

File: 12600-11
12450-09

May 13, 2003

To: Chris Fletcher
Timber Supply Branch
PO Box 9512
Stn Prov Govt
Victoria, BC V8W 9C3

Re: Harvest Method Mapping Pilot Project, Bulkley Timber Supply Area

On July 25, 1997, Bulkley/Cassiar District agreed to participate in a Data Analysis Working Group (DAWG) pilot project for developing a 'harvest method' mapping (HMM) approach to operability mapping. The primary goal of this project was to classify operability in terms of applicability of harvesting systems, using attributes available for the most part in forest inventory data (i.e. FIP). The secondary goal of this project was to conduct a comparison of the operable landbase defined by HMM with that defined by existing licensee Total Chance Plan operability mapping, to determine if HMM provides a reasonable representation of operability.

The product resulting from this project was a database (essentially a modified FIP) for the entire TSA in which 'operability' polygons were assigned primary 'Harvest Method' and secondary 'Stand Quality' codes using FoxPro and ARC/INFO algorithms developed around Table 1 and 2 criteria. The product is very useful in that it has provided the District with a consistent approach for defining operability, and it provides flexible tools which can be adjusted to meet changes in future conditions (i.e. what stands licensees consider economically viable for harvest at that point in time).

The codes used, and criteria and parameters around these codes, are summarized in Tables 1 through 3.

Table 1: Operability Codes

Harvest Method codes	Stand Quality codes
G – ground C – cable/helicopter H – helicopter I – inaccessible, forested N - not typed	S - sawlog stands M - <u>marginal</u> sawlog stands (ITG 18 or 20, AND average total tree height <24 m, AND net type volume >60% BI). P - <u>pulplog</u> stands (ITG 12, 15-17, 19, AND net type volumes >50% H and <20% S; <u>OR</u> ITG 18, 20 AND net type volumes >50% Ba and <20% S; <u>OR</u> net type volumes >50% Ba and H (combined) with <20% S). D - deciduous leading stands L - sites of low volume (<150 m ³ /ha and 25 cm DBH at maturity*, or as projected to maturity), and low productivity T - sites with density problems (thick regeneration).



Table 2: Slope, Volume, and DBH Parameters on Operability Codes

Code	Slope	Volume and DBH	Other
G C H	≤ 35% >35% 0 - 90%	Mature* stands: sawlog/MSL net volume >150 m3/ha, DBH ≥ 25cm. Pulplog net volume >175 m3/ha, DBH ≥ 25 cm. Immature stands: must achieve volume/DBH limits by maturity.	H - only 1° code that can be used in harvestable areas coded I (inoperable) in Secondary Code Qualifier column of FIP database. H - category includes helicopter and cable systems, because of lack of mutual exclusivity for slope limitations. Areas within FPC no-harvest zones (e.g. RRZs); LRMP zones where harvesting is not permitted.
I	none	none	

* mature stands: Pli, Sx, Bl leading - Stand Age ≥ 100
Hw-leading - Stand Age ≥ 110
Deciduous leading - Stand Age ≥ 80

Table 3: Inclusion/Exclusion of Operability Code Combinations

Combinations Contributing to Operable Landbase	Combinations Excluded from Operable Landbase
GS, GM, GP, immature* GT CS, CM, immature* CT, CP HS, HM -	GD, GL, remaining GT CD, CL, remaining CT HP, HD, HL, HT IS, IM, IP, ID, IL, IT

The criteria and parameters resulted from meetings between District and major licensee foresters. A letter summarizing the information presented and the agreements reached during discussions has been included (Attachment 1). Stand Quality definitions reflect those developed for the establishment of the TSA’s ‘stand quality’ AAC partition: a by-product of the 1994 timber supply review in Bulkley TSA.

Attachment 2 provides a ‘layman’s version’ methodology behind the FoxPro and ARC/INFO algorithms developed as tools for HMM. The FoxPro algorithm used to assign secondary ‘Stand Quality’ codes has been included as Attachment 3.

The HMM includes a methodology for building GIS digital coverages depicting realistic Forest Practices Code Riparian Reserve Zones and Riparian Management Zones, because the presence of these zones impact on land availability for harvest and therefore ‘operability’. Attachment 2 contains a simplified version of this methodology, and a more explicit version is included as Attachment 4. The Arc/Info algorithms described in this methodology are available from Ken Bush, Regional GIS Operator, Prince Rupert Forest Region.

As a means of quality control, operability maps were generated for six mapsheets using the inclusion/exclusion criteria for ‘operability’ polygons summarized in Table 3. The lines of operability generated through this process were visually compared to Total Chance Plan operability linework, and vetted through MOF foresters with on-the-ground experience in the areas of interest.

The judgement of the reviewing District foresters was that HMM is reasonably comparable to Total Chance Plan operability mapping. Based on that judgement, the District has used HMM as a tool to define the timber harvesting landbase for the current timber supply review. Pacific Inland Resources (PIR), one of the major licensees in the TSA, has an approved FRBC project for revisiting Total Chance Plan linework for upper limits of operability in the interest of ensuring consistency between their process and HMM. To clarify how HMM has been used in the latest round of the timber supply review, Attachment 5 presents the pertinent Data Tables that relate to the use of HMM.

If you have any questions regarding the products submitted, or the methodologies used in their development, please contact the undersigned. We’ve enjoyed the challenge.

Yours truly,

Glen Buhr, RPF
District Planner
Bulkley/Cassiar Forest District

- Attachments:
- 1) Summary Letter: “Harvest Mapping Framework for Defining Operability, and Applicability to Total Chance Planning Process”;
 - 2) ‘Layman’s Version’ Methodology for Harvest Method Mapping;
 - 3) FoxPro Algorithm for Assignment of Stand Quality Codes;
 - 4) Sections of TSR 2 Data Package Addressing Use of HMM

Attachment 2: ‘Layman’s Version’ Methodology for Harvest Method Mapping

Step 1: Development of Slope Class Digital Coverage (for deriving Harvest Method codes)

Merge TRIM (NAD 83) digital mapsheets for the Bulkley TSA into one overlay.
Create a polygonal slope coverage from TRIM DEM (50 meter grid), into the following slope classes:

Table 1: Slope Class/Harvest Method Parameters

SLOPE CLASS	Predominate Harvest Method	Slope Parameters
1	G(round)	≤ 35%
2	C(able)	> 35 ≤ 60%
3	H(elicopter)	> 60% ≤ 90%
4	I(naccessible)	> 90%
Additional Slope Class (for Step 3)	n/a	< 20%

Step 2: Development of Riparian Buffer Digital Overlay
(derived from Forest Practices Code Operational Planning Regulation)

Use the same NAD 83 TRIM maps, and the FIP database. Merge the Community Watershed digital overlay. Buffer riparian reserve zones (RRZs) and riparian management zones (RMZs) for streams, lakes, and wetlands using the criteria in the following table, and create a polygonal coverage. If using PAMAP GIS, use maximum 10x10 metre pixels.

A further step was required for Bulkley TSA’s S1 streams: the Zymoetz, Telkwa, Bulkley, Canyon, Harold Price, Nichyeskwa, Babine, and Nilkitkwa Rivers. These were manually isolated on TRIM digital coverage, buffered using the criteria in the following table, then remerged with the S2’s-S6’s to form one coverage.

Table 2: Riparian Buffer Parameters

Community Watershed (In/Out)	Slope (%)	Identifying Code/ Criteria	Potential Waterbody Class	RRZ width (m)	RMZ width (m)
Out	≥ 20	NPF_DESCR = RIV	S5	0	30
		single line	S5	0	30
		dashed-line	S6	0	20
Out	< 20	S1 stream name ¹	S1	50	20
		NPF_DESCR = RIV	S2	30	20
		single line	S3 or S4 (S3) ²	13.4	26.7
		dashed-line	S6	0	20
In	all	S1 stream name ¹	S1	50	20
		NPF_DESCR = RIV	S2	30	20
		single line	S3 or S4 (S3) ²	13.4	26.7
		dashed-line	S4	0	30
In or Out	all	NPF_DESCR = SWAMP; POLY_AREA > 5.00	W1	10	40
		NPF_DESCR = SWAMP; POLY_AREA > 0.50 ≤ 5.00	W3 or W4 (W3) ²	0	30
In or Out	all	NPF_DESCR = L; POLY_AREA > 5.00	L1	10	20
		NPF_DESCR = L; POLY_AREA > 0.50 ≤ 5.00	L3 or L4 (L3) ²	0	30

¹ See discussion on S1 streams above table
² The number in brackets refers to the code to be entered into the RRZ or RMZ fields described in Step 4.

Merge the Slope Class and Riparian Buffer digital coverages with NAD 83 forest cover. Generate a new database (called OPBASE) that incorporates all fields in the FIP database for the TRIM mapsheets, plus the following additional fields.

- TS_CLASS

RRZ

RMZ
- new slope classes

- Forest Practices Code (FPC) Riparian Reserve Zone - populate with potential Waterbody Class code from Table 5.

- FPC Riparian Management Zone - populate with potential Waterbody Class code from Table 5.

Step 3: Assigning Primary ‘Harvest Method’ and Secondary ‘Stand Quality’ Codes

Net down the database to productive, forested landbase.

Table 3: *Criteria Defining Productive, Forested Landbase*

OWNERSHIP_CD	= '62', and '67'
OWNERSHIP_CHARACTER_CD	= 'C' and 'N'
NON_FOREST_DESCRIPTOR	= 'NSR' or 'is null'
NON_PRODUCTIVE_FOREST_DESCRIPTOR	= 'is null'

Generate the following new attribute column:

OP_POLY (numbers that uniquely identify each new 'operability' polygon)

Manipulate OPBASE to supply primary and secondary 'operability' codes to each of the new 'operability' polygons. Place the codes into the following two new columns:

PRIMARY ('Harvest Method' code - G, C, H, I, N)
SECOND ('Stand Quality' code - S, M, P, D, L, T)

Assign primary 'Harvest Method' codes. The algorithms developed for populating the 'PRIMARY' column utilize the following parameters and FIP attributes.

Table 4: *Primary ‘Harvest Method’ Code Parameters, Expressions*

Code	Description of Parameters	Expressions to Use in Algorithms
G	- all productive forest of slope class 1, not in RRZs.	CLASS = 1 RRZ = 'is null'
C	- all productive forest of slope class 2 and 3, not in RRZs.	CLASS = 2 CLASS = 3 RRZ = 'is null'
H	- all productive forest with a secondary code qualifier of 'I', slope classes 1, 2, 3, not in RRZs.	CEZONE = NCE INOPERABLE_CD = I CLASS = 1 CLASS = 2 CLASS = 3 RRZ = 'is null'
I	- all productive forest of slope class 4, not in RRZs.	CLASS = 4 RRZ = 'is null'
N	- all productive forest remaining untyped.	

Attachment 3: FoxPro Algorithm for Assignment of Stand Quality Codes

Assign secondary ‘Stand Quality’ codes. The algorithms developed for populating the ‘SECOND’ column utilize the following definitions, parameters and FIP attributes.

- 1) **Low Stand Quality:**
- defined as coniferous stands on low productivity sites, with existing (or projected) stand volumes ≤150 m3/ha, and mean stand DBH < 25 cm

Pli Leading:
Immature Stands
if INV_TYPGRP = 28, 30, 31 and PROJ_AGE < 100 and SITE_INDEX <12
then SECOND = L

Mature Stands
if INV_TYPGRP = 28, 30, 31 and PROJ_AGE ≥ 100 < 250
and [V_SPC1DIA1 + V_SPC2DIA1 + V_SPC3DIA1 ≤ 150.0]
then SECOND = L

Overmature Stands
if INV_TYPGRP = 28, 30, 31 and PROJ_AGE ≥ 250
and [V_SPC1DIA1 + V_SPC2DIA1 + V_SPC3DIA1 ≤ 150.0 OR PROJ_HT < 18 OR
MEAN_DIA_PRI_UTIL_LVL < 25]
then SECOND = L

Hemlock Leading:
Immature Stands
if INV_TYPGRP = 12, 14-17 and PROJ_AGE < 110 and SITE_INDEX <11
then SECOND = L

Mature Stands
if INV_TYPGRP = 12, 14-17 and PROJ_AGE ≥ 110 < 200
and V_SPC1DIA1 + V_SPC2DIA1 + V_SPC3DIA1 ≤ 175
then SECOND = L

Overmature Stands
if INV_TYPGRP = 12, 14-17 and PROJ_AGE ≥ 200
and [V_SPC1DIA1 + V_SPC2DIA1 + V_SPC3DIA1 ≤ 175 OR PROJ_HT < 18]
then SECOND = L

Balsam Leading:
Immature Stands
if INV_TYPGRP = 18-20 and PROJ_AGE < 100 and SITE_INDEX <11
then SECOND = L

Mature Stands
if INV_TYPGRP = 18-20 and PROJ_AGE ≥ 100 < 200
and [V_SPC1DIA1 + V_SPC2DIA1 + V_SPC3DIA1 ≤ 150]
then SECOND = L

Overmature Stands
if INV_TYPGRP = 18-20 and PROJ_AGE ≥ 200
and [V_SPC1DIA1 + V_SPC2DIA1 + V_SPC3DIA1 ≤ 150 OR PROJ_HT < 18 OR
MEAN_DIA_PRI_UTIL_LVL < 25]
then SECOND = L

Spruce Leading:
Immature Stands
if INV_TYPGRP = 21, 23-26 and PROJ_AGE < 100 and SITE_INDEX <10
then SECOND = L

Mature Stands
if INV_TYPGRP = 21, 23-26 and PROJ_AGE ≥ 100 < 200
and [V_SPC1DIA1 + V_SPC2DIA1 + V_SPC3DIA1 ≤ 150]
then SECOND = L

Overmature Stands
if INV_TYPGRP = 21, 23-26 and PROJ_AGE ≥ 200
and [V_SPC1DIA1 + V_SPC2DIA1 + V_SPC3DIA1 ≤ 150 OR PROJ_HT < 18 OR
MEAN_DIA_PRI_UTIL_LVL < 25]
then SECOND = L

2) **Marginal Sawlog Stand Quality:**
- defined as productive stands (where existing or projected volume >150 m3/ha, mean stand DBH >25 cm),
Inventory Type Group (ITG) 18 or 20,
AND average total tree height <24 m,
AND net type volume >60% BL. **PLUS**

- all sawlog quality stands in Planning Cell C7.

note: the inventory database (FIP) often contains generic species codes. An example of this is balsam, whose generic code is ‘B’. In Bulkley TSA, balsam is predominately amabilis fir (Ba) or subalpine fir (Bl). Where the generic code ‘B’ occurs in the CWH biogeoclimatic zone it is most likely Ba; elsewhere it is most likely BL.

ITG, Diameter, Site Index, Volume, Age, and Height Parameters

SECOND ≠ L
INV_TYPGRP = 18, 20 (and 19, in limited cases)

Mature Stands
PROJ_AGE ≥ 100
PROJ_HT < 24.0
V_SPC1DIA1 + V_SPC2DIA1 + V_SPC3DIA1 > 150.0
MEAN_DIA_PRI_UTIL_LVL ≥ 25

Immature Stands
PROJ_AGE < 100
SITE_INDEX ≥ 11

Inside CWH, where B = Ba
Possible combinations considered for inclusion as MSL:
(Note: * = ‘any species other than BL’)
i) BL * *
ii) BL BA, B or H* BA, B or H*

i) if ITG = 18, 20 and SPC_1 = BL and SPC_2 ≠ BL and SPC_3 ≠ BL
and BGC_ZONE = CWH
and V_SPC1DIA1 > [0.60*(V_SPC1DIA1 + V_SPC2DIA1 + V_SPC3DIA1)]

ii) if ITG = 19 and SPC_1 = BL and SPC_2 = BA, B or H* and SPC_3 = BA, B or H*
and BGC_ZONE = CWH
and SPC_1 ≥ [0.5*(V_SPC1DIA1 + V_SPC2DIA1 + V_SPC3DIA1)]

Outside CWH, where B = Bl
Possible combinations considered for inclusion as MSL:
(Note: * = ‘any species other than B or BL’)
i) B or BL * *
ii) B or BL B or BL *
iii) B or BL * B or BL
iv) B or BL BA or H* BA or H*

i) if SPC_1 = BL or B and SPC_2 ≠ B or BL and SPC_3 ≠ B or BL
and BGC_ZONE ≠ CWH
and V_SPC1DIA1 > [0.60*(V_SPC1DIA1 + V_SPC2DIA1 + V_SPC3DIA1)]

ii) if SPC_1 = BL or B and SPC_2 = B or BL and SPC_3 ≠ B or BL
and BGC_ZONE ≠ CWH
and V_SPC1DIA1 + V_SPC2DIA1 > [0.60*(V_SPC1DIA1 + V_SPC2DIA1 + V_SPC3DIA1)]

iii) if SPC_1 = BL or B and SPC_2 ≠ B or BL and SPC_3 = B or BL
and BGC_ZONE ≠ CWH
and V_SPC1DIA1 + V_SPC3DIA1 > [0.60*(V_SPC1DIA1 + V_SPC2DIA1 + V_SPC3DIA1)]

iv) if ITG = 19 and SPC_1 = B or BL and SPC_2 = BA or H* and SPC_3 = BA or H*
and BGC_ZONE ≠ CWH
and SPC_1 ≥ [0.5*(V_SPC1DIA1 + V_SPC2DIA1 + V_SPC3DIA1)]

ITG 21, 23-26, 28, 30, 31: Sawlog quality stands in Planning Cell C7

if INV_TYPGRP = 21, 23-26, 28, 30, 31 and PLANNING_CELL = C7

3) Pulplog

- defined as productive stands (where existing or projected volume >175 m3/ha, mean stand DBH >25 cm), ITG 12, 15-17, 19,

AND net type volumes >50% H and <20% S (**Scenario 1**);

OR ITG 18, 20

AND net type volumes >50% Ba and <20% S (**Scenario 2**);

OR net type volumes >50% Ba and H (combined) with <20% S (**Scenario 3**).

Volume, Age, ITG, Crown Closure, Site Index, and Height Parameters

SECOND $\neq$ **L, M**

INV_TYPGRP = **12, 15-17, 19**

Mature Stands

PROJ_AGE $\geq$ **110**

V_SPC1DIA1 + V_SPC2DIA1 + V_SPC3DIA1 > **175.0**

Immature Stands

PROJ_AGE < **110**

SITE_INDEX $\geq$ **11**

ITG 12, 14-17: Inside CWH, where B = Ba

Possible combinations considered for inclusion as pulplog:
(Note: * = ‘not B or BA or S* or H*’)

- i) H* * *
- ii) H* BA, B or H* S*
- iii) H* S* BA, B or H*
- iv) H* BA, B or H* BA, B or H*
- v) H* BA, B or H* *
- vi) H* * BA, B or H*
- vii) H* S* *
- viii) H* * S*

Biogeoclimatic Zone and Species Composition Parameters:
BGC_ZONE = CWH

- i) if SPC_1 = H* and SPC_2 ≠ BA, B, H*, or S* and SPC_3 ≠ BA, B, H*, or S*
and V_SPC1DIA1 > 0.50*(V_SPC1DIA1 + V_SPC2DIA1 + V_SPC3DIA1)
- ii) if SPC_1 = H* and SPC_2 = BA, B, or H* and SPC_3 = S*
and V_SPC1DIA1 + V_SPC2DIA1 > 0.50*(V_SPC1DIA1 + V_SPC2DIA1 + V_SPC3DIA1)
and V_SPC2DIA1 < 0.20*(V_SPC1DIA1 + V_SPC2DIA1 + V_SPC3DIA1)
- iii) if SPC_1 = H* and SPC_2 = S* and SPC_3 = BA, B, or H*
and V_SPC1DIA1 + V_SPC3DIA1 > 0.50*(V_SPC1DIA1 + V_SPC2DIA1 + V_SPC3DIA1)
and V_SPC3DIA1 < 0.20*(V_SPC1DIA1 + V_SPC2DIA1 + V_SPC3DIA1)
- iv) if SPC_1 = H* and SPC_2 = BA, B, or H* and SPC_3 = BA, B, or H*
then SECOND = P
- v) if SPC_1 = H* and SPC_2 = BA, B, or H* and SPC_3 ≠ BA, B, H*, or S*
and V_SPC1DIA1 + V_SPC2DIA1 > 0.50*(V_SPC1DIA1 + V_SPC2DIA1 + V_SPC3DIA1)
- vi) if SPC_1 = H* and SPC_2 ≠ BA, B, H*, or S* and SPC_3 = BA, B, or H*
and V_SPC1DIA1 + V_SPC3DIA1 > 0.50*(V_SPC1DIA1 + V_SPC2DIA1 + V_SPC3DIA1)
- vii) if SPC_1 = H* and SPC_2 = S* and SPC_3 ≠ BA, B, H*, or S*
and V_SPC1DIA1 > 0.50*(V_SPC1DIA1 + V_SPC2DIA1 + V_SPC3DIA1)
and V_SPC2DIA1 < 0.20*(V_SPC1DIA1 + V_SPC2DIA1 + V_SPC3DIA1)
- viii) if SPC_1 = H* and SPC_2 ≠ BA, B, H*, or S* and SPC_3 = S*
and V_SPC1DIA1 > 0.50*(V_SPC1DIA1 + V_SPC2DIA1 + V_SPC3DIA1)
and V_SPC3DIA1 < 0.20*(V_SPC1DIA1 + V_SPC2DIA1 + V_SPC3DIA1)

ITG 12, 14-17: Outside CWH, where B = Bl

Possible combinations considered for inclusion as pulplog:
(Note: * = 'not BA or S* or H*')

- i) H* * *
- ii) H* BA or H* S*
- iii) H* S* BA or H*
- iv) H* BA or H* BA or H*
- v) H* BA or H* *
- vi) H* * BA or H*
- vii) H* S* *
- viii) H* * S*

Biogeoclimatic Zone and Species Composition Parameters:
BGC_ZONE ≠ **CWH**

- i) if SPC_1 = H* and SPC_2 ≠ BA, H*, or S* and SPC_3 ≠ BA, H*, or S*
and $V_SPC1DIA1 > 0.50 * (V_SPC1DIA1 + V_SPC2DIA1 + V_SPC3DIA1)$
- ii) if SPC_1 = H* and SPC_2 = BA, or H* and SPC_3 = S*
and $V_SPC1DIA1 + V_SPC2DIA1 > 0.50 * (V_SPC1DIA1 + V_SPC2DIA1 + V_SPC3DIA1)$
and $V_SPC3DIA1 < 0.20 * (V_SPC1DIA1 + V_SPC2DIA1 + V_SPC3DIA1)$
- iii) if SPC_1 = H* and SPC_2 = S* and SPC_3 = BA, or H*
and $V_SPC1DIA1 + V_SPC3DIA1 > 0.50 * (V_SPC1DIA1 + V_SPC2DIA1 + V_SPC3DIA1)$
and $V_SPC3DIA1 < 0.20 * (V_SPC1DIA1 + V_SPC2DIA1 + V_SPC3DIA1)$
- iv) if SPC_1 = H* and SPC_2 = BA, or H* and SPC_3 = BA, or H*
then SECOND = P
- v) if SPC_1 = H* and SPC_2 = BA, or H* and SPC_3 ≠ BA, H*, or S*
and $V_SPC1DIA1 + V_SPC2DIA1 > 0.50 * (V_SPC1DIA1 + V_SPC2DIA1 + V_SPC3DIA1)$
- vi) if SPC_1 = H* and SPC_2 ≠ BA, H*, or S* and SPC_3 = BA, or H*
and $V_SPC1DIA1 + V_SPC3DIA1 > 0.50 * (V_SPC1DIA1 + V_SPC2DIA1 + V_SPC3DIA1)$
- vii) if SPC_1 = H* and SPC_2 = S* and SPC_3 ≠ BA, H*, or S*
and $V_SPC1DIA1 > 0.50 * (V_SPC1DIA1 + V_SPC2DIA1 + V_SPC3DIA1)$
and $V_SPC2DIA1 < 0.20 * (V_SPC1DIA1 + V_SPC2DIA1 + V_SPC3DIA1)$
- viii) if SPC_1 = H* and SPC_2 ≠ BA, H*, or S* and SPC_3 = S*
and $V_SPC1DIA1 > 0.50 * (V_SPC1DIA1 + V_SPC2DIA1 + V_SPC3DIA1)$
and $V_SPC3DIA1 < 0.20 * (V_SPC1DIA1 + V_SPC2DIA1 + V_SPC3DIA1)$

ITG 18-20: Inside CWH, where B = Ba

Possible combinations considered for inclusion as pulplog:
(note: * = ‘ not B, BA, H*, or S*’)

- i) BA or B * *
- ii) BA or B BA, B or H* S*
- iii) BA or B S* BA, B or H*
- iv) BA or B BA, B or H* BA, B or H*
- v) BA or B BA, B or H* *
- vi) BA or B * BA, B or H*
- vii) BA or B S* *
- viii) BA or B * S*
- ix) BL BA, B or H* BA, B or H*

Biogeoclimatic Zone and Species Composition Parameters:
BGC_ZONE = CWH

- i) if SPC_1 = BA or B and SPC_2 ≠ BA, B, H*, or S* and SPC_3 ≠ BA, B, H*, or S* and $V_SPC1DIA1 > 0.50 * (V_SPC1DIA1 + V_SPC2DIA1 + V_SPC3DIA1)$
- ii) if SPC_1 = BA or B and SPC_2 = BA, B, or H* and SPC_3 = S* and $V_SPC1DIA1 + V_SPC2DIA1 > 0.50 * (V_SPC1DIA1 + V_SPC2DIA1 + V_SPC3DIA1)$ and $V_SPC3DIA1 < 0.20 * (V_SPC1DIA1 + V_SPC2DIA1 + V_SPC3DIA1)$
- iii) if SPC_1 = BA or B and SPC_2 = S* and SPC_3 = BA, B, or H* and $V_SPC1DIA1 + V_SPC3DIA1 > 0.50 * (V_SPC1DIA1 + V_SPC2DIA1 + V_SPC3DIA1)$ and $V_SPC3DIA1 < 0.20 * (V_SPC1DIA1 + V_SPC2DIA1 + V_SPC3DIA1)$
- iv) if SPC_1 = BA or B and SPC_2 = BA, B, or H* and SPC_3 = BA, B, or H* then SECOND = P
- v) if SPC_1 = BA or B and SPC_2 = BA, B, or H* and SPC_3 ≠ BA, B, H*, or S* and $V_SPC1DIA1 + V_SPC2DIA1 > 0.50 * (V_SPC1DIA1 + V_SPC2DIA1 + V_SPC3DIA1)$
- vi) if SPC_1 = BA or B and SPC_2 ≠ BA, B, H*, or S* and SPC_3 = BA, B, or H* and $V_SPC1DIA1 + V_SPC3DIA1 > 0.50 * (V_SPC1DIA1 + V_SPC2DIA1 + V_SPC3DIA1)$
- vii) if SPC_1 = BA or B and SPC_2 = S* and SPC_3 ≠ BA, B, H*, or S* and $V_SPC1DIA1 > 0.50 * (V_SPC1DIA1 + V_SPC2DIA1 + V_SPC3DIA1)$ and $V_SPC2DIA1 < 0.20 * (V_SPC1DIA1 + V_SPC2DIA1 + V_SPC3DIA1)$
- viii) if SPC_1 = BA or B and SPC_2 ≠ BA, B, H*, or S* and SPC_3 = S* and $V_SPC1DIA1 > 0.50 * (V_SPC1DIA1 + V_SPC2DIA1 + V_SPC3DIA1)$ and $V_SPC3DIA1 < 0.20 * (V_SPC1DIA1 + V_SPC2DIA1 + V_SPC3DIA1)$
- ix) if SPC_1 = BL and SPC_2 = BA, B or H* and SPC_3 = BA, B or H* and $V_SPC2DIA1 + V_SPC3DIA1 > 0.50 * (V_SPC1DIA1 + V_SPC2DIA1 + V_SPC3DIA1)$

ITG 18-20: Outside CWH, where B = BL

Possible combinations considered for inclusion as pulplog:

- i) BA * *
- ii) BA H* S*
- iii) BA S* H*
- iv) BA H* *
- v) BA * H*
- vi) BA S* *
- vii) BA * S*
- viii) BL BA or H* BA or H*

Biogeoclimatic Zone and Species Composition Parameters:

BGC_ZONE ≠ CWH

- i) if** SPC_1 = BA **and** SPC_2 ≠ H*, or S* **and** SPC_3 ≠ H*, or S*
and V_SPC1DIA1 > 0.50*(V_SPC1DIA1 + V_SPC2DIA1 + V_SPC3DIA1)
- ii) if** SPC_1 = BA **and** SPC_2 = H* **and** SPC_3 = S*
and V_SPC1DIA1 + V_SPC2DIA1 > 0.50*(V_SPC1DIA1 + V_SPC2DIA1 + V_SPC3DIA1)
and V_SPC3DIA1 < 0.20*(V_SPC1DIA1 + V_SPC2DIA1 + V_SPC3DIA1)
- iii) if** SPC_1 = BA **and** SPC_2 = S* **and** SPC_3 = H*
and V_SPC1DIA1 + V_SPC3DIA1 > 0.50*(V_SPC1DIA1 + V_SPC2DIA1 + V_SPC3DIA1)
and V_SPC3DIA1 < 0.20*(V_SPC1DIA1 + V_SPC2DIA1 + V_SPC3DIA1)
- iv) if** SPC_1 = BA **and** SPC_2 = H* **and** SPC_3 ≠ H*, or S*
and V_SPC1DIA1 + V_SPC2DIA1 > 0.50*(V_SPC1DIA1 + V_SPC2DIA1 + V_SPC3DIA1)
- v) if** SPC_1 = BA **and** SPC_2 ≠ H*, or S* **and** SPC_3 = H*
and V_SPC1DIA1 + V_SPC3DIA1 > 0.50*(V_SPC1DIA1 + V_SPC2DIA1 + V_SPC3DIA1)
- vi) if** SPC_1 = BA **and** SPC_2 = S* **and** SPC_3 ≠ H*, or S*
and V_SPC1DIA1 > 0.50*(V_SPC1DIA1 + V_SPC2DIA1 + V_SPC3DIA1)
and V_SPC2DIA1 < 0.20*(V_SPC1DIA1 + V_SPC2DIA1 + V_SPC3DIA1)
- vii) if** SPC_1 = BA **and** SPC_2 ≠ H*, or S* **and** SPC_3 = S*
and V_SPC1DIA1 > 0.50*(V_SPC1DIA1 + V_SPC2DIA1 + V_SPC3DIA1)
and V_SPC3DIA1 < 0.20*(V_SPC1DIA1 + V_SPC2DIA1 + V_SPC3DIA1)
- viii) if** SPC_1 = BL **and** SPC_2 = BA or H* **and** SPC_3 = BA or H*
and V_SPC2DIA1 + V_SPC3DIA1 > 0.50*(V_SPC1DIA1 + V_SPC2DIA1 + V_SPC3DIA1)

- 4) **Deciduous Quality**
- defined as productive, deciduous leading stands

INV_TYPGRP = 35-42

- 5) **‘Thick’ Quality**
- defined as coniferous stands with density problems that permit achievement of volume, but prevent achievement of DBH limitations

SECOND ≠ M, P, D, L

Mature Stands, Spruce, Pine, or Balsam Leading
INV_TYPGRP = 18-21, 23-26, 28, 30, 31
PROJ_AGE ≥ 100
CROWN_CLOSURE_AIR ≥ 80
V_SPC1DIA1 + V_SPC2DIA1 + V_SPC3DIA1 > 150.0
MEAN_DIAMETER_PRI_UTIL_LVL ≤ 25.0

Mature Stands, Hemlock Leading
INV_TYPGRP = 12, 14-17
PROJ_AGE ≥ 110
CROWN_CLOSURE_AIR ≥ 80
V_SPC1DIA1 + V_SPC2DIA1 + V_SPC3DIA1 > 175.0
MEAN_DIAMETER_PRI_UTIL_LVL ≤ 25.0

Immature Stands, Spruce, Pine, or Balsam Leading
INV_TYPGRP = 18-21, 23-26, 28, 30, 31
PROJ_AGE < 100
SITE_INDEX ≥ 15
CROWN_CLOSURE_AIR ≥ 80 .or.
DENSITY ≥ 10,000

Immature Stands, Hemlock Leading
INV_TYPGRP = 12, 14-17
PROJ_AGE < 110
SITE_INDEX ≥ 15
CROWN_CLOSURE_AIR ≥ 80 .or.
DENSITY ≥ 10,000

- 6) **Sawlog Quality**
- defined as remaining productive forest (includes all immature logged blocks, and all other catastrophic loss blocks where silviculture activities have been conducted).

Immature Stands - Logged:
PROJ_AGECL ≤ 5
ACTIVITY = L

Immature Stands - Other Catastrophic Loss:
ACTIVITY = B, I, W
ACTIVITY2 ≠ null
ACTIVITY3 ≠ null

Mature Stands:
SECOND ≠ M, P, D, L, T

Attachment 4: Sections of TSR 2 Data Package Addressing Use of HMM

Section 2.2 Statement of Major Forest Management Considerations and Issues

Table 1 Major forest management considerations and issues (part of table only)

Consideration/Issue	Description
Partitioned Cut	To ensure the harvest profile matches the stand quality profile, 367 000 m ³ of the current AAC is harvested in marginal sawlog or pulplog quality stands.
Harvest method mapping (HMM)	Harvest method mapping (HMM) was developed primarily to define operable land base within the Bulkley TSA. HMM also provides information for riparian areas, low sites, problem forest types, and slope classes. The Geographic Information System (GIS) based algorithm for HMM. was designed by Bulkley/Cassiar Forest District staff with input from major licensees. The three tables appended to Table 1 define the HMM parameters.
Community watersheds	Forest management guidelines associated with community watersheds will be considered in the analysis.

Data Source and Comments:

The ‘Harvest Method Mapping’ GIS algorithm defines the physically accessible and economically feasible operable landbase. The methodology used to develop the algorithm was a joint effort of Bulkley/Cassiar Forest District staff and major licensees.

The product of the algorithm is a database containing the following information for 'operability' polygons:
either:
1) an appropriate harvest method code based on slope criteria and stand quality (Tables 1a and 1b); OR
2) appropriate riparian reserve zone and riparian management zone codes, if the ‘operability’ polygon is associated with a stream, lake, or wetland (see Table 7).

The operable landbase was defined by selecting the harvest method/stand quality code combinations considered by licensees to be feasible for harvest. Table 1c illustrates which combinations are included and which are excluded.

Parameters for the Analysis Units described in Table 4 are the same as those for ‘stand quality’ codes, as described in Table 1b.

Table 1a: Operability Codes

Primary ‘Harvest Method’ codes	Secondary ‘Stand Quality’ codes
G - ground C - cable* H - helicopter I - inaccessible, forested	S - sawlog stands M - marginal sawlog stands P - pulplog stands D - deciduous-leading stands L - sites of low volume and low productivity T - sites with density problems (e.g. thick regeneration).

*some H overlaps with C depending on factors such as block location with respect to access

Table 4 Definition of Analysis Units

Analysis Unit (AU)	Criteria		Equivalent HMM Stand Quality Code
	Inventory Type Groups	Site Index Range	
Sawlog AUs:			
Spruce - G	21, 23-26	> 19	S
Spruce - M	21, 23-26	15-19	S
Spruce - P	21, 23-26	≥ 10 < 15	S
Pine - G, M	28, 30, 31	≥ 15	S
Pine - P	28, 30, 31	≥ 12 <15	S
Balsam - G	18, 20	≥ 18	S
Balsam - M	18, 20	≥ 15<18	S
Marginal Sawlog AUs			
Balsam - MS	18, 20	≥ 11<15	M
Spruce/Pine - MS (Planning Cell C7)	18-21, 23-26, 28, 30, 31	≥ 10	M
Overdense Conifer - MS	18-21, 23-26, 28, 30, 31	≥ 15	T
Pulplog AUs			
Hemlock - Pulp	12, 14-17, 19	≥ 11	P
Balsam/Spruce - Pulp	18, 20	≥ 11	P
Overdense Conifer - Pulp	12, 14-17	≥ 11	T

Data Source and Comments:

The ‘Equivalent HMM Stand Quality Code’ column lists the stand quality codes from Table 1a and 1b which equate to the analysis units described. The parameters shown are the same as those used in the HMM algorithm.

Marginal sawlog and pulplog analysis units (AUs) result from the AAC Rationale definition from the 1995 Timber Supply Review.

The ‘Spruce/Pine - MS’ AU identifies conifer-leading stands in planning cell C7 which are assigned to the marginal sawlog category because of their remoteness (AAC Rationale definition of marginal sawlog).
The ‘Overdense Conifer - MS’ and ‘Overdense Conifer - Pulp’ AUs identify those stands which exceed minimum harvest volumes, but where minimum stem size criteria will not be achieved because of excessive stand density.

Section 5.2.5 Areas considered Inoperable

Operable and inoperable codes are generally used to describe the presence or absence of physical barriers or limitations to harvesting, logging methods (e.g. cable), and the merchantability of stands.

‘Harvest Method Mapping’ (HMM), which was based on physical accessibility and economic feasibility for harvest, was used to determine limits of operability within the Bulkley TSA. Operability polygons have been assigned a primary ‘harvest method’ code and a secondary ‘stand quality’ code (Table 1a and 1b). Codes contributing and not contributing to the operable landbase are shown in Table 1c.

Any operability type containing the code ‘**I***’, as designated by the HMM process (i.e. **IL, IM, IP, IT**), will be excluded from the operable landbase.

Section 5.2.6 Sites with Low Timber Growing Potential

Sites may have low productivity either because of inherent site factors (nutrient availability, exposure, excessive moisture, etc.), or because they are not fully occupied by commercial tree species. Typically these stands are combined with other stands within the forested land base. As these stands are not considered harvestable, they need to be identified and removed from the timber harvesting land base.

‘Harvest Method Mapping’ (HMM), which was based on physical accessibility and economic feasibility for harvest, was used to determine low sites within the Bulkley TSA. Operability polygons have been assigned a primary ‘harvest method’ code and a secondary ‘stand quality’ code (Table 1a and 1b). Codes contributing and not contributing to the operable landbase are shown in Table 1c.

Any operability type containing the code ‘***L**’, as designated by the HMM process (i.e. **GL, CL, HL, IL**), will be excluded from the operable landbase.

Section 5.2.7 Problem Forest Types

Problem forest types are stands which are physically operable and exceed low site criteria yet are not currently utilized or have marginal merchantability. These types are excluded from the timber harvesting land base.

To reflect problem forest types, the following HMM codes will be reduced by 100 %:

**ID, GD, CD, HD, HP, HT,
[CT and GT >age class 3], and
cedar (inventory type group 9).**

‘Harvest Method Mapping’ (HMM) was used to identify problem forest types within the Bulkley TSA. Operability polygons have been assigned a primary ‘harvest method’ code and a secondary ‘stand quality’ code (Table 1a and 1b). Codes contributing and not contributing to the operable landbase are shown in Table 1c.

Any operability polygon containing the code ‘*D’ (deciduous), as designated by the HMM process (i.e. ID, GD, CD, HD), is identified as a problem forest type. Additional problem forest types include certain pulp-quality stands (HP), stands with density problems (HT, as well as CT,GT > age class 3), and cedar components of cedar-leading stands.

Section 5.2.11 Riparian management areas

Table 7 Riparian Reserve Zones

Location (e.g. zone)	Stream Class	Riparian Reserve Zone Width (RRZ) in metres	Riparian Management Zone Width (RMZ) in metres	Reduction percent for RMZ (% RMZ area)
Streams				
Within Community Watersheds (all slopes)	S1	50 ²	20 ²	10
	S2	30	20	10
	S3	13.4 ¹	26.7 ¹	10
	S4	0	30	5
Outside Community Watersheds (slopes < 20%)	S1	50 ²	20 ²	10
	S2	30	20	10
	S3, S4	13.4 ¹	26.7 ¹	10
	S6	0	20	5
Outside Community Watersheds (slopes ≥ 20%)	S5	0	30	5
	S6	0	20	5
Wetlands	W1	10 ²	40 ²	10
	W3, W4	0	30	5
Lakes	L1	10 ²	20 ²	10
	L3, L4	0	30	5

¹ Zone widths shown are weighted averages, calculated using stream class densities identified in a ‘Bulkley Stream Inventory Point Sample’ summary.

² The RRZ and RMZ widths selected for this table are the Forest Practices Code Operational Planning Regulation default values for S1 streams less than 100 metres in width, and L1 lakes and W1 wetlands less than 1000 ha in size.

Data Source and Comments

Harvest Method Mapping (HMM) produced a digital overlay in which streams were classed, then buffered with Riparian Reserve Zones (RRZs) and Riparian Management Zones (RMZs). When this buffer overlay is merged with forest cover, the resultant polygons are tagged as ‘in’ or ‘out’ of riparian reserves or riparian management zones.

The reduction percent shown in Table 7 will be applied to riparian management zones (RMZ). Percent reductions within RMZ areas reflect actual management practices of major licensees operating within the TSA. Riparian reserve zones (RRZs) will be reduced by 100%.

Within landscape corridors and core ecosystems, forest cover constraints override riparian management zone criteria.