

**Tolko Industries Ltd.
Tree Farm License 49
Vegetation Resource Inventory
Strategic Implementation Plan**

Prepared for

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July 9, 2007

Funded by
Forest Investment Account
Project SOTFL49 4668008

EXECUTIVE SUMMARY

This Vegetation Resources Inventory (VRI) Strategic Inventory Plan (VSIP) outlines the VRI activities and products that address forest management and inventory issues for Tree Farm License 49 (TFL49). The stakeholders include the Ministry of Forests and Range (MOFR), Tolko Industries Ltd. (Tolko) and BC Timber Sales Okanagan-Columbia Business Unit (BCTS).

The forest cover inventory on TFL49 is one of the first VRI Phase 1 inventories in the province, of 1997 vintage. This was followed by Phase 2 ground sampling, supported by the MOFR over the period 1999, 2000 and 2001.

Based on forest management issues in Tree Farm License 49, some of which were highlighted in the Timber Supply Review, the following data requirements have been identified:

1. Acquiring data to enable quantifying unsalvageable losses. (USL)
2. Assessing the Mountain Pine Beetle induced mortality in the pine and non pine leading polygons.
3. Defining the 'mid-term timber supply' –amount, possible locations, and improved data on these polygons.
4. Improving inaccurate data attributes in the uneven-aged Douglas Fir leading polygons in the IDF and in the uneven-aged Spruce and Balsam in the ESSF.
5. Checking growth and yield predictions.
6. Tracking changes and trends in non-timber values such as wildlife habitat and key biodiversity indicators over time to meet certification requirements.
7. Compilation of Forest Health information on root rots.

During the current planning process, the Stakeholders identified the need for the following VRI activities:

1. Phase II Timber Emphasis ground sampling in the Vegetated Treed Area of TFL49. The ground sampling will include Net Volume Adjustment Factor (NVAF) sampling.
2. A Phase 1 photo interpretation re-inventory of the TFL with particular interest in the multi level Interior Drybelt Douglas Fir and Spruce and Balsam Fir leading stands in the ESSF exhibiting advanced understory . The initial step in this project will include the acquisition of new 1:20,000 scale colour photography through FIA funding in 2007/08.
3. A monitoring program in TFL49 to provide baseline data for monitoring the changes and trends over time. To develop this program, consideration will be made to the monitoring objectives identified including monitoring young stands, mountain pine beetle issues (mortality rates, regeneration in affected stands), deadwood (unsalvageable losses) and certification requirements.

The project was planned to begin in 2006, with a large amount of activity in 2007/08 and 2008/09. The projected costs are provided in Table 4 of this report.

A VRI Project Implementation Plan (VPIP) for Phase II Ground Sampling and NVAF has preceded the preparation of this VSIP. A VPIP for Photo Interpretation will also be prepared for TFL49, based on the direction provided by this VSIP.

List of Acronyms

AAC	Annual Allowable Cut
BEC	Biological Ecological Classification
CMI	Change Monitoring Inventory
CWD	Coarse Woody Debris
ESSF	Engelmann Sub-Alpine Fir
FAIB	Forest Analysis and Inventory Branch
FIA	Forest Investment Account
IDF	Interior Douglas Fir
LBIP	Forest Investment Account Land Base Investment Program
MOFR	Ministry of Forests and Range
MPB	Mountain Pine Beetle
MS	Montane Spruce
PHASE I	Vegetation Resources Inventory photo interpretation
PHASE II	Vegetation Resources Inventory ground sampling
RIC	Resource Inventory Committee
RMZ	Resource Management Zone
TEP	Timber Emphasis Zone
TFL	Tree Farm License
TFL49	Tree Farm License 49 Licensed to Tolko Industries Ltd.
TSA	Timber Supply Area
USL	Unsalvaged Losses
VPIP	Vegetation Resources Inventory Project Implementation Plan
VRI	Vegetation Resources Inventory
VSIP	Vegetation Resources Inventory Strategic Implementation Plan

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1. INTRODUCTION

1.1 BACKGROUND

The Vegetation Resources Inventory (VRI) is the standard for forest cover inventory in the Province of British Columbia. The VRI process includes a formalized planning requirement. This work starts by involving all of the Stakeholders including licensees and government personnel, informing them of the process, providing options and finally making decisions for the inventory. This planning phase is documented in a VRI Strategic Inventory Plan (VSIP). If a project is to be undertaken based on the decisions of the Strategic Planning process, one or more detailed plans are prepared. This may include a Project Implementation Plan (VPIP) for Photo Interpretation and/or a VPIP for Ground Sampling and Net Volume Adjustment Factor (NVAF) sampling.

This VSIP is being written following the VPIP for Phase II Ground Sampling and NVAF for Tree Farm Licence (TFL) 49. To expedite the start up of ground sampling in the 2006 field season, the Strategic Planning step was by-passed in June 2006 and a Project Implementation Plan was developed for the client. This was approved in principal by Jon Vivian, Manager, VRI, Forest Analysis & Inventory Branch (FAIB), Ministry & Forests & Range (MoFR), enabling project field work to start. The VPIP was signed off by FAIB and Tolko Industries Ltd. as of April 4, 2007.

A number of key land based issues on TFL49 lead the licensee to undertake planning for forest cover inventory work. The current beetle epidemic in the pine forests of British Columbia and the information needs related to pine and non-pine species are among the drivers for this initiative.

1.2 SCOPE AND OBJECTIVES

The VSIP identifies issues in a management unit and evaluates the effectiveness of the Vegetation Resources Inventory to provide data to support management decisions.

Terrafor Resources Ltd. collaborated with various contractors to prepare this plan in consultation with the TFL49 Stakeholders. Included in the Stakeholders group are the following:

- Tolko Industries Ltd. (Tolko), Lumby
- BC Timber Sales (BCTS), Okanagan-Columbia Business Unit
- MOFR – Okanagan Shuswap Forest District (DOS), Vernon
 - Southern Interior Forest Region, Vegetation Resource Inventory staff
 - Forest Analysis and Inventory Branch, VRI Section, Victoria

1.3 VRI OVERVIEW

The VRI is a vegetation inventory process that has been approved by the former Resources Inventory Committee (RIC) to assess the quantity and quality of BC's timber and vegetation resources. The VRI estimates overall population totals and averages, as well as individual

polygon attributes, for timber and non-timber resources. Its design is statistically defensible and addresses issues raised by the Forest Resources Commission in its 1991 report, *The Future of Our Forests*.¹

The VRI consists of several components:²

1. Photo Interpreted Estimates (Phase I)
2. Ground Sampling (Phase II) – timber emphasis, ecology, coarse woody debris
3. Net Volume Adjustment Factor sampling
4. Within Polygon Variation (WPV) sampling
5. Change Monitoring Inventory (CMI)
6. Statistical Adjustment.

One or more of these components can address specific forest management or inventory issues. For more detailed information, VRI Standards and Procedures are available on the Ministry of Forest & Range Forest Analysis & Inventory Branch website:

<http://ilmbwww.gov.bc.ca/risc/pubs/teveg/index.htm>

1.4 VRI PLANNING

The VRI planning process requires that a VSIP and VPIP be developed for defined management areas, e.g. a Tree Farm License and Timber Supply Area (TSA). A VSIP outlines VRI products to address forest management issues and provides strategic direction for implementing the inventory activities. A VRI Project Implementation Plan details the operational activities identified in the VSIP. A separate VPIP is prepared for Phase I – Photo Interpretation or Phase II Ground Sampling and NVAF projects. The Guideline provided in the VRI Standards and Procedures for each of these VPIP options identifies the requirements for these plans, including details on the project area, scheduling, priorities, sample locations, estimated inventory costs by year, and roles and responsibilities.

The VRI planning process is an important component of the overall VRI process and related activities (Figure 1). The intent of the VRI planning process is to ensure that baseline products meet a range of applications and that they are efficiently implemented. These processes and activities include:

1. Forest management decision processes (land integration planning);
2. Identifying forest management issues;
3. VRI strategic planning (prepare a VSIP);
4. VRI operational planning (prepare a VPIP); and
5. Implementation, including development and maintenance of procedures and standards:
 - a. Management inventories;
 - b. Database management;
 - c. Data interpretation.

¹ Forest Resources Commission. 1991. *The Future of Our Forests*.

² A glossary of technical terms is provided in Appendix II.

The steps for preparation of a VSIP may include the following:

1. Licensee stakeholders work with MOFR staff to develop Management Unit issue statements related to VRI.
2. An opportunity is made for all agencies and stakeholders to refine issues and to decide which of these issues needs to be considered for funding. One option for this may be the preparation of a VRI "Forest Management and Inventory Issues Discussion Paper". This paper may include an explanation of the VRI process and key issues identified to date. Issues are usually taken from the Timber Supply Review Data Package, plus any other issues identified by stakeholders in Step 1. This discussion paper is circulated for feedback and may be a focus for discussion if a VSIP meeting is held.
3. A VRI Stakeholders meeting is held to:
 - Introduce the VRI tools and process;
 - Table new issues and issues recorded to date;
 - Discuss issues that can be funded or not (under current funding mechanisms); this discussion provides general direction for developing the VSIP. This discussion also affects the extent of photo interpretation and the number and type of VRI plots.
 - Suggest the VRI tools to address currently fundable issues as well as those issues that may be funded in the future.
4. A summary of feedback from the VRI Stakeholder meeting, either minutes or a Discussion Paper is prepared and circulated to all Stakeholders for review and feedback.
5. A VSIP is prepared incorporating all discussions and feedback. This is reviewed and signed off by the Stakeholders including staff of the MOFR Forest Analysis and Inventory Branch.

The Project Implementation Plan process follows. The steps for the preparation of a VPIP include:

1. Review and update VSIP recommendations.
2. Secure funding.
3. Identify project activities, geographic areas, and costs.
4. Specify roles and responsibilities for project implementation.
5. Prepare VPIP.³

1.5 VRI PLANNING – SPECIFICALLY ON TFL49

As was mentioned in Section 1.1 Background, this Strategic Inventory Planning process is being followed out of sequence to the 'standard' approach. To date the following steps have been taken:

1. The stakeholders met with the Forest Analysis & Inventory Branch staff to discuss the proposed VPIP and to review the proposed recommendation that came from the Deputy Chief Forester in December 2005. Throughout the process the VRI activity specific specialists have been consulted.
2. FIA Funding was secured by Tolko Industries Ltd. A decision was made by Tolko that Glen Dick R.P.F. would oversee the work.

³ Separate VPIPs are required for Photo Interpretation and Ground Sampling activities. The ground sampling VPIP includes both Phase II ground sampling and NVAF sampling and analysis and statistical adjustment projects.

3. Phase II ground sampling with NVAF enhancements was proposed, a VPIP was written including an outline of the budget required to undertake this work in 2006/07 and 2007/08.
4. The VSIP has been prepared for TFL49.

1.6 VRI METHODOLOGY

The VRI is the Ministry of Forests and Range's forest inventory standard on public lands in BC. It is a four-step process (Figure 2), as follows:

1. Phase I (unadjusted inventory data) – Estimates of polygon attributes are derived for the target population from photo-interpretation.
2. Phase II (ground sample data) – Measurements are taken from randomly located ground samples in the target population.
3. Net Volume Adjustment Factor sampling – Random trees are selected for stem-analysis, from the Phase II samples, to develop adjustment ratios that correct taper and decay estimation bias.
4. Statistical Adjustment - The final phase of the VRI is the Statistical Adjustment of the Phase 1 using the results of the Phase II sample estimates from hidden decay and taper equation bias and the Phase II plot estimates are used to adjust the Phase I photo interpretation attribute estimates. The final product is a statistically valid new inventory, supported by re-adjustment of photo-estimated attributes based on ground samples.

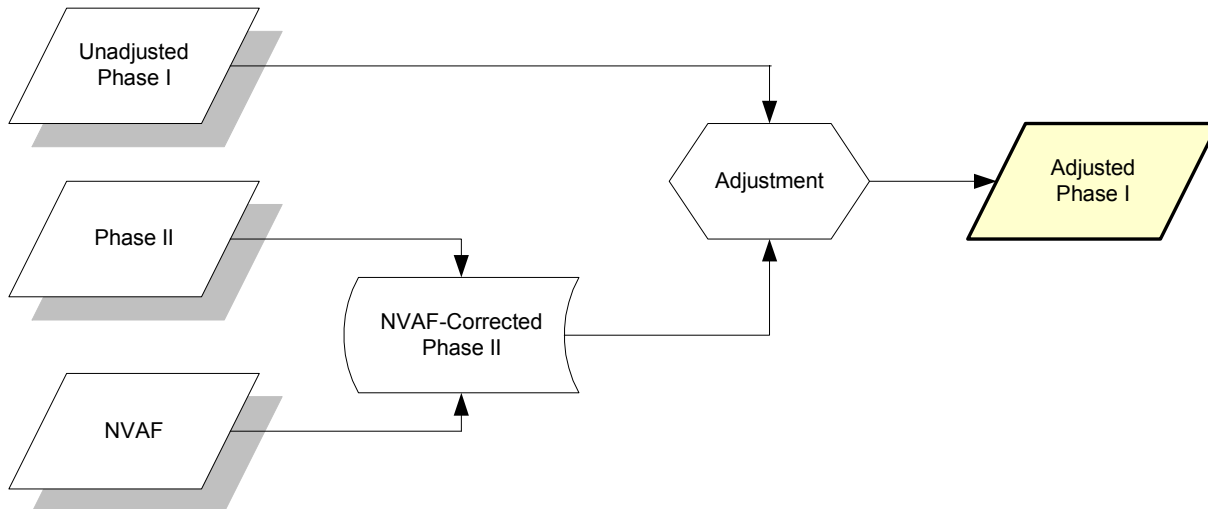


Figure 1. VRI flow-chart.

1.7 FUNDING

Funding for VRI activities will be provided by the Forest Investment Account (FIA) Land Base Investment Program (LBIP) for the fiscal years 2006/07, 2007/08 and 2008/09.

2. BUSINESS CONSIDERATIONS

2.1 TFL 49 LAND BASE

TFL 49 is located west of Okanagan Lake near the communities of Kelowna, Vernon and Armstrong (Figure 3). TFL49 is administered by the MOFR Okanagan Shuswap Forest District Office within the Southern Interior Forest Region.

Interior Douglas Fir (IDF), Montane Spruce (MS), and the Engelmann Spruce – Subalpine Fir (ESSF) Biogeoclimatic zones (BEC), collectively represent approximately 90% of the TFL49 (Table 1). The main species are Lodgepole pine, Douglas-fir, spruce, and sub alpine fir (Table 2).

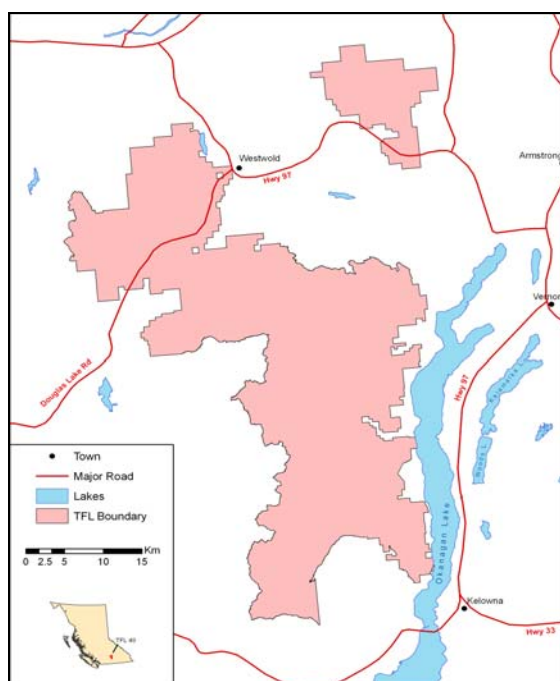


Figure 2. TFL 49 Location

Table 1. Subzone distribution in TFL 49.

BEC	Area (ha)	% of TFL
MS dm2	54,997	38
ESSF dc2	25,692	18
IDF dk1	22,640	16
IDF mw1	11,585	8
ICH mk1	8,167	6
IDF dk2	8,056	6
IDF xh1	5,437	4
ESSF xc	5,139	4
IDF xh2	3,071	2
Total	144,786	100

Table 2. Species and age class distribution of TFL 49.

Leading Species	MoFR Age Classes									Total Area	
	1	2	3	4	5	6	7	8	9	Ha	%
Pl	5,042	7,426	440	3,543	4,147	8,871	13,764	10,503	146	53,881	37%
Fd	390	1,658	2,302	4,690	7,724	6,495	4,141	10,878	517	38,795	27%
Sx	1,752	2,712	124	132	490	1,224	1,614	9,649	1,442	19,138	13%
Bl	780	3,897	2,027	1,285	1,467	1,845	957	3,566	548	16,372	11%
At	576	1,664	102	281	176	228	208	19		3,255	2%
Ep	147	173	124	130	199	86				859	1%
Py	18	22	41	121	53	100	34	327	32	746	1%
Cw	26		20	116	181	66	154	140	16	720	0%
Lw	46	61	64	43				42	2	259	0%
Se	125	32	10							168	0%
Act	3	65	10	2	6	10	4	44		144	0%
Pa								56		56	0%
No Species										10,390	7%
Total ha	8,906	17,709	5,264	10,343	14,443	18,925	20,878	35,225	2,703	144,786	
%	6%	12%	4%	7%	10%	13%	14%	24%	2%		

2.2 CURRENT FOREST COVER INVENTORY

TFL49 has one of the first VRI Phase 1 inventories completed in the province in 1997, followed by Phase II field sampling, supported by the MOFR, over the period 1999, 2000 and 2001. In total, 87 Vegetation Resource Inventory Phase II ground samples were installed in the Tree Farm Licence under a previously approved Project Implementation Plan.⁴ TFL 49 underwent an allowable annual cut (AAC) determination in December 2005 using this new data in the base case. Tolko was granted an AAC uplift of 200,000 m³ due to salvage efforts related to the current MPB epidemic.

The TFL is comprised of 37% Lodgepole Pine. With the anticipated losses in the pine due to MPB, among the issues that timber supply analysts are interested in is the short term and mid term timber supply. The reliance on other species – Douglas Fir, Spruce and Balsam will increase. At this time, due to the harvest history of these species – partial harvesting, high grading – and the lower productivity on some of the growing sites (notably drybelt Fir), there is a knowledge gap about polygons with these leading species. A new inventory (Phase I) would create the opportunity to get a better handle on this portion of the population, with its stand structure complexities. The VPIP will outline a field work approach that could help to provide improved data on these uneven-aged stands.

⁴ J.S. Thrower & Associates Ltd. 1997. Tree Farm Licence 49 Vegetation Resources Inventory – Timber Emphasis Inventory Ground Sampling Plan. Contract report prepared for the MoFR. JST Project MFI-033. September 30, 1997. 31 pp.

2.3 FOREST MANAGEMENT CONSIDERATIONS

The Stakeholders have identified a number of forest management issues and are interested in how the various VRI activities can help to address them. This section outlines a list of forest management issues that have been identified at previous Vegetation Resources Inventory planning tables throughout the province. In many cases, they are relevant for this management unit.

A rating of high, moderate, low or not applicable (N/A) has been applied to the effectiveness of Phase I or VRI Photo Interpretation or Phase II – Ground sampling or NVAF ground sampling activities. Monitoring is also mentioned in the 'Comment' field where it is felt to be particularly relevant.

	Issue	Phase I impact	Phase II impact	Comment
1	Mountain Pine Beetle	Moderate	Moderate-High	Updated photo estimation (Phase I) will provide data on what is dead and what is left. Ground Sampling (Phase II) can give good information about current attributes and volumes of pine leading stands across the TFL.
2	MPB shelf life -monitor duration of merchantability of dead timber due to MPB	N/A	Moderate-High	MoFR is piloting the collection of shelf life attributes to provide data to develop a shelf life model. This data may be available to incorporate into the TFL analysis.
3	Volume of dead wood	Low	High	Critical for this TFL since there is no alternate inventory procedure i.e. the Provincial audit program to provide information for dead wood. Ground sampling & NVAF would be effective to provide good information on dead potential volumes.
4	Mortality in immature stands	Low	Moderate	Ground sampling can target strata with age classes 31 to 60 years. The Monitoring plot sample selection could also target this population.
5	Mid-term wood supply	Low	High	Ground sampling can identify strata that define this part of the population. It can also provide data on the understory i.e.poles, saplings which are part of the mid-term timber.
6	Site index in managed & unmanaged stands	Moderate	High	Phase I can provide better estimates of height for use in determining Site index. Ground sampling can provide good data for SI based on current stands. Monitoring can provide data over time.
7	Problem Forest Types	Moderate	High	New Phase I can verify/improve estimates in these stands. Targeted Ground sampling in these types will provide good data.
8	Landscape level biodiversity	High	Moderate	Phase I can provide more detailed information on non-forest attributes. Ground

				sampling can provide data on Coarse Woody Debris, Forest Succession and ecology.
9	Polygon delineation and spp comp. in younger age classes.	High	Moderate	New Phase I can improve delineation and species composition estimates on openings older than those populated in RESULTS. Ground sampling will provide attribute information for openings age 31+.
10.	In TFL49 there is an update issue for openings.	High	Low	New Phase I using 2007 photos will yield up-to-date harvest opening shapes.
11.	'snapshot' estimates of current volumes of managed stands	Moderate	High	Phase I can provide more accurate attributes for VDYP to use in deriving volumes. Ground sampling will provide data on actual volumes. The data can then be used to adjust the database.
12.	Errors in inventory attributes: spp comp., age, height. For TFL49, the Licensee has noted inaccurate attributes in the uneven-aged Douglas Fir, spruce and balsam leading polygons.	Moderate to High	Moderate	Both Phase I & II can improve individual polygon values and reduce errors in attributes. Further analysis by age and species could also identify trends within the inventory. Photo interpreted database can be adjusted for some numeric attributes using Phase II data.
13.	Decay, waste & breakage	Low	High	NVAF data will provide information on decay & waste. This data could be used to provide information to verify the current loss factors and VRI net factors. Breakage is not part of the VRI system.
14.	Implications of managing species at risk	Moderate	Low	Phase I can provide finer delineation and specific attributes for non-forest areas.

Based on forest management issues in Tree Farm License 49, some of which were highlighted in the Timber Supply Review, the following data requirements have been identified:

1. Acquiring data to enable quantifying unsalvageable losses. (USL)⁶
2. Assessing the Mountain Pine Beetle induced mortality in the pine and non pine leading polygons.
3. Defining the 'mid-term timber supply' –amount, possible locations, and improved data on these polygons.
4. Improving inaccurate data attributes in the uneven-aged Douglas fir leading polygons in the IDF and in the uneven-aged Spruce and Balsam in the ESSF.
5. Checking growth and yield predictions.
6. Tracking changes and trends in non-timber values such as wildlife habitat and key biodiversity indicators to meet certification requirements.
7. Compilation of Forest Health information on root rots.

⁶ Benskin, H., 2005. Tree Farm Licence 49 Riverside Forest Products Ltd. – Rationale for Allowable Annual Cut (AAC) Determination. December 5, 2005.

In summary, to achieve the Stakeholders' overall data requirements, the completion of a VRI re-inventory (Phase I) as well a Phase II VRI ground sampling and NVAF and Monitoring activities are considered critical projects in TFL49. A monitoring program also needs to be considered.

3. STRATEGIC INVENTORY PLAN

3.1 OVERVIEW

This section outlines a strategic inventory plan to undertake a series of VRI activities. The main product of the VRI program is a statistically unbiased vegetation inventory. This will include a new Phase I on the entire TFL49 landbase, Phase II ground sampling and NVAF sampling and Statistical Adjustment. In addition, a Change Monitoring Inventory program will be initiated over the entire TFL.

3.2 PHOTO-INTERPRETATION (PHASE I)

The Stakeholders have agreed to undertake a new Phase I following the acquisition of 1:20,000 colour air photos in 2007. The objective is to improve TFL49 polygon information for identified issues including data attribute accuracy in the IDF and ESSF.

A VPIP for Photo Interpretation will need to be developed for the Phase I inventory to be conducted on the TFL, including photo acquisition. This will include the details for each 'phase' of the photo interpretation project and identify timelines.

The project would be done using softcopy technology. Softcopy refers to the use of 3D digital imagery on a computer. Acquisition of new 1:20,000 scale colour photography, followed by the creation of digital scans, aerial triangulation and digital model building must all occur before the project can begin.

As soon as these steps have been finished, delineation would occur. Delineation is the process of dividing the area into homogeneous polygons. Polygon numbers will be specified during the project planning phase. Strict adherence to minimum polygon size and delineation criteria will keep the number of polygons reasonable.

Fieldwork would be done in the first available field season as these project progresses. The fieldwork is a mixture of ground calibration points and air calibration points spread throughout the TFL. The amount done and the mix between numbers of air and ground points are directly related to the budget.

Attribute estimation can begin immediately after the fieldwork has been completed.

3.3 PHASE II GROUND SAMPLING

3.3.1 Objectives

The objectives of the sample design are to:

1. Establish a sufficient number of samples to obtain an estimate of the average net merchantable volume in the target population with a sampling error of $\pm 10\%$ at a 95% confidence level.
2. Collect information on Deadwood and forest health.

3.3.2 Target Population

The target population will be the Vegetated Treed (VT)⁷ landbase within TFL49, older than 30 years in 2006.

3.3.3 Sample Size

At the time of preparing the Project Implementation Plan for the Phase II ground sampling project, estimates of the variability for volumes will be determined, and based on the sampling objective of $\pm 10\%$ for overall inventory volumes, 95% probability, a sample size will be calculated. The results of the Provincial Inventory section's 'Inventory Audit program'⁸ for a specific management area is often used as a reference to develop this work. For TFL49 there was no audit on the forest cover inventory, so the consultant will use alternate statistical methodology to develop the sample size.

3.3.4 Sampling Approach

VRI Timber Emphasis Plots (TEP) and Coarse Woody Debris (CWD) data will be collected using the MoFR standards. This information corresponds to a 'plot type D' in the VRI Ground Sampling Manual.

3.3.5 Sample Selection

A combination of new plots and remeasurement of previous VRI ground samples will comprise the sample population.

The new plots will be selected using provincial standards. Polygons will be selected using probability proportional to size with replacement (PPSWR) and a random point will be selected within the polygon using the provincial 100 m. grid.

When selecting from the existing sample points, the contractor will need to determine the distribution of plots by strata and sub-strata. Following this step, plots would be randomly chosen from the existing plots that were in the target, which satisfied the strata and sub-strata requirements. This will enable a proper distribution as well as an unbiased selection.

3.4 NET VOLUME ADJUSTMENT FACTOR SAMPLING

The NVAF destructive sampling provides data on decay and taper.

NVAF sampling was undertaken as part of the previous VRI work in 1999 when 55 trees were destructively sampled. The existing sample data is still useful, and needs to be augmented with a new program to ensure that the NVAF is brought up to today's standard. Based on an examination of the existing project, 50 extra trees are needed for NVAF sampling. This will bring the total to 105 including 10 dead trees and 95 live trees.

⁷ B.C. Land Cover Classification Scheme

⁸ This program was established primarily to assess the accuracy of the inventory information, specifically volume, on TSAs and TFLs in the province in the latter half of the 1990's. More detail on this program, its scope and objectives is available on the MoFR website: <http://www.for.gov.bc.ca/hts/vri/audits>

Table 3. Expected NVAF sample distribution by species⁹

Live or Dead	Species Group	Total Samples Required	Existing Samples	New Sample Size
Dead	All	10	10	0
	Total	10	10	0
Live	PI	40	17	23
	Fd	21	10	11
	Sx	19	7	12
	Other	15	11	4
	Total	95	45	50
Total		105	55	50

In the ground sampling phase, 20 samples will be 'enhanced' to provide a population for the selection of NVAF trees. This involves net factoring and call grading of all the trees (live, dead, standing or fallen) within the selected auxiliaries in addition to regular timber emphasis sampling on the selected auxiliary plots. Once the enhanced data is collected on the NVAF samples, the tree data will be compiled in a tree matrix and a sample design for selected trees will be developed.

The VPIP will provide the sampling criteria to identify and select additional NVAF samples on a species and age group basis. It will identify the samples that will be enhanced. Following this field work, a tree matrix will be built with all trees from the auxiliary plots of the NVAF-enhanced samples. NVAF trees will be selected systematically, with a random start, from the matrix sorted by species and diameter at breast height (DBH).

3.5 MANAGEMENT UNIT MONITORING

At this point in the planning process, various objectives for a monitoring program have been identified and include:

1. Monitor mountain pine beetle issues including mortality rates and regeneration in affected stands.
2. Remeasure a subset of VRI samples to assess USL at regular intervals.
3. Check growth and yield predictions.
4. Meet certification requirements by tracking changes and trends in non-timber values such as wildlife habitat and key biodiversity indicators over time

Depending on objectives, the target population could be a stratum in the population (i.e. the pine leading stands with greater than 50% pine composition), the Vegetated Treed landbase, or the entire TFL49 landbase. Options for monitoring plots could be remeasurement of a subset from the Phase II ground sampling plots or the sample cluster design as described in the VRI standards at random sample locations gridded across the landbase using the 100 metre VRI grid. All options including the sample size would be dependent on the data requirement of the specified objectives.

⁹ From the TFL49 VRI Phase II Project Implementation Plan, 2007, page 6.

3.6 IMPLEMENTATION

Tolko will lead this initiative. Using the direction of the VSIP, the VRI Project Implementation Plans will specify the operational details for each phase of the VRI inventory for the TFL.

The Phase II ground sampling that is initially planned for the project will occur over a 2 year time frame, commencing in 2006/07. The sample size will be analysed at the end of this work, and if remaining plots are required, they will be scheduled for completion as soon as possible.

The NVAF-enhanced samples will be measured as a priority, so that the data to develop the matrix for the tree list will be available for selection of the trees to be destructively sampled. The NVAF project could be completed in 2007/08.

The Phase I project requires the photos to be flown prior to the start of the photo interpretation work. This is anticipated to occur in 2007/08.

3.7 VEGETATION RESOURCES INVENTORY PROJECT IMPLEMENTATION PLANS

As previously mentioned, a VPIP for ground sampling has been developed following the MOFR guideline '*Vegetation Resources Inventory Guidelines for Preparing a Project Implementation Plan for Ground Sampling and NVAF*' in order to get this activity underway in the 2006/07 fiscal year.

A VPIP for Photo Interpretation will also need to be prepared for this management unit.

3.8 ROLES AND RESPONSIBILITIES

A VSIP usually outlines organizational roles and responsibilities in the development of a VRI project. The Stakeholders have reviewed and accepted the following:

Licensees:

- Initiate inventory projects through FIA funding process to support planning of VRI inventories.
- Prepare requisite plans for inventory work. (VSIP to establish the overall VRI strategy, VPIPs prior to undertaking a VRI project.)
- Inform other Stakeholders of the planning process and involve them in the project i.e. MoFR and other key government agencies.
- Submit Strategic and Project Implementation Plans to the appropriate MoFR inventory staff for their support, review and sign off.
- Apply to PriceWaterhouseCoopers for approval of project funding based on approved plans.
- Complete the RISC inventory activities following the appropriate Standards and Procedures outlined in the Implementation Plan.
- Submit data from completed projects to the MoFR/Provincial Data Warehouse (as appropriate).
- Licensee contractor will complete an End of Project Report as outlined.

MoFR – Regional Inventory staff and Forest Analysis & Inventory Branch staff, Inventory Section

- Provide mentoring and advice regarding VRI issues and methodology.
- Coordinate plan review within the MoFR.
- Sign off final approved edition of project plan(s).
- Provide expertise to projects as they are ongoing.
- Facilitate the acceptance of the data as is appropriate. MoFR may conduct audits on portions or all VRI activities conducted in this management unit.

3.9 COSTS AND TIMELINES

Aerial photography will occur in the 2007 field season. The VRI Phase I Re-inventory will start in 2007/08 and be completed in 2008/09. VRI Phase 2 TEP sampling began in the fall of 2006 and will be completed in the 2007/08 fiscal year. NVAF destructive sampling will occur in the 2007 field season.

Estimated sample sizes and preliminary costs for TFL49 VRI activities are listed in Table 4. These details will be reassessed in the Project Implementation Plans.

Table 4. Estimated costs for aerial photos, Phase 1 and Phase 2 VRI in TFL49

VRI Activity	Sample size	Unit Cost	Total Cost Approx.
Aerial Photography (Ha)	145,000	1.50	\$ 217,000
VRI Phase 1 Re-inventory	90,000	1.11	\$ 100,000
<i>Sub-total</i>			<i>\$ 317,000</i>
VRI Phase 2 TEP samples	90	\$1,500	\$135,000
NVAF destructive sampling	46	\$ 500	\$ 25,000
<i>Sub-total</i>			<i>\$160,000</i>
Mentoring (TEP only)			\$20,000
Project Management			\$12,000
Data compilation, analysis and reporting (incl. NVAF)			\$30,000
Helicopter time (TEP Only)			\$20,000
Field support (TEP data entry, core Counting, and support)			\$15,000
Prepare sample packages (incl. photos purchase)			\$20,000
<i>Sub-total</i>			<i>\$117,000</i>
TOTAL			\$594,000

4. VEGETATION STRATEGIC IMPLEMENTATION PLAN

It is the intention of the proponent to implement the TFL 49 Vegetation Resources Inventory Strategic Implementation Plan (VSIP) as described. As the key stakeholder in the inventory, the Ministry of Forests and Range (MoFR) VRI staff has been consulted throughout the development of this plan.



Robert Kennett RPF
Divisional Forester
Planning & Silviculture
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February 16, 2007

I have reviewed the TFL 49 Vegetation Resources Inventory Strategic Implementation Plan (VSIP). I will be advising PriceWaterhouse Coopers that the work proposed to this plan meets Vegetation Resources Inventory Standard and MoFR business needs.

Jon Vivian
Manager,
Vegetation Resource Inventory Section
Forest analysis and Inventory Branch
Ministry of Forests and Range

February 16, 2007

APPENDIX I – STAKEHOLDERS

The Stakeholders include the Ministry of Forests and Range (MOFR), Tolko Industries Ltd. (Tolko) and BC Timber Sales Okanagan- Columbia Business Unit (BCTS).

Ministry of Forests and Range

- Jon Vivian - Manager, Vegetation Resource Inventory
- Lawrence Bowdige - VRI Monitoring Program Coordinator
- Gary Johansen - VRI Audit Coordinator

Ministry of Forests and Range – Southern Interior Region

- Matt Makar - VRI Phase II Inventory Forester
- Jim Grace - VRI Phase I Inventory Forester

Ministry of Forests and Range – Okanagan Shuswap Forest District

- Ted McRae - Stewardship Officer – Okanagan Shuswap Forest District

Tolko Industries Ltd.

- Robert Kennett - Regional Forester, Planning and Silviculture
- Glen Dick - FIA Coordinator for Tolko Industries Ltd.

BC Timber Sales

- Brian Bedard - Planning Forester

APPENDIX II – GLOSSARY OF TERMS

Change Monitoring and Inventory

Change Monitoring and Inventorying (CMI) is the process of estimating and monitoring the change over time in timber and non-timber attributes, based on repeated measurements of the same objects over a time series. The MOF Resources Inventory Branch is currently implementing the CMI over the province. The provincial procedures can also be deployed to address management-unit level monitoring objectives.

Ground Sampling

Ground sampling is the field measurement of timber, ecology, range, and/or coarse woody debris values at one or more locations within each sample polygon. Sample polygons are selected using the probability proportional to size with replacement (PPSWR) method. To accommodate a wide variety of resources, various types and sizes of sampling units (e.g., fixed and variable plots, transects) are used to make the measurements.

Inventory Unit

An inventory unit is the target population from which the samples are chosen. The inventory unit could be a specific geographic area (e.g. TFL or TSA) where a specific set of attributes is needed. The size of the inventory unit depends upon the sampling objectives.

Landcover Classification

The BC Land Cover Classification Scheme (BCLCS) was designed specifically to meet VRI requirements, in addition to providing general information useful for “global vegetation accounting” and “integrated resource management.” The BCLCS is hierarchical and reflects the current state of the landcover (e.g., presence or absence of vegetation, type and density of vegetation) and such fixed characteristics as landscape position (i.e., wetland, upland, alpine). There are two main classes of polygons: Vegetated and Non-Vegetated.

Management VRI

Management VRI are specialized inventories that provide detailed information required for specific resource management, i.e., day-to-day forest management. One or more VRI sampling procedures may be used for management inventories. Management inventories may focus on specific resource types (e.g., timber, range, ecology), geographic areas (e.g., landscape unit, TFL), attribute sets (e.g., Douglas-fir leading stands, age class 4+). They may use one or more of the following tools (e.g., photo-interpretation, ground sampling, NVAF sampling).

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National Forest Inventory (NFI)

The NFI provides information on Canada’s resources across all provinces and allows the Federal Government a consistent framework for reporting on Canada’s inventory, including reporting on the Criteria and Indicators and the Kyoto protocols. The inventory unit for the NFI is the entire country, although it is implemented province-by-province. BC’s provincial CMI system will provide the data needed for the NFI as well as provincial reporting.

Net Volume Adjustment Factor (NVAF) Sampling

NVAF sampling provides factors to adjust net tree volume estimated from net factoring and taper equations. The adjustment accounts for hidden decay and possible taper equation bias. NVAF sampling involves detailed stem analysis of sample trees, calculation of actual net volume, and calculation of the ratio between actual net volume and estimated net volume (where estimated net volume is obtained from net factoring and taper equations). The NVAF (and VRI net factoring) replaces the existing loss factors for inventory applications. It does not, however, replace the loss factors for revenue applications.

Photo-Interpretation

Photo-interpretation involves subjective delineation of polygons and photo estimation of attributes for all polygons in an inventory unit. Medium scale aerial photographs (1:15,000) are most often used in photo-interpretation. However, if existing photo-based inventory is acceptable, the database can be translated into VRI format and upgraded to include the additional VRI attributes.

Post-Stratification

Post-stratification involves dividing inventory unit into mutually exclusive sub-populations (strata) *after* ground sampling has been completed. Samples that fall in each post-stratum are analyzed separately and the results are applied to the corresponding population post-strata to improve the precision of the inventory's overall averages and totals.

Pre-Stratification

Pre-stratification divides an inventory unit into mutually exclusive sub-populations (strata) *before* ground sampling to provide estimates for specific areas, or to increase the confidence in the overall estimates by considering special characteristics of each stratum.

Resource-Specific Interpretations

Resource-Specific Interpretations (RSI) use the Resource Inventory Committee (RIC) standard VRI baseline data products (provincial CMI or management inventory), in combination with other data sets and analysis (outside of that required to produce VRI), to produce information to address specific-resource management issues (e.g., TSR review, important ecosystems and habitats). These interpretations include ecosystem interpretations and habitat interpretations.

Retrofit

Retrofitting is the process of translating and upgrading an existing photo-based inventory to VRI Phase I standards. If the polygon linework and attributes are of acceptable quality, the existing FIP (Forest Inventory Planning) databases are translated to VIF (Vegetation Inventory Files) databases and the additional attributes required by the VRI are re-estimated from aerial photographs.

Sample Size

The sample size for an inventory is the minimum number of ground samples to be established in an inventory unit to meet the target precision.

Statistical Analysis

Statistical analysis or adjustment is the process of adjusting the values of the photo-interpretation

variables using ground sampling observations. Ground observations are compared to photo estimated values to develop adjustment factors by species groups. These factors are then applied to the polygons in the photo interpretation database to produce the final adjusted database.

Sub-unit

Sub-unit describes the inventory unit within an Inventory Unit. For example, if the inventory unit is defined as the Vegetated Treed area in a Forest District, then a sub-unit may be defined by a specific geographic area (e.g., operable landbase) or stand type (e.g., problem forest types) within the Vegetated Treed area in the Forest District.

Target Precision

Target precision expresses the amount of variation in key attributes (e.g., timber volume) desired in the final results. Target precision, usually expressed as the coefficient of variation (CV), is used to calculate the minimum sample size for subsequent ground sampling. The current target precision for timber volume is +10% (90% or 95% probability); stakeholders define the probability (uncertainty) level.

Vegetation Resources Inventory (VRI)

VRI is an improved vegetation inventory process for assessing quantity and quality of BC's vegetation resources. The VRI process is designed to include a flexible set of sampling procedures for collecting vegetation resource information. The VRI is essentially a toolbox of procedures, which include:

- *Photo-interpretation*: the delineation of polygons from aerial photography and the estimation of resource attributes.
- *Ground sampling*: the establishment of plot clusters in selected polygons to measure timber, ecological, and/or range attributes.
- *NVAF Sampling*: stem analysis sampling of individual trees for net volume adjustment.
- *WPV Sampling*: intensive sampling of selected polygons to determine the error between the estimated attribute values and the "true" attribute values.
- *Statistical Adjustment*: the adjustment of the photo-interpreted estimates for all polygons in an inventory unit or management unit using the values measured during ground sampling.

The VRI can be deployed over the entire province measuring timber and non-timber resources, or over a large management unit (management VRI) measuring selected resources in specific portions of the landbase. The VRI sampling process produces spatial and non-spatial databases that can be used in multiple resource management applications including timber, ecosystem, and wildlife habitat management.

Within Polygon Variation Sampling

WPV sampling provides information for expressing the true individual polygon error, assessed as the difference between the adjusted polygon value and the "true" value for that polygon. The "true" value for the polygon is an estimate derived from a small sample of polygons that are intensively sampled on the ground.