

Kootenay Lake Timber Supply Area – TSA 13

**Vegetation Resources Inventory
Project Implementation Plan for Volume Audit
Sampling, Young Stand Monitoring and Net
Volume Adjustment Factor Sampling**

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Executive Summary

This Vegetation Resources Inventory (VRI) Project Implementation Plan (VIP) is the planning document that will be used as a guide for the Kootenay Lake Timber Supply Area (TSA) VRI ground sampling project. The critical work undertaken and recorded in this plan for this TSA includes: deciding the requirements around netting down the land base for Young Stand Monitoring (YSM) and Volume Audit sampling; completing the sample selection for YSM and Volume Audit ground sampling and Net Volume Adjustment Factor (NVAF) destructive sampling; identifying each sample's location; providing documentation of the sample selection; and confirming details regarding the sampling protocols that will be undertaken.

This Project Implementation Plan has been prepared following the documents:

- *VRI Guidelines for Preparing a Project Implementation Plan for Ground Sampling and Net Volume Adjustment Factor Sampling (Version 3.1)*
- *Streamlining VRI Ground Sampling Volume Audit (VA) Sampling*
- *A Framework for Implementing Young Stand Growth Monitoring in British Columbia (2012)*

The *Volume Audit Sampling* guideline identifies some standardized items on which to build the VRI ground sampling plan for a management unit. These include:

1. Identifying the populations in the TSA.
2. Establishing the Vegetated Treed (VT) portion of the Kootenay Lake TSA as the land base for the Volume Audit sample selection.
3. Indicating a sample size of fifty (50) samples in the Volume Audit population.
4. Directing the completion of the Volume Audit sample list development and identification of sample locations within the selected polygons according to the *Vegetation Resources Inventory Sample Selection Procedures for Ground Sampling Version 4.0 DRAFT*.

Young Stand Monitoring will be confined to all stands ≥ 15 years and ≤ 50 years. The document *A Framework for Implementing Young Stand Growth Monitoring in British Columbia* outlines details for YSM. The land base for these samples is NOT restricted to the VT. The sample selection for YSM samples is grid based. Using a 2 km grid provided by Forest Analysis and Inventory Branch (FAIB) staff, a list of fifty (50) YSM samples has been developed.

The Volume Audit ground sample selection has been completed based on five strata. The strata were developed after analysing the leading species representation in the Volume Audit population.

- Stratum 1: Balsam
- Stratum 2: Douglas-fir - Larch
- Stratum 3: Spruce
- Stratum 4: Pine
- Stratum 5: Other

The YSM sample selection involves no pre-stratification.

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1.0 Introduction

The Vegetation Resources Inventory (VRI) is the inventory standard for forest cover inventory in the province of British Columbia (BC). It follows a set of procedures with associated standards, administered by the Ministry of Forests, Lands and Natural Resource Operations (Ministry). The VRI was designed to answer two questions: “Where is the resource located?” and “How much of given vegetation resource is within an inventory unit?”¹

The VRI is a photo based, 2-phase program. Phase 1 involves photo interpretation, delineating polygons of homogenous land cover types and providing estimates of the vegetation attributes for each polygon. Phase 2 is ground sampling to verify the accuracy of volumes and some of the key Phase 1 vegetation attributes. It also includes monitoring.

This Project Implementation Plan will provide details to guide the Volume Audit, Net Volume Adjustment Factoring (NVAF) and Young Stand Monitoring (YSM) in the Kootenay Lake Timber Supply Area (TSA). The YSM samples are being established as long term monitoring plots and are intended to be remeasured at an interval to be determined later.

1.1 Document Objectives

The objectives of preparing this Project Implementation Plan are two-fold. This document provides a record of the decisions made to develop this VRI ground sampling project. It also serves as a guide for those undertaking the project. Specific details include the identification of: sampling population; decisions made in the development of sample lists; sample lists for ground sampling in both the Volume Audit population and for Young Stand Monitoring and NVAF enhancement; VRI plot data collection methodology for both the audit and YSM populations; and deliverables for the ground sampling project.

1.2 Project Land base²

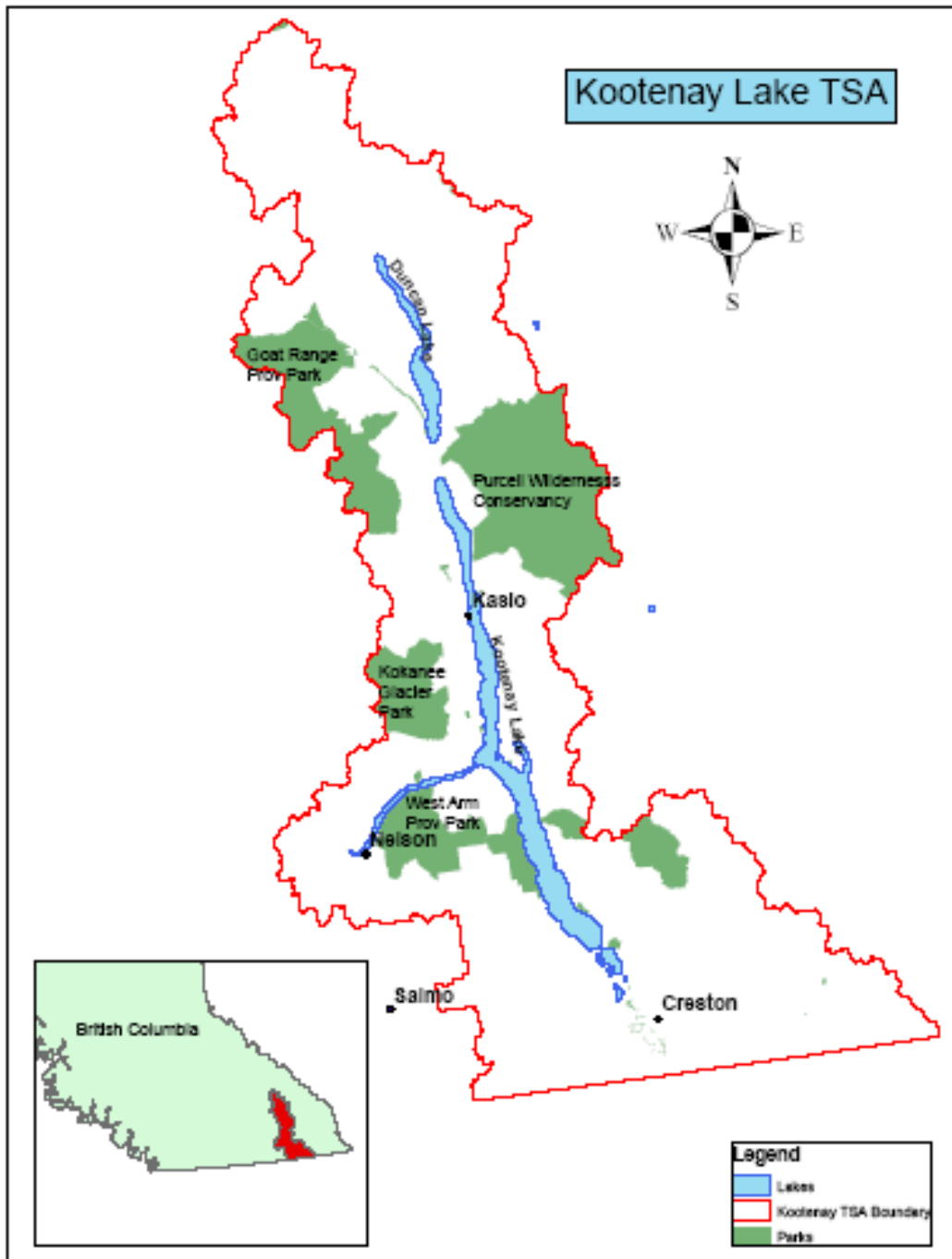
The Kootenay Lake TSA is located in south-eastern British Columbia in the Selkirk and Purcell Mountain ranges. It encompasses three major drainage systems (Kootenay Lake, Duncan River and Lardeau River). To the north of the TSA is Glacier National Park and to the south is the Canada-U.S.A. border. The Arrow TSA is to the west and to the east are the Invermere and Cranbrook TSAs.

¹ From the MFLNRO, Forest Analysis & Inventory Branch, Vegetation Resources Inventory website – Overview - <http://www.for.gov.bc.ca/hts/vri/intro/index.html>

² Text adapted from the Kootenay Lake TSA Data Package, July, 2008.

Figure 1 shows the general location and key geographic features of the Kootenay Lake TSA.

Figure 1. Map of Kootenay Lake TSA³



³ Map adapted from BC government website: <http://www.for.gov.bc.ca/hts/tsa/tsa13/map.gif>

The Kootenay Lake TSA is administered by the Selkirk Resource District of the Ministry, located just north of Nelson. It is approximately 1.24 million hectares in size, with approximately 50 percent of the total TSA being considered as productive forest. The following table shows the land base distribution.

Table 1: Kootenay Lake TSA Land Base Summary

Land Classification	Area	% of TSA
Total TSA Area	1,240,711	100
Net-downs	372,643	30.03%
Parks	231,119	18.63%
Private	139,144	11.21%
Indian Reserve	2,380	0.19%
Net Area	868,068	69.97%
Non Vegetated	126,863	10.23%
Vegetated	741,205	59.74%
Non-treed	122,879	9.90%
Treed	618,326	49.84%

The Kootenay Lake TSA includes moist and wet climatic regions and is commonly referred to as part of the Interior Wet Belt. There are three (3) biogeoclimatic zones⁴ (BGC) in the TSA including: Interior Cedar Hemlock (ICH) occupying valley bottoms and lower slopes to about 1400 metres; Engelmann Spruce-Subalpine Fir (ESSF), the uppermost forested zone, occurring at elevations between 1400 and 2500 metres; and the Interior Mountain-heather Alpine (IMA), occurring at elevations greater than 2250 metres, above the ESSF zone. The main tree species are subalpine fir (Bl), Douglas-fir (Fd), western larch (Lw), spruce (Se and Sx), and lodgepole pine. The Mountain Pine Beetle has been active in the southern Kootenay Lake TSA in recent years

1.3 State of the Inventory

The Kootenay Lake TSA VRI photo interpretation project started in 2008 and was delivered to the Ministry in early 2011. The project used a combination of photos flown in 2004, 2005 and 2006. The last RESULTS update was completed in July 2011. This inventory is the basis for the sample selection.

⁴ For the Kootenay Lake land base, the BGC zone breakdown as provided on page 19 of the Data Package dated July, 2008 is as follows: ESSF – 54%, ICH - 42% and IMA - 4%.

2.0 Ground Sampling Plan

2.1 Sampling objectives

The licensee stakeholder, Tembec Industries Inc., initiated the VRI program for Kootenay Lake TSA through the preparation of the Strategic Inventory Plan. The VSIP referenced a 1995 Pre-Inventory Assessment (PIA) completed by Forest Inventory Branch staff for Kootenay Lake TSA to determine the accuracy, consistency and reliability of the current inventory information. The PIA recommended a new inventory be done in the TSA. Among the forest management and inventory issues identified in the VSIP that the VRI could provide better information on were the following:

- Net merchantable volume;
- Vegetation polygon delineation and polygon attribute descriptions;
- Mountain Pine Beetle (MPB) affected stands.

The sampling objective of the Volume Audit and NVAF sampling project is to verify the accuracy of volumes and other key attributes in the new inventory. It will provide a statistically valid analysis of the Phase I inventory volumes on the mature population. A sampling error of 15% (net volume) is the target set for the Volume Audit sampling..

The primary focus of the YSM program is to check the accuracy of growth and yield (G&Y) predictions of key timber attributes in young stands, to support management unit timber supply review (TSR). No sampling error target will be set for the Young Stand Monitoring. The YSM program targets a statistical power and difference between actual and predicted G&Y estimates.

2.2 Target Population

The project uses two separate populations for sampling.

1. 15 to 50 years (Young Stand Monitoring)
2. 51 years and older in the VT (Volume Audit)

Tables 2, 3, 4 and 5 provide land base figures. For the Volume Audit population, figures in Tables 3 and 5 have formed the basis for decisions such as stratification of the population. The Young Stand Monitoring population is not restricted to the Vegetated Treed component of the land base, but is comprised of all stands $\geq 15 \leq 50$. This allows for the inclusion of silviculture openings where the crown closure in the database is less than 10%. These openings are an important portion of the YSM population. The Volume Audit population is > 50 and represents the Vegetated Treed land base.⁵

⁵ Numbers related to identifying the sampling population are the result of analytical work completed by Nona Phillips Forestry Consulting, using current data files provided by the Ministry. All work has followed the *VRI Sample Selection Standard* and has been documented in a Sample Selection Report provided to the government.

The exclusions from both the Volume Audit and the YSM land base have included Private land, Parks and Indian Reserves. Community Forests and Woodlots have been retained in the Kootenay Lake TSA sampling projects' populations.

Table 2: Species Distribution – Kootenay Lake TSA, Young Stand Monitoring Population, Ages 15-50

Species	Area (ha)	%
Spruce (Se, Sx)	14,224	25%
Balsam (Bl,Bg,B)	15,318	27%
Pine (Pl,Pw,Py,Pa)	10,124	18%
Douglas Fir	7,098	13%
Hemlock (Hw)	2,874	5%
Larch (Lw, La)	2,447	4%
Cedar (Cw)	2,309	4%
Birch (Ep)	1,207	2%
A (At,Ac)	1,057	2%
Total	56,658	100%

Table 3: Species Distribution – Kootenay Lake TSA Total Vegetated Treed Land base, Volume Audit Population, Ages 51+

Species	Area (ha)	%
Balsam (Bl,Bg,B)	172,485	31%
Douglas-fir (Fdi, Fd)	101,987	19%
Spruce (Se,S,Sx)	73,031	13%
Pine (Pli,Pa,Py,Pw,Pl)	71,370	13%
Larch (Lw,La,L)	66,361	12%
Hemlock (Hw,H)	50,285	9%
Cedar (Cw)	10,371	2%
A (At,Ac)	4,877	1%
Birch (Ep)	2,162	0%
Total	552,929	100%

Table 4: Age class Distribution, All Species – Kootenay Lake TSA, Young Stand Monitoring Population, Ages 15 – 50

Age Class	Ages	Area (ha)	%
1	15-20	10,345	18
2	21-40	35,224	62
3	41-50	11,089	20
Total		56,658	100%

Table 5: Age class Distribution, All Species – Kootenay Lake TSA Total Vegetated Treed Land base, Volume Audit Population, Ages 51+

Age Class	Ages	Area (ha)	%
3	51-60	12,032	2
4	61-80	111,166	20
5	81-100	82,784	15
6	101-120	89,225	16
7	121-140	72,227	13
8	141-250	153,245	28
9	251+	32,250	6
Total		552,929	100%

In the Kootenay Lake TSA, the land base in the Young Stand Monitoring population encompasses a total area of 56,658 hectares and the Volume Audit population land base is 552,929 hectares.

2.3 Sample Size

Following the document *Streamlining VRI Ground Sampling Volume Audit Sampling*, a total of 50 ground samples will be established in the Volume Audit population. An additional 30 samples are included in the sample list as alternates.

Based on the grids provided, consultation with Ministry staff has resulted in the sample list for the Young Stand Monitoring samples to include 50 samples for establishment and an additional 91 samples as alternates.

2.4 Strata

2.4.1 Ground Sampling

Volume Audit Population

The Volume Audit population has been stratified into species and species groupings as follows:

- Stratum 1: Balsam
- Stratum 2: Douglas-fir and Larch
- Stratum 3: Spruce
- Stratum 4: Pine
- Stratum 5: Other

The development of these strata was based on species distribution. Each stratum was further divided into 3 sub-strata with equal numbers of polygons, based on volume classes. Appendix D shows how strata and volume class sub-stratum are defined and how samples were distributed among them.

Table 6 shows the distribution of ground samples in the Volume Audit population.

Table 6: Distribution of Ground Samples – Volume Audit population

Stratum	Population Area (ha)	% of area	# of Samples	# of hectares represented by each sample	Replacements
Balsam	172,485	31%	16	10,780.31	9
Douglas-fir and Larch	168,348	31%	15	11,223.2	9
Spruce	73,031	13%	7	10,433	4
Pine	71,370	13%	6	11,895	4
Other	67,695	12%	6	11,282.5	4
Total	552,929	100%	50		30

Table 7 shows the division of the Volume Audit population stratum into sub-strata based on 3 volume classes.

Table 7: Volume Audit Population in VT - Sample breakdown by Volume Class

Stratum	Sub-stratum – Volume class	Area	%	Samples	Replacements
Balsam	1	55706	32.30%	5	3
	2	53961	31.28%	5	3
	3	62817	36.42%	6	3
	Total	172484	100.00%	16	9
Fd and L	1	49370	29.33%	5	3
	2	59492	35.34%	5	3
	3	59486	35.34%	5	3
	Total	168348	100.00%	15	9
Spruce	1	22302	30.54%	2	1
	2	24563	33.63%	2	1
	3	26166	35.83%	3	2
	Total	73031	100.00%	7	4
Pine	1	22168	31.06%	2	1
	2	24883	34.86%	2	2
	3	24321	34.08%	2	1
	Total	71372	100.00%	6	4
Other	1	19186	28.34%	2	1
	2	22109	32.66%	2	1
	3	26399	39.00%	2	2
	Total	67694	100.00%	6	4
Grand Total		552929		50	30

Young Stand Monitoring Population

There is no pre-stratification of the Young Stand Monitoring population.

2.4.2 NVAF

For NVAF sampling, the Volume Audit population is divided into two age groups, age 51 to 120 and 121+. In Kootenay Lake TSA, the 51 to 120 population represents 53% of the area and the 121+ represents 47%. Table 8 (below) shows the distribution of ground samples for NVAF-enhancement by age group.

Table 8: NVAF Ground Sample Distribution by Age Group

Land base	Age Group (years)	NVAF Samples
Volume Audit population	51-120	9
Volume Audit population	121+	16
	Total	25

2.5 Sample Selection

The Standard *VRI Sample Selection Procedures for Ground Sampling* outlines the process for sample selection in detail and Draft Version 4.0 has been used as the guideline for this plan. Documentation of the Sample Selection process followed is included in Appendix D.

2.5.1 Ground Sampling

The initial step was to identify the population of the Kootenay Lake TSA for the YSM and the Volume Audit population land base. Appendix D details the process of identifying the population areas, developing strata and sub-strata for the Volume Audit population, and how samples were distributed within these.

A sample list was developed for each of the two populations. The lists contain the initial samples and replacement samples available in the likely event that some of the initial samples are rejected in the field. There are 50 initial samples and 30 replacement samples in the Volume Audit population. For YSM, 50 initial and 91 replacement samples are identified.

For the Volume Audit population, sample polygons were selected according to procedures outlined in *Vegetation Resources Inventory –Draft Version 4.0 - Sample Selection Procedures for Ground Sampling*-Section 3.0. That is by “probability proportional to size with replacement” (PPSWR). Sample points were located randomly within the sample polygon using ARCMAP 10 GIS techniques and random numbers generated by Excel. Sample locations were reviewed against recent Landsat imagery. One alternate sample fell in recent cutover and this was replaced (see details in the Sample Selection Report).

Where there is a need to replace a sample in the field, the replacement should be from the same stratum or strata and sub-stratum.

The Young Stand Monitoring sample selection was grid based. A 2 km grid providing 141 sample points in the YSM population was approved by the Ministry staff for YSM sample selection. The 50 YSM samples were selected by dividing the total number of available samples (grid points that fell in the population) by 50 and then selecting every nth sample as one to be sampled. The remainder of the grid points provides the ‘alternate’ sample locations. This selection is outlined in Appendix D.

The sample lists are provided in Appendix A.

2.5.2 NVAF

The NVAF samples are a subset of the VRI sample selection in the Volume Audit population. Ministry staff has been involved in initial decisions related to the NVAF

sample selection. Based on their direction, a list of 25 samples has been derived from the final ground sample list, following Section 3.4 of the *Draft VRI Sample Selection Procedures for Ground Sampling*.

The samples that are to be enhanced to the NVAF standard are identified in this Project Implementation Plan. The details of NVAF sample selection and the complete NVAF profile can be found in Appendix C.

Enhancement of auxiliary plots will be completed at the time of the establishment of the ground samples according to the *NVAF Sampling Standards and Procedures*.

2.6 Sample Type

The protocols developed for the ground sampling enable forest managers to select from several options to collect timber and ecology data, dependent on their objectives. The ground samples established for the Kootenay Lake TSA project in the Volume Audit population will be completed by certified VRI Timber contractors following 'Timber Emphasis' procedures. It has not yet been determined if Coarse Woody Debris (CWD) data will be collected at each sample.

The sampling design for the 50 samples in the Young Stand Monitoring will basically follow the Change Monitoring (CMI) Procedures and Quality Assurance (QA) Standard. Since the Kootenay Lake TSA YSM project is a pilot study, any changes or additions to the CMI Procedures will be clearly outlined.

3.0 Project Implementation

3.1 Sample Packages

Sample packages will be prepared by the Ministry for all samples selected in this Kootenay Lake TSA Project Implementation Plan for both Volume Audit and YSM sampling. They will include tools that support the field crews in their efforts to navigate to, and establish each sample in the correct location. They will be prepared according to the document *Guidelines for Preparing a Project Implementation Plan for Ground Sampling and Net Volume Adjustment Factor Sampling*.

3.2 Standards

The current edition of the Vegetation Resources Inventory Ground Sampling Standards and Procedures and the Change Monitoring Inventory Standards and Procedures will be followed to complete this project. The Standards relevant to this project are listed in this document, following the Bibliography. When the project is initiated, the participants

should access the Forest Analysis and Inventory Branch website to confirm that they are using the latest version of each Standard.

3.3 Sample List

A complete sample list is provided in Appendix A. A description of how samples were distributed across the population is included in Appendix D.

3.4 Project Files

The original population files used to determine the selection will be provided to, and kept on file by, the Forest Analysis and Inventory Branch.

3.5 Project Analysis

Statistical analysis projects will be conducted on both the Volume Audit and YSM data collected. Specific analysis procedures are still being determined.

Bibliography

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4. British Columbia Ministry of Forests. Timber Supply Branch. July, 2008. Kootenay Lake TSA Timber Supply Review Data Package. Garry Beaudry, District Manager, Kootenay Lake Forest District & Melanie Boyce, Director, Forest Analysis & Inventory Branch, Victoria.
5. British Columbia Ministry of Forests. Forest Analysis & Inventory Branch. January 1, 2002. Kootenay Lake TSA – Rationale for AAC Determination. Larry Pedersen, Chief Forester, Victoria.
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7. Ministry of Forests, Lands and Natural Resource Operations, 2012, A Framework for Implementing Young Stand Growth Monitoring in British Columbia.
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10. Nona Phillips Forestry Consulting. July 15, 2011. Kootenay Lake TSA – Vegetation Resource Inventory Project Implementation Plan for Ground Sampling and Net Volume Adjustment Factor Sampling.
11. Tembec Industries Inc. December, 2006. Kootenay Lake Timber Supply Area Vegetation Resources Inventory Strategic Inventory Plan.
12. Timberline Natural Resource Group Ltd. June, 2007. Kootenay Lake Timber Supply Area Vegetation Resources Inventory Photo Interpretation Project Implementation Plan.
13. Various. Personal Communication with Ministry of Forests, Lands & Natural Resource Operations staff including Chris Mulvihill, Gary Johansen and Marc Rousseau regarding issues related to the preparation of the Kootenay Lake TSA VPIP.

VRI Standards & Procedures

The list of VRI Standards and Procedures that have been followed in the preparation of this plan and project to date and that must be followed to complete the Kootenay Lake TSA VRI Phase II ground sampling and NVAF sampling project is provided below. The most current edition should be used when this project is undertaken. They will be found at the VRI website:

<http://www.for.gov.bc.ca/hts/vri/index.html#>

Planning:

Preparing a VRI Strategic Inventory Plan (VSIP) for Ground Sampling and Photo Interpretation, January 2005

Vegetation Resources Inventory Guidelines for Preparing a Project Implementation Plan for Ground Sampling and Net Volume Adjustment Factor Sampling Version 3.1, March 2010

VRI Phase 2 Post-Project Documentation and Deliverables, June, 2007

Vegetation Resources Inventory Sample Selection Procedures for Ground Sampling
DRAFT Version 4.0 May 2011

Ground Sampling, Vegetation Resources Inventory (VRI):

Vegetation Resources Inventory Ground Sampling Procedures Version 4.9, March 2010
Ground Sampling Procedure Appendices Version 4.6, March 2010

Vegetation Resources Inventory Ground Sampling Quality Assurance Procedures and
Standards for VRI Ground Sampling Version 3.1, March 2008

Vegetation Resources Inventory Ground Sampling Data Collection Procedures for
Inaccessible Samples Version 1.0, March 2003

Ground Sampling, Change Monitoring Inventory (CMI):

National Forest Inventory B.C. Change Monitoring Procedures for Provincial and
National Reporting. Version 1.4, March 2005

National Forest Inventory B.C. Change Monitoring Procedures for Provincial and
National Reporting Appendices. Version 1.4, March 2005

Change Monitoring Inventory Ground Sampling Quality Assurance Procedures. Version
1.1, March 2002

Change Monitoring Inventory Ground Sampling Standards. Version 2.1 May 2007

Net Volume Adjustment Factors (NVAF):

Net Volume Adjustment Factor Sampling Standards and Procedures Version 5.0, April,
2011

VRI – Data Analysis

VRI Sample Data Analysis Procedures and Standards. Version 1.0, June 2011

Appendix A

Sample Lists for Kootenay Lake TSA Ground Samples

Sample List

The following are sample lists for each of the two populations. Each list contains initial samples for data collection and alternate samples in the event that some of the initial samples need to be replaced during the data collection phase.

For the Young Stand Monitoring (ages 15-50) there are 50 initial samples and 91 alternate samples.

For the Volume Audit population (ages 51+) there are 50 initial samples and 30 alternate samples.

One alternate sample in volume class 1 of the Pine strata was in a recent cutover so it was replaced with the contingency sample at the sample locating stage.

The shapefiles for each of the populations include all of the data fields from the original supplied VRI database.

In the Volume Audit population, samples can be rejected at the field sampling stage if they are in an unsafe location or in a cutover. When replacing samples they must be from the same stratum and sub-stratum (volume class). The project manager must be consulted if samples are rejected.

For the Young Stand Monitoring samples, *A Framework for Implementing Young Stand Growth Monitoring in British Columbia* should be referenced if there is any consideration of rejecting a sample.

Below is a description of the strata, for reference.

Volume Audit Population Strata Definition

Strata	Leading Species
1	Balsam
2	Douglas-fir and Larch
3	Spruce
4	Pine
5	Other

The following are sample lists for the two populations.

Volume Audit Samples

Initial Samples are numbered 1 to 50 and alternate samples are numbers A1 to A30.

Samp no	Strata	Vol Cls	MAP_ID	Polygon	UTM	Sp1	S1%	Sp2	S2%	Sp3	S3%	Age	Ht	BA	Vol	Stems/ha
1	B	1	082F015	31411758	11U 498519 5439232	BL	100		0		0	126	13.7	16	47	604
2	B	1	082F075	35129889	11U 490068 5505697	BL	90	SE	10		0	175	14.4	6	21	237
3	B	1	082F065	58327942	11U 493534 5502132	BL	70	LA	30		0	205	25.3	10	67	111
4	B	1	082K095	4813471	11U 486255 5649190	BL	90	SE	10		0	125	16.6	16	65	445
5	B	1	082K066	23170383	11U 501208 5607970	BL	80	SE	20		0	146	18.6	8	43	187
6	B	2	082K045	1471399	11U 495552 5592982	BL	60	SE	40		0	205	20.3	30	162	458
7	B	2	082F006	21259581	11U 512796 5433775	BL	70	SE	20	PLI	10	66	15.5	30	118	1257
8	B	2	082K056	96768521	11U 513187 5603204	BL	80	LA	20		0	206	21.4	30	150	434
9	B	2	082K054	13033732	11U 481211 5598956	BL	80	SE	20		0	145	15.5	26	96	649
10	B	2	082K005	47993282	11U 497313 5544823	BL	100		0		0	185	19.4	20	83	357
11	B	3	082K005	87102652	11U 486589 5545195	BL	60	SE	40		0	105	20.7	36	210	787
12	B	3	082F065	22785014	11U 486601 5498294	BL	80	PLI	10	SE	10	115	22.7	46	255	860
13	B	3	082F087	74294445	11U 516802 5527315	BL	80	SE	15	LA	5	185	24.3	35	219	356
14	B	3	082F049	68830151	11U 544388 5482194	BL	50	SE	40	PLI	10	165	24.4	45	319	824
15	B	3	082F096	83469354	11U 502500 5537411	BL	60	SE	40		0	125	19.6	36	191	814
16	B	3	082F039	32950216	11U 551858 5463725	BL	70	SE	30		0	95	18.8	37	184	1182
17	FD&L	1	082F095	47654098	11U 495339 5529474	FDI	100		0		0	65	18.1	28	101	1485
18	FD&L	1	082F054	60767927	11U 475016 5487206	LW	40	PLI	40	FDI	20	75	23.1	26	147	603
19	FD&L	1	082F020	35109639	11U 567382 5443813	LW	70	PLI	30		0	76	21.2	32	173	1206
20	FD&L	1	082K016	69447903	11U 502269 5552038	LW	50	CW	30	HW	10	65	22.3	38	181	1213
21	FD&L	1	082K016	76967283	11U 502563 5551195	LW	80	FDI	10	SE	10	95	25.8	16	112	218
22	FD&L	2	082K016	93460530	11U 506507 5556023	LW	80	FDI	10	PLI	10	85	25.0	41	268	990
23	FD&L	2	082F009	51283859	11U 552394 5436001	LW	70	PLI	30		0	76	22.3	37	210	1114
24	FD&L	2	082F017	63886127	11U 521405 5443624	FDI	90	LW	10		0	106	24.8	31	197	670
25	FD&L	2	082F086	43723810	11U 511092 5526742	FDI	100		0		0	105	26.7	36	244	794
26	FD&L	2	082K065	95513281	11U 497065 5614144	FDI	60	HW	20	CW	20	126	26.7	36	228	806
27	FD&L	3	082F086	48921928	11U 512009 5523705	FDI	50	LW	40	PLI	10	85	23.9	52	313	1119
28	FD&L	3	082F010	9315926	11U 562855 5438367	LW	60	PLI	30	FDI	10	86	28.2	41	331	692
29	FD&L	3	082F047	18726665	11U 518204 5479639	FDI	65	CW	15	LW	10	125	33.7	61	504	683
30	FD&L	3	082F056	13651857	11U 501552 5490938	FDI	60	HW	30	SE	5	85	25.0	52	321	1165

31	FD&L	3	082F044	30961279	11U 485344 5474412	FDI	60	BL	20	SE	10	126	35.8	55	472	403
32	S	1	082K085	46644337	11U 491331 5633018	SE	90	BL	10		0	175	23.4	10	64	133
33	S	1	082F054	68730245	11U 476897 5490888	SE	50	FDI	30	LW	10	75	17.2	12	58	459
34	S	2	082K005	61864939	11U 499986 5547600	SE	70	BL	30		0	225	31.2	30	255	200
35	S	2	082F030	35596458	11U 569415 5455618	SE	70	BL	20	LW	10	186	28.4	30	223	281
36	S	3	082K005	31812641	11U 494413 5544189	SE	80	BL	20		0	265	35.1	45	444	399
37	S	3	082F049	81338655	11U 546022 5479267	SE	40	FDI	30	LW	20	75	22.6	42	279	1195
38	S	3	082K067	41272024	11U 521497 5608278	SE	60	BL	40		0	285	30.1	35	293	524
39	P	1	082F058	56881612	11U 542703 5484726	PLI	60	BL	30	SE	10	75	15.6	21	86	955
40	P	1	082F028	4594477	11U 529857 5456913	PLI	100		0		0	56	15.2	32	45	591
41	P	2	082F037	53471021	11U 522792 5469190	PLI	100		0		0	105	23.4	46	165	497
42	P	2	082F039	1579694	11U 547381 5464103	PLI	90	BL	5	LW	5	75	19.7	36	181	1035
43	P	3	082F020	1648757	11U 561789 5443331	PLI	85	FDI	10	LW	5	76	21.9	36	264	915
44	P	3	082G001	80492916	11U 573930 5431501	PLI	70	LW	20	SE	10	80	25.5	41	350	939
45	O	1	082F095	65283739	11U 498109 5528313	HW	60	CW	20	SE	15	75	21.2	42	221	1450
46	O	1	082K074	21117931	11U 485693 5622861	HW	70	SE	20	CW	10	185	18.5	20	80	843
47	O	2	082F034	27578826	11U 484513 5470295	HW	70	LW	20	FDI	10	79	29.2	40	338	552
48	O	2	082F053	1136083	11U 464726 5485407	HW	90	CW	10		0	245	34.2	60	374	591
49	O	3	082F096	98319463	11U 504902 5537303	HW	60	CW	30	FDI	10	205	35.2	65	475	566
50	O	3	082F034	21857764	11U 483183 5468555	HW	50	CW	30	LW	10	56	26.2	55	385	1196

YSM Samples

Initial samples are nos 51 to 100 and alternate samples are nos A51 to A141

Samp_no	MAP_ID	POLYGON_ID	UTM	Sp 1	S1 %	Sp 2	S2 %	Sp 3	S3 %	Age	Height	Basal Area	Vol/ha	Stems/ha
51	082F006	50518673	11U 500324 5433679	SE	90	BL	10		0	31	4.6	0	0	3408
52	082F006	60819920	11U 502557 5435404	SE	90	BL	10		0	36	8.7	4	1	651
53	082F006	47860974	11U 500832 5437635	SE	65	BL	18	CW	9	31	8.0	10	0	6275
54	082F006	82930880	11U 506767 5436874	SE	55	BL	45		0	29	6.0	4	0	2533
55	082F009	27212029	11U 548564 5433514	HW	50	BL	40	SE	10	24	6.3	0	0	4936

56	082G001	53802187	11U 586147 5428664	SE	70	PLI	20	LW	10	36	10.6	18	1	3110
57	082F017	42493201	11U 517167 5439561	PLI	100		0		0	31	8.0	5	0	800
58	082G001	94184434	11U 576751 5433843	PLI	100		0		0	28	8.6	4	0	489
59	082G001	32086830	11U 583198 5437029	LW	60	SE	20	PLI	10	36	16.8	33	50	2662
60	082G011	91557876	11U 577521 5439777	PLI	80	LW	10	BL	5	16	4.2	0	0	3982
61	082F018	60089140	11U 538217 5446877	FDI	70	PLI	20	BG	10	26	7.2	10	0	2725
62	082F030	99923788	11U 562978 5451719	CW	30	SE	30	HW	20	36	14.7	46	46	6550
63	082F034	69226508	11U 474456 5467151	BL	90	SE	10		0	46	6.2	0	0	30
64	082F030	90567563	11U 561769 5457910	SE	70	BL	30		0	36	8.7	4	1	516
65	082F038	58988411	11U 540262 5462704	SE	60	BL	40		0	23	3.1	0	0	1000
66	082F038	1898330	11U 530369 5463981	SX	90	BL	10		0	17	1.6	0	0	1465
67	082F038	13079662	11U 532603 5465705	SE	50	PLI	30	BL	20	28	8.0	9	0	5873
68	082F038	36420795	11U 536816 5467173	PLI	90	BL	10		0	26	7.9	3	0	283
69	082F039	54842051	11U 556858 5466593	BL	50	SE	30	HW	20	44	10.3	16	19	1474
70	082F038	13683321	11U 533369 5471641	SE	100		0		0	20	2.2	0	0	1588
71	082F044	60933294	11U 474000 5479281	PLI	40	CW	20	FDI	20	24	9.3	6	2	487
72	082F047	42484398	11U 521751 5475152	PLI	60	SE	30	BL	10	22	6.5	15	0	3250
73	082F053	1836672	11U 464865 5486488	HW	50	CW	20	SE	20	40	11.8	12	9	1605
74	082F065	43294929	11U 490398 5497296	PLI	45	EP	25	FDI	20	22	12.7	10	2	1186
75	082F067	20429692	11U 521109 5501394	SE	60	BL	20	CW	20	34	7.0	7	0	3384
76	082F067	19830987	11U 521365 5503373	SE	60	BL	25	CW	10	32	5.0	7	0	3490
77	082F077	28973065	11U 523855 5507077	SE	60	HW	20	BL	10	36	8.0	3	1	444
78	082F085	29830266	11U 491728 5523288	FDI	40	HW	30	CW	20	45	18.0	31	85	1819
79	082F087	85171400	11U 517724 5521955	SE	50	BL	50		0	35	8.2	1	0	300
80	082F086	61112507	11U 514019 5524446	CW	40	EP	30	HW	20	35	14.3	47	12	8336
81	082F096	383706	11U 504373 5527702	SE	55	HW	25	CW	20	23	3.5	0	0	5856
82	082F096	90417235	11U 503158 5533898	BL	70	SE	20	PLI	10	41	6.1	5	0	2857
83	082F097	87308227	11U 519257 5533839	PLI	70	FDI	25	SE	5	50	13.1	11	18	671
84	082F095	45488420	11U 495491 5536897	BL	80	SE	10	HW	10	47	2.5	0	0	3806
85	082K006	1350798	11U 505903 5539584	FDI	40	CW	40	EP	20	42	8.3	6	9	651
86	082K006	90654416	11U 504688 5545780	LW	40	FDI	20	HW	10	19	4.6	0	0	3147
87	082K006	78805624	11U 502962 5548016	FDI	40	HW	30	CW	30	22	5.7	0	0	15036
88	082K025	32223261	11U 496823 5562902	BL	80	SE	20		0	38	8.3	3	2	351

89	082K026	78816024	11U 505258 5565845	PLI	40	CW	20	BL	20	18	3.0	1	0	7820
90	082K025	21648348	11U 495861 5571082	SE	90	BL	10		0	15	1.5	0	0	1067
91	082K035	59890330	11U 486463 5576318	SE	51	CW	32	FDI	17	35	5.8	5	0	3303
92	082K036	43981978	11U 500589 5576517	FDI	40	EP	40	CW	20	20	7.3	3	4	303
93	082K035	93533307	11U 492918 5579517	SE	90	CW	10		0	29	10.0	4	0	631
94	082K037	23604578	11U 514970 5578695	PLI	80	FDI	20		0	36	5.0	0	0	800
95	082K045	96298095	11U 493937 5587443	BL	90	SE	10		0	35	3.8	0	0	500
96	082K046	43740074	11U 502374 5590387	FDI	60	HW	20	CW	20	35	13.1	17	15	1744
97	082K054	87601662	11U 476865 5595681	HW	25	CW	25	FDI	25	36	18.2	39	207	1780
98	082K054	66332514	11U 473155 5598172	FDI	30	HW	30	CW	20	26	7.2	0	0	400
99	082K057	27506149	11U 517523 5598511	SE	60	BL	40		0	20	3.0	0	0	1500
100	082K085	27764743	11U 487906 5634562	SE	100		0		0	45	8.5	3	0	385
A51	082F005	35806076	11U 497838 5429976	SE	70	BL	30		0	32	7.0	1	0	4523
A52	082F006	96227471	11U 507983 5430686	BL	60	SE	40		0	46	12.4	23	53	1363
A53	082F009	20088610	11U 545822 5427835	HW	50	CW	30	BL	20	33	9.8	13	11	1454
A54	082F006	48039955	11U 500578 5435657	BL	70	SE	30		0	36	2.7	0	0	600
A55	082F006	79379785	11U 506513 5434896	SE	64	BL	30	PLI	6	31	6.0	5	0	4088
A56	082F009	76190050	11U 555966 5428538	FDI	40	PLI	20	PW	20	23	7.0	10	0	5060
A57	082F006	59630761	11U 502811 5437382	BL	50	SE	50		0	41	11.3	19	30	1619
A58	082F007	53702048	11U 518891 5437330	HW	35	SE	25	PW	15	26	5.0	10	0	2400
A59	082F007	90492350	11U 524826 5436567	AT	80	FDI	20		0	36	9.4	8	1	1030
A60	082G001	6612117	11U 578235 5429687	BL	40	LW	40	PLI	20	21	6.3	0	0	1908
A61	082G001	28822029	11U 582191 5429175	PLI	70	SE	30		0	20	5.7	0	0	1880
A62	082F016	48663344	11U 501341 5441591	SE	60	BL	40		0	36	12.5	20	28	1682
A63	082F016	72863407	11U 505297 5441084	BL	60	SE	40		0	31	7.0	5	0	1230
A64	082G002	89443325	11U 592336 5429874	PLI	60	LW	40		0	19	6.1	0	0	7344
A65	082G001	5074563	11U 578729 5433586	PLI	100		0		0	26	7.9	3	0	355
A66	082F010	47904401	11U 568840 5434869	PLI	100		0		0	20	9.3	4	0	539
A67	082G001	95686769	11U 577264 5437799	SE	64	PLI	31	BL	5	16	1.4	0	0	1450
A68	082G011	7818160	11U 579499 5439521	PLI	70	LW	20	BL	10	16	4.2	0	0	1500
A69	082G011	41459233	11U 585689 5440729	BL	50	SE	50		0	46	14.3	32	83	2046
A70	082F018	72039323	11U 540195 5446622	HW	70	CW	20	LW	5	46	16.2	32	74	2413
A71	082F028	61011528	11U 538728 5450834	LW	70	HW	25	BL	5	36	13.3	27	29	2186

A72	082F029	66642641	11U 556788 5450510	PLI	70	FDI	10	CW	10	21	6.1	4	0	2300
A73	082F029	66883945	11U 557044 5452488	SE	40	BL	30	PLI	20	46	14.8	12	36	692
A74	082F010	16293996	11U 567447 5455162	PLI	70	LW	20	FDI	10	18	8.1	3	0	326
A75	082F030	48007400	11U 571660 5456628	SE	71	BL	18	PLI	8	31	4.9	0	0	4091
A76	082F029	96187601	11U 545941 5459958	PLI	60	FDI	40		0	17	5.2	0	0	4617
A77	082F034	60937304	11U 472731 5469385	BL	100		0		0	46	7.5	1	0	300
A78	082F038	37738634	11U 536305 5463215	SE	60	PLI	40		0	15	1.0	0	0	0
A79	082F038	24298329	11U 534326 5463471	SE	70	BL	20	PLI	10	23	3.3	0	0	4346
A80	082F034	93098656	11U 478921 5470602	FDI	90	AT	10		0	46	11.5	5	8	255
A81	082F038	25839770	11U 534582 5465450	PLI	62	SE	17	BL	13	15	6.0	0	0	2667
A82	082F037	77239841	11U 526667 5466471	SE	90	BL	10		0	25	1.7	0	0	0
A83	082F044	17279786	11U 483133 5472074	PLI	70	SE	30		0	16	5.1	0	0	1114
A84	082F044	94700911	11U 479429 5474561	SE	100		0		0	26	4.6	0	0	1000
A85	082F044	48960970	11U 471513 5475577	HW	30	BL	30	PLI	20	27	3.7	0	0	2500
A86	082F038	32941970	11U 537071 5469152	PLI	43	BL	37	SE	14	17	5.2	0	0	4111
A87	082F048	89143218	11U 529412 5472152	SE	40	BL	30	PLI	30	19	1.3	0	0	0
A88	082F044	71943446	11U 475979 5479027	CW	50	SE	30	AC	8	23	5.7	0	0	3600
A89	082F039	31844665	11U 553413 5471062	PLI	95	BL	5		0	22	6.5	1	0	300
A90	082F039	19094184	11U 551434 5471318	PLI	70	BL	20	SE	10	20	4.3	0	0	3463
A91	082F049	53985726	11U 557626 5472528	BL	90	PA	5	LA	5	45	3.6	0	0	500
A92	082F053	24555574	11U 468570 5484001	FDI	30	CW	20	LW	20	18	6.2	8	0	5552
A93	082F057	51880998	11U 525006 5484792	SE	55	BL	45		0	30	4.3	0	0	800
A94	082F054	62430173	11U 475524 5491157	PLI	50	BL	30	FDI	10	44	14.4	116	370	1854
A95	082F067	19645956	11U 520344 5495455	HW	47	CW	19	FDI	15	39	12.9	22	10	3331
A96	082F065	64727576	11U 494866 5500746	BL	60	SE	40		0	38	11.1	19	26	1928
A97	082F067	31730357	11U 523345 5503118	SE	60	BL	40		0	35	6.7	3	0	2269
A98	082F076	3201012	11U 501569 5505922	FDI	60	CW	20	HW	10	37	8.9	7	4	708
A99	082F077	50893222	11U 527815 5506566	BL	50	PLI	30	SE	20	35	3.8	0	0	250
A100	082F076	91846678	11U 500864 5516076	CW	35	HW	35	SE	20	40	7.2	10	0	2200
A101	082F087	84470232	11U 517468 5519976	BL	80	SE	20		0	35	9.0	5	3	597
A102	082F085	15930368	11U 489748 5523543	BL	80	SE	10	PLI	10	35	6.5	1	0	300
A103	082F087	96911207	11U 519704 5521700	SE	90	BL	10		0	34	5.5	3	0	1244
A104	082F086	89981497	11U 501883 5523995	BL	70	PA	20	LA	10	35	5.4	0	0	30

A105	082F087	80732644	11U 517979 5523936	AC	52	CW	25	SE	10	38	6.8	2	0	3300
A106	082F085	20922460	11U 490257 5527503	SE	90	BL	5	HW	5	22	2.2	0	0	2480
A107	082F097	60945020	11U 514530 5528407	EP	50	FDI	30	CW	20	36	15.3	15	22	1108
A108	082F096	49007410	11U 513060 5532624	CW	35	LW	25	FDI	20	50	28.1	64	517	1128
A109	082F097	22108477	11U 525199 5533074	BL	60	SE	40		0	35	7.8	2	1	254
A110	082F097	96688538	11U 521238 5533584	BL	60	SE	40		0	30	11.1	8	4	1104
A111	082F097	59198523	11U 515296 5534349	HW	30	CW	30	FDI	20	50	12.5	5	18	381
A112	082F096	89178304	11U 503413 5535878	SE	100		0		0	22	2.2	0	0	1470
A113	082F095	96438632	11U 487569 5537915	BL	70	SE	30		0	35	7.8	3	1	367
A114	082F096	3109455	11U 505648 5537604	FDI	40	CW	20	EP	20	24	6.5	8	0	5226
A115	082K005	97420805	11U 488078 5541876	SE	100		0		0	20	1.3	0	0	1621
A116	082K006	89933090	11U 504433 5543799	SE	60	FDI	30	BL	10	24	2.7	0	0	8120
A117	082K006	90515506	11U 504943 5547762	FDI	90	LW	10		0	23	6.1	8	0	4875
A118	082K006	68565531	11U 500981 5548271	BL	70	SE	30		0	21	2.6	0	0	8530
A119	082K016	76577055	11U 503217 5549997	PLI	50	FDI	30	CW	10	21	6.1	0	0	2600
A120	082K026	56135059	11U 501040 5564373	AC	50	HW	20	CW	20	36	17.3	6	17	173
A121	082K026	90576180	11U 507239 5565590	PLI	70	FDI	30		0	36	3.7	0	0	1000
A122	082K025	29826388	11U 497333 5566864	SE	60	CW	30	BL	10	36	16.3	29	74	1936
A123	082K025	72157194	11U 487681 5570119	BL	100		0		0	36	5.7	0	0	800
A124	082K035	32480718	11U 498352 5574790	FDI	40	CW	30	HW	30	31	15.0	40	0	7629
A125	082K035	22940474	11U 496371 5575045	HW	50	CW	40	AC	5	36	22.7	39	194	1375
A126	082K034	48691089	11U 484482 5576573	SE	80	BL	20		0	36	5.5	1	0	400
A127	082K035	20921849	11U 496626 5577026	LW	70	SE	10	CW	10	16	6.5	0	0	500
A128	082K034	39012106	11U 482755 5578809	BL	90	PA	10		0	46	6.2	1	0	600
A129	082K034	39603236	11U 483010 5580790	BL	80	SE	20		0	36	5.7	1	0	400
A130	082K037	85314413	11U 524880 5577421	SE	50	BL	40	HW	10	35	5.8	5	0	3545
A131	082K036	97955419	11U 509280 5581440	BL	100		0		0	36	4.0	0	0	500
A132	082K046	54806674	11U 503590 5584187	EP	60	FDI	40		0	25	16.7	22	10	2586
A133	082K045	91247870	11U 491955 5587697	AT	50	FDI	30	BL	10	35	6.9	2	0	600
A134	082K045	8758913	11U 496173 5589170	FDI	50	HW	20	SE	10	35	5.9	5	0	1700
A135	082K045	95810440	11U 494447 5591407	BL	100		0		0	45	4.9	0	0	80
A136	082K054	4141346	11U 478847 5595426	HW	50	SX	20	FDI	10	16	7.9	6	3	760
A137	082K047	25192493	11U 516757 5592566	LA	70	BL	30		0	35	7.3	0	0	120

A138	082K056	55174985	11U 505375 5598059	BL	100		0		0	36	4.0	0	0	1000
A139	082K055	85814956	11U 493484 5599589	BL	100		0		0	35	5.4	0	0	40
A140	082K065	48218699	11U 488302 5606298	BL	100		0		0	36	5.7	0	0	400
A141	082K066	78761732	11U 510870 5609440	BL	100		0		0	26	3.0	0	0	500

Appendix B

Comparison of the Sample Characteristics to the Population

Sample/Population Comparison

The following tables show how the sample distribution compares to the population distribution for leading species, age class, and volume class. Samples and populations compare reasonably close in most cases.

Volume Audit Age Class Comparison

Age Class	Area	%	Samples	%
3	12,032	2%	2	4%
4	111,166	20%	14	28%
5	82,785	15%	6	12%
6	89,225	16%	5	10%
7	72,227	13%	6	12%
8	153,245	28%	15	30%
9	32,250	6%	2	4%
Total	552,929	100%	50	100%

Volume Audit Height Class Comparison

Height	Area	%	Samples	%
1	11,059	2%		0%
2	148,731	27%	13	26%
3	270,335	49%	29	58%
4	118,340	21%	8	16%
5	4,464	1%		0%
Total	552,929	100%	50	100%

Volume Audit Species Distribution

Species	Area	%	Samples	%
At	4,877	1%		0%
B	172,485	31%	16	32%
CW	10,371	2%		0%
EP	2,162	0%		0%
FD	101,987	18%	8	16%
H	50,285	9%	6	12%
L	66,361	12%	7	14%
P	71,370	13%	6	12%
S	73,031	13%	7	14%
Total	552,929	100%	50	100%

Volume Audit Strata Comparison

Strata	Area (ha)	%	Samples	Replacements
Balsam	172,485	31%	16	9
Doug Fir and Larch	168,348	30%	15	9
Spruce	73,031	13%	7	4
Pine	71,370	13%	6	4
Other	67,695	12%	6	4
Total	552,929	100%	50	30

Young Stand Monitoring Age Class Comparison

Age Class	Area	%	Samples	%
1	10,345	18%	8	16%
2	35,225	62%	34	68%
3	11,089	20%	8	16%
Total	56,658	100%	50	100%

Young Stand Monitoring Height Class Comparison

Height Class	Area	%	Samples	%
1	43,523	77%	40	80%
2	12,714	22%	10	20%
3	401	1%		0%
5	20	0%		0%
Total	56,658	100%	50	100%

Young Stand Monitoring Species Comparison

Species	Area	%	Samples	%
AC	1,057	2%		0%
B	15,319	27%	6	12%
CW	2,309	4%	2	4%
EP	1,207	2%		0%
FDI	7,098	13%	7	14%
HW	2,874	5%	3	6%
LW	2,447	4%	2	4%
PL	10,124	18%	10	20%
S	14,224	25%	20	40%
Total	56,659	100%	50	100%

Appendix C

NVAF Profile - NVAF Sample Selection Process and Methodology for Kootenay Lake TSA

NVAF Sample Selection

Based on the document outlining the streamlined approach to *VRI Ground Sampling Volume Audit Sampling* and supplementary direction provided by the MFLNRO, 25 of the samples from the Volume Audit population were selected from the original 50 to be completed as part of the Net Volume Adjustment Factor sampling. As specified in the Draft Schedule A of the Invitation to Quote, samples were divided between 2 strata as follows:

Age Group	# of samples
>51≤120	9
>120	16
TOTAL	25

The following 2 tables show how the NVAF samples were chosen. The process was as specified in *Sample Selection Procedures for Ground Sampling Draft Version 4.0* section 3.4. The table of selected VRI samples for each Age Class grouping was sorted by leading species then by volume. The NVAF sample selection interval (K) was determined ($K = (\text{number of VRI samples in the grouping} / \text{number of NVAF samples})$). A random number between 1 and K was generated using Excel and this was the first VRI sample on the sorted list chosen for NVAF sampling. The next NVAF sample was K samples down the list -and so on until all of the NVAF samples were selected.

The following are the two NVAF sample lists.

NVAF Samples 15-121 Age Group

Sam p no	Strat a	Vo l CIs	MAP_ID	Polygon	UTM	Sp 1	S1 %	Sp 2	S2 %	Sp 3	S3 %	Age	Ht	B A	Vol	Stems/h a
16	B	3	082F039	32950216	11U 551858 5463725	BL	70	SE	30		0	95	18.8	37	184	1182
17	FD&L	1	082F095	47654098	11U 495339 5529474	FDI	100		0		0	65	18.1	28	101	1485
18	FD&L	1	082F054	60767927	11U 475016 5487206	LW	40	PLI	40	FDI	20	75	23.1	26	147	603
23	FD&L	2	082F009	51283859	11U 552394 5436001	LW	70	PLI	30		0	76	22.3	37	210	1114
27	FD&L	3	082F086	48921928	11U 512009 5523705	FDI	50	LW	40	PLI	10	85	23.9	52	313	1119
33	S	1	082F054	68730245	11U 476897 5490888	SE	50	FDI	30	LW	10	75	17.2	12	58	459
40	P	1	082F028	4594477	11U 529857 5456913	PLI	100		0		0	56	15.2	32	45	591
42	P	2	082F039	1579694	11U 547381 5464103	PLI	90	BL	5	LW	5	75	19.7	36	181	1035
47	O	2	082F034	27578826	11U 484513 5470295	HW	70	LW	20	FDI	10	79	29.2	40	338	552

NVAF Samples 121+ Age Group

Sam p no	Strat	Vol CIs	MAP_ID	Polygon	UTM	Sp1	S1 %	Sp2	S2 %	Sp3	S3 %	Age	Ht	B A	Vol	Stems/ha
2	B	1	082F075	35129889	11U 490068 5505697	BL	90	SE	10		0	175	14.4	6	21	237
3	B	1	082F065	58327942	11U 493534 5502132	BL	70	LA	30		0	205	25.3	10	67	111
4	B	1	082K095	4813471	11U 486255 5649190	BL	90	SE	10		0	125	16.6	16	65	445
5	B	1	082K066	23170383	11U 501208 5607970	BL	80	SE	20		0	146	18.6	8	43	187
8	B	2	082K056	96768521	11U 513187 5603204	BL	80	LA	20		0	206	21.4	30	150	434

9	B	2	082K054	13033732	11U 481211 5598956	BL	80	SE	20		0	145	15.5	26	96	649
13	B	3	082F087	74294445	11U 516802 5527315	BL	80	SE	15	LA	5	185	24.3	35	219	356
15	B	3	082F096	83469354	11U 502500 5537411	BL	60	SE	40		0	125	19.6	36	191	814
26	FD& L	2	082K065	95513281	11U 497065 5614144	FDI	60	HW	20	CW	20	126	26.7	36	228	806
29	FD& L	3	082F047	18726665	11U 518204 5479639	FDI	65	CW	15	LW	10	125	33.7	61	504	683
31	FD& L	3	082F044	30961279	11U 485344 5474412	FDI	60	BL	20	SE	10	126	35.8	55	472	403
34	S	2	082K005	61864939	11U 499986 5547600	SE	70	BL	30		0	225	31.2	30	255	200
35	S	2	082F030	35596458	11U 569415 5455618	SE	70	BL	20	LW	10	186	28.4	30	223	281
36	S	3	082K005	31812641	11U 494413 5544189	SE	80	BL	20		0	265	35.1	45	444	399
48	O	2	082F053	1136083	11U 464726 5485407	HW	90	CW	10		0	245	34.2	60	374	591
49	O	3	082F096	98319463	11U 504902 5537303	HW	60	CW	30	FDI	10	205	35.2	65	475	566

Appendix D

Sample Selection Process and Methodology for Kootenay Lake TSA

Sampling Process and Methodology for Kootenay Lake TSA

1) Data assembly Process

All the shapefile data was obtained from Chris Mulvihill the project coordinator with Ministry of Forests, Lands & Natural Resource Operations (MFLNRO or Ministry). This included VRI data which was not clipped to the TSA boundary.

The VRI data was clipped to a shapefile of the TSA boundary which excluded private, parks, and Indian Reserve land. A “repair geometry” was then run on the new file. This file was called “VRI_net”. A new field called “New_area” was added and geometry calculated.

Consistent with the process for the Cranbrook TSA, polygons less than .01ha were eliminated (called this VRI_net_final). The total area of polygons that were less than .01 ha was less than 1 ha.

The following table is a summary of the landbase.

Table 1: Kootenay Lake TSA Landbase Summary

Land Classification	Area (ha)	% of TSA
Total TSA Area	1,240,711	100
Net-downs	365,561	29.46%
Parks	225,062	18.14%
Private	138,119	11.13%
Indian Reserve	2,380	0.19%
Net Area	875,150	70.54%
Non Vegetated	128,707	10.37%
Vegetated	746,443	60.16%
Non-treed	133,775	10.78%
Treed	612,668	49.38%

2) Creation of Population Shapefiles

Volume Audit: From the VRI_net_final file VT was selected (called VT_net). From VT_net, projected age greater than or equal to 51 was selected and exported to a new shapefile (called this VT_Mature). The area of the Volume Audit population is 552,929 hectares.

Young Stand Monitoring: From the VRI_net (**not** VT_net), projected age greater than or equal to 15 and less than 51 years was selected and exported to a new shapefile (called this Immature). The area of Volume Audit population is 56,658 hectares. The species distribution within the Young Stand Monitoring population is shown in the table below.

3) Sample Selection for the Volume Audit Population

3.1 Stratification

In order to make decisions about stratification, a summary by leading species was run. This provided the leading species distribution shown below.

Table 2: Volume Audit population Species Distribution

Species	Area	%
At	4,877	1%
B	172,485	31%
CW	10,371	2%
EP	2,162	0%
FD	101,987	18%
H	50,285	9%
L	7	0%
L	66,354	12%
P	71,370	13%
S	73,031	13%
Total	552,929	100%

Based on this information, the Ministry staff identified the following strata for the Kootenay Lake TSA VRI ground sampling project.

Table 3: Volume Audit population Strata Definition

Strata	Leading Species
1	Balsam
2	Douglas fir and Larch
3	Spruce
4	Pine
5	Other

Shapefiles were created for each strata.

The number of samples for the Volume Audit and Young Stand Monitoring age populations was specified by the Ministry in the document *Streamlining VRI Ground Sampling – Volume Audit Sampling*. They specified that there would be 50 initial samples and 30 replacements in the Volume Audit population.

Table 4: Volume Audit Population Strata Sample Distribution

Strata	Area (ha)	%	Samples	Replacements
Balsam	172,485	31%	16	9
Doug Fir and Larch	168,348	30%	15	9
Spruce	73,031	13%	7	4
Pine	71,370	13%	6	4
Other	67,695	12%	6	4
Total	552,929	100%	50	30

3.2) Sub-stratification

For the Volume Audit population sub-stratification was carried out the same way for all 5 strata. The process is described below.

- Exported the attribute table from each of the stratum shapefile.
- Determined the number of polygons in each stratum (do a “statistics” report on the New_Area field)
- Divided total number of polygons by 3 to determine the number of polygons (approx.) that should be in each sub-stratum.
- In these new worksheets, sorted data by total volume
- The “number of polygons per sub-strata” figure determined above was used in the table sorted by volume to find the volume figure that would be used to divide the sub-strata

The table below shows the criteria defining the sub-strata.

Table 5: Sub-Stratification of Volume Audit population:

Strata	No of Poly	Div by 3	Sub Strata	Polygon List no	Vol Criteria
Balsam	11,606	3,869	1	1-3869	0-73.55
			2	3870-7738	>73.55-170.55
			3	>7738	>170.55
Doug Fir and Larch	12,318	4,106	1	1-4106	0-187.71
			2	4107-8213	>187.71-304.54
			3	>8213	>304.54
Spruce	5,223	1,741	1	1-1741	0-176.93
			2	1742-3482	>176.93-273.6
			3	3483-5223	>273.6
Pine	5,139	1,713	1	1-1713	0-136.74
			2	1714-3426	>136.74-227.72

			3	>3426	>227.72
Other	4,800	1,600	1	1-1600	0-235.66
			2	1601-3200	>235.66-379.21
			3	>3200	>379.21

Sample distribution in the Volume Audit population was based on area representation of the sub-strata. The table below shows this distribution.

Table 6: Distribution of Volume Audit population - Samples to Sub-strata

Stratum	Sub-stratum	Area	%	Samples	Replacements
Balsam	1	55706	32.30%	5	3
	2	53961	31.28%	5	3
	3	62817	36.42%	6	3
	Total	172484	100.00%	16	9
Fd and L	1	49370	29.33%	5	3
	2	59492	35.34%	5	3
	3	59486	35.34%	5	3
	Total	168348	100.00%	15	9
Spruce	1	22302	30.54%	2	1
	2	24563	33.63%	2	1
	3	26166	35.83%	3	2
	Total	73031	100.00%	7	4
Pine	1	22168	31.06%	2	1
	2	24883	34.86%	2	2
	3	24321	34.08%	2	1
	Total	71372	100.00%	6	4
Other	1	19186	28.34%	2	1
	2	22109	32.66%	2	1
	3	26399	39.00%	2	2
	Total	67694	100.00%	6	4
Grand Total		552929		50	30

3.3 Sample Polygon Selection

- An Excel random number spreadsheet was obtained from the Ministry that creates random numbers from a “seed”. Random numbers between 0 and the total area of each sub-stratum were produced for samples and replacement samples in each of the sub-stratum. As well, one extra random number per stratum was produced for a contingency sample in the event that a sample was eliminated during the sample location stage.

- Accumulated area tables were produced for each of the sub-stratum. This was done by selecting for the sub-strata criteria in the strata shapefiles.
- Two new columns were added to the accumulated area table for recording the samples that were chosen (S for selected, R for replacement and C for contingency) and sample number. The accumulated volume table was then sorted by S/R and then by sample number. All other rows were deleted (saved as Samp list full –sub-stratum). Another table was created from this with just mapsheet, polygon, selection, and area columns (called Samp list part-sub-strat). Using the random numbers generated for each sub-stratum, polygons were selected. A polygon was selected from the accumulated area table if the random number was larger than the accumulated area of the polygon immediately preceding it and less than or equal to its accumulated area.
- Initial Sample Polygons were selected first followed by replacement sample polygons then by contingency samples.

Initial sample numbers were numbered 1 to 50 and alternate samples were numbered A1 to A30.

3.4 Location of Samples Within Polygons

For each population, samples were located within selected polygons using an Arcmap 10 GIS program as follows:

- A new shapefile was created for samples with the following fields:

FID_1	Sample_no	Strata	Sub-strat	X	Y

*FID_1 is to link with the Objectid field in the Young Stand Monitoring VRI shapefile for joining these two files later on.

- The population, 100m grid (obtained from the Ministry), and Landsat shapefiles were displayed on an Arcview map.
- Sample polygons were displayed using the selection tool in the population attribute table.
- Using the tables “Samp list part-sub-strat”, random numbers were generated (with a range between 1 and the total number of dots in the polygon) for each selected polygon using “=Randbetween(1,X)” function in an Excel spreadsheet. The random numbers were recorded in a new column in this spreadsheet.
- The sample was located at the location of the randomly selected dot.
- The location was then checked against the Landsat image to see if any samples fell in a recent cutover. One alternate sample in volume class 1 of the Pine strata was in a recent cutover so it was replaced with the contingency sample.
- After sample location was complete for a population, the sample shapefile was joined to the population VRI shapefile so that all veg information would be included in the sample file.

4) Sample Selection for Young Stand Monitoring (YSM) Samples

The species distribution of the Young Stand Monitoring population is as shown in the following table.

Table 7: Young Stand Monitoring age population Species Distribution

Species	Area	%
B	15,318	27%
S	14,224	25%
PL	10,124	18%
FDI	7,098	13%
HW	2,874	5%
LA	2,447	4%
CW	2,309	4%
EP	1,207	2%
AT	1,057	2%
Total	56,658	100%

Direction from the Ministry was to select young stand monitoring (YSM) samples based on a grid provided by them.

The Young Stand Monitoring population was not subdivided into strata or sub-strata. The number of YSM samples was directed to be 50 initial and a minimum of 100 alternates. **However**, trial and error with the grid files provided by the Ministry determined that the 2 kilometer grid yielded 141 points and the 1 kilometer yielded 512 points within the Young Stand Monitoring population. The Ministry decided that the 2 kilometer should be used in this case despite yielding less than 100 replacement samples. The new shapefile was called "Immature_Samples. Consistent with Ministry direction the 141 grid points were divided by the required number of initial samples (50) giving an interval (n) of 2.82. Every "nth" sample was an initial sample. The remaining 91 samples were alternates.

Initial samples were numbered 51 to 100 and alternates were numbered A51 to A141.

Two new fields were added to the attribute table for Immature_Sample. One was called FID_1 to allow joining the VRI attributes to the sample table. The other was for sample numbers. UTM coordinates were calculated for each sample and joined to sample shapefile.

The VRI attributes were then joined to the sample shapefile. From this the sample lists were developed.