



REVENUE BRANCH

Cruise Compilation Manual

April 1, 2003

Unofficial Copy



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Highlights

2003 Change Descriptions

Section	Highlight
All Reports	Change the version number to 2003.0 in all programs.
All Reports	Delete the block method for April 2003 for appraisal cruises. For coastal mixed block utilization situations or if block reductions are required then assign unique types to each block. If the block method is selected, then all of the cruise compilation reports will be labelled "Not For Appraisal Purposes".
Chapter 2	Columns 19-20 from card type A cannot be left blank as Unit numbers may effect stumpage because of local DWB tables. The current informational message called for in the edits will be upgraded to a warning.
Chapter 2	Column 80 from card type B will accept an A to denote a 100% cruise. If this column is filled in then the area of types from card type D = plot size.
Chapter 2	For April 1, 2003 a warning message will be reported when dates aren't included on card type 9's.
Chapter 3	Note:Table 17, (Cruising Manual) Tree Class Modification of Loss Factor Tables will be revised for April 1, 2003.
Chapter 7	When the Parabola b and c coefficients are both positive, the Weibull function must not be used.
Chapter 7	<p>The following message must be printed on all height curve scattergrams:</p> <p>Major species height curves require a minimum of 20 samples, minor species a minimum of 10 samples and combined a minimum of 20 sample trees. Failure to meet these standards will result in rejection of the cruise.</p>
Chapters 11-12-13	On Forest Licence A57077 in the Bulkley TSA 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 each log in the tree. The average balsam LRF's will be lowered due to the prorating of the sawlog net volume over the total balsam net volume.

Section	Highlight
Chapter 13	The 015 report referred to in the past as the Appraisal Summary will be referred to as the All Method Summary to avoid confusion with the 016 Appraisal Summary that changed name from Cruise Summary, April 2002.
Chapter 13	The net volume per hectare will be reported to 3 decimal places on the All Method Summary.
Chapter 13	The Treatment Unit by Harvest Method and the Old growth/Second growth reports are not required for appraisal purposes after April 1, 2003.
Chapter 14	Appraisal Summaries are mandatory April 1, 2003.
Chapter 14	Include the Lodgepole Pine volume for Highlead/Grapple Harvest Methods on the Interior Appraisal Summary.
Chapter 14	Report net volume per tree, net volume per hectare and slope from the All Method Summary on the Appraisal Summaries.
Appendices 4-5	Changes in Appendix 4 and 5 will co-ordinate maximum heights and ages to agree with the changes in Appendix 2 from April 2002.
Appendix 6	The region and district codes are updated to reflect restructuring.
Appendix 9	The 2002 change descriptions allow all species to be compiled regardless of the FIZ that they occur in. Therefore the Larch genus will use the Fir/Pine coastal algorithm as of April 1, 2003.
Appendix 9	The Coastal Cedar and Spruce high grades are rolled up to represent the last two fiscal years scale grade production.
Appendix 10	The Allocation of Path in Thirds matrix will be expanded to accommodate a tree with greater than 60 metres merchantable height.
Appendix 10	The Allocation of Path in Thirds matrix for a stem with 5 logs will be corrected.

Section	Highlight
Appendix 10	An algorithm utilising conk, blind conk and saprot/sunchecks will be used for dead White Pine in licences A20193 and A20218.
Appendix 10	The Partition Hemlock log grade algorithm will be updated for clarification. Decision boxes will show all log thirds routing.
Appendix 10	Message: Pathological codes are required for tree classes 3,7 and 9 in interior Hemlock Partition and White Pine licences A20193 and A20218.

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Introduction

1

This manual outlines the Ministry of Forests' 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 Revenue 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/revenue/manuals/cruising/>.

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 is 80 characters wide and consists of one card type A, 1 or 2 card type B, 1 or more card type Cs, 1 or more card type D's, 0 or more card type E's, 1 to 10 card type F's 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 2's and 0 or more card type 3's.

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://www.for.gov.bc.ca/revenue/manuals/cruising/>.

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

```

ATL7070001002106CE86000100BD 00000125A 0000000000000 TEST 2000
CRUISER B
BTL7070001 00 13217503015010 A N
CTL7070001 01F H C Y 941M200050
CTL7070001 02F B 440M20005000025
DTL70700010010100025 0200025 M
DTL70700010020100025 020002500025 M
FTL7070001 SC0100050 0200050
FTL7070001 SS0200000000025
GTL7070001CLEARCUT SELECTION
9TL70700010010101O011342M 12000B175 SC0602010
2TL70700010010101O01134201410Y 11005 7 3 4300 E
2TL70700010010101O01134202480F 121024 5400 G
2TL70700010010101O01134203522F 13101 5402
2TL70700010010101O01134204499B 07992 432 3122
2TL70700010010101O01134205388H 08001 4300
2TL70700010010101O01134206398F 04551 4144
2TL70700010010101O01134207400C 08601 5300
2TL70700010010101O01134208355C 03558 4144
9TL70700010010107O011442M 12000B175 SC0602010
2TL70700010010107O01144201355Y 04751 3116
2TL70700010010107O01144202422B 10102 4 4301 1BG
2TL70700010010107O01144203388H 09552 4 4202
2TL70700010010107O01144204395S 04991 3122 6AE
2TL70700010010107O01144205322S 04558 2144
2TL70700010010107O01144206455F 09882 4 3124 5CE
2TL70700010010107O01144207355C 12104
2TL70700010010107O01144208352H 06556
2TL70700010010107O01144209429F 14371 4400
2TL70700010010107O01144210590F 15951 4400
2TL70700010010107O01144211450Y 09003 4400
2TL70700010010107O01144212250Y 03703 2201
9TL70700010010103O021442M 12000B175 SC0502010

```

Figure 2.1a Input File (page 1).

2TL70700010010103O02144201455F 08551	4300
2TL70700010010103O02144202488F 03459	4124
2TL70700010010103O02144203389H 09997	2322
2TL70700010010103O02144204499S 12005	6500
2TL70700010010103O02144205572F 14505	6500
9TL70700010010196O021442M 12000F175	SC0502010
2TL70700010010196O02144201455F 08551	4300
2TL70700010010196O02144202488F 03459	4124
2TL70700010010196O02144203389H 09997	3322
2TL70700010010196O02144204499S 12005	6500
2TL70700010010196O02144205389H 09997	4322
2TL70700010010196O02144206499S 12005	6500
9TL70700010020104O011342M 12000F175	SC0802011
2TL70700010020104O01134201398F 085524	5400
2TL70700010020104O01134202422H 07551	4300
2TL70700010020104O01134203366H 06888	4201
2TL70700010020104O01134204102F 10331	6400
2TL70700010020104O01134205245C 03229	1144
9TL70700010020195O011342M 12000F175	SC0802011
2TL70700010020195O01134201398F 085524	5400
2TL70700010020195O01134202422H 07551	4300
2TL70700010020195O01134203366H 06888	4201
2TL70700010020195O01134204102F 10331	6400
2TL70700010020195O01134203366H 06888	4201
2TL70700010020195O01134204102F 10331	6400
9TL70700010020201O021342M 12000F175	SC0502011
2TL70700010020201O02134201455F 08995	4 4124
2TL70700010020201O02134202420H 07551	5303
2TL70700010020201O02134203435B 05522 2	6400
2TL70700010020201O02134204398C 08631	5401
2TL70700010020201O02134205449F 07881	5402
2TL70700010020201O02134206398Y 05562	4 5312
9TL70700010020202O021542M 10000H175	SS0902011
2TL70700010020202O02154201452F 10155	5400
2TL70700010020202O02154202355C 12001	6300
2TL70700010020202O02154203254H 02998	3124
2TL70700010020202O02154204368B 03558	2144

Figure 2.1b Input File (Page 2).

BRITISH COLUMBIA		MAP AREA STATEMENT		CRUISE COMPILATION	
FOREST REGION		DATE COMPLETED		Y M D	
CODED BY		CRUISING SUPERVISOR		COMPANY OR AGENCY	
CRUISE IDENTITY CARD		LOCALITY DESCRIPTION		CRUISE OR AGENCY	
TOTAL MEASURED AREA (hectares)		NORTH		EAST	
SALETYPE		QUOTA		TENURE	
ELEVATION (metres)		UNIT IDENTITY		UNIT NO.	
BLOCK		TYPE		F.ZONE	
FOREST DISTRICT		FOREST REGION		NO. OF BLOCKS	
CUTTING PERMIT NO.		LICENCE NO.		DUPLICATE FROM ABOVE	
1		2		3	
4		5		6	
7		8		9	
10		11		12	
13		14		15	
16		17		18	
19		20		21	
22		23		24	
25		26		27	
28		29		30	
31		32		33	
34		35		36	
37		38		39	
40		41		42	
43		44		45	
46		47		48	
49		50		51	
52		53		54	
55		56		57	
58		59		60	
61		62		63	
64		65		66	
67		68		69	
70		71		72	
73		74		75	
76		77		78	
79		80		81	
82		83		84	
85		86		87	
88		89		90	
91		92		93	
94		95		96	
97		98		99	
100		101		102	
103		104		105	
106		107		108	
109		110		111	
112		113		114	
115		116		117	
118		119		120	
121		122		123	
124		125		126	
127		128		129	
130		131		132	
133		134		135	
136		137		138	
139		140		141	
142		143		144	
145		146		147	
148		149		150	
151		152		153	
154		155		156	
157		158		159	
160		161		162	
163		164		165	
166		167		168	
169		170		171	
172		173		174	
175		176		177	
178		179		180	
181		182		183	
184		185		186	
187		188		189	
190		191		192	
193		194		195	
196		197		198	
199		200		201	
202		203		204	
205		206		207	
208		209		210	
211		212		213	
214		215		216	
217		218		219	
220		221		222	
223		224		225	
226		227		228	
229		230		231	
232		233		234	
235		236		237	
238		239		240	
241		242		243	
244		245		246	
247		248		249	
250		251		252	
253		254		255	
256		257		258	
259		260		261	
262		263		264	
265		266		267	
268		269		270	
271		272		273	
274		275		276	
277		278		279	
280		281		282	
283		284		285	
286		287		288	
289		290		291	
292		293		294	
295		296		297	
298		299		300	
301		302		303	
304		305		306	
307		308		309	
310		311		312	
313		314		315	
316		317		318	
319		320		321	
322		323		324	
325		326		327	
328		329		330	
331		332		333	
334		335		336	
337		338		339	
340		341		342	
343		344		345	
346		347		348	
349		350		351	
352		353		354	
355		356		357	
358		359		360	
361		362		363	
364		365		366	
367		368		369	
370		371		372	
373		374		375	
376		377		378	
379		380		381	
382		383		384	
385		386		387	
388		389		390	
391		392		393	
394		395		396	
397		398		399	
400		401		402	
403		404		405	
406		407		408	
409		410		411	
412		413		414	
415		416		417	
418		419		420	
421		422		423	
424		425		426	
427		428		429	
430		431		432	
433		434		435	
436		437		438	
439		440		441	
442		443		444	
445		446		447	
448		449		450	
451		452		453	
454		455		456	
457		458		459	
460		461		462	
463		464		465	
466		467		468	
469		470		471	
472		473		474	
475		476		477	
478		479		480	
481		482		483	
484		485		486	
487		488		489	
490		491		492	
493		494		495	
496		497		498	
499		500		501	
502		503		504	
505		506		507	
508		509		510	
511		512		513	
514		515		516	
517		518		519	
520		521		522	
523		524		525	
526		527		528	
529		530		531	
532		533		534	
535		536		537	
538		539		540	
541		542		543	
544		545		546	
547		548		549	
550		551		552	
553		554		555	
556		557		558	
559		560		561	
562		563		564	
565		566		567	
568		569		570	
571		572		573	
574		575		576	
577		578		579	
580		581		582	
583		584		585	
586		587		588	
589		590		591	
592		593		594	
595		596		597	
598		599		600	
601		602		603	
604		605		606	
607		608		609	
610		611		612	
613		614		615	
616		617		618	
619		620		621	
622		623		624	
625		626		627	
628		629		630	
631		632		633	
634		635		636	
637		638		639	
640		641		642	
643		644		645	
646		647		648	
649		650		651	
652		653		654	
655		656		657	
658		659		660	
661		662		663	
664		665		666	
667		668		669	
670		671		672	
673		674		675	
676		677		678	
679		680		681	
682		683		684	
685		686		687	
688		689		690	
691		692		693	
694		695		696	
697		698		699	
700		701		702	
703		704		705	
706		707		708	
709		710		711	
712		713		714	
715		716		717	
718		719		720	
721		722		723	
724		725		726	
727		728		729	
730		731		732	
733		734		735	
736		737		738	
739		740		741	
742		743		744	
745		746		747	
748		749		750	
751		752		753	
754		755		756	
757		758		759	
760		761		762	
763		764		765	
766		767		768	
769		770		771	
772		773		774	
775		776		777	
778		779		780	
781		782		783	
784		785		786	
787		788		789	
790		791		792	
793		794		795	
796		797		798	
799		800		801	
802		803		804	
805		806		807	
808		809		810	
811		812		813	
814		815		816	
817		818		819	
820		821		822	
823		824		825	
826		827		828	
829		830		831	
832					

BLOCK DESCRIPTION CARD		HEIGHT/DIAMETER DESCRIPTION CARD		HARVESTING DESCRIPTION CARD		TREATMENT UNIT DESCRIPTION CARD	
BLOCK NO.	TYPE NO.	A (hectares)	B (hectares)	C (hectares)	D (hectares)	E (hectares)	F (hectares)
11	12	13	14	15	16	17	18
19	20	21	22	23	24	25	26
27	28	29	30	31	32	33	34
35	36	37	38	39	40	41	42
43	44	45	46	47	48	49	50
51	52	53	54	55	56	57	58
59	60	61	62	63	64	65	66
67	68	69	70	71	72	73	74
75	76	77	78	79	80		
DUPLICATE FROM ABOVE							
FOR THESE SPECIES							
SPECIES USED		TYPE USED		TYPE USED		TYPE USED	
SP. #1	SP. #2	SP. #3	TYPE NO.	TYPE NO.	TYPE NO.	TYPE NO.	TYPE NO.
11	12	13	14	15	16	17	18
19	20	21	22	23	24	25	26
27	28	29	30	31	32	33	34
35	36	37	38	39	40	41	42
43	44	45	46	47	48	49	50
51	52	53	54	55	56	57	58
59	60	61	62	63	64	65	66
67	68	69	70	71	72	73	74
75	76	77	78	79	80		
DUPLICATE FROM ABOVE							
HARVESTING METHOD		TREATMENT UNITS		TREATMENT UNITS		TREATMENT UNITS	
TYPE NO.	TYPE NO.	A (hectares)	B (hectares)	C (hectares)	D (hectares)	E (hectares)	F (hectares)
11	12	13	14	15	16	17	18
19	20	21	22	23	24	25	26
27	28	29	30	31	32	33	34
35	36	37	38	39	40	41	42
43	44	45	46	47	48	49	50
51	52	53	54	55	56	57	58
59	60	61	62	63	64	65	66
67	68	69	70	71	72	73	74
75	76	77	78	79	80		
DUPLICATE FROM ABOVE							
TREATMENT UNIT DESCRIPTION CARD		TREATMENT UNITS		TREATMENT UNITS		TREATMENT UNITS	
TYPE NO.	TYPE NO.	A (hectares)	B (hectares)	C (hectares)	D (hectares)	E (hectares)	F (hectares)
11	12	13	14	15	16	17	18
19	20	21	22	23	24	25	26
27	28	29	30	31	32	33	34
35	36	37	38	39	40	41	42
43	44	45	46	47	48	49	50
51	52	53	54	55	56	57	58
59	60	61	62	63	64	65	66
67	68	69	70	71	72	73	74
75	76	77	78	79	80		
DUPLICATE FROM ABOVE							

Figure 2.2b Map Area Statement - Reverse Side.

2.3 Card type A

2.3.1 Table of Data Types

Column Position	Column Name	Accepted Values	Error Type
1	Card type	"A" - hard coded	F
2-7	License	http://www.for.gov.bc.ca/revenue/manuals/cruising/Ch7.htm	F
8-10	Cutting Permit	XXX	F
11-13	No. of Blocks	999	I
14	Forest Region	1-3	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, 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
54-80	Locality Description	Any value is accepted	N/A

2.3.2 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. Refer to <http://www.for.gov.bc.ca/revenue/manuals/cruising/Table-10.htm>.

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 or C.
8. Invalid District within Region. Refer to Appendix 6.

2.2.3 Warning

1. Unity identity column cannot be blank.

2.3.4 Messages

1. UTM co-ordinates and Zones must be valid for the specified Region. For a list of UTM co-ordinates refer to chapter 7 of the *Cruising Manual* at:

<http://www.for.gov.bc.ca/revenue/manuals/cruising/Ch7.htm>

2.4 Card Type B - Compilation Standard

2.4.1 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	N/A	Blank - not used	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, 04, 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 Cruising Manual, Section 6.3.2 http://www.for.gov.bc.ca/revenue/manuals/cruising/Ch6-02.htm#P290_8843	F
32-33, 47-48, 62-63	Type of Comp.	03, 04, 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
76-77	N/A	N/A	N/A
78	Measurement type	C, R	N/A
79	Diameter measure	I	N/A
80	Stump cruise 100% cruise	Blank, S, A	N/A

2.4.2 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.

2.4.3 Warnings

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

2.4.4 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 utilization levels 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 portion of the Kalum Forest District, West of the Cascades 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

2.5 Card type C - Type Identity

2.5.1 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 <i>Cruising Manual</i> , Section 6.3.2 http://www.for.gov.bc.ca/revenue/manuals/cruising/Ch6-02.htm#P290_8843	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, 39-43, 44-48, 49-53, 54-58	Silviculture Treatment Unit Areas (A-F)	9(5, 1) or blanks	F
59-80	N/A	Blanks	I

2.5.2 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.

2.5.3 Warnings

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

2.5.4 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.

2.6 Card Type D - Block Description

2.6.1 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, 46-47	Type number	99 or blanks	F
16-20, 21-25, 26-30, 31-35, 36-40, 41-45,	Type 1 Treatment unit areas A, B, C, D, E, F	9 (5, 1) or blanks	F
48-52, 53-57, 58-62, 63-67, 68-72, 73-77	Type 2 Treatment unit areas A, B, C, D, E, F	9 (5, 1) or blanks	F
78	Block Maturity	Blank, I, M	I

2.6.2 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.

2.6.3 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.

2.7 Card Type E - Height/Diameter Description

2.7.1 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 <i>Cruising Manual</i> , Section 6.3.2 http://www.for.gov.bc.ca/revenue/manuals/cruising/Ch6-02.htm#P290_8843	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

2.7.2 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.

2.8 Card Type F - Harvesting Method Description

2.8.1 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	CC, CS, HC, HS, SC, SS, HO, LC, LS, SP	F
14-15, 46-47	Type number	99 or blanks	F
16-20, 21-25, 26-30, 31-35, 36-40, 41-45,	Type 1 Treatment unit areas A, B, C, D, E, F	9 (5, 1) or blanks	F
48-52, 53-57, 58-62, 63-67, 68-72, 73-77	Type 2 Treatment unit areas A, B, C, D, E, F	9 (5, 1) or blanks	F

2.8.2 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.

2.8.3 Warnings

1. A Harvesting Method should appear only once on the card type F's.
2. Type Numbers should be coded on a preceding card type C.

2.9 Card Type G - Treatment Unit Description

2.9.1 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, 31-40, 41-50, 51-60, 61-70	Silviculture Treatment Units A-F	XXXXXXXXXX	N/A

2.9.2 Fatal Errors

1. There must be 1 card type G.
2. There must be an equal number of Treatment Unit Names specified as there are Treatment Unit Areas on card type C.

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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 ¹ or 99	F
25	Plot type	Blank, C, M, S	F
26	Plot card sequence	Blank - not used ²	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, H, 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	N/A

- 1 Blanks are not allowed for PSYUs Bowron, Longworth, Monkman, Purden, Robson & TFL 30.
- 2 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 card type B utilization standard or exception DBH lower limit, whichever is lower.
9. For coastal compilations, the card type 9 Main/Sub Plot DBH must be the same as the block maturity DBH limit, determined by the Block Maturity indicator on card type D.
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.

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. If 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 <i>Cruising Manual</i> , Section 6.3.2 Http://www.for.gov.bc.ca/revenue/manuals/cruising/Ch6-02.htm#P290_8843	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 1 st live limb	1-9	F

Column Position	Column Name	Accepted Values	Error Type
49	Log no. of 1 st stub	1-9	F
50	Knots in 1 st 5 m	0-6	F
51	Knots in 2 nd 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

- Count trees tallied for a species without measured trees tallied.
- For tree class 2, pathological codes are required.

2.12.3 Warnings

- Insect damage code must be valid for species (refer to the *Cruising Manual*, Section A.7.1).
- Insect damage code must be valid for tree class.
 - Green attack (code 1) - Tree class 1, 2, 5, or 8 only
 - Grey attack (code 3) - Tree class 3, 4, 6, 7, or 9 only
 - Green attack live (code 5) - Tree class 1, 2, 5, or 8 only
 - Green attack (code 6) - Tree class 1, 2, 3, 5, 7, 8, or 9 only
 - Grey attack dead (code 7) - Tree class 3, 4, 6, 7, or 9 only

- f. Defoliator green cambium - Tree class 1, 2, 5, 6, or 8 only
3. For tree classes 4 and 6, do not code blow down damage.

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 coastal 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

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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 SS0200000000025

9 GTL7070001CLEARCUT SELECTION

10 9TL707000100101010011342M 12000B175 SC0602010

PLOT AGE FOR CONIFEROUS - MATURE - SEE TABLE 17

PAGE 11

11 2TL70700010010101001134201410Y 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

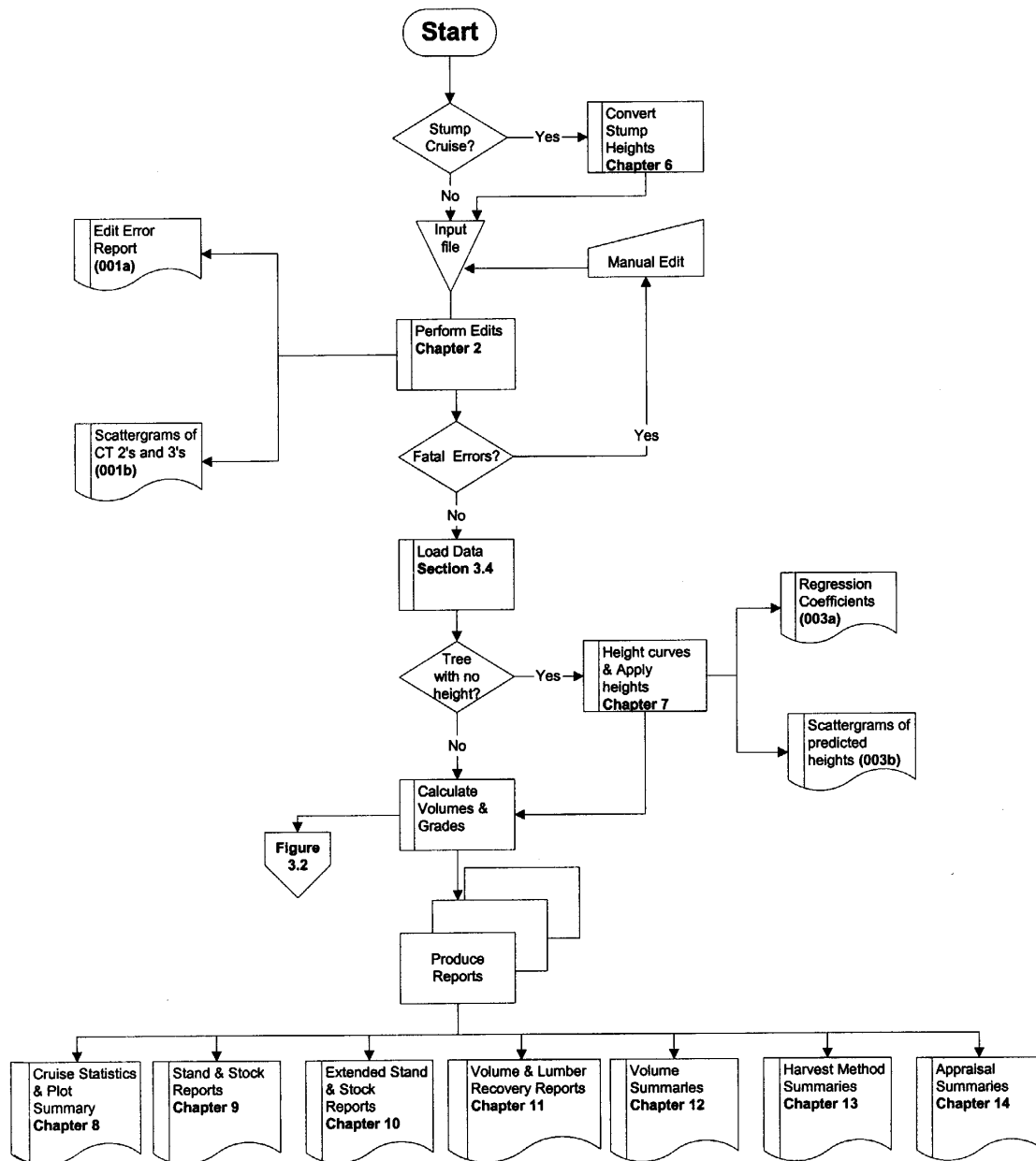


Figure 3.1 Cruise Compilation Sequence.

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* at the following URL:
<http://www.for.gov.bc.ca/revenue/manuals/cruising/Table-10.htm>
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, pathological remarks, and damage.

Tree Class - Tree classes 3, 4, 6, 7 & 9 automatically go to highest Risk Group.

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 at the following URL:
<http://www.for.gov.bc.ca/revenue/manuals/cruising/Table-11.htm>

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, Ministry of Forests for the specific table. Reduce the tree volume by the specified percentages. Apply the loss factors individually and in the order {Decay $\rightarrow$ Waste $\rightarrow$ Breakage}.

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

Example 3.3 - Application of Loss Factors

A tree class 1 Douglas Fir in FIZ C with an age in 10's of 13 would use the mature loss factors. For Risk Group 1 and DBH 45.5 cm, the loss factors are:

$$\text{Decay} - 4.1\% + \text{Waste} - 2.8\% + \text{Breakage} - 5.0\% = 11.9\%$$

If the gross merchantable volume of the tree was 2.023810 m^3 , then the net merchantable volume is:

$$2.023810 - (0.119)(2.023810) = 1.782976 \text{ m}^3$$

Step 5 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 6 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). Tree classes 4 and 6 tallied in count plots are not to be considered in the calculation of a double sampling ratio.

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

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

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 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

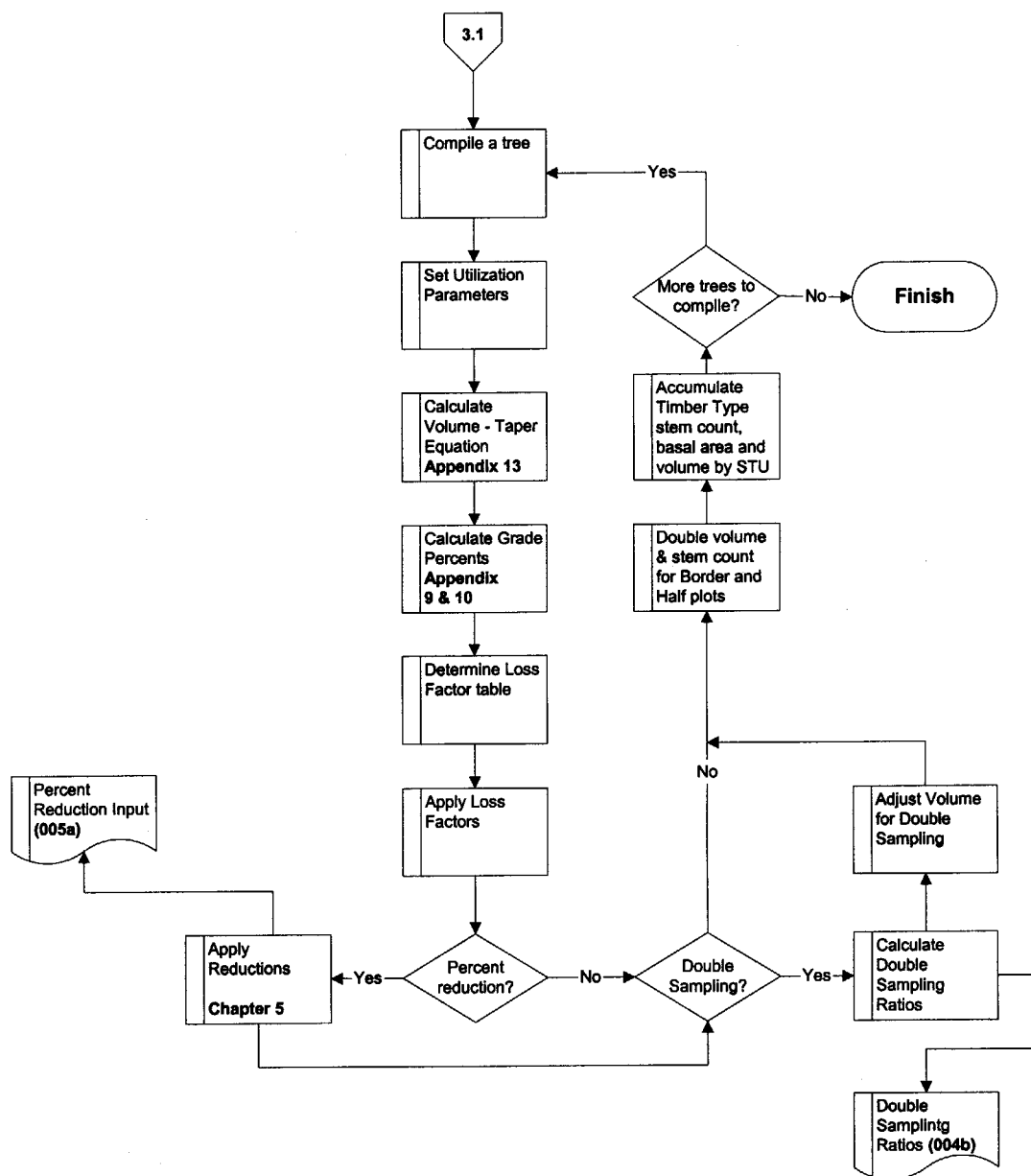


Figure 3.2 Log Volume Calculation.

3.3 Sample Data Model

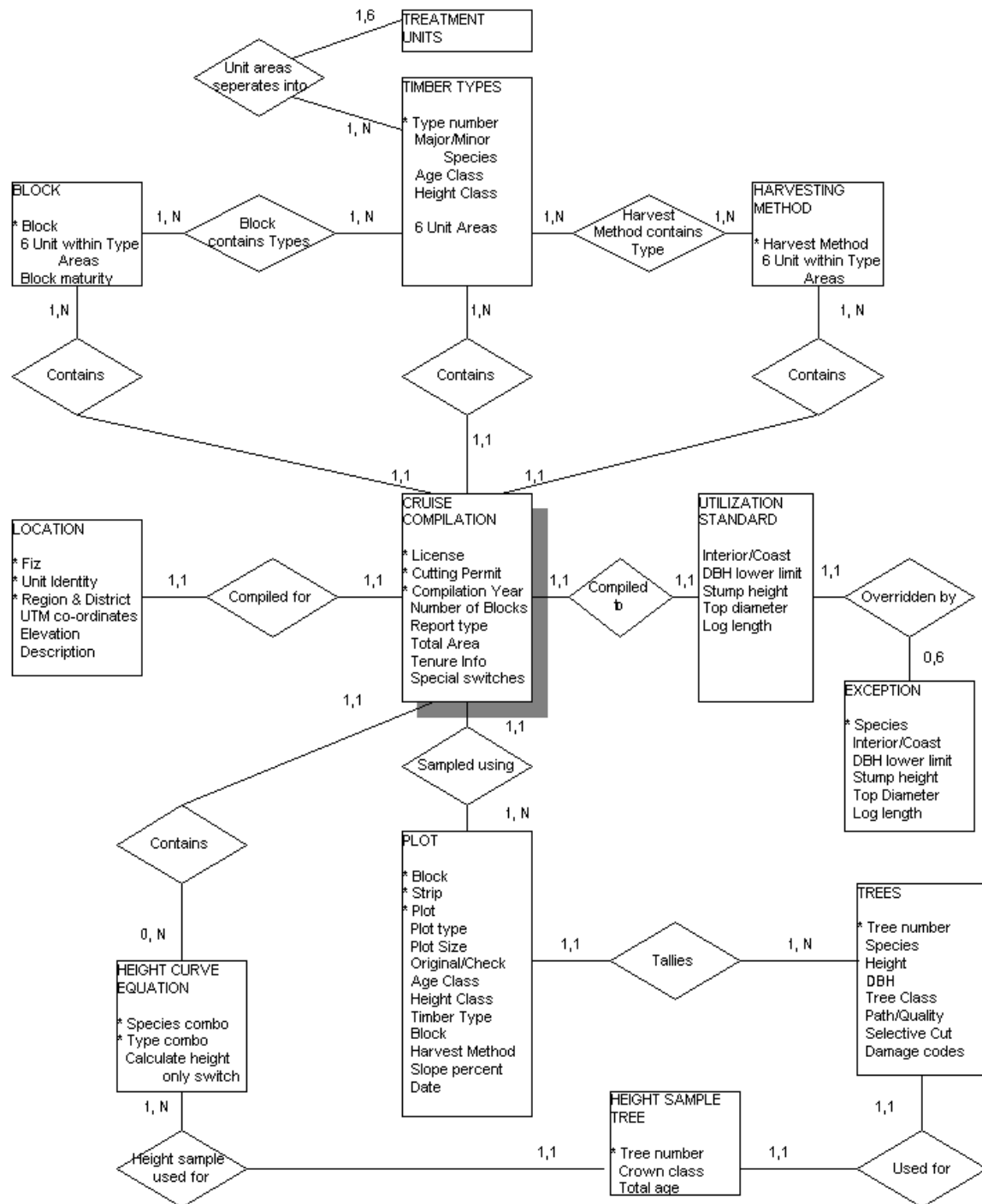


Figure 3.3 Input Data Relationships.

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 can be either full or 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:

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

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

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

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.

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

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

$$S_p = 28.4 + 34.1 = 62.5 \text{ stems per hectare}$$

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:

$$S_t = \frac{\text{Area one hectare}}{\text{Plot Size}} * R_t$$

Each species contributes:

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

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 m². 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 $S_{t,1} = \frac{10\,000}{400} * (1 - 30 / 100) = 17.5 \text{ stems per hectare}$

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

$S_p = 17.5 + 17.5 = 35.0 \text{ stems per hectare}$

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 m²

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 $\pi (\text{DBH}/200)^2$ (i.e., the area of a circle whose diameter is the DBH for the tree).

$$\text{BA}_p = \frac{\sum_{t=1}^{n_p} \pi \left(\frac{\text{DBH}_t}{200} \right)^2}{\text{plot size}} * R_t$$

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.

π = 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 NOT FOR APPRAISAL PURPOSES DUE TO NON-STANDARD UTILIZATION LICENCE: CF7080 - 000 BLOCK NUMBER - 002		RATIOS FOR DOUBLE SAMPLING CRUISE TIMBER TYPES		(004b)	PAGE	4
SPECIES	1	2		COMPUTED	2001-03-19	17:42:49
P	1.00000000	.84615373				
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.

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 Precedence Matrix

For damage reports, the net volume will be only reported for the most severe damage type.

The following matrix outlines the damage code precedence rules. Any code in the Highest Risk Group column takes precedence over any code in any other column. Any code in the Risk Group 2 column takes precedence over any code in the No Risk Group Change column.

Any tree coded with a code from the Highest Risk Group column will be downgraded into the Highest Risk Group.

A tree in Risk Group 1 will be downgraded into Risk Group 2 if it is coded with any code from the Risk Group 2 column. A tree coded with a code from the No Risk Group Change column will not change Risk Group.

	Highest Risk Group	Risk Group 2	No Risk Group Change
C		1	
		2	
	3		
		4	
			5
O		6	
D	7		
		8	
E			A
		B	
S	C		
			E
	G		
			X
			Y

Figure 4.1 Damage Precedence Matrix.

If two damage codes are equal in severity, use the damage type precedence order of:

1. Blowdown.
2. Fire.
3. Insect.

Example:

Blowdown code E takes damage reporting precedence over light fire (A), green insect damage (5), and both defoliators (X and Y).

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									
NOT FOR APPRAISAL PURPOSES DUE TO NON-STANDARD UTILIZATION *** DOUBLE SAMPLING CRUISE ****									
NOTE - ALL TREES GREATER THAN 275 CM ARE INCLUDED IN THE 275 CM CLASS									
LICENCE NUMBER CF7080									
CUTTING PERMIT 000									
ROAD/LANDINGS AREA - 5.0 OTHER AREA - 0.0 NO. OF PLOTS (M/C) 3. NO. OF DEAD TREES 0.									
TYPE 1 - PA H C 9 4 1 SPECIES CEDAR									
DOWN & SHATTERED - UPROOTED DAMAGE									
L I V I N G T R E E S									
DBH	A V E R A G E	GROSS	NET	RISK	RISK	RISK	RISK	DEAD	LIVE
CL	HT	MERCH.	MERCH.	GROUP 0	GROUP 1	GROUP 2	GROUP 3	POTENTIAL	VETERANS
CM.	(M)	PER TREE	PER TREE					TOTAL	DEAD U LIVE U
40		(M3)	(M3)						
45									
50	37.5	2.807	1.348			10.33		10.33	
55									
60									
65									
70									
75									
80									
85									
90									
TOTAL OF AVERAGES +									
PERCENT BY TREE CLASS									
TREES 12.5 +									
TREES 17.5 +									
TREES 22.5 +									
TREES 27.5 +									
TREES 32.5 +									
10.33 100.00 100.00 100.00									
AVERAGE DBH (CM) AT 5 LEVELS									
55.50 55.50 55.50 55.50									
55.50 55.50 55.50 55.50									
55.50 55.50 55.50 55.50									

Figure 4.2 Extended Forest Type Stand and Stock Damage Report - Sample Listing (Partial).

4.3.2 Block Stand Damage Table - Sample Listing

[illegible]

Figure 4.3 Block Stand Damage Table - Sample Listing (Partial).

4.3.3 Block Volume Summary Damage Report - Sample Listing

FOREST REVENUE BRANCH - 2001.0
 NOT FOR APPRAISAL PURPOSES DUE TO NON-STANDARD UTILIZATION *****
 BLOCK SUMMARY
 (009B) PAGE 51
 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
BLOCK NUMBER 001			NO. OF PLOTS USED (N/C)	6 6
CLEARCUT 5.0 SELECTIVE				12.5
UTILIZATION	NORMAL	DOWN	ALBICANULIS PINE - UPROOTED DAMAGE	
COMPILATION TYPE	3		SHATTERED	TOTAL
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 (GREENDP) 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	20	20	48	32
% NET MERCH - SMALL 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 SAMLOG	63.	94.	55.	62.
#3 SAMLOG	10.	0.	27.	14.
#4 CHIPPER	27.	6.	0.	19.
#5 CHIPPER	0.	0.	18.	5.

Figure 4.4 Block Volume Summary Damage Report - Sample Listing.

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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. The file is 80 characters wide and contains 1 or more reduction cards.

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

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

The reduced volume would not be cut, as per the silviculture prescription. 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 Block is coded, then the reduction applies to trees in that Block.
2. If a Timber Type is coded, then the reduction applies to trees in that Type.
3. If both Timber Type and Block are blank, then the reduction applies to all trees.
4. If Damage is coded B, F or I on the reduction card, then do not apply the reduction to trees that have been assigned a damage code of that type.
5. 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.
6. 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.

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 99 appears in a DBH class reduction percent, reduce trees by 100 percent instead of 99 percent. If the DBH class is blank, then do not apply a reduction for that tree.

5.2 Percent Reduction Worksheet Image

[illegible]

Figure 5.1 Percent Reduction Worksheet.

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.

$$\text{Type 1} = ((150+230+170+250)/4) * 5.0\text{ha} = 1000 \text{ m}^3 \text{ (1000 STU A)}$$

$$\text{Type 2} = ((230+260+210+260)/4) * 7.5\text{ha} = 1800 \text{ m}^3 \text{ (1200 STU A + 600 STU B)}$$

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

$$\text{Cutting Permit} = 1000 + 1800 = 2800 \text{ m}^3 \text{ (2200 STU A + 600 STU B)}$$

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.

	<u>Type 1</u>	<u>Type 2</u>
Block 1		
- STU A	$= (2.5/5.0 * 1000)$	$+ (2.5/5.0 * 1200) = 500 + 600 = 1100 \text{ m}^3$
Block 2		
-STU A	$= (2.5/5.0 * 1000)$	$+ (2.5/5.0 * 1200) = 500 + 600 = 1100 \text{ m}^3$
-STU B		$= (2.5/2.5 * 600) = \frac{600 \text{ m}^3}{1700 \text{ m}^3}$
Harvesting Method – SC		
-STU A	$= (5.0/5.0 * 1000) +$	$(5.0/5.0 * 1200) = 1000 + 1200 = 2200 \text{ m}^3$
Harvesting Method – SS		
-STUB	$= 0$	$+ (2.5/2.5 * 600) = 600 \text{ m}^3$

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 m³ (1000 STU A)

Type 2 = **1620 m³** (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 m³** (2200 STU A + **420** STU B)

Block 1

$$\text{- STU A} = (2.5/5.0 * 1000) + (2.5/5.0 * 1200) = 500 + 600 = 1100 \text{ m}^3$$

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

Block 2

$$\begin{aligned} \text{-STU A} &= (2.5/5.0 * 1000) + (2.5/5.0 * 1200) = 500 + 600 = 1100 \text{ m}^3 \\ \text{-STU B} &= (2.5/2.5 * \mathbf{420}) = \mathbf{420 \text{ m}^3} \\ &= \mathbf{1520 \text{ m}^3} \end{aligned}$$

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

Harvesting Method – SC

$$\text{-STU A} = (5.0/5.0 * 1000) + (5.0/5.0 * 1200) = 1000 + 1200 = 2200 \text{ m}^3$$

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

Harvesting Method – SS

$$\text{-STUB} = 0 + (2.5/2.5 * \mathbf{420}) = \mathbf{420 \text{ m}^3}$$

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:

$$\text{Type 1} = 900 \text{ m}^3 \quad (900 \text{ STU A: } 1000 * 0.9)$$

$$\text{Type 2} = 1680 \text{ m}^3 \quad (1080 \text{ STU A: } 1200 * 0.9 + 600 \text{ STU B})$$

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

$$\text{Cutting Permit} = 900 + 1680 = 2580 \text{ m}^3 \quad (1980 \text{ STU A} + 600 \text{ STU B})$$

	<u>Type 1</u>	<u>Type 2</u>
Block 1	- STU A = $(2.5/5.0 * 900)$	+ $(2.5/5.0 * 1080) = 450 + 540 = 990 \text{ m}^3$

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

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

Harvesting Method – SC

$$\text{-STU A} = (5.0/5.0 * 900) + (5.0/5.0 * 1080) = 900 + 1080 = 1980 \text{ m}^3$$

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

Harvesting Method – SS

$$\text{-STUB} = 0 + (2.5/2.5 * 600) = 0 + 600 = 600 \text{ m}^3$$

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

$$\text{Type 1} = 1000 \text{ m}^3 \quad (1000 \text{ STU A})$$

$$\text{Type 2} = 1800 \text{ m}^3 \quad (1200 \text{ STU A} + 600 \text{ STU B})$$

$$\text{Cutting Permit} = 1000 + 1800 = 2800 \text{ m}^3 \text{ (2200 STU A + 600 STU B)}$$

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

$$\begin{aligned} \text{Type 1/Blk 1} &= ((150+170)/2) * 2.5\text{ha} = 400 \text{ m}^3 && (400 \text{ STU A}) \\ \text{Type 1/Blk 2} &= ((230+250)/2) * 2.5\text{ha} = 600 \text{ m}^3 && (600 \text{ STU A}) \\ \text{Type 2/Blk 1} &= ((230+210)/2) * 2.5\text{ha} = 550 \text{ m}^3 && (550 \text{ STU A}) \\ \text{Type 2/Blk 2} &= ((260+260)/2) * 5.0\text{ha} = 1300 \text{ m}^3 && (650 \text{ STU A} + 650 \text{ STU B}) \\ \\ \text{Type 1/SC} &= ((150+230+170+250)/4) * 5.0 \text{ ha} &= 1000 \text{ m}^3 &(1000 \text{ STU A}) \\ \text{Type 2/SC} &= ((230+210)/2) * 5.0 \text{ ha} &= 1100 \text{ m}^3 &(1100 \text{ STU A}) \\ \text{Type 2/SS} &= ((260+260)/2) * 2.5 \text{ ha} &= 650 \text{ m}^3 &(650 \text{ STU B}) \end{aligned}$$

	<u>Type 1</u>	<u>Type 2</u>
Block 1		
- STU A	= 400	+ 550 = 950 m ³
Block 2		
-STU A	= 600	+ 650 = 1250 m ³
-STU B	= 0	+ 650 = $\frac{650 \text{ m}^3}{1900 \text{ m}^3}$
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:

$$\begin{aligned} \text{Type 1} &= 1000 \text{ m}^3 && (1000 \text{ STU A}) \\ \text{Type 2} &= \mathbf{1680 \text{ m}^3} && (1200 \text{ STU A} + \mathbf{480 \text{ STU B}}) \end{aligned}$$

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

$$\text{Cutting Permit} = 1000 + 1680 = \mathbf{2680 \text{ m}^3}$$

$$\text{Type 1/Blk 1} = 400 \text{ m}^3 \text{ (400 STU A)}$$

$$\text{Type 1/Blk 2} = 600 \text{ m}^3 \text{ (600 STU A)}$$

$$\text{Type 2/Blk 1} = 550 \text{ m}^3 \text{ (500 STU A)}$$

$$\text{Type 2/Blk 2} = \mathbf{1170 \text{ m}^3} \text{ (650 STU A + 520 STU B)}$$

$$\text{Type 1/SC} = 1000 \text{ m}^3 \text{ (1000 STU A)}$$

$$\text{Type 2/SC} = 1100 \text{ m}^3 \text{ (1100 STU A)}$$

$$\text{Type 2/SS} = \mathbf{520 \text{ m}^3} \text{ (520 STU B)}$$

	<u>Type 1</u>	<u>Type 2</u>
Block 1		
	- STU A = 400	+ 550 = 950 m ³
Block 2		
	-STU A = 600	+ 650 = 1250 m ³
	-STU B = 0	+ 520 = <u>520 m³</u>
		1770 m³

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

Harvesting Method - SC

$$\text{-STU A} = 1000 \quad + 1100 = 2100 \text{ m}^3$$

Harvesting Method - SS

$$\text{-STUB} = 0 \quad + \mathbf{520} = \mathbf{520 \text{ m}^3}$$

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:

$$\text{Type 1} = 1000 \text{ m}^3 \text{ (1000 STU A)}$$

$$\text{Type 2} = \mathbf{1200 \text{ m}^3} \text{ (600 STU A + 600 STU B)}$$

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

$$\text{Cutting Permit} = 1000 + 1200 = 2200 \text{ m}^3$$

$$\begin{aligned} \text{Type 1/Blk 1} &= 400 \text{ m}^3 && (400 \text{ STU A}) \\ \text{Type 1/Blk 2} &= 600 \text{ m}^3 && (600 \text{ STU A}) \\ \text{Type 2/Blk 1} &= 275 \text{ m}^3 && (275 \text{ STU A}) \\ \text{Type 2/Blk 2} &= 975 \text{ m}^3 && (325 \text{ STU A} + 650 \text{ STU B}) \end{aligned}$$

$$\begin{aligned} \text{Type 1/SC} &= 1000 \text{ m}^3 && (1000 \text{ STU A}) \\ \text{Type 2/SC} &= 550 \text{ m}^3 && (550 \text{ STU A}) \\ \text{Type 2/SS} &= 650 \text{ m}^3 && (650 \text{ STU B}) \end{aligned}$$

	<u>Type 1</u>	<u>Type 2</u>
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 (i.e. Type or Block etc.) 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 m³. Hence, the pre-reduction estimate for gross volume per hectare for both Treatment Units is:

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

The post-reduction estimate for Treatment Unit B is:

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

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

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

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, 3, 4, 6, 7, 9	F
6	Treatment Unit	A - F	F
7-9	Block	Blank, XXX	F
10	Damage type	Blank, B, F, I	F
11-12	N/A		
13-14, 15-16, ..., 79-80	Reduction percent for DBH class	Blank, 01 – 99	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.
4. Cannot have a Block reduction card and a Type reduction card in the same set of reduction cards.

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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 utilization standards 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 Coastal 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.
- b₀, b₁ = Diameter conversion constants, to 6 decimal places. Refer to *Cruising Manual* <http://www.for.gov.bc.ca/revenue/manuals/cruising/Table-04.htm> 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

$$\begin{aligned}
 \text{DBH} &= 53.0 + 0.065728 * 53.0 * (2.3 - 0.25) + 0.575037 * 53.0 * \ln [1.25/2.3] \\
 &= 53.0 + 7.14 - 18.58 \\
 &= 41.6 \text{ cm}
 \end{aligned}$$

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.

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 <i>Cruising Manual</i> , Section 6.3.2 http://www.for.gov.bc.ca/revenue/manuals/cruising/Ch6-02.htm#P290_8843	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.

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Height-Diameter Equations

7

Tree heights are required for the calculation of volume, as explained in Chapter 3. For stump cruises where no trees have heights or other cruises where the heights are not measured for each tree, 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	$H = a[1 - \text{EXP}(-bD^c)]$
Conditioned Weibull	$H = 1.3 + a[1 - \text{EXP}(-bD^c)]$

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. Refer to Section 4.2.1.1 of the *Cruising Manual* for possible exceptions.

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 Section 8.4 of the *Cruising Manual* for a description of the methods of grouping sample trees.

<http://www.for.gov.bc.ca/revenue/manuals/cruising/ch8-03.htm>

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 Figure 7.3 of the *Cruising Manual* for example card type E codes.

<http://www.for.gov.bc.ca/revenue/manuals/cruising/Ch7-04.htm>

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

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

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

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

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

$$E = \Sigma D^4 - \frac{(\Sigma D^2)^2}{N}$$

$$F = \Sigma D$$

$$G = \Sigma H$$

$$H = \Sigma D^2$$

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

$$a = 1.3$$

$$b = 0.62079155$$

$$c = -0.00307971$$

$$\text{Root}_1 = -2.0728 \quad \leftarrow DBH_{\min}$$

$$\text{Root}_2 = 203.647$$

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

$$a = 10.81912465$$

$$b = -9.74355472$$

$$c = 0.23902870$$

$$\text{Root}_1 = 0.8833 \quad \leftarrow \text{DBH}_{\min}$$

$$\text{Root}_2 = -46.1462$$

For the conditioned hyperbola, $\text{DBH}_{\min}$ = The root that is closest to 0 of the following quadratic equation

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

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

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

Example 7.4

$$a = 1.3$$

$$b = -9.48876491$$

$$c = 0.23935168$$

$$\text{Root}_1 = -0.1182 \quad \leftarrow \text{DBH}_{\min}$$

$$\text{Root}_2 = -45.9567$$

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

Weibull

H = height of tree

H' = calculated height from regression equation

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.

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

Where

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

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

$$D_i = \text{DBH of sample tree } i$$

$$H_i = \text{Height of sample tree } i$$

$$H'_i = \text{Calculated height of sample tree } i$$

$$a = \text{Volume constant A, from Appendix 15}$$

$$b = \text{Volume constant B, from Appendix 15}$$

$$c = \text{Volume constant C, from Appendix 15}$$

$$N = \text{Number of sample trees used}$$

$$K = 2, \text{ for the conditioned parabola and conditioned hyperbola or}$$

$$K = 3, \text{ for all other functions}$$

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 DSC000 - 000 COMPUTED 2001-03-20 10:30:00									
DBH	COMBINED SPECIES- C	F H	COMBINED SPECIES- PL	SPECIES- PL	TYPES- 1	TYPES- 1	Y	PW	PL
115..	1	1							
110..	1	1							
105..	2	1							
100..	1	1							
95..	3	3							
90..	7	1							
85..	6	2							
80..	2	1							
75..	3	1							
70..	4	2							
65..	1	6							
60..	8	3							
55..	4	5							
50..	10	9							
45..	2	5							
40..	5	4							
35..	6	6							
30..	2	3							
25..	5	1							
20..	1	2							
15..									
10..									

Figure 7.1 Scattergram of Card Type 2 trees (Partial).

7.4.2 Report 004a - Sample Listing

Height curve edits - required for stump cruises.

FOREST REVENUE BRANCH - 2001.0 NOT FOR APPRAISAL PURPOSES										(004a)		PAGE		1		17:45:17	
TIMBER TYPE	BLOCK/STRIP/PLOT	TREE NO.	SPECIES	LICENCE: DSC000 - 000	D.B.H. / TC	MAYBE IN ERROR	CAL	HEIGHT	REASON	COMPUTED 2001-03-19	REASON	COMPUTED 2001-03-19	REASON	COMPUTED 2001-03-19	REASON	COMPUTED 2001-03-19	REASON
1- 1	001/01/01	63	F - H	102.2 - 1	35.2	DBH GT SAMPLE TREE DBH	-	101.1	DBH GT SAMPLE TREE DBH	-	101.1	DBH GT SAMPLE TREE DBH	-	101.1	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	DBH GT SAMPLE TREE DBH	-	101.1	DBH GT SAMPLE TREE DBH	-	101.1	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	DBH GT SAMPLE TREE DBH	-	101.1	DBH GT SAMPLE TREE DBH	-	101.1	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	DBH GT SAMPLE TREE DBH	-	101.1	DBH GT SAMPLE TREE DBH	-	101.1	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	DBH GT SAMPLE TREE DBH	-	101.1	DBH GT SAMPLE TREE DBH	-	101.1	DBH GT SAMPLE TREE DBH	-	101.1
1- 1	001/01/01	95	F - H	111.4 - 1	37.4	DBH GT SAMPLE TREE DBH	-	101.1	DBH GT SAMPLE TREE DBH	-	101.1	DBH GT SAMPLE TREE DBH	-	101.1	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	DBH GT SAMPLE TREE DBH	-	101.1	DBH GT SAMPLE TREE DBH	-	101.1	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	DBH GT SAMPLE TREE DBH	-	101.1	DBH GT SAMPLE TREE DBH	-	101.1	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	DBH GT SAMPLE TREE DBH	-	101.1	DBH GT SAMPLE TREE DBH	-	101.1	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	DBH GT SAMPLE TREE DBH	-	101.1	DBH GT SAMPLE TREE DBH	-	101.1	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	DBH GT SAMPLE TREE DBH	-	101.1	DBH GT SAMPLE TREE DBH	-	101.1	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	DBH GT SAMPLE TREE DBH	-	101.1	DBH GT SAMPLE TREE DBH	-	101.1	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	DBH GT SAMPLE TREE DBH	-	101.1	DBH GT SAMPLE TREE DBH	-	101.1	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	DBH GT SAMPLE TREE DBH	-	101.1	DBH GT SAMPLE TREE DBH	-	101.1	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 SAMPLE TREE DBH	-	101.1	DBH GT SAMPLE TREE DBH	-	101.1	DBH GT SAMPLE TREE DBH	-	101.1
1- 1	001/01/01	13	F - F	276.8 - 5	51.5	DBH GT EQUATION MAX	-	170.5	DBH GT EQUATION MAX	-	170.5	DBH GT EQUATION MAX	-	170.5	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.

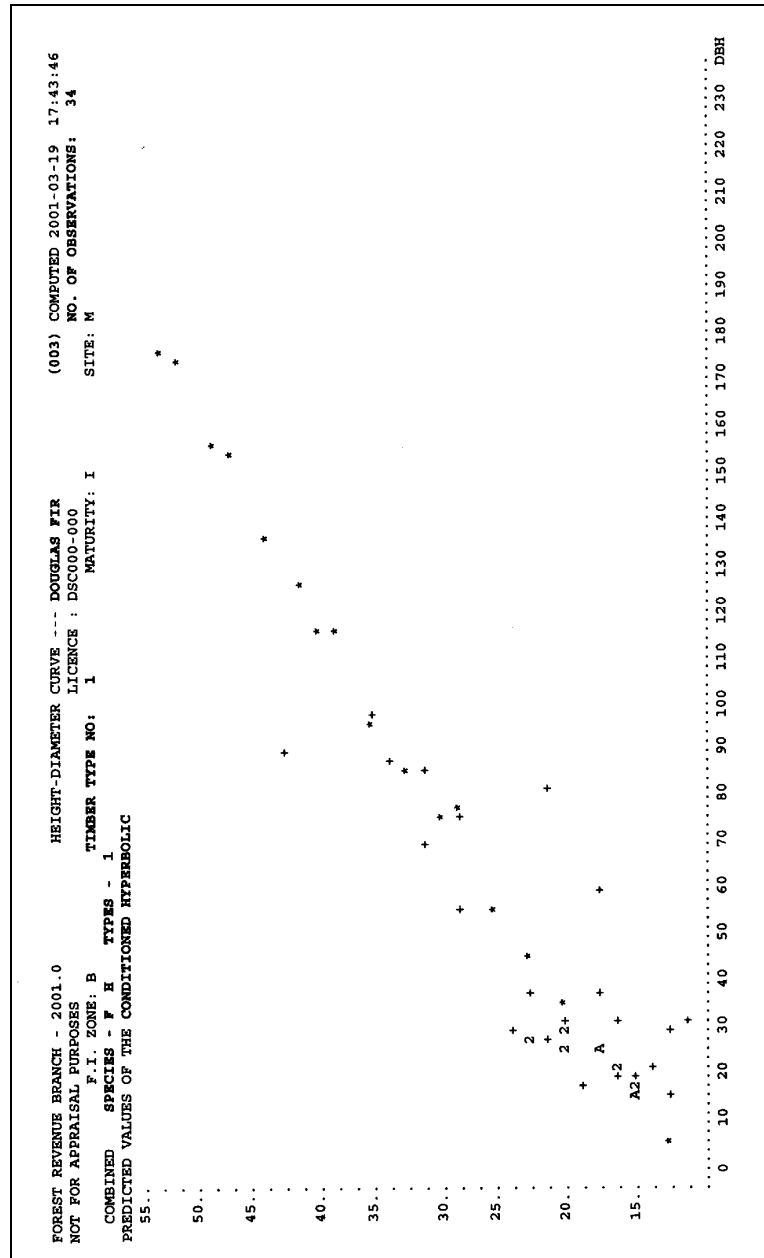


Figure 7.3 Regression Coefficients and Calculated Heights – Sample Listing (Partial).

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

FOREST REVENUE BRANCH - 2001.0 NOT FOR APPRAISAL PURPOSES										(003) COMPUTED 2001-03-19 17:43:46 NO. OF OBSERVATIONS: 34 SITE: M									
F.I. ZONE: B										LICENCE : DSC000-000 MATERIALITY: I									
SPECIES - F H										TIMBER TYPE NO: 1									
COMBINED										TYPES - 1									
DBH										CONDITIONED									
PARABOLA										PARABOLA									
HYPERBOLA										HYPERBOLA									
WEIBULL										WEIBULL									
CONDITIONED										CONDITIONED									
WEIBULL										WEIBULL									
C										C									
S.E.E. HEIGHT										S.E.E. HEIGHT									
BIAS HEIGHT										BIAS HEIGHT									
S.E.E. VOLUME										S.E.E. VOLUME									
BIAS VOLUME										BIAS VOLUME									
D.B.H.										D.B.H.									
MAXIMUM D.B.H. OF SAMPLE DATA 101.1										MAXIMUM D.B.H. OF SAMPLE DATA 101.1									
WEIBULL EQUATION DID NOT CONVERGE										WEIBULL EQUATION DID NOT CONVERGE									
OCONDITIONED WEIBULL EQUATION DID NOT CONVERGE										OCONDITIONED WEIBULL EQUATION DID NOT CONVERGE									
</																			

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. Only stem count is reported for Western Yew.

Count plots are not included in the plot summary.

Only include trees in a plot that meet the utilization standards 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* <http://www.for.gov.bc.ca/revenue/manuals/cruising/Table-10.htm>
5. Message indicating whether compilation is for appraisals or not.
6. Method of calculation (Average Line or Block).
7. Utilization levels 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 3.5 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 $\text{Area} = \pi * \text{radius}^2$. 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).

π = 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 = 0.2887. 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:

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

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									
MINISTRY OF FORESTS - APPRAISAL INFORMATION									
LICENCE NUMBER TL7070									
CUTTING PERMIT 001									
P.S.Y.U. 86-0									
F.I.Z. C									
PLOT SUMMARY									
USELESS VOLUMES EXCLUDED									
STANDARD:									
EXCEPTION:									
DBH LIMIT									
VOLUME M3 / HECTARE									
LESS DB									
GROSS DECAY									
MERCH DB									
AVG.-DIAM.									
L&DP DU&LU									
STEMS-PER-HA									
L&DP DU&LU									
NO.-OF-STEMS									
L&DP DU&LU									
SLOPE									
20/11									
12.000P									
050									
FIR - (QUALITY 1)									
2									
0									
CEDAR									
1									
0									
HEMLOCK									
1									
0									
26.80									
0.00									
75.50									
0.00									
184.51									
0.00									
50.14									
0.00									
55.20									
0.00									
49.42									
0.00									
43.51									
0.00									
83.80									
0.00									
306.63									
0.00									
286.23									
0.00									
111									
212									
212									
115.40									
106.52									
0.00									
174.73									
0.00									
389									
160.56									
0.00									
493									
145.16									
0.00									
132.37									
0.00									
135.49									
151.97									
0.00									
135.49									
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FOREST REVENUE BRANCH - 2001.0			PLOT FREQUENCY		(011)	PAGE	4
MINISTRY OF FORESTS - APPRAISAL INFORMATION			USELESS VOLUMES EXCLUDED		COMPUTED 2001-03-19 15:50:21		
LICENCE NUMBER TL7070			P.S.Y.U. 86-0		AVERAGE LINE		
CUTTING PERMIT 001			P.I.Z. C		STUMP HT. 30. TOP DIAM.		
			TIMBER TYPES		STANDARD:		
					EXCEPTION:		
MEASURED PLOT			1		DBH LIMIT		
BLOCK 001			2				
NO. OF PLOTS			1.25				
HA/PLOT			2				
BLOCK 002			2				
NO. OF PLOTS			1.25				
HA/PLOT			2.50				
CUTTING PERMIT			4				
NO. OF PLOTS			1.25				
HA/PLOT			1.88				

Figure 8.2 Plot Frequency - Sample Listing.

8.3 Plot Summary by Maturity Overview and Listing

For each Block/Timber Type combination, report the number of count and measure plots, by Maturity. Use the Block maturity indicator from card type D to determine whether the block is mature or immature.

This report is only for Coastal compilations

8.3.1 Header Information

1. License from card type A.
2. Cutting Permit from card type A.
3. Total Merchantable area from card type A.
4. Message indicating whether compilation is for appraisals or not.
5. Method of calculation (Average Line or Block).
6. Special compilation messages for:
 - a. Double Sampling.
 - b. Stump cruise compilation.
7. Compiler program name and version.
8. Compile date and time.
9. Page number.

8.3.2 Sample Listing

```
FOREST REVENUE BRANCH - 2001.0  PLOT DISTRIBUTION BY MATURITY (012) PAGE    1
MINISTRY OF FORESTS - APPRAISAL INFORMATION      COMPUTED 2001-03-19  15:50:21
AVERAGE LINE LICENCE NO. TL7070 - 001          TOTAL MERCH AREA    12.5

NUMBER OF MEASURED PLOTS WITHIN EACH FOREST TYPE
BLOCK * TYPE NUMBER
      *   1   2
001 M *   2   2
002 M *   2   2
```

Figure 8.3 Plot Distribution by Maturity - Sample Listing.

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. Standard utilization 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 or half 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 3.5).

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:

$$\overline{V}_1 = (1048.47 + 828.07 + 726.08) / 3 = 867.54 \text{ m}^3 \text{ per hectare}$$

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 i (see Section 3.5).

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

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

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 3.5).

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.

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

Where:

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

BA_p = Basal area/hectare estimate from plot p (see Section 3.5).

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 3.5)

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

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

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

Where:

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

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

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

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

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

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

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

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

$$\bar{b}_m = \frac{\sum_{i=1}^m BA_i}{m} = \text{type average basal area/hectare from measure plots only.}$$

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

FPC = 1.0 for Types sampled using variable plots, or

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

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.

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

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

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

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

$$FPC = 1.0$$

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

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

8.4.2.12 Standard Error of the Mean Percent for Basal Area

$$SEM_b\% = \frac{SEM_b}{b_i} * 100\%$$

Where

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

$$SEM_b = \sqrt{S_b^2} * FPC$$

$$S_b^2 = \sqrt{\frac{SD_b^2}{m + c}}$$

SD_b = Standard deviation for basal area using count and measure plots (defined above).

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 95% Confidence Interval for Volume

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

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:

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

8.4.2.14 95% Confidence Interval for Basal Area

$$95\%CI_b = \bar{b}_i \pm SEM_b * t_{m+C-1}$$

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 Basal Area Coefficient of Variation for Basal Area

$$CV_{bcp} = \sqrt{\sum_{i=1}^k p_{bi}^2 CV_{bi}^2}$$

Where:

p_{bi} = Proportional basal area of Type i - measure plots only.

$$p_{bi} = \frac{\bar{A_i b_i}}{\sum_{i=1}^k \bar{A_i b_i}}$$

$\bar{b}_i$ = Average basal area/hectare for Type i, all plots.

CV_{bi} = Coefficient of Variation for basal area for type i, (defined above).

A_i = Area of Type i.

k = Number of Timber Types.

Report to 1 decimal place.

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

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

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.

$\overline{V}_{cp}$ = 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.

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

8.4.3.3 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.

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

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

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.

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

$\overline{V}_{mcp}$ = 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.

8.4.3.5 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.

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

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

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.

FOREST REVENUE BRANCH - 2001.0									
NOT FOR APPRAISAL PURPOSES DUE TO NON-STANDARD UTILIZATION ***** DOUBLE SAMPLING CRUISE *****									
LICENCE NUMBER CF7080									
CUTTING PERMIT 000									
UTILIZATION LEVEL STANDARD:									
TIMBER TYPE 1 - PA H C 9 4 1									
PRISM PLOTS									
NO. OF POTENTIAL TREES	29								
NO. OF MEASURED PLOTS	3								
NO. OF COUNT PLOTS	3								
TIMBER TYPE 2 - PA S B 9 4 1									
PRISM PLOTS									
NO. OF POTENTIAL TREES	27								
NO. OF MEASURED PLOTS	3								
NO. OF COUNT PLOTS	3								
ALL TIMBER TYPES									
PRISM PLOTS									
NO. OF POTENTIAL TREES	56								
NO. OF MEASURED PLOTS	6								
NO. OF COUNT PLOTS	6								

CRUISE STATISTICS									
P.S.Y.U. 34-0									
F.I.Z. J									
DBH LIMIT 12.5									
STUMP HT. 30.									
FOREST DISTRICT 8									
FOREST REGION 2									
MEAN NET VOL/HA --- BA/HA									
STANDARD DEVIATION									
COEFFICIENT OF VARIATION									
STANDARD ERROR OF THE MEAN %									
95% CONFIDENCE INTERVAL									
MEAN NET VOL/HA --- BA/HA									
STANDARD DEVIATION									
COEFFICIENT OF VARIATION									
STANDARD ERROR OF THE MEAN %									
95% CONFIDENCE INTERVAL									
COEFFICIENT OF VARIATION									
STANDARD ERROR OF THE MEAN %									
95% CONFIDENCE INTERVAL									
MEASURED 95% CONFIDENCE INTERVAL									

(005b)	PAGE 1	COMPUTED 2001-03-19 17:42:51
AVERAGE LINE	USELESS VOLUMES EXCLUDED	BASAL AREA
LOG LENGTH 5.	VOLUME	
TOP DIAM. 10.0	733.4 M3	81.7
	164.7785	23.1661
	19.0 %	28.4 %
	10.7 %	11.6 %
	46.0 %	29.8 %
	632.3 M3	70.7
	98.6896	16.4762
	13.3 %	23.3 %
	7.1 %	9.5 %
	30.6 %	24.5 %
	11.2 %	18.1 %
	6.2 %	7.4 %
	17.1 %	16.4 %
	17.9 %	20.9 %

Figure 8.4 Cruise Statistics - Sample Listing.

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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. For Western Yew, report only the stems per hectare.

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 utilization. Some of the diameter classes have been removed from the sample listing (Figures 9.1, 9.2, and 9.3).

Each table is reported at the Block, Timber Type, and Cutting Permit levels.

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).

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.

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. Utilization levels 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.

9.1 Stand Table

9.1.1 Stand Table - Detail Information

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

9.1.1.1 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.

Timber Type

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

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

Block - Average Line method

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

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

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.

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

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

Example 9.1

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)

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

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

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

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).

9.1.1.2 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.

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.

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.

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.

9.1.1.3 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.

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.

9.1.1.4 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.

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.

Timber Type:

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

Where:

$\bar{D}_{s,l,i}$ = 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.

π = 3.14159265.

Example 9.2

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

$$BA = 2 * 10 = 20$$

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

Plot 2

$$BA = 2 * 10 = 20$$

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

$$\text{Sum of SPH} \quad 107.32 + 118.92 = 226.24$$

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

9.1.2 Block Stand Table - Sample Listing - Block Method

Report 007A - required.

FOREST REVENUE BRANCH - 2001.0 NOT FOR APPRAISAL PURPOSES DUE TO NON-STANDARD UTILIZATION										BLOCK STAND TABLE (STEMS/HA)		(007A) PAGE 1	
LICENCE NO. CP7090										COMPUTED 2001-03-19 17:43:32		USELESS VOLUMES EXCLUDED	
CP NO. 000										TOTAL MERCH AREA 12.5			
BLOCK 001										BLOCK METHOD			
OCLEARCUT 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 12.5 12.5 12.5 12.5													
STUMP HT 30.0 30.0 30.0 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 10.0 10.0 10.0													
LOG LENGTH 5.0 5.0 5.0 5.0 5.0 5.0 5.0 5.0 5.0 5.0													
DBH CL													
5													
10													
15													
20													
25													
30													
35													
40													
45													
50													
55													
60													
65													
70													
75													
TOTAL	62.5	32.5	19.4	16.2	12.5	6.2	149.4						
USELESS													
DEAD P	6.2												
12.5 +	56.5	39.9	45.4	38.6	51.1	41.0	49.0						
17.5 +	56.5	39.9	45.4	38.6	51.1	41.0	49.0						
22.5 +	56.5	45.9	45.4	38.6	51.1	41.0	50.4						
27.5 +	56.5	45.9	45.4	38.6	51.1	41.0	50.4						

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

9.2 Stock Table

9.2.1 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.

9.2.1.1 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.

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 9.3 for a sample Timber Type calculation.

Block - Average Line Method

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

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

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.

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

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

Refer to Example 9.1 for a sample Block calculation.

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.

Example 9.3

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).

9.2.1.2 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.

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).

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.

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.

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.

9.2.1.3 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.

Timber Typ

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

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

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.

9.2.1.4 Total Volume per Hectare at Seven Levels

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

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.

Timber Type

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

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).

9.2.2 Stock Table - Sample Listing - Cutting Permit Level

Report 007h - required.

FOREST REVENUE BRANCH - 2001.0 NOT FOR APPRAISAL PURPOSES DUE TO NON-STANDARD UTILIZATION LICENCE NO. CF7090 CP NO. 000															(007H) PAGE 14 COMPUTED 2001-03-19 17:43:32 USELESS VOLUMES EXCLUDED		
LICENCE OR CUTTING PERMIT STOCK TABLE (M3/HA) - G - DWB															12.5		
TOTAL MERCH AREA															TOTAL USELESS DEAD P		
BLOCK METHOD															TOTAL USELESS DEAD P		
F L C H B S P L E															TOTAL USELESS DEAD P		
MIN DBH 12.5 12.5 12.5 12.5 12.5 12.5 12.5 12.5 12.5 12.5 12.5 12.5 12.5 12.5 12.5															TOTAL USELESS DEAD P		
STUMP HT 30.0 30.0 30.0 30.0 30.0 30.0 30.0 30.0 30.0 30.0 30.0 30.0 30.0 30.0 30.0															TOTAL USELESS DEAD P		
TOP DIA 10.0 10.0 10.0 10.0 10.0 10.0 10.0 10.0 10.0 10.0 10.0 10.0 10.0 10.0 10.0															TOTAL USELESS DEAD P		
LOG LENGTH 5.0 5.0 5.0 5.0 5.0 5.0 5.0 5.0 5.0 5.0 5.0 5.0 5.0 5.0 5.0															TOTAL USELESS DEAD P		
DBH CL															TOTAL USELESS DEAD P		
0																	
15																	
20																	
25																	
30																	
35																	
40																	
45																	
50																	
55																	
60																	
65																	
70																	
75																	
80																	
TOTAL	159.64	24.97	34.94	28.93	20.09	4.62	7.08	280.27									
USELESS																	
DEAD P	14.47																
17.5 +	159.64	24.97	34.94	28.93	20.09	4.62	7.08	280.27									
22.5 +	159.64	23.55	34.94	28.93	20.09	4.62	7.08	278.84									
27.5 +	159.64	23.55	34.94	28.93	20.09	4.62	7.08	278.84									
32.5 +	159.64	23.55	34.94	28.93	20.09	4.62	7.08	278.84									
37.5 +	156.97	21.49	32.49	19.74	20.09	4.62		255.39									
42.5 +	156.97	16.36	32.49	17.23	20.09			243.14									
47.5 +	156.97	12.39	9.29		20.09			198.74									

Figure 9.2 Cutting Permit Stock Table - Sample Listing (Partial).

9.3 Basal Area Table

9.3.1 Basal Area Table - Detail Information

All of the basal area table parameters described below are reported to one decimal place.

9.3.1.1 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.

Timber Type

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

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

Example 9.4

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.

$$BA_{s,d,i} = (20 + 30 + 30 + 50) / 4 = 32.5$$

Block - Average Line method

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

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

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.

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

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

Refer to Example 9.1 for Block level calculations.

Cutting Permit

The cutting permit estimate is the weighted average of the Type estimates based on the a

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

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 9.2 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).

9.3.1.2 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.

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).

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.

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.

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.

9.3.1.3 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.

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)

9.3.1.4 Total Basal Area per Hectare at Five Levels

The total basal area per hectare is also reported for 5 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.

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.

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).

9.3.2 Basal Area Table - Sample Listing - Timber Type Level

Report 007F - required.

FOREST REVENUE BRANCH - 2001.0 NOT FOR APPRAISAL PURPOSES DUE TO NON-STANDARD UTILIZATION									
LICENCE NO. CF7090									
CP NO. 000									
TIMBER TYPE 2									
OCCURANCE									
SELECTIVE									
2.5									
B									
H									
C									
PL									
E									
TOTAL									
USELESS									
DEAD P									
BLOCK METHOD									
TOTAL MERCH AREA									
12.5									
USELESS VOLUMES EXCLUDED									
PAGE 12									
COMPUTED 2001-03-19 17:43:32									
REPORT 007F									
MIN DBH									
12.5									
STUMP HT									
30.0									
TOP DIA									
10.0									
LOG LENGTH									
5.0									
DBH CL									
10									
15									
20									
25									
30									
35									
40									
45									
50									
55									
60									
65									
70									
75									
80									
85									
TOTAL									
USELESS									
DEAD P									
8.9									
2.9									
2.1									
3.5									
0.8									
AVERAGE BASAL AREA AT 5 LEVELS									
1.5									
18.9									
0.8									
1.5									
18.9									
0.8									
1.5									
18.6									
0.8									
1.5									
18.6									
0.8									
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 height tree is based on coded tree heights from measured plots.

$$\bar{H}_{s,d,i} = \frac{\sum_{t=1}^{t_{s,d,i}} H_t}{t_{s,d,i}}$$

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.

$$\bar{H}_{s,d,i} = \frac{(36.6 + 26.5 + 32.2)}{3} = 31.8$$

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.
$\bar{H}_{s,d,i}$	=	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

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

Where:

$\bar{D}_{s,l,i}$ = 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.

π = 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														
NOT FOR APPRAISAL PURPOSES DUE TO NON-STANDARD UTILIZATION *** DOUBLE SAMPLING CRUISE ***														
NOTE - ALL TREES GREATER THAN 275 CM ARE INCLUDED IN THE 275 CM CLASS														
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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. The reports are 1 page per Species in the compilation. 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 utilization standard specified in the Map Area Statement.

Exceptions:

Partition Licences use Appendix 10.2 to assign grades to Hemlock. A new column has been added to the Sound LRF Table to be used for Partition Hemlock, grades 4 and 5. The LRF for all diameter classes for these grades are zero. The average LRF's will be lowered due to the reduction of the sawlog net volume over the total net volume.

Interior White Pine logs from trees recorded as tree class 3,7 and 9 will use Appendix 10.3 to determine grade as of January 1, 2004. When a log is identified as grade 5, an LRF of zero is assigned to it. The average LRF's will be lowered due to the reduction of the sawlog net volume over the total net volume.

In Licence A57077 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 LRF's will be lowered due to the reduction of the sawlog net volume over the total net volume.

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	$DMP_c = (c-5)*5 + 7.5 \text{ cm}$	
$\%D_{s,c,r,i}$	=	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.
CYF_s	=	Chip yield factor for Species s - See Appendix 8.
$CY_{s,r}$	=	Chip yield for Species s and Risk Group r. The Risk Group r, may be a combination of two risk groups
$D_{s,c,r,i}$	=	Decay volume for Species s, Top Diameter Class c, Risk Group r and 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.
$LRF_{s,r,la,i}$	=	LRF (large logs only) for Species s and Type i. The Risk Group r, may be a combination of several risk groups. Large logs have a top diameter ≥ 30 cm.
$LRF_{s,r,i}$	=	LRF for Species s and Type i. The Risk Group r, may be a combination of several risk groups
$LRF_{s,r,sm,i}$	=	LRF (small logs only) for Species s and Type i. The Risk Group r, may be a combination of several risk groups. Small logs have a top diameter < 30 cm and > 4.4 cm.
$VG_{p,s,c,r,i}$	=	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.
$V_{p,s,c,r,i}$	=	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.
339	=	Chip recovery constant for large logs.
360	=	Chip recovery constant for small logs.

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 LRF's (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.

$$VG_{s,c,r,i} = \frac{\sum_{p=1}^{m_i} VG_{p,s,c,r,i}}{m_i} * A_i$$

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

$$\begin{aligned}
 D_{s,c,r,i} &= 0.55 + 1.11 + 1.13 \\
 &= 2.79 \text{ m}^3
 \end{aligned}$$

$$\begin{aligned}
 V_{G,s,c,r,i} &= 27.41 + 55.32 + 3.12 \\
 &= 85.85 \text{ m}^3
 \end{aligned}$$

$$\begin{aligned}
 \%D_{s,c,r,i} &= \frac{2.79}{85.85} * 100 \\
 &= 3.2
 \end{aligned}$$

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 m³ of net merchantable volume in Type 2. The decay for the log is 17.3 percent.

$$\begin{aligned} FBM &= 63.07 * [LRF_{s,c} - (34.256(0.147 - 0.00122 * 42.5) * (17.3 / 2))] \\ &= 63.07 * [235 - (34.256(0.147 - 0.05185) * (8.65))] \\ &= 63.07 * [235 - 28.191] \\ &= 13\ 043 \end{aligned}$$

Example 11.3

There is a Hemlock log in Risk Group 1 within the diameter class (40 - 44.9 cm) in Type 1. The log represents 93.8 m³ of net merchantable volume in Type 1. The decay for the log is 7.3 percent.

$$\begin{aligned} FBM &= 93.8 * [LRF_{s,c} * (1 - (7.3 * 0.01 / 2))] \\ &= 93.8 * [222 * (1 - 0.0365)] \\ &= 93.8 * [213.89256] \\ &= 20\ 064 \end{aligned}$$

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.

11.5.2 Chip Yield by Risk Group Combination

The parameter is reported in bone dry units using chip yield factors, which are listed by species in Appendix 8. The chip yield depends on the average LRF by log size. See below for the definitions of large and small logs.

Report to 2 decimal places.

For the calculation of chip yield:

A small log has a top diameter less than 30 cm.

A large log has a top diameter 30 cm or greater.

All species

$$CY_{s,r} = [(360 - LRF_{s,r,sm,i}) * CYF_s * 0.01] * [VT_{s,r,sm,i} / (VT_{s,r,i})] \\ + [(339 - LRF_{s,r,la,i}) * CYF_s * 0.01] * [VT_{s,r,la,i} / (VT_{s,r,i})]$$

Example 11.4

Using the sample output in Figure 11.1:

$$\text{LRF}_{s,r,sm,i} = (20013 + 31654 + 41643 + 15779) / (163 + 214 + 256 + 92) = 150.47.$$

$$\text{LRF}_{s,r,la,i} = (5519 + 7577 + 13043) / (30 + 38 + 63) = 199.53.$$

$$\text{CYF}_s = 0.067. \text{ (see Cedar Appendix 8)}$$

$$\text{VT}_{s,r,sm,i} = (163 + 214 + 256 + 92) = 725.$$

$$\text{VT}_{s,r,la,i} = (30 + 38 + 63) = 131.$$

$$\text{VT}_{s,r,i} = 725 + 131 = 856.$$

$$\begin{aligned} \text{CY}_{s,r} &= [(360-150.47) * 0.067 * 0.01] * [725 / 856]. \\ &+ [(339-199.53) * 0.067 * 0.01] * [131 / 856]. \end{aligned}$$

$$\begin{aligned} &= [(209.53) * 0.00067] * [0.846963]. \\ &+ [(139.47) * 0.00067] * [0.153037]. \end{aligned}$$

$$\begin{aligned} &= [0.119]. \\ &+ [0.014]. \end{aligned}$$

$$= 0.13$$

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.

$$\%DT_{s,r,i} = \frac{\sum_{r=1}^2 \%D_{s,r,i}}{\sum_{r=1}^2 \text{VGT}_{s,r,i}}$$

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 NOT FOR APPRAISAL PURPOSES DUE TO NON-STANDARD UTILIZATION **** DOUBLE SAMPLING CRUISE **** NOTE - NET VOLUME (G-DWE) IN M3 IN 5. M LOGS 12.5 CM+ DBH INTERIOR FIR - WET BELT CEDAR									
LICENCE NUMBER CF7080 CUTTING PERMIT 000									
LOG TOP DIA (CM)	LRF	GROSS MERCH.	DECAY	NET MERCH.	F.B.M.* MERCH.	GROSS MERCH.	DECAY	NET MERCH.	F.B.M.* MERCH.
6.5 - 7.49	103.	*	*	*	*	*	*	*	*
7.5 - 8.49	108.	*	*	*	*	*	*	*	*
8.5 - 9.9	115.	*	*	*	*	*	*	*	*
10.0 - 14.9	132.	180.	4.4	163.	20013.*	17.	30.0	9.	553.*
15.0 - 19.9	156.	236.	4.1	214.	31654.*	22.	28.8	12.	1140.*
20.0 - 24.9	177.	298.	7.5	256.	41643.*	49.	29.4	26.	3026.*
25.0 - 29.9	197.	121.	13.6	92.	15779.*	69.	29.5	36.	5038.*
30.0 - 34.9	215.	43.	17.3	30.	5519.*	189.	29.1	101.	16296.*
35.0 - 39.9	227.	54.	17.3	38.	7577.*	31.	31.2	15.	2555.*
40.0 - 44.9	235.	89.	17.3	63.	13043.*	50.	31.2	24.	4412.*
45.0 - 49.9	238.	*	*	*	*	*	*	*	*
50.0 - 54.9	239.	*	*	*	*	*	*	*	*
TOTAL FOR ALL LOGS									
L.R.F.		1021.	8.7	857.	135227.*	426.	29.6	222.	33020.*
AVERAGE L.R.F.					158.*				149.*
CHIP RECOVERY		* GROUP 0 + 1		158.		* GROUP 1 + 2	156.		
* DECAY		* GROUP 1+2+3		156.		* GROUP 1 + 2		.13 UNITS/M3	
* STUD LOG NET MER		* GROUP 0 + 1		9.		* GROUP 1 + 2	15.		.13 UNITS/M3
* SMALL LOG NET MER		* GROUP 0 + 1		44.		* GROUP 1 + 2	37.		30.
* LARGE LOG NET MER		* GROUP 0 + 1		85.		* GROUP 1 + 2	75.		9.
				15.		* GROUP 1 + 2	25.		37.
									63.

Figure 11.1 Volume and Lumber Recovery Report - Sample Listing (Partial).

Volume Summaries

12

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.

Do not include Western Yew in the volume summaries.

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.

12.1 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 words REDUCED HEMLOCK LRF will appear in upper case letters at the top of all summary pages when code 04 is used in columns 17-18 of card type B,
 - c. The statement PERCENT REDUCTION APPLIED will be reported in upper case letters and double spaced at the top of all pages when applicable,
 - d. Stump cruise,
 - e. Useless Excluded or Useless Included,
 - f. Selective Cut – Leave,

- g. Selective Cut – Cut,
 - h. 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. 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.
- 15. Type of calculation:
 - a. Average Line,
 - b. Block.
- 16. Compiled date and time.
- 17. Compilation type used for the standards of the species.
- 18. Species letter codes.
- 19. Conifer.

- 20. Total.
- 21. DBH lower limit of the species.
- 22. Stump height of the species.
- 23. Minimum top diameter of the species.
- 24. Log length of the species.

12.2 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.

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.

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
360	=	Chip recovery constant for small 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
CV_i	=	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
$\bar{D}_i$	=	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_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
$LRF_{s,c}$	=	Lumber recovery factor for Species s and Top Diameter Class c
$\overline{LRF}_{s,la,i}$	=	Average LRF based on large logs for Species s in Type i
$\overline{LRF}_{s,sm,i}$	=	Average LRF based on small logs for Species s in 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
π	=	$\cong (3.14159265)$
$p_{i,j}$	=	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
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

12.2.1 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

$$VGT_1 = \frac{148.12 + 131.83 + 107.37}{3} * 5 = 646 \text{ m}^3$$

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

$$VGT_{i,u} = VGT_2 * (A_{i,u} \div A_i) = 958 * (2.5 \div 7.5) = 319 \text{ m}^3$$

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.

$$VGT_j = \sum_{i=1}^{I_j} VGT_{i,j} * (A_{i,j} \div A_i)$$

Report to nearest whole number.

Example 12.3Block 1

$$VGT_j = 646 * (2.5/5.0) + 958 * (2.5/7.5) = 642 \text{ m}^3$$

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

$$VGT_j = ((148.12+131.83) / 2 * 2.5) + (108.73 / 1 * 2.5) = 622 \text{ m}^3$$

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

$$VGT_{j,u} = (646 * (0/5)) + (958 * (2.5/7.5)) = 319 \text{ m}^3$$

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.

$$VGT_{j,u} = (122.17+152.16) / 2 * 2.5 = 343 \text{ m}^3$$

12.2.2 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 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.

12.2.3 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.

12.2.4 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.

12.2.5 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.

12.2.6 Percent Waste - Gross

The percent waste – gross is calculated the same way as the percent decay – gross.

Report the percent waste – gross for all reporting levels.

Timber Type

$$\%WG_I = \frac{WT_i}{VGT_i} * 100$$

The method for determining the total waste volume is the same as for total gross volume.

Report to nearest whole number.

12.2.7 Percent Waste (Billing) - Net

The percent waste – net is calculated the same way as the percent waste – gross, only the total waste volume is divided by the total **net** volume. Report the percent waste – net for all reporting levels.

Timber Type

$$\%W_I = \frac{WT_i}{VT_i} * 100$$

Report to nearest whole number.

12.2.8 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.

12.2.9 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.

12.2.10 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.

12.2.11 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 3.5.1.2 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:

$$\bar{D}_I = 100 * 2 * \sqrt{\frac{BA_i}{\pi * S_i}}$$

12.2.12 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.

12.2.13 Merchantable Volume per Tree - Gross

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.

12.2.14 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.

12.2.15 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:

$$HBV_p = \sum_{t=1}^{n_p} \frac{B_t * H_t}{\text{plotsize}}$$

$$BV_p = \sum_{t=1}^{n_p} \frac{B_t}{\text{plotsize}}$$

$$HBV_i = \frac{\sum_{p=1}^{m_i} HBV_p}{m_i}$$

$$BV_i = \frac{\sum_{p=1}^{m_i} BV_p}{m_i}$$

$$WH_i = \frac{HBV_i}{BV_i}$$

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

$$1. \quad HBV_1 = \frac{2 * 10.0 * 12732.39545}{45.5^2} * 36.6 * 2.481693 * 0.875$$

$$= 9775.8497$$

$$HBV_2 = 3847.0289$$

$$HBV_3 = 2601.3376$$

$$HBV_i = (9775.8497 + 3847.0289 + 2601.3376) = 16224.22$$

$$2. \quad BV_1 = \frac{2 * 10.0 * 12732.39545}{45.5^2} * 2.481693 * 0.875$$

$$= 267.0997$$

$$BV_2 = 119.4729$$

$$BV_3 = 98.1637$$

$$BV_i = (267.0997 + 119.4729 + 98.1637) = 484.65$$

The average total weighted height for Type 1 is:

$$WH_1 = 16224.22 / 484.65 = 33.5 \text{ m}$$

12.2.16 Average Weighted Merchantable Height

The merchantable height and volume are from stump height to utilization top diameter.

Use the same method as for the average weighted total height.

Report to 1 decimal place.

12.2.17 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

$$NL_p = \sum_{t=1}^{n_p} \frac{BAF_t * 12732.39545}{DBH_t^2} * NL_t$$

Fixed area plots

$$NL_p = \sum_{t=1}^{n_p} \frac{NL_t}{\text{plotsize}}$$

Timber Type

The number of logs estimate for the Timber Type must be calculated.

$$NL_{i,} = \frac{\sum_{p=1}^{m_i} NL_p}{m_i}$$

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 m³.

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.

$$NL_1 = (645.768 + 397.651 + 296.016) / 3 = 446.478$$

$$VGT_1 = \frac{2 * 10.0 * 12732.39545}{45.5^2} * 2.408381 * 0.875 = 259.209$$

$$VGT_2 = 115.354$$

$$VGT_3 = 93.948$$

The Timber Type per hectare gross volume is:

$$VGT_1 = (259.209 + 115.354 + 93.948) / 3 = 156.17$$

$$DT_1 = \frac{2 * 10.0 * 12732.39545}{45.5^2} * 1.387227 * 0.875 = 149.305$$

$$DT_2 = 15.342$$

$$DT_3 = 9.958$$

The Timber Type per hectare decay is:

$$DT_1 = (149.305 + 15.342 + 9.958) / 3 = 58.202$$

$$WT_1 = \frac{2 * 10.0 * 12732.39545}{45.5^2} * 0.341989 * 0.875 = 36.808$$

$$WT_2 = 5.883$$

$$WT_3 = 0.0939$$

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:

$$\frac{156.17 - 14.26 - 58.202}{446.478} = 0.19$$

12.2.18 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

$$LPT_1 = \frac{NL_i}{S_i * A_i}$$

Report to 2 decimal places.

12.2.19 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 at this URL: <http://www.for.gov.bc.ca/revenue/manuals/cruising/Table-10.htm>

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 = $(110.57 + 131.92) / (88.69 + 110.57 + 131.92) = .73$
 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 = $202.82 / 277 = .73 * 100 = 73$

12.2.20 Percent Net Merch - Small Logs

Grade each log by the coastal or interior log grade algorithms (see Appendices 9 & 10). 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 Lumber and Chip Information – Interior Only

The lumber and chip information is also contained in chapter 11 – Volume and Lumber Recovery Reports.

12.3.1 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.

12.3.2 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.

12.3.3 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.

12.3.4 LRF - Small Logs (bd ft/m³)

Each log has a Top Diameter Class and an associated Lumber Recovery Factor (LRF), depending on the Species. (See Appendix 7). For each Top Diameter Class there is a mid-point, DMP_c, of the class. Mid-points are defined in section 11.3.5. See Chapter 11 for more information on LRFs.

For Interior cruises that include the species Douglas Fir, Card Type B column 14 on the Map Area Statement will be marked either with a 1 or a 2. If a 1 is used, the cruise is in the wet belt Douglas Fir zone, while a 2 indicates the cruise is in the dry belt zone.

Appendix 7 lists the LRF's for these variations under the headings (wet belt), F-wb and (dry belt), F-db.

If the cutting permit occupies both Wet and Dry belt zones, compile using the zone with the highest total Douglas Fir net volume (before reduction).

Optionally, Fir may be broken down into Quality Class 1 or 2. An algorithm to compute this on a tree by tree basis is shown in Appendix 18. In Appendix 7 these classes are indicated by the headings, F-qcl for Quality Class 1 and F-qc2 for Quality Class 2.

A small log for lumber recovery, has a top diameter less than 30.0 cm.

LRF is defined as the total FBM divided by the net merchantable volume.

Calculate Foot Board Measure (FBM) for each log as follows:

Cedar:

$$FBM_i = V_i * [LRF_{s,c} - (34.256(0.147 - 0.00122) * (DMP_c * (\%D_i / 2)))]$$

Other Species:

$$FBM_i = V_i * [LRF_{s,c} * (1 - (\%D_i * 0.01 / 2))]$$

Timber Type

$$FBM_I = \sum_{i=1}^{NL_i} FBM_i$$

$$LRF_I = \frac{FBM_i}{VT_i}$$

Report to nearest whole number.

12.3.5 LRF - Large Logs (bd ft/m³)

A large log has a top diameter of 30.0 cm or greater. Using only large logs, calculate the LRF using the same method as for small logs.

Report to nearest whole number.

12.3.6 Average LRF - All Logs (bd ft/m³)

Calculate the average LRF for all logs by adding the small and large log FBM and dividing by the total net merchantable volume.

Report to nearest whole number.

12.3.7 Chip Yield

Each Species has a chip yield factor used to convert volume and LRF information into chip yield, expressed in 'bone dry units' (see Appendix 8 and Section 11.4.6).

$$CY_{s,i} = [(360 - \overline{LRF}_{s,sm,i}) * CYF_s * 0.01] * [VT_{s,sm,i} / (VT_{s,i})] + [(339 - \overline{LRF}_{s,la,i}) * CYF_s * 0.01] * [VT_{s,la,i} / (VT_{s,i})]$$

Timber Type

$$CY_I = \frac{\sum_{s=1}^{sp_i} CY_{s,i} * VT_{s,i}}{VT_i}$$

Coniferous and all Species Totals

Species cannot be grouped together in the chip yield calculation, as a chip yield factor is dependent on a particular species. Therefore, the Coniferous total and All Species total are obtained by weighting the species parameters by the proportional gross volume of the species.

12.4 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.

12.4.1 Number of Measured Plots Used

Average line method:

$$\# \text{ measure plots} = \sum_{i=1}^{I_j} m_i$$

Block method:

$$\# \text{ measure plots} = \sum_{i=1}^{I_j} m_{i,j}$$

12.4.2 Type of Plots

Report either 'Fixed' or 'Prism'. If both fixed area and prism plots are used in the Block, report 'Mixed'.

12.4.3 Number of Measured Potential Trees

A tree tallied in a border or half 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.

12.4.4 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.

12.4.5 Number of Trees per Plot - Cutting Permit and Timber Type Only

Divide the total number of trees tallied (all Species combined), excluding tree class 4 and 6 by the number of plots in the Cutting Permit. Include count plots in the average.

Report to 1 decimal place.

Example 12.12

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:

$$(84 + (6 + 6) - 1) / 12 = 7.9$$

12.4.6 Coefficient of Variation for Volume

Block

The Block coefficient of variation (CV) is a weighted average of the Type CVs. Weight the Type CVs based on the proportional volume of the Type within the Block based on measured plots only. Do not correct for double sampling. Refer to Section 8.4.2.9 for an explanation of the Type CV.

$$p_{i,j} = \frac{V_{m,i} * A_i}{\sum_{i=1}^{I_j} V_{m,i} * A_i}$$

Average Line Method:

The Type CVs are based on all the measure plots from the Type.

$$CV_j = \sqrt{\sum_{i=1}^{I_j} p_{i,j}^2 CV_i^2}$$

Block Method:

The Type CVs are based on only those measure plots from the Type within the Block.

$$CV_j = \sqrt{\sum_{i=1}^{I_j} p_{i,j}^2 CV_{i,j}^2}$$

12.4.7 95% 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.

$$95\% \text{ CI} = \pm 100 * \frac{\sqrt{\sum_{i=1}^{I_j} r_{i,j}^2 SEM_i^2}}{V_j} * t\text{-value (refer to Appendix 11)}$$

Block Method:

Weight the Type SEMs based on plots from the Type within the Block.

$$95\% \text{ CI} = \pm 100 * \frac{\sqrt{\sum_{i=1}^{I_j} r_{i,j}^2 SEM_{i,j}^2}}{V_j} * t\text{-value (refer to Appendix 11)}$$

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.

12.5 Volume Summary - Sample Listings

Report 009A - Timber Type summary - required.

FOREST REVENUE BRANCH - 2001.0 TIMBER TYPE SUMMARY							(009A)	PAGE	1
NOT FOR APPRAISAL PURPOSES DUE TO NON-STANDARD UTILIZATION							COMPUTED 2001-03-19 17:42:57		
**** DOUBLE SAMPLING CRUISE ****							AVERAGE LINE		
LICENCE NUMBER	CF7080	P.S.Y.U.	34-0	USELESS VOLUMES EXCLUDED					
CUTTING PERMIT	000	F.I.Z.	J	NO OF TIMBER TYPES	2	TOTAL MERCH AREA	12.5		
TIMBER TYPE 01				NO. OF PLOTS	USED (M/C)	3	3	TIMBER	
CLEARCUT	5.0	SELECTIVE							
UTILIZATION	PA	PL	C	H	B	E	CONIFER	TOTAL	
COMPILATION TYPE	3	3	3	3	3	3			
MINIMUM DBH	12.5	12.5	12.5	12.5	12.5	12.5			
STUMP HEIGHT	30.0	30.0	30.0	30.0	30.0	30.0			
TOP DIAMETER	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			
VOLUME AND SIZE DATA									
GROSS MERCH VOLUME	M3	1748.	781.	538.	852.	423.	233.	5117.	5349.
NET MERCH VOLUME	M3	1473.	403.	313.	469.	337.	127.	3540.	3667.
NET MERCH./HECTARE	M3	295.	81.	63.	94.	67.	25.	708.	733.
% DISTRIBUTION/HECTARE		40.	11.	9.	13.	9.	3.	97.	100.
DECAY % GROSS		10.	37.	26.	29.	13.	32.	21.	21.
WASTE % GROSS		4.	9.	8.	13.	4.	10.	7.	7.
WASTE (BILLING) % NET		4.	18.	14.	23.	5.	18.	10.	10.
BREAKAGE % GROSS		2.	2.	8.	3.	4.	4.	3.	3.
TOTAL CULL (DWB) % GROSS		16.	48.	42.	45.	20.	45.	31.	31.
STEMS/HA (GREEN & DP)		102.5	82.6	70.9	66.0	56.3	40.2	423.0	463.2
SNAGS/HA (DU)		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AVG. DBH (GREEN&DP) CM		59.3	42.4	42.4	47.4	38.8	32.5	48.6	47.4
AVG. DBH (SNAGS) CM		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
GROSS MERCH VOL/TREE M3		3.41	1.89	1.52	2.58	1.50	1.16	2.42	2.31
NET MERCH VOL/TREE M3		2.87	0.98	0.88	1.42	1.20	0.63	1.67	1.58
AVG. WEIGHT TOTAL HT M		30.3	33.5	33.5	38.9	32.4	38.8	34.5	34.7
AVG. WEIGHT MERCH HT M		26.9	27.9	27.7	33.4	26.7	29.5	29.6	29.6
AVG. 5M LOG NET MER M3		0.56	0.19	0.19	0.24	0.25	0.11	0.31	0.29
AVG. # OF 5M LOGS/TREE		5.24	5.40	5.16	6.38	5.00	6.00	5.59	5.63
LUMBER AND CHIPS									
% NET MERCH - STUD LOG			10			15		4	4
% NET MERCH - SMALL LOG	15	45	55	33	54	100	29	31	
% NET MERCH - LARGE LOG	85	55	45	67	46		71	69	
LRF SMALL LOGS BD FT/M3	187	179	132	171	187	166	173	172	
LRF LARGE LOGS BD FT/M3	229	195	167	201	214		216	216	
AVG LRF BD FT/M3	223	188	147	191	200	166	204	203	
CHIP YIELD UNITS/M3	.09	.14	.14	.14	.11	.21	.11	.11	
ALGORITHM GRADE %									
#1 SAWLOG	61.	0.	51.	90.	100.	15.	56.	54.	
#3 SAWLOG	0.	62.	0.	0.	0.	0.	7.	7.	
#4 CHIPPER	30.	38.	49.	10.	0.	85.	28.	30.	
#5 CHIPPER	9.	0.	0.	0.	0.	0.	9.	9.	
STATISTICAL SUMMARY									
NO. OF MEASURED PLOTS USED			3						
TYPE OF PLOTS			PRISM						
NO. OF MEASURED POTENTIAL TREES			29.0						
COEFF. OF VARIATION			19.0						
TWO STANDARD ERRORS			46.0						

Figure 12.1 Type Volume Summary - Sample Listing (Partial).

Report 009D - Treatment Unit within Block summary - required for coast compilations.

FOREST REVENUE BRANCH - 2001.0		TREATMENT UNIT SUMMARY				{009D}	PAGE 47	
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	BLOCK TOTAL		5.0		
CLEARCUT	5.0							
UTILIZATION	PA	PL	C	H	B	E	CONIFER	TOTAL
COMPILATION TYPE	3	3	3	3	3	3		
MINIMUM DBH	12.5	12.5	12.5	12.5	12.5	12.5		
STUMP HEIGHT	30.0	30.0	30.0	30.0	30.0	30.0		
TOP DIAMETER	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		
VOLUME AND SIZE DATA								
GROSS MERCH VOLUME M3	1742.	517.	572.	749.	607.	202.	4575.	4776.
NET MERCH VOLUME M3	1484.	235.	412.	420.	481.	110.	3305.	3414.
NET MERCH./HECTARE M3	297.	47.	82.	84.	96.	22.	661.	683.
% DISTRIBUTION/HECTARE	43.	7.	12.	12.	14.	3.	97.	100.
DECAY % GROSS	9.	42.	17.	28.	13.	32.	18.	19.
WASTE % GROSS	3.	10.	5.	12.	4.	10.	6.	6.
WASTE(BILLING) % NET	4.	23.	7.	22.	5.	18.	9.	9.
BREAKAGE % GROSS	2.	2.	7.	3.	4.	4.	3.	3.
TOTAL CULL (DWB) % GROSS	15.	55.	28.	44.	21.	46.	28.	29.
STEMS/HA (GREEN & DP)	135.0	51.6	135.4	72.6	70.2	36.8	487.2	524.0
SNAGS/HA (DU)	12.3	0.0	0.0	0.0	0.0	0.0	12.3	12.3
AVG. DBH (GREEN&DP) CM	51.8	43.0	33.6	44.3	39.6	33.9	43.6	43.0
AVG. DBH (SNAGS) CM	52.5	0.0	0.0	0.0	0.0	0.0	52.5	52.5
GROSS MERCH VOL/TREE M3	2.50	2.01	0.84	2.06	1.73	1.10	1.88	1.82
NET MERCH VOL/TREE M3	2.20	0.91	0.61	1.16	1.37	0.60	1.36	1.30
AVG. WEIGHT TOTAL HT M	30.0	34.5	29.7	36.3	36.2	35.0	33.3	33.4
AVG. WEIGHT MERCH HT M	26.3	28.8	23.6	30.6	30.2	26.4	28.2	28.2
AVG. 5M LOG NET MER M3	0.45	0.17	0.18	0.21	0.25	0.13	0.28	0.27
AVG. # OF 5M LOGS/TREE	5.04	5.72	3.78	5.74	5.80	5.09	5.07	5.07
LUMBER AND CHIPS								
% NET MERCH STUD LOG		10			12		3	3
% NET MERCH - SMALL LOG	26	43	72	41	51	100	38	40
% NET MERCH - LARGE LOG	74	57	28	59	49		62	60
LRF SMALL LOGS BD FT/M3	193	175	146	173	190	167	176	176
LRF LARGE LOGS BD FT/M3	228	190	179	198	214		217	217
AVG LRF BD FT/M3	219	184	155	188	202	167	201	200
CHIP YIELD UNITS/M3	.10	.14	.13	.14	.11	.21	.11	.12
ALGORITHM GRADE %								
#1 SAWLOG	62.	0.	77.	74.	68.	51.	60.	59.
#3 SAWLOG	14.	66.	0.	0.	0.	0.	11.	11.
#4 CHIPPER	19.	33.	23.	26.	32.	49.	24.	25.
#5 CHIPPER	5.	1.	0.	0.	0.	0.	5.	5.

Figure 12.2 Treatment Unit within Block Volume Summary - Sample Listing (Partial).

Report 009B - Block summary - required.

FOREST REVENUE BRANCH - 2001.0		BLOCK SUMMARY				(009B)	PAGE 48	
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	BLOCK TOTAL		5.0		
CLEARCUT	5.0							
UTILIZATION	PA	PL	C	H	B	E	CONIFER TOTAL	
COMPILATION TYPE	3	3	3	3	3	3		
MINIMUM DBH	12.5	12.5	12.5	12.5	12.5	12.5		
STUMP HEIGHT	30.0	30.0	30.0	30.0	30.0	30.0		
TOP DIAMETER	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		
VOLUME AND SIZE DATA								
GROSS MERCH VOLUME M3	1742.	517.	572.	749.	607.	202.	4575.	4776.
NET MERCH VOLUME M3	1404.	235.	412.	420.	481.	110.	3305.	3414.
NET MERCH./HECTARE M3	297.	47.	82.	84.	96.	22.	661.	683.
% DISTRIBUTION/HECTARE	43.	7.	12.	12.	14.	3.	97.	100.
DECAY % GROSS	9.	42.	17.	28.	13.	32.	18.	19.
WASTE % GROSS	3.	10.	5.	12.	4.	10.	6.	6.
WASTE(BILLING) % NET	4.	23.	7.	22.	5.	18.	9.	9.
BREAKAGE % GROSS	2.	2.	7.	3.	4.	4.	3.	3.
TOTAL CULL(DWB) % GROSS	15.	55.	28.	44.	21.	46.	28.	29.
STEMS/HA (GREEN & DP)	135.0	51.6	135.4	72.6	70.2	36.8	487.2	524.0
SNAGS/HA (DU)	12.3	0.0	0.0	0.0	0.0	0.0	12.3	12.3
AVG. DBH (GREEN&DP) CM	51.8	43.0	33.6	44.3	39.6	33.9	43.6	43.0
AVG. DBH (SNAGS) CM	52.5	0.0	0.0	0.0	0.0	0.0	52.5	52.5
GROSS MERCH VOL/TREE M3	2.58	2.01	0.84	2.06	1.73	1.10	1.88	1.82
NET MERCH VOL/TREE M3	2.20	0.91	0.61	1.16	1.37	0.60	1.36	1.30
AVC. WEIGHT TOTAL HT M	30.0	34.5	29.7	36.3	36.2	35.0	33.3	33.4
AVG. WEIGHT MERCH HT M	26.3	28.8	23.6	30.6	30.2	26.4	28.2	28.2
AVG. 5M LOG NET MER M3	0.45	0.17	0.18	0.21	0.25	0.13	0.28	0.27
AVG. # OF 5M LOGS/TREE	5.04	5.72	3.78	5.74	5.80	5.09	5.07	5.07
LUMBER AND CHIPS								
% NET MERCH - STUD LOG		10			12		3	3
% NET MERCH - SMALL LOG	26	43	72	41	51	100	38	40
% NET MERCH - LARGE LOG	74	57	28	59	49		62	60
LRF SMALL LOGS BD FT/M3	193	175	146	173	190	167	176	176
LRF LARGE LOGS BD FT/M3	228	190	179	198	214		217	217
AVG LRF BD FT/M3	219	184	155	188	202	167	201	200
CHIP YIELD UNITS/M3	.10	.14	.13	.14	.11	.21	.11	.12
ALGORITHM GRADE %								
#1 SAWLOG	62.	0.	77.	74.	68.	51.	60.	59.
#3 SAWLOG	14.	66.	0.	0.	0.	0.	11.	11.
#4 CHIPPER	19.	33.	23.	26.	32.	49.	24.	25.
#5 CHIPPER	5.	1.	0.	0.	0.	0.	5.	5.
STATISTICAL SUMMARY								
NO. OF MEASURED PLOTS USED	6							
TYPE OF PLOTS	PRISM							
NO. OF MEASURED POTENTIAL TREES	56.0							
COEFF. OF VARIATION	11.9							
TWO STANDARD ERRORS	18.4							

Figure 12.3 Block Volume Summary - Sample Listing (Partial).

Report 009C - Cutting Permit summary - required.

FOREST REVENUE BRANCH - 2001.0 CUTTING PERMIT SUMMARY (009C) PAGE 96									
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				
UTILIZATION	PA	PL	C	H	B	E	CONIFER	TOTAL	
COMPILATION TYPE	3	3	3	3	3	3			
MINIMUM DBH	12.5	12.5	12.5	12.5	12.5	12.5			
STUMP HEIGHT	30.0	30.0	30.0	30.0	30.0	30.0			
TOP DIAMETER	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			
VOLUME AND SIZE DATA									
GROSS MERCH VOLUME M3	4353.	1161.	1447.	1821.	1610.	489.	11165.	11654.	
NET MERCH VOLUME M3	3717.	503.	1079.	1025.	1274.	266.	8144.	8409.	
NET MERCH./HECTARE M3	297.	40.	86.	82.	102.	21.	651.	673.	
% DISTRIBUTION/HECTARE	44.	6.	13.	12.	15.	3.	97.	100.	
DECAY % GROSS	9.	44.	15.	20.	13.	32.	18.	18.	
WASTE % GROSS	3.	11.	4.	12.	4.	10.	6.	6.	
WASTE(BILLING) % NET	4.	25.	6.	22.	5.	18.	8.	9.	
BREAKAGE % GROSS	2.	2.	6.	3.	4.	4.	3.	3.	
TOTAL CULL(DWB) % GROSS	15.	57.	25.	44.	21.	46.	27.	28.	
STEMS/HA (GREEN & DP)	141.5	45.4	148.3	73.9	73.0	36.2	500.0	536.2	
SNAGS/HA (DU)	14.8	0.0	0.0	0.0	0.0	0.0	14.8	14.8	
AVG. DBH (GREEN&DP) CM	50.7	43.3	32.6	43.7	39.8	34.3	42.7	42.2	
AVG. DBH (SNAGS) CM	52.5	0.0	0.0	0.0	0.0	0.0	52.5	52.5	
GROSS MERCH VOL/TREE M3	2.46	2.05	0.78	1.97	1.76	1.08	1.79	1.74	
NET MERCH VOL/TREE M3	2.10	0.89	0.58	1.11	1.40	0.59	1.30	1.25	
AVG. WEIGHT TOTAL HT M	29.9	34.8	29.1	35.7	36.7	34.1	33.0	33.1	
AVG. WEIGHT MERCH HT M	26.2	29.2	22.9	29.9	30.7	25.7	27.9	27.8	
AVG. 5M LOG NET MER M3	0.43	0.16	0.17	0.21	0.25	0.13	0.27	0.26	
AVG. # OF 5M LOGS/TREE	5.02	5.84	3.65	5.62	5.92	4.89	4.98	4.97	
LUMBER AND CHIPS									
% NET MERCH - STUD LOG		9			12		3	3	
% NET MERCH - SMALL LOG	28	43	75	43	51	100	40	42	
% NET MERCH - LARGE LOG	72	57	25	57	49		60	58	
LRF SMALL LOGS BD FT/M3	194	174	147	173	190	167	177	176	
LRF LARGE LOGS BD FT/M3	228	188	182	197	214		217	217	
AVG LRF BD FT/M3	218	182	156	187	202	167	201	200	
CHIP YIELD UNITS/M3	.10	.14	.13	.14	.11	.21	.11	.12	
ALGORITHM GRADE %									
#1 SAWLOG	63.	0.	81.	70.	64.	59.	60.	61.	
#3 SAWLOG	16.	69.	0.	0.	0.	0.	12.	11.	
#4 CHIPPER	17.	30.	19.	30.	36.	41.	24.	24.	
#5 CHIPPER	4.	1.	0.	0.	0.	0.	4.	4.	
STATISTICAL SUMMARY									
NO. OF MEASURED PLOTS USED		6							
TYPE OF PLOTS		PRISM							
NO. OF PLOTS PER HA(M/C)		1.0							
NO. OF MEASURED POTENTIAL TREES		56.0							
NO. OF TREES PER PLOT(M/C)		7.9							
COEFF. OF VARIATION	17.0	33.2	23.4	62.7	37.8	122.6		11.2	
TWO STANDARD ERRORS	24.0	72.7	31.6	108.6	48.9	138.9		17.1	
MEASURED 2 STAND ERROR	27.2	53.2	37.6	100.5	60.6	196.5		17.9	

Figure 12.4 Cutting Permit Volume Summary - Sample Listing (Partial).

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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
LC	- Skyline Clear Cut
LL	- Skyline Selective Cut
HO	- Horse
SC	- Ground Skidding Clear Cut
SS	- Ground Skidding Selective Cut
SP	- Specified Operation

For non-appraisal compilations, the Block maturity can be left blank. In these cases, the main plot DBH lower limit in the Map Area Statement is used to determine maturity.

If there are no plots in a Harvest Method, then use the Average Line method of calculation, even if the Block Method is specified. If more than one Type is in the Harvest Method, then weight the parameters based on the proportional area of the Type within the Harvest method.

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. Cottonwood, Alder, Maple, Birch and Aspen are deciduous species and would not be included in the coniferous total.

Do not include Western Yew.

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.

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. Utilization levels 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.
 - f. Reduced hemlock LRF compilation.
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 Type i
$VGT_{,h}$	=	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. Multiply 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:

$$VGT_h = \left(\frac{148.12 + 131.83 + 107.37}{3} * 5 * \frac{2.5}{5} \right) + \left(\frac{108.73 + 122.17 + 152.16}{3} * 7.5 * \frac{5}{7.5} \right) = 961 \text{ m}^3$$

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:

$$VGT_h = \left(\frac{131.83 + 107.37}{2} * 5 * \frac{2.5}{5} \right) + \left(\frac{108.73 + 152.16}{2} * 7.5 * \frac{5}{7.5} \right) = 951 \text{ m}^3$$

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

These reports are phased out as of April 1, 2003 and so will not be described here.

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 also <http://www.for.gov.bc.ca/revenue/manuals/cruising/Table-10.htm#TopOfPage> 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 not subtract the breakage percent.

The number of merchantable logs in a tree includes the small 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, 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 give the total number of logs.

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:

$$NL_p = \frac{\sum_{t=1}^{n_p} NL_t}{\text{plotsize}}$$

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. Multiply 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. Multiply 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 m³

Total net volume in Type 2 within Harvest Method SC = 385 m³

Total net volume in Harvest Method SC = 582 m³

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 is second growth based on plot age in 10s. The Cedar is second growth based on tree class. The Hemlock is Tree Class 5 and no tree class 5 or 7 trees are 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 will be viewed 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.

$$\%SL_h = \frac{\sum_{i=1}^{I_h} \%SL_{i,h} * A_{i,h}}{A_h}$$

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:

$$\%SL_h = ((85 * 2.5) + (55 * 5)) / 7.5 = 65$$

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

Grade each log by the coastal or interior log grade algorithms (see Appendices 9 & 10). 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 on the coast or from Blank grade to grade 5 in the interior.

Example 13.6

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 and Chip 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 the using the same method as for the stud logs but include all species.

Report to nearest whole number.

13.3.4 LRF – Small Logs

Each log has a Top Diameter Class and an associated LRF, depending on the Species. (See Appendix 7). For each Top Diameter Class there is a mid-point, DMP_c , of the class. Mid-points are defined in section 11.3.5. See Chapter 11 for more information on LRF.

For Interior cruises that include the species Douglas Fir, Card Type B column 14 on the Map Area Statement will be marked either with a 1 or a 2. If a 1 is used, the cruise is in the wet belt Douglas Fir zone, while a 2 indicates the cruise is in the dry belt zone. Appendix 7 lists the LRF's for these variations under the headings (wet belt), F-wb and (dry belt), F-db.

If the cutting permit occupies both Wet and Dry belt zones, compile using the zone with the highest total Douglas Fir net volume based on the cruise data.

Optionally, Fir may be broken down into Quality Class 1 or 2. An algorithm to compute this on a tree by tree basis is shown in Appendix 18. In Appendix 7 these classes are indicated by the headings, F-qcl for Quality Class 1 and F-qc2 for Quality Class 2.

A small log has a top diameter less than 30.0 cm.

LRF is the total FBM divided by the net merchantable volume.

Calculate Foot Board Measure (FBM) for each log as follows:

Cedar:

$$FBM_1 = V_1 * [LRF_{sp,c} - (34.256(0.147 - 0.00122 * DMP_c * (\%D_1 / 2)))]$$

Other Species:

$$FBM_1 = V_1 * [LRF_{sp,c} * (1 - (\%D_1 * 0.01 / 2))]$$

Harvest Method

$$FBM_{s,h} = \sum_{l=1}^{NL_{s,h}} FBM_1$$

$$LRF_{s,h} = \frac{FBM_{s,h}}{VT_h}$$

Report to nearest whole number.

All Method

Sum the FBM of small logs from the Cutting Permit. Divide by the net volume of the Cutting Permit.

Report to nearest whole number.

13.3.5 LRF – Large Logs

A large log has a top diameter of 30.0 cm or greater. Using only large logs, calculate the LRF the same as for the small logs.

Report to nearest whole number.

13.3.6 Average LRF – All Logs

Calculate the average LRF for all logs by adding the small and large log FBM and dividing by the total net merchantable volume.

Report to nearest whole number.

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Appraisal Summaries

14

Appraisal Summary Reports are mandatory as of April 1, 2003.

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. If the compilation is not for appraisals, label the appraisal summary "Not for Appraisals".

14.1 Appraisal Summary - Coast

14.1.1 Header information

Include the following header information for the Coast Cruise 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.

^{*} The second growth percent reported is for coniferous species only.

14.1.2 Detail Information

Report the following detail information for the Coast Cruise 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.

The columns would report each grade percent, with an extra column reporting the total net merchantable volume for the species from the All Method report (see Chapter 13).

Report the sum of the total net volume column.

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 for each parameter.

Net volume	Report the total net merchantable volume from the Harvesting Method Summary.
Net Volume per 10 m Log	Use the actual utilization log length, if not equal to 10 m.
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 m³. The post-reduction net merchantable volume is 1696 m³.

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. Do not report this parameter if a reduction is being compiled.
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

Report each of the following parameters from the All Method Summary report (see 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.

14.2 Coast Appraisal Summary - Sample Listing

COAST APPRAISAL SUMMARY																COMPUTED 2001-03-19 15:50:22			
FOREST REVENUE BRANCH - 2001.0																			
MINISTRY OF FORESTS - APPRAISAL INFORMATION																			
LICENCE NUMBER TL7070 CUTTING PERMIT 001																			
NO. OF BLOCKS 002																LOCATION TEST 2000			
SECOND GROWTH PERCENT: 76. %																TOTAL MERCH AREA 12.5			
SPECIES GRADE PERCENTS - ALL METHOD																			
SPECIES/GENUS		B	C	D	E	F	G	H	I	J	K	L	M	U	X	Y	TOTAL		
ALDER		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.		
MAPLE		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.		
BIRCH		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.		
BALSALM		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.		
CEDAR		0	0	15	0	0	0	19	16	41	0	0	0	3	8	13	1338.		
COTTONWOOD		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.		
CYPRESS		0	0	15	0	5	0	3	0	0	0	0	0	0	0	0	0.		
FIR		0	8	14	0	6	0	14	5	25	0	0	0	4	20	53	1205.		
HEMLOCK		0	0	0	0	15	0	42	13	13	0	0	0	9	1	18	5462.		
LOGSPOLE		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.		
SPRUCE		0	0	9	2	11	9	18	11	35	0	0	0	0	0	0	1983.		
WHITE PINE		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.		
WH BARK PINE		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.		
YELLOW PINE		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.		
TOTAL NET VOLUME: 13776.																			
INDIVIDUAL HARVESTING METHOD SUMMARIES																			
VARIABLE		CONVENTIONAL		HELIICOPTER		GROUND SKIDDER		HORSE		SKYLINE		SPECIFIED							
		CLEARCUT SELECT		CLEARCUT SELECT		CLEARCUT SELECT		CLEARCUT SELECT		CLEARCUT SELECT		CLEARCUT SELECT							
NET MERCH VOLUME M3		0.00 0.00		0.00 0.00		11408. 2367.		0.00 0.00		0.00 0.00		0.00 0.00							
NET MERCH./10M LOG						1.00 0.92													
NET VOLUME/HECTARE						1140.846 946.880													
HEMLOCK / BALSALM VOL %						30. 24.													
PARTIAL CUT																			
AVERAGE SLOPE %																			
DOWN TREE VOL %						60. 90.													
HEAVY FIRE DAMAGE VOL %						9. 2.													
CUTTING AUTHORITY																			
95% CONF. INTERVAL (M/C)		46.5																	
TREES PER PLOT (M/C)		9.6																	
BLOCK NUMBER:		001 002																	
% IMMATURE BY BLOCK		23. 24.																	
PLOTS (M/C) PER HA		0.6																	

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 (Albicaulis Pine).
10. Conifer - combine all coniferous Species in the compilation.

Net Volume	Report the net merchantable volume from the All Method Summary.
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	Report the Lodgepole Pine volume for Highlead/Grapple Harvest Methods from the Harvesting Method Report.

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.

14.4 Interior Appraisal Summary - Sample Listing

FOREST REVENUE BRANCH - 2001.0		INTERIOR APPRAISAL SUMMARY				
COMPUTED 2001-03-19 17:43:35						
NOT FOR APPRAISAL PURPOSES DUE TO NON-STANDARD UTILIZATION						
LICENCE NUMBER CF7090	CUTTING PERMIT 000	LOCATION TEST 2000 C				
CRUISED BY RUISE R C						
F.I.Z. G ARROWHEAD	NO. OF BLOCKS 002	TOTAL MERCH AREA 12.5				
HELICOPTER PARTIAL-CUT NET VOLUME	0.	HELICOPTER CLEAR-CUT NET VOLUME 0				
HORSE LOGGING NET VOLUME 0.						
ALL HARVESTING METHOD SUMMARY						
SPECIES/GENUS	NET VOLUME	DECAY %	STUD LOG %	LRF	BURN %	
BALSAM	362.	20.	11.	197.		
CEDAR	312.	15.		170.		
FIR	2176.	3.	6.	225.		
HEMLOCK	437.	16.		193.		
LARCH						
LODGE	181.	44.	9.	182.		
SPRUCE	412.	19.	8.	212.		
YELLOW PINE						
WHITE PINE						
WHBARK PINE						
ASPEN						
BIRCH	89.	32.		167.		
COTTONWOOD						
CONIFER	3880.	13.	5.	211.		
ALL SPECIES	3969.	13.	5.	210.		
INDIVIDUAL HARVESTING METHOD SUMMARIES - CONIFEROUS						
VARIABLE	GROUND SKIDDER		GRAPPLE/HIGHLEAD		SKYLINE	
	CLEARCUT	PARTIAL	CLEARCUT	PARTIAL	CLEARCUT	PARTIAL
NET MERCH VOLUME M3		68.			3321.	478.
AVERAGE SLOPE %		63.			62.	55.
NET VOLUME/TREE		2.06			1.94	1.99
NET VOLUME/HECTARE	.250	339.450	.250	.250	335.496	199.054
STAND DEFECT VOL %		20.			19.	21.
PARTIAL CUT VOL %		100.				100.
ALL FIRE DAMAGE VOL %						
HEAVY FIRE DAMAGE VOL %						
DOWN TREE VOL %						
DEAD/LIVE USELESS %						
INDIVIDUAL HARVESTING METHOD SUMMARIES - ALL SPECIES						
VARIABLE	GROUND SKIDDER		GRAPPLE/HIGHLEAD		SKYLINE	
	CLEARCUT	PARTIAL	CLEARCUT	PARTIAL	CLEARCUT	PARTIAL
NET MERCH VOLUME M3		69.			3347.	518.
AVERAGE SLOPE %		63.			62.	55.
NET VOLUME/TREE		1.97			1.91	1.66
NET VOLUME/HECTARE		346.250			338.098	215.654
STAND DEFECT VOL %		21.			19.	23.
PARTIAL CUT VOL %		100.				100.
ALL FIRE DAMAGE VOL %						
HEAVY FIRE DAMAGE VOL %						
DOWN TREE VOL %						
DEAD/LIVE USELESS %						
CUTTING AUTHORITY						
95% CONF. INTERVAL(M/C)	15.7					
TREES PER PLOT (M/C)	8.0					
PLOTS (M/C) PER HA	0.8					

Figure 14.2 Interior Appraisal Summary - Sample Listing.

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 - (Quality 1)	F, FD	Cottonwood	AC
- (Quality 2)	F, FD	Spruce	S
- (Quality 3)	F, FD	- Sitka	SS
Hemlock	H	- Englemann	SE
- Western	HW	- White	SW
- Mountain	HM	- Black	SB
		Western Yew	T

Appendix 2 Allowable Species By Forest Inventory Zone

S P E C I E S																	
		F	C	H	B	S	Y	Pw	Pl	Py	L	Ac	D	Mb	E	AT	Pa
F O R E S T	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
I N V E N T O R Y	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
Z O N E	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
E L E M E N T	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							N	
Cedar						N	N	
Yellow Cedar		N				N		
White Pine						N		
Yellow Pine						N		
Larch	N	N	N	N	N	N	N	N
Cottonwood		N				N		
Alder		N				N		
Maple		N				N		
Birch		N				N		
Aspen		N				N		
White Bark Pine						N		

"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						N		
Yellow Cedar		N				N		
White Pine						N		
Yellow Pine						N		
Larch	N	N	N	N	N	N	N	N
Cottonwood		N				N		
Alder		N				N		
Maple		N				N		
Birch		N				N		
Aspen		N				N		
White Bark Pine						N		

"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							N	
Cedar						N	N	
Hemlock						N		
Yellow Cedar		N				N		
White Pine						N		
Yellow Pine						N		
Cottonwood		N				N		
Alder	N	N	N	N	N	N	N	N
Maple	N	N	N	N	N	N	N	N
Birch		N				N		
Aspen		N				N		
White Bark Pine						N		

"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						N		
Hemlock						N		
Yellow Cedar		N				N		
White Pine						N		
Yellow Pine						N		
Larch						N(1)		
Cottonwood		N				N		
Alder	N	N	N	N	N	N	N	N
Maple	N	N	N	N	N	N	N	N
Birch		N				N		
Aspen		N				N		
White Bark Pine						N		

(1) Zones K and L 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

	S P E C I E S																
		F	C	H	B	S	Y	Pw	Pl	Py	L	Ac	D	Mb	E	At	Pa
F O R E S T	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
I N V E N T O R Y																	
	C	81	81	81	78	90	60	72	42	42	54	72	45	36	36	36	33
Z O N E	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																	
		F	C	H	B	S	Y	Pw	Pl	Py	L	Ac	D	Mb	E	AT	Pa
F	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
O																	
	C	800	600	600	500	600	800	500	300	500	500	300	200	200	200	200	400
R																	
	D	500	400	400	400	400	800	500	300	500	500	300	200	200	200	200	400
E																	
	E	500	400	400	400	400	800	500	300	500	500	300	200	200	200	200	400
S																	
	F	500	400	400	400	400	800	500	300	500	500	300	200	200	200	200	400
T																	
	G	500	400	400	400	400	800	400	300	500	500	300	200	200	200	200	400
I																	
	H	500	400	400	400	400	800	500	300	500	500	300	200	200	200	200	400
N																	
	I	500	400	400	400	400	800	500	300	500	500	300	200	200	200	200	400
V																	
	J	500	400	400	400	400	800	500	300	500	500	300	200	200	200	200	400
E																	
	K	500	400	400	400	400	800	500	300	500	500	300	200	200	200	200	400
Z																	
	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

Region	Number	Code	District Name	Number	FTAS Code
Coast	1	RCO	Chilliwack	01	DCK
			Squamish	02	DSQ
			Sunshine Coast	03	DSC
			South Island	04	DDU
			Campbell River	05	DCR
			North Island-Central Coast (Port McNeill, Mid-Coast)	06	DIC
			Queen Charlotte	07	DQC
			North Coast	08	DNC
Southern Interior	2	RSI	Headwaters (Clearwater, Robson Valley)	01	DHW
			Kamloops	02	DKA
			Okanagan Shuswap (Vernon, Penticton, Salmon Arm)	03	DOS
			Cascades (Merritt, Lillooet)	04	DCS
			Chilcotin	05	DCH
			Central Cariboo (Williams Lake, Horsefly)	06	DCC
			Quesnel	07	DQU
			100 Mile House	08	DMH
			Arrow Boundary (Arrow, Boundary)	09	DAB
			Columbia	10	DCO
			Rocky Mountain (Cranbrook, Invermere)	11	DRM
			Kootenay Lake	12	DKL
			Prince George	01	DPG
			Vanderhoof	02	DVA
Northern Interior	3	RNI	Fort St James	03	DJA
			Mackenzie	04	DMK
			Peace (Dawson Creek, Fort St. John)	05	DPC
			Fort Nelson	06	DFN
			Skeena Stikine (Bulkley, Cassiar, Kispiox)	07	DSS
			Nadina (Lakes, Morice)	08	DND
			Kalum	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 Dia.	F-db	F-wb	F-qc1	F-qc2	C	H	Partition Hemlock Grades 4, 5			B	S	YC
							0	1	2			
4.5 - 5.49	91	91	100	91	91	91	0	0	0	91	91	91
5.5 - 6.49	102	103	109	100	97	102	0	0	0	103	103	102
6.5 - 7.49	111	113	118	109	103	111	0	0	0	113	113	111
7.5 - 8.49	120	123	128	119	108	120	0	0	0	123	123	120
8.5 - 9.99	129	134	139	130	115	129	0	0	0	134	134	129
10.0 - 14.9	151	158	170	160	132	151	0	0	0	158	158	151
15.0 - 19.9	172	185	217	206	156	172	0	0	0	185	185	172
20.0 - 24.9	187	202	246	234	177	187	0	0	0	202	202	187
25.0 - 29.9	199	217	266	251	197	199	0	0	0	217	217	199
30.0 - 34.9	210	226	279	262	215	210	0	0	0	226	226	210
35.0 - 39.9	217	234	287	270	227	217	0	0	0	234	234	217
40.0 - 44.9	222	240	292	275	235	222	0	0	0	240	240	222
45.0 - 49.9	228	246	297	279	238	228	0	0	0	246	246	228
50.0 - 54.9	233	252	299	281	239	233	0	0	0	252	252	233
55.0 - 59.9	237	258	302	282	239	237	0	0	0	258	258	237
60.0 - 64.9	240	263	302	282	237	240	0	0	0	263	263	240
65.0 - 69.9	241	266	303	281	233	241	0	0	0	266	266	241
70.0 - 74.9	240	267	302	280	228	240	0	0	0	267	267	240
75.0 - 79.9	237	265	302	279	223	237	0	0	0	265	265	237
80.0 - 84.9	234	263	301	277	217	234	0	0	0	263	263	234
85.0 - 89.9	231	261	298	275	210	231	0	0	0	261	261	231
90.0 - 94.9	227	259	297	273	201	227	0	0	0	259	259	227
95.0 - 99.9	224	257	295	272	193	224	0	0	0	257	257	224
100.0 +	221	254	295	269	184	221	0	0	0	254	254	221

Figure A.7a Lumber Recovery Factors.

All Balsam logs in trees with DWB summing 48% or over in Licence A57077 and dead White Pine logs in the Interior that are classified as grade 5 by means of Appendix 10.3 have a LRF of zero.

Log Top Dia.	Pw	Pl	Py	L	Ac	D	Mb	E	At	Pa
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.

Appendix 8 Chip Yield Factors

This Appendix lists factors used to calculate chip yield (bone dry units per 100 board feet).

Fir	.098
Cedar	.067
Hemlock	.089
- Western	.089
- Mountain	.089
Balsam	.072
- White Fir	.072
- Balsam Fir	.072
- Grand Fir	.072
- Mountain Fir	.072
Spruce	.076
- Sitka	.076
- Englemann	.076
- White	.076
- Black	.076
Yellow Cedar	.091
White Pine	.078
Lodgepole Pine	.087
Albicaulis Pine	.078
Yellow Pine	.095
Larch	.119
- Tamarack	.119
- Western	.119
- Alpine	.119
Cottonwood	.065
Alder	.080
Broadleaf Maples	.102
Birch	.110
Aspen	.090

Appendix 9 Coastal Log Grade Algorithms

Explanatory Notes for Coast Metric Standing Tree Log Grading Flowcharts

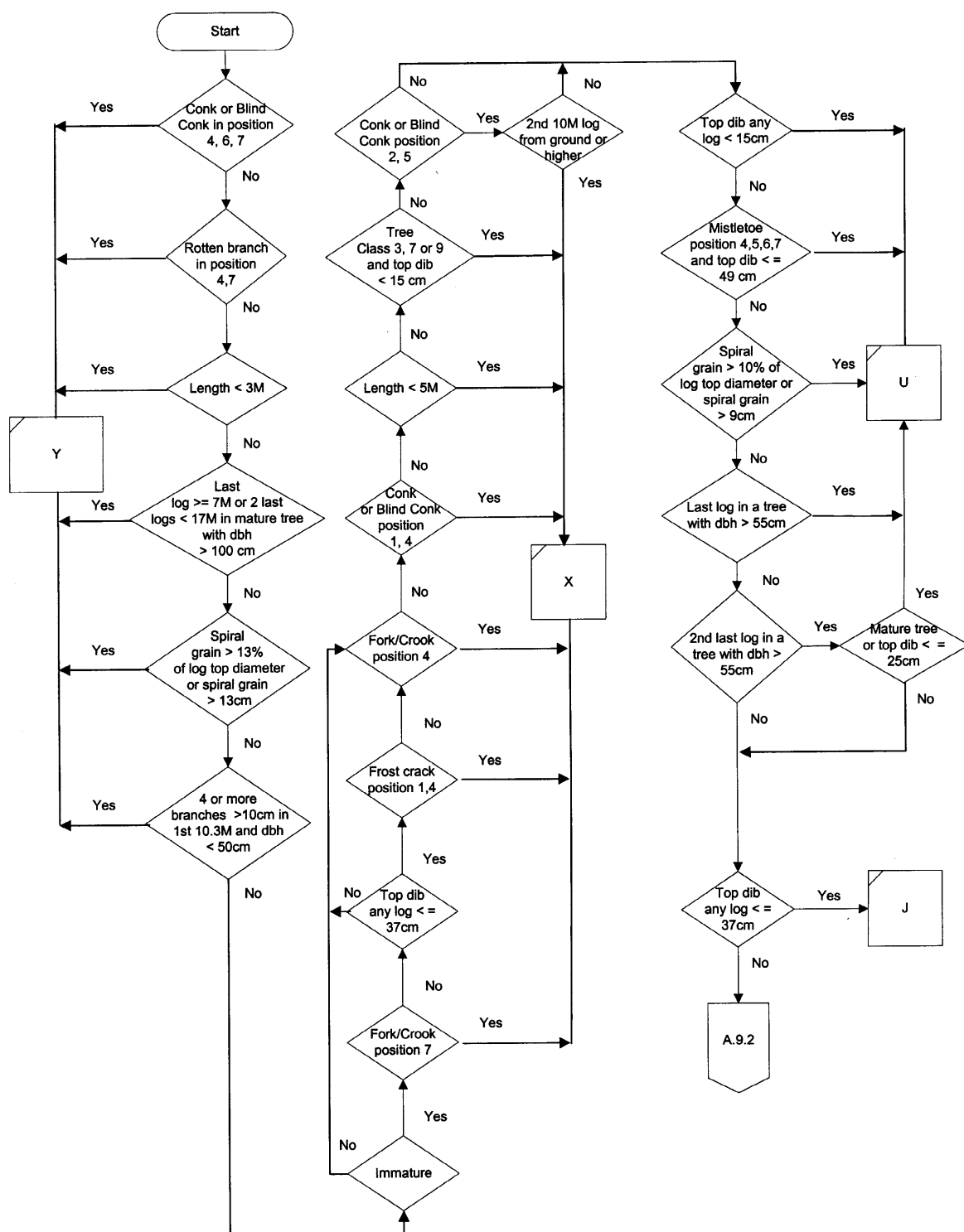
1. The flowcharts contain logic for restricting the grade of logs with spiral grain.

Spiral grain (cm.) = spiral grain code from cruise sheet * 3

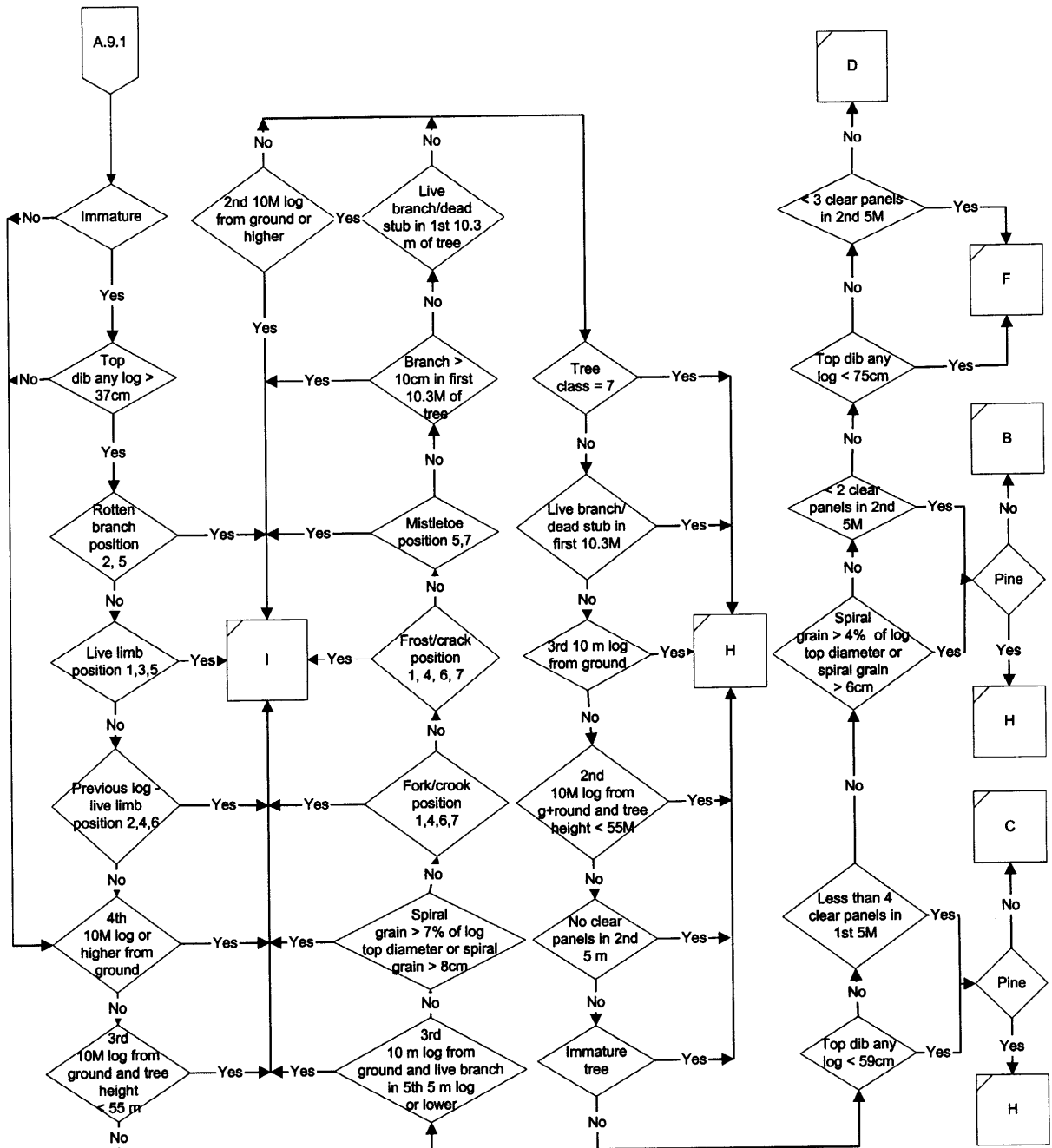
2. The test for two or more other pathological indicators in hemlock and balsam is restricted to the following indicators: frost crack, mistletoe, rotten branches and scars, with open and closed scars occurring together in the same tree counting as only one indicator.
3. The tests for two and three or more other pathological indicators in cypress are restricted to frost crack, fork or crook, rotten branches 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%.

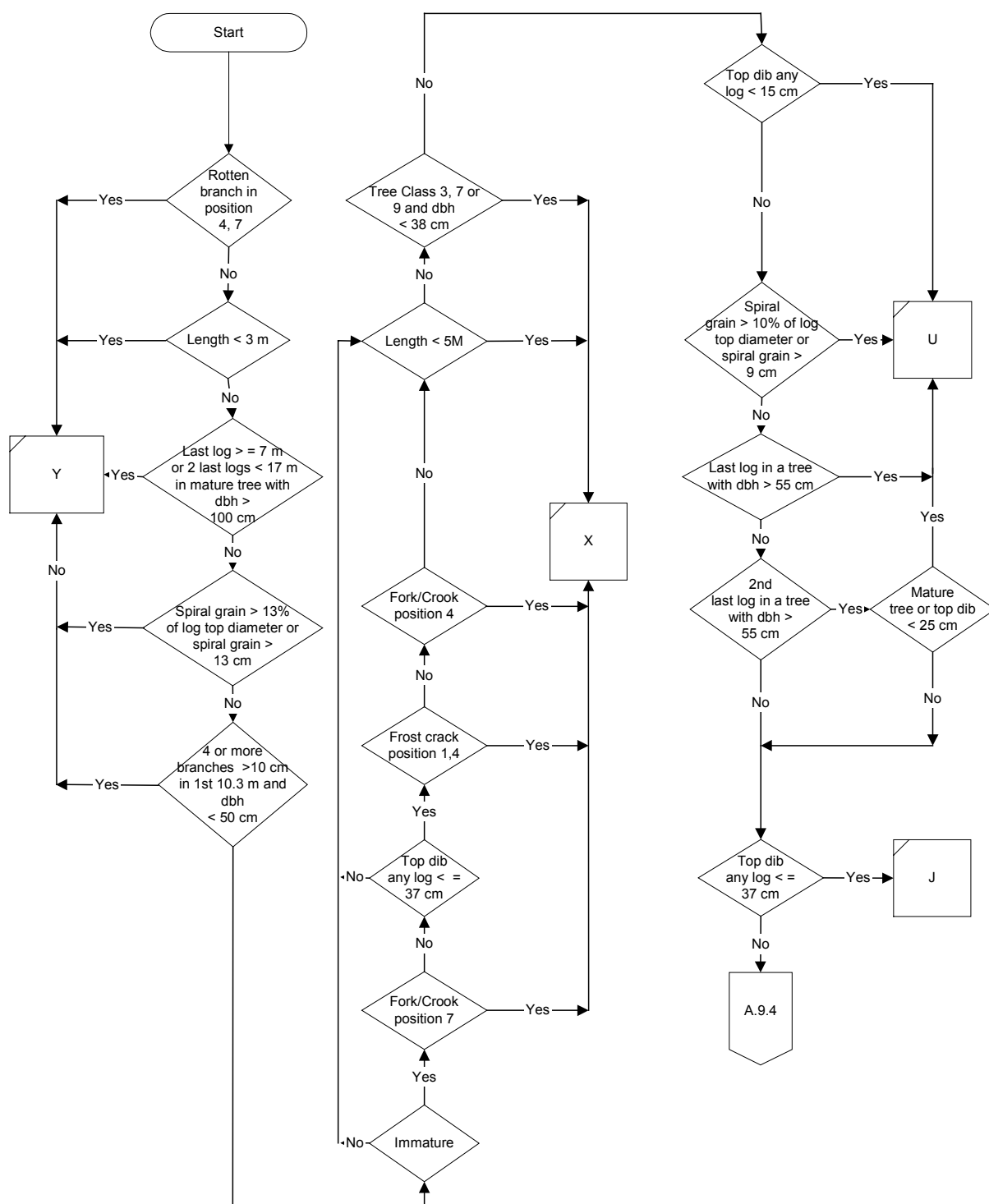
A9.1 Douglas Fir, Pine and Larch



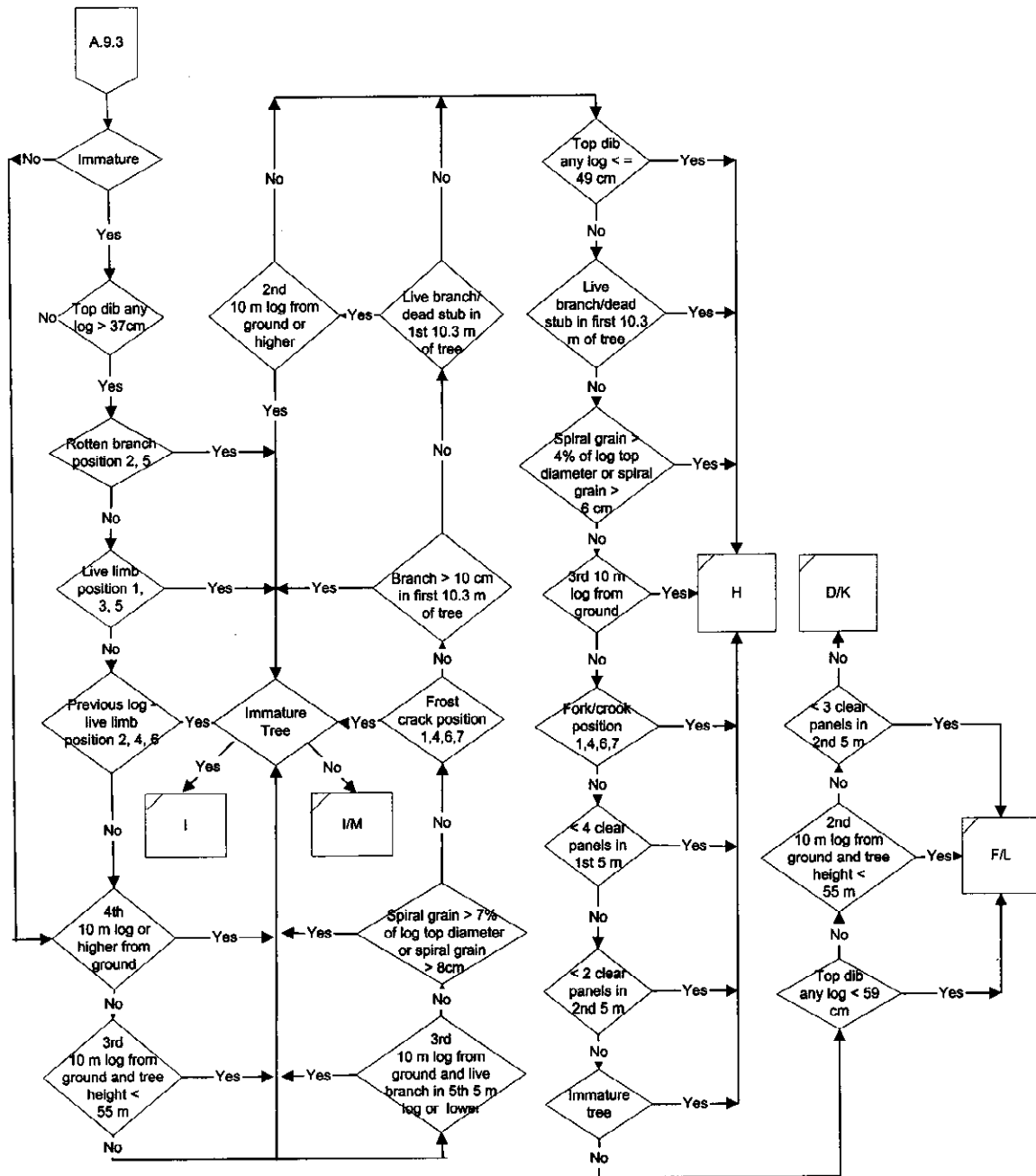
A9.2 Douglas Fir, Pine and Larch



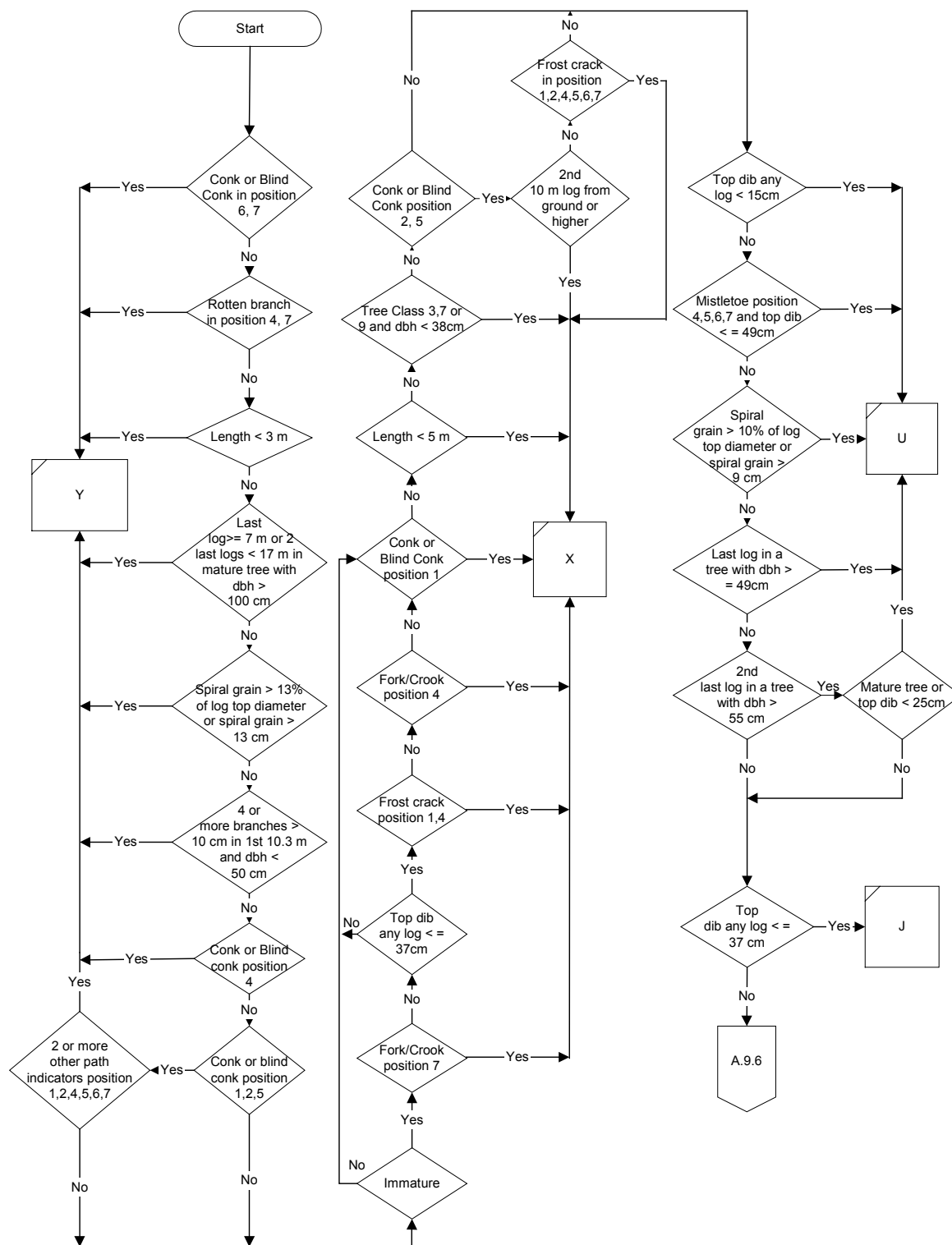
A9.3 Western Red Cedar



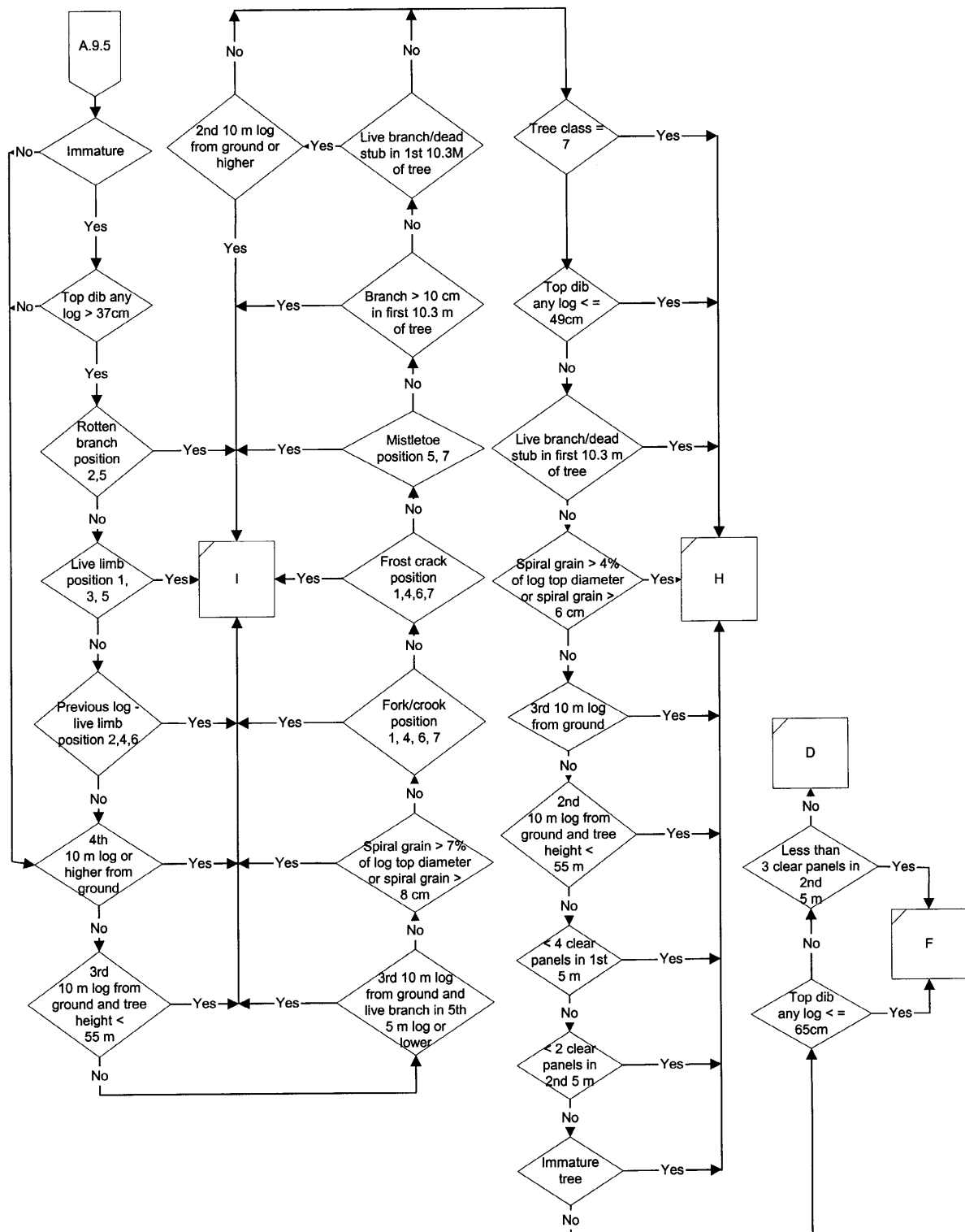
A9.4 Western Red Cedar



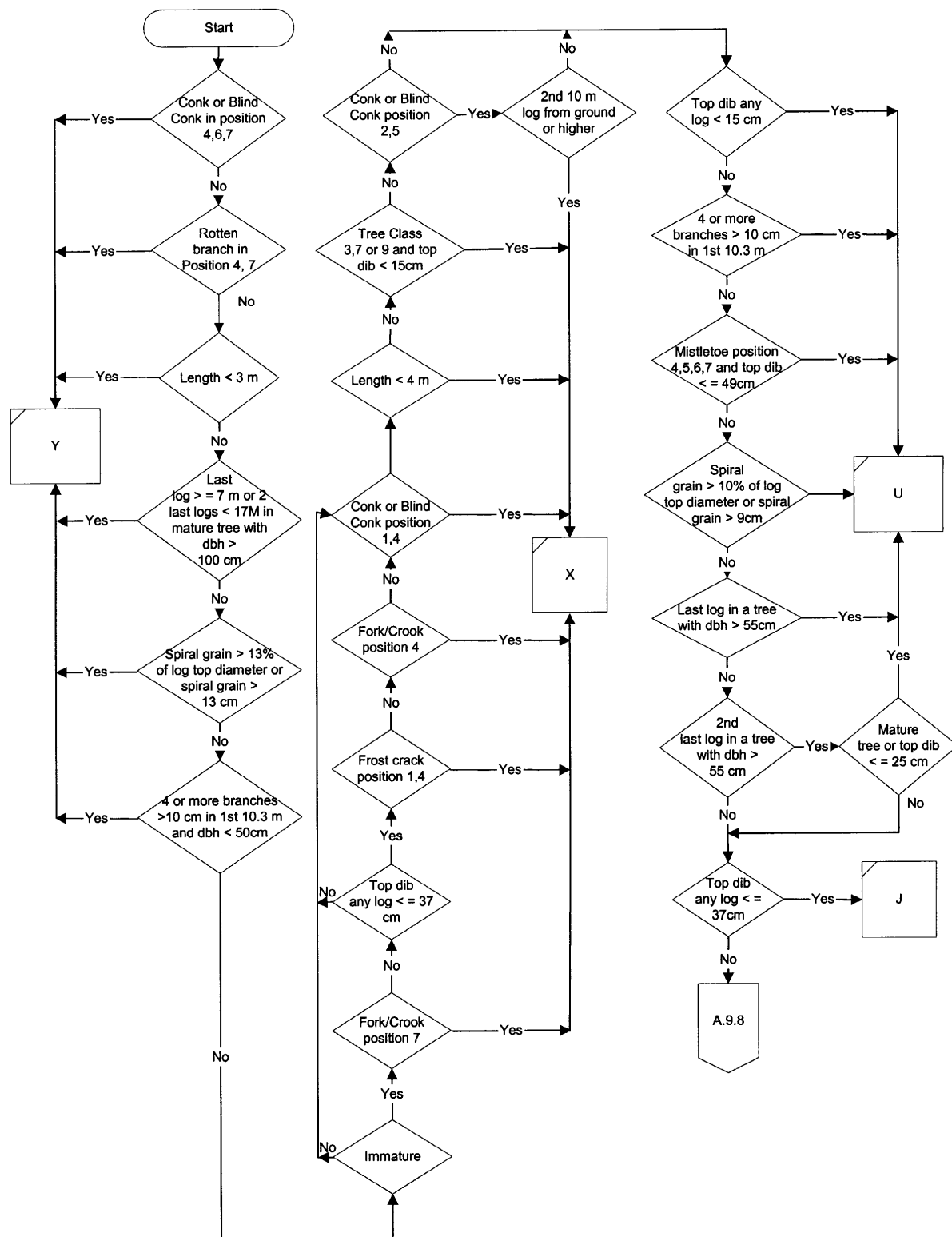
A9.5 Hemlock and Balsam



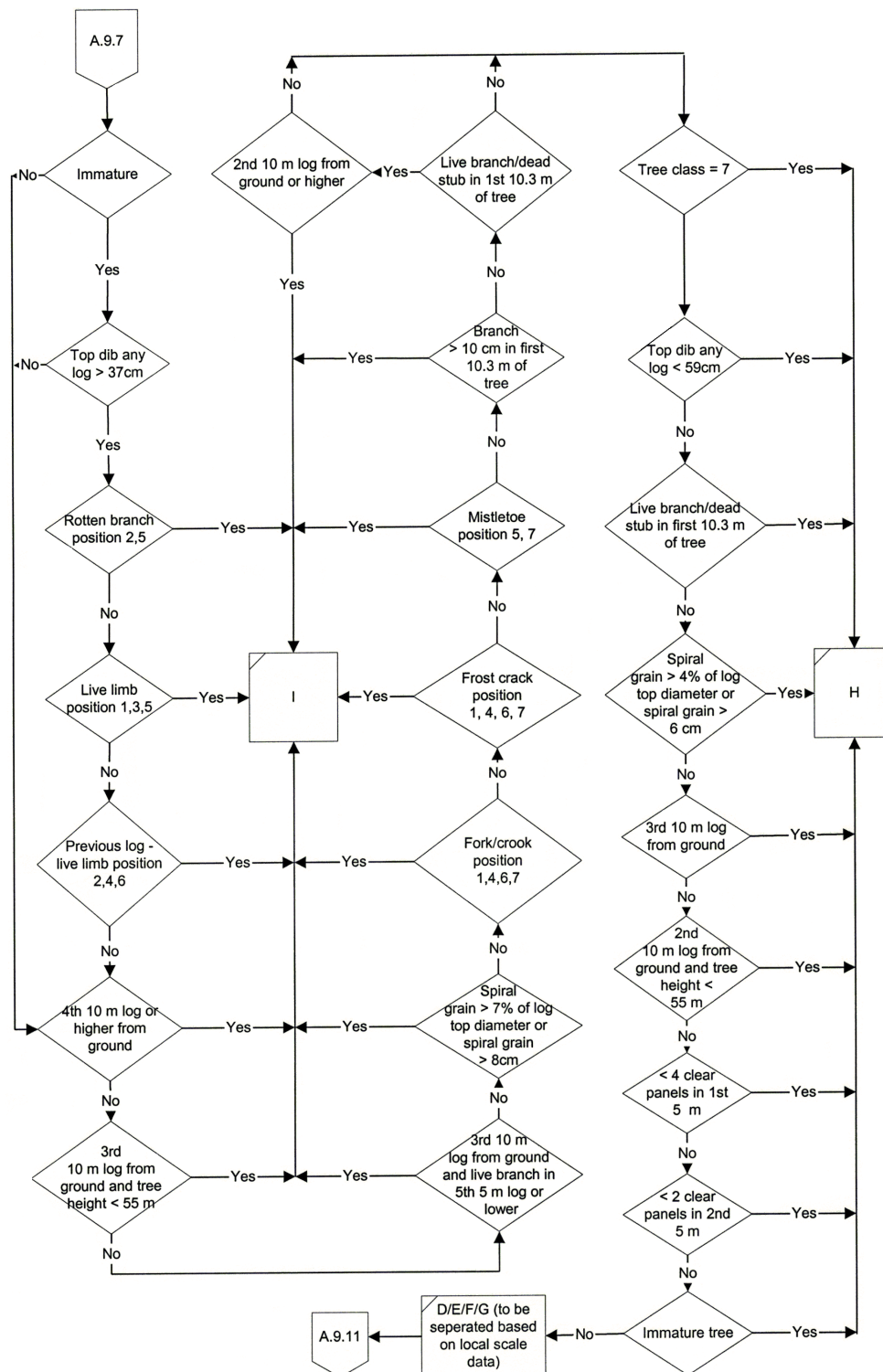
A9.6 Hemlock and Balsam



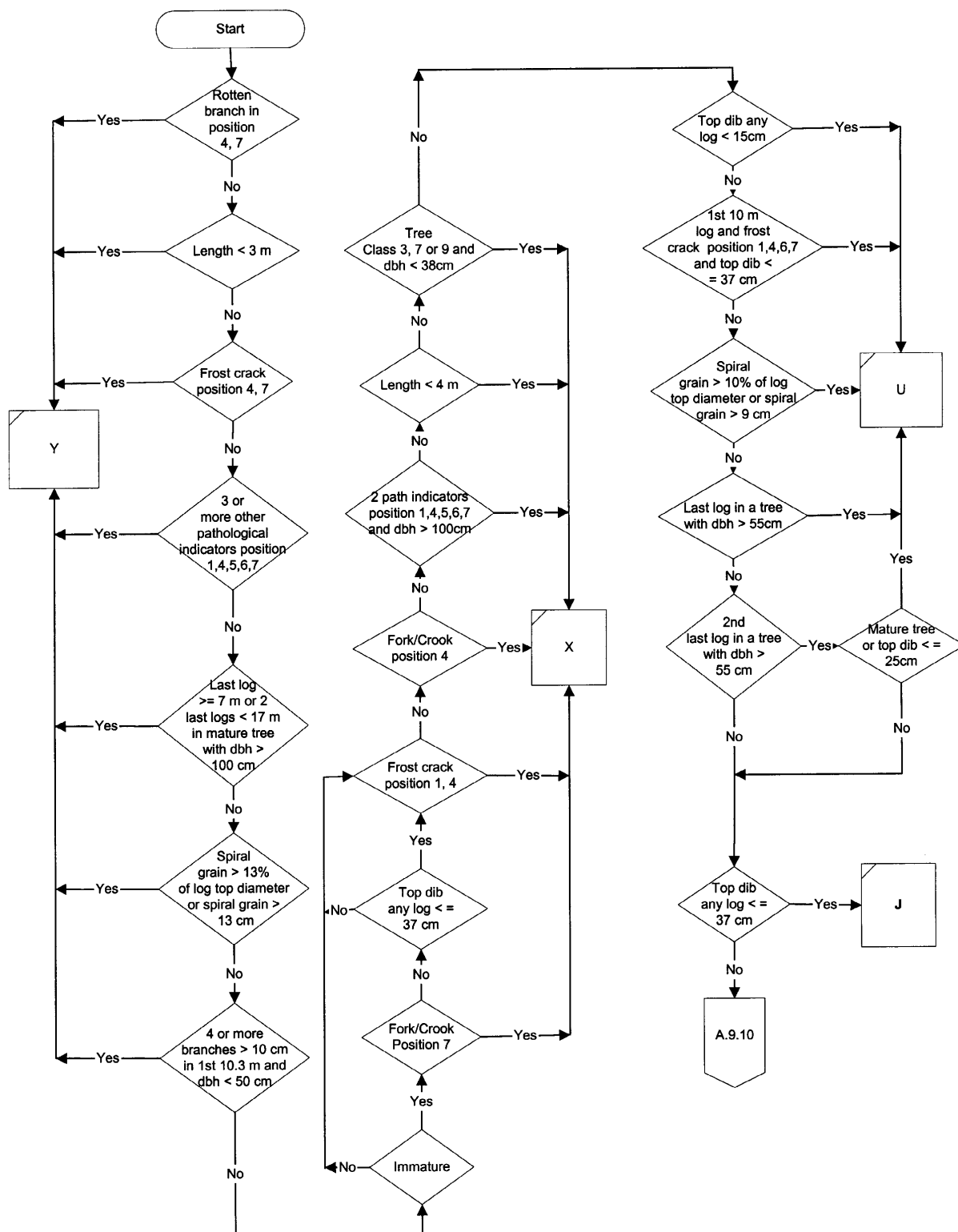
A9.7 Spruce



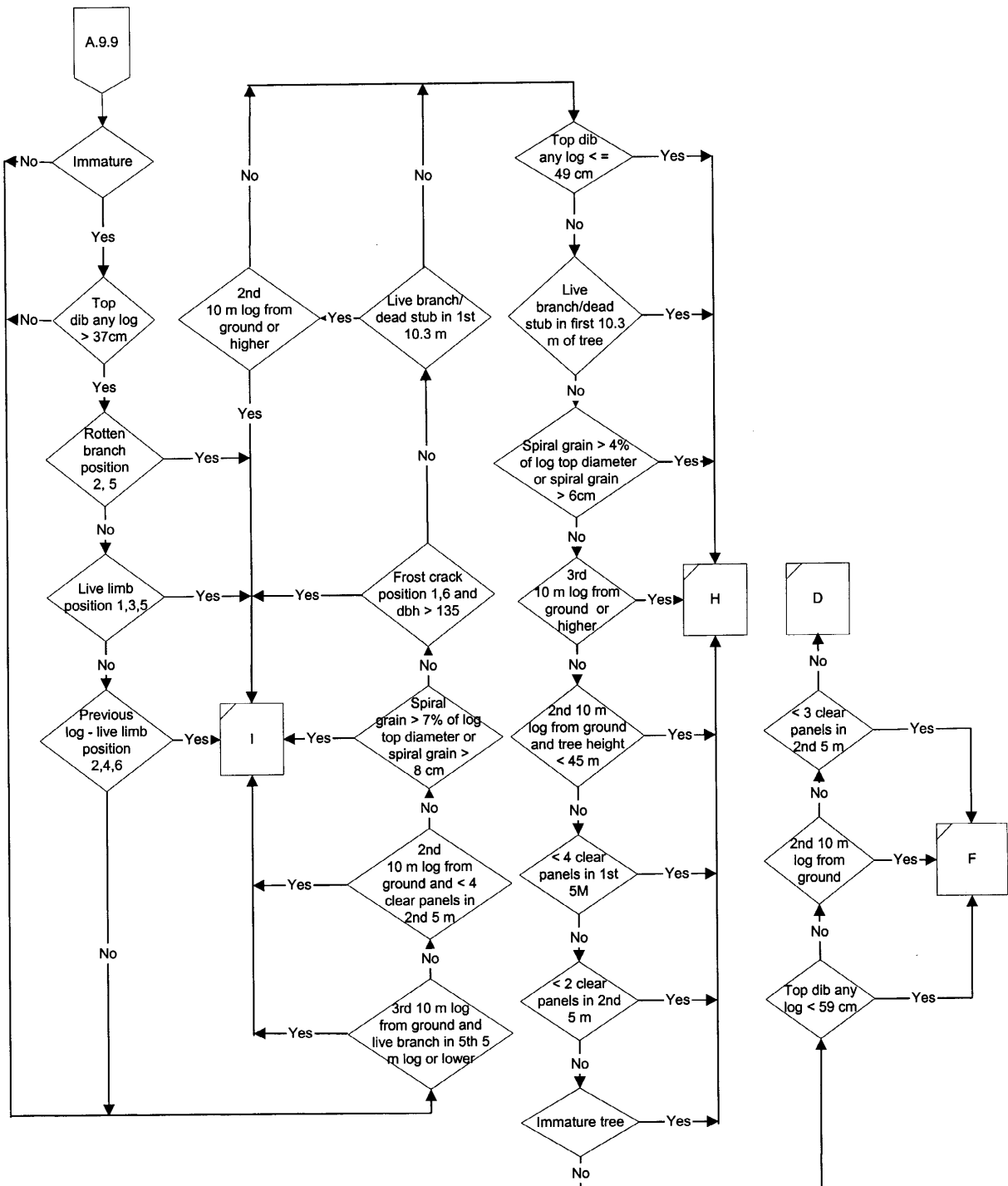
A9.8 Spruce



A9.9 Cypress



A9.10 Cypress



A9.11 Percentages within Spruce Grades

District	D	E	F	G
Campbell River	14.29	14.29	28.57	42.85
Chilliwack	0.0	0.0	0.0	100.00
South Island	20.00	10.00	30.00	40.00
North Coast	18.18	18.18	18.18	45.46
North Island – Central Coast	16.52	8.26	29.35	45.87
Queen Charlotte	16.67	25.00	16.67	41.66
Squamish	0.0	0.0	0.0	100.00
Sunshine Coast	0.0	0.0	0.0	100.00

Source of the table is the Coast Grade Distribution Report 2000-04 to 2002-03.

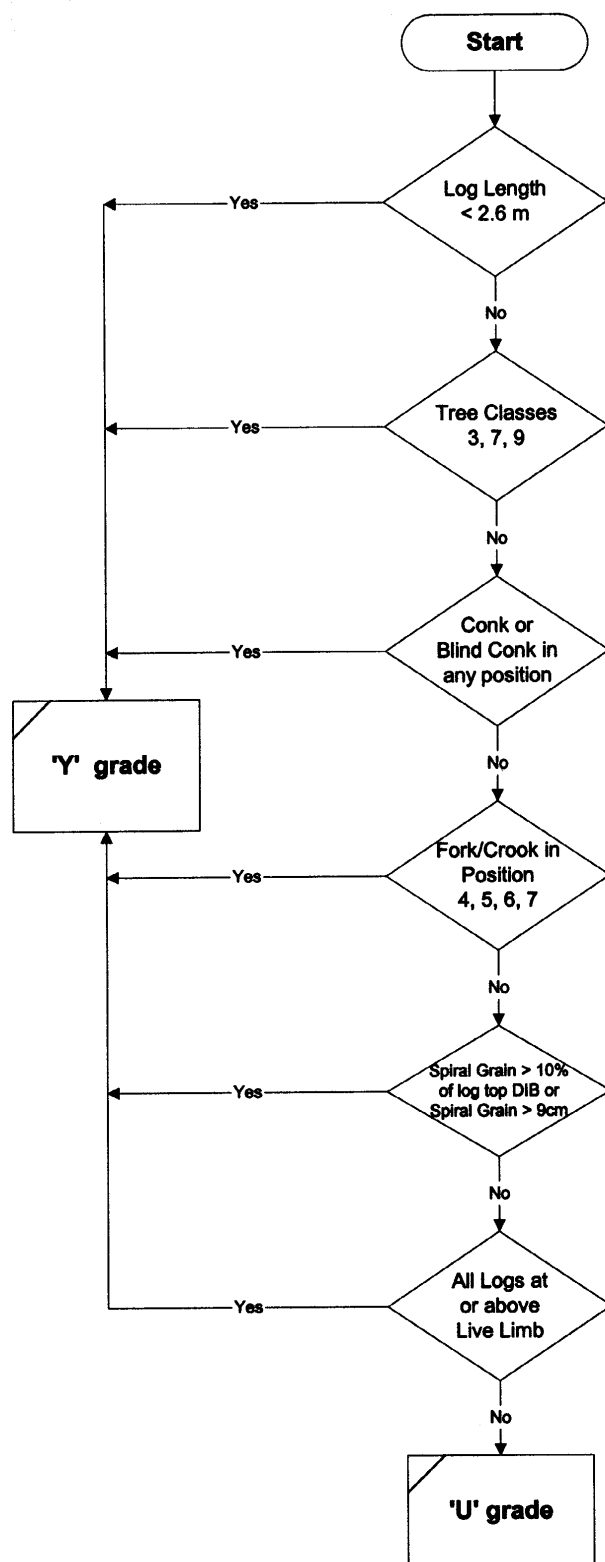
A9.11.1 Percentages within Cedar Grades

District	D	F	I
	K	L	M
Campbell River	33.00 67.00	17.00 83.00	62.00 38.00
Chilliwack	25.00 75.00	13.00 87.00	60.00 40.00
South Island	50.00 50.00	23.00 77.00	60.00 40.00
North Coast	33.00 67.00	14.00 86.00	75.00 25.00
North Island – Central Coast	37.00 63.00	18.00 82.00	66.00 34.00
Queen Charlotte	33.00 67.00	14.00 86.00	67.00 33.00
Squamish	33.00 67.00	9.00 91.00	54.00 46.00
Sunshine Coast	33.00 67.00	17.00 83.00	71.00 29.00

- Source of the table is the Coast Grade Distribution Report 2000-04 to 2002-03.
- Immature red cedar logs (up to 120 years old based on the age in 10's and tree classes) flow only into the I-grade where appropriate. Mature red cedar (greater than 120 years based on the age in 10's and tree class) will be separated into I and M grades where appropriate.

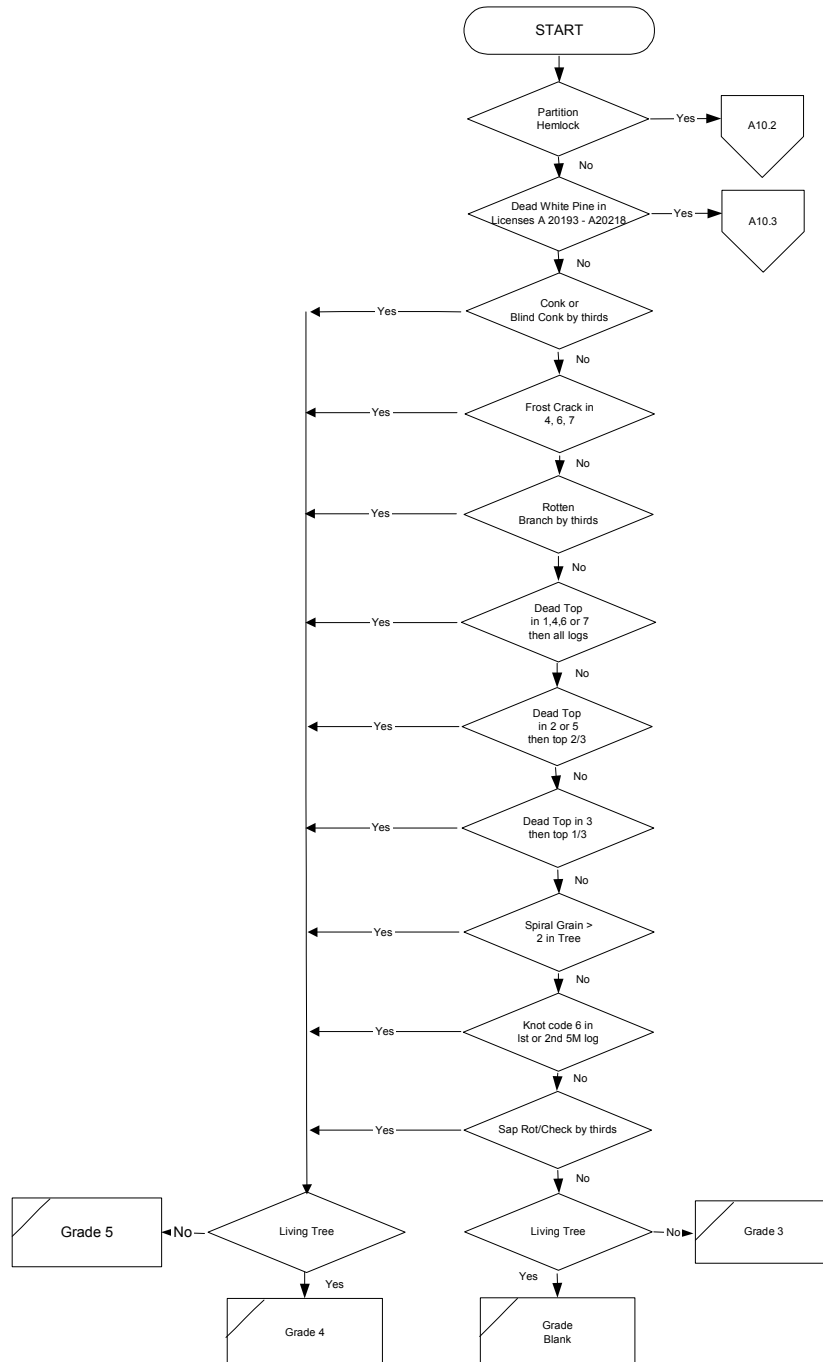
Example: In the Campbell River District when a log reaches the D/K decision box 33% of the log will be deemed to be D grade and 67% will be deemed to be K grade.

A9.12 Deciduous



Appendix 10 Interior Log Grade Algorithm

A10.1 Interior Log Grade Algorithm

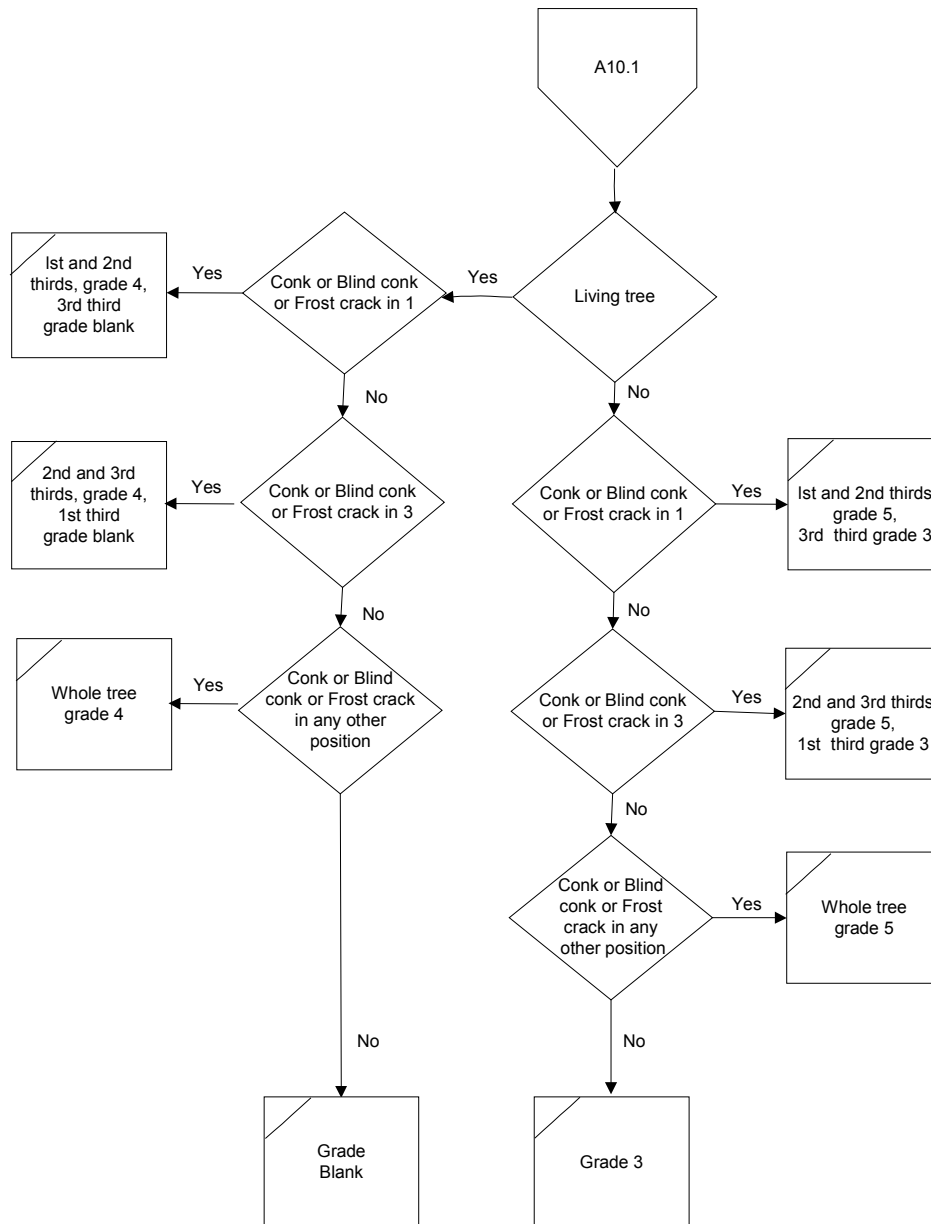


If the sum of the reported grade percents is not exactly 100 percent (due to rounding), then add or subtract from the grade with the highest percent to make the total 100 percent. If there is a tie for the largest grade percent, then adjust the grade in sequence from Blank to 5.

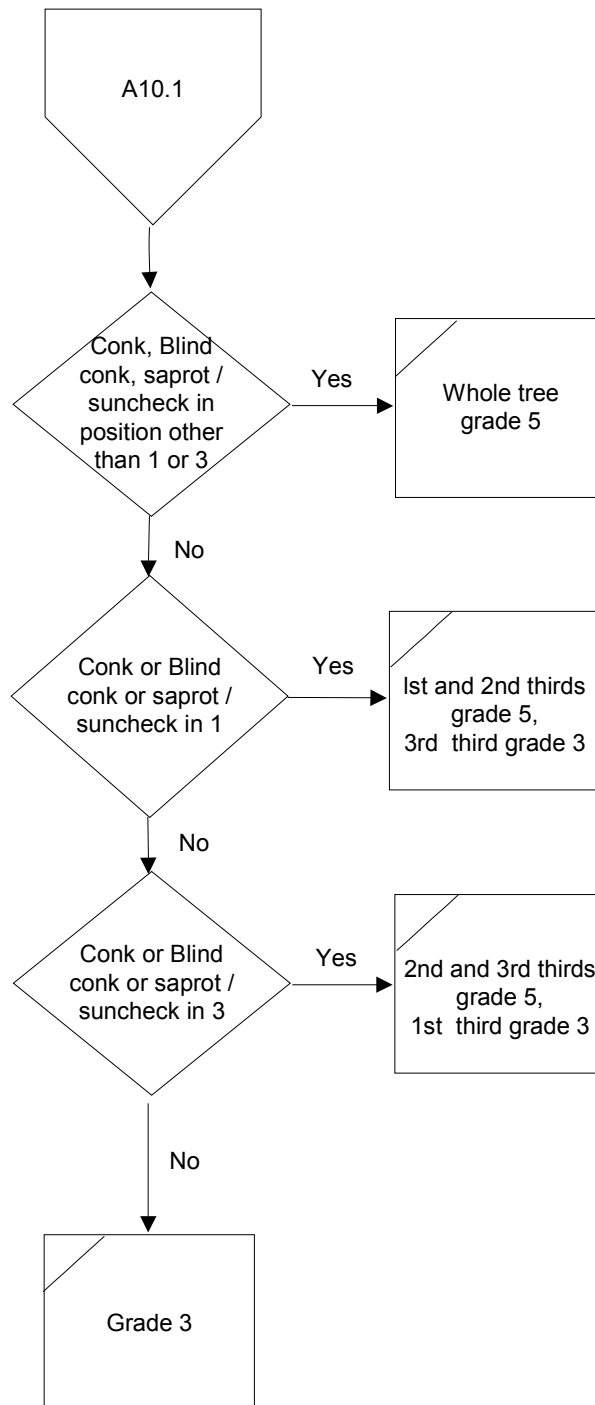
A10.2 Partition Hemlock

As of April 1, 2002 the use of Appendix A10.2 is mandatory for Interior Hemlock from Partition licences.

Begin at the start of A10.1. A “YES” answer at the Partition Hemlock decision box directs the log to A10.2.



Pathological codes are required for tree classes 3, 7 and 9 in Partition Hemlock.

A10.3 White Pine

Pathological codes are required for White Pine tree classes 3, 7 and 9 in the Interior.

A10.4 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 Logs	Path Location						
	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

	Biogeoclimatic Zone	Biogeoclimatic Subzone and Variant
Wet Belt Code = 1	ICH (Interior Cedar Hemlock)	dw, dk, mw, mm, mk, mc, wk, vk, vc
	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, vv, wm, wk, wc, vc, vv
	SBPS (Sub-Boreal Pine - Spruce)	mk, dc, mc
Dry Belt Code = 2	ICH (Interior Cedar Hemlock)	xw
	IDF (Interior Douglas Fir)	undifferentiated, dk1, dk2, dm2, xh, xw, xm, dm
	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 utilization top diameter is achieved. This portion is divided into logs based on the utilization log length in the Map Area Statement.

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	=	inflexion point, see the end of this Appendix
$a_1 \dots a_8$	=	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:

$$\begin{aligned}
 p &= 0.30 \\
 a_1 &= 0.928138 \\
 a_2 &= 0.945293 \\
 a_3 &= 0.999206 \\
 a_4 &= 0.301423 \\
 a_5 &= -0.040792 \\
 a_6 &= -1.235630 \\
 a_7 &= 0.030743 \\
 a_8 &= 0.672879
 \end{aligned}$$

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).

$$\begin{aligned}
 X &= (1 - \sqrt{0.3/41.0}) / (1 - \sqrt{0.3}) \\
 &= (0.914460107...) / (0.452277442...) \\
 &= 2.021900767...
 \end{aligned}$$

$$\begin{aligned}
 \text{Exp} &= a_4 z^2 + a_5 \ln(z + 0.001) + a_6 \sqrt{z} + a_7 (D/H) + a_8 e^z \\
 &= 0.301423(0.30 / 41.0)^2 - 0.040792 \ln((0.30 / 41.0) + 0.001) \\
 &\quad - 1.235630 \sqrt{0.3 / 41} + 0.030743(110.0 / 41.0) \\
 &\quad + 0.672879(2.718281828)^{0.30/41.0}
 \end{aligned}$$

$$= 0.854665$$

$$\begin{aligned} d_{30} &= (0.928138(110.0)^{0.945293})(0.999206)^{110.0}(2.02190)^{0.854665} \\ &= 131.604 \end{aligned}$$

- 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.

$$\# \text{ of logs} = \frac{\text{merchantable height} - \text{stump height}}{\text{log length}} + 1$$

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:

$$\text{Last log} = 36.14 - (4 - 1) * 10.0 - 0.30$$

$$= 6.14 - 0.30$$

$$= 5.84 \text{ m}$$

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 standard utilization 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:

$$\frac{\text{Stump volume}}{\text{(30cm \& below)}} = C * d_{30}^2 * (\text{stump height})$$

Where $C = 0.00007854$

d_{30} = diameter at 30 cm

Example A13.2

$$\text{Stump volume} = (0.00007854) * (0.30) * (131.60)^2 = 0.408 \text{ m}^3$$

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

$$V_{\text{top}} = C * L_1 [D_1/2 + 2D_2 + D_3 + 2D_4 + D_5/2] = 0.00005236 * (4.8595/4) * 407.06 = 0.026 \text{ m}^3$$

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

a₂

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

a₃

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

a₄

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

a₅

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

a₆

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

a₇

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

a₈

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 what DBH range the tree falls into.

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
	<hr/>	
	9999.84	would round to 10000

In other words, the cutting permit total would be 10000, not 9999.

The MOF mainframe PL/1 code uses variables with a maximum precision of 32 significant digits. The log volume routine uses variables with 6 significant digits.

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 d^{th} characteristic of the u^{th} individual of the h^{th} 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

Compilation Compiler Name	Version Number	Date	Type of Cruise
Claymore Consulting Group Ltd.	2003.0	April 1, 2003	C, I, S
Industrial Forestry Service Ltd.	2003.0	April 1, 2003	I, S, B, PW
J.S. Thrower & Associates Ltd.	2003.0	April 1, 2003	C, I, S, B, PW
Timberline Forest Inventory Consultants Ltd.	2003.0	April 1, 2003	C, I, S
643188 B.C. Ltd.	2003.0		

C = Coast

I = Interior

S = Stump

B = Reduced Balsam LRF in Licence A57077

PW = Reduced PW LRF in licences A20193 and A20218

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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 of the circle formed by the cross-section of a tree taken 1.3 m above the ground.
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.
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.
Coastal Compilation	A compilation for Forest Inventory Zones A, B, or C.
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	Diameter at breast height measured at 1.3 m above ground.
DBH Class	A range of DBH values used to group trees together.
Dead Potential	A dead tree with sound wood potential.
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 to calculate the stems per hectare when count and measure plots are used in a compilation.
Foot Board Measure	A volume of lumber equal to 12 inches by 12 inches by 1 inch.
Grade	A qualitative assessment of a logs value.
Harvesting Method	Method used to harvest a cutting permit.
Height-diameter Curve	A regression model used to estimate heights from DBH.
Inflexion Point	Point where a curve changes from concave to convex or vice versa.
Interior	Forest Inventory Zones D - L.
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	Amount of lumber, expressed in Foot Board Measures, obtained from a given volume of wood.
Lumber Recovery Factor	The amount of lumber recovery per cubic meter of merchantable volume.
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).
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.
Species Grouping	A set of species that will report using one species code in a report.
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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