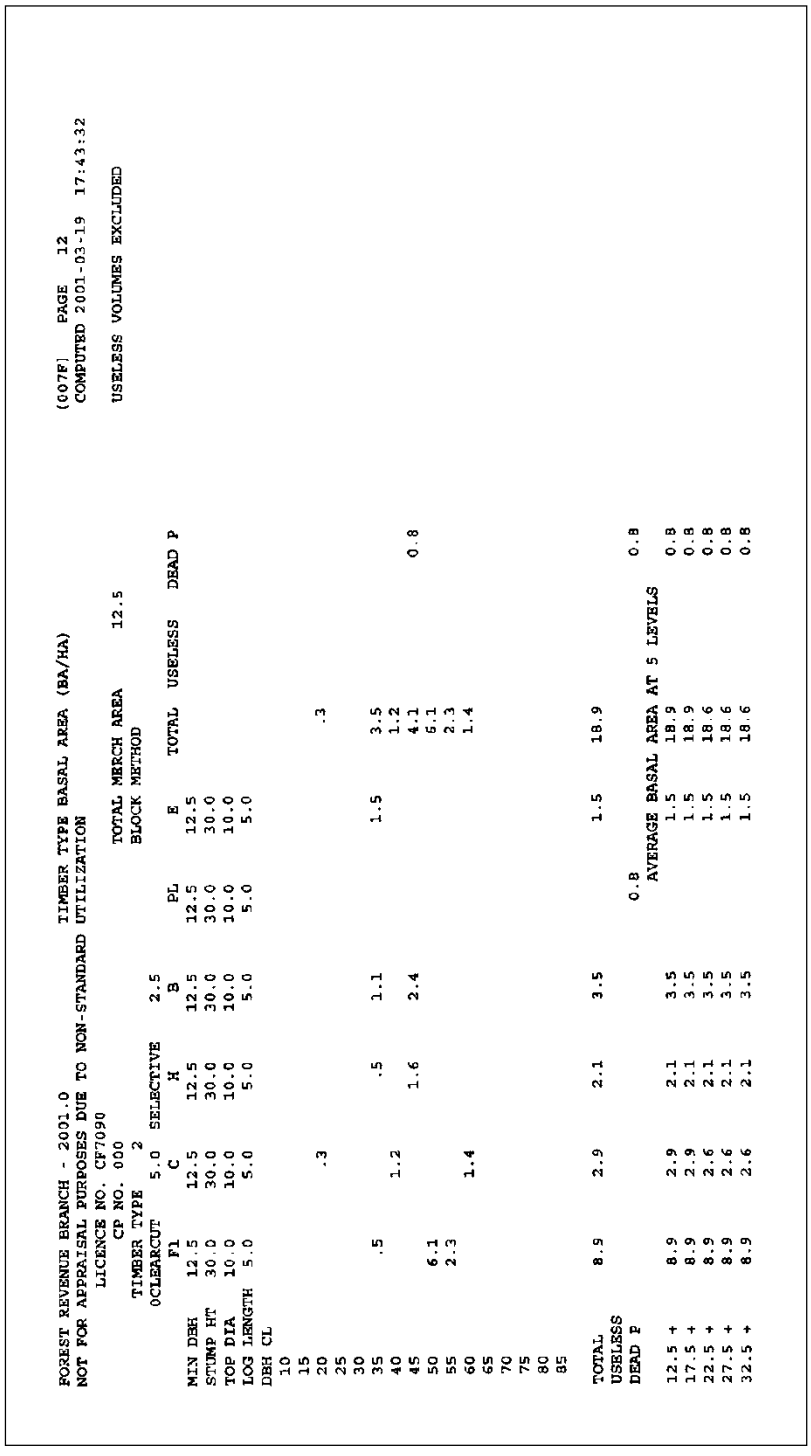
$BAT_{s,l,i}$ = Total basal area per hectare for Species s at level l in Timber Type i.

$BA_{s,d,i}$ = Basal area per hectare estimate for species s, diameter class d and Timber Type i.

1 = DBH lower limit level (1-7).

9.4.2 Basal Area Table - Sample Listing - Timber Type Level

Report 007F - required.



```
FOREST REVENUE BRANCH - 2001.0                    TIMBER TYPE BASAL AREA (BA/HA)                    (007F)   PAGE   12
NOT FOR APPRAISAL PURPOSES DUE TO NON-STANDARD UTILIZATION                                          COMPUTED 2001-03-19  17:43:32
          LICENCE NO. CF7090                                                                        USELESS VOLUMES EXCLUDED
             CP NO. 000                                TOTAL MERCH AREA     12.5
          TIMBER TYPE   2                              BLOCK METHOD
         0CLEARCUT      5.0 SELECTIVE      2.5
                         F1          C          H          B         PL         E     TOTAL  USELESS   DEAD P
     MIN DBH           12.5       12.5       12.5       12.5       12.5       12.5
     STUMP HT          30.0       30.0       30.0       30.0       30.0       30.0
     TOP DIA           10.0       10.0       10.0       10.0       10.0       10.0
     LOG LENGTH         5.0        5.0        5.0        5.0        5.0        5.0
     DBH CL
          10
          15
          20                                                                    .3                  3.5
          25                                                                                        1.2
          30                                                                                        4.1                0.8
          35                    .5         .5         1.1                    1.5                   6.1
          40                              1.6         2.4                                          2.3
          45                    6.1                                                               1.4
          50                    2.3
          55                              1.4
          60
          65
          70
          75
          80
          85

     TOTAL                      8.9        2.9        2.1        3.5                    1.5    18.9
     USELESS                                                                                                          0.8
     DEAD P                                                                                                                    0.8
                                                                                  AVERAGE BASAL AREA AT 5 LEVELS
          12.5 +                8.9        2.9        2.1        3.5                    1.5    18.9                      0.8
          17.5 +                8.9        2.9        2.1        3.5                    1.5    18.9                      0.8
          22.5 +                8.9        2.6        2.1        3.5                    1.5    18.6                      0.8
          27.5 +                8.9        2.6        2.1        3.5                    1.5    18.6                      0.8
          32.5 +                8.9        2.6        2.1        3.5                    1.5    18.6                      0.8
```

Figure 9.3 Timber Type Basal Area.

Extended Forest Type Stand and Stock Reports 10

The Extended Forest Type Stand and Stock Tables report average height, gross volume, and net volume by DBH class.

Each table is reported at the Timber Type level and contains a single Species. Hence, if there were 5 species in a Type, then 5 separate tables would be produced.

If a percent reduction is being compiled, report each table at the Treatment Unit level. Refer to chapter 5 for an explanation of reductions based on Treatment Units.

Where damaged species exist in a Type, produce reports for that Species for each damage code. Include a page that reports all non-damaged trees for the Species, as well as a page for each damage code. Do not produce a report for a damage code that does not occur for the Species in the Type. Refer to Chapter 4 for a sample damage report listing.

10.1 Header Information

Include the following header information on the extended stand and stock reports, including the damage reports. For damage reports, add the species and damage type, as shown in Chapter 4.

1. License from card type A.
2. Cutting Permit from card type A.
3. Timber Type number, species composition, age class, height class, and stocking class from card type C.
4. Species.
5. Number of live and dead trees (reduction applied if compiling a reduction):
    - Live Trees include tree classes 1, 2, 5, 6 and 8.
    - Dead Trees include tree classes 3, 4, 7 and 9.
6. Number of measured and count plots.
7. Silviculture Treatment Unit areas for the Timber Type.
8. Message indicating whether compilation is for appraisals or not.
9. Method of calculation (Average Line or Block).
10. Special compilation messages for:
    a. Reduction compilation,
    b. Stump cruise compilation,
    c. Tree class combination - useless volumes are included or excluded, from column 15 of card type B (0 or blank - snags excluded, 1 - snags included),
    d. Selective cut indicator - which trees to compile depends on column 12 of card type B (blank - include all trees, 'C' - include cut-indicated and non-indicated trees, 'L' - include leave-indicated trees),
    e. Double sampling, if count plots are used.
11. Compiler program name and version.
12. Compile date and time.
13. Page number.
14. Damage code - for damage reports only.

10.2 Detail Information

10.2.1 Average Height

The average tree height is based on coded tree heights from measured plots.

$$\overline{H}_{s,d,i} = \frac{\sum_{t=1}^{t_{s,d,i}} H_t}{t_{s,d,i}}$$

Report to 1 decimal place.

Example 10.1

3 Lodgepole pine were tallied in measured plots in Type 1. The measured heights are 36.6 m, 26.5 m, and 32.2 m.

$$\overline{H}_{s,d,i} = \frac{(36.6 + 26.5 + 32.2)}{3} = 31.8$$

10.2.2 Gross Merchantable Volume per Tree

Report gross merchantable volume per tree. Divide the gross volume by the number of stems in the Type.

$$VG_{s,d,I} = \frac{\sum_{t=1}^{t_{s,d,i}} VG_t}{t_{s,d,i}}$$

Report to 3 decimal places.

10.2.3 Net Merchantable Volume per Tree

Report net merchantable volume per tree (i.e., gross less decay, waste, breakage). Refer to Section 8.1.3.6 for an explanation of applying loss factors.

$$V_{s,d,i} = \frac{\sum_{t=1}^{t_{s,d,i}} V_t}{t_{s,d,i}}$$

Report to 3 decimal places.

10.2.4 Stems per Hectare by Risk Group

Include only tree class 1, 2, 5 and 8 trees. Refer to Section 3.3.1 Step #3 for the method of determining the Risk Group for a tree. Only use trees for species s, diameter class d, risk group r and type i.

$$S_{s,d,i,r} = \frac{\sum_{p=1}^{m_i} S_{p,s,d,i,r}}{m_i}$$

Report to 2 decimal places.

10.2.5 Total Stems per Hectare

Sum the 4 Risk Group Stems per hectare. If the Tree Class Combination from card type B is 1, then include the live and dead useless stems per hectare.

$$S_{s,d,i} = \sum_{r=0}^{3} S_{s,d,i,r}$$

Report to 2 decimal places.

10.2.6 Live Veterans per Hectare

Use the same method as above for risk group stems per hectare. Include only tree class 5 trees for all risk groups.

Report to 2 decimal places.

10.2.7 Dead Useless Snags per Hectare

Use the same method as above for risk group stems per hectare. Include only tree class 4 trees for all risk groups.

Report to 2 decimal places.

10.2.8 Live Useless Snags per Hectare

Use the same method as above for risk group stems per hectare. Include only tree class 6 trees for all risk groups.

Report to 2 decimal places.

10.2.9 Total of Averages

Report the stems per hectare estimate for the Species and Type. Sum the Stems/Snags per hectare for all DBH classes. Do not sum the average height or volume per hectare parameters.

$$S_{s,i} = \sum_{d=1}^{34} S_{s,i,r}$$

10.2.10 Percent by Risk Group

Calculate the percent that each risk group contributes to the total stems per hectare estimate for the Species and Type.

$$RG_{s,i,r}\% = 100 * \frac{S_{s,i,r}}{S_{s,i}}$$

If the Tree class combination from card type B = 1, then add the Live and Dead Useless stems per hectare to the total stems per hectare in the above calculation.

Where:

$t_{s,d,i}$ = Number of measured trees for Species s and Diameter Class d in Type i.

$S_{s,d,i,r}$ = Number of stems/ha for Species s, Diam. Class d, Type i and Risk Group r.

$S_{s,i,r}$ = Number of stems/ha for Species s, Type i and Risk Group r.

$S_{s,d,i}$ = Number of stems/ha for Species s, Diameter Class d and Type i.

$S_{s,i}$ = Number of stems/ha for Species s and Type i.

S_p = Stems/ha estimate from Plot p.

$VG_{s,d,i}$ = Gross volume/tree for Species s, Diameter Class d and Type i.

VG_t = Gross volume for tree t.

V_t = Net volume for tree t.

$V_{s,d,i}$ = Net volume/tree for Species s, Diameter Class d and Type i.

$V_{s,d,i,r}$ = Net volume/tree for Species s, Diam. Class d, Type i and Risk Group r.

H_t = Height of tree t.

$\overline{H}_{s,d,i}$ = Average height for Species s, Diameter Class d and Type i.

R_t = Post-reduction percent of tree t.

$DSR_{s,i}$ = Double sampling ratio for species s in Type i.

m_i = Number of measured plots in Type i.

$RG_{s,i,r}\%$ = Percent of stems per hectare for Risk Group r for Species s in Type i.

r = Risk Group.

10.2.11 Average DBH at Five Levels

The average DBH is also reported for five diameter levels:

1. DBH greater than 12.4 cm
2. DBH greater than 17.4 cm
3. DBH greater than 22.4 cm
4. DBH greater than 27.4 cm
5. DBH greater than 32.4 cm

$$\overline{D}_{s,l,i} = 2 * \sqrt{\frac{BA_{s,l,i}}{pi * S_{s,l,i}}}$$

Where:

$\overline{D}_{s,l,i}$ = Average diameter of trees with DBH lower limit l for Species s and type i.

$BA_{s,l,i}$ = Average basal area per hectare estimate of trees with DBH lower limit l for Species s and Type i.

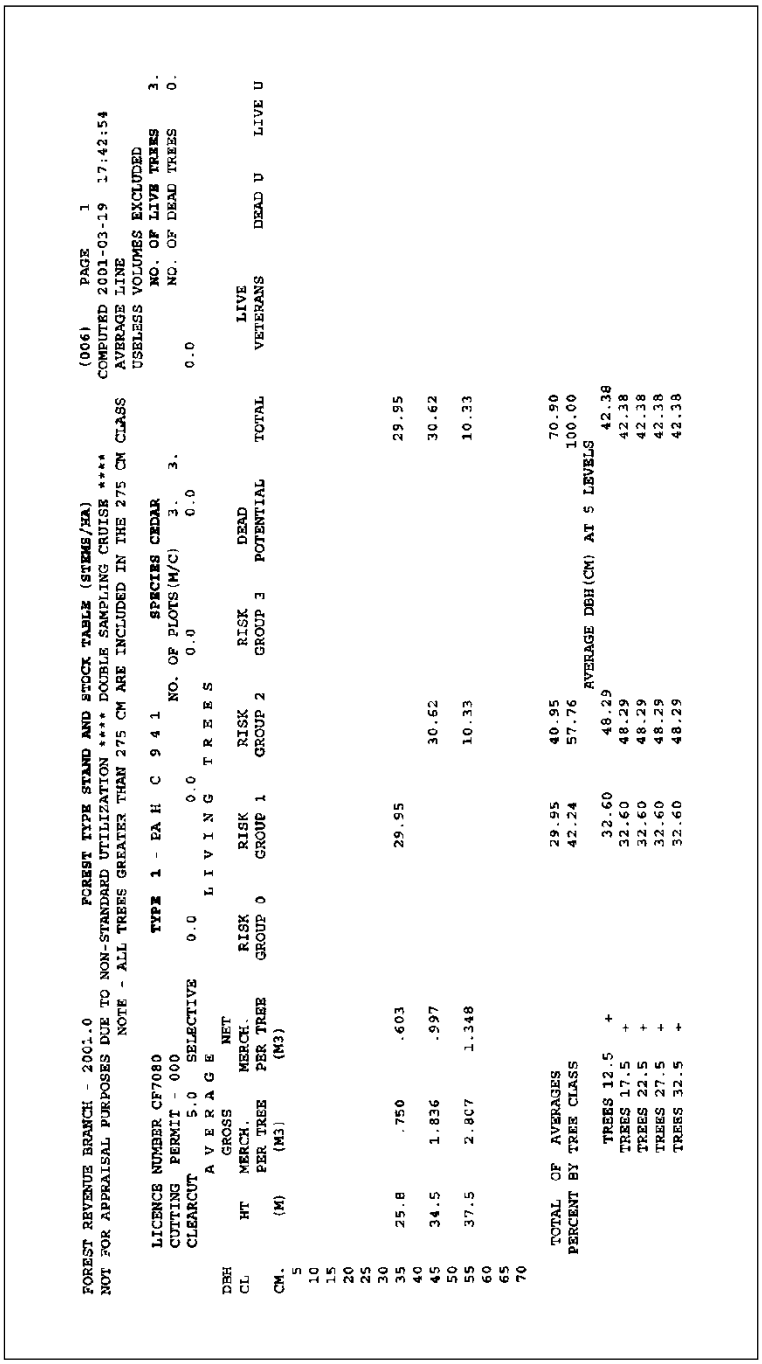
$S_{s,l,i}$ = Stems (or snags) per hectare estimate of trees with DBH lower limit l for Species s and Type i.

pi = 3.14159265.

Report to 2 decimal places.

10.3 Extended Forest Type Stand and Stock - Sample Listing

Report 006 - required.



FOREST REVENUE BRANCH - 2001.0 FOREST TYPE STAND AND STOCK TABLE (STEMS/HA) (006) PAGE 1
NOT FOR APPRAISAL PURPOSES DUE TO NON-STANDARD UTILIZATION **** DOUBLE SAMPLING CRUISE **** COMPUTED 2001-03-19 17:42:54
NOTE - ALL TREES GREATER THAN 275 CM ARE INCLUDED IN THE 275 CM CLASS AVERAGE LINE
USELESS VOLUMES EXCLUDED

LICENCE NUMBER CF7080 TYPE 1 - EA H C 9 4 1 SPECIES CEDAR NO. OF LIVE TREES 3.
CUTTING PERMIT - 000 NO. OF PLOTS(M/C) 3. 3. NO. OF DEAD TREES 0.
CLEARCUT 5.0 SELECTIVE 0.0 0.0 0.0 0.0 0.0

AVERAGE LIVING TREES

DBH CL.	HT	GROSS MERCH. PER TREE (M3)	NET MERCH. PER TREE (M3)	RISK GROUP 0	RISK GROUP 1	RISK GROUP 2	RISK GROUP 3	DEAD POTENTIAL	TOTAL	LIVE VETERANS	DEAD U	LIVE U
CM.	(M)											
5												
10												
15												
20												
25												
30												
35	25.8	.750	.603		29.95				29.95			
40												
45	34.5	1.836	.997			30.62			30.62			
50												
55	37.5	2.807	1.348			10.33			10.33			
60												
65												
70												
TOTAL OF AVERAGES					29.95	40.95			70.90			
PERCENT BY TREE CLASS					42.24	57.76			100.00			

AVERAGE DBH(CM) AT 5 LEVELS

TREES 12.5 +	32.60 48.29 42.38
TREES 17.5 +	32.60 48.29 42.38
TREES 22.5 +	32.60 48.29 42.38
TREES 27.5 +	32.60 48.29 42.38
TREES 32.5 +	32.60 48.29 42.38

Figure 10.1 Extended Forest Type Stand and Stock Table - Sample Listing (Partial).

Volume and Lumber Recovery Reports 11

11.1 Volume and Lumber Recovery Reports - Overview

Volume and lumber recovery reports are produced for Interior compilations only. Most reports are 1 page per Species in the compilation (see "Exceptions" below). Segregate the logs from each Species by Risk Group and Top Diameter Class.

Risk Group determination is described in section 3.3.1 (step 3).

Top Diameter Classes are found, by species, in Appendix 7.

The LRF reports are based on logs that meet the merchantability requirements specified in the Map Area Statement.

Exceptions:

Use Appendix 10.1 to assign LRF to Hemlock.

Interior White Pine logs from trees recorded as tree class 3,7 and 9 will use Appendix 10.2 to determine LRF.

The LRF compiled for Balsam is to be based on the sawlog component only. The compilation will assess each balsam tree and segregate those with decay, waste and breakage of less than 48% as all sawlogs. Those balsam trees with greater than or equal to 48% DWB will have zero LRF assigned to the complete volume of the tree. The average LRFs will be lowered due to the reduction of the sawlog net volume over the total net volume.

Lodgepole pine will be broken down into categories for reporting. One page each for categories: green, green attack, red attack, grey attack and dead potential.

11.2 Header Information

Include the following header information on the LRF reports.

1. License from card type A.
2. Cutting Permit from card type A.
3. Species.
4. Message indicating whether compilation is for appraisals or not.
5. Total merchantable area from card type A.
6. Message indicating whether Interior Fir is in wet belt or dry belt. (see Appendix 12)
   - If column 14 of card type B is coded 1, Fir is in the wet belt.
   - If column 14 of card type B is coded 2, Fir is in the dry belt.
7. Special compilation messages for:
   a. Reduction compilation.
   b. Stump cruise compilation.
   c. Tree class combination - useless volumes are included or excluded, from column 15 of card type B (0 or blank - snags excluded, 1 - snags included).
   d. Selective cut indicator - which trees to compile depends on column 12 of card type B (blank - include all trees, 'C' - include cut-indicated and non-indicated trees, 'L' - include leave-indicated trees).
   e. Double sampling, if count plots are used.
8. Compiler program name and version.
9. Compile date and time.
10. Page number.

11.3 Detail Information

Variable Definitions used in this chapter.

DMP_c	=	Midpoint of Top Diameter Class c (see Appendix 7):
	DMP_1 - 5cm	(Top diameter class 4.5 - 5.49)
	DMP_2 - 6cm	(Top diameter class 5.5 - 6.49)
	DMP_3 - 7cm	(Top diameter class 6.5 - 7.49)
	DMP_4 - 8cm	(Top diameter class 7.5 - 8.49)
	DMP_5 - 9.25cm	(Top diameter class 8.5 - 9.99)
	If c > 5, then	$DMP_c = (c-5)*5 + 7.5$ cm
$\%D_{s,c,r,i}$	=	Percent Decay of Gross volume for Species s, Top Diam. Class c, Risk Group r and Type i.
$\%D_{s,r,i}$	=	Percent Decay for Species s, Risk Group r and Type i. The Risk Group r may be a combination of two risk groups
$\%DT_{s,r,i}$	=	Percent Decay for species s, Risk Group r and Type i.
$\%LA_{s,r,i}$	=	Percent Large Logs in Species s, by Risk Group r in Type i.
$\%SM_{s,r,i}$	=	Percent Small Logs in Species s, by Risk Group r in Type i.
$\%ST_{s,r,i}$	=	Percent Stud Logs in Species s, by Risk Group r in Type i.
A_i	=	Area of Type i.
$D_{s,c,r,i}$	=	Decay volume for Species s, Top Diameter Class c, Risk Group r and Type i.
$FBM_{G,i}$	=	Foot Board Measure of Lodgepole Pine in category G within Type i.
$FBM_{s,c,r,i}$	=	Foot board measure for Species s, Top Diameter Class c, Risk Group r and Type i.
$FBM_{s,r,i}$	=	Total Foot Board Measure for Species s, Risk Group r and Type i. The Risk Group r, may be a combination of two risk groups.
$LRF_{s,c}$	=	LRF for Species s and Top Diameter Class c - see Appendix 7.
m_i	=	Number of measure plots in Type i.

$LRF_{PI,G,i}$	=	Lumber recovery factor for Lodgepole Pine in Category G within Type i.
$LRF_{PI,i}$	=	Average LRF for Lodgepole Pine within Type i.
$LRF_{s,r,i}$	=	LRF for Species s and Type i. The Risk Group r, may be a combination of several risk groups
$VG_{p,s,c,r,i}$	=	Gross volume for plot p for Species s, Top Diameter Class c, Risk Group r and Type i.
$VG_{s,c,r,i}$	=	Gross volume for Species s, Top Diameter Class c, Risk Group r and Type i.
$VGT_{s,r,i}$	=	Total gross volume for Species s, Risk Group r and Type i. The Risk Group r, may be a combination of two risk groups.
$V_{G,i}$	=	Net merchantable volume of Lodgepole Pine in Category G within Type i.
$V_{p,s,c,r,i}$	=	Net volume for plot p for Species s, Top Diameter Class c, Risk Group r and Type i.
$V_{s,c,r,i}$	=	Net volume for Species s, Top Diameter Class c and Risk Group r and Type i.
$VT_{s,r,i}$	=	Total net volume for Species s and Type i. The Risk Group r, may be a combination of two risk groups.
$VT_{s,r,i,la}$	=	Total net volume (large logs only) for Species s and Type i. The Risk Group r, may be a combination of two risk groups.
$VT_{s,r,i,sm}$	=	Total net volume (small logs only) for Species s and Type i. The Risk Group r, may be a combination of two risk groups.
$VT_{s,r,i,st}$	=	Total net volume (stud logs only) for Species s and Type i The Risk Group r, may be a combination of two risk groups.

Report the following information by Risk Group and Top Diameter Class for the Species and Type.

11.3.1 Base Lumber Recovery Factor

The base lumber recovery factor (LRF) for the Species and Top Diameter Class is in Appendix 7 and is applied for all Risk Groups.

For interior appraisal cruises, Douglas Fir is broken down into wet or dry variants with separate LRFs (see Section 12.3.4 for details). Optionally, ("Not for Appraisal Purposes"), Douglas Fir may be broken down into quality class 1 or quality class 2 with separate LRF's (see Section 12.3.4 for details).

11.3.2 Gross Merchantable Volume by Top Diameter Class

Gross volume per log is calculated as per Appendix 13.

Sum the gross volumes for logs in the same Species, Type, Risk Group and Top Diameter Class.

$$VGs,c,r,i = \frac{\sum_{p=1}^{m_i} VG_{p,s,c,r,i}}{m_i} * A_i$$

Report to the nearest whole number.

11.3.3 Percent Decay by Top Diameter Class

Determine decay percent for individual trees as described in section 3.3.1 step 3. All logs in a tree will have the same decay percent applied to them. Multiply the decay percent by the gross volume of the log to get the decay volume of the log. Sum the decay volumes of all the logs in the same Species, Type, Risk Group and Top Diameter Class. Divide by the gross volume of all the logs in the same Species, Type, Risk Group and Top Diameter Class. Multiply by 100.

$$\%Ds,c,r,i = \frac{D_{s,c,r,i}}{VG_{s,c,r,i}} * 100$$

Report to one decimal place.

Example 11.1

Log top diameter class: 10.0 - 14.9

Log top Diameter	Log Gross Volume by Type	Tree Decay %	Log Decay Volume by Type
10.00	27.41	0.02	0.55
14.77	55.32	0.02	1.11
10.00	3.12	0.36	1.13

$D_{s,c,r,i} = 0.55 + 1.11 + 1.13$

$= 2.79\ m^3$

$VG_{s,c,r,i} = 27.41 + 55.32 + 3.12$

$= 85.85\ m^3$

$\%D_{s,c,r,i} = \frac{2.79}{85.85} * 100$

$= 3.2$

11.3.4 Net Merchantable volume by Top Diameter Class

The net merchantable volume is calculated the same way as the gross merchantable volume, only the loss factors (decay, waste and breakage) have been applied.

$$V_{s,c,r,i} = \frac{\sum_{p=1}^{m_i} V_{p,s,c,r,i}}{m_i} * A_i$$

Report to the nearest whole number.

11.3.5 Foot Board Measure by Top Diameter Class

The calculation for Cedar is different than for other species.

Cedar -

$$FBM_{s,c,r,i} = V_{s,c,r,i} * [LRF_{s,c} – (34.256(0.147- 0.00122 * DMP_c)*(\%D_{s,c,r,i} / 2))]$$

All other Species -

$$FBM_{s,c,r,i} = V_{s,c,r,i} * [LRF_{s,c} * (1 – (\%D_{s,c,r,i} * 0.01 / 2))]$$

Example 11.2

There is a Cedar log in Risk Group 1 within the diameter class (40 - 44.9 cm) in Type 2. The log represents 63.07 m^3 of net merchantable volume in Type 2. The decay for the log is 17.3 percent.

FBM = $63.07 * [LRF_{s,c} – (34.256(0.147- 0.00122 * 42.5)*(17.3 / 2))]$

= $63.07 * [235 – (34.256(0.147 – 0.05185)*(8.65)]$

= $63.07 * [235 – 28.191]$

= 13 043

Example 11.3

There is a Hemlock log in Risk Group1 within the diameter class (40 - 44.9 cm) in Type 1. The log represents 93.8 m^3 of net merchantable volume in Type 1. The decay for the log is 7.3 percent.

FBM = $93.8 * [LRF_{s,c} * (1 - (7.3* 0.01 / 2))]$

= $93.8 * [222 * (1 – 0.0365)]$

= $93.8 * [213.89256]$

= 20 064

11.4 Totals and Averages

11.4.1 Total Gross Merchantable Volume by Risk Group

For each Risk Group, sum the gross volumes of each Top Diameter Class. The 24 Top Diameter Classes are listed in Appendix 7.

$$VGT_{s,r,i} = \sum_{c=1}^{24} VG_{s,c,r,i}$$

Report to nearest whole number.

11.4.2 Percent Decay by Risk Group

Calculate individual top diameter class decay volumes by multiplying the decay percent by the class gross volume then sum individual parameters in the risk group. Divide by the gross volume for the risk group.

$$\%DT_{s,r,i} = \frac{\sum_{c=1}^{24} \%D_{s,c,r,i} * VG_{s,c,r,i}}{VGT_{s,r,i}} * 100$$

Report to one decimal place.

11.4.3 Total net merchantable Volume by Risk Group

For each Risk Group, sum the net volumes of each Top Diameter Class.

$$VT_{s,r,i} = \sum_{c=1}^{24} V_{s,c,r,i}$$

Report to nearest whole number.

11.4.4 Total Foot Board Measure by Risk Group

For each Risk Group, sum the foot board measure of each Top Diameter Class.

$$FBM_{s,r,i} = \sum_{c=1}^{24} FBM_{s,c,r,i}$$

Report to nearest whole number.

11.4.5 LRF by Risk Group

The average LRF for a risk group is determined by dividing the total foot board measure by the total net volume.

$$LRF_{s,r,i} = \frac{FBM_{s,r,i}}{VT_{s,r,i}}$$

Report to nearest whole number.

11.5 Risk Group Combinations

The Risk groups are combined in the following groups: (Group 1), (Group 1 and 2), and (Group 2 and 3). LRF is also reported in a (Group 1, 2 and 3) combination.

11.5.1 LRF by Risk Group Combination

Sum the net volume and foot board measure of the Risk Groups that are included. Divide the summed foot board measure by the summed net volume.

$$LRF_{s,r,i} = \frac{\sum_{r=1}^{3} FBM_{s,r,i}}{\sum_{r=1`}^{3} VT_{s,r,i}}$$

Report to nearest whole number.

Lodgepole Pine (Pl):

LRF Adjustment factors for Lodgepole Pine will be applied to the Group 1, 2 and 3 LRF by Risk Group Combination.

Pl is divided into several categories; green stems, green beetle attack, red beetle attack, grey beetle attack and dead potential stems.

Green stems are described as living stems with no Mountain Pine Beetle (MPB) damage codes associated with them. Green attack stems are those that are marked with insect code 1, red attack stems are those marked with insect code 2 and grey attack stems are those marked with insect code 3. Dead potential stems are dead potential trees with no MPB insect damage codes. Each category will be reported on a separate page.

Category	Tree Classes	Damage code	Pl Adjustment Factor
Green	1, 2, 5, 8	No Mountain Pine beetle code	0
Green attack	1, 2, 5, 8	1	3
Red attack	1, 2, 5, 8	2	33
Grey Attack	3, 7, 9	3	83
Dead potential	3, 7, 9	No Mountain Pine beetle code	0

Cruise LRFs will be calculated separately for each category of Pl. Reduction factors will then be applied separately to the Cruise LRFs calculated for the green beetle attack, red beetle attack, grey beetle attack and dead potential categories.

Total Lodgepole Pine average LRF will be reported as the weighted average, by net volume, of these categories after the adjustments have been applied. See Section 12.3.6.

Calculate the LRF of a category:

$$LRF_{Pl,G,i} = \frac{FBM_{G,i}}{V_{G,i}}$$

Example 11.4

There are 3 categories of Pl in a CP: green, red attack and grey attack.

Category	Net Volume	Foot Board Measure	LRF	MPB Reduction	MPB LRF
Green	361	70469	195	0	195
Red Attack	377	71716	190	33	157
Grey Attack	362	70677	195	83	112

Weight the LRFs in each category by net volume to get Pl species LRF.

$$\overline{LRF_{Pl,i}} = \frac{361 \times 195 + 377 \times 157 + 362 \times 112}{361 + 377 + 362}$$

$$= 155$$

Report to nearest whole number.

11.5.2 Pl Adjustment

On Lodgepole Pine summaries a field headed “Pl ADJUSTMENT” will contain the adjustment factor used for the specific category being reported.

The adjustment factors are:

Green	0
Green attack	3
Red attack	33
Grey attack	83
Dead Potential	0

11.5.3 Percent Decay by Risk Group Combination

Calculate the decay volume of individual risk groups by multiplying the percent decay of the risk group by the gross volume of the risk group as in 11.4.2. Sum the decay volumes of the risk groups in the combination as well as the gross volumes of the same risk groups. Divide the resulting decay volume by the resulting gross volume.

$$\%DT_{s,r,i} = \frac{\sum_{r=1}^{2} \%D_{s,r,i}}{\sum_{r=1`}^{2} VGT_{s,r,i}}$$

Report to 1 decimal place.

11.5.4 Percent Stud Log by Risk Group Combination

A stud log has a top diameter less than 20 cm. The combinations of Risk Groups are (Risk Group 1), (Risk Group 1 and 2) and (Risk Group 2 and 3). Report the percent stud log for Fir, Balsam, Spruce, Lodgepole Pine, and Larch only.

Sum the stud log net volumes of the risk groups in the combination. Divide by the summed net volumes of the risk groups in the combination. Multiply by 100.

$$\%ST_{s,r,i} = \frac{VT_{s,r,st,i}}{VT_{s,r,i}} * 100$$

Report to nearest whole number.

11.5.5 Percent Small Log by Risk Group Combination

A small log has a top diameter less than 30 cm. The combinations of Risk Groups are (Risk Group 1), (Risk Group 1 and 2) and (Risk Group 2 and 3). Calculate in the same manner as the stud log percent but include all species.

$$\%SM_{s,r,i} = \frac{VT_{s,r,i,sm}}{VT_{s,r,i}} * 100$$

Report to nearest whole number.

11.5.6 Percent Large Log by Risk Group Combination

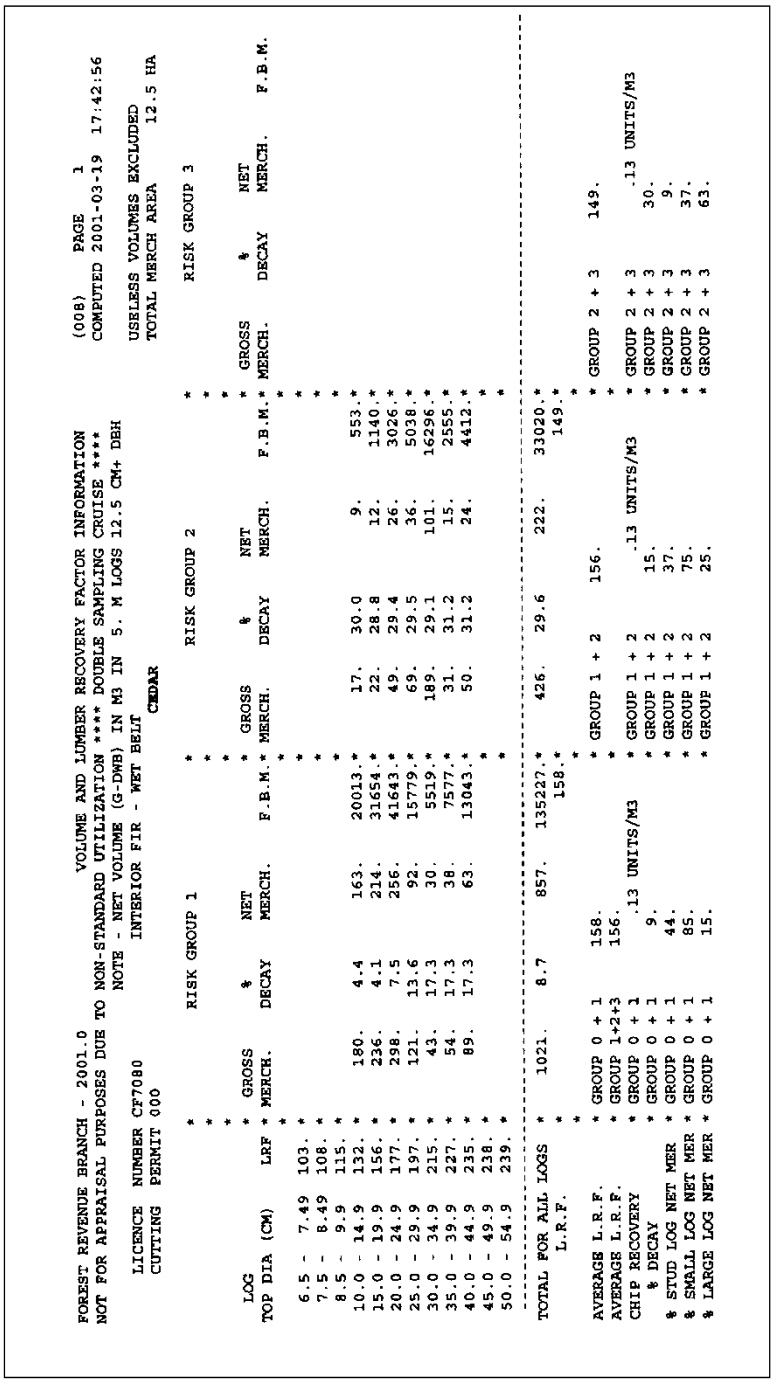
A large log has a top diameter 30 cm or greater. Therefore, percent small log and percent large log should sum to 100 percent. The combinations of Risk Groups are (Risk Group 1), (Risk Group 1 and 2) and (Risk Group 2 and 3). Calculate in the same manner as the stud log percent but include all species.

$$\%LA_{s,r,i} = \frac{VT_{s,r,i,la}}{VT_{s,r,i}} * 100$$

Report to nearest whole number.

11.6 Volume and Lumber Recovery report - Sample Listing

Report 008 - Required for Interior compilations.



```
FOREST REVENUE BRANCH - 2001.0          VOLUME AND LUMBER RECOVERY FACTOR INFORMATION          (008)     PAGE     1
NOT FOR APPRAISAL PURPOSES DUE TO NON-STANDARD UTILIZATION **** DOUBLE SAMPLING CRUISE ****   COMPUTED 2001-03-19  17:42:56
                                NOTE - NET VOLUME (G-DWB) IN M3 IN  5. M LOGS 12.5 CM+ DBH
                                                                                USELESS VOLUMES EXCLUDED
     LICENCE  NUMBER CF7080          INTERIOR FIR - WET BELT                    TOTAL MERCH AREA      12.5 HA
     CUTTING  PERMIT 000                        CEDAR

                                *                                *                                *
                                *      RISK GROUP 1              *      RISK GROUP 2              *      RISK GROUP 3
                                *                                *                                *
                                *                                *                                *
  LOG                           *  GROSS     %       NET         *  GROSS     %       NET         *  GROSS     %       NET
TOP DIA (CM)        LRF         * MERCH.    DECAY   MERCH.      * MERCH.    DECAY   MERCH.      * MERCH.    DECAY   MERCH.    F.B.M.
                                *                                *                                *
  6.5 -  7.49  103.             *                                *                                *
  7.5 -  8.49  108.             *                                *                                *
  8.5 -  9.9   115.             *                                *                                *
 10.0 - 14.9   132.             *    180.    4.4      163.      *     17.   30.0       9.        *     553.
 15.0 - 19.9   156.             *    236.    4.1      214.      *     22.   28.8      12.        *    1140.
 20.0 - 24.9   177.             *    298.    7.5      256.      *     49.   29.4      26.        *    3026.
 25.0 - 29.9   197.             *    121.   13.6       92.      *     69.   29.5      36.        *    5038.
 30.0 - 34.9   215.             *     43.   17.3        30.      *    189.   29.1     101.        *   16296.
 35.0 - 39.9   227.             *     54.   17.3        38.      *     31.   31.2      15.        *    2555.
 40.0 - 44.9   235.             *     89.   17.3        63.      *     50.   31.2      24.        *    4412.
 45.0 - 49.9   238.             *                                *                                *
 50.0 - 54.9   239.             *                                *                                *
-------------------------------------------------------------------------------------------------------------
TOTAL FOR ALL LOGS              *   1021.    8.7       857.      *  135227.*    426.   29.6      222.      *   33020.*
      L.R.F.                    *                                *     158.*                      149.      *
                                *                                *                                *
AVERAGE L.R.F.                  * GROUP 0 + 1          158.      * GROUP 1 + 2          156.                * GROUP 2 + 3     149.
AVERAGE L.R.F.                  * GROUP 1+2+3          156.      *                                          *
CHIP RECOVERY                   * GROUP 0 + 1          .13 UNITS/M3 * GROUP 1 + 2          .13 UNITS/M3 * GROUP 2 + 3          .13 UNITS/M3
  % DECAY                       * GROUP 0 + 1            9.      * GROUP 1 + 2           15.              * GROUP 2 + 3      30.
% STUD LOG NET MER              * GROUP 0 + 1           44.      * GROUP 1 + 2           37.              * GROUP 2 + 3       9.
% SMALL LOG NET MER             * GROUP 0 + 1           85.      * GROUP 1 + 2           75.              * GROUP 2 + 3      37.
% LARGE LOG NET MER             * GROUP 0 + 1           15.      * GROUP 1 + 2           25.              * GROUP 2 + 3      63.
```

Figure 11.1 Volume and Lumber Recovery Report - Sample Listing (Partial).

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Volume Summaries 12

12.1 Volume Summary - Overview

The volume summary reports summarize volume, grade and statistical data at the Type, Cutting Permit, Treatment Unit within Block and Block levels.

CSV All Treatment Unit Summaries (Pre and post–harvest) – The Cutting Permit Summary and each Block Summary will be exported from the cruise compilation program in comma-separated value (CSV) formats. See the required format for the summaries and the file descriptions at the following web link:

http://www.for.gov.bc.ca/hva/manuals/csvdocumentation.htm

12.1.1 List of Reports

(009A) - Timber Type Summary

(009B) - Block Summary

(009C) - Cutting Permit Summary

(009D) - Treatment Unit within Block Summary

For the (009A), (009B), and (009C) reports there are three additional damage reports for the damage types Blowdown, Fire, and Insect. For the (009B) report, there is also an optional Root Rot damage summary based on the letters J, K, and L in column 60 of card type 2. If three species in a type have insect damage, then there would be three additional insect damage reports for that type. The damage reports are by damage type and species and are depicted in chapter 4.

12.2 Header Information - All Reports

Include the following header information on Type, Block, Cutting Permit and Treatment Unit reports, including the damage reports. For damage reports, add the species and damage type, as shown in Chapter 4.

1. Compilers name and version number.
2. Title.
    a. Timber Type Summary,
    b. Block Summary,
    c. Cutting Permit Summary,
    d. Treatment Unit Summary.
3. Table Number.
    a. 009A,
    b. 009B,
    c. 009C,
    d. 009D.
4. Page Number.
5. Message indicating if compilation is for appraisal purposes or not.
6. Message if:
    a. Double sampling cruise,
    b. The statement PERCENT REDUCTION APPLIED will be reported in upper case letters and double spaced at the top of all pages when applicable,
    c. Stump cruise,
    d. Useless Excluded or Useless Included,
    e. Selective Cut – Leave,
    f. Selective Cut – Cut,
    g. Damage-Type of Damage.

7. Licence number.
8. Unit identity number.
9. Unit identity Block.
10. Cutting Permit number.
11. Forest Inventory Zone (F.I.Z).
12. Number of blocks.
13. Total merchantable Area of:
    a. Cutting Permit,
    b. Type,
    c. Block,
    d. Treatment Unit.
14. R/W Area removed under other licence:
    a. Block.
15. Timber Type, Treatment Unit or Block Summaries:
    a. Block or Type number,
    b. Number of measure plots in Type or Block,
    c. Number of count plots in Type or Block,
    d. Treatment Unit name.
16. Type of calculation:
    a. Average Line,
    b. Block.
17. Compiled date and time.
18. Compilation type used for the standards of the species.
19. Species letter codes.
20. Conifer.

21. Total.

22. DBH lower limit of the species.

23. Stump height of the species.

24. Minimum top diameter of the species.

25. Log length of the species.

12.3 Detail Information

All of the detail information is shown at the Timber Type, Block and Cutting Permit levels for the Gross Volume parameter only. For all other parameters only Timber Type calculations using the Average Line method will be shown. The methodology used in the Gross Volume section can be extrapolated for use in the remaining sections.

Lumber recovery and chip yield parameters are only reported for interior compilations.

Average slope, Minimum slope %, Maximum slope %, Coefficient of Variation, Standard Error of the Mean and the Sampling Error at the 95% level of probability slope calculations are required for coastal compilations in the Block summaries. Although not required at this time, slope calculations may also be provided for interior compilations.

Calculate each parameter for a particular species, s, and then calculate the parameter grouping all coniferous species and all species combined. For example, if there were five species in a compilation, then there would be seven calculations of each parameter at each of the four reporting levels. Cottonwood, Alder, Maple, Birch and Aspen are deciduous species and would not be included in the coniferous total.

When the Block method is being used, then apply the Block double sampling ratio for the Block and Treatment Unit within Block levels.

12.3.1 Summary Report Variables

The variables used throughout the chapter are defined below:

$\%D_l$	=	Decay percent for log l
$\%DG_i$	=	Decay percent – gross in Type i
$\%G_{i,g}$	=	Percent of grade g for Type i
$\%IM_j$	=	Percent immature for Block j
$\%IM_{j,u}$	=	Percent immature for Treatment Unit u in Block j
$\%S_{s,i}$	=	Percent of total volume from Species s in Type i
$\%ST_i$	=	Percent stud log for Type i
$\%TC_i$	=	Total cull percent – net for Type i
$\%W_i$	=	Waste percent – net for Type i
$\%WG_i$	=	Waste percent – gross for Type i
339	=	Chip recovery constant for large logs

A_{cp}	=	Area of Cutting Permit
A_i	=	Area of Type i
$A_{i,j}$	=	Area of Type i within Block j
$A_{i,j,u}$	=	Area of Treatment Unit u within Type i within Block j
$A_{i,u}$	=	Area of Treatment Unit u within Type i
A_j	=	Area of Block j
BAF_t	=	Basal area factor used to tally tree t (prism plots only)
BA_i	=	Basal area per hectare in Type i
BA_p	=	Basal area per hectare estimate for plot p
B_t	=	Biological volume for tree t (see Appendix 13)
BT_i	=	Total breakage volume in Type i
BV_i	=	Biological volume in Type i
BV_p	=	Biological volume in Plot p
CVi	=	Coefficient of Variation for Type i (measured plots only)
$CV_{i,j}$	=	Coefficient of Variation for Type i within Block j (measured plots only)
CV_j	=	Coefficient of Variation for Block j.
CV_i	=	Coefficient of Variation for Type i (measured plots only).
CYF_s	=	Chip yield factor for species s
CY_i	=	Chip yield for Type i
$CY_{s,i}$	=	Chip yield for Species s in Type i
DBH_t	=	DBH from card type 2
DMP_c	=	Midpoint of Top Diameter Class c
$D_{p,i}$	=	Total decay volume in Type i from Plot p
$\overline{D}_i$	=	Average DBH of Type i

DSR_t	=	Double sampling ratio applied to tree t (prism plots only)
DT_i	=	Total decay volume in Type i
$FBM_{G,i}$	=	Foot Board Measure of Lodgepole Pine in category G within Type i
FBM_i	=	Foot Board Measure in Type i
FBM_l	=	Foot Board Measure for log l
HBV_i	=	Biological volume times total height in Type i
HBV_p	=	Biological volume times total height in Plot p
H_t	=	Total height of tree t from card type 2
I	=	Number of Types in Cutting Permit
I_j	=	Number of Types in Block j
LPT_i	=	Number of logs per tree for Type i
LRF_i	=	Lumber recovery factor for Type i
$LRF_{PI,G,i}$	=	Lumber recovery factor for Lodgepole Pine in Category G within Type i
$LRF_{s,c}$	=	Lumber recovery factor for Species s and Top Diameter Class c
$\overline{LRF}_{PI,i}$	=	Average LRF for Lodgepole Pine within Type i
m_i	=	Number of measure plots in Type i
$m_{i,j}$	=	Number of measure plots in Type i within Block j
$m_{i,j,u}$	=	Number of measure plots in Treatment Unit u within Type i within Block j
NL_i	=	Number of logs in Type i
NL_p	=	Number of logs per hectare estimate from Plot p
NL_t	=	Number of logs in tree t including short log if >= 2.5 m
NVL_i	=	Net merchantable volume per log for type i
n_p	=	Number of trees in Plot p

pi	=	≅ (3.14159265)
$p_{i,j}$	=	proportional volume of Type i within Block j.
plotsize	=	Area of fixed area plots in hectares, to the nearest hundredth
$r_{i,j}$	=	Proportional area of Type i within Block j
R_t	=	Reduction for tree t
SEM_i	=	Standard error of the mean for Type i
$SEM_{i,j}$	=	Standard error of the mean for Type i within Block j
S_i	=	Stems per hectare for Type i
S_p	=	The stems per hectare estimate for Plot p
sp_i	=	Number of Species in type i
S_t	=	The stems per hectare estimate for tree t
t-value	=	Average line – total number of measured plots in all of the types occurring in the block minus the number of types in the block.
t-value	=	Block method – total number of measured plots in the block minus the number of types in block.
U_i	=	Number of Treatment Units in Type i
U_j	=	Number of Treatment Units in Block j
$VG_{i,j,u}$	=	Gross volume/ha of Treatment Unit u within Type i within Block j
$VG_{i,u}$	=	Gross volume per hectare for Treatment Unit u within Type i
$VG_{p,i}$	=	Gross volume per hectare estimate for Type i from plot p
$VG_{p,i,j}$	=	Gross volume/ha of Plot p within Type i within Block j
$VG_{p,i,j,u}$	=	Gross volume/ha of Plot p within Treatment Unit u within Type i within Block j
$VG_{t,i}$	=	Gross volume per tree in Type i
VGT_{cp}	=	Total gross volume in Cutting Permit
VGT_i	=	Total gross volume in Type i

$VGT_{i,j}$	=	Total gross volume in Type i within Block j
VGT_j	=	Total gross volume in Block j
$VGT_{j,u}$	=	Total gross volume in Treatment Unit u within Block j
$VGT_{G,i}$	=	Net merchantable volume of Lodgepole Pine in Category G within Type i
V_i	=	Net merchantable volume per hectare in Type i
V_j	=	Volume per hectare of Block j
V_l	=	Net merchantable volume of log l
$V_{m,i}$	=	Volume per hectare of Type i from measure plots only, not corrected for double sampling.
VST_i	=	Total stud log volume for Type i
VT_i	=	Total net merchantable volume of Type i
$VT_{i,g}$	=	Total grade g volume for Type i
VTI_j	=	Total immature net volume for Block j
$VTI_{j,u}$	=	Total immature net volume for Treatment Unit u in Block j
VT_j	=	Total net volume for Block j
$VT_{j,u}$	=	Total net volume for Treatment Unit u in Block j
$VT_{s,i}$	=	Total net volume for Species s in Type i
$VT_{s,la,i}$	=	Total net volume of large logs for Species s in Type i
$VT_{s,sm,i}$	=	Total net volume of small logs for Species s in Type i
$VT_{t,i}$	=	Net merchantable volume per tree in Type i
WH_i	=	Average weighted total height for Type i
$W_{p,i}$	=	Total waste volume in Type i from Plot p
WT_i	=	Total waste volume in Type i

12.3.2 Gross Merchantable Volume

The gross merchantable volume is obtained by multiplying the gross merchantable volume per hectare by the number of hectares in the report level. The gross merchantable volume per hectare is calculated as in section 3.5 with the double sampling ratio applied and using post-reduction volumes, if applicable. When compiling a reduction, pre and post reduction reports are required.

Timber Type

Multiply the average gross volume per hectare from the plots within the Type by the area of the Type. Type parameters are always calculated using the Average Line method.

$$VGT_{i,} = \frac{\sum_{p=1}^{m_i} VG_{p,i}}{m_i} * A_i$$

Report to nearest whole number.

Example 12.1

Type 1 is 5 Ha.

Type 2 is 7.5 Ha.

Block 1 is 5 Ha, 2.5 Ha of Type 1 and 2.5 Ha of Type 2.

Block 2 is 7.5 Ha, 2.5 Ha of Type 1 and 5 Ha of Type 2.

Treatment Unit 1 is 10 Ha, 5 Ha in Type 1 and 5 Ha in Type 2.

Treatment Unit 2 is 2.5 Ha in Type 2.

Plot	Type	Block	Volume/ha estimate	Treatment Unit
1	1	1	148.12	1
2	1	1	131.83	1
3	1	2	107.37	1
4	2	1	108.73	1
5	2	2	122.17	2
6	2	2	152.16	1

$$VGT_1 = \frac{148.12 + 131.83 + 107.37}{3} * 5 = 646\ m^3$$

Treatment Unit within Type

Treatment Unit within Type volumes are needed when performing reductions. See Section 5.3.1 for examples. The Average Line method is used only. Multiply the Gross volume of the Type by the proportional area of the Treatment Unit within the Type.

Example 12.2

Treatment Unit 2 within Type 2

$$VGT_{i,u} = VGT_2 * \left(A_{i,u} \div A_i\right) = 958 * \left(2.5 \div 7.5\right) = 319\ m^3$$

Report to nearest whole number.

Cutting Permit

Sum the Type volumes within the Cutting Permit.

$$VGT_{cp} = \sum_{i=1}^{I} VGT_i$$

Report to nearest whole number.

Block

Average line method:

Sum the portion of the Type volumes from the Types within the Block.

$$VGT_j = \sum_{i=1}^{I_j} VGT_{i,j} * \left(A_{i,j} \div A_i\right)$$

Report to nearest whole number.

Example 12.3

Block 1

$VGT_j = 646*(2.5/5.0) + 958*(2.5/7.5) = 642\ m^3$

Block Method:

Sum the volume per hectare of plots in the Types within the Block. Divide by the number of measure plots in the Type within the Block. Multiply by the area of the Type within the Block.

$$VGT_j = \sum_{i=1}^{I_j} \frac{VG_{p,i,j}}{m_{i,j}} * A_{i,j}$$

Report to nearest whole number.

Example 12.4

Block 1

$VGT_j = ((148.12+131.83) / 2 * 2.5) + (108.73 / 1 * 2.5) = 622\ m^3$

Treatment Unit within Block

Average line method:

Sum the Type gross volumes within the Block and multiply by the area of the Treatment Unit within the Types within the Block divided by the area of the Type within the Block.

$$VGT_{j,u} = \sum_{i=1}^{I_j} VGT_{i,j} * \left(\frac{A_{i,j,u}}{A_{i,j}} \right)$$

Example 12.5

Treatment Unit 2, Block 2

$VGT_{j,u} = (646 * (0/5)) + (958 * (2.5/7.5)) = 319\ m^3$

Block method:

Sum the volume/ha estimates of plots from Types containing the Treatment Unit within the Block. Divide by the number of Treatment Unit plots within Type within the Block. Multiply by the area of the Treatment Unit within the Type within the Block. Sum the individual Type parameters. See Section 5.3.2 for an example.

$$VGT_{j,u} = \sum_{i=1}^{I_j} \frac{VG_{p,i,j,u}}{m_{i,j,u}} * A_{i,j,u}$$

Example 12.6

Treatment Unit 2, Block 2

The only Type that contains Treatment Unit 2 is Type 2, therefore only those plots that are in Type 2 within Block 2 are used in the calculation.

$VGT_{j,u}$ = (122.17+152.16) /2* 2.5 = 343 m^3

12.3.3 Net Merchantable Volume

The total net merchantable volume is calculated the same way as the gross volume only the loss factors have been applied (see section 3.3 step 4). Each tree volume is reduced by the applicable loss factors, which convert the gross volume per hectare estimates into net volume per hectare estimates. Report the net merchantable volume for all summary reports.

Report to nearest whole number.

12.3.4 Net Merchantable Volume per Hectare

Divide the total merchantable volume by the applicable area. Report the net merchantable volume per hectare for all reporting levels. Only the Type calculation is shown.

Timber Type

Divide the total net merchantable volume in the Type by the area of the Type.

$$V_I = \frac{VT_i}{A_i}$$

Report to nearest whole number.

12.3.5 Percent Distribution per Hectare

The percent distribution is the percentage of the net volume that a Species contributes to the total net volume.

Timber Type

$$V_i = \frac{VT_i}{A_i}$$

Use the same method for all reporting levels.

Report to nearest whole number.

12.3.6 Percent Decay – Gross

Each tree is reduced by a decay percent as explained in section 3.3.1 Step #4. The decay volume would be the gross merchantable volume for the tree multiplied by the decay percent.

Timber Type

$$\%DG_I = \frac{DT_i}{VGT_i} * 100$$

The method for determining the total decay volume is the same as for total gross volume.

Report to nearest whole number.

12.3.7 Percent Waste - Gross

This report is obsolete.

12.3.8 Percent Waste (Billing) - Net

This report is obsolete.

12.3.9 Percent Total Cull - Gross

The percent total cull – gross is the total of the three loss factors (decay, waste, and breakage) divided by the total gross merchantable volume. Report the percent total cull – gross for all reporting levels. Only the Type calculation is shown.

Timber Type

$$\%TC_i = \frac{DT_i + WT_i + BT_i}{VGT_i} * 100$$

The method for determining the total breakage volume at all four reporting levels is the same as for total gross merchantable volume.

Report to nearest whole number.

12.3.10 Stems per Hectare

The stems per hectare parameter uses tree classes 1, 2, 3, 5, 7, 8 and 9. Apply the double sampling ratio and reduction, if applicable. (Refer to section 3.5.1.1).

Timber Type

Each tree contributes:

$$S_t = \frac{BAF_t * 12732.39545}{DBH^2} * DSR_t * R_t$$

To the number of stems per hectare in each plot. Therefore:

$$S_p = \sum_{t=1}^{n_p} S_t$$

And

$$S_I = \frac{\sum_{p=1}^{m_i} s_p}{m_i}$$

Report to 1 decimal place.

12.3.11 Snags per Hectare

The snags per hectare estimate is based on tree classes 4 and 6. Calculate the snags per hectare using the same method as the stems per hectare.

Report to 1 decimal place.

12.3.12 Average DBH - Stems

Include tree classes 1, 2, 3, 5, 7, 8 and 9 for this calculation.

The average DBH is calculated using the average Basal Area per Hectare estimates from the plots. See Section 3.4.1.2 for the method of calculating Basal Area per Hectare.

The calculated average DBH is expressed in meters. Report in centimeters by multiplying by 100.

Timber Type

The Basal Area per Hectare is:

$$BA_p = \sum_{t=1}^{n_p} BAF_t * DSR_t * R_t$$

$$BA_i = \frac{\sum_{p=1}^{m_i} BA_p}{m_i}$$

The Average DBH for Type i is:

$$\overline{D}_I = 100 * 2 * \sqrt{\frac{BA_i}{pi * S_i}}$$

12.3.13 Average DBH – Snags

The average DBH – snags estimate is based on tree classes 4 and 6. Calculate the average DBH – snags using the same method as the average DBH – stems.

Report to 1 decimal place.

12.3.14 Merchantable Volume per Tree - Gross

The gross merchantable volume is the volume between the compiled stump height (30cm) and the compiled mimmum top diameter inside bark. Divide the total gross merchantable volume by the total number of stems.

Timber Type

$$VG_{t,i} = \frac{VGT_i}{S_i * A_i}$$

Report to 2 decimal places.

12.3.15 Merchantable Volume per Tree - Net

Divide the total net merchantable volume by the total number of stems. Report the net merchantable volume per tree for all reporting levels.

Timber Type

$$VT_{t,i} = \frac{VT_i}{S_i * A_i}$$

Report to 2 decimal places.

12.3.16 Average Weighted Total Height

The total height from card type 2 is weighted by the biological volume. See Appendix 13 for the calculation of biological volume.

Prism Plots:

$$HBV_p = \sum_{t=1}^{n_p} \frac{BAF_t * 12732.39545}{DBH_t^2} * H_t * B_t$$

$$BV_p = \sum_{t=1}^{n_p} \frac{BAF_t * 12732.39545}{DBH_t^2} * B_t$$

$$HBV_i = \frac{\sum_{p=1}^{m_i} HBV_p}{m_i}$$

$$BV_i = \frac{\sum_{p=1}^{m_i} BV_p}{m_i}$$

$$WH_i = \frac{HBV_i}{BV_i}$$

Report to 1 decimal place.

Fixed Area Plots:

$$HBV_p = \sum_{t=1}^{n_p} \frac{B_t * H_t}{plotsize}$$

$$BV_p = \sum_{t=1}^{n_p} \frac{B_t}{plotsize}$$

$$HBV_i = \frac{\sum_{p=1}^{m_i} HBV_p}{m_i}$$

$$BV_i = \frac{\sum_{p=1}^{m_i} BV_p}{m_i}$$

$$WH_i = \frac{HBV_i}{BV_i}$$

Report to 1 decimal place.

Example 12.7

Calculate the average weighted total height for Lodgepole Pine in Type 1. The Type is double sampled, with 3 measure plots.

DSR_t = 0.875 for all Lodgepole Pine in Type 1.

BAF_t = 10.000 for all trees in the Type 1 measure plots.

The Lodgepole Pine samples are as follows:

Plot	Plot Type	DBH	Biological Volume	Total Height
1	Border	45.5	2.481693	36.6
2	Full measure	41.0	1.802682	32.2
3	Full measure	38.8	1.326466	26.5

1. $HBV_1 = \frac{2*10.0*12732.39545}{45.5^2} * 36.6 * 2.481693 * 0.875$

$= 9775.8497$

$HBV_2 = 3847.0289$

$HBV_3 = 2601.3376$

$HBV_i = (9775.8497 + 3847.0289 + 2601.3376) = 16224.22$

2. $BV_1 = \frac{2*10.0*12732.39545}{45.5^2} * 2.481693 * 0.875$

$= 267.0997$

$BV_2 = 119.4729$

$BV_3 = 98.1637$

$BV_i = (267.0097 + 119.4729 + 98.1637) = 484.65$

The average total weighted height for Type 1 is:

$WH_1 = 16224.22 / 484.65 = 33.5$ m

12.3.17 Average Weighted Merchantable Height

The merchantable height and volume are from stump height to merchantable top diameter.

Use the same method as for the average weighted total height.

Report to 1 decimal place.

12.3.18 Net Merchantable Volume per Log

The net merchantable volume for this parameter is the gross merchantable volume less decay and waste. Do not subtract the breakage percent.

The number of merchantable logs in a tree includes the short log at the end, if it is 2.5 m or greater. If the last log is less than 2.5 m, then do not include it as an extra log. The short last log would then be included as part of the second last log.

Prism plots

$$NL_p = \sum_{t=1}^{np} \frac{BAF_t * 12732.39545}{DBH_t^2} * NL_t$$

Fixed area plots

$$NL_p = \sum_{t=1}^{np} \frac{NL_t}{plotsize}$$

Timber Type

The number of logs estimate for the Timber Type must be calculated.

$$NL_{i,} = \frac{\sum_{p=1}^{mi} NL_p}{m_i}$$

Net merchantable volume per log for the type is:

$$NVL_{i,} = \frac{VGT_i - WT_i - DT_i}{NL_i}$$

Report to 2 decimal places.

Example 12.8

Calculate the net merchantable volume per log for Lodgepole Pine in Type i. The Type is double sampled, with 3 measure plots. No reduction is applied.

The Type gross merchantable volume is 781 m^3.

The Type is 5.0 hectares in area.

DSR_t = 0.875 for all Lodgepole Pine in Type 1

BAF_t = 10.000 or all trees in the Type 1 measure plots

The Lodgepole Pine samples are as follows:

Plot	Plot type	DBH	Gross merch.	Decay volume	Waste volume	No. of logs
1	B	45.5	2.408381	1.387227	0.341989	6
2	F	41.0	1.740533	0.231490	0.088767	6
3	F	38.8	1.269496	0.134566	0.001269	4

$$NL_1 = \frac{2*10.0*12732.39545}{45.5^2} * 6 * 0.875 = 645.768$$

NL_2 = 397.651

NL_3 = 296.016

The Timber Type per hectare number of logs is the average of the plots.

NL_I = (645.768 + 397.651 + 296.016) / 3 = 446.478

$$VGT_1 = \frac{2*10.0*12732.39545}{45.5^2} * 2.408381 * 0.875 = 259.209$$

VGT_2 = 115.354

VGT_3 = 93.948

The Timber Type per hectare gross volume is:

VGT_I = (259.209 + 115.354 + 93.948) / 3 = 156.17

$$DT_1 = \frac{2*10.0*12732.39545}{45.5^2} * 1.387227 * 0.875 = 149.305$$

DT_2 = 15.342

DT_3 = 9.958

The Timber Type per hectare decay is:

$DT_I = (149.305 + 15.342 + 9.958) / 3 = 58.202$

$$WT_1 = \frac{2 * 10.0 * 12732.39545}{45.5^2} * 0.341989 * 0.875 = 36.808$$

$WT_2 = 5.883$

$WT_3 = 0.0939$

The Timber Type per hectare waste is:

$WT_1 = (36.808 + 5.883 + 0.0939) / 3 = 14.26$

Net merchantable volume per log for the type is:

$$\frac{156.17 - 14.26 - 58.202}{446.478} = 0.19$$

12.3.19 Average Number of Logs per Tree

Divide the number of logs by the number of trees. If position 15 of card type B is coded 1 then include snags. In this case reports will be marked "Not for appraisal purposes".

Timber Type

$$LPT_I = \frac{NL_i}{S_i * A_i}$$

Report to 2 decimal places.

12.3.20 Percent Immature - Coast Only

This parameter is reported for the Treatment Unit within Block and Block levels in the Coniferous and Total columns only.

Determine the maturity by the tree species, plot age in 10s, and tree class. Divide the immature net volume by the total net volume to give a percent immature. Calculate the immature net volume the same way the total volume is calculated using the following rules:

Coniferous species

Immature:	Tree class 8 and 9 are always immature
	Tree classes 1, 2 and 3 are immature if the plot age in 10s < 13

Deciduous species

Immature: Tree class 8 and 9 are always immature

Tree classes 1, 2 and 3 are immature if the plot age in 10s < 5 except for Aspen and Cottonwood in FIZ K and L which are immature if the age in 10s <9

Refer to the Tree Class Modification of Loss Factor Tables in table 17 of the *Cruising Manual*.

Tree class 4 and 6 are only included if the tree class combination from card type B is 1. In this case, summaries are "Not For Appraisal Purposes ".

Example 12.9

The specified maturity level would be assigned in the following cases:

Species	Plot age in 10s	Tree class	Maturity
Fir	11	1	Immature
Cedar	13	8	Immature
Hemlock	13	1	Mature
Maple	11	9	Immature
Alder	11	2	Mature

Block

Average line method:

Begin by calculating the % immature for the Types within the Block by dividing the % immature merchantable net volume of the Type by the total net volume of the Type. Then multiply the net merchantable volume the Type adds to the Block (see Section 12.2.1) by the % immature of that Type. Next sum for all Types in the Block. Divide by the total net merchantable volume of the Block and multiply by 100.

$$\%IM_j = \frac{VTI_j}{VT_j} * 100$$

Treatment Unit within Block

Average line method:

Calculate the Type % immature as above. Then multiply the net merchantable volume the Treatment Unit within Type adds to the Block by the % immature of that Type. Multiply by the area of the Treatment Unit within the Type within the Block divided by the area of the Block. Sum for all Treatment units within Types within Blocks. Divide by the total net merchantable volume of the Treatment Unit within Block. Multiply by 100.

$$\%IM_{j,u} = \frac{VTI_{j,u}}{VT_{j,u}} * 100$$

Report to nearest whole number.

Example 12.10

Type 1 net vol.	=	430 m^3 Area	=	5 hectares
Type 2 net vol.	=	831 m^3 Area	=	7.5 hectares
Block 1 net vol.	=	492 m^3 Area	=	5 hectares: 2.5 hectares from Type 1, 2.5 hectares from Type 2
Block 2 net vol.	=	769 m^3 Area	=	7.5 hectares: 2.5 hectares from Type 1, 5 hectares from Type 2
Treatment Unit 2	=	Area	=	2.5 hectares: 0 hectares within Type 1 within Blk. 2, 2.5 hectares within Type 2 within Blk. 2

Plot	*Type*	*Block*	Vol / Ha	Treatment Unit	Maturity
1	1	1	49.13	1	M
2	1	1	120.23	1	I
3	1	2	89.81	1	M
4	2	1	88.69	1	M

5	2	2	110.57	2	I
6	2	2	131.92	1	I

Block 1: % immature

Type 1 % immature = 120.23 / (49.13+120.23+89.81) = .46
Type 2 % immature = (110.57+131.92) / (88.69+110.57+313.92) = .73
Volume of Type 1 in Block 1 = 430 * (2.5/5) = 215
Volume of Type 2 in Block 1 = 831 * (2.5/7.5) = 277
Volume of immature in Type 1 in Block 1 = 215 * .46 = 99.74
Volume of immature in Type 2 in Block 1 = 277 * .73 = 202.82
Volume of immature in Block 1 = 99.74 + 202.82 = 302.56
% immature in Block 1 = 302.56 / 492 = .61 * 100 = 61

Treatment Unit 2 within Block 2:

Type 1 % immature = .46
Type 2 % immature = .73
Volume of Treatment Unit 2 within Type 1 in Block 2 = 430 * (0/5) = 0
Volume of Treatment Unit 2 within Type 2 in Block 2 = 831 * (2.5/7.5) = 277
Volume of immature in Treatment Unit 2 within Type 1 in Block 2 = 0 * .46 = 0
Volume of immature in Treatment Unit 2 within Type 2 in Block 2 = 277 * .73 = 202.82
% immature in Treatment Unit 2 within Block 2 = 202.82 / 277 = .73 * 100 = 73

12.3.21 Grade Percent - Coast Only

Grade each log by using the coast log grade algorithms (see Appendix 9). Divide the total net volume for each grade by the total net volume to give a percent for that grade.

If the sum of the reported grade percents is not exactly 100% (due to rounding), then add or subtract from the grade with the highest percent to make the total 100%. If there is a tie for the largest grade percent, then adjust the grade letter that is first alphabetically from B to Y.

Timber Type

$$\%G_{i,g} = \frac{VT_{i,g}}{VT_i} * 100$$

Report to nearest whole number.

Example 12.11

If D=33%, E=33% and F=33% - Adjust grade D to 34%

12.3.22 Block Slope – Coast Only

Using the Block Method (as per section 13.2.17) report the following statistics: Minimum slope %, Maximum slope %, Coefficient of Variation, Standard Error of the Mean and the Sampling Error at the 95% level of probability for coast compilations, by block, in the Block Summaries. Use both measure and count plot slopes in the calculations.

No slope statistics need to be generated for a block if there are less than 2 cruise plots in the block.

Minimum slope %, Maximum slope %:

Example 12.12

Block X has 4 plots.

Slope%:

Plot 1 = 10%

Plot 2 = 20%

Plot 3 = 30%

Plot 4 = 40%

Minimum slope % = 10%

Maximum slope % = 40%

Coefficient of Variation:

$$SD_{sp} = \sqrt{\frac{\sum_{p=1}^{m+c} SP_{p,j}^2 - \left(\sum_{p=1}^{m+c} SP_{p,j}\right)^2 \Big/ m+c}{m+c-1}}$$

$$CV_{sp} = \frac{SD_{SP}}{\overline{SP}} * 100\%$$

Where:

SD_{sp} = Standard Deviation for slope from measure and count plots.

CV_{sp} = Coefficient of Variation of slope for all plots.

Standard Error of the Mean for Slope:

$$SEM_{sp} = \frac{SD_{sp}}{\sqrt{n}}$$

Where:

SEM_{sp} = Standard Error of the Mean for Slope.

n = Number of plots sampled.

Sampling Error at the 95% level of probability for Slope:

$$95\%\ CIsp = \overline{SP} \pm SEM_{sp}\% * t_{m+c-1}$$

Where:

$$SEM_{sp}\% = \frac{SEM_{sp}}{\overline{SP}} * 100$$

95% CIsp = Error at the 95% level of probability for Slope.

t_{m+c-1} = Value from Appendix 11 with m + c – 1 degrees of freedom.

12.4 Lumber Information – Interior Only

The lumber information is also contained in chapter 11 – Volume and Lumber Recovery Reports.

12.4.1 Percent Net Merch - Stud Logs

A stud log has a top diameter less than 20.0 cm. Calculate the total net merchantable stud log volume for the reporting levels the same way as for the total net merchantable volume. Divide the Stud log volume by the total net merchantable volume. Report the percent stud log for Fir, Balsam, Spruce, Lodgepole Pine and Larch only.

Timber Type

$$\%ST_I = \frac{VST_i}{VT_i} * 100$$

Report to nearest whole number.

12.4.2 Percent Net Merch - Small Logs

A small log has a top diameter less than 30.0 cm. Calculate the percent net merchantable small logs using the same method as for the stud logs but include all species.

Report to nearest whole number.

12.4.3 Percent Net Merch - Large Logs

A large log has a top diameter greater than 29.9 cm. Calculate the percent net merchantable large logs using the same method as for the stud logs but include all species.

Report to nearest whole number.

12.4.4 Average LRF - All Logs (bd ft/m^3)

See Chapter 11 for more information on LRF and FBM.

Timber Type

$$FBM_I = \sum_{1=1}^{NL_i} FBM_1$$

$$LRF_I = \frac{FBM_i}{VT_i}$$

Lodgepole Pine (Pl):

Pl is divided into several categories; green stems, green beetle attack, red beetle attack, grey beetle attack and dead potential stems. Green stems are described as living stems with no Mountain Pine Beetle (MPB) damage codes associated with them. Green attack stems are those that are marked with insect code 1, red attack stems are those marked with insect code 2 and grey attack stems are those marked with insect code 3. Dead potential stems are dead potential trees with no MPB insect damage codes.

Cruise LRFs will be calculated separately for each category. Pl reduction factors will be then applied to Cruise LRFs calculated for the green beetle attack, red beetle attack, grey beetle attack and dead potential categories. See section 11.5.1.

Lodgepole Pine average LRF will be reported as the weighted average, by net volume, of these categories.

Calculate the average Lodgeploe Pine LRF by weighting the individual category LRFs by net volume.

$$\overline{LRF_{Pl,i}} = \sum_{G=1}^{G_{Pl,i}} \frac{LRF_{Pl,G,i} * V_{G,i}}{V_{G,i}}$$

Example 12.12

There are 3 categories of Pl in a CP: green, red attack and grey attack.

Category	Net Volume	Foot Board Measure	LRF	MPB Reduction	MPB LRF
Green	361	70469	195	0	195
Red Attack	377	71716	190	33	157
Grey Attack	362	70677	195	83	112

Weight the LRFs in each category by net volume to get Pl species LRF.

$$\overline{LRF_{Pl,i}} = \frac{361 \times 195 + 377 \times 157 + 362 \times 112}{361 + 377 + 362}$$

$$= 155$$

Report to nearest whole number.

12.5 Statistical Summary

The statistical summary is reported at the Type, Block and Cutting Permit levels.

For the Type and Block levels, only the all-Species statistics need to be reported. For the Cutting Permit summary, the individual Species as well as the all-Species statistics are reported.

The Type and Cutting Permit calculations are shown in Section 8.4 except for the Cutting Permit number of plots per hectare (See 12.4.4) and Cutting Permit number of trees per plot (See 12.4.5). The rest of this section deals only with Block level reporting.

12.5.1 Number of Measured Plots Used

Average line method:

$$\text{\# measure plots} = \sum_{i=1}^{I_j} m_i$$

Block method:

$$\text{\# measure plots} = \sum_{i=1}^{I_j} m_{i,j}$$

12.5.2 Type of Plots

Report either 'Fixed' or 'Prism'. If both fixed area and prism plots are used in the Block, report 'Mixed'.

12.5.3 Number of Measured Potential Trees

A tree tallied in a border plot will count as two trees. Do not apply a reduction or a double sampling ratio.

Average Line Method:

Report the total number of potential trees (exclude tree class 4 and 6) tallied in the Types that occur in the Block.

Block method:

Report the total number of potential trees (exclude tree class 4 and 6) tallied in the Block.

Report to nearest whole number.

12.5.4 Number of Plots per Hectare - Cutting Permit Only

Divide the total number of plots, including count plots, by the area of the Cutting Permit.

Report to 1 decimal place.

12.5.5 Number of Trees per Plot - Cutting Permit and Timber Type Only

Divide the total number of trees tallied (all commercial Species combined), excluding tree class 4 and 6 by the number of plots in the Cutting Permit. Include count plots in the average.

When a cruised tree meets the minimum DBH utilization level but does not produce a 3 m log according to the taper equation then that tree will be used in the trees per plot equation. These trees will be converted to Tree Class 6 for other purposes.

Report to 1 decimal place.

Example 12.13

There were 84 trees tallied in 12 count and measure plots. One of the trees in a measure plot was a tree class 4. Six of the tallied trees were in a border plot. Six of the tallied trees were in a half plot. Therefore the number of trees per plot is:

$(84 + (6 + 6) – 1) / 12 = 7.9$

12.5.6 % Confidence Interval for Volume

The Block 95 Percent Confidence interval expresses the Standard Error of the Mean (SEM) as a percentage of the volume per hectare. Calculate the Block SEM by weighting the Type SEMs based on the proportional area of the Type within the Block. Refer to Section 8.4.2 for an explanation of the Type SEM.

$$r_{i,j} = \frac{A_i}{\sum_{i=1}^{I_j} A_i}$$

Average Line method:

Weight the Type SEMs based on plots from the Type.

$$95\%\ CI = \pm\ 100 * \frac{\sqrt{\sum_{i=1}^{I_j} r_{i,j}^2 SEM_i^2}}{V_j} * \text{t-value (refer to Appendix 11)}$$

Block Method:

Weight the Type SEMs based on plots from the Type within the Block.

$$95\%\ CI = \pm 100 * \frac{\sqrt{\sum_{i=1}^{I_j} r_{i,j}^2 SEM_{i,j}^2}}{V_j} * \text{t-value (refer to Appendix 11)}$$

Degrees of Freedom for t-value:

The number of degrees of freedom associated with the t-value is calculated as:

Average Line method:

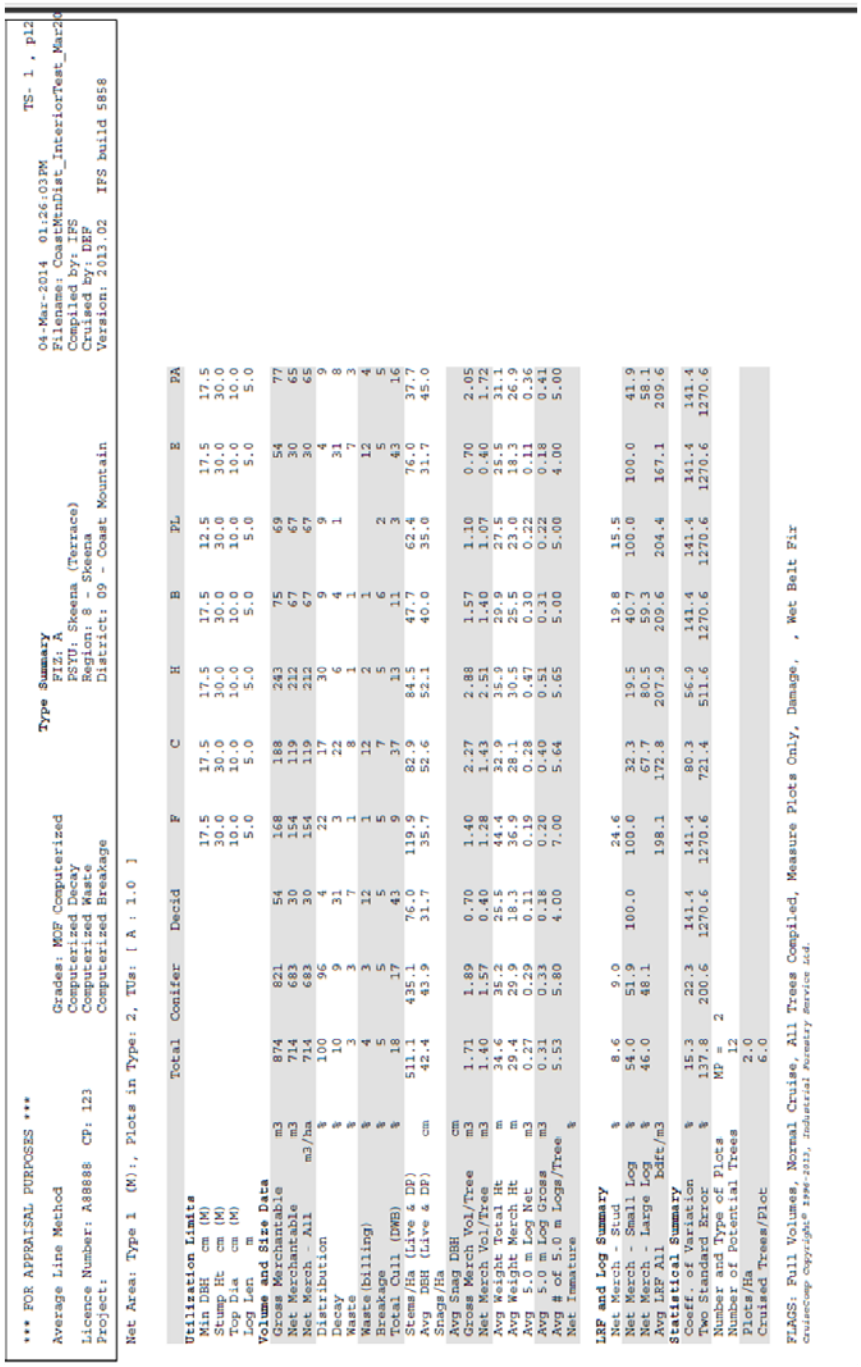
Total number of measured plots in all of the types occurring in the block minus the number of types in the block.

Block method:

Total number of measured plots in the block minus the number of types in block.

12.6 Volume Summary - Sample Listings

Report 009A - Timber Type summary - required.



*** FOR APPRAISAL PURPOSES ***

Average Line Method — Grades: MOF Computerized; Compute rized Decay; Computerized Waste; Computerized Breakage

Licence Number: A88888 CP: 123

Project:

Type Summary — FIZ: A; PSYU: Skeena (Terrace); Region: 8 - Skeena; District: 09 - Coast Mountain

04-Mar-2014 01:26:03PM — TS- 1 , p12

Filename: CoastMtnDist_InteriorTest_Mar20

Compiled by: IFS

Cruised by: DEP

Version: 2013.02 IFS build 5858

Net Area: Type 1 (M):, Plots in Type: 2, TUs: [A : 1.0]

		Total	Conifer	Decid	F	C	H	B	PL	E	PA
Utilization Limits											
Min DBH cm (M)					17.5	17.5	17.5	17.5	12.5	17.5	17.5
Stump Ht cm (M)					30.0	30.0	30.0	30.0	30.0	30.0	30.0
Top Dia cm (M)					10.0	10.0	10.0	10.0	10.0	10.0	10.0
Log Len m					5.0	5.0	5.0	5.0	5.0	5.0	5.0
Volume and Site Data											
Gross Merchantable	m3	874	821	54	168	188	243	75	69	54	77
Net Merchantable	m3	714	683	30	154	119	212	67	67	30	65
Net Merch - All	m3/ha	714	683	30	154	119	212	67	67	30	65
Distribution	%	100	96	4	22	17	30	9	9	4	9
Decay	%	10	9	31	3	22	6	4	1	31	8
Waste	%	3	3	7	1	8	1	1		7	3
Waste (billing)	%	4	3	12	1	12	2	1		12	4
Breakage	%	5	5	5	5	7	5	6	2	5	5
Total Cull (DWB)	%	18	17	43	9	37	13	11	3	43	16
Stems/Ha (Live & DP)		511.1	435.1	76.0	119.9	82.9	84.5	47.7	62.4	76.0	37.7
Avg DBH (Live & DP)	cm	42.4	43.9	31.7	35.7	52.6	52.1	40.0	35.0	31.7	45.0
Snags/Ha											
Avg Snag DBH	cm										
Gross Merch Vol/Tree	m3	1.71	1.89	0.70	1.40	2.27	2.88	1.57	1.10	0.70	2.05
Net Merch Vol/Tree	m3	1.40	1.57	0.40	1.28	1.43	2.51	1.40	1.07	0.40	1.72
Avg Weight Total Ht	m	34.6	35.2	25.5	44.4	32.9	35.9	29.9	27.5	25.5	31.1
Avg Weight Merch Ht	m	29.4	29.9	18.3	36.9	28.1	30.5	25.5	23.0	18.3	26.9
Avg 5.0 m Log Net	m3	0.27	0.29	0.11	0.19	0.28	0.47	0.30	0.22	0.11	0.36
Avg 5.0 m Log Gross	m3	0.31	0.33	0.18	0.20	0.40	0.51	0.31	0.22	0.18	0.41
Avg # of 5.0 m Logs/Tree		5.53	5.80	4.00	7.00	5.64	5.65	5.00	5.00	4.00	5.00
Net Immature	%										
LRF and Log Summary											
Net Merch - Stud	%	8.6	9.0		24.6			19.8	15.5		
Net Merch - Small Log	%	54.0	51.9	100.0	100.0	32.3	19.5	40.7	100.0	100.0	41.9
Net Merch - Large Log	%	46.0	48.1			67.7	80.5	59.3			58.1
Avg LRF All	bdft/m3				198.1	172.8	207.9	209.6	204.4	167.1	209.6
Statistical Summary											
Coeff. of Variation	%	15.3	22.3	141.4	141.4	80.3	56.9	141.4	141.4	141.4	141.4
Two Standard Error	%	137.8	200.6	1270.6	1270.6	721.4	511.6	1270.6	1270.6	1270.6	1270.6
Number and Type of Plots		MP = 2									
Number of Potential Trees		12									
Plots/Ha		2.0									
Cruised Trees/Plot		6.0									

FLAGS: Full Volumes, Normal Cruise, All Trees Compiled, Measure Plots Only, Damage, , Wet Belt Fir

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Figure 12.1 Type Volume Summary - Sample Listing (Partial).

Report 009B - Block summary - required.

*** FOR APPRAISAL PURPOSES ***

Block Summary 04-Mar-2014 01:26:03PM BS- 1 , p10

Average Line Method — Grades: MOF Computerized — FIZ: A — Filename: CoastMtnDist_InteriorTest_Mar20
Computerized Decay — PSYU: Skeena (Terrace) — Compiled by: IFS
Licence Number: A80808 CP: 123 — Computerized Waste — Region: 8 - Skeena — Cruised by: DEF
Project: — Computerized Breakage — District: 09 - Coast Mountain — Version: 2013.02 IFS build 5858

Net Area: Block : (M) - 703:, Plots in Block: 2, TUs: [A : 1.0]

		Total	Conifer	Decid	F	C	H	B	PL	E	PA
Utilization Limits											
Min DBH cm (M)					17.5	17.5	17.5	17.5	12.5	17.5	17.5
Stump Ht cm (M)					30.0	30.0	30.0	30.0	30.0	30.0	30.0
Top Dia cm (M)					10.0	10.0	10.0	10.0	10.0	10.0	10.0
Log Len m					5.0	5.0	5.0	5.0	5.0	5.0	5.0
Volume and Size Data											
Gross Merchantable	m3	974	821	54	168	188	243	75	69	54	77
Net Merchantable	m3	714	683	30	154	119	212	67	67	30	65
Net Merch - All	m3/ha	714	683	30	154	119	212	67	67	30	65
Distribution	%	100	96	4	22	17	30	9	9	4	9
Decay	%	10	9	31	3	22	6	4	1	31	8
Waste	%	3	3	7	1	8	1	1		7	3
Waste(billing)	%	4	3	12	1	12	2	1		12	4
Breakage	%	5	5	5	5	7	5	6	2	5	5
Total Cull (DWB)	%	18	17	43	9	37	13	11	3	43	16
Stems/Ha (Live & DP)		511.1	435.1	76.0	119.9	82.9	84.5	47.7	62.4	76.0	37.7
Avg DBH (Live & DP)	cm	42.4	43.9	31.7	35.7	52.6	52.1	40.0	35.0	31.7	45.0
Snags/Ha											
Avg Snag DBH	cm										
Gross Merch Vol/Tree	m3	1.71	1.89	0.70	1.40	2.27	2.88	1.57	1.10	0.70	2.05
Net Merch Vol/Tree	m3	1.40	1.57	0.40	1.28	1.43	2.51	1.40	1.07	0.40	1.72
Avg Weight Total Ht	m	34.6	35.2	25.5	44.4	32.9	35.9	29.9	27.5	25.5	31.1
Avg Weight Merch Ht	m	29.4	29.9	18.3	36.9	28.1	30.5	25.5	23.0	18.3	26.9
Avg 5.0 m Log Net	m3	0.27	0.29	0.11	0.19	0.28	0.47	0.30	0.22	0.11	0.36
Avg 5.0 m Log Gross	m3	0.31	0.33	0.18	0.20	0.40	0.51	0.31	0.22	0.18	0.41
Avg # of 5.0 m Logs/Tree		5.53	5.80	4.00	7.00	5.64	5.65	5.00	5.00	4.00	5.00
Net Immature	%										
Average Slope	%										
L&P and Log Summary											
Net Merch - Stud	%	8.6	9.0		24.6			19.8	15.5		
Net Merch - Small Log	%	54.0	51.9	100.0	100.0	32.3	19.5	40.7	100.0	100.0	41.9
Net Merch - Large Log	%	46.0	48.1			67.7	80.5	59.3			58.1
Avg LRP All	bdft/m3				198.1	172.8	207.9	209.6	204.4	167.1	209.6
Statistical Summary											
Coeff. of Variation	%	15.3	22.3	141.4	141.4	80.3	56.9	141.4	141.4	141.4	141.4
Two Standard Error	%	137.8	200.6	1270.6	1270.6	721.4	511.6	1270.6	1270.6	1270.6	1270.6
Number and Type of Plots		MP = 2									
Number of Potential Trees		12									
Plots/Ha		2.0									
Cruised Trees/Plot		6.0									

FLAGS: Full Volumes, Normal Cruise, All Trees Compiled, Measure Plots Only, Damage, , Wet Belt Fir

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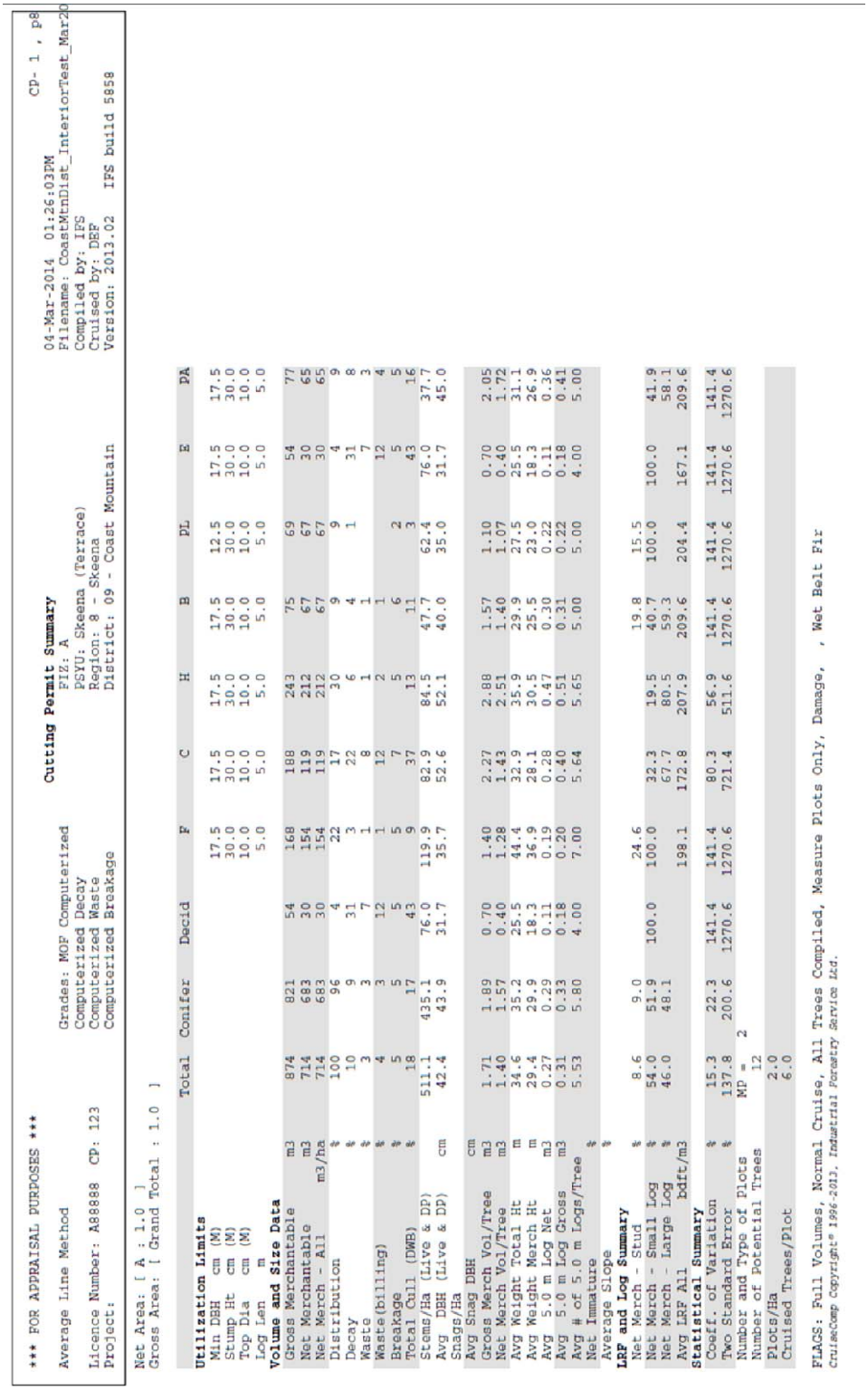
Figure 12.2 Block Volume Summary - Sample Listing (Partial).

Report 009C - Cutting Permit summary - required.



*** FOR APPRAISAL PURPOSES ***

Cutting Permit Summary

04-Mar-2014 01:26:03PM CP- 1 , p8
Filename: CoastMtnDist_InteriorTest_Mar20
Compiled by: IFS
Cruised by: DEF
Version: 2013.02 IFS build 5858

Average Line Method
Grades: MOF Computerized
Computerized Decay
Computerized Waste
Computerized Breakage

FIZ: A
PSYU: Skeena (Terrace)
Region: 8 - Skeena
District: 09 - Coast Mountain

Licence Number: A88888 CP: 123
Project:

Net Area: [A : 1.0]
Gross Area: [Grand Total : 1.0]

		Total	Conifer	Decid	F	C	H	B	PL	E	PA
Utilization Limits											
Min DBH cm (M)					17.5	17.5	17.5	17.5	12.5	17.5	17.5
Stump Ht cm (M)					30.0	30.0	30.0	30.0	30.0	30.0	30.0
Top Dia cm (M)					10.0	10.0	10.0	10.0	10.0	10.0	10.0
Log Len m					5.0	5.0	5.0	5.0	5.0	5.0	5.0
Volume and Size Data											
Gross Merchantable	m3	874	821	54	168	188	243	75	69	54	77
Net Merchantable	m3	714	683	30	154	119	212	67	67	30	65
Net Merch - All	m3/ha	714	683	30	154	119	212	67	67	30	65
Distribution	%	100	96	4	22	17	30	9	9	4	9
Decay	%	10	9	31	3	22	6	4	1	31	8
Waste	%	3	3	7	1	8	1	1		7	3
Waste(billing)	%	4	3	12	1	12	2	1		12	4
Breakage	%	5	5	5	5	7	5	6	2	5	5
Total Cull (DWB)	%	18	17	43	9	37	13	11	3	43	16
Stems/Ha (Live & DP)		511.1	435.1	76.0	119.9	82.9	84.5	47.7	62.4	76.0	37.7
Avg DBH (Live & DP)	cm	42.4	43.9	31.7	35.7	52.6	52.1	40.0	35.0	31.7	45.0
Snags/Ha											
Avg Snag DBH	cm										
Gross Merch Vol/Tree	m3	1.71	1.89	0.70	1.40	2.27	2.88	1.57	1.10	0.70	2.05
Net Merch Vol/Tree	m3	1.40	1.57	0.40	1.28	1.43	2.51	1.40	1.07	0.40	1.72
Avg Weight Total Ht	m	34.6	35.2	25.5	44.4	32.9	35.9	29.9	27.5	25.5	31.1
Avg Weight Merch Ht	m	29.4	29.9	18.3	36.9	28.1	30.5	25.5	23.0	18.3	26.9
Avg 5.0 m Log Net	m3	0.27	0.29	0.11	0.19	0.28	0.47	0.30	0.22	0.11	0.36
Avg 5.0 m Log Gross	m3	0.31	0.33	0.18	0.20	0.40	0.51	0.31	0.22	0.18	0.41
Avg # of 5.0 m Logs/Tree		5.53	5.80	4.00	7.00	5.64	5.65	5.00	5.00	4.00	5.00
Net Immature	%										
Average Slope	%										
LRF and Log Summary											
Net Merch - Stud	%	8.6	9.0		24.6			19.8	15.5		
Net Merch - Small Log	%	54.0	51.9	100.0	100.0	32.3	19.5	40.7	100.0	100.0	41.9
Net Merch - Large Log	%	46.0	48.1			67.7	80.5	59.3	100.0		58.1
Avg LRF All	bdft/m3				198.1	172.8	207.9	209.6	204.4	167.1	209.6
Statistical Summary											
Coeff. of Variation	%	15.3	22.3	141.4	141.4	80.3	56.9	141.4	141.4	141.4	141.4
Two Standard Error	%	137.8	200.6	1270.6	1270.6	721.4	511.6	1270.6	1270.6	1270.6	1270.6
Number and Type of Plots		MP = 2									
Number of Potential Trees		12									
Plots/Ha		2.0									
Cruised Trees/Plot		6.0									

FLAGS: Full Volumes, Normal Cruise, All Trees Compiled, Measure Plots Only, Damage, , Wet Belt Fir

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Figure 12.3 Cutting Permit Volume Summary - Sample Listing (Partial).

Harvesting Method Summary - Overview 13

The Harvest Method summary reports summarize volume and grade data at the Harvest Method and All Method levels.

Approved Harvest Methods:

CC	- Cable Clear Cut	
CS	- Cable Selective Cut	
HC	- Helicopter Clear Cut	
HS	- Helicopter Selective Cut	(Interior)
HL	- Helicopter Land Drop	(Clear Cut)
SL	- Helicopter Selection Land Drop	(Does not include Single Standing Stem Selection)
FL	- Helicopter Single Standing Stem Selection Land Drop	
HW	- Helicopter Water Drop	(Clear Cut)
SW	- Helicopter Selection Water Drop	(Does not include Single Standing Stem Selection)
FW	- Helicopter Single Standing Stem Selection Water Drop	
LC	- Skyline Clear Cut	
LS	- Skyline Selective Cut	

HO - Horse

SC - Ground System Clear Cut

SS - Ground System Selective Cut

SP - Specified Operation

The All Method Summary always uses the Average Line method of calculation similar to the Cutting Permit.

The parameters are reported by species, coniferous and all species total, except LRF values which need to be reported at the species level only. Cottonwood, Alder, Maple, Birch and Aspen are deciduous species and would not be included in the coniferous total.

There are no additional damage reports for the Harvest Method Summaries. Instead there are specific damage parameters included in the reports. Trees with multiple damage codes contribute to the net volume percent for all applicable damage parameters. See Sections 13.2.12 through 13.2.15. Net volume deducted from a tree because of damage, to be used in calculating species net volume, will be calculated using the most severe damage type, as outlined in Section 4.2.

CSV *All Treatment Unit Summaries* (Pre and post–harvest) – Each *Harvesting Method Summary* will be exported from the cruise compilation program in comma-separated value (CSV) formats. See the required format for the summaries and the file descriptions at the following web link:

http://www.for.gov.bc.ca/hva/manuals/csvdocumentation.htm

List of Reports

(015A) - Harvesting Method and All Method

13.1 Header Information

Include the following header information on Harvesting Method reports.

1. License from card type A.
2. Cutting Permit from card type A.
3. Number of Harvesting Methods.
4. Harvesting Method name, for the Harvesting Method reports only.
5. Cruiser name or agency from card type A.
6. Forest Inventory Zone from card type A.
7. Unit number and block from card type A.
8. Total merchantable area from card type A.
9. Number of count and measure plots.
10. Message indicating whether compilation is for appraisals or not.
11. Method of calculation (Average Line or Block).
12. Merchantability requirements from card type B for each species on the report.
13. Special compilation messages for:
    a. Reduction compilation.
    b. Stump cruise compilation.
    c. Tree class combination - useless volumes are included or excluded, from column 15 of card type B (0 or blank - snags excluded, 1 - snags included).
    d. Selective cut indicator - which trees to compile depends on column 12 of card type B (blank - include all trees, 'C' - include cut-indicated and non-indicated trees, 'L' - include leave-indicated trees).
    e. Double sampling, if count plots are used.
14. Compiler program name and version.
15. Compile date and time.
16. Page number.

13.2 Detail Information Variable Definitions

The variables used throughout the chapter are defined below.

$%B_{am}$ = Percent Blowdown damage for Cutting Permit

$%B_h$ = Percent Blowdown damage for Harvest Method h

$%DG_h$ = Decay percent – gross for Harvest Method h

$%D_l$ = Decay percent for log l

$%F_h$ = Percent Fire damage for Harvest Method h

$%FH_h$ = Percent Heavy Fire damage for Harvest Method h

$%G_{am,g}$ = Percent of grade g for Cutting Permit

$%G_{h,g}$ = Percent of grade g for Harvest Method h

$%SG_{am}$ = Percent second growth for the Cutting Permit

$%SL_{am}$ = Slope percent in Cutting Permit

$%SL_h$ = Slope percent in Harvest method h

$%SL_i$ = Slope percent in Type i

$%SL_{i,h}$ = Slope percent in Type i within Harvest Method h

$%SL_{p,i}$ = Slope percent in Plot p within Type i

$%ST_{am}$ = Percent stud log – net for Cutting Permit

$%ST_h$ = Percent stud log – net for Harvest Method h

$%TC_h$ = Total cull percent – gross in Harvest Method h

$%U_h$ = Percent useless trees in Harvest Method h

$%W_h$ = Waste percent – net for Harvest Method h

A_{am} = Area of Cutting Permit

A_h = Area of Harvesting Method h

A_i = Area of Type i

$A_{i,h}$ = Area of Harvest Method h within Type i

B_h = Total net volume of blowdown damage in Harvest Method h

B_i Total net volume of blowdown damage in Timber Type i

BAF_t = Basal area factor for tree t (prism plots only)

BT_h = Total breakage volume for Harvest Method h

DBH_t = Diameter 1.3 m above ground for tree t

DMP_c = Midpoint of Top Diameter Class c

DT_h = Total decay volume in Harvest Method h

$DT_{i,h}$ = Total decay volume in Harvest Method h (Block Method)

FBM_{am} = Lumber recovery in Cutting Permit

FBM_l = Lumber recovery for log l, in Foot Board measures

$FBM_{s,h}$ = Total lumber recovery for small logs in Harvest Method h

F_h = Total Fire net volume for Harvest Method h

FH_h = Total Heavy Fire net volume for Harvest Method h

I = Number of Types in Cutting Permit

I_h = Number of Types in Harvesting Method h

LRF_{am} = Lumber recovery factor for Cutting Permit

$LRF_{sp,c}$ = Lumber recover factor for Species s and Top Diameter Class c

$LRF_{s,h}$ = Lumber recovery factor for small logs in Harvest Method h

mc_i = Number of measure and count plots in Type i

m_i = Number of measure plots in Type i

$m_{i,h}$ = Number of measure plots in Type i within Harvest Method h

NL_{am} = Number of logs in Cutting Permit

NL_h = Number of logs in Harvest Method h

$NL_{i,h}$ = Number of logs in Harvest Method h within Type i

NL_p = Number of logs per hectare for Plot p

$NL_{s,h}$	=	Number of small logs in Harvest Method h
NL_t	=	Number of logs in tree t including small log if greater than 2.5 m
n_p	=	Number of trees in plot p
NVL_{am}	=	Net merchantable volume per log for the Cutting Permit
NVL_i		Net merchantable volume per log for Timber Type i
NVL_h	=	Net merchantable volume per log for Harvest Method h
plotsize	=	Area of a fixed area plot in hectares, to the nearest hundredth
SG_{am}	=	Total second growth net volume for the Cutting Permit
S_h	=	Stems per hectare for Harvest Method h
SN_h	=	Number of snags in Harvest Method h
$VB_{p,i,h}$	=	Net merch Blowdown volume per hectare from Plot p within Type i within Harvest Method h
$VB_{p,i}$	=	Net merch Blowdown volume per hectare from Plot p within Type i
$VG_{p,i}$	=	Gross volume per hectare estimate for Plot p in Type i
$VG_{p,i,h}$	=	Gross volume per hectare estimate for Plot p in Type i within Harvest Method h
VGT_{am}	=	Total gross volume in Cutting Permit
VGT_i	=	Total gross volume in Timber Typei
$VGT_{,h}$	=	Total gross volume in Harvest Method h
V_h	=	Net merchantable volume per hectare in Harvest Method h
V_l	=	Net merchantable volume of log l
$V_{p,i}$	=	Net merchantable volume per hectare from Plot p within Type i
$V_{p,i,h}$	=	Net merchantable volume per hectare from Plot p within Type i within Harvest Method h
VST_{am}	=	Total stud log volume for Cutting Permit
VST_h	=	Total stud log volume for Harvest Method h

VT_{am} = Total net volume in the Cutting Permit

$VT_{am,g}$ = Total grade g volume for Cutting Permit

VT_{h} = Total net volume in Harvest Method h

$VT_{h,g}$ = Total grade g volume for Harvest Method h

$VT_{i,h}$ = Total net volume in Type i within Harvest Method h

$VT_{t,h}$ = Net merchantable volume per tree for Harvest Method h

WT_{h} = Total waste volume in Harvest Method h

$WT_{i,h}$ = Total waste volume in Harvest Method h (Block Method)

13.2.1 Gross Merchantable Volume

The gross merchantable volume is calculated as the volume per hectare multiplied by the number of hectares for each reporting level.

Harvest Method

Average Line method:

Calculate the gross volume per hectare within the Types that contain the Harvest Method using all of the plots within these Types.

Sum the Plot per hectare estimates in a Type. Divide by the number of plots in the Type. Multiple by the area of the Type. Multiply by the ratio of the Type within the Harvest Method.

$$VGT_h = \frac{\sum_{p=1}^{m_i} VG_{p,i}}{m_i} * A_i * \left(\frac{A_{i,h}}{A_i} \right)$$

Report to nearest whole number.

Example 13.1

Type 1 is 5 Ha

Type 2 is 7.5 Ha

Harvest Method SC is 7.5 Ha, 2.5 Ha of Type 1 and 5 Ha of Type 2.

Plot	Type	Volume/ha estimate	Harvest Method
1	1	148.12	SS
2	1	131.83	SC
3	1	107.37	SC
4	2	108.73	SC
5	2	122.17	SS
6	2	152.16	SC

Harvest Method SC:

$$VGT_h = \left(\frac{148.12+131.83+107.37}{3} * 5 * \frac{2.5}{5}\right) + \left(\frac{108.73+122.17+152.16}{3} * 7.5 * \frac{5}{7.5}\right) = 961\ m^3$$

Block Method:

Calculate the gross volumes within a Type that contains the Harvest Method using only the plots within the Harvest Method. Use the Harvest Method double sampling ratio for the plot estimates, if needed.

Sum the Plot per hectare estimates from the Plots in the Type containing the Harvest Method. Divide by the number of plots in the Type within the Harvest Method. Multiple by the area of the Type. Multiply by the ratio of the Type within the Harvest Method.

$$VGT_h = \frac{\sum_{p=1}^{m_{i,h}} VG_{p,i,h}}{m_{i,h}} * A_i * \left(\frac{A_{i,h}}{A_i}\right)$$

Report to nearest whole number.

Example 13.2

Harvest Method SC:

Using the table from Example 13.1:

$$VGT_h = \left(\frac{131.83+107.37}{2} * 5 * \frac{2.5}{5}\right) + \left(\frac{108.73+152.16}{2} * 7.5 * \frac{5}{7.5}\right) = 951\ m^3$$

All Method

The All Method calculations always use the Average Line method.

Sum the Type gross volumes within the Cutting Permit. See Section 12.2.1.

$$VGT_{am} = \sum_{i=1}^{I} VGT_i$$

Report to nearest whole number.

Old Growth and Second Growth Reports

This report is obsolete.

13.2.2 Net Merchantable Volume

The total net merchantable volume is calculated the same way as the gross volume only the loss factors have been applied (see section 3.3.1 step # 3). See Table 17 of the *Cruising Manual* and the Metric Diameter Class Decay, Waste and Breakage Factors 1976 tables.

Each tree volume is reduced by the applicable loss factors, which convert the gross volume per hectare estimates into net volume per hectare estimates. Report the net merchantable volume for all reporting levels.

Report to nearest whole number.

13.2.3 Net Merchantable Volume per Hectare

Divide the net merchantable volume by the area of the reporting level. Only the Harvest Method is shown.

Harvest Method

$$V_h = \frac{VT_h}{A_h}$$

Report to 3 decimal places.

13.2.4 Net Merchantable Volume per Hectare - Live

Live trees include tree classes 1, 2, 5, and 8. Calculate the total net merchantable volume for live trees and divide by the area for each reporting level.

Report to 3 decimal places.

13.2.5 Net Merchantable Volume per Hectare - Dead Potential

Dead potential trees include tree classes 3, 7, and 9. Calculate the total net merchantable volume for dead potential trees and divide by the area for each reporting level.

Report to 3 decimal places.

13.2.6 Net Merchantable Volume per Tree

Divide the total net merchantable volume by the total number of stems. Refer to section 12.2.9 for an explanation of the number of stems per hectare calculation. Report the net merchantable volume per tree for all reporting levels. Only the Harvest Method calculation is shown.

Harvest Method

$$VT_{t,h} = \frac{VT_h}{S_h * A_h}$$

Report to 2 decimal places.

13.2.7 Net Merchantable Volume per Log

The 'net merchantable volume' for this parameter is the gross merchantable volume less decay and waste. Do <u>not</u> subtract the breakage percent.

The number of merchantable logs in a tree includes the small log at the top of the tree if it is 2.5 m or greater. If the last log is less than 2.5 m, then do <u>not</u> include it as an extra log, rather add it to the second last log.

Plot estimates are calculated for the number of logs per hectare. Multiplying the number of logs per hectare by the area of the reporting level will report the total number of logs in the unit.

Refer to example 12.8 for sample calculations for the net merchantable volume per log.

Number of trees per plot:

Prism plots:

$$NL_p = \sum_{t=1}^{n_p} \frac{BAF_t * 12732.39545}{DBH_t^2} * NL_t$$

Fixed area plots:

$$NL_p = \sum_{t=1}^{n_p} \frac{NL_t}{plotsize}$$

Harvest Method

Average Line method:

Calculate the number of logs per hectare estimate for the Timber Types that have plots within the Harvest Method using all of the plots in the Type. Divide by the number of full measure plots in the Type. Multiply by the area of the Type. Multiple by the ratio of the Harvest Method area within the Type to get the number of logs in the Type within the Harvest Method.

$$NL_{i,h} = \frac{\sum_{p=1}^{m_i} NL_p}{m_i} * A_i * \left(\frac{A_{i,h}}{A_i} \right)$$

Sum the number of logs in the Types within the Harvest Method:

$$NL_h = \sum_{i=1}^{I_h} NL_{i,h}$$

The net merchantable volume per log for the Harvest Method is:

$$NVL_h = \frac{VGT_h - WT_h - DT_h}{NL_h}$$

See Chapter 12 for a discussion on calculating waste and decay volumes.

Report to 2 decimal places.

Block method:

Calculate the number of logs per hectare estimate for the Types that have plots within the Harvest Method using only the plots in the Type that are within the Harvest Method. Divide by the number of plots in the Type within the Harvest Method. Multiply by the area of the Type. Multiple by the ratio of the Harvest Method area within the Type to get the number of logs in the Type within the Harvest Method.

$$NL_{i,h} = \frac{\sum_{p=1}^{m_{i,h}} NL_p}{m_{i,h}} * A_i * \left(\frac{A_{i,h}}{A_i} \right)$$

Sum the number of logs in the Types within the Harvest Method:

$$NL_h = \sum_{i=1}^{I_h} NL_{i,h}$$

The net merchantable volume per log for the Harvest Method is:

$$NVL_h = \frac{VGT_{i,h} - WT_{i,h} - DT_{i,h}}{NL_h}$$

See Chapter 12 for a discussion on calculating waste and decay volumes.

Report to 2 decimal places.

All Method

Multiply the Harvest Method net merchantable volume per log, calculated by the Average Line method, by the ratio of the Harvest Method area to the Cutting Permit area. Sum these values for all of the Harvest Methods within the Cutting Permit.

$$NVL_{am} = \sum_{i=1}^{I}\left(NVL_i * \left(\frac{A_i}{A_{am}} \right) \right)$$

Report to 2 decimal places.

Second Growth and old Growth

These reports are to be discontinued as of April 1, 2003 and so will not be illustrated here.

13.2.8 Percent Decay - Gross

Each tree is reduced by a decay percent as explained in section 3.3.1 Step #4. The decay amount would be the gross volume for the tree multiplied by the decay percent.

The percent decay – gross is calculated by dividing the total decay volume by the total gross merchantable volume for each reporting level.

Harvest Method

$$\%DG_h = \frac{DT_h}{VGT_h} * 100$$

The method for determining the total decay volume is the same as for total gross volume.

Report to nearest whole number.

13.2.9 Percent Waste (Billing) - Net

Each tree is reduced by a waste percent as explained in section 3.3.1 Step #4. The waste volume would be the gross volume for the tree multiplied by the waste percent.

The percent waste (billing) – net is calculated by dividing the total waste volume by the total net merchantable volume for each reporting level.

Harvest Method

$$\%W_h = \frac{WT_h}{VT_h} * 100$$

The method for determining the total waste volume is the same as for total gross volume.

Report to nearest whole number.

13.2.10 Percent Total Cull - Gross

The percent total cull – gross is the total of the 3 loss factors (decay, waste and breakage) divided by the total gross merchantable volume. Report the percent total cull – gross for all reporting levels

Harvest Method

$$\%TC_h = \frac{DT_h + WT_h + BT_h}{VGT_h} * 100$$

The method for determining the total breakage volume at all reporting levels is the same as for total gross merchantable volume.

Report to nearest whole number.

13.2.11 Percent Useless Trees

Useless trees include tree classes 4 and 6. Divide the number of snags by the total number of trees for each reporting level. Refer to sections 12.2.9 and 12.2.10 for an explanation of the calculation of stems and snags.

$$\%U_h = \frac{SN_h}{SN_h + S_h} * 100$$

Report to the nearest whole number.

13.2.12 Percent Blowdown Volume - Net

Trees with multiple damage codes contribute to the net volume percent for all applicable damage parameters. Net volume deducted from a tree because of damage, to be used in calculating species net volume, will be calculated using the most severe damage type, as outlined in Section 4.2.

Any tree with a blowdown code of E or G in column 63 of card type 2 will contribute to the percent net merchantable blowdown total. Report the percent blowdown – net for each reporting level. See Section 4.2

Harvest Method

Average Line method:

Calculate the net volume of damage by: summing the net volume per hectare of stems having damage from all plots within the Type within the Harvest Method. Divide by the total volume per hectare from all plots within the Type within the Harvest Method. Multiply by the volume of the Type within Harvest Method. Sum the damage volumes from all Types within the Harvest Method.

$$B_h = \sum_{i=1}^{I_h} \left(\frac{VB_{p,i}}{V_{p,i}} * VT_{i,h} \right)$$

Divide the net volume of stems coded as having damage within the Harvest Method by the total net volume of the Harvest Method. Multiply by 100.

$$\%B_h = \frac{B_h}{VT_h} * 100$$

Report to the nearest whole number.

Block Method:

Calculate the net volume of damage by: summing the net volume per hectare of stems having damage from only plots within the Type within the Harvest Method. Divide by the total volume per hectare from only plots within the Type within the Harvest Method. Multiply by the volume of the Type within Harvest Method. Sum the damage volumes from all Types within the Harvest Method.

$$B_h = \sum_{i=1}^{I_h} \left(\frac{VB_{p,i,h}}{V_{p,i,h}} * VT_{i,h} \right)$$

Divide the net volume of stems coded as having damage within the Harvest Method by the total net volume of the Harvest Method. Multiply by 100.

$$\%B_h = \frac{B_h}{VT_h} * 100$$

Example 13.3

Blowdown volumes include all stems in plots 1, 3 and 5.

Plot	Type	Volume/ha estimate	Harvest Method
1	1	38.81	SS
2	1	108.9	SC
3	1	88.69	SC
4	2	89.81	SC
5	2	16.98	SS
6	2	124.16	SC

Average Line: Harvest Method Summary

Total net volume in Type 1 within Harvest Method SC = 197 m^3

Total net volume in Type 2 within Harvest Method SC = 385 m^3

Total net volume in Harvest Method SC = 582 m^3

Type 1:

Volume per hectare of stems with damage: 38.81 + 88.69 = 127.5

Total volume per hectare for all plots: 38.81 + 108.9 + 88.69 = 236.4

Ratio of damage net volume to total net volume: 127.5 / 236.4 = .53934

Multiply by the net volume of the Type within the Harvest Method:
.53934 * 197 = 106.25

Type 2:

Volume per hectare of stems with damage: 16.98	= 16.98
Total volume per hectare for all plots: 89.91 + 16.98 + 124.16	= 231.05
Ratio of damage net volume to total net volume:16.98/230.95	= .07349
Multiply by the net volume of the Type within the Harvest Method: .07349 * 385	= 28.29
Sum the damage volume from all Types within the Harvest Method. B_h = 106.25 + 28.29	= 134.54

Divide the net volume of stems coded as having damage within the Harvest Method by the total net volume of the Harvest Method. Multiply by 100.

$\%B_h$ = (134.54 / 582) * 100	= 23

Block Method: Harvest Method Summary

Total net volume in Type 1 within Harvest Method SC	= 247 m^3
Total net volume in Type 2 within Harvest Method SC	= 535 m^3
Total net volume in Harvest Method SC	= 782 m^3

Type 1:

Volume per hectare of stems with damage within the Harvest Method: 88.69	= 88.69
Total volume per hectare for plots within the Harvest Method:108.9 + 88.69	= 197.59
Ratio of damage net volume to total net volume:88.69 / 197.59	= .45
Multiply by the net volume of the Type within the Harvest Method: .45 * 247	= 111.15

Type 2:

Volume per hectare of stems with damage: 0	= 0
Total volume per hectare for all plots: 89.81 + 124.16	= 213.97
Ratio of damage net volume to total net volume: 0 / 213.97	= 0.00
Multiply by the net volume of the Type within the Harvest Method: 0.00 * 535	= 0.00
Sum the damage volume from all Types within the Harvest Method. B_h = 111.15 + 0.00	= 111.15
Divide the net volume of stems coded as having damage within the Harvest Method by the total net volume of the Harvest Method. Multiply by 100. $\%B_h$ = (111.15 / 782) * 100	= 14

All Method

Sum the Blowdown net volume of all Types within the Cutting Permit and divide by the All Method net volume. Multiply by 100.

$$\%B_{am} = \frac{\sum_{i=1}^{I} B_i}{VT_{am}} * 100$$

Report to the nearest whole number.

13.2.13 Percent Fire Damage Volume - Net

Trees with multiple damage codes contribute to the net volume percent for all applicable damage parameters. Net volume deducted from a tree because of damage, to be used in calculating species net volume, will be calculated using the most severe damage type, as outlined in Section 4.2.

Any tree with a fire code of A, B or C in column 62 of card type 2 will contribute to the Percent Fire Damage Volume – net (All Burn %). Report the percent Fire damage for each reporting level.

Divide the net volume of stems coded as having Fire damage within the Harvest Method by the total net volume of the Harvest Method. Multiply by 100.

The net volume of stems coded as having Fire damage within the Harvest Method is calculated in the same way as the net volume of stems coded as having Blowdown damage. See Example 13.3.

Harvest Method

$$\%F_h = \frac{F_h}{VT_h} * 100$$

Report to the nearest whole number.

All Method

Calculate in the same manner as Blowdown damage.

Report to the nearest whole number.

13.2.14 Percent Heavy Fire Damage Volume – Net

Trees with multiple damage codes contribute to the net volume percent for all applicable damage parameters. Net volume deducted from a tree because of damage, to be used in calculating species net volume, will be calculated using the most severe damage type, as outlined in Section 4.2.

Any tree with a fire code of C in column 62 of card type 2 will contribute to the percent Heavy Fire total. Report the parameter for each reporting level.

Divide the net volume of stems coded as having Heavy Fire damage within the Harvest Method by the total net volume of the Harvest Method. Multiply by 100.

The net volume of stems coded as having Heavy Fire damage within the Harvest Method is calculated in the same way as the net volume of stems coded as having Blowdown damage. See Example 13.3.

Harvesting Method

$$\%FH_h = \frac{FH_h}{VT_h} * 100$$

Report to the nearest whole number.

All Method

Calculate in the same manner as Blowdown damage.

Report to the nearest whole number.

13.2.15 Percent Insect Damage Volume – Net

Trees with multiple damage codes contribute to the net volume percent for all applicable damage parameters. Net volume deducted from a tree because of damage, to be used in

calculating species net volume, will be calculated using the most severe damage type, as outlined in Section 4.2.

Any tree with an insect code of 1-8, X or Y in column 61 of card type 2 will contribute to the Percent Insect Damage Volume – net total. Report the parameter at all reporting levels.

Divide the net volume of stems coded as having Insect damage within the Harvest Method by the total net volume of the Harvest Method. Multiply by 100.

The net volume of stems coded as having Insect damage within the Harvest Method is calculated in the same way as the net volume of stems coded as having Blowdown damage. See Example 13.3.

Harvest Method

$$\%I_h = \frac{I_h}{VT_h} * 100$$

Report to the nearest whole number.

All Method

Calculate in the same manner as Blowdown damage.

Report to the nearest whole number.

13.2.16 Percent Second Growth Volume – Net

Report the percent second growth volume – net for the All Method report coniferous species only. Divide the second growth total net merchantable volume of the coniferous species by the total net merchantable volume of the coniferous species. Multiply by 100.

The net merchantable second growth volume is calculated in the same way as the net volume of stems coded as having Blowdown damage. See Example 13.3.

A tree will contribute to the second growth total net merchantable volume depending on the Age in 10s from card type 9 and the tree class:

If Age in 10s < 15, then tree classes 1, 2, 3, 4, 6, 8 and 9 are second growth.

If Age in 10s >= 15, then tree classes 8 and 9 are second growth.

Example 13.4

The Fir and Cedar are second growth based on their age in 10s and tree classes. The Hemlock is Tree Class 5, which is not second growth.

Species	Plot age in 10s	Tree class	Second growth
Fir	11	1	Yes
Cedar	15	8	Yes
Hemlock	13	5	No

All Method

$$\%SG_{am} = \frac{SG_{am}}{VT_{am}} * 100$$

Report to the nearest whole number.

13.2.17 Average Slope Percent

Report the average slope percent once only at each reporting level; i.e., there is no segregation of species for this parameter.

The average slope must be calculated using the Block method unless there are no plots in the Harvest Method, in which case the Average Line method must be used.

Include both count and measure plot slopes.

A blank slope field on Card type 9 is compiled as 0 percent.

Harvest Method

Calculate the Harvest Method percent slope by weighting the Type within Harvest Method value based on the area of the Type within the Harvest Method using only the plots in the Type within the Harvest Method.

When there are no plots in a Type within a Harvest Method assign the average slope for the Type to that Harvest Method.

$$\%SL_h = \frac{\sum_{i=1}^{I_h} \%SL_{i,h} * A_{i,h}}{A_h}$$

Report to the nearest whole number.

Example 13.5

Harvest Method SC is 7.5 Ha, 2.5 Ha of Type 1 and 5 Ha of Type 2.

Type	Slope	Harvest Method
1	50	SS
1	90	SC
1	80	SC
2	50	SC
2	70	SS
2	60	SC

Harvest Method SC slope:

Type 1:

$\%SL_{i,h}$ = (90 + 80) / 2 = 85

Type 2:

$\%SL_{i,h}$ = (50 + 60) / 2 = 55

Harvest Method SC:

$\%SL_{h}$ = ((85 * 2.5) + (55 * 5)) / 7.5 = 65

Example 13.6

Harvest Method SS is 3.3 Ha, 0.3 Ha of Type 1 and 3.0 Ha of Type 2. Type 1 has no plots in the Harvest Method, Type 2 has 3 plots.

Type	Slope	Harvest Method
1	29	SC
1	27	SC
1	34	SC
1	21	SC
2	31	SS
2	63	SS
2	55	SS

Type 1 consists of 4 plots, none of which fall in the SS method. Area for this type in SS method is 0.3 ha, thus Average Line for this segment is to be used:

Average Slope for type 1 is (29 + 27 + 34 + 21) / 4 = 27.75 (Average Line Method)

Average Slope for type 2 is (31 + 63 + 55) / 3 = 49.67 (Block Method)

Harvest Method slope:
(27.75 x 0.3 ha) + (49.67 x 3 ha) / 3.3ha

8.32 + 149.01 = 157.33 / 33 = 47.67
Report 48

Example 13.7

Assume there will be 0.5 ha HO method, in type 2. Type 2 consists of 3 plots, none of which fall in the HO method. Average Line for this method is to be used.

Type	Slope	Harvest Method
2	31	SS
2	63	SS
2	55	SS

Average Slope for type 2 is (31 + 63 + 55) / 3 = 49.67 (Average Line Method)

Report 50% for the 0.5 ha HO method.

All Method

Calculate the Type average slope.

$$\%SL_I = \frac{\sum_{p=1}^{mc_i} \%SL_{p,i}}{mc_i}$$

Calculate the average slope percent for the All Method Summary by weighting the Type values based on area of the Type within the Cutting permit.

$$\%SL_{am} = \sum_{i=1}^{I} \frac{\%SL_i * A_i}{A_{am}}$$

Report to the nearest whole number.

13.2.18 Algorithm Grade Percent - Coast

Grade each log using the coast log grade algorithm (see Appendix 9). Divide the total net volume for each grade by species by the total net volume by species to give a percent for that grade.

If the sum of the reported grade percents is not exactly 100% (due to rounding), then add or subtract from the grade with the highest percent so that the total is 100%. Do this for the species as well as for the Total and Coniferous columns. If there is a tie for the largest grade percent, then adjust the grade letter that is first alphabetically from B to Y.

Example 13.8

If D=33%, E=33% and F=33% - Adjust grade D to 34%

Harvest Method

$$\%G_{h,g} = \frac{VT_{h,g}}{VT_h} * 100$$

Report to nearest whole number.

All Method

$$\%G_{am,g} = \frac{VT_{am,g}}{VT_{am}} * 100$$

Report to nearest whole number.

13.3 Lumber Information - Interior Only

13.3.1 Percent Stud Log Volume - Net

A stud log has a top diameter less than 20.0 cm. Calculate the total merchantable stud log volume for the reporting levels the same way as for the total merchantable volume. Divide the Stud log volume by the total net volume of the reporting level. Calculate the percent stud log for Fir, Balsam, Spruce, Lodgepole Pine and Larch species only.

Harvest Method

$$\%ST_h = \frac{VST_h}{VT_h} * 100$$

Report to nearest whole number.

All Method

Sum the stud log net volumes from the Types within the Cutting Permit. Divide by the total net volume of the Cutting Permit. Multiply by 100.

$$\%ST_{am} = \frac{VST_{am}}{VT_{am}} * 100$$

Report to nearest whole number.

13.3.2 Percent Net Merch – Small Logs

A small log has a top diameter less than 30.0 cm. Calculate the percent net merchantable small logs using the same method as for the stud logs but include all species.

Report to nearest whole number.

13.3.3 Percent Net Merch – Large Logs

A large log has a top diameter greater than 29.9 cm. Calculate the percent net merchantable large logs using the same method as for the stud logs, but include all species.

Report to nearest whole number.

13.3.4 Average LRF – All Logs

See Chapter 11 for more information on LRF and FBM.

Report to nearest whole number.

Appraisal Summaries 14

The Appraisal Summary Reports combine appraisal information from the Volume summaries (Chapter 12) and the Harvesting Method summaries (Chapter 13). There are separate reports for Coast and Interior compilations.

Produce the Appraisal Summary Report even if the compilation does not meet appraisal standards.

When appropriate, these messages will be reported on all Appraisal Summary Reports: For Appraisal Purposes, Not for Appraisal Purposes, Sale is in the wet belt, Sale is in the dry belt, 100% Cruise, Stump Cruise.

14.1 Appraisal Summary - Coast

14.1.1 Header information

Include the following header information for the Coast Appraisal Summary Report.

1. License from card type A.
2. Cutting Permit from card type A.
3. Locality description from card type A.
4. Cruiser or agency from card type A.
5. Forest Inventory Zone and Unit (long name) from card type A.
6. Number of Blocks from card type A.
7. Total merchantable area from card type A.
8. Second growth percent* from the All Method report.
9. Second growth net volume (m^3) for the cutting authority.

> * The second growth percent and net volume reported is for coniferous species only.

14.1.2 Detail Information

Report the following detail information for the Coast Appraisal Summary Report.

14.1.2.1 Species Grade Percent Table

Each row of the table would report the algorithm grade percent for a particular species from the All Method report (see Chapter 13). The reported species are:

1. Alder.
2. Balsam.
3. Cedar.
4. Cottonwood.

5. Cypress.
6. Fir.
7. Hemlock.
8. Lodgepole Pine.
9. Spruce.
10. White Pine (Albicaulis Pine).
11. Maple.
12. Birch.
13. Total.

The following information will be reported for each species:

1. Each grade percent.
2. The total net merchantable volume for each species and total from the All Method Report (see Chapter 13). Report the whole number.
3. Net Volume per Hectare and Net Volume – All (tree classes 1, 2, 3, 5, 7, 8, 9): Report the net merchantable volume for each species and total from the All Method Summary. Report the number to 3 decimal places.
4. Net Volume per Hectare and Net Volume – Live (tree classes 1, 2, 5, 8): Report the net merchantable volume for each species and total from the All Method Summary. Report the number to 3 decimal places.
5. Net Volume per Hectare and Net Volume – Dead Potential (tree classess 3, 7, 9): Report the net merchantable volume for each species and total from the All Method Summary. Report the number to 3 decimal places.

14.1.2.2 Harvesting Method Parameter Table

Report each of these parameters for each Harvesting Method. The source of the data is the individual Harvesting Method report described in Chapter 13. Use the same number of significant digits that are used for the Harvesting Method Report parameters.

Net volume	Report the total net merchantable volume from the Harvesting Method Summary.
Net Volume per 10 m Log	Use a 10 m log for coast appraisal cruises.

Net Merchantable Volume per Hectare	Report the total net merchantable volume per hectare from the Harvesting Method summary.
Partial Cut Percent	Divide the post-reduction net merchantable volume by the pre-reduction net merchantable volume and multiply by 100. Report this parameter for reduction compilations only. Report to nearest whole number.

Example 14.1

For Harvesting Method 'SS', the pre-reduction net merchantable volume is 2367 m^3. The post-reduction net merchantable volume is 1696 m^3.

The partial cut percent is 100 * (1696 / 2367) = 72 percent

Average Slope Percent	Report the average slope percent from the Harvesting Method Report.
Down Tree Percent	Report the percent blowdown volume - net from the Harvesting Method Report.
Heavy Fire Percent	Report the percent heavy fire volume - net from the Harvesting Method Report.

14.1.2.3 Cutting Permit Parameters

Report each of the following parameters from the Cutting Permit volume summary report (see Chapter 12).

95 Percent Confidence Interval	Report the 95 percent confidence interval from the Cutting Permit statistical summary. Always report pre-reduction values.
Trees per Plot	Report the average number of trees per plot (excluding tree class 4 and 6) from the Cutting Permit Statistical Summary.
Percent Immature by Block	Report the percent immature parameter from the Block Volume Summaries.
Plots per Hectare	Report the plots per hectare (including count plots) from the Cutting Permit Statistical Summary.

14.1.2.4 All Method Parameters

Net volume per tree	Report net volume per tree from the All Method Summary.
Net volume per hectare	Report the Net volume per hectare from the All Method Summary.
NHSVPH	Report the coniferous, non-helicopter partial cut, net volume/hectare. Heli single standing stem is a partial cut harvest method.
Conventional Slope	Report total weighted non-helicopter Harvest Method Slope.

Example 14.2

NHSVPH:

Harvest Method	**Total Net Coniferous Volume (m^3)**	**Area (ha.)**
CC	10,000	20
CS	5,000	20
HL	2,500	15
SL	500	10
FL	50	10
HW	2,500	15
SW	500	10
FW	50	10

Sum the cutting permit's non-helicopter partial cut Harvest Method's coniferous volumes.

$$10{,}000 + 5{,}000 + 2{,}500 + 2{,}500 = 20{,}000\ m^3$$

Sum the cutting permit's non-helicopter partial cut Harvest Method's areas.

$$20 + 20 + 15 + 15 = 70\ ha.$$

Divide the sum of the volumes by the sum of the areas.

$$20{,}000 / 70 = 285.71 \text{ m}^3/\text{ha}.$$

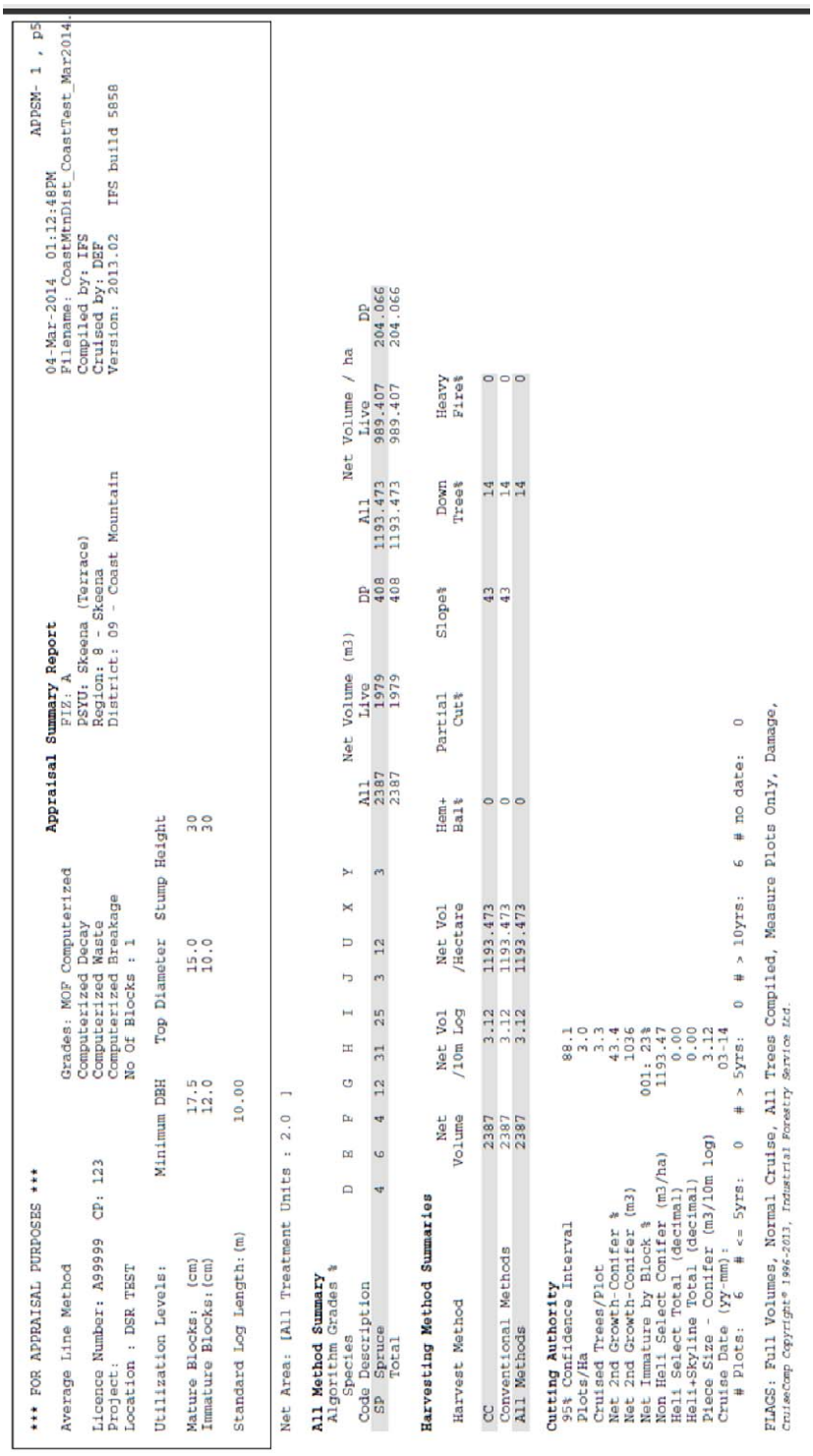
Report to 2 decimal places.

Example 14.3

Conventional Slope:

Cable	Twenty-five hectares, average slope = 40 percent.
Ground Skidding	Twenty-five hectares, average slope = 20 percent.
Helicopter	Fifty hectares, average slope = 80 percent.
	= (25* 40 + 25* 20)/(25 + 25) = 30 %.

14.2 Coast Appraisal Summary - Sample Listing



*** FOR APPRAISAL PURPOSES ***

Appraisal Summary Report

04-Mar-2014 01:12:48PM APPSM- 1 , p5
Filename: CoastMtnDist_CoastTest_Mar2014.

Average Line Method
Grades: MOF Computerized
Computerized Decay
Computerized Waste
Computerized Breakage
No Of Blocks : 1

PIA: A
PSYU: Skeena (Terrace)
Region: 8 - Skeena
District: 09 - Coast Mountain

Compiled by: IFS
Cruised by: DEP
Version: 2013.02 IFS build 5858

Licence Number: A99999 CP: 123
Project:
Location : DSR TEST

Utilization Levels: Minimum DBH Top Diameter Stump Height

Mature Blocks: (cm) 17.5 15.0 30
Immature Blocks: (cm) 12.0 10.0 30

Standard Log Length: (m) 10.00

Net Area: [All Treatment Units : 2.0]

All Method Summary
Algorithm Grades %

Species Code	Description	D	E	P	G	H	I	J	U	X	Y	Net Volume (m3) All	Live	DP	Slope%	Net Volume / ha All	Live	DP	Down Tree%	Heavy Fire%
SP	Spruce	4	6	4	12	31	25	3	12		3	2387	1979	408	43	1193.473	989.407	204.066	14	0
	Total											2387	1979	408	43	1193.473	989.407	204.066	14	0

Harvesting Method Summaries

Harvest Method	Net Volume	Net Vol /10m Log	Net Vol /Hectare	Hem+ Bal%	Partial Cut%
CC	2387	3.12	1193.473	0	
Conventional Methods	2387	3.12	1193.473	0	
All Methods	2387	3.12	1193.473	0	

Cutting Authority

95% Confidence Interval	88.1
Plots/Ha	3.0
Cruised Trees/Plot	3.3
Net 2nd Growth-Conifer %	43.4
Net 2nd Growth-Conifer (m3)	1036
Net Immature by Block %	001: 23%
Non Heli Select Conifer (m3/ha)	1193.47
Heli Select Total (decimal)	0.00
Heli+Skyline Total (decimal)	0.00
Piece Size - Conifer (m3/10m log)	3.12
Cruise Date (yy-mm):	03-14
# Plots: 6 # <= 5yrs: 0 # > 5yrs: 0 # > 10yrs: 6 # no date: 0	

FLAGS: Full Volumes, Normal Cruise, All Trees Compiled, Measure Plots Only, Damage,

CruiseComp Copyright© 1996-2013, Industrial Forestry Service Ltd.

Figure 14.1 Coast Appraisal Summary - Sample Listing.

14.3 Appraisal Summary - Interior

14.3.1 Header Information

Include the following header information for the Interior Appraisal Summary Report.

1. License from card type A.
2. Cutting Permit from card type A.
3. Locality description from card type A.
4. Cruiser or agency from card type A.
5. Forest Inventory Zone and Unit (long name) from card type A.
6. Number of Blocks from card type A.
7. Total merchantable area from card type A.
8. Horse Logging net volume*.
9. Helicopter clear cut net volume*.
10. Helicopter partial cut net volume*.

> * The total net merchantable volume from the individual Harvesting Method Reports.

14.3.2 Detail Information

Report the following detail information for the Interior Appraisal Summary Report.

14.3.2.1 Species Parameter Table

Report each of the following parameters from the All Method summary for the following Species:

1. Balsam.
2. Cedar.

3. Fir.
4. Hemlock.
5. Larch.
6. Lodgepole Pine.
7. Spruce.
8. Yellow Pine (Ponderosa Pine).
9. White Pine.
10. Whitebark Pine.
11. Conifer - combine all coniferous Species in the compilation.
12. Total.

Net Volume	Report the net merchantable volume for each species, conifer and total from the All Method Summary.
Net Volume per Hectare and Net Volume - All (tree classes 1, 2, 3, 5, 7, 8, 9):	Report the net merchantable volume for each species, conifer and total from the All Method Summary. Report the number to 3 decimal places.
Net Volume per Hectare and Net Volume - Live (tree classes 1, 2, 5, 8):	Report the net merchantable volume for each species, conifer and total from the All Method Summary. Report the number to 3 decimal places.
Net Volume per Hectare and Net Volume - Dead Potential (tree classes 3, 7, 9):	Report the net merchantable volume for each species, conifer and total from the All Method Summary. Report the number to 3 decimal places.
Percent Decay	Report the percent decay - net from the All Method Summary.
Stud Log Percent	Report the percent stud log volume - net from the All Method Summary.
LRF	Report the Average LRF from the All Method Summary.
Burn Percent	Report the percent fire damage volume - net from the All Method Summary.

14.3.2.2 Harvesting Method Parameter Table

Report each of the following parameters from the Harvesting Method summaries as described in chapter 13. Use the same number of significant digits for each parameter.

Net volume	Report the total net merchantable volume from the Harvesting Method Summary.
Average Slope Percent	Report the average slope percent from the Harvesting Method Summary.
Net Volume per Tree	Report the net merchantable volume per tree from the Harvesting Method Summary.
Net Volume per hectare	Report the net merchantable volume per hectare from the Harvesting Method Summary.
Stand Defect Percent	Report the percent total cull from the Harvesting Method Summary.
Partial Cut Percent	Divide the post-reduction net merchantable volume by the pre-reduction net merchantable volume and multiply by 100. Report this parameter for reduction compilations only. Report to nearest whole number.
All Fire Percent	Report the percent fire volume - net from the Harvesting Method Report.
Heavy Fire Percent	Report the percent heavy fire volume - net from the Harvesting Method Report.
Down Tree Percent	Report the percent blowdown volume - net from the Harvesting Method Report.
Dead Useless Percent	Report the percent dead useless trees from the Harvesting Method Report.
Lodgepole Pine volume for Highlead/Grapple Harvest Methods	Lodgepole Pine volume for Highlead/Grapple Harvest Methods. This attribute is obsolete.

14.3.2.3 All Method Parameter Table

Report each of the following parameters from the All Method summaries as described in chapter 13.

Net volume per tree	Report net volume per tree from the All Method Summary.
Net volume per hectare	Report the Net volume per hectare from the All Method Summary.
Slope	Report the slope from the All Method Summary.
Cruise Dates (yy/mm) oldest date on the tally cards:	Total # of Plots #</=5years #>5years #>10 years #No Date

14.3.2.4 Appraisal Summary Page – Insect Damage Table

Report the following attributes in a tabular format below the Lodgepole Pine Harvesting Method attributes on the Interior Appraisal Summary Page:

Cutting Permit PL green attack net merchantable volume (m^3)	This is the Pl insect code 1 (green attack) net merchantable volume reported in the "Cutting Permit Damage Summary (Insect) - All Treatment Unit" report.
Cutting Permit PL red attack net merchantable volume (m^3)	This is the Pl insect code 2 (red attack) net merchantable volume reported in the "Cutting Permit Damage Summary (Insect) - All Treatment Unit" report.
Cutting Permit PL grey attack net merchantable volume (m^3)	This is the Pl insect code 3 (grey attack) net merchantable volume reported in the "Cutting Permit Damage Summary (Insect) - All Treatment Unit" report.
All other species insect and defoliator attack net merchantable volumes	This is the sum of the non-Pl insect codes 1, 2, 3, 5, 6, 7, 8, X, Y beetle and defoliator net merchantable volume reported in the "Cutting Permit Damage Summary (Insect) - All Treatment Unit" reports. Do not include the "Normal" category in the sum of the net merchantable volume.
All other species insect and defoliator attack net merchantable volumes	This is the sum of the non-Pl insect codes 1, 2, 3, 5, 6, 7, 8, X, Y beetle and defoliator net merchantable volume reported in the "Cutting Permit Damage Summary (Insect) - All Treatment Unit" reports. Do not include the "Normal" category in the sum of the net merchantable volume.

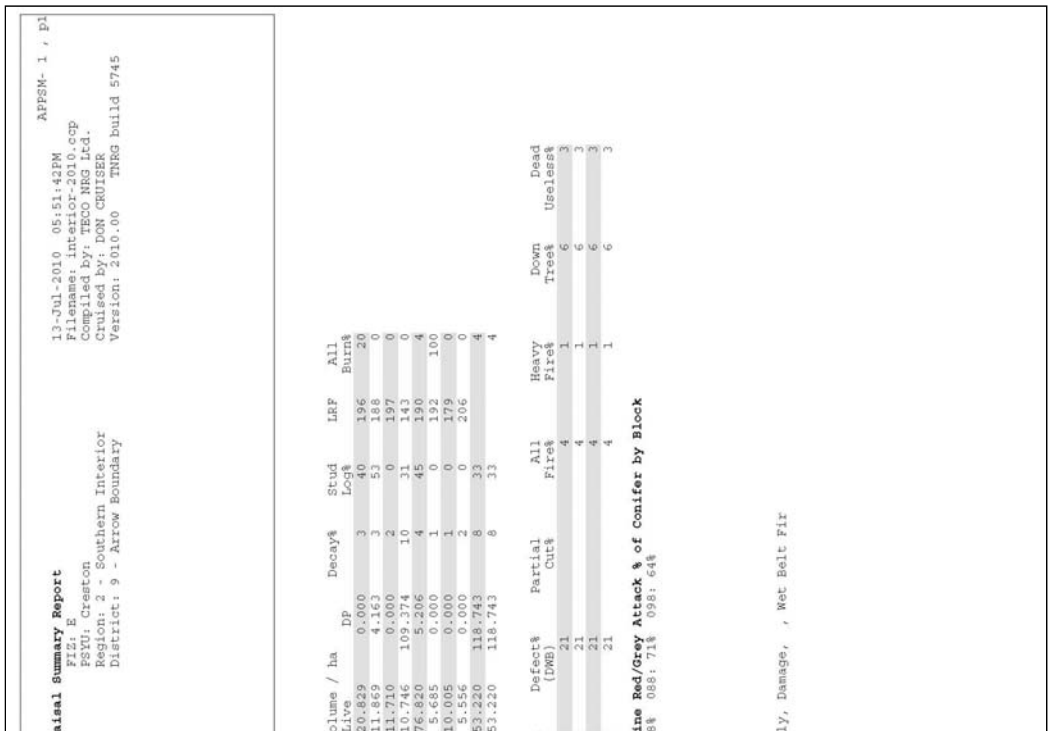
Refer to Figure 14.4 for the format of the new Interior Appraisal Summary page.

14.3.2.5 Appraisal Summary Page – Lodgepole Pine Insect Damage by Block

Report the following attributes in a tabular format beside the Insect Damage Table on the Interior Appraisal Summary Page:

Report the lodgepole pine (Pl) net volume percent in each block that is red and grey attack. Divide the Pl red and grey attack net volume in each block by the total coniferous volume in each block and multiply by 100. The volume is expressed as percent (%) to one decimal place.

14.4 Interior Appraisal Summary – Sample Listing



*** FOR APPRAISAL PURPOSES ***

Appraisal Summary Report

APPSM- 1 , pl

13-Jul-2010 05:51:42PM
Filename: interior-2010.cop
Compiled by: TEKO NRG Ltd.
Cruised by: DON CRUISER
Version: 2010.00 TNRG build 5745

Average Line Method
INTERIOR TEST 2010
Licence Number: TEST10 CP: INT
Project :
Location :

Grades: MOF Computerized
Computerized Decay
Computerized Waste
Computerized Breakage
No Of Blocks : 3

FIZ: E
PSYU: Creston
Region: 2 - Southern Interior
District: 9 - Arrow Boundary

Utilization Levels: Minimum DBH Top Diameter Stump Height

Mature Blocks: (cm)	17.5	10.0	30
Immature Blocks: (cm)	12.0	10.0	30
Exception(PL): (cm)	12.5	10.0	30

Standard Log Length:(m) 5.00

Net Area: [All Treatment Units : 22.0]

All Method Summary

Species Code	Description	Net Volume (m3) All	Live	DP	Net Volume / ha All	Live	DP	Decay%	Stud Log%	LRF	All Burn%
BA	Balsam	458	458	0	20.829	20.829	0.000	3	40	196	20
FI	Doug-Fir	353	261	92	16.032	11.869	4.163	3	53	188	0
HE	Hemlock	258	258	0	11.710	11.710	0.000	2	0	197	0
LO	Lodgepole Pine	4843	2436	2406	220.120	110.746	109.374	10	31	143	0
SP	Spruce	1805	1690	115	82.026	76.820	5.206	4	45	190	4
WB	Whitebark Pine	125	125	0	5.685	5.685	0.000	1	0	192	100
WH	Western White Pine	220	220	0	10.005	10.005	0.000	1	0	179	0
YE	Yellow Pine	122	122	0	5.556	5.556	0.000	2	0	206	0
	Conifer	8183	5571	2612	371.963	253.220	118.743	8	33		4
	Total	8183	5571	2612	371.963	253.220	118.743	8	33		4

Species	Harvest Method	Net Volume	Average Slope%	Net Vol /Tree	Net Vol/ha	Defect% (DWB)	Partial Cut%	All Fire%	Heavy Fire%	Down Tree%	Dead Useless%
All Species	SC	8183	10	0.58	371.963	21		4	1	6	3
	All Methods	8183	10	0.58	371.963	21		4	1	6	3
Conifer	SC	8183	10	0.58	371.963	21		4	1	6	3
	All Methods	8183	10	0.58	371.963	21		4	1	6	3

Harvesting Method Summaries

Insect Damage Net Volume (m3)

L.P. Pine Green Attack	L.P. Pine Red Attack	L.P. Pine Grey Attack	All Other Conifer Insect Damage
146	2290	2076	1335

L.P. Pine Red/Grey Attack % of Conifer by Block

078: 28% 088: 71% 098: 64%

Cutting Authority

95% Confidence Interval	28.5
Plots/Ha	0.5
Cruised Trees/Plot	6.5

FLAGS: Full Volumes, Normal Cruise, All Trees Compiled, Measure Plots Only, Damage, , Wet Belt Fir

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Figure 14.2 Interior Appraisal Summary – Sample Listing..

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Appendices

Appendix 1 Species Groupings

Use the following species for stump diameter conversion (Chapter 6), Taper equation coefficients (Chapter 7), and Harvesting Method Summaries (Chapter 13).

Species Reported	Species Codes Used
Alder	D, DR
Aspen	AT
Balsam	B, BA, BG, BL
Birch	E, EP, EN
Red Cedar	C, CW
Yellow Cedar	Y, Yc
Douglas Fir	F, FD
Hemlock	H, HW, HM
Larch	L, LL, LO, LT
Broadleaf Maple	MB
Lodgepole Pine	PL
White Pine	PW
Albicaulis Pine	PA
Yellow Pine	PY
Cottonwood	AC
Spruce	S, SB, SE, SS, SW

Use the following species groupings for all other summaries.

Species Reported	Species Codes Used	Species Reported	Species Codes Used
Alder	D, DR	Larch	L
Aspen	AT	- Tamarack	LT
Balsam	B	- Western	LO
- White Fir	BA	- Alpine	LL
- Grand Fir	BG	Broadleaf Maple	MB
- Mountain Fir	BL	White Pine	PW
Birch	E, EP, EN	Lodgepole Pine	PL
Red Cedar	C, CW	Albicaulis Pine	PA
Yellow Cedar	Y, YC	Yellow Pine	PY
Fir	F, FD	Cottonwood	AC
		Spruce	S
		- Sitka	SS
Hemlock	H	- Englemann	SE
- Western	HW	- White	SW
- Mountain	HM	- Black	SB

Appendix 2 Allowable Species By Forest Inventory Zone

		SPECIES															
FOREST INVENTORY ZONE		F	C	H	B	S	Y	Pw	Pl	Py	L	Ac	D	Mb	E	AT	Pa
	A	X	X	X	X	X	X	X	X	**C**	**H**	X	X	X	X	X	X
	B	X	X	X	X	X	X	X	X	**C**	**H**	X	X	X	X	X	X
	C	X	X	X	X	X	X	X	X	X	**D**	X	X	X	X	X	X
	D	X	X	X	X	X	X	X	X	X	X	X	**C**	**C**	X	X	X
	E	X	X	X	X	X	X	X	X	X	X	X	**C**	**C**	X	X	X
	F	X	X	X	X	X	**G**	X	X	X	X	X	**C**	**C**	X	X	X
	G	X	X	X	X	X	X	X	X	X	X	X	**C**	**C**	X	X	X
	H	X	X	X	X	X	**A**	X	X	**D**	X	X	**B**	**A**	X	X	X
	I	X	X	X	X	X	**J**	**H**	X	**G**	X	X	**J**	**A**	X	X	X
	J	**I**	X	X	X	X	X	**H**	X	**G**	**I**	X	X	**A**	X	X	X
	K	**I**	**J**	X	X	X	**J**	**H**	X	**G**	X	X	X	**A**	X	X	**A**
	L	**I**	**I**	**K**	X	X	**J**	**H**	X	**G**	X	X	**K**	**A**	X	X	**J**

X -indicates that the species may be found in the Forest Inventory Zone

When a species is not normally found in a FIZ a letter other than an X will be present. This letter represents the FIZ to use for calculating volume as well as Decay Waste and Breakage for the species.

When a letter other than an X is present it will initiate a warning message in the cruise compilation program.

Appendix 3 Allowable Pathological Remarks By Forest Inventory Zone

A3.1 Coast Immature

The following table is for immature trees in Forest Inventory Zones A, B & C.

Species	Conk	Blind Conk	Scars	Fork & Crook	Frost Crack	Mistle Toe	Rotten Branch	Dead Top
Douglas Fir	Y	Y	Y	Y	Y	Y	N	Y
Cedar	Y	Y	Y	Y	Y	N	N	Y
Yellow Cedar	Y	N	Y	Y	Y	N	Y	Y
White Pine	Y	Y	Y	Y	Y	N	Y	Y
Yellow Pine	Y	Y	Y	Y	Y	N	Y	Y
Larch	N	N	N	N	N	N	N	N
Cottonwood	Y	N	Y	Y	Y	N	Y	Y
Alder	Y	N	Y	Y	Y	N	Y	Y
Maple	Y	N	Y	Y	Y	N	Y	Y
Birch	Y	N	Y	Y	Y	N	Y	Y
Aspen	Y	N	Y	Y	Y	N	Y	Y
White Bark Pine	Y	Y	Y	Y	Y	N	Y	Y
Hemlock	Y	Y	Y	Y	Y	Y	Y	Y
Balsam	Y	Y	Y	Y	Y	Y	Y	Y
Spruce	Y	Y	Y	Y	Y	Y	Y	Y
Lodgepole Pine	Y	Y	Y	Y	Y	Y	Y	Y

"N" indicators will be included as warnings in the Edit Error Report. The "N" indicated samples would be allowed to process to completion.

A3.2 Coast Mature

The following table is for mature trees in Forest Inventory Zones A, B and C.

Species	Conk	Blind Conk	Scars	Fork & Crook	Frost Crack	Mistle Toe	Rotten Branch	Dead Top
Cedar	Y	Y	Y	Y	Y	N	Y	Y
Yellow Cedar	Y	N	Y	Y	Y	N	Y	Y
White Pine	Y	Y	Y	Y	Y	N	Y	Y
Yellow Pine	Y	Y	Y	Y	Y	N	Y	Y
Larch	N	N	N	N	N	N	N	N
Cottonwood	Y	N	Y	Y	Y	N	Y	Y
Alder	Y	N	Y	Y	Y	N	Y	Y
Maple	Y	N	Y	Y	Y	N	Y	Y
Birch	Y	N	Y	Y	Y	N	Y	Y
Aspen	Y	N	Y	Y	Y	N	Y	Y
White Bark Pine	Y	Y	Y	Y	Y	N	Y	Y
Douglas Fir	Y	Y	Y	Y	Y	Y	Y	Y
Hemlock	Y	Y	Y	Y	Y	Y	Y	Y
Balsam	Y	Y	Y	Y	Y	Y	Y	Y
Spruce	Y	Y	Y	Y	Y	Y	Y	Y
Lodgepole Pine	Y	Y	Y	Y	Y	Y	Y	Y

"N" indicators will be noted as warnings in the Edit Error report. The "N" indicated samples would be allowed to process to completion.

A3.3 Interior Immature

The following table is for immature trees in Forest Inventory Zones D-L.

Species	Conk	Blind Conk	Scars	Fork & Crook	Frost Crack	Mistle Toe	Rotten Branch	Dead Top
Douglas Fir	Y	Y	Y	Y	Y	Y	N	Y
Cedar	Y	Y	Y	Y	Y	N	N	Y
Hemlock	Y	Y	Y	Y	Y	N(1)	Y	Y
Yellow Cedar	Y	N	Y	Y	Y	N	Y	Y
White Pine	Y	Y	Y	Y	Y	N	Y	Y
Yellow Pine	Y	Y	Y	Y	Y	N	Y	Y
Cottonwood	Y	N	Y	Y	Y	N	Y	Y
Alder	N	N	N	N	N	N	N	N
Maple	N	N	N	N	N	N	N	N
Birch	Y	N	Y	Y	Y	N	Y	Y
Aspen	Y	N	Y	Y	Y	N	Y	Y
White Bark Pine	Y	Y	Y	Y	Y	N	Y	Y
Hemlock	Y	Y	Y	Y	Y	Y	Y	Y
Balsam	Y	Y	Y	Y	Y	Y	Y	Y
Spruce	Y	Y	Y	Y	Y	Y	Y	Y
Lodgepole Pine	Y	Y	Y	Y	Y	Y	Y	Y
Larch	Y	Y	Y	Y	Y	Y	Y	Y

(1) Yes for FIZ J only.

> "N" indicators will be noted as warnings in the Edit Error report. The "N" indicated samples would be allowed to process to completion.

A3.4 Interior Mature

The following table is for mature trees in Forest Inventory Zones D-L.

Species	Conk	Blind Conk	S cars	Fork & Crook	Frost Crack	Mistle Toe	Rotten Branch	Dead Top
Cedar	Y	Y	Y	Y	Y	N	Y	Y
Hemlock	Y	Y	Y	Y	Y	N(2)	Y	Y
Yellow Cedar	Y	N	Y	Y	Y	N	Y	Y
White Pine	Y	Y	Y	Y	Y	N	Y	Y
Yellow Pine	Y	Y	Y	Y	Y	N	Y	Y
Larch	Y	Y	Y	Y	Y	N(1)	Y	Y
Cottonwood	Y	N	Y	Y	Y	N	Y	Y
Alder	N	N	N	N	N	N	N	N
Maple	N	N	N	N	N	N	N	N
Birch	Y	N	Y	Y	Y	N	Y	Y
Aspen	Y	N	Y	Y	Y	N	Y	Y
White Bark Pine	Y	Y	Y	Y	Y	N	Y	Y
Douglas Fir	Y	Y	Y	Y	Y	Y	Y	Y
Hemlock	Y	Y	Y	Y	Y	Y	Y	Y
Balsam	Y	Y	Y	Y	Y	Y	Y	Y
Spruce	Y	Y	Y	Y	Y	Y	Y	Y
Lodgepole Pine	Y	Y	Y	Y	Y	Y	Y	Y

(1) Zones K and L only

(2) Yes for FIZ J only.

> "N" indicators will be noted as warnings in the Edit Error report. The "N" indicated samples would be allowed to process to completion.

Appendix 4 Maximum Height by Forest Inventory Zone

FOREST INVENTORY ZONE	SPECIES																
		F	C	H	B	S	Y	Pw	Pl	Py	L	Ac	D	Mb	E	At	Pa
	A	81	81	81	78	81	60	72	42	42	45	72	45	36	36	42	33
	B	90	81	81	78	81	60	72	42	42	45	72	45	36	36	36	33
	C	81	81	81	78	90	60	72	42	42	54	72	45	36	36	36	33
	D	60	54	54	51	60	42	53	42	42	54	54	45	36	42	42	33
	E	72	60	60	57	57	42	60	42	48	60	54	45	36	42	42	33
	F	72	60	60	57	57	42	60	42	48	60	54	45	36	42	42	33
	G	72	60	60	57	57	42	60	42	48	60	54	45	36	42	42	33
	H	60	54	54	54	54	60	42	42	42	45	54	45	36	42	33	33
	I	60	54	54	54	54	54	42	42	48	45	54	33	36	42	42	33
	J	60	54	54	54	60	54	42	42	48	45	60	33	36	42	42	33
	K	60	54	54	54	60	54	42	42	48	54	60	33	36	42	42	33
	L	60	54	54	45	54	54	42	42	48	36	54	33	36	42	42	33

Minimum height is 3 m.

Appendix 5 Maximum Age by Forest Inventory Zone

		S P E C I E S															
FOREST INVENTORY ZONE		F	C	H	B	S	Y	Pw	Pl	Py	L	Ac	D	Mb	E	AT	Pa
	A	800	600	600	500	600	800	500	300	500	500	300	200	200	200	200	400
	B	800	600	600	500	600	800	500	300	500	500	300	200	200	200	200	400
	C	800	600	600	500	600	800	500	300	500	500	300	200	200	200	200	400
	D	500	400	400	400	400	800	500	300	500	500	300	200	200	200	200	400
	E	500	400	400	400	400	800	500	300	500	500	300	200	200	200	200	400
	F	500	400	400	400	400	800	500	300	500	500	300	200	200	200	200	400
	G	500	400	400	400	400	800	400	300	500	500	300	200	200	200	200	400
	H	500	400	400	400	400	800	500	300	500	500	300	200	200	200	200	400
	I	500	400	400	400	400	800	500	300	500	500	300	200	200	200	200	400
	J	500	400	400	400	400	800	500	300	500	500	300	200	200	200	200	400
	K	500	400	400	400	400	800	500	300	500	500	300	200	200	200	200	400
	L	500	400	400	400	400	800	500	300	500	500	300	200	200	200	200	400

Minimum age is 40 years.

Appendix 6 Regions and District Numbers

Area	Natural Resource Region	FTAS Code	Number	Natural Resource District	Number	FTAS Code
COAST	South Coast	RSC	1	Chilliwack	01	DCK
				Sea to Sky (Squamish)	02	DSQ
				Sunshine Coast	03	DSC
	West Coast	RWC	2	South Island	04	DSI
				Campbell River	05	DCR
				North Island/Central Coast	06	DNI
				Haida Gwaii	07	DHG
SOUTH	Cariboo	RCB	3	Quesnel	01	DQU
				Cariboo Chilcotin (amalgamation)	02	DCC
				100 Mile	03	DMH
	Kootenay / Boundary	RKB	4	Selkirk (Arrow Boundary, Columbia, Kootenay Lake)	04	DSE
				Rocky Mountain	05	DRM
	Thompson / Okanagan	RTO	5	Thompson Rivers (Kamloops & part of Headwaters)	06	DKA
				Cascades	07	DCS
				Okanagan Shuswap	08	DOS
NORTH	Omineca	ROM	6	Prince George (+ part of Headwaters)	01	DPG
				Vanderhoof	02	DVA
				Fort St James	03	DJA
				MacKenzie	04	DMK
	Northeast	RNO	7	Fort Nelson	05	DFN
				Peace	06	DPC
	Skeena	RSK	8	Skeena Stikine	07	DSS
				Nadina	08	DND
				Coast Mountain (Kalum & N. Coast)	09	DKM

Re-organization has resulted in the amalgamation of several districts. District names not in brackets replace names in brackets where applicable.

Appendix 7 Lumber Recovery Factors

The following table lists the lumber recovery factors in board feet per cubic meter.

Log Top Diameter (cm)	Fir – Dry Belt	Fir – Wet Belt	Fir – QC1	Fir – QC2	Cedar	Hemlock	Balsam	Spruce	Yellow Cedar
4.5 – 5.49	91	91	100	91	91	91	91	91	91
5.5 – 6.49	102	103	109	100	97	102	103	103	102
6.5 – 7.49	111	113	118	109	103	111	113	113	111
7.5 – 8.49	120	123	128	119	108	120	123	123	120
8.5 – 9.99	129	134	139	130	115	129	134	134	129
10.0 – 14.9	151	156	170	160	132	151	158	158	151
15.0 – 19.9	172	185	217	206	156	172	185	185	172
20.0 – 24.9	187	202	246	234	177	187	202	202	187
25.0 – 29.9	199	217	266	251	197	199	217	217	199
30.0 – 34.9	210	226	279	262	215	210	226	226	210
35.0 – 39.9	217	234	287	270	227	217	234	234	217
40.0 – 44.9	222	240	292	275	235	222	240	240	222
45.0 – 49.9	228	246	297	279	238	228	246	246	228
50.0 – 54.9	233	252	299	281	239	233	252	252	233
55.0 – 59.9	237	258	302	282	239	237	258	258	237
60.0 – 64.9	240	263	302	282	237	240	263	263	240
65.0 – 69.9	241	266	303	281	233	241	266	266	241
70.0 – 74.9	240	267	302	280	228	240	267	267	240
75.0 – 79.9	237	265	302	279	223	237	265	265	237
80.0 – 84.9	234	263	301	277	217	234	263	263	234
85.0 – 89.9	231	261	298	275	210	231	261	261	231
90.0 – 94.9	227	259	297	273	201	227	259	259	227
95.0 – 99.9	224	257	295	272	193	224	257	257	224
100.0 +	221	254	295	269	184	221	254	254	221

Figure A.7a Lumber Recovery Factors.

For additional information please see Interior LRF Algorithms – A10.1 Interior Hemlock

All Balsam logs in trees with DWB summing 48% or over in the interior will have a LRF of zero. See Appendix A10.2 for information concerning dead white pine LRF. See Appendix A10.1 for information concerning hemlock LRF.

Log Top Diameter (cm)	White Pine	Lodgepole Pine	Yellow Pine	Larch	Cottonwood	Alder	Maple	Birch	Aspen	Whitebark Pine
4.5 – 5.49	91	91	91	91	91	91	91	91	91	91
5.5 – 6.49	102	103	103	103	103	103	103	103	103	103
6.5 – 7.49	111	113	113	113	113	113	113	113	113	113
7.5 – 8.49	120	123	123	123	123	123	123	123	123	123
8.5 – 9.99	129	134	134	134	134	134	134	134	134	134
10.0 – 14.9	151	158	158	158	158	158	158	158	158	158
15.0 – 19.9	172	185	185	185	185	185	185	185	185	185
20.0 – 24.9	187	202	202	202	202	202	202	202	202	202
25.0 – 29.9	199	217	217	217	217	217	217	217	217	217
30.0 – 34.9	210	226	226	226	226	226	226	226	226	226
35.0 – 39.9	217	234	234	234	234	234	234	234	234	234
40.0 – 44.9	222	240	240	240	240	240	240	240	240	240
45.0 – 49.9	228	246	246	246	246	246	246	246	246	246
50.0 – 54.9	233	252	252	252	252	252	252	252	252	252
55.0 – 59.9	237	258	258	258	258	258	258	258	258	258
60.0 – 64.9	240	263	263	263	263	263	263	263	263	263
65.0 – 69.9	241	266	266	266	266	266	266	266	266	266
70.0 – 74.9	240	267	267	267	267	267	267	267	267	267
75.0 – 79.9	237	265	265	265	265	265	265	265	265	265
80.0 – 84.9	234	263	263	263	263	263	263	263	263	263
85.0 – 89.9	231	261	261	261	261	261	261	261	261	261
90.0 – 94.9	227	259	259	259	259	259	259	259	259	259
95.0 – 99.9	224	257	257	257	257	257	257	257	257	257
100.0 +	221	254	254	254	254	254	254	254	254	254

Figure A.7b Lumber Recovery Factors.

For additional information please see Interior LRF Algorithms – A10.2 Dead Potential White Pine

Appendix 8 Removed

This Appendix has been removed.

Appendix 9 Coast Log Grade Algorithms

Explanatory Notes for Coast Metric Standing Tree Log Grading Flowcharts

1. The flowcharts contain logic for restricting the grade of logs with spiral grain.

   Spiral grain (cm.) = spiral grain code from cruise sheet * 3

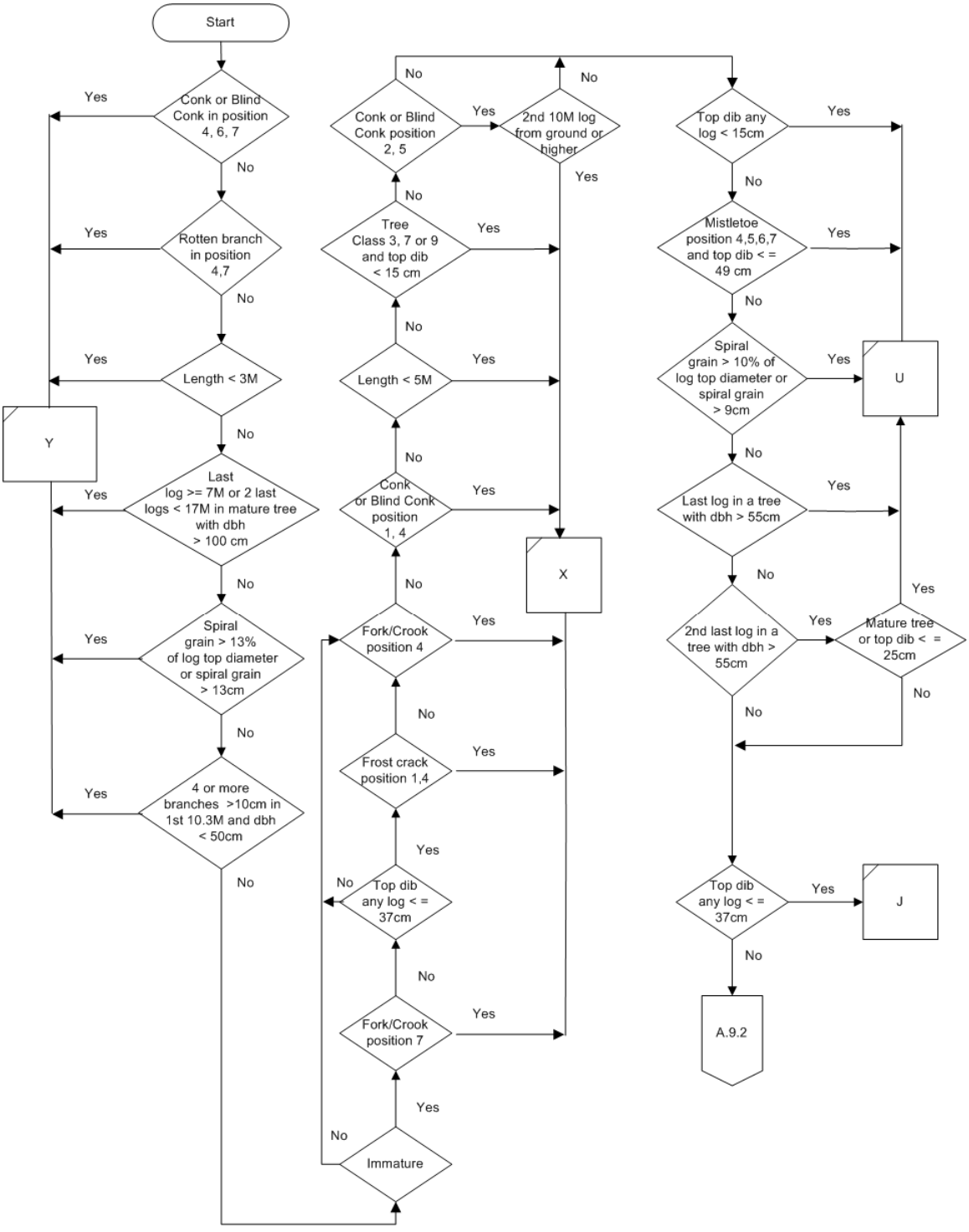
2. The test for two or more other pathological indicators in hemlock and balsam is restricted to the following indicators: frost crack, mistletoe, rotten branches, dead or broken top and scars with open and closed scars occurring together in the same tree counting as only one indicator.

3. The tests for two and three or more other pathological indicators in cypress are restricted to frost crack, fork or crook, rotten branches, dead or broken top and scars occurring together in the same tree counting as only one indicator.

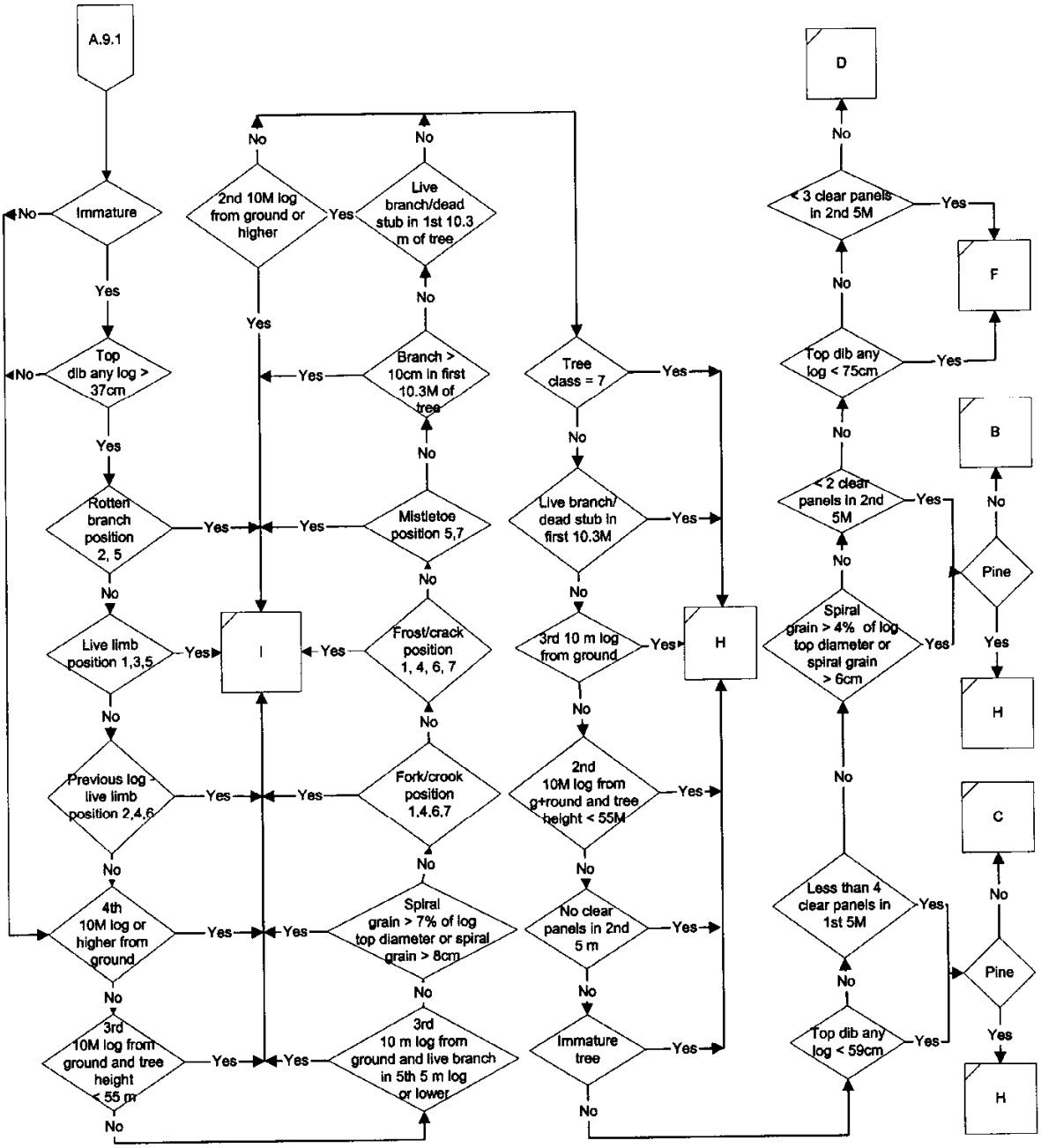
4. If the sum of the reported grade percents is not exactly 100 percent (due to rounding), then add or subtract from the grade with the highest percent to make the total 100 percent. If there is a tie for the largest grade percent, then adjust the grade letter that is first alphabetically from B to Y.

If D=33%, E=33% and F=33% - Adjust grade D to 34%.

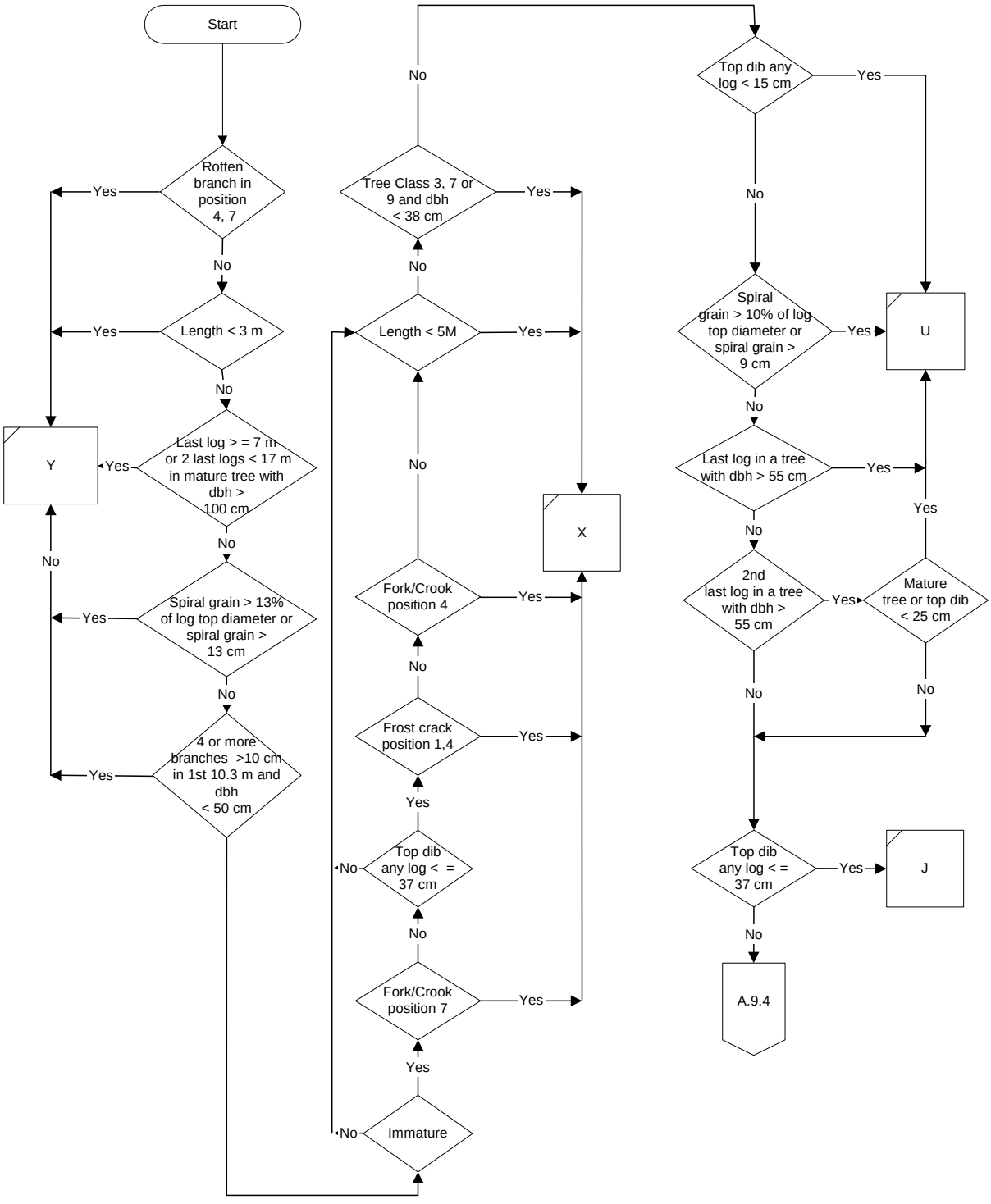
A9.1 Douglas Fir, Pine and Larch



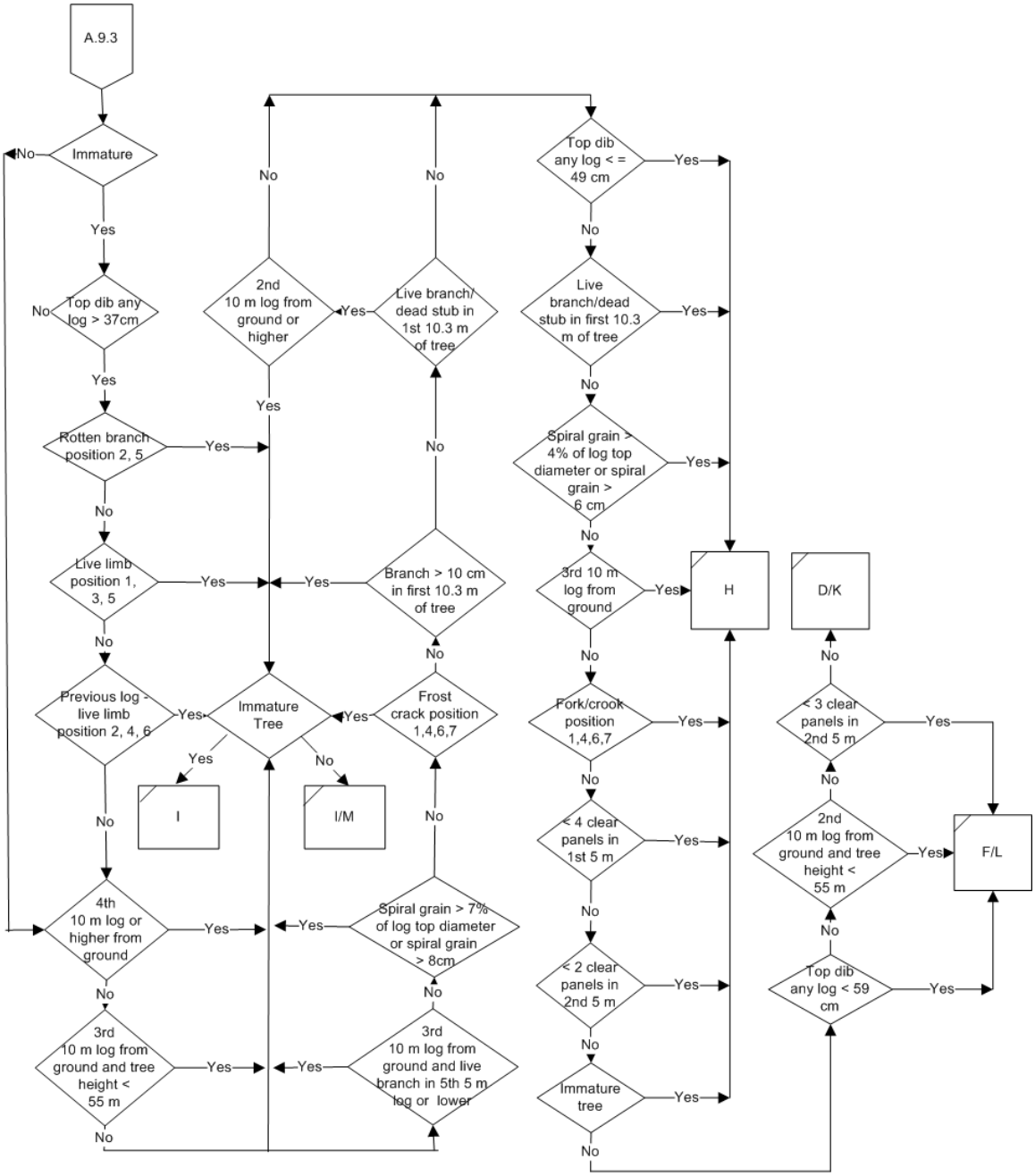
A9.2 Douglas Fir, Pine and Larch



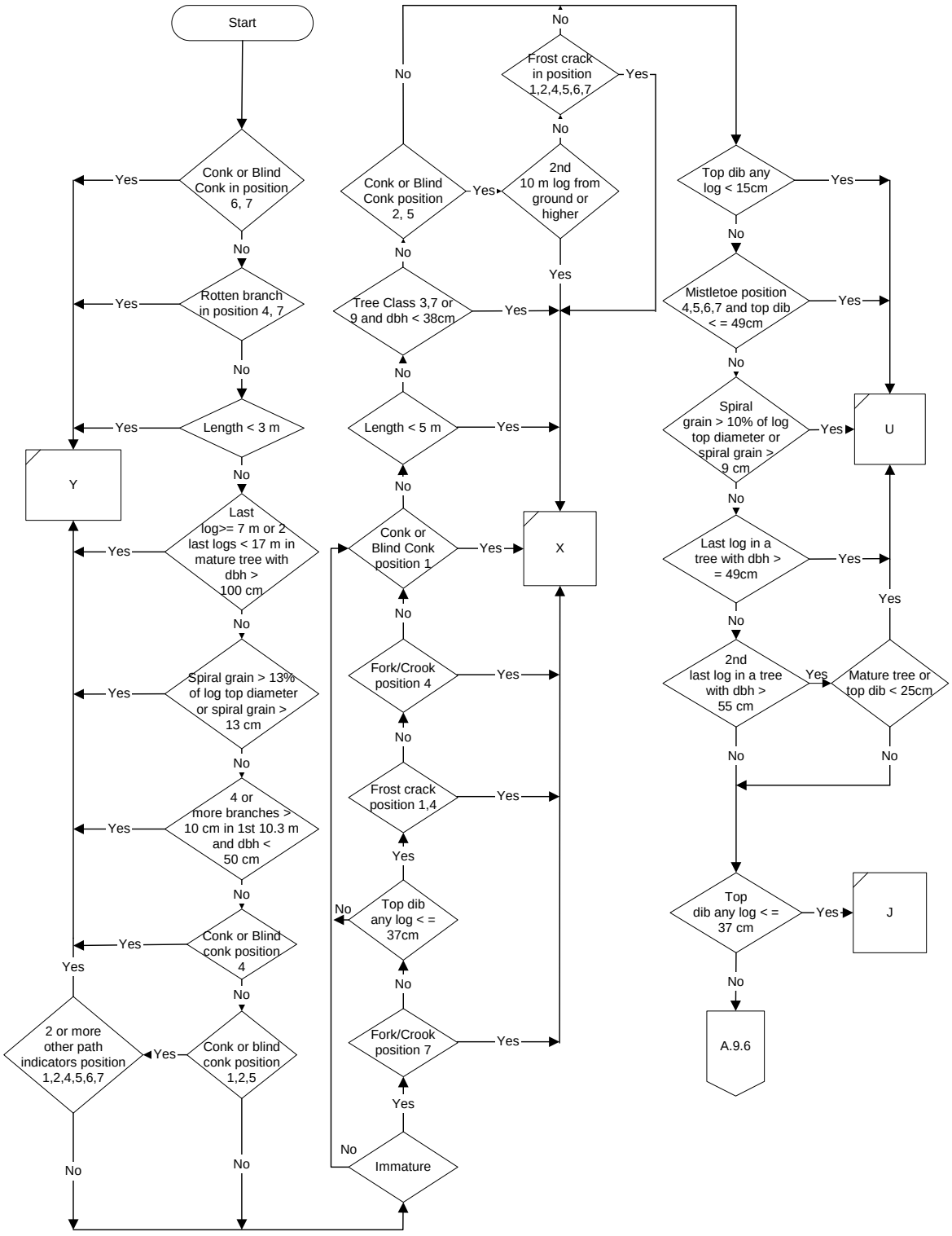
A9.3 Western Red Cedar



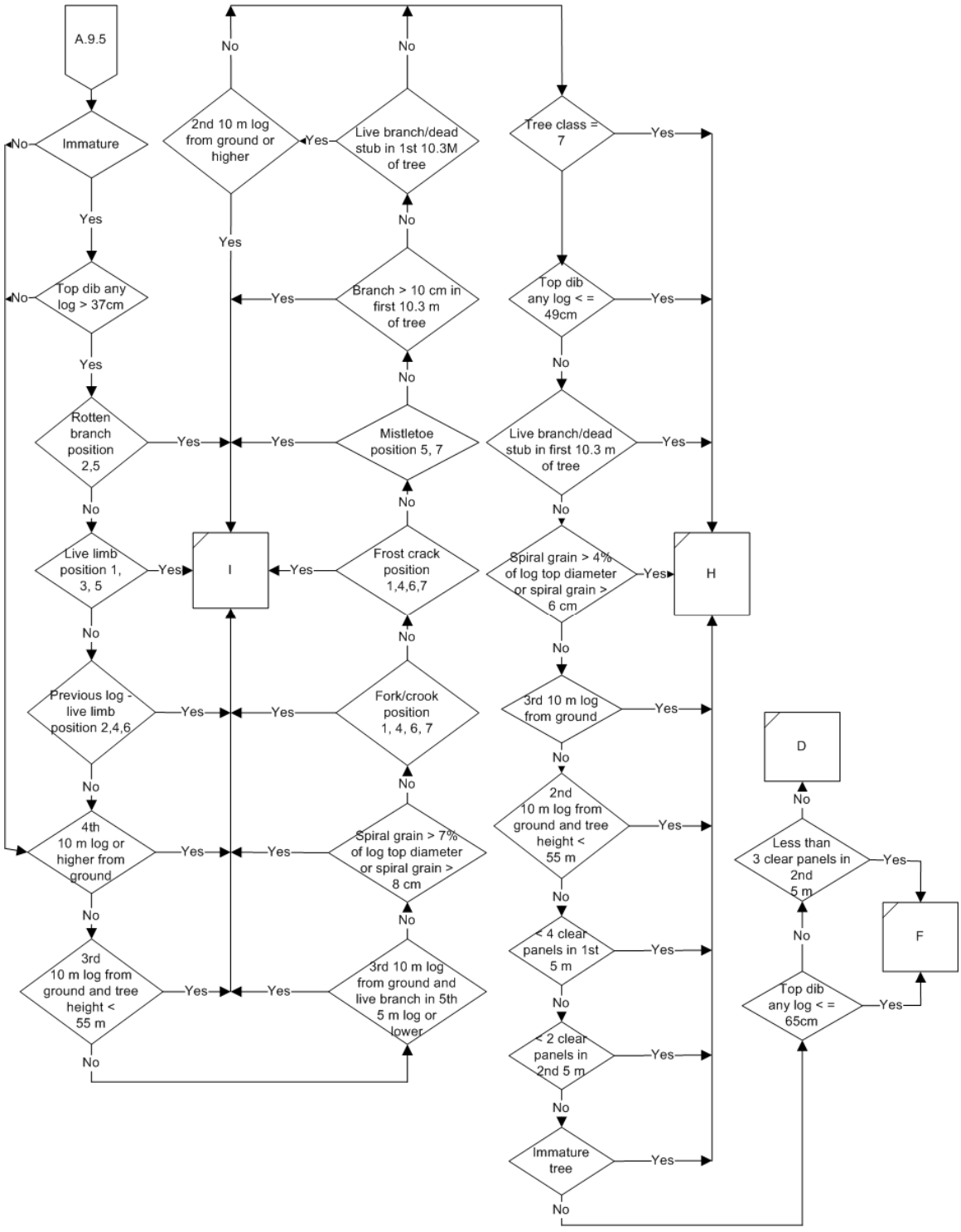
A9.4 Western Red Cedar



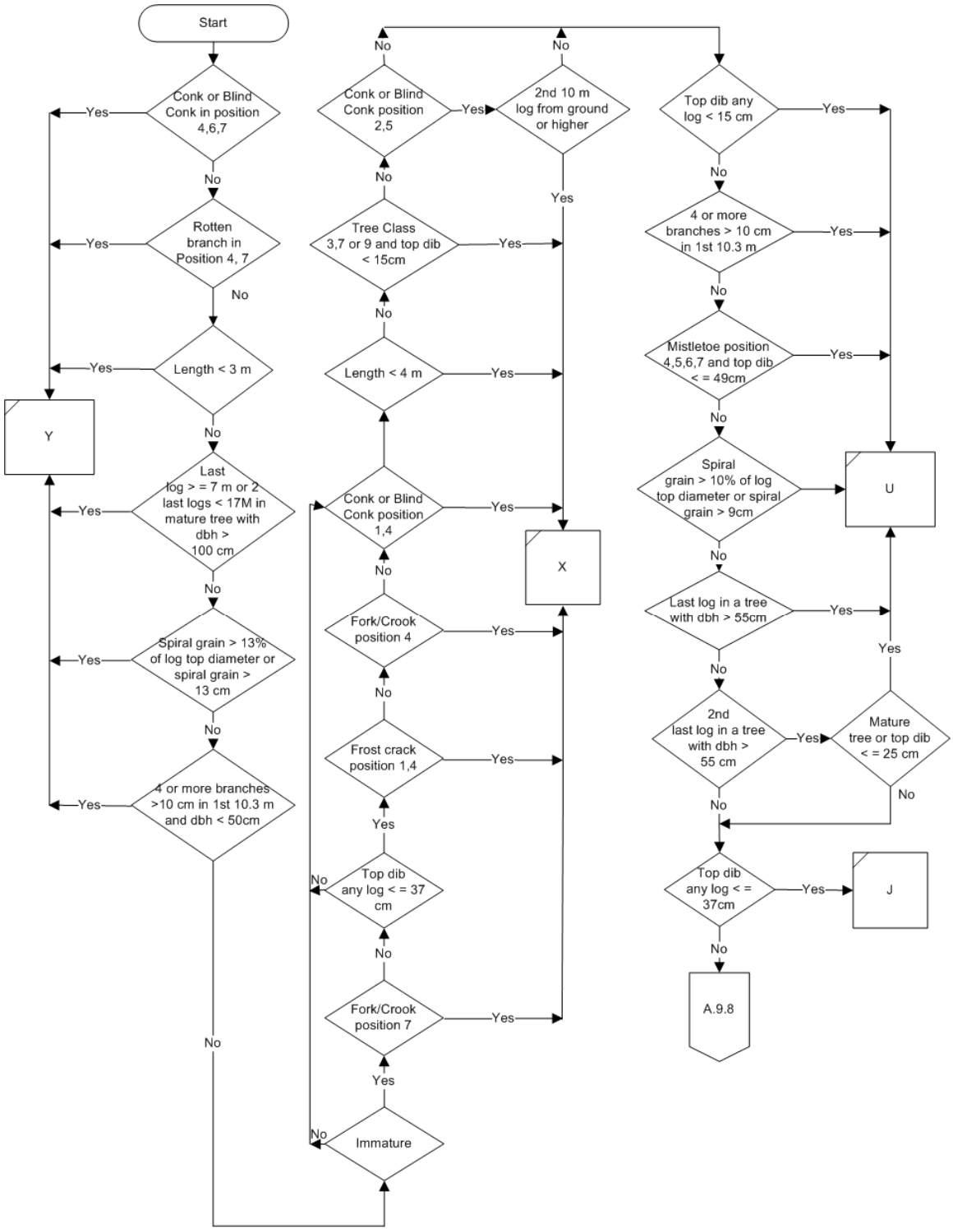
A9.5 Hemlock and Balsam



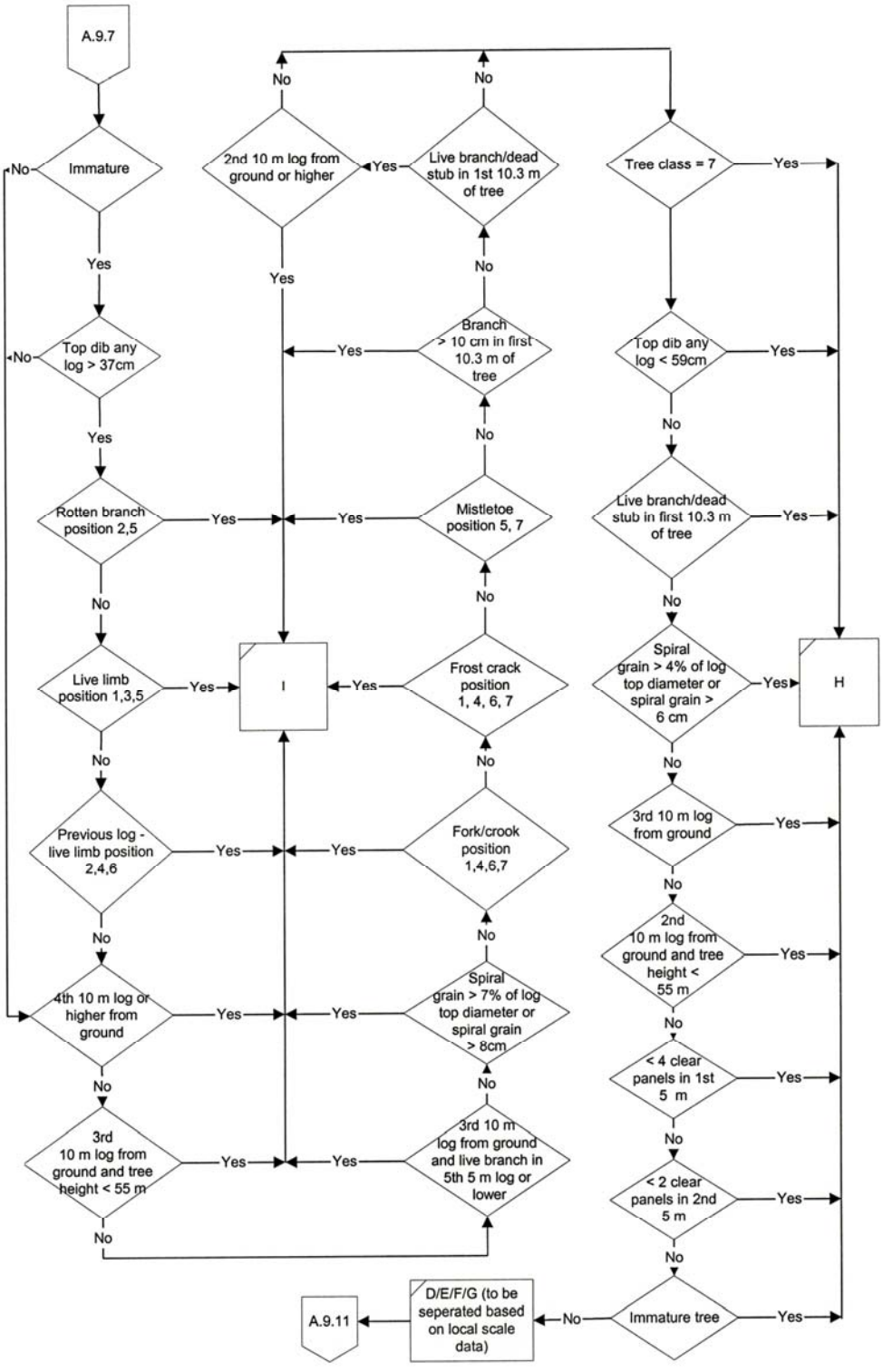
A9.6 Hemlock and Balsam



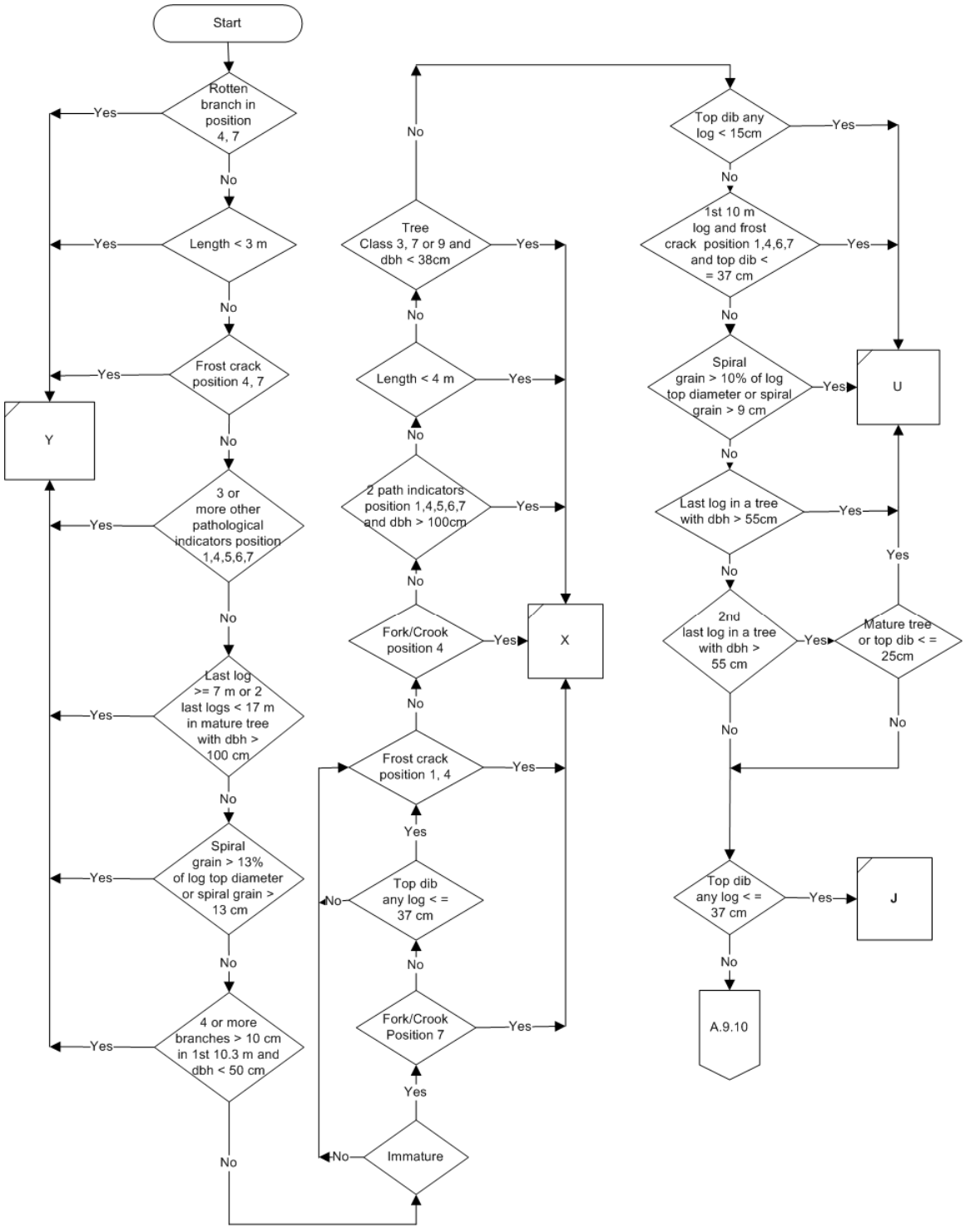
A9.7 Spruce


Start
Conk or Blind Conk in position 4,6,7
Yes
No
Rotten branch in Position 4, 7
Yes
No
Length < 3 m
Yes
No
Y
Last log > = 7 m or 2 last logs < 17M in mature tree with dbh > 100 cm
Yes
No
Spiral grain > 13% of log top diameter or spiral grain > 13 cm
Yes
No
4 or more branches >10 cm in 1st 10.3 m and dbh < 50cm
Yes
No
Conk or Blind Conk position 2,5
No
Yes
2nd 10 m log from ground or higher
No
Yes
Tree Class 3,7 or 9 and top dib < 15cm
No
Yes
Length < 4 m
No
Yes
Conk or Blind Conk position 1,4
No
Yes
X
Fork/Crook position 4
No
Yes
Frost crack position 1,4
Yes
No
Top dib any log < = 37 cm
No
Fork/Crook position 7
Yes
No
Immature
Top dib any log < 15 cm
No
Yes
4 or more branches > 10 cm in 1st 10.3 m
No
Yes
Mistletoe position 4,5,6,7 and top dib < = 49cm
No
Yes
Spiral grain > 10% of log top diameter or spiral grain > 9cm
No
Yes
U
Last log in a tree with dbh > 55cm
No
Yes
2nd last log in a tree with dbh > 55 cm
Yes
Mature tree or top dib < = 25 cm
No
Yes
No
Top dib any log < = 37cm
Yes
J
No
A.9.8

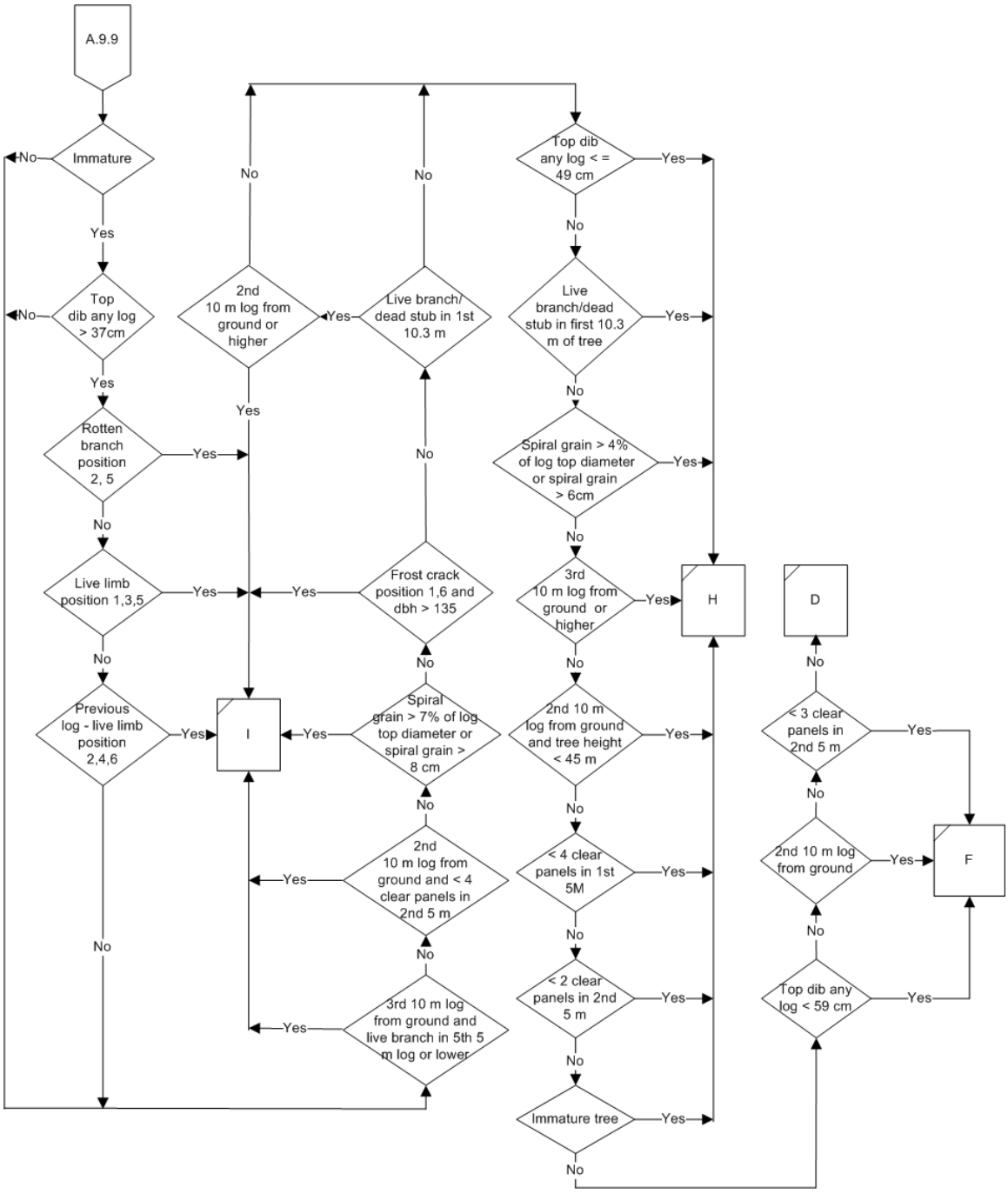
A9.8 Spruce


A.9.7
Immature
Top dib any log > 37cm
Rotten branch position 2,5
Live limb position 1,3,5
Previous log - live limb position 2,4,6
4th 10 m log or higher from ground
3rd 10 m log from ground and tree height < 55 m
2nd 10 m log from ground or higher
Live branch/dead stub in 1st 10.3 m of tree
Branch > 10 cm in first 10.3 m of tree
Mistletoe position 5, 7
Frost crack position 1, 4, 6, 7
Fork/crook position 1,4,6,7
Spiral grain > 7% of log top diameter or spiral grain > 8cm
3rd 10 m log from ground and live branch in 5th 5 m log or lower
I
Tree class = 7
Top dib any log < 59cm
Live branch/dead stub in first 10.3 m of tree
Spiral grain > 4% of log top diameter or spiral grain > 6 cm
3rd 10 m log from ground
2nd 10 m log from ground and tree height < 55 m
< 4 clear panels in 1st 5 m
< 2 clear panels in 2nd 5 m
Immature tree
H
D/E/F/G (to be seperated based on local scale data)
A.9.11
Yes
No

A9.9 Cypress


Start
Rotten branch in position 4, 7
Yes
No
Length < 3 m
Yes
No
Frost crack position 4, 7
Yes
No
Y
3 or more other pathological indicators position 1,4,5,6,7
Yes
No
Last log >= 7 m or 2 last logs < 17 m in mature tree with dbh > 100 cm
Yes
No
Spiral grain > 13% of log top diameter or spiral grain > 13 cm
Yes
No
4 or more branches > 10 cm in 1st 10.3 m and dbh < 50 cm
Yes
No
Tree Class 3, 7 or 9 and dbh < 38cm
Yes
No
Length < 4 m
Yes
No
2 path indicators position 1,4,5,6,7 and dbh > 100cm
Yes
No
Fork/Crook position 4
Yes
X
No
Frost crack position 1, 4
Yes
Yes
Top dib any log < = 37 cm
No
No
Fork/Crook Position 7
Yes
Yes
Immature
No
Top dib any log < 15cm
Yes
No
1st 10 m log and frost crack position 1,4,6,7 and top dib < = 37 cm
Yes
No
Spiral grain > 10% of log top diameter or spiral grain > 9 cm
Yes
U
No
Last log in a tree with dbh > 55cm
Yes
Yes
No
2nd last log in a tree with dbh > 55 cm
Yes
Mature tree or top dib < = 25cm
No
No
Top dib any log < = 37 cm
Yes
J
No
A.9.10

A9.10 Cypress



A9.11 Percentages within Spruce Grades

Natural Resource District	D	E	F	G
Campbell River	8	3	32	57
Chilliwack	0	0	0	100
South Island	10	23	3	64
Coast Mountain	7	21	18	54
North Island - Central Coast	19	17	22	42
Haida Gwaii	14	19	9	58
Sea to Sky	30	8	10	52
Sunshine Coast	0	0	0	100

Source of the table is the Coast Grade Distribution Report 2014-04-01 to 2016-03-31.

Mature spruce logs (greater than 120 years based on the age in 10s and tree class) will be separated into D, E, F and G grades where appropriate.

Example: In the Campbell River District when a log reaches the D/E/F/G decision box 8% of the log net volume will be deemed to be D grade, 3% will be deemed to be E grade, 32% will be deemed to be F grade and 57% will be deemed to be G grade.

A9.12 Percentages within Cedar Grades

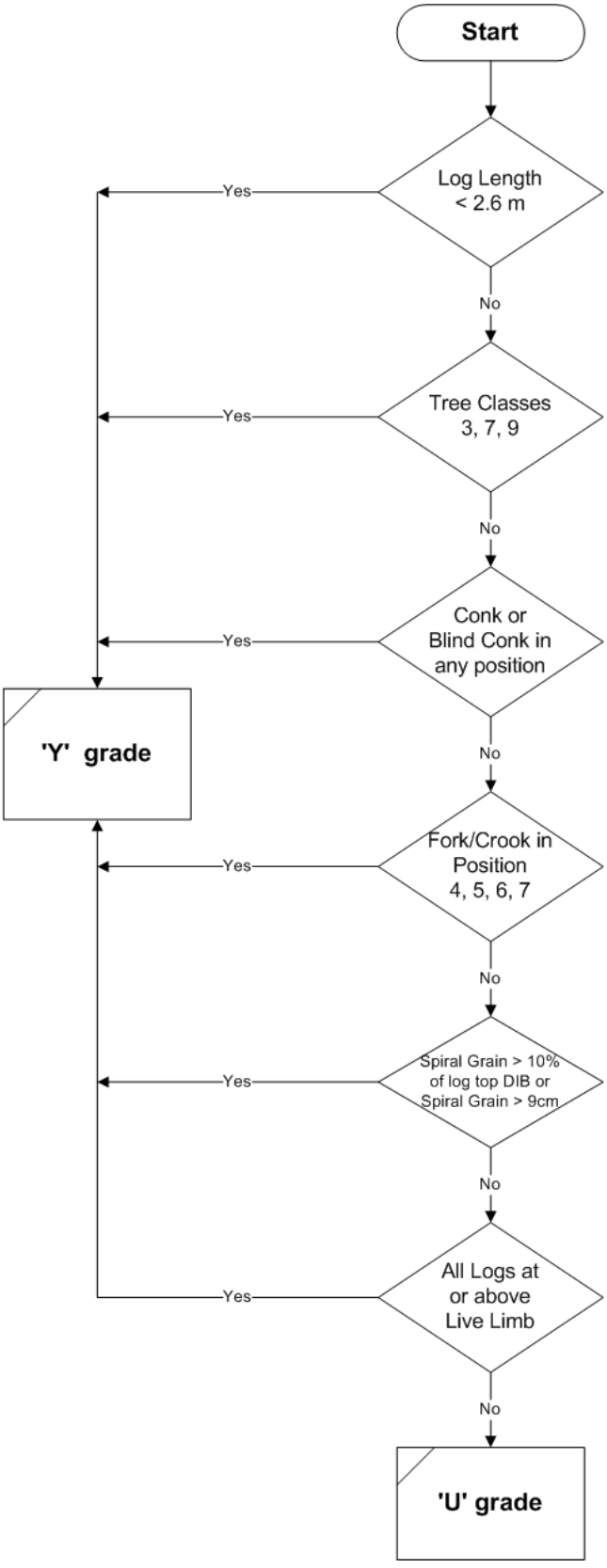
Natural Resource District	D	F	I
	K	L	M
Campbell River	**37** 63	**10** 90	**65** 35
Chilliwack	**23** 77	**8** 92	**64** 36
South Island	**40** 60	**15** 85	**70** 30
Coast Mountain	**28** 72	**14** 86	**75** 25
North Island - Central Coast	**35** 65	**11** 89	**68** 32
Haida Gwaii	**26** 74	**14** 86	**72** 28
Sea to Sky	**20** 80	**5** 95	**67** 33
Sunshine Coast	**27** 73	**10** 90	**82** 18

Source of the table is the Coast Grade Distribution Report 2014-04-01 to 2016-03-31.

Immature red cedar logs (up to 120 years old based on the age in 10s and tree Classes) flow only into the I-grade where appropriate. Mature red cedar (greater than 120 years based on the age in 10s and tree class) will be separated into I and M grades where appropriate.

Example: In the Campbell River District when a log reaches the D/K decision box, 37% of the log net volume will be deemed to be D grade and 63% will be deemed to be K grade.

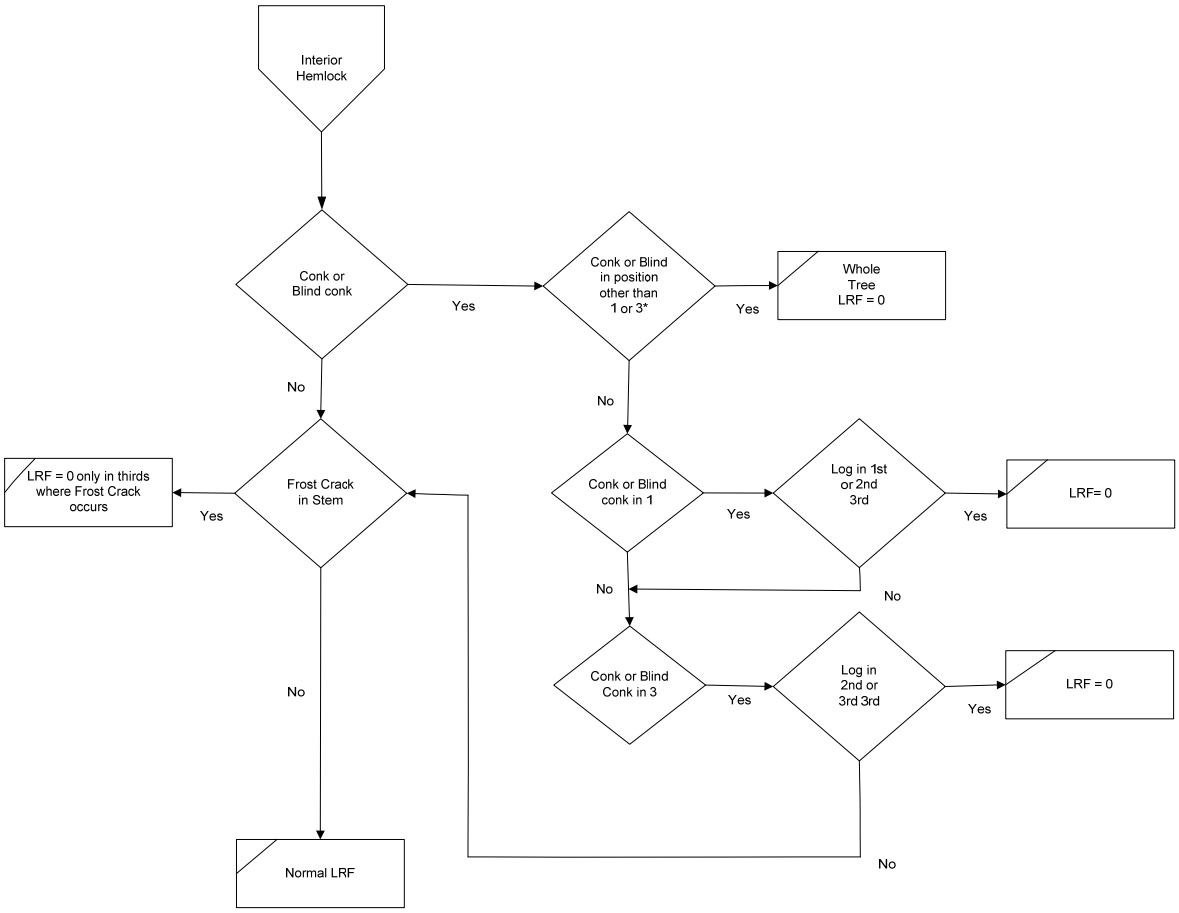
A9.13 Deciduous



Appendix 10 Interior LRF Algorithms

A10.1 Interior Hemlock

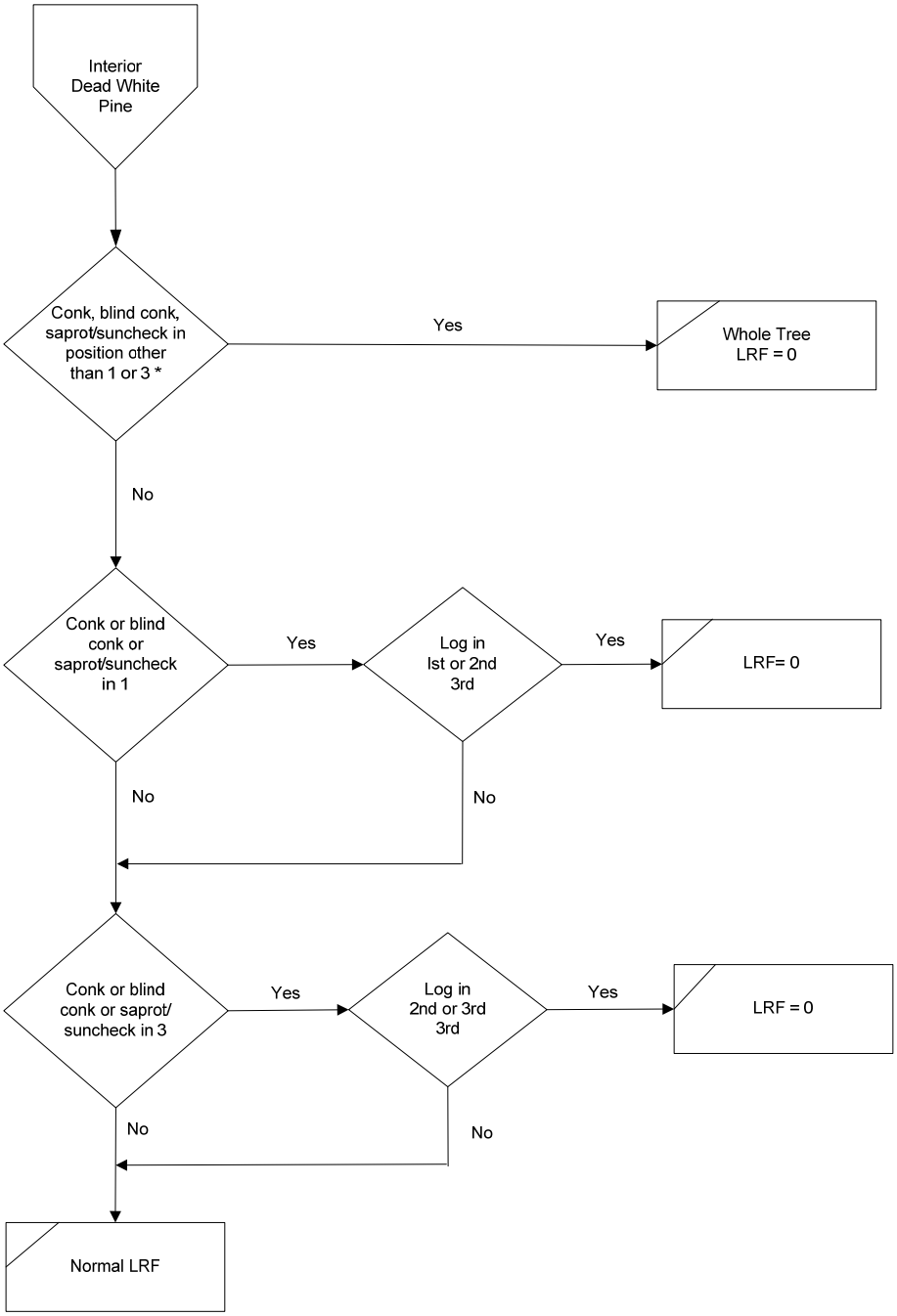
The use of Appendix A10.1 is mandatory for Interior Hemlock.



Pathological codes are required for tree classes 3, 7 and 9 for Hemlock in the Interior.

* Any combination of 1 and 3, of the pathological indicators in question, in the first decision box indicates a yes answer.

A10.2 Dead Potential White Pine



Pathological codes are required for White Pine tree classes 3, 7 and 9 in the Interior.

* Any combination of 1 and 3, of the pathological indicators in question, in the first decision box indicates a yes answer.

A10.3 Allocation of Path in Thirds

1. See table below for allocation of path in thirds to the log.
2. Spiral grain is collected as per the *Cruising Manual* (at 5 m).
3. Sap rot checks are collected by thirds and recorded in root rot column.

No. of	Path Location						
Logs	1	2	3	4	5	6	7
1	1	1	1	1	1	1	1
2	1	1	2	1	2	1,2	1,2
3	1	2	3	1,2	2,3	1,3	1,2,3
4	1	2,3	4	1,2,3	2,3,4	1,4	1 to 4
5	1,2	3	4,5	1,2,3	3,4,5	1,2,4,5	1 to 5
6	1,2	3,4	5,6	1 to 4	3 to 6	1,2,5,6	1 to 6
7	1,2	3,4,5	6,7	1 to 5	3 to 7	1,2,6,7	1 to 7
8	1,2,3	4,5	6,7,8	1 to 5	4 to 8	1-3,6-8	1 to 8
9	1,2,3	4,5,6	7,8,9	1 to 6	4 to 9	1-3,7-9	1 to 9
10	1,2,3	4 to 7	8 to 10	1 to 7	4 to 10	1-3,8-10	1 to 10
11	1 to 4	5 to 7	8 to 11	1 to 7	5 to 11	1-4,8-11	1 to 11
12	1 to 4	5 to 8	9 to 12	1 to 8	5 to 12	1-4,9-12	1 to 12
13	1 to 4	5 to 9	10 to 13	1 to 9	5 to 13	1-4,10-13	1 to 13
14	1 to 5	6 to 9	10 to 14	1 to 9	6 to 14	1-5,10-14	1 to 14
15	1 to 5	6 to 10	11 to 15	1 to 10	6 to 15	1-5,11-15	1 to 15

Appendix 11 Student's "T" Table

This appendix shows the t-values used to calculate the 95 percent confidence interval for the given degree of freedom.

Degrees of Freedom	t-value
1	12.706
2	4.303
3	3.182
4	2.776
5	2.571
6	2.447
7	2.365
8	2.306
9	2.262
10	2.228
11	2.201
12	2.179
13	2.160
14	2.145
15	2.131
16	2.120
17	2.110
18	2.101
19	2.093
20	2.086
21	2.080
22	2.074
23	2.069
24	2.064
25	2.060
26	2.056
27	2.052
28	2.048
29	2.045
30	2.042
31-67	2.000
68-112	1.980
113+	1.960

Appendix 12 Wet and Dry Belt Douglas Fir BEC Zones

WET AND DRY BELT DOUGLAS FIR ZONES

WET AND DRY BELT DOUGLAS FIR ZONES		
	Biogeoclimatic Zone	**Biogeoclimatic Subzone and Variant**
Wet Belt	ICH (Interior Cedar Hemlock)	dw, dk, dm, mw, mm, mk, mc, wk, vk, vc
Code = 1	SBS (Sub-Boreal Spruce)	dh, dw, dk, mh, mw, mm, mk, mc, wk, vk
	IDF (Interior Douglas Fir)	mw, ww
	ESSF (Englemann Spruce - Subalpine Fir)	dc, dk, dv, mw, mv, mm, mk, mc, wv, wm, wk, wc, vc, vv
	SBPS (Sub-Boreal Pine - Spruce)	mk, dc, mc
Dry Belt	ICH (Interior Cedar Hemlock)	xw
Code = 2	IDF (Interior Douglas Fir)	undifferentiated, dk1, dk2, dm2, xh, xw, xm, dm1
	ESSF (Englemann Spruce - Subalpine Fir)	xc
	MS (Montane Spruce)	xk, dc, dk, dm, xv
	SBPS (Sub-Boreal Pine - Spruce)	xc
	PP (Ponderosa Pine)	xh, dh

If subzones are missing from the above listing, the general rule to apply is: very dry and dry subzones are Dry Belt; and moist, wet and very wet are Wet Belt.

Appendix 13 Volume Calculation

This appendix will demonstrate how to calculate the volume for a tree using Kozak's taper equation, and will provide the associated regression coefficients and inflexion points. The volume is calculated for three sections of the tree. Section 1 is the stump, section two is the merchantable volume, and section 3 is the top of the tree. Hence, by applying these steps, both the total volume and the merchantable volume are calculated.

The merchantable portion of the tree is between the stump height and the height where the merchantable top diameter is calculated. This portion is divided into logs based on the log length specified by the timber merchantability specifications.

The last merchantable log is generally shorter than the other logs. If the last log is less than 2.5 m, then add its length and volume to next to last log.

There are two equations that must be used in order to determine the volume of the tree. The first is the taper equation, used to determine the diameter inside bark at a specified height above the ground. The second equation calculates the volume of a log given an upper and lower height above the ground, with associated diameters.

Taper Equation

$$d_i = a_1 D^{a_2} a_3^{D} X^{exp}$$

Where:

d_i	=	diameter inside bark in cm. at height h_i from the ground
exp	=	$a_4 z^2 + a_5 \ln(z + 0.001) + a_6 \sqrt{z} + a_7(D/H) + a_8 e^z$
D	=	diameter at breast height in cm
X	=	$(1 - \sqrt{h_i/H}) / (1 - \sqrt{p})$
H	=	total height of tree in meters
h_i	=	height from ground in meters
z	=	h_i/H
p	=	inflection point, see the end of this Appendix
$a_1 \ldots a_8$	=	regression coefficients, see the end of this Appendix
ln	=	natural logarithm
e	=	2.718281828

Volume calculation

For logs <= 5 m:

$$V = C * L_1 [D_1/2 + 2D_2 + D_3 + 2D_4 + D_5/2]$$

For logs > 5 m:

$$V = C * L_2 [D_1/2 + 2D_2 + D_3 + 2D_4 + D_5 + 2D_6 + D_7/2]$$

Where:

V	=	volume of log in m^3
C	=	0.00005236
L_1	=	log length / 4
L_2	=	log length / 6
d_1	=	diameter inside bark at a given height from ground calculated using the Taper Equation
D_1	=	d_1^2

To determine the height intervals for log volume calculation, use the following method:

Set the 1st height as the butt end of the log and the last height as the top end of the log. Assign the other heights at equal intervals between the butt and top of the log.

Example

For a 5 m log whose butt starts at 0.3 m and top is 5.3 m up the tree:

Interval	Height	Diameter
1	0.30 m	d_1
2	1.55 m	d_2
3	2.80 m	d_3
4	4.05 m	d_4
5	5.30 m	d_5

For a 10 m log whose butt is 0.3 m and top is 10.3 m:

Interval	Height	Diameter
1	0.30 m	d_1
2	1.97 m	d_2
3	3.63 m	d_3
4	5.30 m	d_4
5	6.97 m	d_5
6	8.63 m	d_6
7	10.30 m	d_7

Substitute each of the heights into the taper equation to yield a corresponding diameter, d_I, then substitute these diameters into the appropriate volume equation to yield the volume of the log.

Steps for Calculating the Volume of a Tree

An example of the volume calculations for a single tree is given. The tree parameters are:

Species:	Cypress
DBH:	110.0 cm
Total height:	41.0 m
F.I.Z.	C
Stump height:	30 cm
Top diameter:	15.0 cm
Log length:	10 m

Step 1 Look up the appropriate regression coefficients, a_1, a_2,, a_8 and the inflection point, p. These parameters are dependent on species and Forest Inventory Zone. They are provided in the tables in the back of this Appendix.

Example for Cypress in F.I.Z C:

$p = 0.30$

$a_1 = 0.928138$

$a_2 = 0.945293$

$a_3 = 0.999206$

$a_4 = 0.301423$

$a_5 = -0.040792$

$a_6 = -1.235630$

$a_7 = 0.030743$

$a_8 = 0.672879$

Step 2 Determine the biological and gross merchantable volume.

2.1 Calculate the diameter inside bark at stump height using the Taper equation. Substitute the stump height for h_i. [If the resultant diameter is less than the specified top diameter, return 0 volume.]

Example A13.1

Solve the taper equation using 0.3 m as h_I (only 8 decimal places are shown).

$$X = (1 - \sqrt{0.3/41.0}) / (1 - \sqrt{0.3})$$

$$= (0.914460107\ldots) / (0.452277442\ldots)$$

$$= 2.021900767\ldots$$

$$Exp = a_4z^2 + a_5\ln(z + 0.001) + a_6\sqrt{z} + a_7(D/H) + a_8e^z$$

$$= 0.301423(0.30 / 41.0)^2 - 0.040792\ln((0.30 / 41.0) + 0.001)$$

$$- 1.235630\sqrt{0.3/41} + 0.030743(110.0 / 41.0)$$

$$+ 0.672879(2.718281828)^{0.30/41.0}$$

$= 0.849993$

$d_{30} = (0.928138(110.0)^{0.945293})(0.999206)^{110.0}(2.02190)^{0.849993}$

$= 131.604$

2.2 Calculate the diameter inside bark at stump height using the Taper equation. Substitute the stump height for h_i. [If the resultant diameter is less than the specified top diameter, return 0 volume.]

Example:

Using the Taper equation for height 36.1405 m, the calculated diameter is 14.99368 cm, which is within the allowable range for merchantable height.

2.3 Calculate the number of merchantable logs.

$$\#\text{ of logs} = \frac{\text{merchantble height.} - \text{stump height}}{\text{log length}} + 1$$

Truncate the trailing decimal points.

Example:

$$\#\text{ of logs} = \frac{(36.14 - 0.30)}{10.0} + 1$$

$= 3.58 + 1$

$= 3 + 1$

$= 4$

2.4 Calculate the length of the last log.

Last log = merch. Height – (# of logs –1) * log length – stump height

Generally speaking the last log will be shorter than the other logs.

Example:

Last log = 36.14 - (4 - 1)*10.0 - 0.30

= 6.14 - 0.30

= 5.84 m

If the last log is less than 2.5 m, then append it to the next to last log.

2.5 Calculate the top diameter of each merchantable log using the Taper equation and then, calculate the volume of the log using the appropriate volume equation, based on the length of the log.

Example:

Consider a tree with four merchantable logs, with the following top heights and top diameters.

Log #	Top Height	Top Diameter (Taper Equation)
1	10.3000 m	75.25 cm
2	20.3000 m	60.58 cm
3	30.3000 m	35.58 cm
4	36.1400 m	15.00 cm

For the 1st log, if the stump height is less than 30 cm, then use the volume of a cylinder formula to calculate the volume of the merchantable portion below 30 cm. Use the Taper equation and corresponding volume formula for the portion of the log above 30 cm. The total length of the 1st log would be the merchantability required length based on the Map Area Statement, with the butt end of the log starting at the specified stump height.

Example:

Calculate the below 30 cm portion using:

$C * d_{30}^2 * (0.30 - \text{stump height})$

Where C = 0.00007854

d_{30} = diameter at 30 cm

Volume of a Single Log:

Use the Taper equation to determine the 7 diameters for log # 1:

Position	h_i	d_i - taper equation	$D_i = d_i^2$
1	0.3000 m	131.60 cm	17318.56
2	1.9666 m	102.70 cm	10547.29
3	3.6333 m	92.18 cm	8497.15
4	5.3000 m	85.85 cm	7370.22
5	6.9666 m	81.42 cm	6629.22
6	8.6333 m	78.04 cm	6090.24
7	10.300 m	75.25 cm	5662.56

Volume of Log # 1:

$$V_1 = C * L_2 [D_1/2 + 2D_2 + D_3 + 2D_4 + D_5 + 2D_6 + D_7/2] = 0.00005236 * (10/6) * 74632.65 = 6.513 \text{ m}^3$$

The other 3 merchantable logs volumes are 3.659 m^3, 1.957 m^3 and 0.313 m^3 respectively.

Step 3 Calculate the stump volume.

If the stump height <= 30 cm, then:

$$\frac{\text{Stump volume}}{(30\text{cm \& below})} = C * d_{30}^2 * (\text{stump height})$$

Where C = 0.00007854

d_{30} = diameter at 30 cm

Example A13.2

Stump volume = $(0.00007854)*(0.30)*(131.60)^2 = 0.408\ m^3$

If the stump height is greater than 30 cm, then calculate the stump volume below 30 cm as shown above. Then, apply the appropriate log volume equation using the lower bound parameters (30 cm, d_{30}) and the upper bound parameters (stump height, diameter at stump height).

Step 4 Calculate the top volume.

Depending on the length of the log, apply the appropriate log volume equation using the lower bound parameters of (merch. height and top diameter) and the upper bound parameters of (total height and 0.0).

Example:

The log length is 41.0 - 36.14 = 4.86 m, so the volume equation for logs less than 5 m would be used.

5 diameters for top:

Position	h_i	d_i - taper equation	$D_i = d_i^2$
1	36.1405 m	15.00 cm	225.00
2	37.3553 m	10.74 cm	115.35
3	38.5702 m	6.71 cm	45.02
4	39.7850 m	3.07 cm	9.42
5	41.0000 m	0.00 cm	0.00

$V_{top} = C * L_1 [D_1/2 + 2D_2 + D_3 + 2D_4 + D_5/2] = 0.00005236 * (4.8595/4) * 407.06 = 0.026\ m^3$

Inflection Points

p

Species	F.I.Z. A, B & C	F.I.Z. D - J	F.I.Z. K & L
F	0.25	0.25	0.25
C	0.25	0.30	0.30
H	0.20	0.25	0.25
B	0.25	0.30	0.30
S	0.25	0.30	0.30
Y	0.30	0.30	0.30
PW	0.25	0.25	0.25
PL	0.25	0.25	0.25
PY	0.25	0.25	0.25
L	0.30	0.30	0.30
AC	0.25	0.25	0.25
D	0.30	0.30	0.30
MB	0.25	0.25	0.25
E	0.25	0.25	0.25
AT	0.20	0.20	0.20
PA	0.25	0.25	0.25

Regression Coefficients

a_1

Species	F.I.Z. A, B & C	F.I.Z. D - J	F.I.Z. K & L
F	1.012675	0.920840	0.920840
C	1.218296	1.033575	1.033575
H	0.830874	0.752027	0.752027
B	0.988964	1.008741	0.764353
S	0.924126	0.897311	0.897595
Y	0.928138	0.928138	0.928138
PW	0.868943	0.984019	0.984019
PL	0.774601	0.774601	0.793793
PY	0.856592	0.856592	0.856592
L	0.746827	0.746827	1.164819
AC	0.802839	0.802839	0.852579
D	0.718188	0.718188	0.718188
MB	0.802839	0.802839	0.852579
E	0.648830	0.648830	0.633306
AT	0.855966	0.855966	0.891641
PA	1.078961	1.078961	1.078961

a_2

Species	F.I.Z. A, B & C	F.I.Z. D - J	F.I.Z. K & L
F	0.899136	0.923867	0.923867
C	0.855983	0.896971	0.896971
H	1.005210	1.028970	1.028970
B	0.951803	0.916357	1.053220
S	0.950707	0.957090	0.957499
Y	0.945293	0.945293	0.945293
PW	0.976312	0.941322	0.941322
PL	1.040320	1.040320	1.049320
PY	0.936402	0.936402	0.936402
L	1.003900	1.003900	0.831995
AC	0.993776	0.993776	0.952969
D	1.052190	1.052190	1.052190
MB	0.993776	0.993776	0.952969
E	1.121390	1.121390	1.110510
AT	0.987014	0.987014	0.957835
PA	0.894083	0.894083	0.894083

a_3

Species	F.I.Z. A, B & C	F.I.Z. D - J	F.I.Z. K & L
F	1.000123	1.000568	1.000568
C	0.999921	0.999079	0.999079
H	0.999142	0.998660	0.998660
B	0.999789	1.001159	0.994711
S	0.999518	0.999370	0.998952
Y	0.999206	0.999206	0.999206
PW	0.999773	0.999700	0.999700
PL	0.996984	0.996984	0.995709
PY	1.002104	1.002104	1.002104
L	0.997233	0.997233	1.003909
AC	0.998974	0.998974	1.000477
D	0.997551	0.997551	0.997551
MB	0.998974	0.998974	1.000477
E	0.992077	0.992077	0.994733
AT	0.999828	0.999828	1.001450
PA	1.001749	1.001749	1.001749

a_4

Species	F.I.Z. A, B & C	F.I.Z. D - J	F.I.Z. K & L
F	0.968978	1.095560	1.095560
C	2.037620	1.598260	1.598260
H	1.770670	1.174800	1.174800
B	2.336270	1.415990	1.381630
S	1.750510	1.532270	1.110150
Y	0.301423	0.301423	0.301423
PW	1.676930	1.571030	1.571030
PL	0.745750	0.745750	0.583403
PY	0.566217	0.566217	0.566217
L	0.747048	0.747048	1.880250
AC	0.706093	0.706093	0.731911
D	0.599235	0.599235	0.599235
MB	0.706093	0.706093	0.731911
E	0.865974	0.865974	1.021680
AT	0.424473	0.424473	0.695143
PA	1.377540	1.377540	1.377540

a_5

Species	F.I.Z. A, B & C	F.I.Z. D - J	F.I.Z. K & L
F	-0.190913	-0.202191	-0.202191
C	-0.486492	-0.411541	-0.411541
H	-0.329190	-0.263576	-0.263576
B	-0.502311	-0.325671	-0.306534
S	-0.408021	-0.364679	-0.281544
Y	-0.040792	-0.040792	-0.040792
PW	-0.372195	-0.369344	-0.369344
PL	-0.130177	-0.130177	-0.077654
PY	-0.087141	-0.087141	-0.087141
L	-0.133729	-0.133729	-0.401856
AC	-0.096789	-0.096789	-0.084192
D	-0.033036	-0.033036	-0.033036
MB	-0.096789	-0.096789	-0.084192
E	-0.106757	-0.106757	-0.141481
AT	-0.037553	-0.037553	-0.039652
PA	-0.286807	-0.286807	-0.286807

a_6

Species	F.I.Z. A, B & C	F.I.Z. D - J	F.I.Z. K & L
F	0.825961	0.967329	0.967329
C	2.632080	2.402420	2.402420
H	2.185610	2.233330	2.233330
B	4.154490	2.793270	2.637080
S	2.659000	2.741210	2.125100
Y	-1.235630	-1.235630	-1.235630
PW	2.567510	2.703200	2.703200
PL	0.558818	0.558818	-0.036267
PY	-0.063450	-0.063450	-0.063450
L	0.397110	0.397110	3.082780
AC	0.312724	0.312724	0.196339
D	-0.261339	-0.261339	-0.261339
MB	0.312724	0.312724	0.196339
E	0.257139	0.257139	0.641499
AT	-0.517540	-0.517540	-0.603404
PA	1.038780	1.038780	1.038780

a_7

Species	F.I.Z. A, B & C	F.I.Z. D - J	F.I.Z. K & L
F	0.048766	0.081696	0.081696
C	0.109094	0.094283	0.094283
H	0.105050	0.045184	0.045184
B	0.086560	0.108427	0.163996
S	0.092651	0.117756	0.148340
Y	0.030743	0.030743	0.030743
PW	0.071928	0.049628	0.049628
PL	0.198687	0.198687	0.142531
PY	0.071720	0.071720	0.071720
L	0.078345	0.078345	0.276300
AC	0.119634	0.119634	0.148285
D	0.215536	0.215536	0.215536
MB	0.119634	0.119634	0.148285
E	0.254574	0.254574	0.258921
AT	0.102211	0.102211	0.193706
PA	0.072537	0.072537	0.072537

a_8

Species	F.I.Z. A, B & C	F.I.Z. D - J	F.I.Z. K & L
F	-0.426214	-0.514604	-0.514604
C	-1.486550	-1.252170	-1.252170
H	-1.192970	-1.002020	-1.002020
B	-2.186240	-1.326790	-1.292080
S	-1.396760	-1.362760	-1.005560
Y	0.672879	0.672879	0.672879
PW	-1.340830	-1.334700	-1.334700
PL	-0.324178	-0.324178	-0.022523
PY	0.051415	0.051415	0.051415
L	-0.183542	-0.183542	-1.661550
AC	-0.080057	-0.080057	-0.069852
D	0.123059	0.123059	0.123059
MB	-0.080057	-0.080057	-0.069852
E	-0.149926	-0.149926	-0.359508
AT	0.303931	0.303931	0.209159
PA	-0.647372	-0.647372	-0.647372

Appendix 14 Diameter Classes

Assign a DBH class by determining the DBH range that the tree is in as per the table below:

DBH Class	Tree DBH Range (cm)
10	7.5 - 12.4
15	12.5 - 17.4
20	17.5 - 22.4
25	22.5 - 27.4
30	27.5 - 32.4
35	32.5 - 37.4
40	37.5 - 42.4
45	42.5 - 47.4
50	47.5 - 52.4
55	52.5 - 57.4
60	57.5 - 62.4
65	62.5 - 67.4
70	67.5 - 72.4
75	72.5 - 77.4
80	77.5 - 82.4
85	82.5 - 87.4
90	87.5 - 92.4
95	92.5 - 97.4
100	97.5 - 102.4
105	102.5 - 107.4
110	107.5 - 112.4
115	112.5 - 117.4
120	117.5 - 122.4
125	122.5 - 127.4
130	127.5 - 132.4
135	132.5 - 137.4
140	137.5 - 142.4
145	142.5 - 147.4
150	147.5 - 162.4
175	162.5 - 187.4
200	187.5 - 212.4
225	212.5 - 237.4
250	237.5 - 262.4
275	262.5 +

Appendix 15 Volume Constants

The following tables are indexed by Species, Maturity and Forest Inventory Zone. They are used to determine the S.E.E. and Bias for volume for height-curve calculations (see Chapter 7).

Volume Constant A, B and C

Species	Maturity	F.I.Z.	A	B	C
Douglas Fir	Immature	A, B, C	-4.319071	1.81382	1.042420
Douglas Fir	Mature	A, B, C	-4.348375	1.69244	1.181970
Douglas Fir	All	D – L	-4.383102	1.74294	1.156410
Red Cedar	Immature	A, B, C	-4.139118	1.71677	1.047420
Red Cedar	Mature	A, B, C	-4.103107	1.74324	0.981729
Red Cedar	All	D – L	-4.178431	1.75995	1.019080
Hemlock	Immature	A, B, C	-4.418820	1.86778	1.099890
Hemlock	Mature	A, B, C	-4.337451	1.78350	1.120230
Hemlock	All	D – L	-4.394633	1.94290	0.990275
Balsam	All	A, B, C	-4.266202	1.78296	1.103820
Balsam	All	D – L	-4.291919	1.87293	0.998274
Spruce	Immature	A, B, C	-4.310416	1.82284	1.057290
Spruce	Mature	A, B, C	-4.368545	1.64699	1.282450
Spruce	All	D – L	-4.294193	1.85859	1.007790
Yellow Cedar	All	A – L	-4.187127	1.77736	1.032990
White Pine	All	A – L	-4.300522	1.85780	1.022250
Lodgepole Pine	All	A – L	-4.349504	1.82276	1.108120
Albicaulis Pine	All	A – L	-4.300522	1.85780	1.022250
Yellow Pine	All	A – L	-4.482485	1.95443	1.016770
Larch	All	A – L	-4.350486	1.71236	1.135270
Cottonwood	All	A – L	-4.648431	1.73518	1.356010
Alder	All	A – L	-4.431705	1.89057	1.090770
Maple	All	A – L	-4.536696	1.90785	1.120160
Birch	All	A – L	-4.443142	1.90956	1.052050
Aspen	All	A – L	-4.419728	1.89476	1.053730

Appendix 16 Rounding

Round all reported parameters to the specified number of significant digits from this manual. Use the normal rules for rounding (i.e. digits 0 - 4 are rounded down and digits 5 - 9 are rounded up). For example if a parameter is to be reported to one decimal place, then:

825.123 would round to 825.1, whereas
825.158 would round to 825.2

In cases where a reported parameter is based on summing or weighting the parameters of previously reported parameters, then save all the intermediate calculations to the maximum precision and round at the end. For example, the gross total volumes for 2 types in a cutting permit are as follows:

825.123 would round to 825.1, whereas
825.158 would round to 825.2

Type 1	5555.423	would round to 5555
Type 2	4444.423	would round to 4444
	9999.84	would round to 10000

In other words, the cutting permit total would be 10000, not 9999.

Throughout the manual the sample calculations will show all the necessary digits for intermediate calculations. It is assumed that any intermediate calculation that is not shown in this manual uses an adequate number of significant digits to carry the precision to result in the values used in the sample calculations that are shown. Whenever constants, e.g., pi, are used in this manual, use the constants as shown.

Use the following rules to determine how many decimal places are required for intermediate calculations.

Addition and Subtraction

Save the resultant sum or difference with the maximum precision in the operands used.

Multiplication

Add the number of decimal places for each of the operands used in the calculation.

Division, Square Root, Exponential and Logarithm

Carry enough decimal places to achieve the required precision for the output value. For example, if the output value is reported to 1 decimal place, the program variable should be accurate to 2 decimal places to produce accurate rounded numbers.

Appendix 17 Mathematical Notation

Subscripts:

In x_d the d means that x can take on different forms or values. Putting in a particular value of d tells which form or value of x we are concerned with. The d may be a particular characteristic of an individual tree. The term x_1 might be the height of the tree, x_2 might be its' DBH. Or the subscript might imply a particular tree. In this case, x_1 could be the height of the first tree and x_2 the height of the second tree. Which meaning is intended will usually be clear in the text.

A variable (say x) will often be identified in more than one way. Multiple classification is accomplished with more subscripts. In $x_{d,u}$ the d might identify the characteristic (for height, d = 1: for DBH, d = 2). The u could identify which individual we are dealing with. Then $x_{2,7}$ would tell us that we are dealing with the DBH (d = 2) of the seventh tree (u = 7). If the individuals are from different groups we can use another subscript (say h).

The symbol $x_{d,u,h}$ would indicate the dth characteristic of the uth individual of the hth group.

Summations:

To indicate that several (say 6) values of a variable (x) are to be added together we could write $\sum_{d=1}^{6} x_d$. In words this tells us to sum all values of x_d, letting d go from 1 up to 6.

The symbol $\sum$ indicates that a summation should be performed. The x is what should be summed and the values above and below the $\sum$ indicate the limits over which the subscript d will be allowed to vary.

Brackets:

The equation $\sum_{d}\left(\sum_{u} x_{d,u}\right)$ says that for each value of d we should first add up the $x_{d,u}$ over all values of u. Then add these up over all values of d.

If the range of d is from 1 to 3 and the range of u is 1 to 4 then:

$$\sum_{d=1}^{3}\left(\sum_{u=1}^{4} x_{d,u}\right) = (x_{1,1} + x_{1,2} + x_{1,3} + x_{1,4}) + (x_{2,1} + x_{2,2} + x_{2,3} + x_{2,4}) + (x_{3,1} + x_{3,2} + x_{3,3} + x_{3,4}).$$

Appendix 18 Interior Fir Quality Class Algorithm

This is computed on a tree by tree basis.

Quality Class 1

- No conk,
- no blind conk,
- no scars in lower third,
- no forks or crooks in lower two thirds,
- no frost cracks in lower third,
- no rotten branches greater than 10 cm in diameter in lower third,
- no dead or broken top, and
- no $\left(\frac{\text{DBH (cm)}}{\text{Height (cm)}}\right)$ ratio less than 1:48.

Quality Class 2

- Trees of lower quality than those above, and
- tree class 3, 4, 6, 7 and 9 trees.

Appendix 19 Valid Compilation Versions

- The valid compilation versions are listed at the following site:

  http://www.for.gov.bc.ca/hva/manuals/validcompversions.htm
  http://www.for.gov.bc.ca/hva/manuals/cruisecompilation.htm

Appendix 20 CGNF Compilation for the Coast Forest Region

For the Coast Forest Region, the effective date is January 1, 2007.

The CGNF Compilation for the Coast Forest Region is available at:

http://www.for.gov.bc.ca/hva/manuals/cgnfcompilation.htm

Glossary

Average Line Method	A calculation method that utilizes all the plots within a timber type regardless of whether all those plots are in the same block or harvest method.
Basal Area	The area in m^2 that each tree in a cruise plot represents on a per hectare basis. For example, each tree in a variable radius plot using a BAF 10 prism represents $10m^2$/ha of basal area.
Basal Area Factor	Factor assigned to a prism diopter, which determines the stems and basal area per hectare estimates for each tree tallied in a plot.
Bias	A systematic error between the calculated values and actual values. Bias can be either positive or negative.
Biological Volume	Volume of a tree from the ground to the top.
Block	An enclosed area within a Cutting Permit.
Block Method	A calculation method that only utilizes plots from within a Block or Harvesting Method.
Board Foot	A volume of lumber equal to 12 inches by 12 inches by 1 inch.
Bone Dry Unit	A measure of chip recovery for a given volume of merchantable wood.
Chip Yield	Amount of chips, expressed in bone dry units, obtained from a given volume of lumber.
Coast Compilation	A cruise compilation that will be compiled for a coast stumpage appraisal. http://www.for.gov.bc.ca/hva/manuals/coast.htm .
Coefficient of Variation	The standard deviation expressed as a percentage of the mean.
Cull	Decay, waste, and breakage volume combined.

Cut Tree	A tree that will be felled.
Cutting Permit	Total area assessed in a compilation.
DBH	The diameter at breast height measured on a tree at 1.3 m above the high side of the ground.
DBH Class	A range of DBH values used to group trees together.
Dead Potential	A dead tree with at least 50% sound wood fiber remaining.
Degree of Freedom	A value used in the lookup of the T-Table. It is the number of measurements used, n, minus the number of statistics already derived from the observations, and used in the calculations.
Diameter Conversion	A method of estimating the DBH based on the stump diameter.
Double Sampling Ratio	A factor applied in the cruise compiliation to adjust the basal area, stems per hectare and other cruise parameters when count and measure plots are used in a compilation.
Grade	A qualitative assessment of a log.
Harvesting Method	Method used to harvest a cutting permit.
Height-diameter Curve	A regression model used to estimate heights from DBH.
Inflection Point	Point where a curve changes from concave to convex or vise versa.
Interior Compilation	A cruise compilation that will be compiled for an interior stumpage appraisal. http://www.for.gov.bc.ca/hva/manuals/interior.htm
Large Log	A log whose top diameter is 30 cm or greater.
Leave Tree	A tree that will not be felled.
Loss Factor	Amount reduced from the gross volume to give the net volume of a tree. The three types of loss factors are decay, waste and breakage.
Lumber Recovery Factor	The amount of lumber recovery per cubic meter of net volume (i.e. board feet per cubic meter).
Maximum Age	Age limit for sample trees used for height-curve calculations.
Maximum DBH	The largest DBH that can be used in a height-diameter curve.

Maximum Height	The largest height that a height-diameter curve produces.
Merchantable Height	Height of a tree where the diameter is equal to the Top Diameter for utilization.
Merchantable Volume	The volume of a tree between the stump height and the merchantable height.
Minimum DBH	The smallest DBH that can be used in a height-diameter curve.
Old Growth	A mature stand that has never been felled.
Pathological Indicator	Codes found on tally sheet card type 2 which describe imperfections in a tree.
Plot	A sample of the cutting permit. The plot is used to estimate the compilation parameters on a 'per hectare' basis. The 'per hectare' value is multiplied by an area, which provides an estimate of the parameter total for that area. For example, a plot would estimate the number of stems per hectare. Multiplying by the area of the cutting permit would provide an estimate of the number of stems in the cutting permit.
Plot Size	For fixed area plots only. The plot size is the area of each plot to the nearest one hundredth of a hectare.
Plot Sweep	The size of the plot. A plot sweep can be full or border. For border plots, each tree tallied would count double towards the number of stems per hectare.
Reduction	A method of reducing the volume and stem estimates by assigning some trees as cut trees and some trees as leave trees.
Regression Coefficient	Coefficient that yields the 'line of best fit' for an equation, determined using linear or non-linear regression analysis.
Risk group	A Risk group is determined based on tree class, damage and pathological indicators. It helps determine the loss factors to apply to the gross volume of a tree.
ScatterGram	A type of graph that plots a collection of points, rather than a curve. For example, a graph which plots the measured heights over measured DBH.
Second Growth	Coniferous species tallied in a plot where the age in 10s is less than 15 or the tree class is 8 or 9. Tree classes 5 and 7 are never counted as second growth.

Silviculture Treatment Unit	An area allocated for a partial cut prescription (including a clear cut prescription).
Small Log	A log whose top diameter is less than 30 cm.
Snag	A useless tree having no potential for sound wood. Snags are coded tree class 4 (living) or 6 (dead).
Species Grouping	A set of species that will report using one species code in a report.
Standard Deviation	A measure of spread of observations around the mean.
Standard Error Estimate	A measure of spread or observations around a regression line.
Stem	A tree having potential for sound wood.
Stem Volume	See biological volume.
Stud Log	A log whose top diameter is less than 20 cm.
Stump Diameter	The measured diameter of a stump in cm, inside bark.
Stump Height	The measured height above the ground where a tree has been felled.
Stump Volume	Volume of a stump calculated using the volume of a cylinder formula.
Sub Plot	A method of differentiating between different sized trees in a plot.
'T' Table	A list of values used to determine the Confidence Interval given the Standard Error of the mean.
Taper Equation	Equation used to assign a diameter to a given height of a tree.
Timber Type	A stratification of the Cutting Permit, which identifies trees of differing quality and/or quantity.
Top Volume	Volume of the non-merchantable portion of a tree above the merchantable height.
Tree Class	A code assigned to a tallied tree based on the maturity, sound wood potential and whether the tree is still living or not.
UTM Co-ordinates	Universal Traverse Map co-ordinates. These co-ordinates specify a physical location for a cruise and are coded on the

	Map Area Statement - card type A.
Variance	The average of the squared deviation of observations from the mean.
Volume Constant	Regression coefficients used to determine the biological tree volume from DBH and tree height.

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