PROJECT IMPLEMENTATION PLAN TO CONDUCT A VEGETATION RESOURCES INVENTORY AND DIGITAL MAP PRODUCTION

of

Federated Co-operatives Limited
TFL 33

Prepared for

Federated Co-operatives Limited
Canoe, B.C.

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1.0 INTRODUCTION

This project implementation plan (PIP) is submitted to Federated Co-operatives Limited (FCL) for consideration for the planned VRI (Vegetation Resources Inventory) for TFL 33. As identified in the Implementation Strategy of the Okanagan Timber Supply Area VRI Preliminary Strategic Inventory Plan (March 31, 1999), the inventory of TFL 33 is a priority. The objective of this plan is to present a technical plan, activity schedule, preliminary budget estimates, and deliverables for the VRI softcopy retro-fit of TFL 33 (located in the Kamloops Forest Region) to the most current provincial standards and FCL expectations.

Tree Farm Licence 33 (see key map, Figure 1) is located in south central British Columbia and is administered by Federated Co-operatives Limited from Canoe, B.C. The project area is approximately 8,366 hectares, of which approximately 7,678 hectares is productive forest according to the current forest cover inventory. The long-term net operable landbase is 6,788 hectares according to the MP #8 Information Package.

1.1 Vegetation Resources Strategy

The Forest Resources Commission in its report, *The Future of our Forests,* recommended a review of the provincial resource inventory process. The Resources Inventory Committee (RIC) was established with the objective of achieving common standards and procedures. This resulted in the establishment of several Task Forces that include the Terrestrial Ecosystem Task Force with several attached working groups. The Vegetation Inventory Working Group within this Task Force was charged with the following:

"...making recommendations pertaining to the Vegetation Inventory...(and)...designing and recommending standards and procedures for an accurate, flexible...inventory process".

The Vegetation Inventory Working Group recommended a photo-based; two phased Vegetation Inventory program, which FCL has adopted for this proposed inventory of TFL 33.

The design and development of the TFL 33 VRI program will be carried out as two separate phases; namely:

Phase I

"Estimates" of vegetation attributes based on pre-delineated polygons on aerial photos. These estimates are supported through trending and extrapolation by the use of available and *useful* existing source data and new, measured and estimated attributes collected during the VRI Phase I field data collection programs.

Phase II

Ground samples will involve the collection of extensive vegetation attributes within a statistically determined subset of the polygons. The ground samples provide the means for unbiased estimation of the population total or coverage's, and are used to adjust individual polygon photo estimates.

The ground sampling (VRI Phase II) provides statistically valid answers of how much of a given

vegetation attribute is within TFL 33. However, due to the complexity and labour intensive nature of establishing Phase II samples, it is recognized that the ground samples by themselves cannot be collected in sufficient numbers to provide for the spatial location of attributes. Therefore, Phase I *"estimates"* of vegetation attributes are made, based on pre-delineated polygons on aerial photos (i.e.: provides the framework for the location of attributes). These estimates are supported by a field data collection program to provide photo interpretation calibration points. The relationship between the polygon estimates and ground samples are used to adjust the polygon estimates and provide a theoretically overall correct answer. To enhance the proposed re-inventory of TFL 33, FCL has decided to incorporate the Ministry of Forests' BC Vegetation Resources Inventory protocol.

This project implementation plan briefly outlines Phase II process that will be followed to complete the VRI sampling of TFL 33. Vegetation Inventory standards follow the MoF Vegetation Resources Inventory Sampling Standards and Procedures. These standards will be used to ensure continuity of procedures for all TFL sampling.

While the MoF is not currently able to store/report an operational adjusted VRI (TFL) inventory, once the INCOSADA project is complete the MoF tools will be able to report the adjusted inventory.

The ground sampling in the TFL will involve installing a number of timber emphasis sample clusters (TEP), and net volume adjustment factor (NVAF) samples. This ground sampling, followed by statistical adjustment of the new Phase I estimates, will provide a higher statistical confidence in the timber volume estimates across the TFL.

A Phase II Sampling plan will be completed for TFL 33 at a future date, and will specify the exact number of TEP and NVAF plots necessary to meet the statistical requirements of Phase II sampling. The ground sampling plan will be completed with support and input from RIB staff.

1.2 Rationale for the Estimated Number of Polygons

This implementation plan has assumed an average polygon size of 8 ha. based on factors that are expected to influence the 'average' vegetation cover polygon size as follows.

- Geographic area and physical landscape;
- Mapping standards;
- Degree of disturbance (influence of silviculture polygons);
- Photo interpreter's skill, judgement and interpretation of the current VRI standards as applied to the existing TFL linework which would be transferred across in the retro-fit process; and
- Expectations of FCL.

Based on extensive vegetation resources inventory and ecosystem mapping experience, it is believed that the average polygon-size for this project area will be approximately 8 hectares and in any case, smaller than the current average polygon size due the effects of the VRI standards in terms of delineation within vegetated non-treed and non-vegetated polygons. This number (8 ha.) coincides with other similar areas across B.C. and addresses the impact of the un-restricted minimum size of silviculture polygons and small non-productive types on the overall average

polygon size.

1.3 Scheduling

Successful completion of this project within the desired time frame will require the cooperation and coordination of efforts between the inventory consultant, FCL, and the Ministry of Forests.

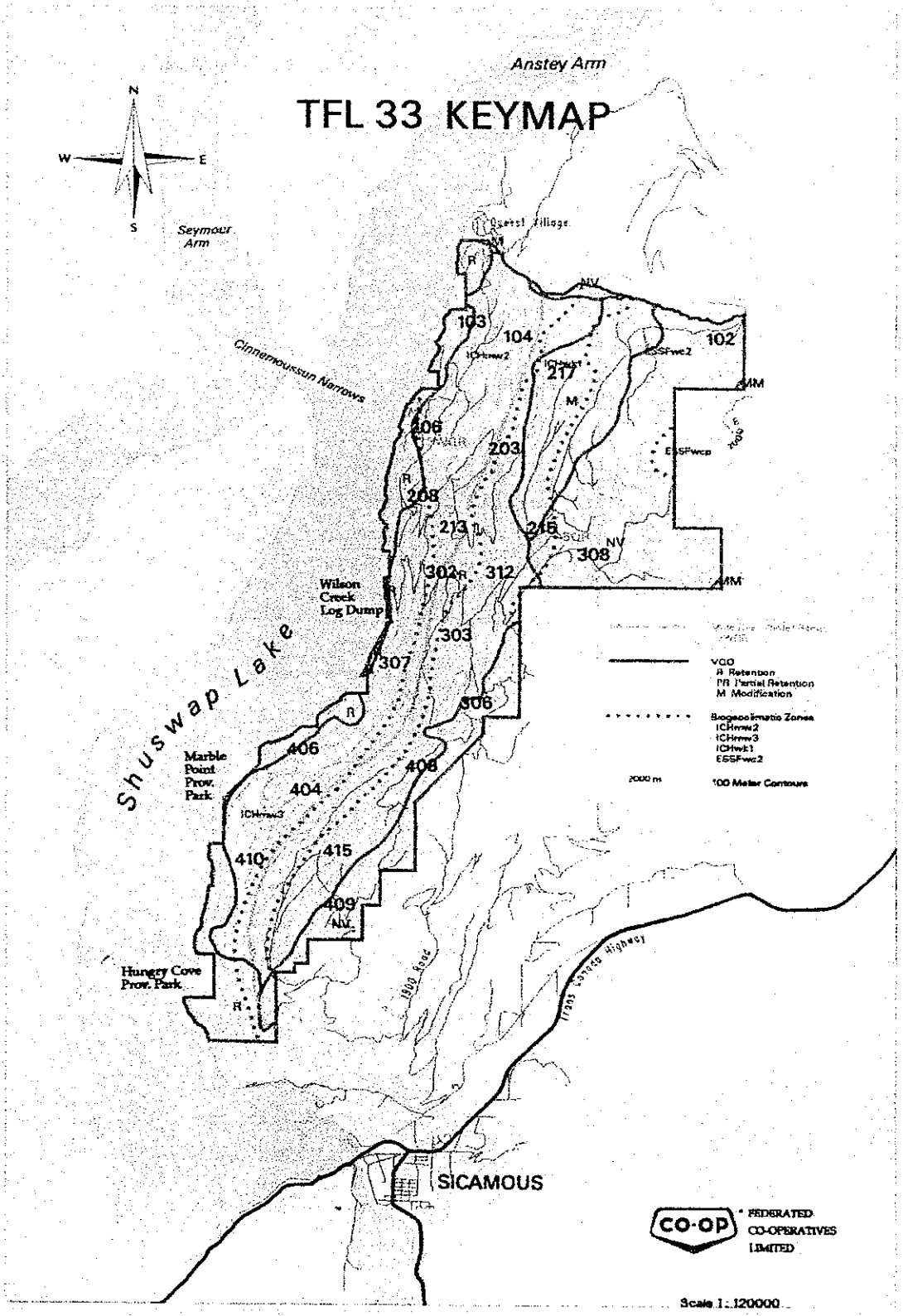
The role of the inventory consultant will be to complete the technical aspects of the inventories as well as internal quality control. Federated Co-operative's role will be to provide the necessary support materials and to coordinated quality assurance with Ministry of Forests staff. The VRI will be completed in a series of interdependent work phases. Each phase will be completed by the inventory consultant and approved by FCL staff and Ministry of Forests before work progresses too far on following phases.

The schedules contained in this proposal assumes that FCL / Ministry of Forests will provide materials and complete quality assurance services in a timely manner (i.e. within ten working days of request for material or services). The following proposed project schedule will be contingent on funding availability from FCL Multi-Year Agreement (MYA).

Proposed Project Definition and Activity Components

Activity	Schedule
PHASE 1	
Sampling plan	April 2001
Field calibration	May / June 2001
PHASE 2	
Project aerial photo acquisition and processing	June - August 2001
Digital photo image sourcing, scanning, aerial triangulation, control transfer, and viewer set production	September 2001
VRI pre-delineation of retro-fitted forest cover	Sept. / Oct. 2001
Data source transfer (post FC inventory data sources and 2001 field calibration data points)	October 2001
Softcopy retro-fit VRI attribute estimation and final delineation	Oct. – Nov. 2001
Databases	November 2001
Digital map files	Nov. / Dec. 2001
Final Report	December 2001

KEY MAP


TFL 33 KEYMAP
Anstey Arm
Seymour Arm
Cinnamousun Narrows
Shuswap Lake
Wilson Creek Log Dump
Marble Point Prov. Park
Hungry Cove Prov. Park
SICAMOUS
Trans Canada Highway
103
104
102
217
406
203
208
213
216
308
302
312
303
307
306
406
404
408
410
415
409
VQO
R Retention
PR Partial Retention
M Modification
Biogeoclimatic Zones
ICHmw2
ICHmw3
ICHwk1
ESSFwc2
100 Meter Contours
Scale 1:120000
FEDERATED CO-OPERATIVES LIMITED

2.0 INTEGRATED VRI – PEM METHODOLOGY

For numerous reasons, with information utility, efficiency, and cost effectiveness being paramount, it is strongly suggested that the field work component of the TFL 33 softcopy retro-fit be integrated with Predictive Ecosystem Mapping (PEM) plots. This will allow for the completion of a PEM of the TFL using the new VRI immediately following completion of it.

The proposed methodology for completing the proposed integrated VRI is presented in the following sections. All inventory methods and procedures will conform to all relevant procedures outlined in "Photo Interpretation Procedures" (March 1999) and the "Standards for Terrestrial Ecosystem Mapping in B.C." (1998), or more recent versions if they become available prior to the commencement of the project.

2.1 Inventory Issues

The last forest cover inventory for TFL 33 was completed in 1977 and last updated in 1998, based on 1997 aerial photos and 1998 manual updates. Regardless of standards, the information is dated despite being detailed enough to provide reliable information, especially spatially, as a management tool. The existing inventory is functional yet inadequate as a base with which to conduct accurate predictive ecosystem mapping. The detailed nature of the existing inventory makes it particularly suitable for a digital retro-fit.

A prime objective of this project is to complete a 1:20,000 scale Vegetation Resources Inventory and digital map production of the TFL.

The objective of the combined vegetation resources inventory with integrated ecosystem data collection is to provide reliable and cost effective baseline information for applying predictive ecosystem mapping in the future as well as being able to develop the following management tools and interpretations:

Douglas-fir Bark Beetle
Root Rot Prediction
Fire hazard mapping
Fuel loading/fuel type mapping
Fire history interpretation
Vegetation regeneration prediction/modelling
Sensitive/rare ecosystem identification and location
Old growth forest distribution
General ecosystem distribution
Wildlife habitat change prediction (caribou, moose, grizzly bear)

2.2 Project Initiation

Project initiation will involve a meeting between the consultant and FCL staff to gather information and review contract specifics regarding the VRI, digital mapping, interpretive applications, reports, dates, etc. Any existing data sources, project maps, and aerial photos will be provided to the consultant at this time. Following this meeting, consultant staff, FCL staff, the MoF Regional Inventory Forester, and MoF District Inventory Officer (or designate) will meet to discuss interpretation issues, data collection standards, numbers of plots, interpretive applications, reports and legends, quality control methods, etc.

2.3 Gap Analysis of Existing Plot Data

The magnitude of existing data is relatively clear at this time; however, a gap analysis will be conducted to examine the availability and location of all existing forest cover and ecosystem data, which could be used to improve the image interpretation. All existing data sources (digital from the existing inventory and any additional data source data collected subsequently) will be requested from FCL and Kamloops Forest Region staff. The number of proposed plots (ground calibration plots, air calls and observations) have been noted in the PIP but could be adjusted to save field costs based on the results of the gap analysis. The summary of the analysis, including background and previously known information and previously collected plot data, for the project area will be delivered. Recommendations for the sample plan will be provided to the appropriate project correlator(s) for review and approval.

Federated Co-operatives should provide copies of all such information as a project support item. All currently available sample locations will be presented on the digital sample location map. Refer to Section 2.4.2 for the data source entry method for VRI/Eco plots.

2.4 Softcopy

2.4.1 Introduction

For this proposed project, a digital retro-fit and enhancement of the existing forest cover inventory of TFL 33 to the current VRI standards is recommended. While the current inventory is dated, it was completed to intensive operational standards, particularly with respect to polygon delineation. The option remains open however, to follow traditional inventory methodology for the completion of a VRI if this is desired. The term retro-fit leaves open the option for how much of the existing interpretation to keep, based on information provided by the last inventory audit.

2.4.2 Softcopy Methodology

2.4.2.1 Aerial Photo Preparation

A set of colour scale photographs (scale at either 1:15,000 or 1:20,000 for operational utility beyond the softcopy retro-fit project) and diapositives supplied by Federated Co-operatives will make up the document photos for the VRI. Aerial triangulation and cascade of the TRIM II control will be completed prior to the diapositives being sent for scanning and digital image prep. While the traditional use of unsuitable 1:40,000 scale TRIM II photos and more suitable 1:30,000 colour photos is a viable alternative, the small area of the TFL would suggest a large gain for a

nominal cost in acquiring the aerial photos for the project at a larger scale. 1:20,000 scale aerial photos would provide an operational compromise for inventory and subsequent operational use. This must be a consideration in the acquisition of aerial photos.

2.4.2.2 Data Source Transfer

The locations of all data source's from the current inventory as well as data source information collected by the inventory contractors field crews will be transferred to Level 14 of the 3D VG1 files using the softcopy systems.

2.4.2.3 Vegetation Polygon Retro-Fit and Pre-Delineation

Delineation is the separation of land into homogeneous types based on observable differences in vegetation, land class, species composition, age, height, crown closure or stand structure. It is suggested that the TFL be delineated with enhanced VRI polygons to ensure the highest possible utility of the resultant line work to the potential subsequent application of PEM to the TFL.

The photo interpreters will stereoscopically identify and delineate homogeneous vegetated and non-vegetated types at an image scale of 1:7,500 using the softcopy system and then assign each newly created polygon a unique number. Any comments or notations will be entered on Level 12 of the 3D VG1 File.

The photo interpreters will also review the position and classification of all roads and trails visible on the digital images. Any amendments will be digitized directly into the new 3D VG1 files. Delineation will be completed to the TFL boundary only and will be tied to any adjacent and existing VRI inventories. As most if not all other inventories surrounding the TFL are to the older Forest Cover standards, the TFL boundary will act as a type line separating the 'unlike' inventory standards until such time as the adjacent areas are updated to VRI standards. This procedure is consistent with other district VRI initiatives, and TFL boundaries can act as type lines.

It is recommended that enhanced VRI polygons be retro-fitted onto the digital aerial photograph images in a softcopy system. Certified VRI interpreters will be involved throughout this phase to ensure VRI objectives are met and aerial photos will be signed-off by certified VRI personnel. The key personnel who are delineating on the softcopy systems will be those that were involved in field data collection and again in final delineation and attribute estimation. This approach ensures that the experience gained in the field is effectively applied to the final attribute estimation and edits.

The pre-delineation (softcopy retro-fit) and data source transfer phases will commence shortly after the project digital image preparation has been completed. Interpreters will be pre-assigned areas for interpretation of which they will be responsible for the pre-delineation and data source transfer phases. Initially, due to the size of the TFL, one experienced VRI interpreter will be involved in the softcopy pre-delineation retro-fit process. All pre-delineation retro-fitting will be quality control checked by a certified photo interpreter other than the interpreter who will be completing the pre-delineation of the TFL.

The enhanced VRI softcopy pre-delineation retro-fit with consideration to Bioterrain and site series will be a two-step process. The first 5% of the project area will be delivered to FCL and

MoF Regional Inventory Forester for review and suggestions. The second step will be the completion of all remaining pre-delineation retro-fitting on the remainder of the TFL by fully incorporating the comments and suggestions made by FCL and Ministry staff.

The contractor will attempt to achieve an average polygon size of approximately 8 hectares (see Section 1.1).

The delineation of polygons will meet VRI standards and will be based on the B.C. Land Cover Classification Scheme. To ensure continuity with VRI standards the delineations must acknowledge the following:

- Will delineate areas of homogeneous vegetated and non-vegetated complexes that will provide the spatial location of polygons within the geographic landscape. Complexes will be based upon distinct, significant and observable differences visible on the photography according to defined criteria briefly discussed below and in the latest available version of Vegetation Resources Inventory Photo Interpretation Procedures (April, 1999 or newer).
- Will minimize stand variation within a polygon, thereby facilitating a meaningful photo interpretation of vegetation inventory attributes.
- Minimum polygon sizes will be no less than 0.5ha and no narrower than 30 meters in width. Due to the operational importance of the TFL inventory, generally the minimum polygon size will be 1 hectare for polygons with distinct boundaries and 4 hectares for areas with indistinct boundaries.

Final pre-delineation (retro-fitted, adjusted lines and additional lines to bring the delineation up to desired TFL VRI standards), will be reviewed and audited to ensure general adherence to Ministry of Forests VRI standards as a minimum. Please refer to section 11.1 *Inventory Projects Quality Control Protocols.*

All line transfer will meet Ministry TRIM mapping specifications and standards.

2.4.2.4 BEC Sub zone/Variant Delineation and Verification

BEC Sub zone lines are available from the MoF at 1:250,000 scale. Verification of these BEC sub-zone/variant boundaries is a necessary preliminary step in ensuring a reliable ecosystem map and is useful in assisting with the consistent interpretation of expected soil moisture and nutrient regimes. This verification will be completed as follows:

- The existing BEC Sub zone lines will be digitally transferred from the 1:250,000 scale Provincial overview maps to the Softcopy systems as an overlay that can be turned on or off as required.
- The Alpine Tundra (AT) zone (very little if any) will be delineated on the digital images, with reference to the BEC sub-zone lines.

The results of these 2 steps will be greater consistency in soil moisture and soil nutrient interpretation by project interpreters and between project interpreters.

2.4.2.5 Vegetation Polygon Descriptions

A detailed VRI description of each polygon will be derived based on the available field data and the photo interpreter's local knowledge, skills, experience, and lastly the existing forest cover attribute information (a premise of the retro-fit process). These descriptions will then be entered directly into a digital database.

All type lines will be digitally edge-tied to all adjacent mapsheets within the project area. All of these map edge types will then be checked with attribute comparison software that will ensure that the VRI descriptions for common polygons are identical.

2.4.3 Deliverables/Outputs (Pre-Delineation and Final Delineation)

Deliverables from this phase will be the following:

- Pre-delineated digital images depicting integrated VRI/PEM polygons that meet the RIC standards for VRI. The final deliverable will include the complete set of digital scanned project aerial photo images and accompanying vegetation line work.
- Data sources transferred from any and all available previous surveys from the original digital coverage of TFL 33.
- Quality control documentation (refer to section 11.1 *Inventory Projects Quality Control Protocols*).

3.0 FIELD CALIBRATION

3.1 Integrated VRI Field Data Collection Plan

The intensity of field visitation that is being proposed is based on the understood objectives of FCL staff in terms of the desired stand level accuracy of inventory as well as the projected utility of the inventory as a base for any future planned ecosystem mapping (PEM). The relatively small size of the TFL allows for a significant polygon visitation percent that due to past ground visitation intensity can be provided through increased aerial visitation. Past data source information is somewhat limited by the increased data requirements of the new VRI standards however, and a base level of ground visitation will be critical to acquire measured calibration data for certain VRI attributes. The objective of the field calibration program is to provide further field information to the VRI photo interpreters that will help improve local knowledge for making estimates of VRI attributes of polygons not visited on the ground.

To maximize the effectiveness of the ground calibration data collection phase, it is recommended that VRI ground calibration plots be established as single point plots (measurement) with multiple attendant prism sweeps collected throughout the target calibration polygons, rather than the more formal and time consuming three point observations. This recommendation will allow for a greater distribution of plots across the project area and provide for the field visitation of at least two times as many polygons with the same ground calibration plot budget.

In addition, and to improve the quality and utility of the ground and air programs, it is suggested that all VRI ground plots be completed with integrated PEM quick visual and ground observation plots. This methodology will provide widespread and cost efficient ecological data collection for future ecosystem mapping work. Two person crews are usually used to increase the effectiveness

of ground plot establishment. Replacing the crew assistant with a trained forest ecologist significantly enhances the integrated utility of all field collected data at a minimally increased per plot cost. In addition, all air calls can be completed with a combined VRI specialist/Ecologist air call crew to collect all required VRI attributes as well as quick visual calls of BEC sub-zone/variant and site series.

3.2 Field data Collection

3.2.1 Distribution of Calibration Plots

Due to variable access throughout most landbases, there is always some difficulty in achieving an equal distribution of calibration plot locations throughout a project area. Every effort should be made to ensure an even distribution of samples both spatially as well as across most representations of vegetation cover types.

For the cost structure of this plan, GPS has not been considered for ground calibration plots and is not a Ministry requirement for Phase I VRI calibration plots. Current MoF requirements dictate the use of GPS in air call calibration data collection. Past experience in using GPS to determine coordinates of air calibration points across any remotely mountainous terrain has indictaed intermittent success. The Ministry should recognize that quite often satellites are not available during the time some air calibration points are being established and therefore the coordinates for these points would not be available. All efforts will be made to ensure that GPS data points are collected for all air calls. However, in instances where the signal is lost, locations will be transferred to the project field photographs and later transferred to the appropriate digital coverage.

A data collection plan will be developed based primarily on the following:

- The results from the gap analysis;
- The desired number of plots to achieve a satisfactory percentage polygon visitation according to the desired objectives of the licencee.
- An assessment of the necessary number of plots (or adjusted ratio of plot types) to ensure reliable photo interpretation (based primarily on discussions and approval by the licencee);
- Accessibility; and
- Location and placement of existing calibration point locations (as well as age and confidence in these existing data points)

The exact distribution of the ground and air calibration plots will be described in detail in the field data collection plan produced as a part of the VRI contract itself. A calibration data collection plan map should be produced that shows the existing data sources and the proposed location for all plots. The plan and accompanying map will be presented to the appropriate discipline correlators for review and approval before proceeding with the fieldwork.

The contractor will observe the general rule of a 500m distance from a safe helicopter-landing site for determining access to proposed data collection sites where road access limitations exist. Distances greater than 500m will be considered inaccessible or be considered for multiple plots on a field strip.

Data collection will occur in polygons that do not otherwise have any source information or in polygons where the source information is questionable (date and type limited). Location of

VRI/PEM plots should be such that there are a variety of forest cover types visited including treed, non-treed and non-vegetated polygons (i.e. different structural stages). The following table provides a summary of the fieldwork to be completed.

Calibration Category	TFL 33
Integrated Ground VRI/PEM plots (1-point with multiple prism sweeps)	60
*Ground Observations (without measurements)	20
Air Calls	200
*Air Observations (collected between Air Calls)	50

*Ground and Air Observations (without measurements) can be collected at no extra cost to the project.

3.2.2 Integrated VRI/TEM Field Data Collection

The field data collection program is designed as an integrated VRI/PEM approach. Data collection should be conducted according to the procedures outlined in the *VRI Air Calibration (Air Call) Data Collection Procedures* and *VRI Ground Calibration (Ground Call) Data Collection Procedures* and to the *Standards for Terrestrial Ecosystem Mapping in British Columbia* (1995 and the 1996 Addenda) for TEM 'quick visual' plot establishment.

Upon completion of all fieldwork, the VRI/PEM plot locations will be documented onto the digital images. PEM quick visual and ground inspection plot information will be entered into GRAVITI immediately following the fieldwork.

3.2.3 Integrated VRI/PEM Sampling Crews

The inventory contractor must have the personnel resources to put together a minimum of two integrated crews consisting of a VRI specialist and an ecologist. Due to the nature of the data being collected all personnel must be professionals in their field, no temporary non-permanent staff should be designated for this project. It is planned that the project manager will form part of the crews. This high level of expertise is imperative to ensure quality data particularly since the field program is not overly intensive.

3.2.4 Ground Collection of VRI/PEM Plots

The ground program will involve 2 types of ground calls dependant upon accessibility to the candidate polygon (i.e. road or by helicopter).

- Ground 'helicopter access' calibration points will consist of 1 ground plot complemented by a minimum of 4 associated informal ground observations.
- Ground observations collected independent of the above plots to serve strictly as additional field estimations (optional to include measurements) to assist with photo interpretation.

Each ground crew will consist of 2 persons, a VRI specialist and an ecology specialist. Ground plots should be biased towards treed polygons for calibration of tree estimated attributes while ground observations without measurements will be made up of a mixture of all vegetated and

non-vegetated cover types, as the majority of these cover type groups do not require mensurational data. A tally of candidate cover types for visitation will be kept during the delineation phase to ensure that an appropriate range of treed and non-treed cover types are sampled. No plots will be established within 40m of a polygon edge, if practical, to minimize edge effect.

3.2.5 Data Collection Specifications

VRI field data will consist of the following:

- **Tally of stems** by species: for stands greater than 40 years old, a variable radius prism plot will tally all stems, by species, down to 4.0cm. All subsequent calculations for stems/hectare, species composition and basal area will be calculated using only those stems identified as dominant, co-dominant and high intermediate, as per MoF VRI standards. For stands less than 40 years old a fixed radius plot will be utilized to tally all trees down to 4.0cm and in some cases less. Again, calculations will only be based on the three highest crown classes as per MoF standards. This topic will be addressed during the pre work conference.
- **Diameters**: will be measured for each tallied stem at diameter breast height (dbh).
- **Age**: will be measured to the nearest year on sample trees selected for height measurements of the first and second leading species weighted by basal area for that stand. **All** age cores will be stored in straws for subsequent office age confirmation.
- **Height**: will be measured to the nearest 0.1m and will represent the average of all the dominant and co-dominant trees weighed by basal area for the first and second leading species per stand.
- **Crown Class**: will be determined for each tallied stem; classes are: dominant (1), co-dominant (2), intermediate (3) and suppressed (4).
- **Density**: will be based on the variable radius prism plot and/or fixed radius tally of stems per hectare for all dominant, co-dominant and high intermediate stems. Coniferous understorey stems will also be tallied where applicable.
- **Snag Density**: will be based on the variable radius prism plot and/or fixed radius tally of dead stems per hectare for all dominant, co-dominant and high intermediate snags.
- **Basal Area**: will be calculated for all dominant, co-dominant and high intermediate stems.

PEM data should be collected as either ground inspections or visual checks as indicated by the approved sampling plan. Data for either of these plot types should be collected using the MoF Ground Inspection Form or equivalent.

Ground plots: While the standard MoF protocol for ground calls is for the more formal three point ground calibration plots, it is suggested that the plot structure be changed to single established measure point plots with multiple prism plots (minimum of five sweeps) to ensure accurate basal area and species composition determination. Plot quality is not diminished from that derived from the more formal three point plot structure, but will allow for the placement of two times as many plots as three point plots with the same budget, for the same overall cost. The advantage to FCL is significant. This initiative will result in increased polygon visitation resulting in an enhanced level of calibration information available to assist the interpreters in improving their attribute estimation.

3.2.6 Field Marking

Integrated field plots are 'temporary' in nature so every effort should be made to keep all field marking to a minimum to minimise visual impact. Field marking is proposed as follows:

- **Tie Points**: should be painted, marked with red stripe and blue flagging tape, and metal tagged to indicate the plot number and bearing to plot centre in degrees azimuth. The length of the transit and plot location should be at the discretion of the sampler, but must be of sufficient distance from openings to ensure representation and avoid edge effect. All marking should be minimal with aluminium tags (and aluminium nails) and flagging tape used to eliminate any long term visual impact or tree scarring.
- **Strip Lines**: should be marked with blue VRI flagging tape.
- **Plot Centres**: should be marked with blue and red stripe flagging tape at eye height if possible; wood plot centre stakes will be used. Plot centres should be referenced to the nearest live tree and a small metal tag to indicate the sample number, prism or plot radius, crew and date.
- **Tally Trees**: all tallied trees should be unobtrusively marked with paint (minimal), borderline trees and tree diameters should be measured and sample trees selected for age and height indicated with a small 'S' facing the direction from which the height measurements are taken.

3.2.7 Air Calibration Program

Air calls should be collected using a helicopter and an aircrew consisting of one Certified VRI Photo Interpreter and one Ecologist. The methodology should follow the same standards and procedures as described in the Vegetation Resources Inventory Air Calibration (Air Call) Data Collection Procedures (July 11,1997). Air calls will provide estimated vegetation attributes for only the path navigated along the extent line as designed and shown on the document photos.

The following VRI attributes should be estimated during the air call program:

- **Species composition**: estimated based on the amount of basal area by species and by layer (if applicable).*
- **Age**: an estimate of age for the first and second leading species based on basal area for each layer (if applicable).*
- **Height**: an estimate of the average height of the dominant and co-dominant stems for the first and second leading species. As an initiative to improve the accuracy of height estimates, the air call team should employ a laser range finder to determine the average stand height for the air calls.
- **Crown closure**: estimated for each layer (if applicable).*
- **Non-treed data**: to be estimated when non-tree data (i.e. shrub, herb and non-vegetated) attributes are collected when these features are distinguishable both from the aircraft and on the photo.
- **Snag density:** estimated.
- **PEM 'air' visual checks:** The emphasis will be for BEC Sub zone confirmation and will include an estimate of site series. Should be collected by an ecologist only.

** **Conifer understorey present in deciduous stands will also be noted and attributes recorded.***

To improve the quality of air called estimates, the air calls should be conducted after the

interpreters have established a number of ground plots in the landscape unit and will also "double sample" a number of stands that have been previously sampled by integrated VRI/PEM plots. These will serve, along with the occasional setting down of the aircraft for ground measurements, as measured examples of vegetation attributes for the air crew. The air call crew should land several times each day to measure at least one age and height of the leading species to provide adequate age calibration data for the air calls. This should be coordinated with helicopter refuelling requirements whenever possible to save time and helicopter costs.

As an initiative to improve the height estimates, air call crews should use a helicopter mounted laser rangefinder that allows for accurate measurement of flying height of the helicopter over the ground.

An example of a VRI air call sheet is included in Appendix 1.

In addition to the air calls discussed above, the air call crew should collect a number of air observations in conjunction with the air call program. Air observations record, as a minimum, species composition (for treed polygons), vegetation or non-vegetation components for non-treed polygons, and a comment on BEC Sub zone. Remaining VRI attributes will be estimated if time permits. There is no additional cost associated with the collection of air observations, as they are collected for stands located between actual planned air calls.

3.2.8 Photo/Field Calibration Summary

Upon completion of the fieldwork, the data should be collected and combined with relevant existing data and be compiled by like strata and summarized into look-up tables illustrating trends observed. These tables will serve only as references or base lines from which the photo interpreters can make consistent estimates of basal area and stems per hectare (live and dead).

3.2.9 Deliverables/Outputs (Field Program)

The deliverables for this phase are as follows:

- Integrated VRI/PEM Ground Plots in hard copy and digital format (PEM ground inspections in GRAVITI format) and a spreadsheet of all visual check data. Final deliverable will include original plot cards and one good quality copy of each plot form (GIF and Visual). Both of these sets will be delivered to FCL.
- Air call calibration data hard copy and digital format.
- Calibration point locations and identifiers transferred to document photo digital images and map base.
- Quality control reports.
- Sorted data tables of collected field data.

3.3 Post Field VRI Activities

3.3.1 Interpretation

The inventory contractor will ensure that the same interpreters who have acquired on-site experience through participation in the field program will undertake all VRI photo interpretation. Personnel having the MoF VRI Photo Interpreters Certification will complete and supervise photo

interpretation and quality control. The photo interpretation process will incorporate the methods and standards prescribed in the Photo Interpretation Procedures (April, 1999 or newer) and will reference new and previously established samples.

All vegetation attributes will be recorded as continuous variables. The photo interpreter will directly enter estimated VRI attributes, for each polygon into a database using developed VRI data input software as the attributes are estimated. Validation software will be used simultaneously with the input software. A final validation check will involve using the MoF validation process and software (VegCAP) to edit data stored in .mdb (Access) format. Edit checking includes input data, calculated and projected values, and resultant data.

The implementation of the Validation Inventory software in conjunction with SPEC CHECK will ensure meeting the required zero tolerance of error for data files submitted to Resources Inventory Branch (RIB) for quality assurance.

3.3.2 Reference Material

The following reference material is available to photo interpreters:

- Vegetation Resources Inventory Photo Interpretation Procedures (April, 1999).
- Vegetation Resources Inventory Ground Calibration (Ground Call) Data Collection Procedures.
- Vegetation Resources Inventory Air Calibration (Air Call) Data Collection Procedures.
- Quality Assurance of Photo Interpretation, B.C. Vegetation Resources Inventory.
- Describing Ecosystems in the Field.
- A Field Guide for Site Identification and Interpretation for the Kamloops Forest Region.
- Terrain Classification System for British Columbia (1988).
- Ministry of Forests, Forest Inventory Manual (1992) which includes Volume 4, Photogrammetry and Photo Interpretation.
- Ministry of Forests Colour Stereogram Handbook (1987).
- Ministry of Forests Black and White Stereogram Handbook (1987).
- Ministry of Forests, Resource Inventory Branch, Field Handbook (1992).

3.3.3 Deliverables/Outputs (Photo Interpretation)

Deliverables/outputs of this phase will be as follows:

- Creation of vegetation cover attribute files in FS810B format in digital and hard copy format.
- VRI Phase I data converted to the appropriate MS Access data format (.mdb) to facilitate MoF validation routines.
- Creation of Vegetation Inventory Files (VIF).
- Input data validation, calculation and projection values and resultant data.
- Quality control reports.

4.0 Digital Map Production

4.1 Methodology

4.1.1 IGDS Map Production

Final IGDS map production for the project area will be undertaken by a mapping contractor. This will ensure that all maps are produced to expected exacting standards.

In order to provide compatibility and facilitate data exchange with other agencies, all newly mapped polygons and detail will be transferred onto TRIM I controlled base maps with NAD 83 positioning.

The transfer of the existing forest cover polygons from the current forest cover inventory of TFL 33 and additional VRI polygon delineation will be carried out by using softcopy methodology as described in *Vegetation Resources Inventory Photo Interpretation Standards Using Softcopy Photogrammetry* (revised July 5, 1999) *and Vector Cleaning Specifications* (April 22,1997).

The VRI polygon coverage will be plotted at a scale of 1:20,000. The resultant digital manuscript maps will provide a base map serving the following purposes

- To supply a clean, easy to read map to assist in subsequent photo interpretation.
- To serve as a digital entry check whereby edits to the digital loading can be made during final classification.

In addition to the tasks outlined above, the following procedures will be used to produce the digital VRI polygon files:

1. Digitize overlay updates and enter attributes.
2. Label map with vegetation inventory labels using a projected *Vegetation Inventory File (VIF).*
3. Grid levels to ensure all polygons are closed and there are not redundant nodes, or polygons lacking nodes.
4. Run checking algorithms to ensure integrity of file and validity of elements.
5. Generate report, listing all nodes and compare to label file.
6. Produce paper plots of VRI and base map, including reports, attribute files and digital files.
7. Translate complete IGDS files to Arc/INFO for all subsequent digital map production.
8. Run a digital editing program in Arc/INFO to determine digital line and attribute integrity within mapsheets and along mapsheet neatlines.
9. Clean all errors identified and re-run the digital editing routine until all line attribute errors are cleaned.
10. Translate Arc/INFO GIS map products to IGDS format to complete project deliverables as required.
11. Supply cleaned and edited IGDS design files and .mdb attribute files to RIB for editing and QA.
12. FRGIS (RIB) to complete IGDS map labelling and label placement to INCOSADA specifications.

4.1.2 Hard Copy Checking Procedures

An ink on paper check copy of each map, at a scale of 1:20.000 and a 8.5" X 11" hardcopy of

- Original digital photo (diapositive) image source files with photogrammetrical control transferred as per specifications outlined in *Vegetation Resources Inventory Photo Interpretation Standards Using Softcopy Photogrammetry* (revised July 5, 1999) *and Vector Cleaning Specifications* (April 22,1997).
- Digital file containing control points in both ASCII and IGDS format.
- All original source materials provided by FCL / MoF, including TRIM prints and diapositives, along with TRIM digital control.
- Digital vegetation polygon coverage.
- Complete digital data file on CD ROM in Ministry Digital Standard Format Intergraph Design File (IGDS) format (no label placement, unless supplied by RIB) and Arc/INFO format for each completed mapsheet.
- Spec check.
- Single neat line format processing.
- Validation and zero tolerance quality assurance of the data prior to submission.
- All digital files will be vector clean and polygon clean in IGDS and Arc/INFO formats and provide appropriate report documentation.
- Produce check copies of vegetation cover overlays with associated reports.

each overlay, plus all quality control documents will be submitted for review before final plotting

The following check procedures will be incorporated:

1. Plot all hard copies at the appropriate scale.
2. Check that all planimetric features and management boundaries have the correct nomenclature, all cadastre have the correct identification numbers, and all vegetation polygons have the correct unique numbers.
3. Check that all data sources have been digitized in the exact locations and have the correct numbers where applicable.
4. Check that flight lines and photo centre numbers are correct.
5. Check that the geographic grids, map numbers, map surround and title block information are correct.
6. Check all joins along the neat lines.
7. Indicate all errors in red.
8. Incorporate all changes to digital files.
9. Repeat plotting of paper hard copies for final checking.
10. Submit clean check copies with documentation to the IFPA contract administrator and Ministry of Forests quality assurance staff.

4.1.3 Digital Checking Procedures

The graphic file will be checked for the integrity of the file structure to ensure that there are no corrupt elements or missing pointers internally. A further check will be made to ensure that the data entered meets the criteria defined in the standards and specifications by checking the parameters that are entered on each layer or theme. A log report indicates the type of errors found on each level.

In order to produce the VRI equivalent to the Forest Inventory and Planning File (FIP) the overlay themes must have closed shape and unique nodes before the information is combined to produce a resultant file.

Arc/INFO will be used to check for polygon closure and for the presence of duplicate or missing text nodes. A log report is produced which identifies and documents errors.

The following reports will be delivered with the check plots to ensure that all the forest cover polygons have node numbers and labels

- A hard copy report, sorted by text node number, of the area in hectares of all polygons on each level (HEC).
- Each level (UTM node lists).
- A hard copy report, sorted by text node number, of the UTM location of all forest cover text nodes on the log file of the forest cover label placement on level 10 that indicates that there are no missing or duplicate labels and/or text nodes.
- A hard copy report, sorted by text node number and overlay level, of all the text nodes and attached attribute key-ins for all overlay levels in the design file (Overlay/Attribute Report).

4.1.4 VRI Deliverables/Outputs