Alberta Vegetation Inventory Standards

Version 2.1.5

JANUARY 2022

Agriculture, Forestry and Rural Economic Development,
Government of Alberta

January 2022

Title: Alberta Vegetation Inventory Standards. Version 2.1.5

ISBN 978-1-4601-5305-5

For information on this report, contact AF.FMB-GIS@gov.ab.ca

Alberta Vegetation Inventory Standards

Pursuant to section 2.0 in Annex 1 of the *Alberta Forest Management Planning Standard (2006)* and section 106 of the *Timber Management Regulation AR 60/1973*, I, Ken Greenway, Acting Executive Director, Forest Stewardship and Trade Branch, hereby approve the Alberta Vegetation Inventory (AVI) Standards (AVI Standards 2.1.5).

Pursuant to section 2.0 in Annex 1 of the *Alberta Forest Management Planning Standard (2006)*, the AVI Standards are published at https://open.alberta.ca/publications (Search "AVI Standards 2.1.5"). The AVI TPR Calculator and the AVI Audit Tools are published at https://www.alberta.ca/vegetation-inventory-standards.aspx.

The AVI Standards 2.1.5 come into effect on January 31, 2022 and supersedes all AVI Standards previously approved. These AVI Standards are effective until superseded or repealed.

DATED at the City of Edmonton, in the Province of Alberta, this ______day of January, 2022.

______<Original signed and dated by>______

Ken Greenway
Executive Director (A),
Forest Stewardship and Trade Branch

UPDATES

Date	Type of Revision	Version No.	Sections Revised
November 2021	Major	2.1.5	All standalone documents compiled into one standards document: • Chapter 3 is now Section 4 o Dropped Sections 2, 4, 5, 6, 7 and Appendices I, II, III, V, VI, VII, IX, X, including Table AX-1 • Chapter 4 is now Section 7 • Chapter 6 is dropped • Chapter 8 is now Appendix III • Incorporated draft AVI Audit Procedures Manual as Section 6 • Added Section 1 overview of forest inventories • Added Section 3 AVI Plans
			Section 4.2.1 – Added specifications for aerial imagery
			Section 4.2.2 – Added section on ancillary data
			3.1.1 (old) – dropped minimum polygon size
			Section 4.6.2 Added CIH to anthropogenic vegetated land types
			Section 4.6.3.1 Increased maximum shrub height from 6m to 10m
			Section 4.7.5.4 – Complex structures dropped requirement for a variation in height
			Section 4.7.6.1 Condition modifiers – made changes on how to interpret fires and use of BK modifier; added condition modifiers BV, SF, SL, FS, UP, MO, RT, SN, ST
			Section 4.7.7 TPR - TPR is a calculated field (using ArcTool) for forested polygons > 6m. TPR is interpreted for polygons < 6m
			Section 4.9 Year of Imagery – added field PHOTO_YR (N 4 0)
			Section 4.10 ARIS – added field ARIS (C 11)
			Section 5.2 AVI file format – specified feature class name(s); specified file-naming convention

Table of Contents

List of Tables

List of Figures

1 Introduction

An accurate understanding of our Provincial forest resource is foundational to informed resource management decision making. The Alberta Vegetation Inventory (AVI) is a standardized digital forest inventory product that is central to our understanding of the Provincial forest resource. AVI is an aerial imagery-based inventory that requires interpretation in a 3D digital environment referred to as "softcopy". It is developed to spatially identify the type, extent and condition of forest vegetation. The AVI is also a detailed, spatially explicit, standard to assist in the decision-making process for forest management planning, wildfire management, wildlife habitat classification, ecological classification and integrated resource management activities.

The establishment of AVI standards helps ensure: data quality, consistency, and compatibility with Government of Alberta (GOA) forest inventory database architecture. This is of particular importance as the responsibility to acquire AVI across the province is shared between Forest Management Agreement (FMA) holders, as defined in their forest management agreements, and the Province.

Forest management agreements establish the requirement for FMA holders to acquire and maintain a "complete and accurate forest inventory in accordance with the forest management planning standard." The standard is the Minister-approved AVI classification and data standards pursuant to the Alberta Forest Management Planning Standard (2004)[1], Annex 1 s 2.0 and s 2.1.

The AVI Standard 2.1.5, Section 7, establishes the specifications, for timber disposition holders with reforestation obligations, to submit final spatial harvest area boundaries. These requirements are established pursuant to the *Timber Management Regulation*[2], s 105 and s 106, and the Spatial Data Directives (SDD No.1 - *Standards for Spatial Digital Data Submissions*[3], SDD No.3 - *Final Harvest Area Digital Data Submissions*[4]).

[1] Alberta Forest Management Planning Standard: Version 4.1 (April 2006)
[2] Timber Management Regulation
[3] SDD No.1 – Standards for Spatial Digital Data Submissions
[4] SDD No.3 – Final Harvest Area Digital Data Submissions

2 Background

There were several reasons behind the impetus for a new forest inventory in Alberta in the mid-1980s, including:

- Increasing forest industry development;
- Improving technology (hardware and software); and
- Rapidly changing forest management objectives and constraints.

Previous forest inventories, such as the Phase 2 and Phase 3 inventories, were considered to be heavily biased towards coniferous forests, so one of the objectives for the new inventory was to create a detailed, flexible inventory useful for many applications, including strategic level planning. In addition, with a standardized inventory system throughout province, stored primarily in a digital format, easier data sharing would be facilitated.

An inventory design committee was established that included representatives from all the line divisions within the Department, including Fish and Wildlife, Public Lands, and AFS Forest Land Use and Timber Management Branches, as well as representation from Land Information Services. The first specifications (called the White Area Forest Inventory) for an integrated vegetation inventory were drafted in 1987 and field tested the same year. These initial standards borrowed heavily from Phase 3 with similar attributes and codes. The standards were revised in February 1988. The result was AVI version 1.0, designed to meet Land and Forest Service and Fish and Wildlife needs, as well as to provide spatial data suitable for use in a geographic information system (GIS). A contract for an inventory of 100 townships within the White Area (which was thought to have a substantial aspen resource) commenced in 1989.

The first three provincial forest inventories were completed by the Government of Alberta, but with the growth of the forest industry in the 1990's, the responsibility for inventory, including updates, fell to the FMA holder for FMA-managed FMUs and remained with the department for Crown-managed FMUs. Therefore, engagement with the Forest industry was crucial in the design of forest inventories standards since the early 1990's.

In 1990 a joint forest industry/AFS task force was established to review the AVI specifications. On November 22, 1991, the Vegetation Information Steering Committee, composed of representatives of all the Forest Management Agreement (FMA) holders and the four departmental ADMs, agreed to an enhanced version of the AVI specifications as the minimum standard for inventorying accessible forest lands. This new inventory standard was referred to as the Collective Vegetation Inventory (CVI), to signify that the forest industry had accepted the specifications. Three FMA holders, ANC Timber Ltd., Daishowa-Marubeni International Ltd. and Canadian Forest Products Ltd. began to inventory their FMA lands as now required under the terms of their Forest Management Agreements, following the CVI specifications. Subsequently, the name of the inventory standard was changed to Alberta Vegetation Inventory version 2.0 to reduce user confusion.

The Alberta Vegetation Inventory Standards version 2.1 was released in November 1991. Major changes included dropping references to "productive" and "non-productive" forest land, changing the term "Site Index" to "Timber Productivity Rating", adding additional Field Check types, dropping "Photo Interpretation and Base Map Procedures and Specifications" as well as "Standards" (audit) from the manual.

Beginning in January 1995, a series of meetings were held to discuss changes and updates to AVI 2.1 standards. A draft of the AVI 2.2 Standards was sent to FMA holders and forest inventory consultants in May of 1997. Some of the suggested changes turned out to be quite controversial and so a workshop was held in February of 1998. Changes were incorporated into what was then called AVI version 2.3. The draft document was circulated to stakeholders in March 1998. Several FMA holders (Alpac, ANC, and Millar Western) did use the AVI 2.2 standards. However, the department only accepted AVI 2.1 for audit and review. There was additional cost to producing AVI 2.2 and without the department officially adopting the standards, there ended up being very little uptake of AVI 2.2.

In January 2003, Alberta Sustainable Resource Development (ASRD) approached the Alberta Forest Products Association (AFPA) about striking a committee to review AVI standards jointly with the department. The issues for resolution included:

1. AVI Data Model
2. AVI Photo-Interpretation Specifications
3. AVI Update Standards
4. Base Data Update Standards
5. Re-Inventory Standards
6. AVI Audit
7. AVI Photo-Interpreter Certification Standards
8. Ecological Land Classification

The AVI 2.1.1 Standards (Volume 1) was planned to consist of a series of chapters, which included:

- Abstract
- Introduction
  - Overview of AVI Process (including a flow chart)
  - Discussion of Photo-Interpretation
- Chapter 1 – Photo Acquisition
- Chapter 2 – Digital Mapping
- Chapter 3 – Photo-Interpretation Standards
- Chapter 4 – Disturbance Update
- Chapter 5 – Re-inventory/Inventory Upgrade
- Chapter 6 – Inventory Enhancements
  - 6.1 Detection of Coniferous Understorey under Deciduous-Dominant Stands
- Chapter 7 – Audit Procedures
- Chapter 8 – Data Models
- Chapter 9 - Metadata

In June 2007, ASRD released Alberta Vegetation Inventory 2.1.1 (Chapters 3, 4, 6 and 8) for review and comment. AVI 2.1.1 consisted of clarifications, improvements and refinements to AVI 2.1, which had been the standard since November, 1991. The changes were made in response to concerns raised by AVI users, mostly from FMA holders and forest inventory consultants.

The Alberta Vegetation Inventory Standards version 2.1.1 were approved by Alberta Sustainable Resource Development in September 2007. Only Chapters 3, 4, 6 and 8 were ever officially released. Chapter 4 was revised and released in July 2009.

2.1 AVI Training and Certification

There was broad recognition that AVI must meet the agreed upon inventory standards. The provision of training, to ensure the skills and competencies were available, was one means to achieve the standards. To that end, in 1993, the Alberta Environmental Protection/Forest Industry Steering Committee (formerly the Vegetation Information Steering Committee) endorsed the concept of a certification program for AVI photo-interpreters to ensure competent and skilled AVI photo-interpreters are available to work in the province. A committee was formed to prepare and recommend a program for interpreter certification.

The AVI Interpreter Certification Program was initiated in September of 1994, guided by the following objectives:

1. To improve the quality and consistency of vegetation classification using aerial photography as the primary interpretation tool.
2. To develop a core of qualified photo-interpreters in both the private and public sectors, with a basic understanding of vegetation classification procedures and the necessary skill sets to achieve AVI vegetation classification standards.
3. To improve vegetation and forest management decisions, and growth and yield predictions through better vegetation type descriptions.
4. To standardize vegetation classification procedures and ensure classification uniformity across the provincial landbase covered by AVI and to enhance the credibility of the inventory with the public users and throughout the natural resource community.
5. To provide a more streamlined verification process that will lead to a more cost effective audit.

The program was initially delivered through the Environmental Training Centre (now the Hinton Training Centre). There were three levels of certification:

1. Level 1 – Basic
2. Level 2 – Intermediate
3. Level 3 - Advanced

The different levels required increasingly higher levels of work experience and/or education as well as successfully completing a certification exam for each level. The courses focused on the application of the AVI standards and procedures for vegetation classification through both in-class and practical experiences.

By 2009, forest inventory consultants (who were contracted to do the bulk of AVI acquisition) started using softcopy photogrammetry techniques to capture AVI polygons. Several software packages (e.g., DiAP Viewer, Purview, Summit DAT/EM) allowed interpreters to view scanned images (usually scanned contact prints) in a 3D environment and capture the polygon boundaries with integrated GIS/CAD software. From 2010 onwards, digital aerial imagery became widely available and is now the accepted standard.

In September of 2009, the AVI courses were re-vamped to reflect the current state of AVI. Departmental staff delivered three AVI courses:

1. AVI for Resource Managers was a 1-day course intended as a general introduction to AVI. Those planning to become interpreters were expected to take the course.
2. AVI 100 was a 1-week course with an exam which interpreters are required to take/pass after they complete at least one year of work helping with interpretation. This course was considered to the previous level 2.
3. AVI 200 was a 3-day course with an exam which interpreters must take/pass to qualify as certified interpreters. This course was considered equivalent to the previous level 3.

2.2 AVI Audit

Not only was there the recognized need for AVI certified photo-interpreters, there was (and still is) a need to ensure that the AVI created meets the agreed upon inventory standards through an audit process. "Conformity standards" were included in the inventory standards manuals for AVI 1.0. CVI/AVI 2.0 had standards for photo-interpretation, transfer of photo detail to the base map as well as for data input. These standards also included an Interpretation Audit Form. They were dropped from the AVI 2.1 manual, but resurrected as "Quality control criteria" in AVI 2.1.1.

Under former Directive 97-12 Verification of Disposition Holder Forest Inventories (repealed), auditing involved checking the submitted dataset to confirm acceptability with respect to:

1. quality and coverage of the aerial photography;
2. conformance of the interpretation to the AVI standard;
3. transfer of the interpreted information to the base map;
4. digitization and coding;
5. validation of the digital integrity using routines developed by the department; and
6. addition of geoadminstration data, including the Alberta Township grid.

If the inventory met the required standards, the Department prepared a letter and a report outlining the audit results for each completed AVI audit to the disposition holder. If the inventory did not meet acceptable standards, the disposition holder was notified of the discrepancies and a request for the data to be corrected and resubmitted. The disposition holder was responsible for rectifying discrepancies.

2.3 AVI Era Vegetation Inventories Compared

A comparison of major inventory specifications from the various versions of AVI era vegetation inventories are outlined in Table 2-1: Comparison of Major Inventory Specifications below.

Table 2-1: Comparison of Major Inventory Specifications

Specification	White Area Forest Inventory	AVI 1.0	CVI/AVI 2.0	AVI 2.1	AVI 2.1.1	AVI 2.1.5
Productive Land	Stands reaching 50 m^3/ha by age 120	No change from previous standard	Stands reaching 50 m^3/ha by age 140. If TPR is G, M or F the stand is considered productive	If TPR is G, M or F the stand is considered productive. If TPR is U, stand is considered unproductive.	No change from previous standard	Not specifically referenced.
Moisture Regime	Codes u, d, m, w, a	No change from previous standard	No change from previous standard	Dropped 'u' code (upland undifferentiated)	No change from previous standard	No change from previous standard
Crown Closure	Codes A, B, C, D equivalent to percent closure	No change from previous standard	No change from previous standard	No change from previous standard	No change from previous standard	No change from previous standard
Height	Estimated to nearest metre, neighbouring stands must have a 3m difference	No change from previous standard	No change from previous standard	No change from previous standard	No change from previous standard	No change from previous standard
Species Composition	Maximum of **3 s**pecies, each having a crown closure ≥20% and one additional species only with a crown closure of 11-20%	Maximum of **5** species in decreasing order based on crown closure with % composition of each in 10% classes	No change from previous standard	No change from previous standard	List of tree species names and associated codes updated showing all species codes	No change from previous standard
Site Class/TPR	Site class is coded as G, M, F, U where U is set at a minimum SI by species group: Sw/Fd/Se/Fa < 6 Sb/Lt < 7 Pl/Pines < 6 Hardwoods < 10	No change from previous standard	Site class becomes Timber Productivity Rating (TPR). TPR is coded as G, M, F, U where U is set at a minimum SI by species group: Sw/Fd/Se/Fa < 7 Sb/Lt < 8 Pl/Pines < 6 Hardwoods < 11	TPR is coded as G, M, F, U where U is set at a minimum SI by species group: Sw/Fd/Se/Fa < 7 Sb/Lt < 7 Pl/Pines < 6 Hardwoods < 11	Overlapping range values in Site Index equations were corrected. TPR calculations for complex polygons is changed.	TPR is a calculated field (using ArcTool) for forested polygons ≥ 6 m. TPR is interpreted for polygons < 6 m
Origin	10-year age classes	No change from previous standard	No change from previous standard	No change from previous standard	No change from previous standard	No change from previous standard
Disturbance and Severity	Disturbance Codes V, W, X, Y, Z with 4 severity classes 1, 2, 3, 4	No change from previous standard	Combined with Condition into Modifiers with extents and years	Not used	Not used	Not used
Condition	Condition (treatment) codes A, B, P, D, S, T	Added G (grazing)				
Modifier Code, Extent and Year	Not used	Not used	CC, PC, BU, PB, WF, CL, DI, IK, UK, WE, DT, BT, SN, ST, SI, SC, PL, TH, GR, IR with extents 1, 2, 3, 4 or 5	Dropped PC, PB	If a polygon has been harvested (CC) and a new activities occur after the cut, the modifier CC is retained regardless of any other activity	Added condition modifiers BV, SF, SL, BK, FS, UP, MO, SN, ST
Stand Structure	Complex (C), Horizontal (H), Single-storey, Multi-storey (inferred, no code)	No change from previous standard	Complex (C), Horizontal (H), Single-storey (no code), Multi-storey (M)	No change from previous standard	More definitive criteria added for classifying complex polygons	Removed height variation restriction
Field Checks	f' for field-checked	No change from previous standard	No change from previous standard	7 additional codes P, V, C, S, A, L, I plus year of data	Hierarchy introduced F, A, I, S, P, C, V, L	No change from previous standard

Specification	White Area Forest Inventory	AVI 1.0	CVI/AVI 2.0	AVI 2.1	AVI 2.1.1	AVI 2.1.5
Snags	Not captured	Snag density per 100 ha in 5 classes	No change from previous standard	No change from previous standard	Units for snag density changed to per ha; still 5 classes	No change from previous standard
Peatland	Not captured	No change	Captured as the modifier PT	Dropped from previous standard	No change from previous standard	No change from previous standard
Unproductive	Coded FL, OM, TM, CS, DS, SA, RB, BS, GR	Unproductive forest lands have same descriptors as productive forest land but site class is always U	No change from previous standard	No change from previous standard	No change from previous standard	No change from previous standard
Non-forested	Coded WA, CL, CU	SC, SO, HG, HF, BR, CA, CP, CPH, CPI, CPR, ASC, ASR, AIP, AIE, AIB, AIF, AIC, AIR, AIM, AIW, AIL, AII, NWI, NWL, NWR, NMB, NMC, NMR, NMS	No change from previous standard	Dropped CPH, CPI, AIP, AIB, AIC, AIR, AIW Added CIP, CIW	No change from previous standard	Added CIH
Minimum Polygon Size	Similar types: 20 ha minimum Dissimilar types: 10 ha minimum Conifers in other types: 2 ha minimum	No change from previous standard	No change from previous standard	More definitive criteria added for determining minimum polygon size	More definitive criteria added for determining minimum polygon size	No minimum polygon size
Linear Clearing	Width <30 m not delineated; ≥30 m delineated	No change from previous standard	No change from previous standard	No change from previous standard	Width <20 m not delineated; ≥20 m delineated	Width <15 m not delineated; ≥15 m delineated
Audit Standards	Conformity standards for photo-interpretation and transfer to ortho	No change from previous standard	Standards for photo-interpretation, transfer to orthos and data input	Audit standards not included in AVI version 2.1 Standards Manual	Appendix X - Quality Control Criteria for photo-interpretation audit, fieldwork audit, orthophoto base transfer audit, attribute coding audit and digital attribute database audit	Section 6 - AVI Audit Procedures Appendix IV - AVI Validation Rules Appendix V - AVI Audit Tools Appendix VII - Polygon Sampling and Auditor Assessment Appendix VIII - Sample AVI Audit Report

3 AVI Plans

3.1 Objectives

As a first step in AVI acquisition, the company is required to submit an AVI Plan, outlining the detailed intent for AVI acquisition, for review by the Department. This plan outlines the data sources, methodologies and timelines. This allows for upfront consideration to the efficacy of either typical or novel methodologies that are planned to meet the standard, as well as allowing the Department to manage audit workload with clearly defined timelines. Work should not commence until an approval-in-principle is granted on the plan by the Director, Reforestation, Inventory and Biometrics Section, Forest Stewardship and Trade Branch (FSTB).

An AVI plan is required as a first step in any forest inventory acquisition where the intent is to use the AVI to meet regulatory requirements or to seek Departmental approvals. Approval to use the AVI data is dependent upon having an approved AVI plan and successfully completing the AVI audit process.

In the AVI plan, companies need to identify one or more "pilot" areas for which they will submit AVI for an "informal" audit early in the AVI acquisition process. Generally, the submission should be preceded by a field visit with the company, inventory contractor and Department staff. This field visit and pilot submission provides an opportunity for those involved in the inventory, to review the methods planned to meet the AVI standard. Once there is agreement on any outstanding issues identified in the pilot submission the company can proceed with inventory acquisition.

The objectives of this section are to describe AVI plan content and provide an example outline for an AVI plan.

3.2 Plan Content

AVI plans should provide an overview of the project, the project objectives as well as identify the pilot area(s). Methodologies should describe aerial imagery to be used (e.g., leaf-off or leaf-on) and the interpretation approach. Any novel approaches to stand delineation and vegetation attributing must be detailed in the AVI Plan. Additional inventory attributes, over the AVI 2.1.5 standard are important features to note. If leaf-off aerial imagery is being used, descriptions of how species interpretation and crown closure are validated must be included. A description of the ancillary data (e.g., previous inventory, harvest areas, lidar, etc.) that will be used in the inventory project is important to include in the plan. Quality control processes must be described in the plan. The plan should highlight how harvest areas will be delineated as well as the ARIS reconciliation process.

Timelines must be included. The timeline should outline dates for photo acquisition, pilot area submission, compartment completion schedule, progress reports and submission timelines, and overall inventory completion. Appendices could include sections on past experience and performance, references, resumes outlining the training, experience and certification level of the individuals who will work on the project and any other information that may be useful for the plan reviewers.

3.3 Example Table of Contents for an AVI Plan

1. OVERVIEW
2. PROJECT OBJECTIVES
3. METHODOLOGY
- 3.1 Aerial Imagery Type/Camera
- 3.2 Softcopy Software/Interpretation Approach
- 3.3 Additional Inventory Attributes Captured (over AVI 2.1.5 standard)
  - 3.3.1 Density
  - 3.3.2 Crown Closure
  - 3.3.3 Mountain Pine Beetle Modifier (BK)
  - 3.3.4 Moisture Regime
  - 3.3.5 Nutrient Regime
  - 3.3.6 Wetlands Inventory
- 3.4 Overstorey/Understorey/Third Storey
- 3.5 Origins
- 3.6 Deciduous Leaf-off Species Interpretation
- 3.7 Crown Closure in Deciduous Leaf-off Interpretation
- 3.8 Historical Data
- 3.9 Minimum Mapping Units
- 3.10 Lidar
  - 3.10.1 Lidar Height Validation
- 3.11 Harvest Area Delineation
  - 3.11.1 ARIS Reconciliation
- 3.12 Field Calibration and Validation
- 3.13 Pilot Area
- 3.14 Quality Control and Audit Protocol
  - 3.14.1 Interpretation
  - 3.14.2 Polygon Verification
  - 3.14.3 Attribute Verification
  - 3.14.4 Metadata

4. PROJECT ADMINISTRATION
5. PROJECT SCHEDULE
- 5.1 Progress Reports
- 5.2 Deliverables

APPENDICES
- Past Experience
- References
- Project Personnel

4 Interpretation Standards

4.1 Objectives

The objective of this section is to describe the processes for capturing AVI polygons through interpretation.

The data models associated with the AVI 2.1.5 standard are described in Appendix III - AVI 2.1.5 Data Models.

4.2 Interpretation

The acquisition of vegetation inventories is based upon the interpretation of aerial imagery in a softcopy environment. The Departmental requirements for the acquisition of inventory data are mainly concerned with the compliance to standards.

4.2.1 Certification

In April 2017, the AVI 100 course was redeveloped to incorporate interpreting in a softcopy environment. The aim of the AVI 100 course is to provide background knowledge and practice that will allow learners to demonstrate that they can meet AVI photo-interpretation standards. At the end of the course, the learner should be able to delineate and interpret polygons according to the AVI system and to provide rationale for how to draw/describe polygons. The learner should be able to demonstrate how to incorporate ancillary data into decision-making processes. The course consists of three days of in-class learning, followed by a field day. The certification exam is on the last day of the five-day course. Successful completion of the exam results in a Level 1 certification. The AVI 200 course is currently under development.

The Department maintains a registry of interpreters who have successfully completed the AVI 100 and AVI 200 courses. The expectation is that all submissions have been “signed off” by a Level 2 certified interpreter.

4.2.2 Aerial Imagery

General aerial imagery specifications are defined by Alberta Environment and Parks in *General Specifications for Acquiring Aerial Photography (March 2014)*[5]. The following minimum specifications apply for aerial imagery used for inventory interpretation:

- Uncompressed, original bit-depth (minimum 8 bits per pixel/band) TIFF images;
- 4-band colour/IR (RGBI);
- Projection – NAD83 (CSRS) UTM Zone 11N, Zone 12N;
- Resolution - 0.3 m;
- Sun angle - >30 degrees;
- Aerial imagery must have 60% forward lap and 30% side lap, with minimal or zero cloud cover and no gaps.

Alternative imagery/remotely-sensed data must meet or exceed current standards.

4.2.3 Ancillary Data

Ancillary data is existing data used to assist interpretation. Using ancillary data improves interpretation and inventory accuracy. Potential sources of ancillary data include (but are not necessarily limited to):

- previous inventories - Phase 3 and/or AVI;
- harvesting data;
- silvicultural data;
- wetland inventories;
- plot data;
- field data;
- historical data (e.g., fire boundary data);
- lidar-derived data;
- ecological data (e.g., Derived Ecosite Phase[6]);
- Alberta Regeneration Information System (ARIS);
- Digital Integrated Dispositions (DIDS).

4.2.4 Vegetation Interpretation

Interpret the aerial imagery to AVI 2.1.5 specifications outlined in the rest of this section, with the help of all available ancillary data.

If new AVI replaces an existing softcopy-derived AVI dataset, the original polygon boundaries should be preserved if the delineation is still relevant. Only when errors are found or depletions have significantly altered the boundary (or some event or succession has changed the vegetation within a polygon to the point where modifying the boundary is necessary to meet AVI standards) may the original polygon boundary be modified.

---

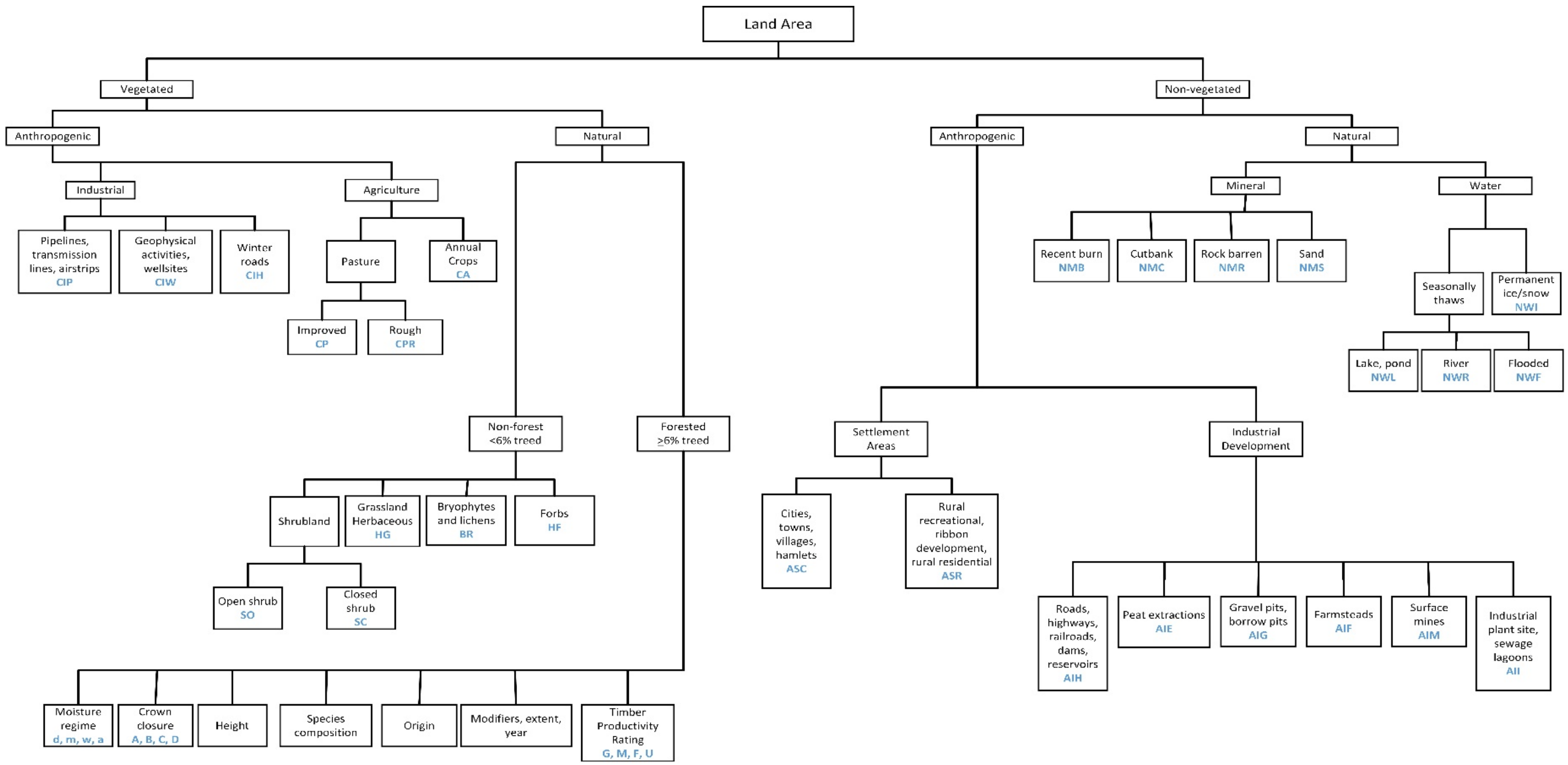
[5] Alberta Environment and Parks, 2014. General Specifications for Acquiring Aerial Photography (March 2014).
[6] Derived Ecosite Phase ver 2.0

4.3 Cover Type Specifications

The primary purpose of a vegetation inventory is to separate the land base into homogeneous polygons, the smallest unit recognized. Delineated polygons are then assigned a description (attributes) based on the cover type specifications. Other features such as hydrography, access, etc., are also delineated and attributed.

Figure 4-1 illustrates the hierarchical classification overview for the interpretation of AVI polygons.

Ancillary data (see Section 4.2.3) is critical for a robust AVI product.



Stand Condition Modifiers
CC Clearcut/Partial Cut
BU Burn/Partial Burn
WF Windfall
CL Clearing
DI Disease
IK Insect Kill
UK Unknown Kill
WE Weather
DT Discoloured/Dead Tops
BT Broken Tops
GR Grazing
BV Beaver Activity
SF Seasonal Flooding
SL Slump or Landslie
BK Mountain Pine Beetle Killed
FS FireSmart
UP Understorey Protection
MO MOF Block
SN Snags
ST Scattered Timber
RT Retention

Stand Treatment Modifiers
SI Site Improved
SC Seedbed Prepared
PL Planted and/or Seeded
TH Thinned

Extent
1 1% - 25%
2 26% - 50%
3 51% - 75%
4 76% - 94%
5 Entire

Figure 4-1: Alberta Vegetation Inventory primary classification

4.4 Polygon Delineation

Polygons are delineated based on significant and observable differences between polygons. At a minimum, polygon lines are drawn to separate the following features:

- uplands differentiated from wetlands;
- anthropogenic land occurs within vegetated land;
- non-forested land occurs within forested land;
- productive forest land occurs within unproductive forest land;
- coniferous or mixedwood type occurs within a deciduous type;
- deciduous or mixedwood type occurs within a coniferous type;
- crown closure differs by one class;
- tree species composition percentage of a single species within the cover type differs by >10%;
- origin differs by one class (>10 years);
- height differs by more than 3 metres.

4.5 Non-Vegetated Land

Those areas with less than 6% vegetation cover are considered non-vegetated. No moisture regime or TPR is required for non-vegetated lands.

4.5.1 Anthropogenic Non-Vegetated Land

Anthropogenic non-vegetated lands are the result of human activities and include settlements and areas of industrial development (see Table 4-1).

Table 4-1: Anthropogenic, non-vegetated land types and associated codes

Industrial Development	Code
Permanent rights of way; roads, highways, railroads, dam sites, reservoirs.	AIH
Peat extractions.	AIE
Gravel pits (including borrow pits).	AIG
Farmsteads (related to agriculture).	AIF
Surface mines.	AIM
Industrial (plant sites), sewage lagoons.	AII
Cities, towns, villages, hamlets.	ASC
Ribbon development, rural recreation e.g., rural stores and isolated housing sub-divisions, cottages, rural residential, acreage owners (agriculture is not the primary source of income).	ASR

4.5.2 Linear Clearings

Linear clearings for communication, transmission, and exploration routes that exceed a certain size are delineated during the interpretation process (see Table 4-2).

Table 4-2: Linear clearing interpretation specifications

Width	Example	Delineation	Classified
< 15 m	Seismic lines, roads, pipelines.	Not delineated.	No reduction of crown closure rating.
≥ 15 m	Roads, pipelines and major highways.	Delineated, edge of clearing forms boundary, splitting polygons in two.	Treated as independent “cleared land” units (e.g., AIH).

4.5.3 Naturally Non-Vegetated

Lands that naturally have less than 6% vegetation cover are classified in AVI as naturally non-vegetated. They are grouped into cover types that are primarily water and those that are primarily mineral (see Table 4-3). TPR and moisture regime are not required.

If non-vegetated lands become vegetated, these lands are no longer classified as non-vegetated even if the original dominant feature remains obvious (e.g., a well site or a gravel pit). None of the non-vegetated codes may be used since these lands are now vegetated.

Table 4-3: Naturally non-vegetated land types and associated codes

Water	Code
Permanent ice, snow.	NWI
Seasonally thaws, lakes, ponds.	NWL
Rivers.	NWR
Flooded (areas periodically inundated with water). Snag modifier (see Table 4-15: Description of modifier extents, snag density and associated codes) and snag extent are included if snags are present.	NWF
Mineral	
Recent burn with no recovery of vegetation to date. Include snag modifier and snag density if present. Moisture regime and TPR are required.	NMB
Cutbank.	NMC
Rock barren.	NMR
Sand.	NMS

Non-vegetated land attributes may be used in a horizontal structure with non-forest vegetated lands. The use of NMB (Recent Burn) is strongly discouraged (see Section 4.7.6.1).

4.6 Vegetated Land

Vegetated lands include all lands with ≥ 6% vegetation cover.

4.6.1 Moisture Regime

Moisture regime is assigned to all vegetated land cover types. Moisture regime signifies the available moisture supply for plant growth, using a descriptive code ranging from dry to aquatic (Table 4-4).

Table 4-4: Moisture regime definitions and codes

Moisture Regime	Definition	Code
Dry	Rapidly drained substratum.	d
Mesic	Moderately well drained substratum.	m
Wet	Poorly drained to flooded where the water table is usually at or near the surface, or the land is covered by shallow water (e.g., sedge fens).	w
Aquatic	Permanent deep-water areas where the predominant growth medium is water and the vegetation is characterized by hydrophytic vegetation (emergent) that grows in or at the surface of the water (e.g., pond weeds, water-lilies, etc.).	a

Moisture regime is based on plant indicators or environmental factors and soil properties. Moisture regime is correlated with the following factors: micro-variations in topoclimate, slope position (macro and meso relief), slope gradient, depth of surface humus layers, soil texture (including the content of coarse fragments), soil depth and the presence of an impermeable layer. In general, the factor that most influences moisture regime is the position of the vegetation on the slope. Refer to Appendix I for more detailed information on moisture regime.

4.6.2 Anthropogenic Vegetated Land

Anthropogenic vegetated lands are areas where humans have influenced the vegetation, usually by planting cultivated species (i.e., crops in fields). Areas cleared (e.g., for pasture) but not broken and seeded or planted to non-native (cultivated) plant species are included in the non-forest vegetated land category (see Section 4.6.3.1).

Anthropogenic vegetated land types are described in Table 4-5. No TPR (see Section 4.7.7) is required for any of these types, with the exception of CPR. Moisture regime must be described on all polygons. If the code "CPR" is used, the codes "SO" or "SC" (non-forested land) must also be populated.

Agriculture codes may also be used in horizontal structures in conjunction with other non-forest vegetated and non-vegetated lands.

Features under disposition should be classified to reflect the disposition type (e.g. PLA = CIP). When the feature is no longer under disposition it should be classified by its vegetation type but with a CL modifier, to indicate that there has been human-caused disturbance in the past.

Table 4-5: Anthropogenic vegetated land types and associated codes

Industrial	**Code**
Pipelines, transmission lines, airstrips, microwave tower sites that have been seeded to perennial grasses. Includes golf courses and cemeteries.	CIP
Geophysical activities including wellsites that have been seeded to perennial grasses.	CIW
Roads that are under disposition (LOC/DLO), are used under frozen ground conditions only and so remain vegetated.	CIH
Agriculture	
Cultivated farmland or farmland planted with annual crop species.	CA
Reclaimed lands, improved pastures or farmlands planted with cultivated grasses and/or legumes. These lands are used primarily for grazing livestock and/or may have cultivated species harvested at least once a year. These lands contain < 10% crown closure of woody cover (shrubs). These lands also include pastures that have been irrigated or otherwise treated to improve their productivity.	CP
Rough pastures are similar to improved pastures with > 10% woody cover. Normally, this pasture has not been irrigated, fertilized or cultivated to improve productivity. An open or closed shrub attribute must be added to indicate the height, extent and type of shrub cover in the non-forested vegetated field.	CPR

4.6.3 Naturally Vegetated Land

Cover types that have not been created by humans or which do not have any cultivated plant species are considered naturally vegetated. There are two main categories of naturally vegetated lands: non-forest (described below) and forested (see Section 4.7). A moisture regime and timber productivity rating class (G, M, F or U) is assigned to all naturally vegetated cover types (see section 4.7.7).

4.6.3.1 Non-Forest Vegetated Land

Non-forest, naturally vegetated lands includes vegetated areas with ≥ 6% vegetation cover but with less than 6% tree cover. These cover types can be used alone or in overstorey/understorey situations with or without any differences in height class between the two storeys. Table 4-6 summarizes the possible structures resulting from the natural non-vegetated understoreys that are assigned to non-forest vegetated overstoreys.

Table 4-6: Natural non-vegetated understoreys assigned to non-forest vegetated overstoreys

Non-Forest Vegetated Overstorey		
SO or SC	**HG or BR**	**HF**
Allowable Understories		
NMR	NMR +'F or A'	NMR +'F or A'
NMS + 'F or A'	NMS +'F or A'	NMS +'F or A'
NMC	NMC +'F or A'	NMC +'F or A'
Understories Not Allowed		
NWI	NWI	NWI
NWR	NWR	NWR
NWF	NWF	
NWL	NWL	

F = field checked; A = air call

Shrub Types

Shrub types are areas where multiple-stemmed woody plants (e.g., alder, willow, bog birch) cover a minimum of 10% of the polygon area and tree cover is less than 6%. Non-forest areas with shrub vegetation are described using codes for height and crown closure (Table 4-7).

Table 4-7: Shrub descriptors, modifiers and associated codes

Shrubs		Code
Height descriptors of 1 m to 10 m will only apply to shrub cover.		1 - 10
Crown descriptor	Closed shrub (crowns of most shrubs interlocking).	SC
	Open shrub (crowns of most shrubs not touching each other).	SO
Shrub cover percentage (to the nearest 10%) of polygon area occupied by the closed or open shrub.		1 - 10

Non-woody Types

Non-woody vegetation includes grasses, forbs and bryophytes (shrub cover must account for less than 10% of the polygon area). Non-forest areas with non-woody vegetation are identified using codes described in Table 4-8.

Table 4-8: Description of non-woody vegetation types and associated codes

Non-woody Vegetation	Code
Herbaceous Grassland - Natural meadow, grassland and/or sedge lands, graminoids dominant.	HG
Herbaceous Forbs - Natural herbaceous plant cover dominated by forbs (not graminoids). Forbs include aquatic plants. For example, HF can describe pond weeds, water-lilies, etc. living in shallow water (aquatic).	HF
Bryophyte - Bryophytes (mosses, liverworts) and/or lichen dominate.	BR

4.7 Forest Land

Land is considered forested if it supports tree growth (including seedlings and saplings) with a crown closure of $\geq$ 6%.

Every forested polygon, at a minimum, must have the following attributes captured:

Moisture Regime
Crown Closure
Height
Species 1
Species 1 Percentage
Origin
Timber Productivity Rating
Interpreter's Initials, and
Photo Year.

If other attributes such as understorey, disturbances, conditions, structure, etc., are observed, they are also captured.

4.7.1 Species Composition

The common, naturally occurring Alberta forest tree species, along with their AVI codes are listed in Table 4-9. Tree species present in a polygon are captured (to a maximum of 5) in decreasing order of occurrence based on percent crown closure for each layer. The percentages for each layer must add up to 10 (100%).

When more than five tree species occur in a polygon, the percentage of the canopy represented by each of the additional coniferous or deciduous species is added to one of the first five species as appropriate. Appropriate combinations include:

- Aw, Pb, Bw;
- Sw, Fb, Fa, Se, Fd;
- Sb, Lt, Lw;
- Pl, Pj, Pa, Pf.

The interpreter will decide the sequence in which the tree species are listed in polygons where two or more species have similar crown closures based on which species they estimate has the greater crown closure.

Table 4-9: Tree species and associated codes

Tree Species		Code
White spruce	*Picea glauca*	Sw
Engelmann spruce	*Picea engelmannii*	Se
Black spruce	*Picea mariana*	Sb
Lodgepole pine	*Pinus contorta*	Pl
Jack pine	*Pinus banksiana*	Pj
White-bark pine	*Pinus albicaulis*	Pa
Limber pine	*Pinus flexilis*	Pf
Undifferentiated pine	*Pinus*	P
Balsam fir	*Abies balsamea*	Fb
Alpine fir	*Abies lasiocarpa*	Fa
Douglas fir	*Pseudotsuga menziesii*	Fd
Alpine larch	*Larix lyallii*	La
Tamarack	*Larix laricina*	Lt
Western larch	*Larix occidentalis*	Lw
Trembling aspen	*Populus tremuloides*	Aw
Balsam poplar	*Populus balsamifera*	Pb
Undifferentiated *Populus*	*Populus*	A
Paper (white) birch	*Betula papyrifera*	Bw

4.7.2 Crown Closure

Crown closure refers to the ground area (expressed as a percentage of the total polygon area) covered by a vertical projection of tree crowns onto the ground for each identified storey. Table 4-10 lists the classes used to describe crown closure. If the overstorey crown closure is A or B, then there must be an understorey, that describes the vegetation in the remainder of the polygon, as either treed or non-forest vegetation (e.g., SO or SC).

Table 4-10: Crown closure classes

Crown Closure (%)	Code
6 – 30	A
31 – 50	B
51 – 70	C
71 – 100	D

4.7.3 Height

Polygon height is the average height of the dominant and codominant trees of the leading species. Polygon height can be interpreted, determined through field measurements, or with a Canopy Height Model (CHM). Height is recorded to the nearest metre. Adjacent polygons differentiated on the basis of height alone must have a difference of 3 metres or greater.

4.7.4 Origin

A forested polygon must have an origin associated with it. For a natural polygon, the origin is the average “year of origin” (see Table 4-11).

Table 4-11: Origin classes and codes

Year of Origin	Code
2000-09	2000
1990-99	1990
1980-89	1980
1970-79	1970
etc.	etc.

The origin of the polygon is validated against an upper and lower limit. The lower limit is currently 1600 and the upper limit is the current year. Understorey origin cannot not exceed the overstorey origin unless the polygon has been field checked. Polygons that have been modified by harvesting or wildfires must have the modifier year populated. The origin field must be populated with the modifier year when the modifier extent is 5. In all cases, the actual year of origin (when known) must be used (e.g., 1997, not 1990).

When a fire origin is greater than 30 years (calculated using PHOTO_YR), do not populate the modifiers with BU. The burn year is instead reflected in the origin.

Possible sources of polygon origins include:

- Phase 3 Inventory maps;
- Previous AVI;
- Field check/Plots;
- PSP information, and/or
- Tone and texture.

Because tree ages are generally taken at breast height in the field, an age adjustment factor to account for the growth of the tree to reach breast height must be added to breast height age, if the breast height age is going to be used to determine origin. The adjustment varies with species (Table 4-12).

Table 4-12: Age adjustment factors (bh_{age} to total age) by tree species

Species	Adjustment
Fir, Larch, White spruce.	15 years
Pine.	10 years
Black spruce.	20 years
Deciduous.	6 years

4.7.5 Structure

Single and two-storeyed polygons were recognized in previous Alberta timber inventories and are included in the AVI specifications. AVI also accommodates horizontal and complex polygon structures to better describe polygon conditions.

4.7.5.1 Single-storeyed Structure

Single-storey polygons are generally of even height (dominants and codominants crown classes, mostly within a 3 meter range) with only one canopy layer (see Figure 4-2). Single-storey structures are the default (no structure attribute).

Figure 4-2: Single Storey Structure

4.7.5.2 Two-storeyed Structure

Two-storeyed polygons have two distinct layers or canopies that are visible and fairly evenly distributed throughout the polygon area. In polygons where tree species are present in the overstorey and understorey, AVI requires the average height of the top layer to differ from the average height of the lower layer by at least 3 metres.

Understoreys are identified if they are clearly observable on aerial imagery or if they have been confirmed through ground observations.

Each storey of a two-storeyed polygon is given an independent description (see Figure 4-3).

Figure 4-3: Two-storeyed Structure with Treed Understorey

In the absence of one of the tree species (listed in Table 4-9) in the understorey, a non-forest understorey may be recognized that has a height difference from the overstorey of less than 3 metres. If a non-forest understorey is identified, the TPR of the understorey must be the same as the overstorey (see Figure 4-4).

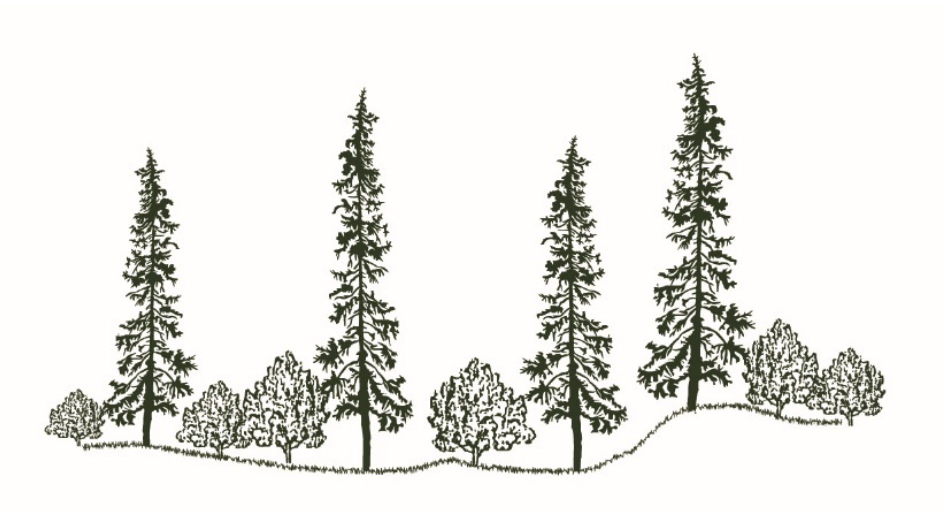


Figure 4-4: Two-storeyed Structure with Non-forested Understorey

Natural non-vegetated land codes can be used in two-storey polygon situations if none of the tree species listed in Table 4-9 are present (see Table 4-6). Anthropogenic features such as rough pasture, settlement areas, ribbon development and farmstead descriptions can be listed as understoreys of forested lands. The TPRs must be the same in both layers and be based on the overstorey trees. In two-storeyed polygons, the tallest vegetation layer is indicated as the upper layer. The same moisture regime is assigned to both layers of a two-storeyed polygon. If the leading species are the same for both layers of a multi-storey polygon, the same TPR is assigned to both layers; otherwise ratings may differ.

4.7.5.3 Horizontal Structures

Horizontal structures can be identified when polygons have two or more significant and observable strata or homogeneous units occurring within the same polygon, at least one of which is too small to delineate out individually (see Figure 4-5).

The use of horizontal structures in forested land should be strictly limited or altogether avoided by using smaller polygon sizes. Horizontal structures can describe vegetation accurately but they do not inform the AVI user of where the structures occur spatially within a polygon.

Each structure is assigned an independent description. The total of the structure value (10% increments) must combine to 10 (100%).

A height difference between each structure is not required. Moisture regimes may differ in each structure.

The tallest vegetation structure (when both layers are forested or non- forested) is captured in the overstorey. If only one component of the polygon is forested, the forested component of a horizontal structure is captured in the overstorey. Non-forest land and naturally non-vegetated anthropogenic lands are also captured if they occur as a component of a horizontal polygon.

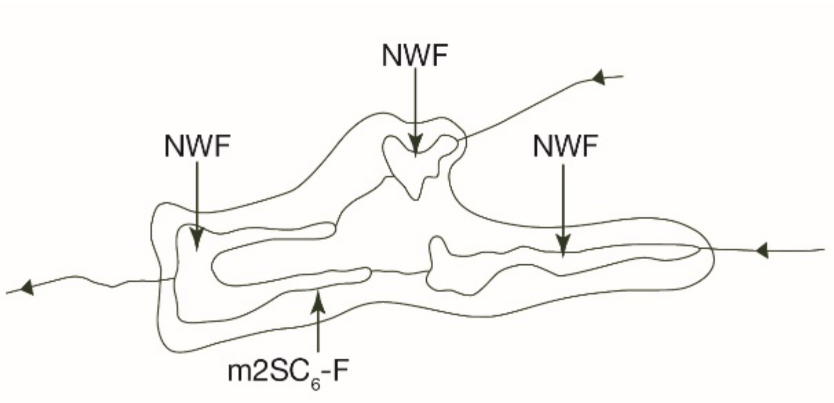


Figure 4-5: Horizontal Structure

4.7.5.4 Complex Structures

Complex-structured polygons are those where multiple layers form a pattern or mosaic that cannot be clearly described using the criteria for two-storeyed or horizontally structured polygons. These polygons are often a mixture of trees of different heights and sometimes species that are intermixed throughout the polygon (e.g., black spruce polygons growing on a muskeg site). Figure 4-6 provides an example of one of these polygons. The height assigned to such polygons is the median tree height of all the trees in the polygon. The median range of tree heights is captured in the Struc_val field (e.g., C4 indicates a complex structure with a 4 m height range). TPR is determined using the polygon origin and the upper median height (determined by adding half the height range to the median height).

Complex structures can only be used for treed polygons, with a crown closure > 50% (C or D) in which a minimum of 80% of the leading tree species (by crown closure) are Sb and/or Lt, Fb or Sw that show: a) a variation in height, and b) no evidence of recent fires nor anthropogenic disturbance.

Complex-structured polygons are coded as “C” plus a numeric code between 1 and 9 which indicates the range of median tree heights within the polygon (e.g., C6).

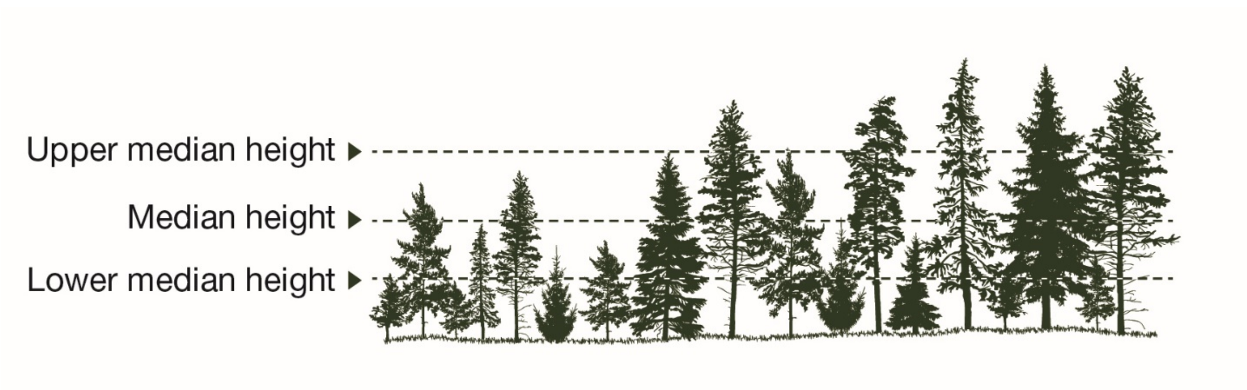


Figure 4-6: Complex structure, 10 m height with 4 m median height range

4.7.6 Modifiers to Land Classification

Modifiers are used to provide additional information about the condition of a polygon or treatments it has received. Two types of modifiers are used to provide additional information: polygon condition and polygon treatment. A maximum of two conditions and/or treatments may be used. In addition, a numeric extent code is used to describe the extent of the condition or treatment (the only exception is for clearings, where neither extent nor year is required). Year must be captured in the case of harvesting and fires; years should be captured for other modifiers when known. Modifiers may be used only for vegetated lands. The polygon condition or treatment applies to the whole polygon, not specific layers, so no modifiers are required to describe the understorey.

4.7.6.1 Condition

Polygon condition modifiers present additional information about the origin or condition of the vegetation. Polygon conditions and their associated codes are listed in Table 4-13. Two types of extent codes are used, based on one of the following:

- percent loss of crown closure;
- snag density (used only for snags or in conjunction with the BK modifier).

Harvest Areas

Vegetation developed following timber harvesting (either clear or partial cutting), is represented by a CC modifier and an extent code (see Section 4.7.6.3). The year of harvesting must be recorded in both the modifier year and origin fields, where the modifier extent is 5. The extent captured must reflect the area of the timber that was harvested.

Harvest area boundaries approved under Spatial Data Directive No. 3 – Final Harvest Area Digital Data Submissions must be incorporated into the AVI, during AVI acquisition. Post-1990 harvest area boundaries, reconciled to ARIS through the FMP ARIS Reconciliation process and approved, must be incorporated into the AVI delineation.

Generally, a single polygon is sufficient to characterize a harvest area. There are four cases which require further delineation within the outer polygon boundary of the harvest area:

- A forested leave patch or non-forested area occurs within a harvest area boundary;
- Post-harvest vegetation conditions vary significantly within the harvest area;
- Anthropogenic features were constructed after harvesting;
- Naturally non-vegetated features created post-harvesting (e.g., flooded areas or ponds created as a result of beaver activity).

It is important that both unharvested, naturally vegetated patches and naturally non-forested polygons, within the boundaries of a harvested area, are attributed with appropriate AVI attributes. Areas with residual trees (trees remaining after any type of harvest; see Figure 7-4) that meet the disposition holder definition of retention[7] should be identified with the modifier RT (extent and year are not required). If the RT modifier is used, the ARIS field must be populated with the appropriate opening number. Non-productive forested lands are generally not considered retention.

In some harvest areas, particularly older ones, the vegetation conditions may vary enough that, according to AVI specifications, separate polygons may have to be delineated within the original harvest area. Polygons both inside and outside the original harvest area boundary may be delineated, but the original outer boundary must remain intact. All polygons within the harvest area must maintain the CC modifier, extent and year as well as the ARIS opening number.

Anthropogenic features constructed within an opening *after* harvesting was completed must be delineated and the opening number field (ARIS) *must* be populated, so the net harvested area is preserved. Wellsites, dugouts, borrow pits, pipelines, roads and industrial clearings, including industrial camps, are the most common instance where this occurs (see Figure 7-6).

Burned Areas

The definition of NMB is “Recent burn with no recovery of vegetation to date. Include snag modifier and snag density if present. Moisture regime and TPR are required.” This situation occurs rarely as burned areas do not remain non-vegetated for very long. As such, the use of NMB is strongly discouraged.

For pre-2013 wildfires, use the existing historical boundary as a guideline for delineation. [8] If the fire is more than 30 years old, do not use the BU modifier and use the burn year for origin purposes. If the fire is less than or equal to 30 years, keep the BU modifier and use the burn year for both the modifier year and origin where the modifier extent is 5.

The polygons for the majority of post-2012 wildfires were digitized in a softcopy environment using digital aerial imagery (i.e., to AVI standards). These fire polygons must be incorporated into the AVI delineation. The BURN_CLASS field indicates the percentage of trees killed by the fire, following the same general

---

[7] Definitions for retention are set either in the disposition holder’s Forest Management Plan Structure Retention Strategy or through the Operating Ground Rules.

[8] Historical wildfire boundaries are available at https://wildfire.alberta.ca/resources/historical-data/spatial-wildfire-data.aspx

grouping as that for extent (see Table 4-15). The BURN_CLASS code becomes the modifier extent code. Interpreters may delineate within the existing fire polygons based on vegetation differences, but must maintain the original boundaries and extents.

How harvest areas that have subsequently burned over are classified depends on several factors:

- Pre-1991 harvest areas that have been burned over and the original boundary is indistinguishable from the surrounding polygons do not have to have the original harvest boundary preserved. The Origin is the year of the fire.
- Pre-1991 harvest areas that have been burned over and subsequently have their ARIS Reforestation Clock Start Date reset to the year of the fire must have their original boundaries maintained.
- Post-1991 harvest areas that have been burned over and subsequently have their ARIS Reforestation Clock Start Date reset to the year of the fire must have their original boundaries maintained.
- Disposition holders must make the effort to determine original boundaries, but in cases where this is not possible, new interpretation may be allowed.

Mountain Pine Beetle

The modifier BK (Beetle Kill) is used to describe the presence of Mountain Pine Beetle killed pine in a polygon. The BK extent relates to the percent of pine that has been affected by MPB. An SN modifier and extent must be present when BK is present. The BK and SN modifiers are used to describe conditions in the layer in which they are populated. A year is not required for these two modifiers.

The following business rules apply when the BK and SN modifiers codes are used:

- If BK MOD1_EXT = 5 then polygon cannot contain pine,
- If BK MOD1_EXT < 5 then polygon must contain pine (in SP1, SP2, SP3, SP4 or SP5),
- SN MOD2_EXT describes the number of dead pine trees per hectare (see Table 4-15).

Table 4-13: Polygon condition modifiers and associated codes

Condition	Description	Code
Clearcut/partial cut	An area of forest land from which all or some merchantable trees have been removed.	CC
Burn/partial burn	Land which has been previously burned, less than 30 years previously.	BU
Windfall	A tree uprooted or broken off by wind and areas containing such trees.	WF
Clearing (no extent)	Land cleared of trees, usually as a result of human activities.	CL
Disease	Trees within polygon have been affected by disease or pathogens (e.g. witches broom, dwarf mistletoe, etc.).	DI
Insect kill	Trees within polygon have been killed by insects (with the exception of Mountain Pine Beetle).	IK
Unknown kill	Trees within polygon have been killed by an unknown agent.	UK
Weather	Trees within polygon have been damaged by a weather event e.g., red belt, hail, snow/ice/frost, etc.	WE
Discoloured/dead tops	Trees within the polygon have discoloured or dead tops.	DT
Broken tops	Trees within the polygon have broken tops.	BT
Grazing	Area has been developed for grazing commercial livestock.	GR
Beaver Activity	Indicates polygons that have experienced tree removal and falling by beavers. Do not use BV for trees killed by beaver flooding (see SF code below).	BV
Mountain Pine Beetle	Identifies polygons that have dead or dying trees resulting from Mountain Pine Beetle attack. The intent is to identify the percentage of dead trees with a snag code and snag extent. If modifier 1 = BK then modifier 2 must = SN.	BK
FireSmart Treatment	Indicates that the polygon has been modified through FireSmart treatments (thinning, understorey removal, etc.).	FS
Seasonal Flooding	Used when a polygon has experienced flooding that is seasonal in nature that was in place long enough to kill the trees but has since returned to a non-flood condition. The flooding has since gone away (or is still in progress depending on the timing of photos and the flood event). Do not confuse this code with NWF, which is used to indicate a permanent flood condition such as flooding from beaver dams. Fringe areas with dead trees adjacent to NWF polygons can be coded with an SF code if the water that killed trees has receded to a different level.	SF
MOF block	Identifies polygons that were harvested/treated under the “Maintaining Our Forests” program that ran from 1979 to 1986.	MO
Understorey Protection	Identifies polygons where understorey protection measures have been applied.	UP

Condition	Description	Code
Slump or Landslide	Indicates a polygon that has been modified by moving earth, either as a sudden onetime event (landslide) or an area that has been slowly moving downhill. Some indicators include tension cracks in the earth, moving earth, leaning or fallen trees, ponding, open areas or new regeneration of vegetation. These areas typically occur where there are slopes and gullies that are unstable due to seepage water, landform materials (silts and clays) or erosion from a river system in combination. Do not confuse these areas with NMC (cutbank). Cutbanks will always be next to a river with active erosion or from human activity.	SL
Snags	Snags are standing dead trees. Snag modifiers and snag density are used only when snags are clearly observable on aerial imagery or were identified on the ground. Snags are most often associated with burned areas.	SN
Scattered timber	Scattered timber is used for anthropogenic vegetated land and non-forest land only.	ST
Retention	Residual patches (trees remaining after any type of harvest) that remain unharvested within the extent of the harvest area.	RT
Permafrost Melt	An area where the permafrost has melted, leading to subsidence and possibly dead trees.	PM

4.7.6.2 Treatment

Treatment modifiers indicate that silvicultural treatments have been applied to a polygon.

Table 4-14 lists treatments and their associated codes. Treatment codes are also used with an extent modifier (see Section 4.7.6.3).

Table 4-14: Treatment modifiers and associated codes

Treatment	Code
Site improved (e.g., fertilization, drainage, weed control.)	SI
Seedbed prepared (e.g., scarification).	SC
Planted and/or seeded (regardless of success).	PL
Thinned.	TH
Irrigated.	IR

4.7.6.3 Condition and/or Treatment Extent and Year

Condition and treatment modifiers are used in combination with a severity (i.e., extent) code and year of disturbance. Table 4-15 defines the extent classes and provides their associated codes. Extent codes for the snag modifier are based on density (i.e., snags per hectare).

If two conditions and/or treatments occur in a polygon, they are listed in order of occurrence with the most recent appearing last, unless a polygon has been harvested. If a polygon has been harvested (MOD1 = CC) and new activities occur after harvest, the CC modifier must still be coded in the MOD1 field, regardless of the other activities (e.g., polygon harvested in 1987, then scarified in 1988 then planted in 1989, will have the following modifiers: CC5 1987 and PL4 1989).

For harvested areas, the year of harvest is based on the timber year (May 1 to April 30), as determined by the skid clearance date. For example, a polygon with a skid clearance date of March 3, 2016 would have MOD1_YR = 2015.

All modifiers except CL, FS and RT must have an extent. The modifiers CC, BU and MO must have a modifier year. The modifiers CL, RT and FS must not have a year. All other modifiers may have a modifier year if known. The modifiers CC, MO, RT, FS and BK may only occur in the modifier 1 field.

Table 4-15: Description of modifier extents, snag density and associated codes

Extent	Snag Density (Per ha)	Code
Nil	<5	
Light – 1% - 25% loss of crown closure or land area affected.	5 – 99	1
Moderate – 26% - 50 % loss of crown closure or land area affected.	100 – 299	2
Heavy – 51% - 75% loss of crown closure or land area affected.	300 – 499	3
Severe – 76% - 94% loss of crown closure or land area affected.	500 – 700	4
Entire – entire crown or land area is affected.	>700	5

4.7.7 Timber Productivity Rating (TPR)

Timber productivity rating (TPR) is an estimate of the potential productivity of forest land and non-forest vegetated land to grow trees based on the height and age of the leading species in the polygon. TPR reflects tree growth response to environmental factors including soil, topography, climate, elevation and moisture. The TPR calculations are based on a set of equations (see Appendix II). Four TPR classes are recognized (see Table 4-16).

For polygons with trees less than 6 m in height and for polygons where trees are not currently present, the TPR is interpreted. The data source code “I” is used to signify an interpreted TPR.

TPR is calculated for all polygons greater than 5 m in height.

TPR is not assigned to anthropogenic vegetated polygons within the industrial or agricultural categories except for rough pasture (CPR).

When a polygon is multi-layered and the overstorey species 1 is the same as the understorey species 1 then the understorey TPR must match the overstorey TPR.

If a polygon is multi-layered and one of those layers is forested and the other is non-forest vegetated, anthropogenic vegetated CPR, or naturally non-vegetated NMB then the TPR of this non-forest layer must match that of the forested layer.

In polygons with a complex structure, TPR is determined using the polygon Origin and the upper median height (determined by adding half the height range to the median height).

FSTB has developed an Esri® ArcGIS tool, TPR Calculator, which must be used to calculate TPR in all AVI databases. The tool is available to the forest industry and forest industry consultants. All AVI submitted for audit will have TPR evaluated against the value generated by the TPR Calculator as part of the attribute audit.

The TPR Calculator uses the mid-point of a decadal origin (e.g., if ORIGIN = 1930, then 1935 is used in the calculation of TPR). The actual year of origin must be used when known.

Table 4-16. Timber productivity classes and codes

Timber Productivity	Code
Good	G
Medium	M
Fair	F
Unproductive	U

4.8 Existing Polygon Data and Confirmation of Attributes

When AVI attributes have been confirmed from other information sources or existing polygon data are available to confirm attributes, codes are used to describe the data source. The reference year for the data sources is also coded if known (e.g., F 1991 interpreter plot measured in 1991). When more than one data source attribute exists, the hierarchy indicated by order of listing in Table 4-17 applies.

Table 4-17: Codes for data sources

Data Source	Code
Interpreter plot	F
Air call	A
Interpreted TPR	I
Supplementary Imagery	S
PSP	P
Cruise Plot	C
Volume plot	V

The following describes the values for the data source codes:

- Data year: 1940 – present year;
- Data Source I (interpreted TPR). Only field that cannot have a data year attached;
- I cannot be used with Anthropogenic Vegetated;
- I cannot be used with Anthropogenic Non-Vegetated;
- I cannot be used with Natural Non-Vegetated.

4.9 Year of Aerial Imagery

The year that the aerial imagery used in AVI interpretation becomes the effective date of the inventory. The year of the aerial imagery is captured in the PHOTO_YR field.

4.10 ARIS

A unique identifier is assigned to a harvest area to enable tracking within the Alberta Regeneration Information System (ARIS).

All harvest areas harvested after 1990 should have a valid ARIS opening number assigned to them that is registered in the ARIS database.

5 Specifications

5.1 Objectives

The objective of this section is to describe the standardized file format for the data is stored in an Esri® polygon feature class(es) contained in a file geodatabase (FGDB), as well as describing standardized feature class names and file naming conventions.

5.2 AVI File Format

Feature Class Name: AVI (for standard AVI 2.1.5 attributes)
EXTRA (for additional attributes)
TERTIARY (for third-storey attributes)

Geometry: Polygon

File Naming Convention: SSSS_AVI_yyyymmdd.gdb where SSSS is the ARIS Stakeholder Code.

Table 5-1: AVI File Format

Field Name	Data Type	Description	
OBJECTID	OID	Esri Object ID.	
SHAPE	Geometry	Esri polygon geometry.	
Poly_num	Integer	Unique number assigned to polygon.	
Moist_reg	Text (1)	Moisture regime.	
		d	dry
		m	mesic
		w	wet
		a	aquatic
Density	Text (1)	A	6 to 30 %
		B	31 to 50 %
		C	51 to 70 %
		D	70 % +

Field Name	Data Type	Description	
Height	Integer (2)	Average height of the dominant and codominant trees of the leading species in metres.	
Sp1, Sp2, Sp3, Sp4, Sp5	Text (2)	Declining order of species based on crown closure: Sw, Se, Sb, P, Pl, Pj, Pa, Pf, Fb, Fa, Fd, Lt, La, Lw, A, Aw, Pb, Bw.	
Sp1_per to Sp5_per	Integer (2)	Actual % (to nearest 10 percent class) of species listed above.	
Struc	Text (1)	Structure.	
		Blank M C H	Inferred single storey. Multi-layer canopy (2 storey). Complex (multiple or uneven stories). Horizontal (homogeneous stand with scattered pockets).
Struc_val	Integer (2)	Structure percentage for Struc = 'H'.	
Origin	Integer (4)	Year of polygon origin (actual year if known).	
Tpr	Text (1)	Timber Productivity Rating.	
		U F M G	Unproductive. Fair. Medium. Good.
Initials	Text (2)	AVI interpreters' initials.	
Nfl	Text (2)	Non-forest vegetated land (>6% vegetation cover and <6% tree cover).	
		SC SO HG HF BR	Closed shrub. Open shrub. Herbaceous grassland. Herbaceous forbs. Bryophyte (moss).
Nfl_per	Integer (1)	Percentage of polygon area (to nearest 10% class) occupied by SC or SO.	
Nat_non	Text (3)	Naturally non-vegetated (<6% vegetation cover).	
		NWI NWL NWR NWF NMB NMC NMR NMS	Permanent ice/snow. Seasonal thaws, lakes, ponds. Rivers. Flooded. Recent burn. Cutbank. Rock/barren. Sand.
Anth_veg	Text (3)	Human-induced vegetation.	
		CA CP CPR CIH CIP CIW	Annual crops (farmland). Perennial forage crops. Rough pasture (>10% woody cover). Roads used under frozen ground conditions only and so remain vegetated. Pipelines, powerlines etc. seeded to grass. Geophysical and wellsites seeded to grass.

Field Name	Data Type	Description	
Anth_non	Text (3)	Anthropogenic non-vegetated land.	
		ASC	Cities, towns, villages, hamlets.
		ASR	Ribbon development, subdivisions, and acreages.
		AIH	Permanent right-of-way.
		AIE	Peat extractions.
		AIG	Gravel/borrow pits.
		AIF	Farmyards.
		AIM	Surface mines.
		AII	Industrial sites, sewage lagoons.
Mod1, Mod2	Text (2)	Modifier 1 (or 2) condition/treatment.	
		CC	Clearcut, partial cut.
		BU	Burn.
		WF	Windfall.
		CL	Clearing.
		DI	Disease.
		IK	Insect kill.
		UK	Unknown kill.
		WE	Weather (e.g., redbelt).
		DT	Discolored/dead tops.
		BT	Broken tops.
		SN	Snags.
		ST	Scattered timber.
		SI	Site improvement (fertilization, draining).
		SC	Seedbed prepared.
		PL	Planted/seeded.
		TH	Thinned.
		GR	Grazing development (domestic).
		IR	Irrigated.
		BV	Beaver activity.
		SF	Seasonal flooding.
		SL	Slumping.
		BK	MPB-killed.
		FS	FireSmart.
		UP	Understorey protection.
		MO	Maintaining Our Forests program.
		RT	Retention.
Mod1_ext, Mod2_ext	Integer (2)	Modifier extent (loss of crown closure or area affected).	
		Blank	Nil.
		1	1 to 25%.
		2	26 to 50%.
		3	51 to 75%.
		4	76 to 94%.
		5	>94%.
Mod1_yr, Mod2_yr	Integer (4)	Year of the modifying occurrence.	

Field Name	Data Type	Description	
Data	Text (1)	Data Source	
		F	Interpreter plot.
		P	PSP.
		V	Volume plot.
		C	Cruise data.
		S	Supplementary imagery.
		A	Air call.
		L	Large-scale photography.
		I	Interpreted TPR.
Data_yr	Integer (4)	Year of the data source.	
Umoist_reg	Text (1)	Understorey moisture regime.	
Udensity	Text (1)	Understorey density.	
Uheight	Integer (2)	Understorey height.	
Usp1, Usp2, Usp3, Usp4, Usp5	Text (2)	Understorey species composition.	
Usp1_per to Usp5_per	Integer (2)	Understorey species percent.	
Ustruc	Text (1)	Understorey structure.	
Ustruc_val	Integer (2)	Understorey structure value.	
Uorigin	Integer (4)	Understorey origin.	
Utpr	Text (1)	Understorey TPR.	
Uinitial	Text (2)	Understorey interpreter's initials.	
Unfl	Text (2)	Understorey non-forest vegetated land.	
Unfl_per	Integer (2)	Understorey non-forest vegetated land percent.	
Unat_non	Text (3)	Understorey naturally non-vegetated land.	
Uanth_veg	Text (3)	Understorey human induced vegetation.	
Utpr	Text (1)	Understorey TPR.	
Uinitial	Text (2)	Understorey interpreter's initials.	
Unfl	Text (2)	Understorey non-forest vegetated land.	
Unfl_per	Integer (2)	Understorey non-forest vegetated land percent.	
Unat_non	Text (3)	Understorey naturally non-vegetated land.	
Uanth_veg	Text (3)	Understorey human induced vegetation.	
Uanth_non	Text (3)	Understorey anthropogenic non-vegetated.	
Umod1, Umod2	Text (2)	Understorey modifier.	
Umod1_ext, Umod2_ext	Integer (2)	Understorey modifier extent.	
Umod1_yr, Umod2_yr	Integer (4)	Understorey modification year.	
Udata	Text (1)	Understorey data source.	
Udata_yr	Integer (4)	Understorey data source year of collection.	
Photo_yr	Integer (4)	Year of .imagery	
ARIS	Text (11)	Opening Number registered in ARIS database.	
SHAPE_LENGTH	Double	Polygon perimeter in metres.	
SHAPE_AREA	Double	Polygon area in square metres.	

*NOTE: All leading "U" refers to understorey, the same codes apply as were used for the overstorey

6 AVI Audit Procedures

In 2014, the Department began exploring alternative procedures for assessing the accuracy of the AVI submitted for audit. There was a desire for a more objective audit procedure, so after piloting new procedures with an FMA holder, the Department circulated *Audit Procedures for Alberta Vegetation Inventory version 1.0 (Draft)* to FMA holders and forest inventory service providers in October 2016. The audit procedures consist of a digital data integrity audit and an interpretation audit. The AVI attribute validation criteria (business rules) are documented in Appendix IV, while Appendix V and Appendix VII contain additional information related to audits.

As noted in Section 3, there are several steps and approvals required before AVI is submitted for audit. AVI audit submissions should be staged throughout the inventory process (30,000 to 40,000 polygons per submission), so that issues can be worked through prior to the final audit submission. Following this process results in fewer resubmissions and a higher quality final AVI product.

6.1 Objectives

The objectives of this section is to describe the procedures for auditing AVI data to ensure conformance to AVI 2.1.5 standards and to provide an indication of the accuracy of the inventory information by reviewing the interpretation and the integrity of the digital data.

A process defines “what” needs to be done. A procedure defines “how” to do the task. The AVI audit process includes two procedures: the Digital Data Integrity Audit and the Interpretation Audit.

6.2 Digital Data Integrity Audit

The Digital Data Integrity Audit checks both the spatial data and the attribute data. It is a complete (as opposed to a sample) evaluation of the inventory data, using the AVI Audit Tools developed by FSTB (see Appendix V).

6.2.1 Spatial Procedures

The spatial audit performs a number of quality control checks of the AVI feature class. While the majority of checks are spatial checks, some attribute structure checks are also performed. The results of the audit process are written to a log file indicating any errors detected.

Table 6-1 indicates the types of audit checks that are performed on the selected AVI feature class.

Table 6-1: Types of Audit Checks

Check	Description
Missing Fields	Checks the AVI feature class to ensure that all the required AVI fields are present.
Extra Fields	Checks to ensure that only valid AVI feature class fields are present.
Overlap	Checks for polygon overlap. Any overlaps that are detected are written as polygons to the Overlap feature class in the audit FGDB.
Gaps	Checks for potential gaps in the AVI feature class. Note that in some cases gaps are legitimate if they represent excluded regions within the project area. These gaps must be manually reviewed to determine if they are in fact errors. Any potential gaps are written to the Gaps feature class in the audit FGDB.
Neighbour Attributes	Checks the attributes of neighbouring polygons to ensure they are not the same. If any errors are detected the offending polygons are written to the att_neighbor feature class in the audit FGDB. The log file will list the OBJECTID values for the offending polygons.
Multi-parts	Makes sure there are no multi-part polygons. Will list the OBJECTID of features that are multi-part.
Duplicate POLY_NUM	Makes sure that each POLY_NUM is unique. Note that if there are multi-part polygons converted into single part polygons there will probably be duplicate POLY_NUM values. Calculate these to the OBJECTID field to make them unique.
Attribute Structure	Checks to make sure that the AVI fields match the proper structure for name, type and length.

In addition, a number of feature classes may be created containing elements indicating spatial errors detected. Table 6-2: Spatial Error Checking outlines these feature classes. These feature classes can be reviewed in ArcMap so that the errors can be corrected.

Table 6-2: Spatial Error Checking

Feature Class	Description
Overlap	Polygon feature class containing features indicating where overlapping polygons were detected.
Gaps	Polygon feature class containing features indicating where potential gaps between polygons were detected.
Att_neighbor	Polygon feature class that contains the polygons where the attributes are the same across their shared border.

6.2.2 Attribute Procedures

Contractors must use the FSTB AVI Audit Tools prior to submitting the data for audit (tools supplied upon request).

The warnings should be reviewed prior to submission as they can often identify trends. The error log file must be empty unless some prior agreement has been made between the disposition holder and FSTB for allowable errors.

The AVI attribute validation criteria are detailed in Appendix IV.

6.3 Interpretation Audit

It is well understood that the drivers in the use of AVI in forest management, wildfire management, wildlife habitat, etc. are species composition, height, crown closure and age. Heights can now be evaluated using lidar-generated Canopy Height Models (CHM). Historical fire data can inform the polygon origin, leaving species composition as the most important variable audited through the interpretation audit.

Polygons selected for the interpretation audit need to be representative of the area of interest as well as representing the attributes that are most important.

POLygon **S**ampling tool (POLS) [9] is a versatile GIS tool for extracting a random subset of polygons from a vector layer. POLS enables users to optionally (i) set the sampling intensity in terms of percent area of the layer, number of polygons, or both; (ii) specify different strata to be sampled with equal or different intensity; (iii) preclude the occurrence of adjacent polygons in the sample; (iv) ensure that the output sample is spatially balanced; (v) estimate empirically (through simulation) the inclusion probability of each individual polygon; and (vi) compute the Horvitz–Thompson Estimator (HTE)[10] and its confidence interval for target variables measured in the sample polygons. POLS is especially suited for accuracy assessments of thematic maps that use polygons as sampling units, but it can also be applied to any probability-based survey that relies on GIS polygons.

6.3.1 Polygon Sampling

The Base 10 Strata is a derived variable, calculated using leading species and species composition (percent). Each audit submission is assessed using the Base 10 Strata. There are, of course, other types that need to be sampled as well, such as non-forested areas and harvest areas.

In the Boreal Natural Region, testing has resulted in classification of AVI into fifteen strata, described in Table 6-3 below.

Table 6-3: Sampling Strata for Boreal Natural Region

Code	Strata	Description
1	D w U/S	Deciduous with understorey.
2	D w/o U/S	Deciduous without understorey.
3	DC w U/S	Deciduous-leading mixedwood with understorey.
4	DC w/o U/S	Deciduous-leading mixedwood without understorey.
5	CD w U/S	Coniferous-leading mixedwood with understorey.
6	CD w/o U/S	Coniferous-leading mixedwood without understorey.
7	C-Sw w U/S	Spruce-leading coniferous with understorey.
8	C-Sw w/o U/S	Spruce-leading coniferous without understorey.
9	C-P w U/S	Pine-leading coniferous with understorey.
10	C-P w/o U/S	Pine-leading coniferous without understorey.
11	C-Sb w U/S	Black spruce-leading coniferous with understorey.
12	C-Sb w/o U/S	Black spruce-leading coniferous without understorey.
13	NON_FOR	Naturally non-vegetated/non-forested and anthropogenic features.
14	CC	Harvested Areas.
15	BK	Mountain Pine Beetle-killed.

[9] Castilla, G., Hernando, A., Zhang, C., Mauro, F., McDermid, G., 2014. POLS: A versatile tool for sampling polygon GIS layers. Computers & Geosciences 67, 139–149. https://doi.org/10.1016/j.cageo.2013.10.003

[10] Horvitz, D.G., Thompson, D.J., 1952. A Generalization of Sampling Without Replacement from a Finite Universe. Journal of the American Statistical Association 47, 663–685. https://doi.org/10.1080/01621459.1952.10483446

In the Foothills Natural Region, testing has resulted in classification of AVI into ten strata, as described below in Table 6-4:

Table 6-4: Sampling Strata for the Foothills Natural Region

Code	Strata	Description
1	D	Deciduous.
2	DC	Deciduous-leading mixedwood.
3	CD	Coniferous-leading mixedwood.
4	C-Sw	Spruce-leading coniferous.
5	C-P w U/S	Pine-leading coniferous with understorey.
6	C-P w/o U/S	Pine-leading coniferous without understorey.
7	C-Sb	Black spruce-leading coniferous.
8	NON_FOR	Naturally non-vegetated/non-forested and anthropogenic features.
9	CC	Harvested areas.
10	BK	Mountain Pine Beetle-killed.

The POLS tool creates a sample dataset using the strata outlined above, with a minimum of 30 polygons/strata.

6.3.2 Auditor Assessment

Once a representative sample of polygons have been chosen, the auditor independently assesses the attribution of those polygons, using all the information available to the original interpreters, including ancillary data (see Section 4.2.3).

The auditors have four options when assessing a polygon:
1. the auditor agrees with interpreted attribution;
2. the auditor mostly agrees with interpretation attribution but needs to revise one component;
3. the auditor agrees with much of the interpretation attribution but needs to revise more than one component; or
4. the auditor completely disagrees with the AVI attribution.

At the end of the procedure, the source dataset and audited dataset are exported to formatted database tables.

6.3.3 Statistical Analysis

After the auditor completes the assessment, a statistical test is used to determine whether or not the differences in interpretation are statistically significant.

The following analysis is conducted on the data sets, which contain paired AVI interpretations for the same polygons: an industry/consultant interpretation and an audit interpretation. For each polygon in each data set, the following fourteen attributes are compared for yes and no agreements:

- Moisture regime;
- Crown closure (A/B/C/D);
- Crown closure (AB/CD);
- Height;
- Non-forested;

- Seral Stage;
- Species 1;
- Modifier 1;
- Base 10 Strata;
- Cover Group;
- Understorey Height;
- Understorey Species 1;
- Understorey Base 10 Strata;
- Understorey Cover Group.

The percentage of polygons with matching attributes are subsequently calculated for each of the 14 attributes. For each polygon, the number of matching attributes are tallied across all 14 attributes, and the total numbers and percentages of polygons with different numbers of matching calls are calculated. Similarly, the number of matching attributes are tallied for each polygon across 13 attributes (without HEIGHT and UHEIGHT), and the total numbers and percentages of polygons with different numbers of matching calls are calculated. In addition, the percentages of polygons with absolute height differences of 1, 2, 3, 4, 5, 6, 7 and ≥ 8 m were calculated for HEIGHT and UHEIGHT.

The target is to have at least 90% agreement for each specified parameter (see Appendix VII for a sample AVI Audit Report). Submissions that fail to meet the target will be reviewed with the disposition holder and the forest inventory service provider. Resubmissions may be required.

Once all interim submissions and/or resubmissions have been approved, a final submission for the entire project area is required. A letter of approval is then issued by the Director of the Reforestation, Inventory and Biometrics Section.

6.4 Spatial Digital Data Submissions for AVI Audit

6.4.1 Spatial Data Format

Spatial data must be submitted as an Esri® polygon feature class contained in a file geodatabase (FGDB). Data is stored as independent feature classes. A zip file that can be unzipped into FGDB format is also acceptable (see Section 5.2 for AVI file format and file naming conventions).

The FGDB must also contain the outputs of the AVI Audit Tools, including the following tables:

- [FGDB_FileName]_att_log,
- [FGDB_FileName]_info,
- warning_summary, and
- error_summary.

6.4.2 Projection and Datum

NAD83 (CSRS) is the only acceptable datum. Acceptable projections include:

- UTM Zone 11N (WKID 2955) and
- UTM Zone 12N (WKID 2956).

6.4.3 General Documentation Requirements

Every submission needs to include appropriate metadata that defines:

- Dates;
- Operational area;
- Source organization;
- Contact for data issues;
- Aerial Imagery specifications including:
    - Camera;
    - Spatial resolution (pixel size);
    - Bands;
    - Leaf-on/leaf-off; and
    - Date(s).

7 Standards and Specifications for Capturing Timber Harvesting Activities

Well defined standards and specifications are an important component of the Department's effort to expedite forest update data exchange between the government and the forest industry. This section describes the Department's standards and specifications related to capturing timber harvesting activities, which are defined as the cutting and removal of trees from a forested area.

The purpose of these standards and specifications is to outline the process that will assure that timber harvesting activities are captured in a consistent and an accurate manner.

There are a variety of disturbances that can affect the vegetation on forested lands. These include wildfires, timber harvesting, clearings for various land use activities (particularly related to the petroleum industry), certain insect and disease damage (chiefly tree defoliation), and weather effects (e.g., windthrow).

This section deals solely with standards and specifications for capturing harvesting activities.

7.1 Objectives

The objective of this section is to describe the process for gathering data on recently harvested areas to maintain the integrity of the associated vegetation inventory. In particular, to:

- Identify, define and accurately capture the external boundaries of harvest areas (treed areas harvested, usually in one season, for the purpose of obtaining fibre for the production of various wood products such as lumber and pulp);
- Identify, accurately capture and exclude the areas of unharvested residual vegetation, naturally non-forested areas and anthropogenic areas within harvest areas;
- Establish, for tree harvesting events, a link to the Alberta Regeneration Information System (ARIS);

- Maintain the harvest area boundaries as a permanent record by timber year (May 1 to April 30) of harvesting for each activity.

It is important to note that the objectives for the capturing harvesting activities differ slightly from the standards of the associated inventory information. Primarily, AVI involves identifying the boundaries and labelling the contents of different homogeneous vegetation types. The objective of this data capture is to precisely identify the boundaries of any areas affected by *timber harvesting activities*.

7.2 Standards

A clear understanding of the purpose of the harvest area capture process is required to understand the specifications. **The current process identifies the location and the area (maximum extent) where harvesting activities have taken place.** The process also ensures that a current and accurate portrayal of the extent and condition of the forest resource is made available to forest managers and others seeking information on forest land conditions.

The Department standard for capturing final harvest area boundaries is with stereo digital aerial imagery in a softcopy environment. This methodology aligns with AVI standards. In addition, the aerial imagery provides an ongoing, permanent record of the original harvest event. Aerial imagery used in determining the harvest area boundary must be made available to the Department upon request.

Historically, harvest area boundaries have been captured multiple times for various purposes. The intent of these standards and specifications is to capture the final boundary once. The final boundary will serve multiple purposes, including incorporation into the next inventory, forest management plan and for meeting Reforestation Standards of Alberta (RSA) requirements.

7.2.1 Feature Representation

The level of precision used for mapping harvest areas is within 5 m of the boundary as identified on the ground.

7.2.2 Aerial Imagery

General aerial imagery specifications are defined by Alberta Environment and Parks in *General Specifications for Acquiring Aerial Photography (March 2014)*[11]. The following best practices apply for aerial imagery used for harvest area interpretation:

- Uncompressed, original bit-depth (minimum 8 bits per pixel/band) TIFF images;
- 4-Band colour/IR (RGBI);
- Projection – NAD83 (CSRS) UTM Zone 11N, Zone 12N;
- Resolution - 0.3 m;
- Sun angle - >30 degrees;
- Imagery must have 60% forward lap and 30% side lap, with minimal or zero cloud cover and no gaps.

The aerial imagery used for harvest area mapping must be acquired within two years of the ARIS Reforestation Clock Start Date.[12]

Alternative imagery/remotely-sensed data must meet or exceed current standards.

[11] Alberta Environment and Parks, 2014. General Specifications for Acquiring Aerial Photography. Informatics Branch.
[12] See AF, Forestry Policy, 2015, No. 3: Final Harvest Area Digital Data Submissions

7.2.3 Interpretation of Aerial Imagery

The detection and capture of recently harvested harvest areas is based upon the interpretation of aerial imagery in a softcopy environment. The Departmental requirements for the acquisition of harvest area data are mainly concerned with the compliance to standards. The following describes the current aerial image-interpretation specifications required by the Department.

7.2.4 Extent of Feature to Capture

The potential use of the harvest area boundaries for determining areas of reforestation responsibility influences the capture process, making the process somewhat different than that used for other types of disturbances such as agricultural areas or land use disturbances such as road or powerline rights-of-way. The extent captured must reflect the area of the timber that was harvested.

Each harvest area will create one or more harvest area polygons. Final harvest area boundaries should be based on appropriate source aerial imagery using planned harvest area boundaries as a reference.

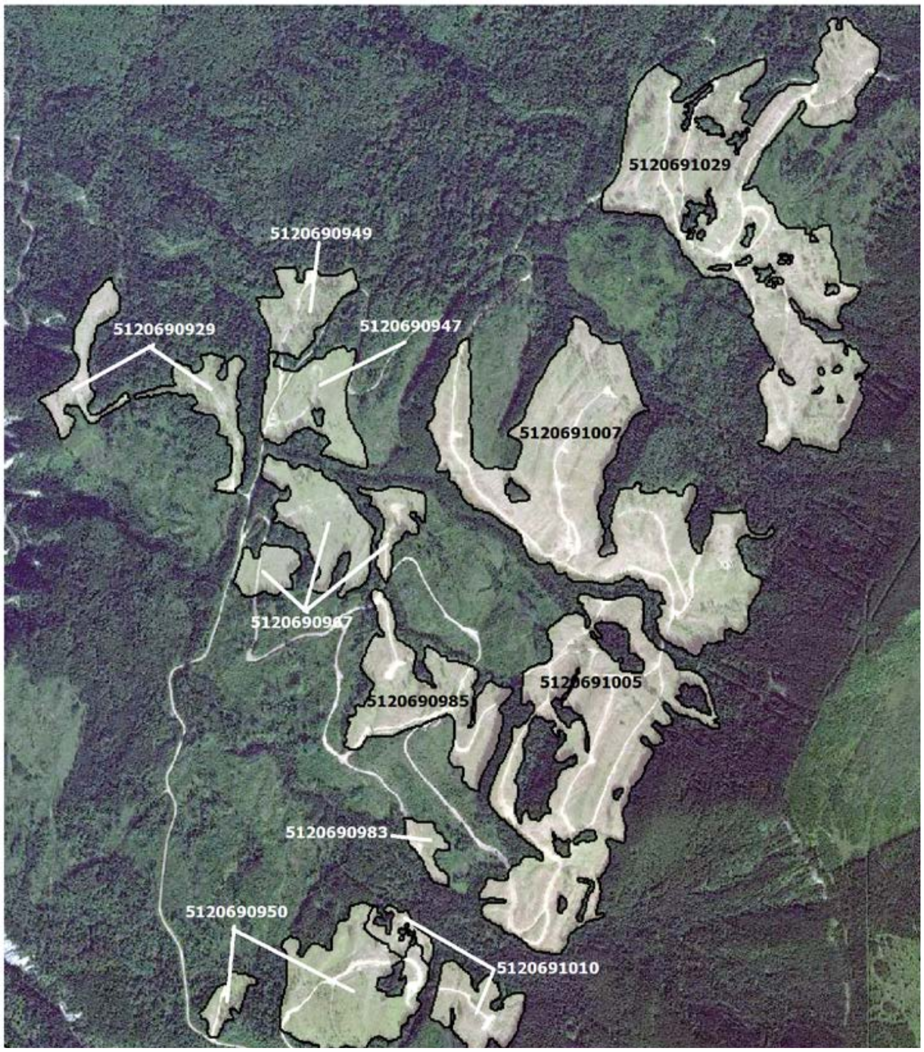
Interpreters should ensure coincidence with existing AVI polygon boundaries where appropriate. Harvest area features should be split where they straddle administrative boundaries (such as FMUs, etc.). Harvest areas split along administrative boundaries must be node-matched.

Where a harvest area spans a UTM zone boundary the data should be referenced to the zone in which the majority of the feature occurs unless the feature extends more than 0.5 km into the other zone. When that occurs the data should be divided into distinct datasets each within its own projection zone (either Zone 11 or Zone 12).

The current requirement (recognizing that it may not be possible to obtain aerial imagery every year) is that the net harvested hectares, the final harvest area boundary and area, must be submitted within two years of the ARIS Reforestation Clock Start Date. Harvest areas generally range from 2 - 200 ha; therefore, most harvest area boundaries will be readily visible on 30 cm digital aerial imagery in a softcopy process. Figure 7-1 illustrates a range of harvest area sizes.

If a harvest area is represented as multiple disjointed polygons, then the harvest area should be captured as a multipart polygon resulting in a single harvest area feature.

Figure 7-1: Range of harvest area sizes



7.2.4.1 External Boundaries - Clearly Visible

In some cases, harvest area boundaries are quite distinct and easy to identify. For example, first-pass harvest areas in single-species cover types without understoreys are easily identified and are usually associated with very distinct boundaries. The harvest area polygon is simply delineated so that the entire harvested area is included. Any non-forested areas or portions of a treed polygon that were not harvested that occur adjacent to or extend into the harvested area are excluded from the harvest area polygon.

7.2.4.2 External Boundaries - Unclear

In some cases, harvest areas and their associated boundaries may be difficult to identify. Primarily, these situations are associated with partial harvests (e.g. selective or shelterwood tree harvest) or where harvest activities occur adjacent to a low-density polygon, a natural opening (e.g. meadow, muskeg or wet area) or to recently cleared or partially cleared areas that have not been captured as a disturbance prior to harvesting the new harvest area being interpreted.

Any non-forested, non-harvested areas or areas previously harvested that are located adjacent to the harvest area (i.e. they were not harvested or they were harvested at a different time) must be excluded from the harvest area polygon (see Figure 7-2: Harvest areas with unclear external boundaries).

Transition areas

To meet certain forest management objectives (e.g. minimize windthrow or visual impact) or in an attempt to harvest all of the trees of merchantable size, the boundary between harvested areas and adjacent unharvested areas may not be obvious because the percentage of trees harvested along the boundary reduces gradually. This technique is often called 'feathering' and results in a progression from a harvest area in the central area of the harvest area polygon to a selectively cut area to the unharvested adjacent polygons. The feathering seldom extends more than the distance a feller buncher can reach (10 - 12 m) beyond the boundary of the clearly visible harvest area.

In these cases, the harvest area boundary must extend to the outermost limit of the harvested area (i.e. follow the stump line rather than stopping at some transitional boundary where, for example, more stems were left standing than were harvested).

Partial Harvests

Partial or selective harvesting or thinning is done to meet a wide variety of forest management objectives and can, therefore, vary in terms of harvest intensity, pattern, etc. The intensity and pattern of harvest, the availability of ancillary data and the characteristics of the timber being cut all influence an interpreter's ability to accurately identify and define the extent of harvesting using aerial imagery. Partial harvesting in mixedwood forest cover types (e.g. removal of the conifer component) can be very difficult to identify. Mixedwood cover types can vary significantly in density and species composition and an interpreter will experience difficulty properly identifying and describing harvesting-caused changes in species composition, density, etc.

Ancillary information should be used to help identify the extent and the type of harvesting activity that has occurred. These include:

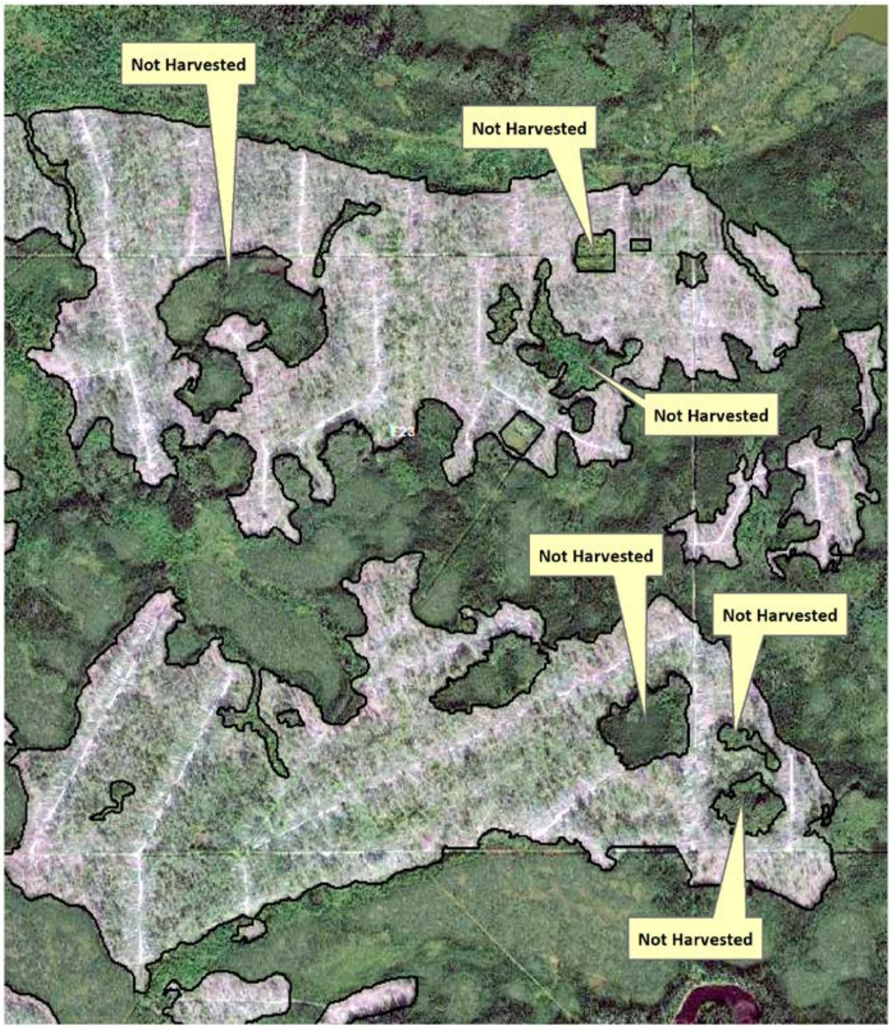
- Forest harvest plans or other detailed harvest area maps available from the Department field staff or companies, or global navigation satellite system (GNSS) tracks from harvesting equipment that show the extent of actual or planned harvest activities[13].

- Any aerial imagery, if available, taken prior to the initiation of harvest activities (e.g. the aerial imagery used for the original AVI interpretation or previous update aerial imagery) which can help identify changes in vegetation that are associated with harvesting.

As in the case of feathered harvest area boundaries, the harvest area boundary identified on the digital aerial imagery must extend to include the outermost trees harvested, rather than to some transitional boundary where, for example, more stems were left standing than were harvested.

[13] Final harvest boundary must be based on an appropriate source image. Planned harvest area boundaries should be used as a reference to ensure mapping consistency.

Figure 7-2: Harvest areas with unclear external boundaries



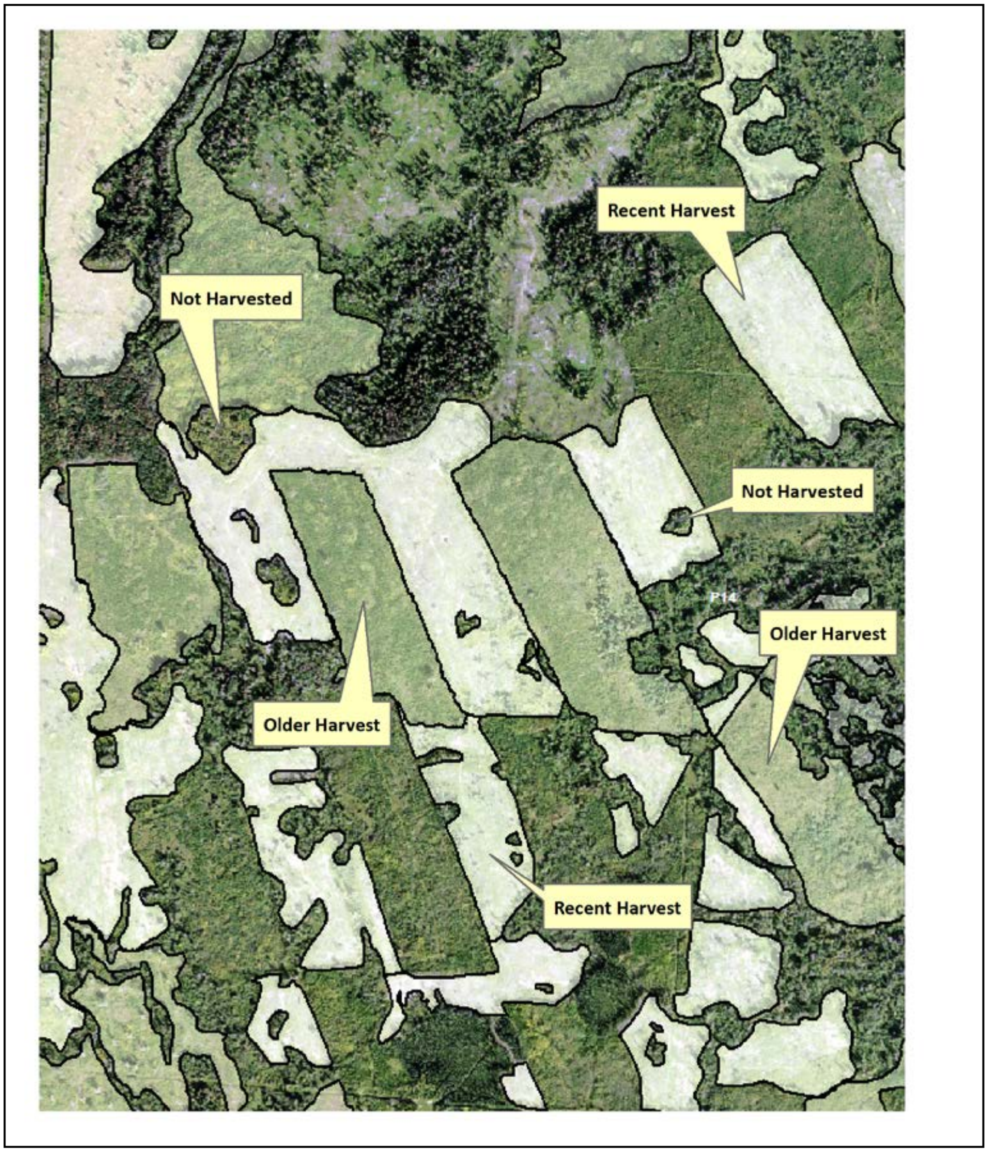
Progressive Harvesting

In some cases, harvesting may proceed in a progressive manner with the original harvest area being enlarged over a period of two or more years of harvesting. The final harvest area boundary must be submitted within two years of the ARIS Reforestation Clock Start Date.

Adjacency to Other Disturbances

Occasionally, a harvested area may lie adjacent to an area which has been disturbed or otherwise cleared (e.g. previously harvested area, wellsite, pipeline or other industrial activity), making the task of establishing the boundary between the harvest area and the adjacent disturbance difficult (see Figure 7-3). In all cases, the intent is to differentiate disturbed areas by the cause and date of disturbance. Older aerial images or other ancillary sources of information must be consulted to achieve this objective. If at all possible, boundaries between old and new disturbances should be coincident.

Figure 7-3: Timber harvesting adjacent to other disturbances



7.2.4.3 Internal Boundaries

Generally, a single polygon is sufficient to characterize a harvest area. If any of the following conditions are met, however, the area must be excluded from the harvested area:

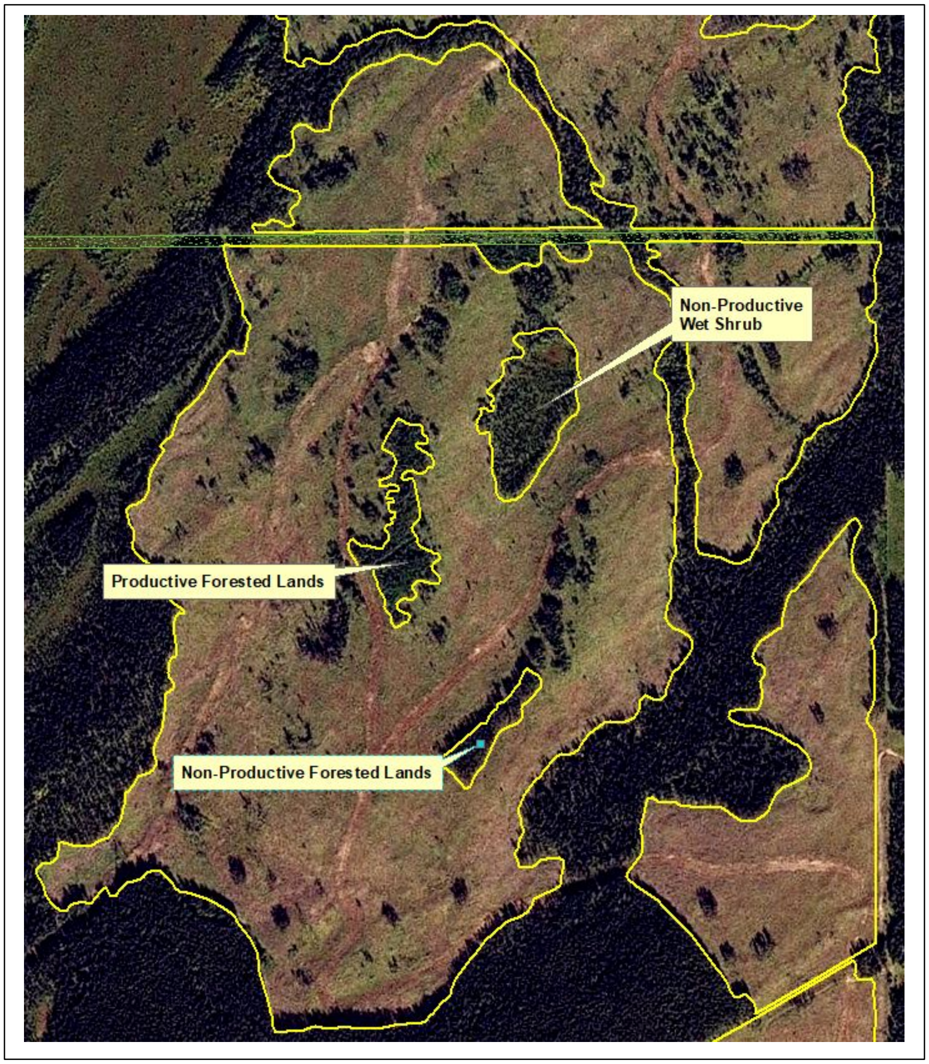
- A forested leave patch or non-forested area occurs within a harvest area boundary (see explanations below);
- Post-harvest vegetation conditions vary significantly within the area (e.g. due to understorey protection, partial harvest intensity, etc.).

Disposition holders are free to determine the minimum polygon size for exclusions.

Leave Patches (Residuals or Retention)

It is important that unharvested naturally vegetated patches within harvested areas are captured and excluded from the net harvest area (see Figure 7-4: Harvest area with residual timber).

Figure 7-4: Harvest area with residual timber



Naturally Non-forested Areas

Any naturally non-forested polygons within the boundaries of the harvest area polygon must be excluded from the harvest area polygon (see Figure 7-5).

Figure 7-5: Harvest area differentiated from naturally non-forested areas

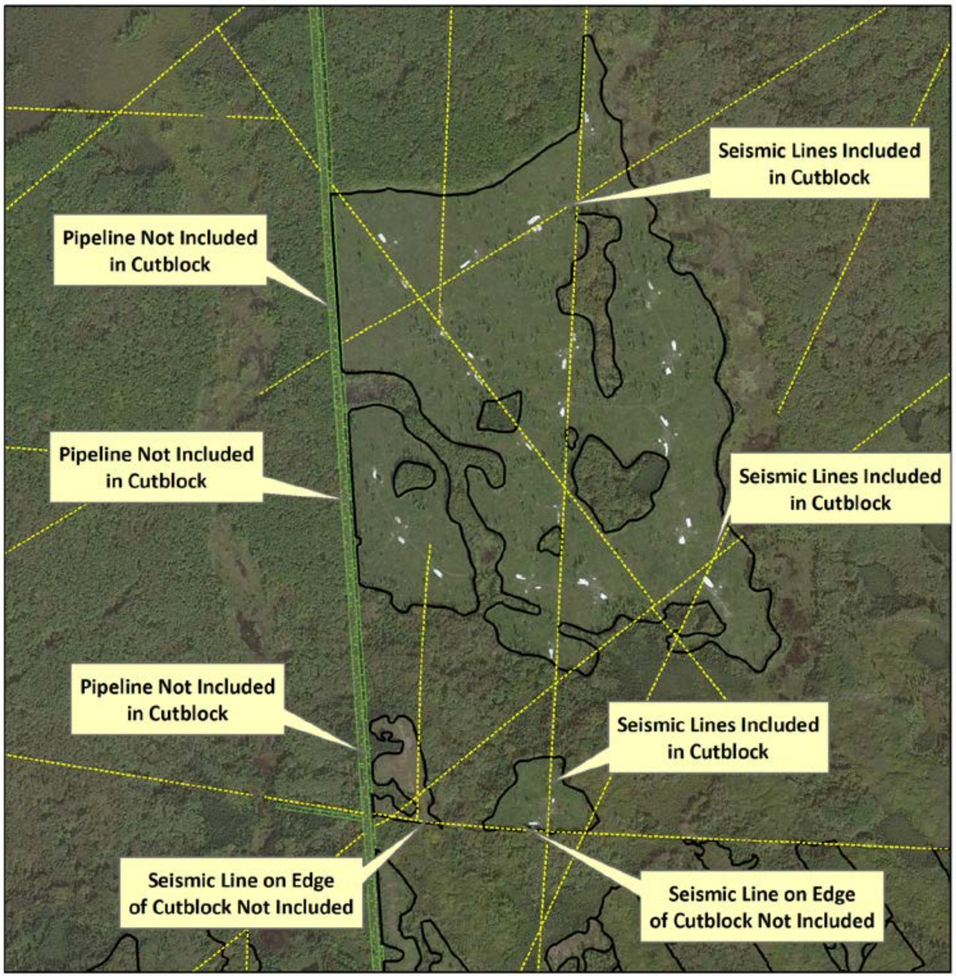
Anthropogenic Areas

The year of construction of an anthropogenic feature that falls within a harvested area must be determined. If the anthropogenic feature was constructed prior to harvesting the attribution will not require an ARIS number and the feature is excluded from the net harvested area. If it is determined that the anthropogenic feature was constructed within an opening *after* harvesting was completed the opening number field (OPEN_NUM) *must* be populated, so the net harvested area is preserved. Wellsites, dugouts, borrow pits, pipelines, roads and industrial clearings, including industrial camps, are the most common instance where this occurs (see Figure 7-6).

Figure 7-6: Harvest area with pre-harvest dispositions excluded and post-harvest dispositions delineated and attributed with opening number

In the case of permanent anthropogenic features like pipelines, transmission lines and major roads, all features greater than 15 m in width must be excluded from the harvest area polygon. Seismic lines that form a boundary for a harvest area may or may not be excluded from the harvest area polygon (consistent with the company Forest Management Plan); however, existing seismic lines within the outer boundary must be included in the harvested area. Provincial regulations require these areas to be reforested (see Figure 7-7).

Figure 7-7: Harvest areas and seismic lines



There may also be cases where a disposition has been issued but not yet constructed. Forestry companies may enter into agreements with the disposition holder to harvest trees from the disposition but the area under disposition should not be included in the net harvested hectares nor should it be assigned to the opening number (see Figure 7-8 and Figure 7-9).

Figure 7-8: Existing disposition not constructed

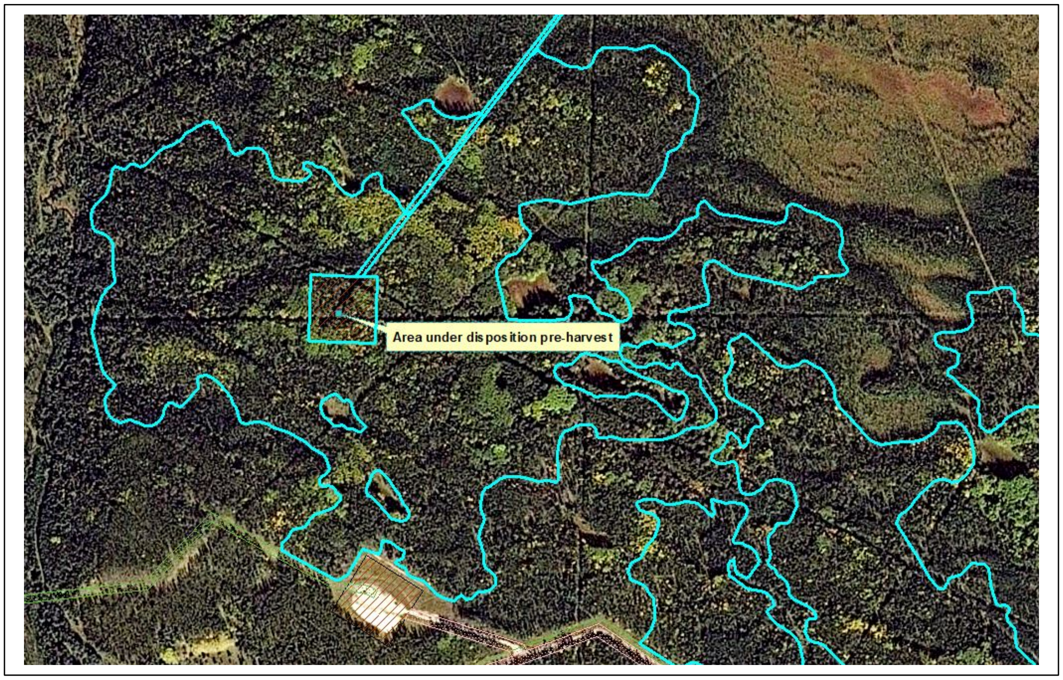
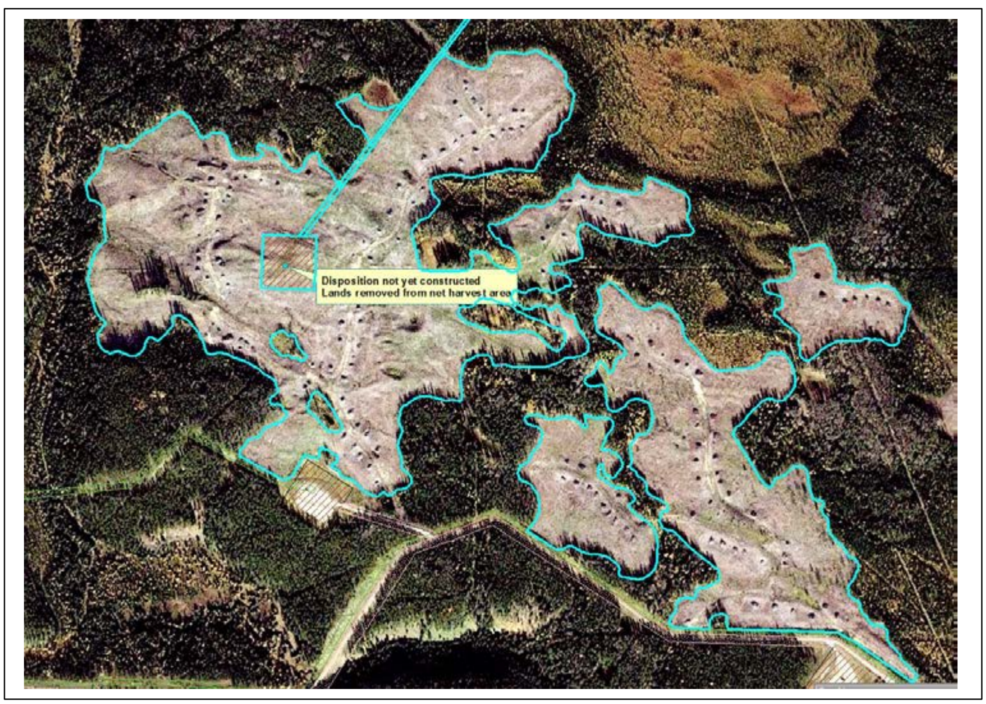


Figure 7-9: Existing disposition harvested but excluded from net harvested area



7.2.5 Field Verification

The harvest area capture process does not require field verification, but, in instances where the interpreter cannot differentiate between the disturbed and undisturbed boundaries, field confirmation may be required.

7.3 Specifications

Specifications define the process, methods or rules for achieving the standards.

7.3.1 Feature Attributes[14]

If a polygon is classified as harvested, all attributes must be populated.

Feature attributes identify the company/agency to which reforestation responsibility is attached, as well as providing a link to the Alberta Reforestation Information System (ARIS).

In all cases, the following attributes must be included with the data:

- Object-id;
- Geometry;
- Disposition holder;
- Disposition number (authority to harvest);
- ARIS opening number;
- Harvest code;
- Skid clearance date;
- Length; and
- Area.

[14] These are Forestry Division standards. Disposition holders should refer to at AF, Forestry Policy, 2015, No. 3: Final Harvest Area Digital Data Submissions for direction on digital data submission standards.

7.3.2 Final Harvest Area File Format

Feature Class Name: FINAL_HARV_AREA

Geometry: Polygon

File Naming Convention: SSSS_CCP_yyyymmdd.gdb

Table 7-1: Final Harvest Area File Format

Field Name	Data Type	Description	
OBJECTID	OID	Esri Object ID.	
SHAPE	Geometry	Esri polygon geometry.	
DISP_HOLDR	Text (4)	ARIS stakeholder code that uniquely identifies the company or organization with the authority to harvest.	
DISP_NUM	Text (10)	Identifies the primary Disposition Number to which the authority to harvest is attached.	
OPEN_NUM	Text (11)	ARIS Opening Number.	
HARV_CODE	Text (1)	Code to identify harvested areas.	
		H	Harvested.
		A	Anthropogenic.
SKID_CLEARANCE_DATE	Date	The date when all merchantable timber contained with an opening has been skidded to the landing areas as recorded in ARIS.	
Shape_Length	Double	Feature perimeter length.	
Shape_Area	Double	Feature area.	

7.3.3 Linkage to ARIS

The Alberta Regeneration Information System (ARIS) contains data and information on harvest areas. The ARIS opening number is used to provide a link between ARIS and the update polygon.

Approval of, amendment, and changes to the Net Harvested Hectares recorded in ARIS must involve a designated forest industry representative and Forestry Division staff (a forest officer and/or ARIS staff). ARIS has a mandatory, Timber Year after the Timber Year of Harvest requirement for reporting of Net Harvested Hectares. The Net Harvested Hectares declared in ARIS should be the same as the area in the spatial record.

7.3.4 Spatial Digital Data Submissions

7.3.4.1 Spatial Data Formats

Spatial data must be submitted in the provided Esri® polygon feature class template contained in a zipped file geodatabase (FGDB).

7.3.4.2 File Geodatabase

Data is stored as an independent feature class.

7.3.4.3 Projection and Datum

NAD83 (CSRS) is the only acceptable datum. Acceptable projections include:

- UTM Zone 11N (WKID 2955); and
- UTM Zone 12N (WKID 2956).

consistent with the geographic location of the features captured.

7.3.4.4 General Submission Requirements

Data must be submitted through the Spatial Data Directives Submission Portal.

Metadata is collected as part of the submission process.

Detailed information on data format, business and topology rules are documented in Spatial Data Directives – Data Formats and Business and Topology Rules for CCP/SAP Submissions.

7.4 Quality Control

The quality control process will involve the following aspects of the update data:

- Validation of the digital data; and
- Positioning and completeness of the data.

7.4.1 Digital Verification

Verification/validation procedures will be applied to the attributes and the spatial data. Business rules applied to the data are outlined in Appendix IX.

7.4.2 Positioning and Completeness

The most recent satellite imagery available to the Department will be used to verify the 'completeness' of the update information. The satellite imagery will also be used to verify the relative positioning of the harvest area boundaries.

In cases where the Department does not agree with the boundaries, the aerial imagery used to create the boundaries must be submitted upon request.

Appendices

Appendix I Ecological moisture regime

Ecological Moisture Regime (Adapted from Klinka et al., 1979[15] and Utzig 1978[16])

Ecological moisture regime (hygrotype), relative to the specific macroclimatic conditions representing a biogeoclimatic subzone or any other biogeoclimatic unit, signifies the available moisture supply for plant growth. At present, there has been little quantitative investigation of the classes described here. Assuming that, within a given subzone, climatic variables such as temperature and precipitation are essentially constant (or vary within narrow ranges), the subzone variation of available moisture results from the redistribution of precipitation by edaphic factors. Sites that have a specific amount of available moisture that reflects the given climate, and have average conditions of slope, moisture translocation and texture, have a mesic moisture regime; those with less than normal available moisture grade to xeric (i.e., dry) and those with more than normal available moisture grade to hydric (wet) (see Table AI-1).

The ecological moisture regime is a relative ranking of sites based on their available moisture supply (available moisture is that held between 1/3 bar and 15 bars matrix potential). The moisture regime is assessed regardless of osmotic potential (i.e., salt content is not considered). Because available moisture is a dynamic property that varies throughout the year, the intent of the assessment is to evaluate available moisture on the basis of the growing season as a whole, not at any particular time.

The ecological moisture regime integrates many interrelated environmental and biotic parameters that, when combined, determine the actual amount of available moisture. The field assessment is ideally completed by evaluating a combination of environmental factors, soil properties and indicator plants. However, the assessment can be made on the basis of plant indicators or environmental factors and soil properties alone. A schematic illustration of the influence of these factors is given in Figure AI-1Figure AI-1.

Ecological moisture regime is correlated with the following factors: micro-variations in topoclimate, slope positions (macro- and meso-relief), slope gradient, soil drainage, depth of surface humus layers, soil texture (including the content of coarse fragments), soil depth and the presence of an impermeable layer. Factors related to internal soil properties can be evaluated in a soil pit, on road cuts or in disturbed spots. In general, the most influential factor is the position on the slope. On ridges and upper slopes, precipitation is the main source of water since moisture passes quickly downslope and little, if any, moisture is retained. Middle slopes receive, in addition to precipitation, some seepage from up-slope which is usually discontinued during the summer. The lower slopes, flats and depressions are usually enriched by a temporary or permanent seepage waterflow. The other factors can be considered as compensating this general pattern, i.e., affecting to a varying degree the ultimate ecological moisture regime.

The amount of available moisture often increases with decreasing slope gradient, decreasing soil particle size (i.e., from coarse to fine-textured soils), decreasing content of coarse fragments, increasing soil depth, and increasing thickness of humus layers (in particular with the thickness of colloidal and humified H-layer.

[15] Klinka, K., F.C. Nuszdorfer, and L. Skoda. 1979. Biogeoclimatic units of central and southern Vancouver Island. B.C. Min. For. Victoria, B.C. Retrieved from https://www.for.gov.bc.ca/hfd/pubs/docs/srs/srs06.pdf.

[16] Utzig, G. (1978). *Classification and detailed mapping of soil and terrain features in two mountainous watersheds of southeastern British Columbia* (T). University of British Columbia. Retrieved from https://open.library.ubc.ca/collections/ubctheses/831/items/1.0094506.

Table AI- 1: Ecological Moisture Regime Defining Characteristics and Soil Properties

		Defining Characteristics			Soil Properties					
AVI Code	**Moisture Regime**	**Description**	**Primary Water Source**	**Slope Position**	**Texture**	**Drainage**	**Depth to Permeable Layer**	**Surface Humus Depth**	**Available Water Storage Capacity**	**Slope Gradient**
d	Xeric	Water removed very rapidly in relation to supply; soil is moist for brief periods following precipitation	Precipitation	Ridge crest, shedding	Very coarse (gravelly-sand), coarse fragments	Rapid	Very Shallow (<0.5m)	Very Shallow	Extremely low	Very steep
d	Subxeric	Water removed rapidly in relation to supply; water is available for moderately short periods following precipitation	Precipitation	Upper crests, shedding	Coarse to moderately coarse (LS-SL), moderately coarse fragments	Rapid to well	Shallow (<1m)	Shallow	Very low	Steep
m	Submesic	Water removed rapidly in relation to supply; water is available for moderately short periods following precipitation	Precipitation	Upper crests, shedding	Coarse to moderately coarse (LS-SL), moderately coarse fragments	Rapid to well	Shallow (<1m)	Shallow	Low	Moderate
m	Mesic	Water removed somewhat slowly in relation to supply; soil may remain moist for a significant, but sometimes short periods of the year; available soil water reflects climatic input.	Precipitation in moderately to fine-textured soils and limited seepage in coarse-textured soils	Mid-slope, normal, rolling to level	Moderate to fine (L-SiL); few coarse fragments	Well to moderately well	Moderately deep (1-2m)	Moderately deep	Moderate	Moderate
m	Subhygric	Water removed slowly enough to keep the soil wet for a significant part of the growing season; some temporary seepage and possible mottling below 20 cm.	Precipitation	Lower slopes, receiving	Variable, depending on seepage	Moderately well to imperfect	Deep (>2m)	Deep	High	Slight
w	Hygric	Water removed slowly enough to keep the soil wet for most of the growing season; permanent seepage and mottling present; possibly weak gleying.	Seepage	Lower slopes, receiving	Variable, depending on seepage	Imperfect to poor	Variable, depending on seepage	Deep	Variable, depending on seepage	Slight
w	Subhydric	Water removed slowly enough to keep the water table at or near the surface for most of the year; organic and gleyed mineral soils; permanent seepage less than 30 cm below the surface.	Seepage or permanent water table	Lower slopes, receiving	Variable, depending on seepage	Poor to very poor	Variable, depending on seepage	Very deep	Variable, depending on seepage	Slight
a	Hydric	Water removed so slowly that the water table is at or above the soil surface all year; gleyed and organic mineral soils.	Permanent water table	Depressions, receiving	Variable, depending on seepage	Very poor	Variable, depending on seepage	Very deep	Variable, depending on seepage	Flat

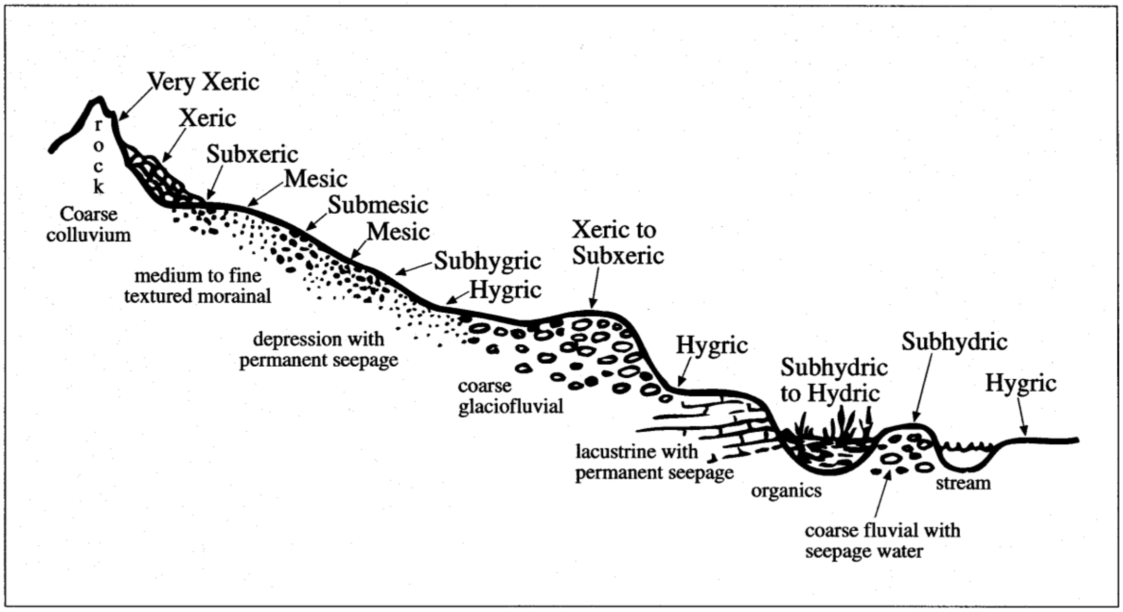


Figure AI-1: Ecological moisture regime in relation to landscape position and geologic material

The presence of an impermeable layer (e.g., bedrock, compacted till, cemented layer) may inhibit soil water storage, or create conditions for temporary or permanent seepage if subsurface water flow seepage is present. This can also result in an increase of available moisture.

The use of plant indicators for assessing ecological moisture regimes requires an existing vegetation classification scheme for the subzone under consideration or a reconnaissance of the areas sufficient to establish relationships between vegetation indicators and the range of edaphic conditions. When assessing sites near subzone boundaries, care must be taken to differentiate between seepage inputs and increases in precipitation or decreases in evapotranspiration demands. For example, plants normally found on mesic sites in one subzone can occur on subhygric sites in an adjacent subzone with lower precipitation or higher temperatures. Care must also be taken to assess the plant community as a whole. Some species may have a limited rooting depth and may not reflect the presence of deeper seepage waters, while others may reflect changes in nutrient availability rather than available moisture. Even when extensive vegetation information is available, it is always best to consider the environmental factors as well.

Appendix II Site index equations[17]

FORMULAS FOR CALCULATING TPR FOR THE FIVE MAIN SPECIES GROUPS

1. Aw, Bw, Pb, A

SI_{50} = 1.3 + 17.0100096 + 0.878406 *(THEIGHT – 1.3)
+ 1.836354 * LOG (BR_HEI_AGE)
- 1.401817 * (LOG (BR_HEI_AGE))**2
+ 0.437430 * LOG (THEIGHT- 1.3) /BR_HEI_AGE

Table AII- 1: Site class guide for deciduous species

TPR	SI Age	Range
U	50	5.00 – 10.05
F	50	>10.05 – 14.05
M	50	>14.05 – 18.05
G	50	>18.05 – 30.00

2. Sw, Fd, Fb, Fa

SI_{50} = 1.3 + 10.398053 + 0.324415 * (THEIGHT – 1.3)
+ 0.00599608 * LOG (BR_HEI_AGE) * BR_HEI_AGE
- 0.838036 * (LOG (BR_HEI_AGE)) ** 2
+ 27.487397 * (THEIGHT – 1.3) /BR_HEI_AGE
+ 1.191405 * LOG (THEIGHT – 1.3)

Table AII- 2: Site class guide for white spruce, Douglas-fir and the true firs

TPR	SI Age	Range
U	50	3.00 – 6.05
F	50	> 6.05 – 10.05
M	50	> 10.55 – 15.55
G	50	> 15.55 – 25.00

[17] Alberta Energy and Natural Resources, Alberta Forest Service. ENR Report No. 20, Dept. 60a Yield Tables for Unmanaged Stands and Dept. 60b Yield Tables for Unmanaged Stands: Appendix 1.

3. Pine

SI_{50} = 1.3 + 10.940796 + 1.675298 * (THEIGHT – 1.3)
- 0.932222 * (LOG (BR_HEI_AGE)) ** 2
+ 0.005439671 * LOG (BR_HEI_AGE) * BR_HEI_AGE
+ 8.228059 * (THEIGHT – 1.3) / BR_HEI_AGE
- 0.256865 * (THEIGHT – 1.3) * LOG (THEIGHT – 1.3)

Table AII- 3: Site class guide for the pines

TPR	SI Age	Range
U	50	3.00 – 7.05
F	50	> 7.05 – 12.05
M	50	> 12.05 – 16.05
G	50	> 16.05 – 25.00

4. Sb and Lt

SI_{50} = 1.3 + 4.903774 + 0.811817 *(THEIGHT – 1.3)
- 0.363756 * (LOG (BR_HEI_AGE)) **2
+ 24.030758 * (THEIGHT – 1.3) / BR_HEI_AGE
- 0.102076 * (THEIGHT – 1.3) * LOG (THEIGHT – 1.3)

Table AII- 4: Site class guide for black spruce and tamarack

TPR	SI Age	Range
U	50	1.00 – 6.05
F	50	> 6.05 – 7.05
M	50	> 7.05 – 10.05
G	50	> 10.05 – 20.00

Appendix III AVI 2.1.5 Data Models

1.1 Objectives

The objective of this appendix is to provide an overview of AVI entities/pseudo-entities and the relationships that exist between them in context of the AVI business rules. This appendix details the digital format currently used within Alberta Agriculture and Forestry AVI Data Model is designed for use with AVI Version 2.1.5.

1.2 AVI 2.1.5 Logical Data Model

The AVI 2.1.5 Logical Data Model outlines the entity definition and relationships with other entities are governed by the business rules established for them. For example, when an Anthropogenic Vegetated Layer contains CPR then business rules dictate that a Naturally Non-Vegetated Code of SO or SC must also exist. This results in a relationship connection between these two entities. Because of certain exceptions dictated by business rules, some leeway for the purpose of simplification was taken when defining some entities. For example Layer Site has been related to the subtype Layer since it exists either optionally or by requirement in the majority of subtype Layers. This relationship, however, violates the rule that MOISTURE_REGIME and TPR cannot be found in association with the Anthropogenic Non-Vegetated Layer subtype. Where these types of exceptions exist, notes have been added to describe the situation.

1.3 Logical Entity Relationships

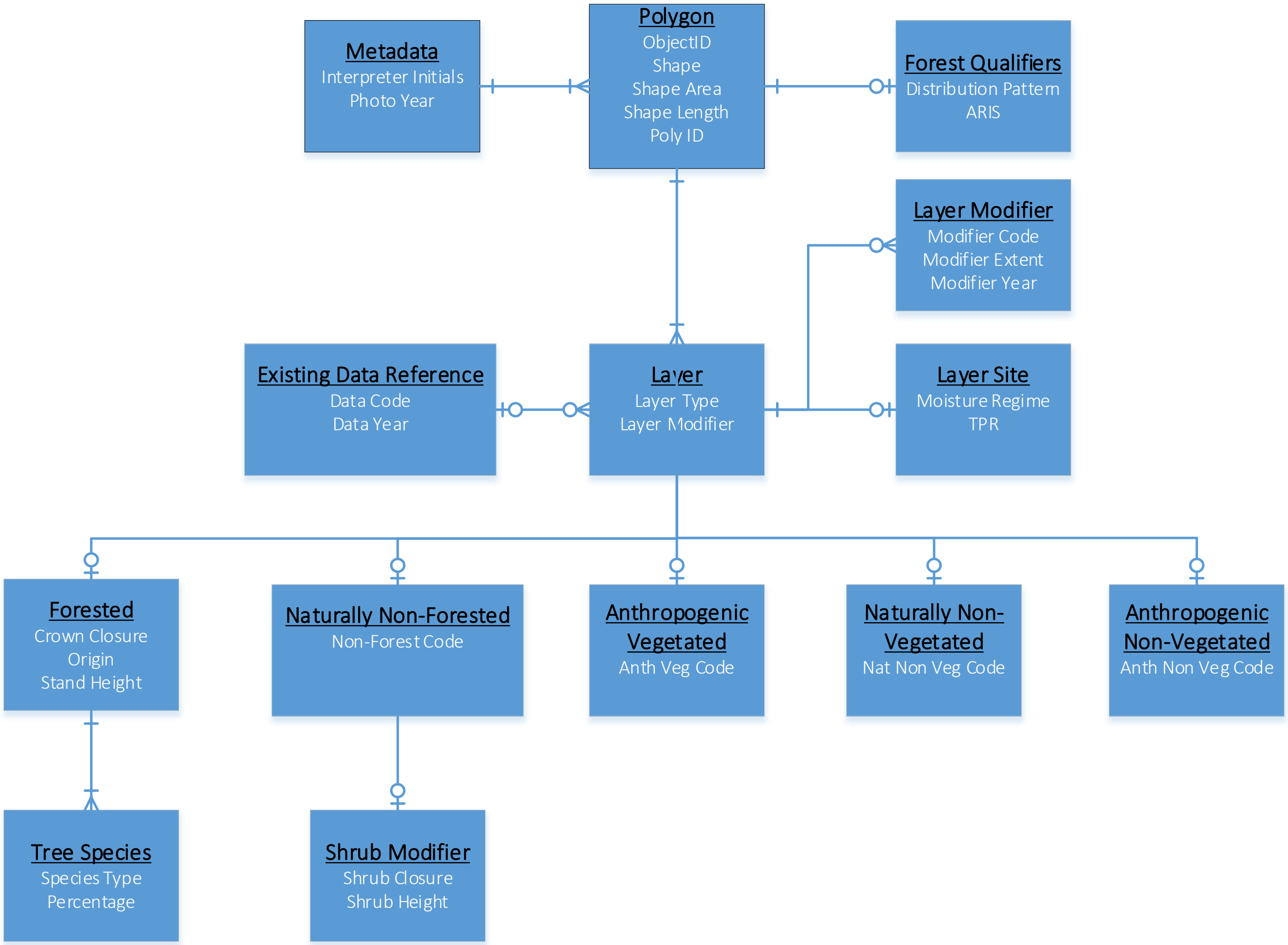


Figure AIII-1: Logical Entity Diagram

1.3.1 Metadata

Description: Compilation information regarding interpreter and photo year.

Attributes:

Interpreter Initials **(INITIALS)**
Description: Initials of person that interpreted the polygon

Name	Alias	Type	Length	Domain Values
INITIALS	Interpreter Initials	Text	2	Any alphaInteger Text

Photo Year (**PHOTO_YR**)
Description: Year of aerial imagery used to interpret AVI

Name	Alias	Type	Length	Domain Values
PHOTO_YR	Photography Year	Integer	4	Valid year not greater than current year

1.3.2 Forest Qualifiers

Description: Attributes associated with a forested polygon rather than layer level.

Attributes:

ARIS Opening Number (**ARIS**)
Description: A unique identifier is assigned to a harvest area to enable tracking within the Alberta Regeneration Information System.

Name	Alias	Type	Length	Domain Values
ARIS	ARIS	Text	11	Opening number registered in ARIS

1.3.3 Polygon

Description: An area containing a distinct AVI land cover type, possessing uniformity in composition, age, arrangement or condition that can be uniquely delineated from aerial imagery.

Attributes:

Object Identifier (**OBJECT-ID**)
Description: Uniquely system generated ID.

Name	Alias	Type	Length	Domain Values
OBJECT-ID		Integer	10	1 – 2147483646

Geometry (**SHAPE**)
Description: Polygon geometry.

Name	Alias	Type	Length	Domain Values
SHAPE		Blob		

Area (**SHAPE_Area**)
Description: Area of polygon in square metres.

Name	Alias	Type	Length	Domain Values
SHAPE_Area		Double		≥ Min Polygon Size

Length (**SHAPE_Length**)
Description: Length of feature in internal units (metres).

Name	Alias	Type	Length	Domain Values
SHAPE_Length		Real		> 0

Polygon ID (**POLY_NUM**)
Description: Business assigned polygon identifier

Name	Alias	Type	Length	Domain Values
POLY_NUM	Polygon ID	Integer	10	> 0

1.3.4 Layer

Description: Structure includes the horizontal and vertical distribution of forest elements, including the heights and diameters of live and dead trees and the arrangement of foliage, crown layers, shrubs, herbs, and downed wood.

Attributes:

Layer Type (**STRUC and USTRUC**)
Description: Class of polygon layer.

Name	Alias	Type	Length	Domain Values
STRUC	Overstorey Structure	Text	1	Blank, C, H, M
USTRUC	Understorey Structure	Text	1	Blank, C, H, M

Layer Modifier (**STRUC_VAL and USTRUCT_VAL**)
Description: Percentage area of polygon covered by Horizontal layer, or difference between the midpoint of upper layer to midpoint of lower layer for complex polygons. The total of the structure value (10% increments) must combine to 10 (100%) for Horizontal layers.

Name	Alias	Type	Length	Domain Values
STRUC_VAL	Structure Modifier	Integer	1	1 to 9
USTRUC_VAL	U Structure Modifier	Integer	1	1 to 9

1.3.5 Existing Data Reference

Description: Data gathered from other existing sources to verify or aid in the interpretation of the polygon attributes. When AVI attributes have been confirmed from other information sources or existing polygon data are available to confirm attributes, codes are used to describe the data source. If more than one set of attributes (Data Code and Data Year) exists for a polygon, the following hierarchy applies: 1 Interpreter field plot (F), 2 Air call (A), 3 Interpreted TPR (I), 4 Supplementary photography (S), 5 PSP (P), 6 Cruise data (C), 7 Volume plot (V), 8 Large- scale photography (L).

Attributes:

Data Code (**DATA and UDATA**)
Description: Code indicating external source used.

Name	Alias	Type	Length	
DATA	Existing Data	Text	1	F, A, I, S, P, C, V, L
UDATA	U Existing Data	Text	1	F, A, I, S, P, C, V, L

Data Year (**DATA_YR, UDATA_YR**)
Description: Year associated with external data source.

Name	Alias	Type	Length	Domain Values
DATA_YR	Existing Data Year	Integer	4	1940 – current year of inventory
UDATA_YR	U Existing Data Year	Integer	4	1940 – current year of inventory

1.3.6 Layer Site

Description: Distinct attribute information that is gathered for the majority of layer types.

Attributes:

Moisture Regime (**MOIST_REG and UMOIST_REG**)
Description: Moisture regime signifies the available moisture supply for plant growth, using a descriptive code ranging from dry to aquatic.

Name	Alias	Type	Length	Domain Values
MOIST_REG	Moisture Regime	Text	1	d, m, w, or a
UMOIST_REG	U Moisture Regime	Text	1	d, m, w, or a

Timber Productivity Rating (**TPR and UTPR**)
Description: Potential timber productivity of a polygon based on height and age of dominant and co-dominant trees of the leading species.

Name	Alias	Type	Length	Domain Values
TPR	Timber Productivity Rating	Text	1	G, M, F, or U
UTPR	U Timber Productivity Rating	Text	1	G, M, F, or U

1.3.7 Layer Modifier

Description: A condition or treatment providing additional information about the origin or condition of the cover type.

Attributes:

Modifier Code (**MOD1, MOD2, UMOD1, UMOD2**)
Description: Code related to condition or treatment

Name	Alias	Type	Length	Domain Values
MOD1, MOD2	Modifier 1, Modifier 2	Text	2	CC, BU, WF, CL, DI, IK, UK, WE, DT, BT, SN, ST, SI, SC, PL, TH, GR, IR, BV, SF, SL, BK, FS, UP, MO, RT
UMOD1, UMOD2	U Modifier 1, U Modifier 2	Text	2	CC, BU, WF, CL, DI, IK, UK, WE, DT, BT, SN, ST, SI, SC, PL, TH, GR, IR, BV, SF, SL, BK, FS, UP, MO, RT

Modifier Extent (**MOD1_EXT, MOD2_EXT, UMOD1_EXT, UMOD2_EXT**)
Description: Percentage based indication of what portion of polygon (by crown closure or land area affected) is affected by the condition or treatment.

Name	Alias	Type	Length	Domain Values
MOD1_EXT, MOD2_EXT	Modifier 1 Extent Modifier 2 Extent	Integer	1	1 to 5
UMOD1_EXT, UMOD2_EXT	U Modifier 1 Extent U Modifier 2 Extent	Integer	1	1 to 5

Modifier Year (**MOD1_YR, MOD2_YR, UMOD1_YR, UMOD2_YR**)
Description: Year that condition or treatment took place.

Name	Alias	Type	Length	Domain Values
MOD1_YR, MOD2_YR	Modifier 1 Year Modifier 2 Year	Integer	4	1900 - current year
UMOD1_YR, UMOD2_YR	U Modifier 1 Year U Modifier 2 Year	Integer	4	1900 - current year

1.3.8 Forested Layer

Description: A layer is considered forested if it supports tree growth (including seedlings and saplings) with a crown closure of ≥ 6%.

Attributes:

Crown Closure (**DENSITY and UDENSITY**)
Description: Percentage of ground area covered by a vertical projection of the tree crowns to the ground.

Name	Alias	Type	Length	Domain Values
DENSITY	Density	Text	1	A, B, C, or D
UDENSITY	U Density	Text	1	A, B, C, or D

Origin (**ORIGIN and UORIGIN**)
Description: Year of origin.

Name	Alias	Type	Length	Domain Values
ORIGIN	Origin	Integer	4	1400 – current year
UORIGIN	U Origin	Integer	4	1400 – current year

Height (**HEIGHT and UHEIGHT**)
Description: Average height of the dominant and co-dominant trees of the leading species in metres. Polygon height can be interpreted, determined through field measurements or with a Canopy Height Model (CHM).

Name	Alias	Type	Length	Domain Values
HEIGHT	Height	Integer	2	1 – 40
UHEIGHT	U Height	Integer	2	1 – 40

1.3.9 Tree Species

Description: A tree species approved in AVI 2.1.5 specification. Tree species present in a polygon are captured (to a maximum of 5) in decreasing order of occurrence based on percent crown closure for each layer.

Attributes:

Species Type (**SP1 to SP5** and **USP1 to USP5**)
Description: Code indicating type of tree species.

Name	Alias	Type	Length	Domain Values
SP1, SP2, SP3, SP4, SP5	Species 1, Species 2, Species 3, Species 4, Species 5	Text	2	Sw, Se, Sb, P, Pl, Pj, Pa, Pf, Fb, Fa, Fd, Lt, La, Lw, A, Aw, Pb, Bw
USP1, USP2, USP3, USP4, USP5	U Species 1, U Species 2, U Species 3, U Species 4, U Species 5	Text	2	Sw, Se, Sb, P, Pl, Pj, Pa, Pf, Fb, Fa, Fd, Lt, La, Lw, A, Aw, Pb, Bw

Percentage (SP1_PER to SP5_PER and USP1_PER to USP5_PER)
Description: Percentage of species within polygon based on crown closure to closest 10%.

Name	Alias	Type	Length	Domain Values
SP1_PER, SP2_PER, SP3_PER, SP4_PER, SP5_PER	Species 1 Percent, Species 2 Percent, Species 3 Percent, Species 4 Percent, Species 5 Percent	Integer	2	1-10
USP1_PER, USP2_PER, USP3_PER, USP4_PER, USP5_PER	U Species 1 Percent, U Species 2 Percent, U Species 3 Percent, U Species 4 Percent, U Species 5 Percent	Integer	2	1-10

1.3.10 Naturally Non-Forested Layer

Description: A layer where the major component is naturally non-forested.

Attributes:

Non-Forest Code (**NFL and UNFL**)
Description: A layer containing ≥ 6% vegetation cover but < 6% tree cover.

Name	Alias	Type	Length	Domain Values
NFL	Non-forest vegetated	Text	2	SC, SO, HG, HF, or BR
UNFL	U Non-forest Vegetated	Text	2	SC, SO, HG, HF, or BR

1.3.11 Shrub Modifier

Description: Attributes required for specific non-forest types such as SO and SC.

Attributes:

Shrub Closure (**NFL_PER and UNFL_PER**)
Description: Indicator to nearest 10% shrub crown closure within the polygon.

Name	Alias	Type	Length	Domain Values
NFL_PER	Shrub Cover Percent	Integer	2	1-10
UNFL_PER	U Shrub Cover Percent	Integer	2	1-10

Shrub Height (**HEIGHT and UHEIGHT**)
Description: Average height of shrubs in metres.

Name	Alias	Type	Length	Domain Values
HEIGHT	Height	Integer	2	1-10
UHEIGHT	U Height	Integer	2	1-10

1.3.12 Anthropogenic Vegetated Layer

Description: Vegetated land where the vegetation has been influenced by humans, usually in areas that have been planted with cultivated species.

Attributes:

Anthropogenic Vegetation Code (**ANTH_VEG and UANTH_VEG**)
Description: Code indicating type of anthropogenic activity.

Name	Alias	Type	Length	Domain
ANTH_VEG	Anthropogenic Vegetated	Text	3	CA, CP, CPR, CIP, CIH or CIW
UANTH_VEG	U Anthropogenic Vegetated	Text	3	CA, CP, CPR, CIP, CIH or CIW

1.3.13 Naturally Non-Vegetated Layer

Description: Natural cover types that have < 6% vegetation cover.

Attributes:

Naturally Non-vegetated Code (**NAT_NON and UNAT_NON**)
Description: Code indicating non-vegetated type.

Name	Alias	Type	Length	Domain
NAT_NON	Naturally Non-vegetated	Text	3	NWI, NWL, NWR, NWF, NMB, NMC, NMR, or NMS
UNAT_NON	U Naturally Non-Vegetated	Text	3	NWI, NWL, NWR, NWF, NMB, NMC, NMR, or NMS

1.3.14 Anthropogenic Non-Vegetated Layer

Description: A layer with less than 6% vegetation cover are considered non-vegetated. Anthropogenic non-vegetated lands are a result of human activities.

Attributes:

Anthropogenic Non-vegetated Code (**ANTH_NON and UANTH_NON**)
Description: Code indicating anthropogenic non-vegetated type.

Name	Alias	Type	Length	Domain
ANTH_NON	Anthropogenic Non-Vegetated	Text	3	ASC, ASR, AIH, AIE, AIG, AIF, AIM, or AII
UANTH_NON	U Anthropogenic Non-Vegetated	Text	3	ASC, ASR, AIH, AIE, AIG, AIF, AIM, or AII

1.4 AVI SDB 2.1.5 Physical Model

The Entity Relationship Diagram in Figure 1-1 represents the current physical implementation of the AVI SDB 2.1.5 specification. The physical model differs significantly from the logical model with the incorporation of almost the entire logical model into a single physical attribute table.

Many of the relationships indicated in the logical model are implied in the physical model, through the existence or absence of particular key fields. For example if the Species 1 field contains data then we can imply that the layer is forested and only those fields associated with a forested layer can be populated. For the most part this key definition schema works, but breaks down when you run into situations where more than one key field contains data. Without some form of discriminator field that distinctly indicates the intended layer type there is no way of clearly determining the intended layer when multiple key fields are populated. This complicates the validation process somewhat where multiple fields must be queried in order to get some idea of what the intended layer type is so that appropriate validation rules can be applied. It can also complicates some types of user queries, rather than query a single discriminatory field the user must query multiple key fields to refine their query according to layer type.

While incorporating the entire model into a single table complicates some situations, it makes the distribution and maintenance of data easier. Processes that extract subsets of data are more efficient since they only have work with a single physical table rather than a relational database. In many cases it is also easier for end users to utilize the data since they do not have to be concerned with any complicated relate and join operations when using the data.

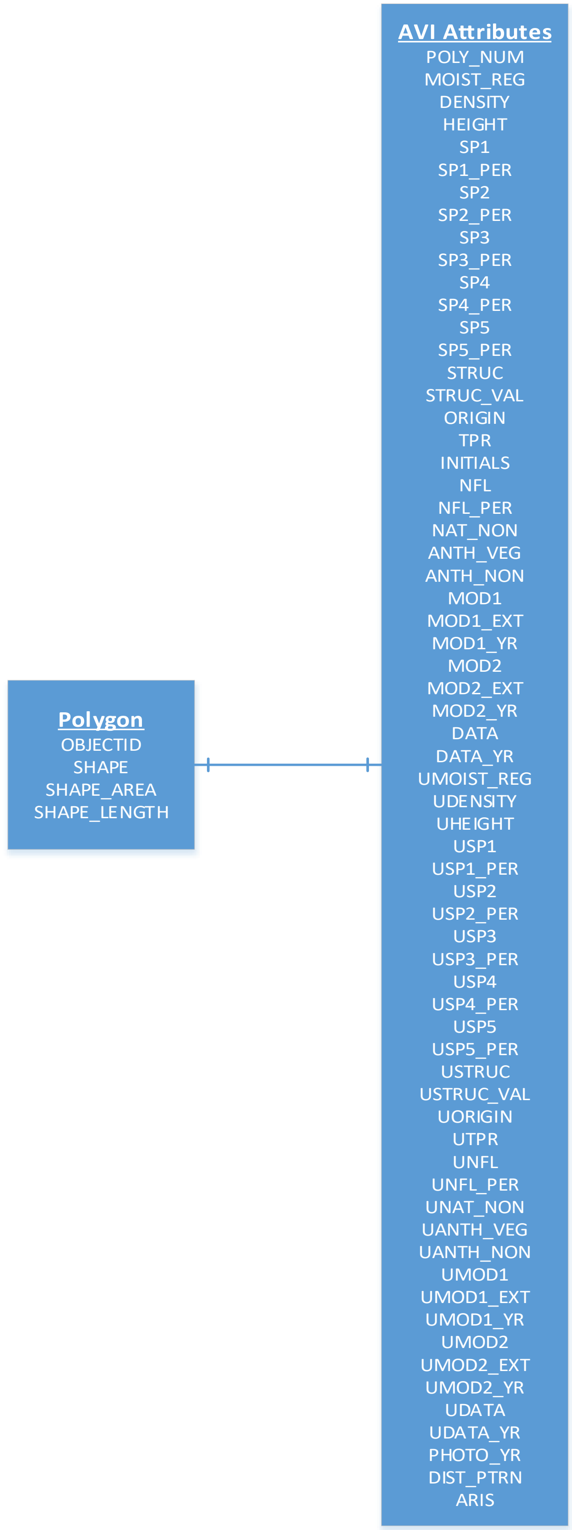


Figure AIII-2: AVI SDB 2.1.5 Physical Model

1.5 Physical to Logical Cross Reference

Rather than repeating the entire attribute definitions and domain values the following table (see Table AIII-1) is used to cross-reference physical fields to their logical equivalents.

Table AIII-1: AVI 2.1.5 Physical to Logical cross reference

Physical Attribute	Entity	Logical Attribute
POLY_NUM	Forest Polygon	POLY_ID
MOIST_REG	Layer Site	MOISTURE REGIME
DENSITY	Forested Layer	CROWN CLOSURE
HEIGHT	Forested Layer	HEIGHT
SP1	Tree Species	SPECIES TYPE
SP1_PER	Tree Species	PERCENTAGE
SP2	Tree Species	SPECIES TYPE
SP2_PER	Tree Species	PERCENTAGE
SP3	Tree Species	SPECIES TYPE
SP3_PER	Tree Species	PERCENTAGE
SP4	Tree Species	SPECIES TYPE
SP4_PER	Tree Species	PERCENTAGE
SP5	Tree Species	SPECIES TYPE
SP5_PER	Tree Species	PERCENTAGE
STRUC	Layer	LAYER TYPE
STRUC_VAL	Layer	LAYER MODIFIER
ORIGIN	Forested Layer	ORIGIN
TPR	Layer Site	TPR
INITIALS	Interpreter	INTERPRETER INITIALS
NFL	Naturally Non-Forest Layer	NON-FOREST CODE
NFL_PER	Non-Forested Modifier	SHRUB CLOSURE
NAT_NON	Naturally Non-Vegetated Layer	NAT NON VEG CODE
ANTH_VEG	Anthropogenic Vegetated Layer	ANTH VEG CODE
ANTH_NON	Anthropogenic Non-Vegetated Laye	ANTH NON VEG CODE
MOD1	Modifier	MODIFIER CODE
MOD1_EXT	Modifier	MODIFIER EXTENT

Physical Attribute	Entity	Logical Attribute
MOD1_YR	Modifier	MODIFIER YEAR
MOD2	Modifier	MODIFIER CODE
MOD2_EXT	Modifier	MODIFIER EXTENT
MOD2_YR	Modifier	MODIFIER YEAR
DATA	Existing Data Reference	EXISTING DATA_CODE
DATA_YR	Existing Data Reference	EXISTING DATA YEAR
UMOIST_REG	Layer Site	MOISTURE REGIME
UDENSITY	Forested Layer	CROWN CLOSURE
UHEIGHT	Forested Layer	HEIGHT
USP1	Tree Species	SPECIES TYPE
USP1_PER	Tree Species	PERCENTAGE
USP2	Tree Species	SPECIES TYPE
USP2_PER	Tree Species	PERCENTAGE
USP3	Tree Species	SPECIES TYPE
USP3_PER	Tree Species	PERCENTAGE
USP4	Tree Species	SPECIES TYPE
USP4_PER	Tree Species	PERCENTAGE
USP5	Tree Species	SPECIES TYPE
USP5_PER	Tree Species	PERCENTAGE
USTRUC	Layer	LAYER TYPE
USTRUC_VAL	Layer	LAYER MODIFIER
UORIGIN	Forested Layer	ORIGIN
UTPR	Layer Site	TPR
UNFL	Naturally Non-Forest Layer	NON-FOREST CODE
UNFL_PER	Non-Forested Modifier	SHRUB CLOSURE
UNAT_NON	Naturally Non-Vegetated Layer	NAT NON VEG CODE
UANTH_VEG	Anthropogenic Vegetated Layer	ANTH VEG CODE
UANTH_NON	Anthropogenic Non-Vegetated Laye	ANTH NON VEG CODE
UMOD1	Modifier	MODIFIER_CODE
UMOD1_EXT	Modifier	MODIFIER EXTENT

Physical Attribute	**Entity**	**Logical Attribute**
UMOD1_YR	Modifier	MODIFIER YEAR
UMOD2	Modifier	MODIFIER CODE
UMOD2_EXT	Modifier	MODIFIER EXTENT
UMOD2_YR	Modifier	MODIFIER YEAR
UDATA	Existing Data Reference	EXISTING DATA CODE
UDATA_YR	Existing Data Reference	EXISTING DATE YEAR
PHOTO_YR	Photo Year	PHOTO YEAR
ARIS	Opening Number	ARIS

1.6 Valid Field Domain Values

The following is a summary of physical AVI fields and valid domain values associated with them:

Polygon Number: 1 – 2147483646

Species 1 – 5: Sw, Se, Sb, P, Pl, Pj, Pa, Pf, Fb, Fa, Fd, Lt, La, Lw, A, Aw, Pb, Bw

Species 1 Percentage: 2 – 10

Species 2 Percentage: 1 – 5

Species 3 Percentage: 1 – 3

Species 4 Percentage: 1 – 2

Species 5 Percentage: 1 – 2

Moisture Regime: d, m, w, a

Crown Closure: A, B, C, D

Height: 0 – 40

Structure: M, C, H

Structure Modifier: 0 – 9

Origin: 1400 – current year

Timber Productivity Rating: G, M, F, U

Interpreter Initials: AA- ZZ

Non-Forest Vegetated: SC, SO, HG, HF, BR

Non-Forest Vegetated Shrub Closure: 0 – 10

Naturally Non-Vegetated: NWI, NWL, NWR, NWF, NMB, NMC, NWR, NMS

Anthropogenic Vegetated: CA, CP, CPR, CIP, CIH, CIW

Anthropogenic Non-Vegetated: ASC, ASR, AIH, AIE, AIG, AIF, AIM, AII

Modifier 1 –2: CC, BU, WF, CL, DI, IK, UK, WE, DT, BT, SN, ST, SI, SC, PL, TH, GR, IR, BV, SF, SL, BK, FS, UP, MO, RT

Modifier Extent 1 – 2: 0 – 5

Modifier Year 1 – 2: 1900 – current year

Existing Data: F, P, V, C, S, A, L, I

Existing Data Year: 1940 – current year

ARIS: Opening Number registered in ARIS database.

Photo Year: valid four Integer value greater than 1980 and not greater than the current year.

Appendix IV AVI Validation Rules

1 Initial Classification

Each AVI polygon has potentially two layers associated with it, primary and secondary. The validation process begins by determining the land cover type for the each layer and then runs the appropriate methods to evaluate attribute content of the layer. If a polygon contains two layers then additional validation is performed to validate the relationship between the layers. Each layer can be classified as one of the following land cover types. Specific field values are evaluated to determine the land cover for the layer:

1.1 Treed

If any of SP1 to SP5 contains a value then the layer is considered treed and will be evaluated using rules for this land cover type.

1.2 Non-forest Vegetated

If the NFL field is populated then the layer is evaluated using rules for non-forest vegetated.

1.3 Naturally Non-vegetated

If the NAT_NON field is populated then the layer is evaluated as naturally non-vegetated.

1.4 Anthropogenic Vegetated

If the ANTH_VEG field is populated then the layer is evaluated as anthropogenic vegetated.

1.5 Anthropogenic Non-vegetated

If the ANTH_NON field is populated then the layer is evaluated as anthropogenic vegetated.

Each layer is evaluated for land cover and if it meets the criteria for more than one type then it is considered an error. For example, if both SP1 and NFL are populated then it meets the criteria for both Treed and Non-forest Vegetated and so would be considered an error. If the layer does not meet the criteria for any of the land cover types then it is also considered an error.

Each land cover type has a set of required fields as well as optional fields. Required fields must be populated with values that are within the domain of acceptable values for that field. An individual AVI polygon can have either one or two layers associated with it. The primary layer is required while the secondary layer is optional. Regardless of the land cover type, the following field must be populated in the primary layer.

NOTE: A rule may be classified as either an error or a warning. The rule type is indicated with either a (Error) or (Warning) after rule description. When you see a %s in the message this represents a place holder for the field value. For example, for the message: Interpreter Initials: %s must be uppercase the %s will contain the Interpreter Initials field value.

INITIALS

Rule	Message
1.1.1 Must be populated (error)	Interpreter Initials missing, must be entered
1.1.2 Field must contain two characters (Error)	Interpreter Initials: %s less than 2 characters
1.1.3 Must be uppercase (Error)	Interpreter Initials: %s must be uppercase
1.1.4 Can only contain characters A-Z (Error)	Interpreter Initials: %s must only contain letters A-Z

CORE DATA

The primary layer must always contain data according to one of the land cover types indicated.

Rule	Message
1.2.1 Only one land cover type can be associated with a layer. For instance, a layer cannot be both treed and naturally non-vegetated (Error)	Layer contains core data for both: %s and %s, cannot have data for more than 1 type in same layer
1.2.2 A layer must have complete core data for one of the land cover types (Error)	No core data found for forested, non-forest veg, nat-non-veg, anth-veg, or anth-non-veg, must contain data for at least one of these types

2 Field Domain Values

Each field has a set of acceptable values that can be assigned to the field based on the land cover assigned to the layer. Where a field is not required for the assigned land cover, then the value is usually Null, Blank (empty string), or Zero depending on the field type. The following sections indicate the range of acceptable values that can be assigned to a field.

2.1 Polygon Number (POLY_NUM)

Integer value between 0 – 9999999999

2.2 Moisture Regime (MOIST_REG)

Where field is not applicable (ANTH_NON, etc…) value should be Null or Blank, otherwise one of:

d, m, w, a

2.3 Crown Closure (DENSITY)

Where field is not applicable (ANTH_NON, etc…) value should be Null or Blank, otherwise one of:

A, B, C, D

2.4 Height (HEIGHT)

Where field is not applicable (NAT_NON, etc…) the value should be Null or 0, otherwise:

Integer value between: **1-40**

Note: Height range is validated in context of land cover so may have additional constraints placed on range of valid values. See specific land cover validation sections for further details.

2.5 Species (SP1 – SP5)

Where field is not applicable (NAT_NON, etc…) the value should be Null or Blank, otherwise one of:

Sw, Sb, Se , P, Pl, Pj, Pa, Pf, Fb, Fd, Fa, Lt, La, Lw, Aw, Bw, Pb, A

2.6 Species Percent (SP1_PER – SP5_PER)

Where field is not applicable (NAT_NON, etc…) the value should be Null or 0, otherwise:
Integer value between: **1 – 10**

2.7 Structure (STRUC)

Where field is not applicable (single layer) value should be Null or Blank, otherwise one of:
M, C, H

2.8 Structure Value (STRUC_VAL)

This is a layer specific value dependent on the Structure value assigned. It either represents a percent of the layer area for Horizontal polygons or a height range for Complex polygons

2.8.1 Multi-storied (M)

0 or Null

2.8.2 Horizontal (H)

1 – 9

2.8.3 Complex (C)

1 – 10

2.9 Origin (ORIGIN)

Where field is not applicable (NAT_NON, etc…) the value should be Null or 0, otherwise:
1600 – Current Year

2.10 Timber Productivity Rating (TPR)

Where field is not applicable value should be Null or Blank, otherwise one of:
G, M, F, U

2.11 Interpreter Initials (INITIALS)

For primary layer must be two upper case alphabetic characters between A – Z.

2.12 Non-forest Vegetated (NFL)

Where layer is **not** Non-forest Vegetated the value should be Null or Blank otherwise one of:
SC, SO, HG, HF, BR

2.13 Non-forest Vegetated Crown Closure (NFL_PER)

Where layer is **not** Non-forest Vegetated the value should be Null or 0 otherwise:
Integer value between: **1 – 10**

2.14 Naturally Non-vegetated (NFL)

Where layer is **not** Naturally Non-vegetated the value should be Null or Blank otherwise one of:
NWI, NWL, NWR, NWF, NMB, NMC, NMR, NMS

2.15 Anthropogenic Vegetated (ANTH_VEG)

Where layer is **not** Anthropogenic Vegetated the value should be Null or Blank otherwise one of:
CA, CP, CPR, CIP, CIW, CIH

2.16 Anthropogenic Non-vegetated (ANTH_NON)

Where layer is **not** Anthropogenic Non-vegetated the value should be Null or Blank otherwise one of:
ASC, ASR, AIH, AIE, AIG, AIF, AIM, AII

2.17 Modifier (MOD1 – MOD2)

Where field is not applicable value should be Null or Blank, otherwise one of:
BV, SF, SL, BK, CC, BU, WF, CL, DI, IK, UK, WE, DT, BT, SN, ST, SI, SC, PL, TH, GR, IR, RT

2.18 Data and Confirmation (DATA)

Where field is not applicable value should be Null or Blank, otherwise one of:
F, P, V, C, S, A, L, I

2.19 Data and Confirmation Year (DATA_YR)

Where not applicable the value should be Null or 0 otherwise:
1940 – Current Year

3 Treed Layer (SP1 – SP5)

If SP1 is populated then the layer is classified as treed and the following rules will be enforced:

3.1 Required Fields

The following fields must be populated for a treed layer:
1. SP1
2. SP1_PER
3. MOIST_REG
4. HEIGHT
5. DENSITY
6. ORIGIN
7. TPR
8. PHOTO_YR
9. INITIALS

3.2 Excluded Fields

The following fields cannot be populated if the layer is classified as treed:
1. NAT_NON
2. NFL
3. NFL_PER
4. ANTH_VEG
5. ANTH_NON

All other fields are optional.

3.3 Moisture Regime Validation

Rule	Message
3.3.1 If SP1 is Sb or Lt then MOIST_REG should not be m or d (Warning)	A mesic or dry Moisture Regime: %s found in conjunction with a %s species 1
3.3.2 If SP1 in: Pl, Pj, Pa, Pf, P, A, Aw then MOIST_REG should not be w (Warning)	A wet Moisture Regime: %s found in conjunction with a %s species 1
3.3.3 A MOIST_REG of ‘a’ is unlikely for a treed polygon (Error)	An aquatic Moisture Regime of "a" cannot be associated with a Forested layer

3.4 TPR Validation

Rule	Message
3.4.1 If SP1 in Sw, Se, Pl, Pj, P, A, Aw, Pb, Bw, Fd then TPR is unlikely to be U (Warning)	TPR: %s found in conjunction with a %s species 1

3.5 Species Validation

Rule	Message
3.5.1 Species must be sequentially entered with no missing values within the sequence. Example, SP1 cannot be blank if SP2 is populated (Error)	%s Species 1 cannot be blank if any of SP2 - SP5 is populated %s Species 2 cannot be blank if any of SP3 - SP5 is populated Etc…
3.5.2 The sum of all SP_PER fields must add up to 10 (Error)	%s Total species percent: %s invalid, does not add up to 10
3.5.3 If a SP field is populated then the associated SP_PER field must also be populated and vice-versa (Error)	%s Species percent 1: %s present but missing a species call
3.5.4 No species may be duplicated in SP1 – SP5 (Error)	%s Species 2: %s invalid, already exists, cannot be duplicated (Same for SP 3 – 5)
3.5.5 If one of SP1 – SP5 is Aw or Pb then there cannot be an ‘A’ in SP1 – SP5 (Error)	%s Cannot have a species: A if one of the other species is Aw or Pb
3.5.6 If one of SP1 – SP5 is Pl, Pj, Pa, Pf then there cannot be a ‘P’ is SP1 – SP5	'%s Cannot have a species: P if one of the other species is Pl, Pj, Pa, or Pf
3.5.7 SP1_PER must be between 1 – 10 (Error)	Species percent 1: %s invalid, must be between 1 and 10
3.5.8 SP2_PER – SP5_PER must be between 1 – 5 (Error)	Species percent 2: %s invalid, must be between 1 and 5 (Same for SP_PER3 – SP_PER5)

Rule	Message
3.5.9 SP_PER must appear in descending order. Example: you cannot has a SP1_PER of 4 then a SP2_PER of 6 (Error)	%s Species percent 5: %s invalid, cannot be greater than percent of a previous species

The Modifier (MOD1 – MOD2) and Data (DATA) fields are validated in a separate section as they can apply to more than one land cover layer type. See these sections for further details.

4 Non-Forest Vegetated Layer (NFL)

If the NFL field is populated then the layer is classified as Non-forest Vegetated

4.1 Required Fields

The following fields must be populated:

1. NFL
2. MOIST_REG
3. TPR

4.2 Excluded Fields

The following fields cannot be populated if the layer is classified as Non-forest Vegetated:

1. SP1 – SP5
2. SP1_PER – SP5_PER
3. DENSITY
4. ORIGIN
5. NAT_NON
6. ANTH_NON

All other fields are optional.

4.3 Height

Rule	Rule
4.3.1 If NFL is SO or SC then the HEIGHT field must be populated (Error)	Non-forest Vegetated Height for SO or SC is missing
4.3.2 If NFL is SO or SC then HEIGHT must be between 1 – 10 (Error)	Non-forest Vegetated Height for SO or SC: %s invalid, must be between 1 – 10
4.3.3 If NFL is **not** SO or SC then HEIGHT must be Null or 0 (Error)	Height cannot exist with Non-forest Vegetated types other than SC or SO.

4.4 Non-forest Vegetated Crown Closure (NFL_PER)

Rule	Rule
4.4.1 If NFL is SO or SC then the NFL_PER field must be populated (Error)	Non-forest Vegetated Percent is missing, required when SO or SC
4.4.2 If NFL is SO or SC then NFL_PER must be between 1 – 10 (Error)	Non-forest Vegetated Percent: %s invalid must be between 1 – 10
4.4.3 If NFL is not SO or SC then NFL_PER must be Null or 0 (Error)	Non-forest Vegetated Percent can only be associated with SC or SO

4.5 Anthropogenic Vegetated

Rule	Rule
4.5.1 Only an ANTH_VEG value of CPR is allowed with a non-forest vegetated layer (Error)	Non-forest Vegetated can only be associated with an Anthropogenic Vegetated of CPR, was found with: %s

4.6 Data Confirmation (DATA)

Rule	Rule
4.6.1 A DATA value of 'I' is not allowed (Error)	Non-forest Vegetated cannot have a Data Source code of I

5 Naturally Non-vegetated Layer (NAT_NON)

A layer is classified as Naturally Non-vegetated if the NAT_NON field is populated.

5.1 Required Fields

The following fields must be populated:

1. NAT_NON

5.2 Excluded Fields

The following fields cannot be populated if the layer is classified as Non-forest Vegetated:

1. SP1 – SP5
2. SP1_PER – SP5_PER
3. DENSITY
4. HEIGHT
5. ORIGIN
6. ANTH_VEG
7. ANTH_NON
8. NFL

5.3 Moisture Regime (MOIST_REG)

Rule	Message
5.3.1 If NAT_NON is NMB then a moisture regime is required (Error)	Moisture Regime required when Naturally Non-vegetated layer is NMB
5.3.2 If NAT_NON is **not** NMB then no moisture regime is allowed (Error)	Moisture Regime cannot be present in Naturally Non-vegetated layer unless NMB

5.4 Modifier (MOD1 – MOD2)

Rule	Message
5.4.1 No MOD is allowed if NAT_NON in NMC, NMS, NWI, NMR (Error)	Modifier cannot be present in Naturally Non-vegetated layer type NMC, NMS, NWI or NMR
5.4.2 The MOD SN is only allowed if NAT_NON is in NWL, NWR, NWF (Error)	Modifier restricted to SN in Naturally Non-vegetated layer of NWL, NWR or NWF

5.5 Data Confirmation (DATA)

Rule	Rule
5.6.1 A DATA value of 'I' is not allowed (Error)	Naturally Non-vegetated layer cannot have a Data Source code of I

6 Anthropogenic Vegetated Layer (ANTH_VEG)

If the ANTH_VEG field is populated then the layer is evaluated as anthropogenic vegetated.

6.1 Required Fields

The following fields are required for an ANTH_VEG layer:
1. ANTH_VEG
2. MOIST_REG

6.2 Excluded Fields

The following fields cannot be populated if the layer is classified as Anthropogenic Vegetated:
1. SP1 – SP5
2. SP1_PER – SP5_PER
3. DENSITY
4. HEIGHT
5. ORIGIN
6. TPR
7. NAT_NON
8. ANTH_NON

6.3 Non-forest Vegetated (NFL)

Rule	Message
6.3.1 NFL must be populated if ANTH_VEG is CPR and then NFL must be either SC or SO (Error)	When Anthropogenic Vegetated is CPR then must have an Non-forest Vegetated call of SO or SC

6.4 Modifier (MOD1 – MOD2)

Rule	Message
6.4.1 If ANTH_VEG is CIP or CIW then the only allowable modifier is one of the following: SN, ST, IR, GR, CC, , BU (Error)	Invalid Modifier 1: %s When Anthropogenic Vegetated is CIP or CIW then Modifier can only be SN, ST, IR, GR, CC, or BU
6.4.2 If ANTH_VEG is **not** CIP or CIW then the only allowable modifier is one of the following: SN, ST, IR, GR, CC (Error)	Invalid Modifier 1: %s When Anthropogenic Vegetated is not CIP or CIW then Modifier can only be SN, ST, IR, GR, or CC

6.5 Data Confirmation (DATA)

Rule	Rule
6.5.1 A DATA value of 'I' is not allowed (Error)	Anthropogenic Vegetated cannot have a Data Source code of I

7 Anthropogenic Non-vegetated Layer (ANTH_NON)

If the ANTH_NON field is populated then the layer is evaluated as anthropogenic vegetated.

7.1 Required Fields

The following fields are required for an ANTH_VEG layer:

1. ANTH_NON

7.2 Excluded Fields

The following fields cannot be populated if the layer is classified as Anthropogenic Vegetated:

1. SP1 – SP5
2. SP1_PER – SP5_PER
3. DENSITY
4. HEIGHT
5. MOIST_REG
6. ORIGIN
7. TPR
8. NAT_NON
9. NFL
10. ANTH_VEG
11. MOD1 – MOD2
12. MOD1_EXT – MOD2_EXT
13. MOD1_YR – MOD2_YR

7.3 Data Confirmation (DATA)

Rule	Rule
7.3.1 A DATA value of 'I' is not allowed (Error)	Anthropogenic Non-vegetated cannot have a Data Source code of I

8 Layer Structure (STRUC)

Layer structure is not restricted to a single land cover layer type and a special set of validation functions have been implemented to evaluate it.

8.1 General Rules

Rule	Message
8.1.1 If the primary layer (overstorey) has a DENSITY of A or B then there must be an secondary layer call (Error)	No understorey; when Density is either A or B then must have an understorey
8.1.2 If primary layer contains a NFL value of SO and NFL_PER is <= 5 then likely to have a secondary layer (Warning)	No understorey; when NFL is SO and NFL_PER is less than or equal to 5 then likely to have an understorey

8.2 Multi-story Layers (STRUC = M)

Rule	Message
8.2.1 If primary layer has a STRUC value of M then there must be a secondary layer (Error)	Stand structure M but no data was found in understorey
8.2.2 The STRUC_VAL cannot be populated (in either the primary or secondary layer) if STRUC is M (Error)	Invalid stand structure value: %s, when stand structure is M cannot have stand structure value
8.2.3 If the primary layer STRUC is M then do not need a secondary USTRUC value of M (Warning)	Understorey stand structure value M not required when overstorey stand structure is M
8.2.4 If the primary layer STRUC is M then secondary USTRUC value cannot contain any other value other then M (Error)	Invalid stand structure value: %s, when overstorey stand structure is M understorey stand structure should be blank

8.3 Horizontal Layers (STRUC = H)

Rule	Message
8.3.1 When primary layer has STRUC value of H then the secondary layer USTRUC must also be H (Error)	Stand structure: %s invalid, when overstorey stand structure is H then the understorey stand structure must also be H
8.3.2 The primary layer STRUC_VAL and secondary layer USTRUC_VAL must be between 1 and 9 (Error)	Stand structure value: %s invalid, must be between 1 and 9 when a horizontal stand
8.3.3 The primary layer STRUC_VAL and secondary layer USTRUC_VAL must add up to 10 (Error)	When stand structure is H the stand structure total value must be 10 but is: %s for this stand

8.4 Complex Layers (STRUC = C)

Rule	Message
8.4.1 The secondary layer USTRUC value cannot be C (Error)	Complex structure: C only allowed in overstorey
8.4.2 The primary layer SP1 field must be populated if classified as complex (Error)	Complex structure only allowed for forested layers
8.4.3 The primary layer SP1 field must only contain one of following: Sb, Lt, Fb, Sw (Error)	Species 1: %s invalid, when the stand structure is C, leading tree species must be either Sb, Lt, Fb, or Sw
8.4.4 If the primary layer SP1_PER < 8 then SP2 must also be in Sb, Lt, Fb, Sw and the sum of SP1_PER and SP2_PER must be >= 8 (Error)	When the stand structure is C, the leading tree species (1 and 2) must be either Sb, Lt, Fb, or Sw and have a minimum stand percentage of 8: sp1/sp2_per is only %s for this stand
8.4.5 The STRUC_VAL field must contain a value (Error)	When the stand structure is C must have a height range in STRUC_VAL field
8.4.6 The STRUC_VAL must be between 1 - 10	Complex height difference: %s invalid, must be between 1 and 10

9 Data and Confirmation (DATA)

In addition to validation at the layer level, the following rules are independently implemented for the DATA field:

Rule	Message
9.1.1 DATA field cannot be used with an Anthropogenic Vegetated layer (Error)	Data Source I cannot be used in conjunction with an Anthropogenic Vegetated stand
9.1.2 DATA field cannot be used with an Anthropogenic Non-vegetated layer (Error)	Data Source I cannot be used in conjunction with an Anthropogenic Non-vegetated stand
9.1.3 DATA field cannot be used with an Naturally Non-vegetated layer (Error)	Data Source I cannot be used in conjunction with an Naturally Non-vegetated stand
9.1.4 When the DATA value is 'I' then no DATA_YR can be used (Error)	When Data Source is I then no Data Source Year is allowed
9.1.5 If DATA_YR is populated then the DATA field must also be populated (Error)	Data Source is missing but Data Source Year: %s is populated
9.1.6 DATA_YR value must be within the range of 1940 and the current year (Error)	Data Source Year: %s invalid, must be between 1940 and %s

10 Modifiers (MOD1 – MOD2)

In addition to validation at the layer level, the following rules are independently implemented for the MOD1 and MOD2 field:

10.1 Modifier Extents (MOD1_EXT – MOD2_EXT)

Following rules are applied to both MOD1_EXT and MOD2_EXT:

Rule	Message
10.1.1 Modifier extent value must be between 1 – 5 (Excluding modifiers CL, FS, RT) (Error)	Modifier 1 Extent: %s invalid, must be between 1 - 5
10.1.2 If the modifier is CL, FS, RT then no modifier extent is allowed (Error)	Modifier 1 Extent: %s invalid, no extent is allowed with a CL, FS or RT modifier
10.1.3 If modifier extent is populated then the modifier field must also be populated (Error)	Modifier 1 Extent: %s present without a modifier

10.2 Modifier Year (MOD1_YR – MOD2_YR)

The following rules apply to both MOD1_YR and MOD2_YR

Rule	Message
10.2.1 The valid range for year is between 1600 and the current year (Error)	Modifier 1 Year: %s invalid, must be between 1600 and %s
10.2.2 If modifier year is populated then the corresponding modifier must also be populated (Error)	Modifier 1 Year: %s present without a modifier

10.3 Modifier (MOD1 – MOD2)

Rule	Message
10.3.1 The following list of modifiers cannot be duplicated in MOD1 and MOD2: BV, SF, SL, BK, WF, CL, DI, IK, UK, WE, DT, BT, SN, ST, GR, IR, FS,UP,MO, RT (Error)	Modifier 1: %s and Modifier 2: %s cannot be the same
10.3.2 The following modifiers can be duplicated if the modifier year is different: CC, BU, SI, SC, PL, TH (Error)	Modifier 1: %s and Modifier 2: %s cannot be the same unless modifier years are different
10.3.3 Notification that modifier 1 and modifier 2 are the same with only the modifier years being different (Warning)	Modifier 1: %s Year: %s) and (Modifier 2: %s Year: %s) are the same with only difference in modifier years
10.3.4 Modifier 2 cannot be populated if modifier 1 does not contain a value (Error)	Modifier 2 cannot have a value if Modifier 1 does not already have a value. (mod1: %s mod2: %s)
10.3.5 If both modifier 1 and modifier 2 contain a value and one of those modifiers is CC then the CC modifier must be modifier 1 (Error)	Where a layer has multiple modifiers and one of them is CC then the CC must be defined as modifier 1 regardless of origins
10.3.6 If modifier 1 is not CC then if there are more than one modifier the most recent modifier according to modifier year must be the second modifier (Error)	Where first modifier is not CC then the most recent Stand Modifier must be second modifier. (mod1 yr: %s mod2 yr: %s)
10.3.7 Where modifier 1 and modifier 2 is CC then the most recent CC by modifier year must be modifier 2 (Error)	Where CC is contained in both modifier 1 and 2, the most recent CC must be the second modifier. (mod1 yr: %s mod2 yr: %s)
10.3.8 The modifier year cannot be greater than the PHOTO_YR unless DATA = S (Error)	Modifier year: %s cannot be greater than the Photo year: %s unless DATA = S
10.3.9 If the modifier is CC-4 and the difference between the modifier year and photo year is less than 5 years then crown closure must not be greater than A (Error)	When modifier 1 is CC, extent is 4, and year of cut is less than 5 years old (using photo year), then you cannot have a forested stand with a crown closure greater than A. (crown closure: %s)
10.3.10 If the modifier is CC-3 and the difference between the modifier year and photo year is less than 5 years then crown closure must not be greater than B (Error)	When modifier 1 is CC, extent is 3, and year of cut is less than 5 years old (using photo year), then you cannot have a forested stand with a crown closure greater than B. (crown closure: %s)
10.3.11 If the modifier is CC-2 and the difference between the modifier year and photo year is less than 5 years then crown closure must not be greater than C (Error)	When modifier 1 is CC, extent is 2, and year of cut is less than 5 years old (using photo year), then you cannot have a forested stand with a crown closure greater than C. (crown closure: %s)
10.3.12 If modifier is BU and the origin of the layer is >= 30 years then the BU modifier should not be used (Error)	When a burn origin is > or = 30 years (using photo year) then modifier 1 BU should not be used. Burn is reflected in origin. Calculated Age: %s
10.3.13 If the modifier is CC then a modifier year is required (Error)	Year of cutblock missing for modifier 1; must have a modifier year
10.3.14 If the modifier is CC then modifier year cannot be less than 1930 (Error)	Year of cutblock is prior to 1930 for modifier 1. (mod yr: %s)
10.3.15 If the modifier is CC then modifier year is questionable if less than 1950 (Warning)	Year of cutblock is prior to 1950 for modifier 1. (mod yr: %s)

Rule	Message
10.3.16 If modifier is either CC or BU and the modifier extent is 5 then origin of layer cannot be less than modifier 1 year (Error)	When MOD1 is CC or BU and MOD1_EXT is 5 then Origin cannot be less than MOD1_YR (origin: %s mod1_yr: %s)
10.3.17 If layer is treed with MOD1 = CC, MOD1_EXT = 5 and no BU modifier 2 then origin of layer must be same as modifier 1 year (Error)	For treed stands, when MOD1 is CC and MOD2 <> BU and MOD1_EXT is 5, then Origin must be same as MOD1_YR (origin: %s mod1_yr: %s)
10.3.18 If modifier 1 is CC and modifier 1 extent is less than 5 then the origin of the layer must be less than modifier 1 year (Error)	When MOD1 is CC and MOD1_EXT < 5, then Origin must be less than MOD1_YR (origin: %s mod1_yr: %s)
10.3.19 If modifier 1 is CC with modifier 1 extent = 5 and modifier 2 is BU with modifier 2 extent < 5 then the layer origin must be the same as modifier 1 (Error)	When MOD1 is CC with MOD1_EXT = 5 and MOD2 is BU with MOD2_EXT < 5 then origin must be the same as MOD1_YR
10.3.20 If modifier 1 is CC and modifier 1 extent is 5 and modifier 2 is **not** BU then layer origin must be same as modifier 1 year (Error)	When MOD1 is CC with MOD1_EXT = 5 then origin must be the same as MOD1_YR
10.3.21 If modifier is BU then modifier year must be populated (Error)	Year of burn missing for modifier 1; must have a modifier year
10.3.22 If modifier 1 is CC and modifier 2 is BU and both modifier extents are 5 and if modifier 2 year is greater than modifier 1 year then the origin must match modifier 2 year (Error)	If modifier extent is 5 for both CC and BU modifiers and where modifier year for BU is more recent then CC then Origin must match that of BU
10.3.23 For the primary layer, If layer origin is >= 1970 then likely to have modifier of CC or BU (Warning)	Stands with origin >= 1970 have most likely been burned or harvested so should have a modifier, extent and modifier year (origin: %s)
10.3.24 If the ARIS field is populated then should have a CC modifier with associated modifier year or RT with no modifier year (Error)	When ARIS field is populated then should have a CC modifier and modifier year or an RT modifier with no modifier year.
10.3.24.2 If modifier 1 is CC and modifier 1 year > 1990, then ARIS field should be populated (Warning)	Areas harvested after 1990 should have the ARIS field populated.
10.3.25 If modifier 1 is BK and the TPR is U or F then the BK call is questionable (Warning)	A modifier of BK is questionable in association with a of TPR U or F
10.3.26 If modifier 1 is BK then modifier 2 must be SN (Error)	When BK is used as a modifier then MOD2 must be SN
10.3.27 If modifier 1 is BK with a modifier extent of 5 and the layer is treed then no pine species is allowed in SP1-SP5 (Error)	When modifier is BK and modifier extent is 5 then no pine is allowed as a species
10.3.28 If modifier 1 is BK with a modifier extent less than 5 and the layer is treed then a pine species must be present in SP1-SP5 (Error)	When modifier is BK and modifier extent is less than 5 then one of the species must be pine
10.3.29 If modifier is BK then the layer should be treed (Warning)	When BK is used as a modifier then layer should be treed
10.3.30 The modifier BK can only be assigned to modifier 1 (Error)	The modifier BK must be assigned to MOD1 not MOD2

Rule	Message
10.3.32 If layer is treed and crown closure is > A and modifier 1 is either CC or BU with a modifier extent = 5 then origin must = modifier 1 year (Error)	Treed layer has a CC or BU modifier1 with an associated year and extent = 5 but the origin of the stand does not match the modifier year. (mod_yr: %s origin: %s)
10.3.33 If layer is treed and crown closure is A and modifier 1 either CC or BU and a modifier extent = 5 then origin must = modifier 1 year (Warning)	Treed layer has a CC or BU modifier1 with an associated year and extent = 5 but the origin of the stand does not match the modifier year. (mod_yr: %s origin: %s)
10.3.34 If modifier 1 is either CC or BU and the modifier 1 extent = 4 then origin of layer should = modifier 1 year (Warning)	Treed layer has a CC or BU modifier1 with an associated year but the origin of the stand does not match the modifier year. (mod_yr: %s origin: %s)
10.3.35 If modifier 1 is CC then modifier 2 cannot be CL (Error)	A CC modifier cannot be found in conjunction with a CL modifier
10.3.36 If the moisture regime is 'a' then there should not be a CC modifier associated with the layer (Warning)	A CC modifier was found in association with an aquatic moisture regime

11 Timber Productivity Rating (TPR)

The main validation for TPR is performed by calculating its value using the formulas that determine the value that should be applied to the layer.

Rule	Message
11.1.1 TPR calculations require that the photo year for the polygon is populated (Error)	Field PHOTO_YR not populated, required to calculate TPR
11.1.2 If the polygon stand structure is M and both layers are treed then if the primary layer species 1 is the same as the secondary layer species then the TPR for each layer must match (Error)	Overstorey and understorey have different TPR values, should be same when overstorey species 1 is same as understorey species 1. (O sp1: %s tpr: %s U sp1: %s tpr: %s)
11.1.3 If the polygon stand structure is M and neither the primary or secondary layer is treed then if each layer has been assigned a TPR value then these values should be the same (Error)	Non-forest Overstorey/Non-forest Understorey: TPR values do not match. (O tpr: %s U tpr: %s)
11.1.4 If the polygon stand structure is M and the primary layer is treed while the secondary layer is not treed but has an assigned TPR value then the TPR for secondary layer must match that of the primary layer (Error)	Understorey TPR value should match forested overstorey TPR. (O tpr: %s U tpr: %s)
11.1.5 If the polygon stand structure is M and the secondary layer is treed while the primary layer is not treed but has an assigned TPR value then the TPR for primary layer must match that of the secondary layer (Error)	Overstorey TPR value should match forested understorey TPR. (O tpr: %s U tpr: %s)
11.1.6 If a layer is treed then it must have a TPR value (Error)	TPR missing from forested layer
11.1.7 If a layer is non-forest vegetated then it must have a TPR value (Error)	TPR missing: when NFL populated: (%s) then TPR is required

Rule	Message
11.1.8 If the layer is anthropogenic vegetated with a value of CPR then the layer requires a TPR (Error)	TPR missing: when Anthropogenic Vegetated is CPR then TPR is required
11.1.9 If the layer is naturally non-vegetated with a value of NMB the it requires a TPR (Error)	TPR missing: when Naturally Non-vegetated is NMB then TPR is required
11.1.10 If the layer is naturally non-vegetated and is not NMB then no TPR value is allowed (Error)	TPR cannot be present in Naturally Non-vegetated layer unless NMB (NatNon: %s TPR: %s)
11.1.11 Photo year must be between 1980 and current year (Error)	Invalid PHOTO_YR: %s, must be between 1980 and current year
11.1.12 Submitted TPR must match the calculated TPR (Error)	Calculated TPR: %s does not match submitted TPR: %s

12 Relationship Validation

These rules apply to relationships between layers and other attributes that are is some way related or dependent.

Rule	Message
12.1.1 The second layer of a stand cannot contain any data unless the stand structure is either M or H (Error)	Understorey attributes found but overstorey stand structure is neither M nor H (Fields with data: %s)
12.1.2 If the stand structure contains either M or H then the secondary layer must contain data (Error)	When the Stand Structure is M or H then must have understorey attributes, none were found. (Stand Structure: %s)
12.1.3 If the primary layer has a moisture regime of 'a' and NFL is HF then if the stand structure is **not** H, there must not be an understorey (Error)	When the overstorey contains HF and the moisture regime is aquatic then there cannot be an understorey
12.1.4 If the primary layer is non-forest vegetated with a value of either SO or SC then the secondary layer should **not** contain the same NFL value as the overstorey (Warning)	Overstorey and understorey have the same non-forest vegetated call of: %s
12.1.5 If the primary layer is non-forest vegetated (other than SO or SC) then the secondary layer cannot contain the same non-forest vegetated call (Error)	Overstorey and understorey have the same non-forest vegetated call of: %s
12.1.6 If primary layer is naturally non-vegetated then the secondary layer cannot contain the same naturally non-vegetated call (Error)	Overstorey and understorey have the same naturally non-vegetated call of: %s
12.1.7 If primary layer is anthropogenic vegetated then the secondary layer cannot contain same anthropogenic vegetated call (Error)	Overstorey and understorey have the same anthropogenic vegetated call of: %s'
12.1.8 If primary layer is anthropogenic non-vegetated then the secondary layer cannot contain same anthropogenic non-vegetated call (Error)	Overstorey and understorey have the same anthropogenic non-vegetated call of: %s
12.1.9 If stand structure is M then none of the secondary layer modifiers should be CC or BU (Error)	CC or BU modifier should not be contained in understorey

Rule	Message
12.1.10 If stand structure is M and the secondary layer contains either treed, anthropogenic vegetated, or non-forest vegetated then the moisture regimes of both layers must be the same (Error)	When stand structure is M then overstorey and understorey moisture regime values should be same. (O moist reg: %s U moist reg: %s)
12.1.11 If stand structure is M and the secondary layer is non-forest vegetated SC or SO then the primary layer cannot be anthropogenic vegetated (Error)	When SO or SC is contained in understorey then you cannot have an anthropogenic vegetated call in the overstorey. (O anth veg: %s U nfl: %s)
12.1.12 If stand structure is M and the secondary layer is non-forest vegetated SC or SO then the primary layer cannot be anthropogenic non-vegetated (Error)	When SO or SC is contained in understorey then you cannot have an anthropogenic non-vegetated call in the overstorey. (O anth non: %s U nfl: %s)
12.1.13 If stand structure is M then the secondary layer origin cannot be greater than the primary layer origin unless the DATA field contains F indicating it has been field checked (Error)	Understorey origin cannot be older than overstorey origin unless stand is field checked. (O origin: %s U origin: %s)
12.1.14 If stand structure is M then the secondary layer cannot be anthropogenic vegetated (Error)	Cannot have an anthropogenic vegetated understorey: %s
12.1.15 If primary layer is treed and stand structure is M then secondary layer cannot be anthropogenic non-vegetated unless it is ASR, ASC, or AIF (Error)	Cannot have an anthropogenic non-vegetated understorey (other than ASR, ASC, or AIF) unless overstorey is treed. (U anth non-veg: %s)
12.1.16 If primary layer is treed and stand structure is M then secondary layer cannot be naturally non-vegetated (Error)	A Naturally Non-vegetated understorey is not allowed in a multistoried stand when the overstorey is treed. (O sp1: %s U nat non-veg: %s)
12.1.17 If stand structure is M then the only time the secondary layer can contain a naturally non-vegetated call (restricted to: NMS, NWF, NWL, NMC) is if the primary layer is non-forest vegetated (Error)	You can only have a Naturally Non-vegetated understorey of NMS, NWF, NWL or NMC when overstorey is not Non-forest Vegetated. (O nfl: %s U nat non: %s)
12.1.18 If stand structure is M and the primary layer is non-forest vegetated (excluding SO and SC), then secondary layer cannot be treed unless DATA is A or F (Error)	When non-forest vegetated overstorey is not SO or SC then you cannot have a forested understorey unless data source is A, F. (O nfl: %s U sp1: %s)
12.1.19 If stand structure is M and the primary layer is non-forest vegetated with either SO or SC, then secondary layer cannot be anthropogenic vegetated (excluding CIP and CIW) unless DATA is A, F, S (Error)	When overstorey is SO or SC then you cannot have a anthropogenic vegetated understorey other than CIP or CIW unless data source is A, F, or S. (O nfl: %s U anth veg: %s)
12.1.20 If stand structure is M and the primary layer is non-forest vegetated then the secondary layer cannot have a naturally non-vegetated call of NMS unless DATA is F or A (Error)	When overstorey is SO or SC then you cannot have a naturally non-vegetated understorey of NMS unless data source is A or F. (O nfl: %s U nat non-veg: %s)
12.1.21 If stand structure is M and the primary layer is non-forest vegetated (SO or SC) then the secondary layer cannot have a naturally non-vegetated call of NWL or NWF (Error)	When overstorey is SO or SC then you cannot have a naturally non-vegetated understorey of NWL or NWF. (O nfl: %s U nat non-veg: %s)

Rule	Message
12.1.22 If stand structure is M and the primary layer is non-forest vegetated with a value HG, HF, or BR then the secondary layer cannot be naturally non-vegetated (Error)	When overstorey is HG, HF or BR then you cannot have a non-forest vegetated understorey. (O nfl: %s U nfl: %s)
12.1.23 If stand structure is M and the primary layer is non-forest vegetated HF then the secondary layer cannot be naturally non-vegetated NWI or NWR (Error)	When overstorey is HF then you cannot have a naturally non-vegetated understorey of NWI or NWR. (O nfl: %s U nat non-veg: %s)
12.1.24 If stand structure is M and the primary layer is non-forest vegetated HF then the secondary layer cannot be naturally non-vegetated NMR, NMS, NMC unless DATA is F or A (Error)	When overstorey is HF then you cannot have a naturally non-vegetated understorey of NMR, NMS. or NMC unless data source is A or F. (O nfl: %s U nat non-veg: %s)
12.1.25 If stand structure is M and the primary layer is non-forest vegetated HF and the secondary layer is naturally non-vegetated NWL or NWF then the moisture regime for the primary layer must be 'a' (Error)	When overstorey is HF and you have a naturally non-vegetated understorey of NWL or NWF then the overstorey moisture regime must be aquatic. (O moist reg: %s)
12.1.26 If stand structure is M and the primary layer is non-forest vegetated HR or BR then the secondary layer cannot have a naturally non-vegetated call of NMR, NMS, NMC unless data is F or A (Error)	When overstorey is HG or BR then you cannot have a naturally non-vegetated understorey of NMR, NMS. or NMC unless data source is A or F. (O nfl: %s U nat non-veg: %s)
12.1.27 If stand structure is M and the primary layer is non-forest vegetated HR or BR then the secondary layer cannot have a naturally non-vegetated call other than NMR, NMS, NMC when data is F or A (Error)	When overstorey is HG or BR then you cannot have a naturally non-vegetated understorey other than NMR, NMS. or NMC (Must Also Be Field Checked)
12.1.28 If stand structure is M you cannot have an secondary layer if primary layer is anthropogenic non-vegetated (Error)	When overstorey is Anthropogenic Non-vegetated then no understorey is allowed (O anth non: %s)
12.1.29 If stand structure is M you cannot have a secondary layer if primary layer is anthropogenic vegetated (Error)	When overstorey is Anthropogenic Vegetated then no understorey is allowed (O anth veg: %s)
12.1.30 If stand structure is M you cannot have a secondary layer if primary layer is naturally non-vegetated (Error)	When overstorey is Naturally Non-vegetated then no understorey is allowed (O nat non: %s)
12.1.31 If stand structure is M and the primary and secondary layers both have a height then the primary layer must have the higher height (Error)	Overstorey Height must be greater than understorey Height. (O height: %s U height: %s)
12.1.32 If stand structure is M and the primary and secondary layers both have a height and both layers are treed then height difference between primary and secondary layers must be at least 3 meters (Error)	Overstorey Height must be at least 3 meters greater than understorey Height when both overstorey and understorey are treed. (O height: %s U height: %s)

Rule	Message
12.1.33 If stand structure is M and the primary and secondary layers both have a height then the heights can only be the same if secondary layer contains a non-forest vegetated value of SC or SO (Error)	When the overstorey Height is the same as the understorey Height then understory must be SC or SO. (O height: %s U height: %s)
12.1.34 If stand structure is M and both the primary and secondary have a DATA value of F then the DATA_YR for each layer must be the same (Error)	When both the understorey and overstorey have a Data Source value of F then the Data Source Years must be the same (O: data: %s data yr: %s U data source: %s yr: %s)
12.1.35 If stand structure is M then the secondary UDATA cannot have a value of A unless the primary DATA value is either A or I (Error)	When the understorey has a Data Source value of A then the overstorey Data Source value must be either A or I. (O data source: %s U data source: %s)
12.1.36 If stand structure is M and both the primary and secondary have a DATA value of A then the DATA_YR for each layer must be the same (Error)	When the Data Source of both the understorey and overstorey is A then Data Source Year values must the same. (O data yr: %s U data yr: %s)
12.1.37 If stand structure is M and DATA value is F or S then UDATA must also be F and bother DATA-YRs must be the same (Error)	When the understorey has a Data Source value of F or S then the overstorey Data Source must be F and the data years must be the same (O: data source: %s data yr: %s U data: %s yr: %s)
12.1.38 If stand structure is M and overstorey Data Source is A then UDATA can only be A, S, F, I (Error)	When overstorey Data Source is A then understorey Data Source can only be A, S, F, or I. (O data: %s U data: %s)
12.1.39 If stand structure is M and DATA is S or F then UDATA must be the same value and DATA_YR must be same as UDATA_YR (Error)	When the overstorey has a Data Source value of F or S then the understorey Data Source must be same and the Data Years must be the same (O: data: %s data yr: %s U data: %s yr: %s)
12.1.40 If stand structure is H and only one of the layers is treed then the treed layer must be the primary layer (Error)	When a horizontal structure and only one of the horizontal components has forested data then that forested data must be found in the first horizontal component
12.1.41 If stand structure is H and both layers have a height then the layer with the highest height must be the primary layer (Error)	With a horizontal structure the tallest component must be first even if its horizontal percentage is less than the other component. (O height: %s Y height: %s)
12.1.42 If stand structure is H and both layers are treed then SP1 cannot be same in both layers if their height and species percent are the same	With a horizontal structure, species 1 cannot be duplicated in the two components when their species percentages and heights are the same
12.1.43 If stand structure is H then the non-forested vegetated call cannot be duplicated in the layers.	Non-forest vegetated cannot be duplicated if a horizontal structure. (O nfl: %s U nfl: %s)
12.1.44 When both horizontal components are treed then the tall one must be first.	When both components of a horizontal stand are treed then the component with the greater height must be in the first component. (O height: %s Y height: %s)
12.1.45 Unlikely to have understorey if crown closure is D (Warning)	When the overstorey crown closure is D then it is unlikely that there would be an understorey. (O density: %s U density: %s)

Rule	Message
12.1.46 Unlikely to have a UDATA value (Warning)	Understorey data source questionable. (U data: %s)
12.1.47 Unlikely to have modifiers in the understory (Warning)	Understorey modifier 1 questionable. (U mod1: %s

Appendix V AVI Audit Tools

A number of tools have been developed to assist in auditing AVI feature classes stored in a File Geodatabase (FGDB). These tools perform certain audit checks as well as enabling export of AVI attributes to a FGDB table.

Install Tools

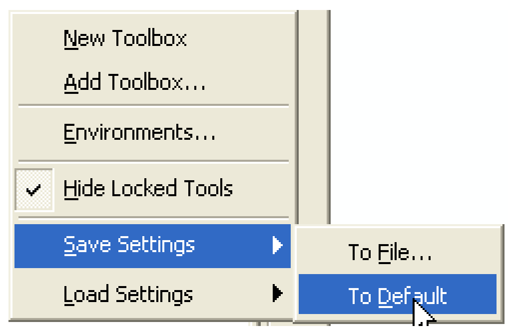
The scripts and ArcToolbox are delivered in a zip file named avi_audit_tools.zip. To install the software simply unzip the contents to a directory you have created to hold these tools. Note that you may wish to place these tools into a network directory where they will be accessible to others. Once the tools are installed they will be available from either ArcMap or ArcCatalog.

Accessing Tools

These tools may be accessed from either ArcMap or ArcCatalog.

Make sure the toolbox window is visible, if not click on the  icon to open it.

Right click on an area within the toolbox window and select **Add Toolbox**. Browse to location where you unzipped the tools and select the **AVI Geodatabase** toolbox. This will add the toolbox to other existing toolboxes. To ensure the toolbox will be available each time you open ArcMap or ArcCatalog, right click on a blank area of you toolbox windows and select **Save Settings → To Default**. This will save the toolbox settings to Normal.mxt

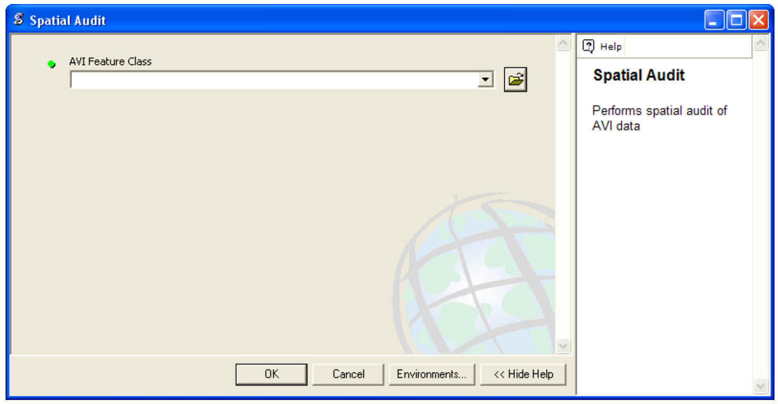


Classification: Public

Spatial Audit

The spatial audit performs a number of quality control checks of the AVI feature class. While the majority of checks are spatial, some attribute structure checks are also performed. The results of the audit process are written to a log file indicating any errors detected. Also, a number of feature classes may be created containing elements indicating spatial errors detected. These feature classes can be reviewed in ArcMap so that the errors can be corrected.

To run the audit, select the **Spatial Audit** tool from the toolbox. Either select or browse to the AVI feature class you wish to evaluate and hit the **OK** button. **Note** that if you have added the audit feature classes to your ArcMap session and are running the audit for a second time then you must remove these feature classes prior to running. If you do not remove these layers (gaps, overlap, etc.) then these layers will be locked and the audit will fail.



As the audit proceeds the results of each test are written to the script window as well as to a log file. The name of the log file will be the same as the File Geodatabase that contains the AVI feature class being evaluated but will have **_audit.log** appended to the end of it. For example, if the FGDB was named S10 the log file would be S10.log. This is a text file that can be reviewed in any text editor.

In addition to a log file an audit FGDB will also be created. The name of the FGDB is the same as the File Geodatabase containing the AVI feature class but with an **_audit** appended to the end of its name. For example, if the AVI FGDB is named S10 then the audit FGDB would be named S10_audit.

The audit FGDB can potentially contain a number of feature classes depending on the results of the spatial audit. The following table indicates the names of these feature classes and their content.

Feature Class	Description
Overlap	Polygon feature class containing features indicating where overlapping polygons were detected.
Gaps	Polygon feature class containing features indicating where potential gaps between polygons were detected.
Att_neighbor	Polygon feature class that contains the polygons where the attributes are the same across their shared border.

The following table indicates the types of audit checks that are performed on the selected AVI feature class.

Check	Description
Missing Fields	Checks the AVI feature class to ensure that all the required AVI fields are present.
Extra Fields	Checks to ensure that only valid AVI feature class fields are present.
Overlap	Checks for polygon overlap. Any overlaps that are detected are written as polygons to the Overlap feature class in the audit FGDB.
Gaps	Checks for potential gaps in the AVI feature class. Note that in some cases gaps are legitimate if they represent excluded regions within the project area. These gaps must be manually reviewed to determine if they are in fact errors. Any potential gaps are written to the Gaps feature class in the audit FGDB.
Neighbour Attributes	Checks the attributes of neighbouring polygons to ensure they are not the same. If any errors are detected the offending polygons are written to the att_neighbor feature class in the audit FGDB. The log file will list the OBJECTID values for the offending polygons.
Multi-parts	Makes sure there are no multi-part polygons. Will list the OBJECTID of features that are multi-part.
Duplicate POLY_NUM	Makes sure that each POLY_NUM is unique. Note that if you had multi-part polygons and converted them into single part polygons you will probably have duplicate POLY_NUM values. Calculate these to the OBJECTID field to make them unique.
Attribute Structure	Checks to make sure that the AVI fields match the proper structure for name, type and length.

Attribute Audit

There are 2 steps to performing an Attribute Audit. The first step is to run the actual AVI attribute validation on the AVI feature class. Open the Attribute Audit tool from the AVI Audit toolbox. Select the AVI feature class you wish to validate and run the tool.

The Attribute Audit will add two tables to the FGDB where the AVI feature class is located. The one table will contain some general information regarding the audit run while the other will contain the errors and warnings encountered. To create a report from the results of an audit run use the Attribute Audit Log Report tool. For the AVI feature class select the one you just ran through the audit. Next enter the name of the log file you wish the reports written to. This is an ASCII file that can be viewed using any text editor. The remaining check-boxes provide some flexibility with displaying report information. Once you have run the report open the log file using a text editor to review results.

See the online help provided through the tool for additional information on their operation.

Appendix VI AVI TPR Calculator

In order to standardise the way TPR is calculated for AVI polygons, a set of ArcGIS tools have been developed to both calculate TPR and validate it. The rules used by these tools are described below.

TPR Calculation

TPR calculations are performed using a set of formulas as documented in the AVI 2.1.5 standards manual. The formulas have been implemented using a Python script that can be run from ArcGIS. TPR is calculated for forested polygons greater than 5 metres high. Any forested polygons less than 6 metres high must have an interpreted TPR. The rules that have been implemented for the TPR calculator are as follows:

1. If a forested layer is less than 6 metres in height, no calculation will be performed on that layer.
2. Photo year is used as the base year in determining the Breast Height Age. This requires that all AVI feature classes have a populated PHOTO_YR field in order to obtain this value.
3. The Breast Height Age is calculated by taking the photo year and subtracting the ORIGIN of the layer. An adjustment value based on the species type is then subtracted from this value to obtain the age. For instance, and polygon with a leading species of 'SW', 'SE', 'FD', 'FB', 'FA' is considered a White spruce/fir species type and an adjustment value of 15 years is used. If the resulting Breast Height Age is less than 1 then no TPR calculation can be performed on the layer and an interpreted TPR will be required.
4. Prior to calculating the Breast Height Age the ORIGIN is adjusted if needed. Since origin is normally reported by decade, the midpoint of the decade is used for the origin value in TPR calculations. For instance, if the origin of the layer is 1930 then 1935 would be used as the origin in the TPR calculation. It is assumed that if the origin of a polygon ends in 0, then it represents a decadal origin and the adjustment will be applied. If it does not end in 0, then it is assumed to be a known origin and its value will be used as is.
5. If the polygon is Complex then the mid-point height (recorded height) is used when calculating TPR.
6. In addition to calculating the pure TPR value of a layer, additional rules are applied in consideration of other AVI standards. These include the following:
    a. If a layer can have its TPR calculated then it will clear any I (interpreted TPR) flags in the Existing Data field for that layer.
    b. It the polygon is multi-storied and the understorey species 1 is the same as the overstorey species 1 then the understory TPR will be forced to be the same as the overstorey.
    c. If the polygon is multi-storied and one of the layers is forested while the other is non-forest vegetated then the non-forest vegetated layer is assigned the TPR from the forested layer.
    d. If the polygon is multi-storied and one of the layers is forested while the other is anthropogenic vegetated CPR then the anthropogenic vegetated layer is assigned the TPR from the forested layer.

e. If the polygon is multi-storied and one of the layers is forested while the other is naturally non-vegetated NMB then the naturally non-vegetated layer is assigned the TPR from the forested layer.

TPR Validation

AVI validation functions have been incorporated into the tools. The rules used for validation are as follows:

1. Any forested layer greater than 5 metres and able to have a TPR value calculated will use this calculated TPR in comparison with the recorded TPR, if they are different an error message is generated. Note that the “I” (Interpreted TPR flag) from the Existing Data field will be ignored since all polygons greater than 5 metres now require a calculated TPR.
2. All forested layers require a TPR.
3. All non-forest vegetated layers require a TPR.
4. Any naturally non-vegetated layers classified as NMB require a TPR.
5. Any anthropogenic vegetated polygons classified as CPR require a TPR.
6. TPR must be one of: 'G','M','F','U'.
7. When a polygon is multi-layered and the overstorey species 1 is the same as the understorey species 1 then the understorey TPR must match the overstorey TPR.
8. If a polygon is multi-layered and one of those layers is forested and the other is non-forest vegetated, anthropogenic vegetated CPR, or naturally non-vegetated NMB then the TPR of this non-forest layer must match that of the forested layer.

Appendix VII Sample AVI Audit Report

FMU R14 AVI Audit Results

Company	Crown
Contractor	XXXXXXXXX
FMU	R14
Date of Submission	February 13, 2015
Aerial Imagery Type	ADS 80 4-band 30 cm
Aerial Imagery Year	2012
LiDAR Year	2005 - 2007
# Interpreters	1
Auditor	XXXXXXXXXX

Spatial Audit

Check	Description	Results
Missing Fields	Required AVI fields are missing	None
Extra Fields	Invalid AVI feature class fields are present	None
Overlap	Polygon overlap	None
Gaps	Gaps in the AVI feature class	None
Neighbour Attributes	Attributes of neighbouring polygons are the same	None
Multi-parts	Multi-part polygons	None
Duplicate POLY_NUM	Each POLY_NUM is not unique	None
Attribute Structure	AVI fields do not match the proper structure for name, type and length	None

Attribute Audit

Error Summary

Frequency	Description	Results
0	No errors were found in the attribute data	No action required

Warning Summary

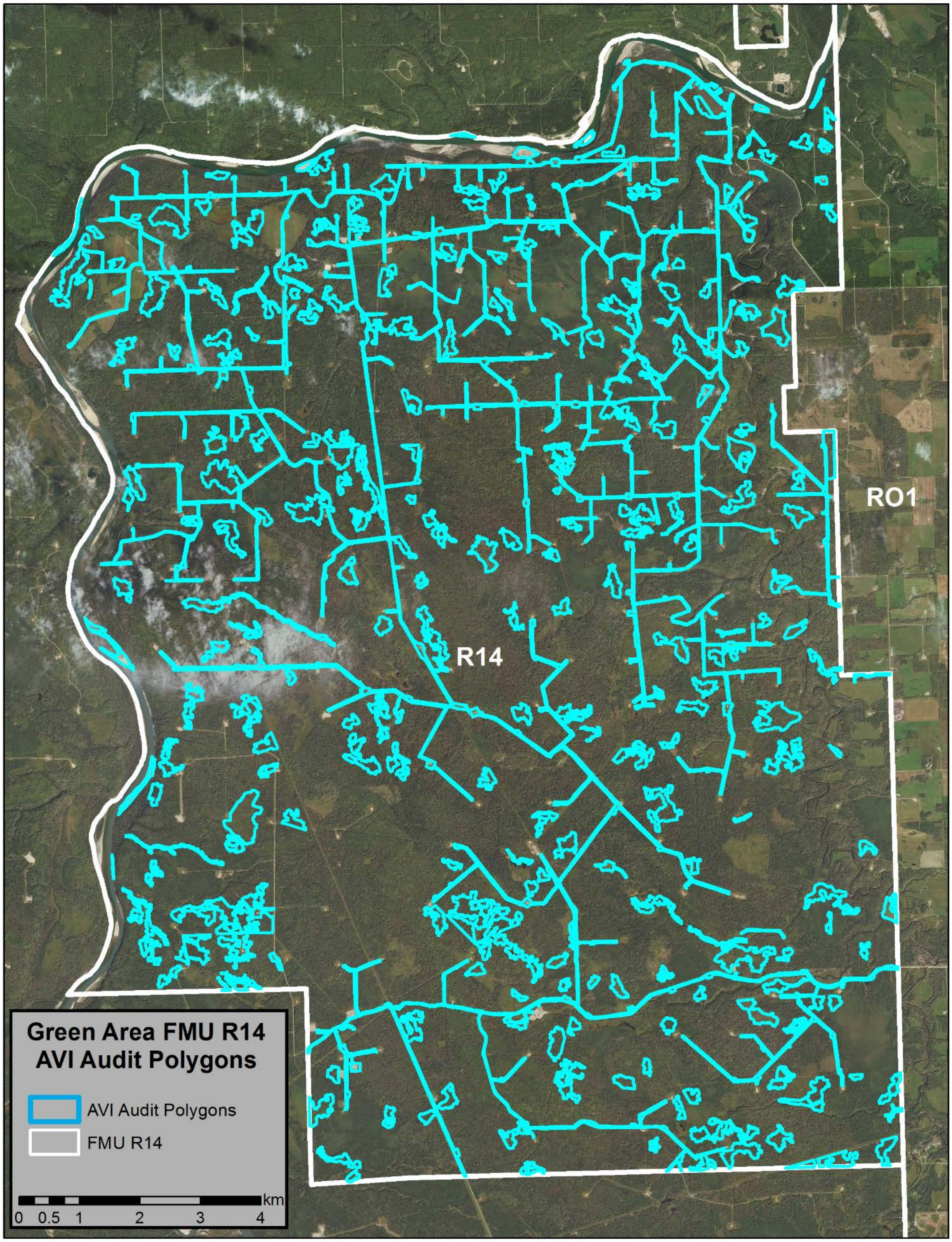
Frequency	Description
33	OVERSTOREY A mesic or dry moisture regime: m found in conjunction with Lt species 1
12	OVERSTOREY A mesic or dry moisture regime: m found in conjunction with Sb species 1
3	OVERSTOREY A wet moisture regime: w found in conjunction with Pl species 1
2	OVERSTOREY TPR: U found in conjunction with Bw species 1
1	OVERSTOREY TPR: U found in conjunction with Pb species 1
56	OVERSTOREY Year of cutblock missing for modifier 1
22	UNDERSTOREY A mesic or dry moisture regime: m found in conjunction with Lt species 1
117	UNDERSTOREY A mesic or dry moisture regime: m found in conjunction with Sb species 1

Interpretation Audit

The interpretation audit process involved creating stratum based on various types deemed to be important indicators in vegetation inventory. The strata are sampled using the strata statistics and random polygons are selected using the POLS (Polygon Sampling) tool for subsequent audit (See Strata Statistics and Sampling Parameters). The variables audited were as follows;

- Moisture regime
- Crown closure (A/B/C/D)
- Crown closure (AB/CD)
- Height
- Non-forested
- Seral Stage
- Species 1
- Modifier 1
- Base 10 Strata
- Cover Group
- Understorey Height
- Understorey Species 1
- Understorey Base 10 Strata
- Understorey Cover Group

The submission contained a total of 8,837 polygons of which 264 were audited. A five-metre canopy height model was generated for each polygon to assist in height estimation. The average agreement between the contractor and auditor of the above variables was found to be 95.5% (See Agreement Summary). Based on this level of agreement the inventory was deemed to be very acceptable.


RO1
R14
Green Area FMU R14
AVI Audit Polygons
AVI Audit Polygons
FMU R14
km
0 0.5 1 2 3 4

Polygon Selection (POLS) Information

- Number of polygons in input feature class: 3,924
- Number of selectable polygons : 3.924
- Total area covered by selectable polygons: 21,114.8 ha
- Total number of polygons audited: 281
- Total area covered by audited polygons: 1,958.7 ha

Strata Statistics and Sampling Parameters

Strata	# Polygons	Area (ha)	% Area	# Sample Polygons	Sample Area (ha)
Deciduous	1,209	8,641.8	40.5	90	557.7
Mixedwood	705	4,246.2	19.9	60	302.7
Upland Conifer	640	2,406.3	12.2	35	153.2
Forested Wetland	383	1,795.4	8.4	30	110.7
Non-forested	691	2,724.3	12.8	36	651.9
CC	296	1,330.9	6.2	30	182.4
Totals	3,924	21,114.8	100	281	1,958.7

Agreement Summary

Variable	% Agreement
Moisture regime	98.6
Crown closure (A/B/C/D)	93.6
Crown closure (AB/CD)	96.8
Height	94.0
Non-forested	99.3
Seral Stage	95.0
Species 1	96.4
Modifier 1	99.6
Base 10 Strata	92.5
Cover Group	92.9
Average Overstorey Agreement	**95.9**
Understorey Height	94.3
Understorey Species 1	95.7
Understorey Base 10 Strata	94.3
Understorey Cover Group	94.3
Average Understorey Agreement	**94.7**
Average Total Agreement	**95.5**

<u>Overall Comments</u>

The delineation of POLY_NUM 16 is very good at capturing the anthropogenic footprint on the exterior; however we would like to see the different dispositions further delineated from within this polygon. Most of the activities we would like to see further delineated are related to MSL dispositions. In the scenario, where the LOC disposition (AIH AVI polygon) cuts through the MSL disposition (CIW AVI polygon) we can give priority to the MSL over the LOC. We will leave it up to the interpreter to make the most logical decision of how the anthropogenic footprint be broken down to best reflect the use of the land. Occasionally a clearing occurs next to or near a CIW but the clearing is not part of the MSL disposition (e.g. POLY_NUM's 3168 and 3515). The non-MSL part of these polygons would be better served if merged into the AIH ROW rather than associated with the MSL disposition.

Of the 56 cutblocks with no year associated with them, 18 polygons have either Phase 3 CC years or R14 MTU blocks with skid clearance dates that can be used to populate the MOD1_YR attribute.

When attributing forested polygons with very marginal "A" density overstorey crown closures (around or under the 10% range) interpreters should consider blending the overstorey with the understorey. This may help the end user get a better representation of what the polygon consists of since it is often the overstorey that garners the most attention. Similarly if the overstorey is marginal (around or under the 10% range) and there is a second forested layer that is slightly denser, consider calling the denser layer (blending in the marginal overstorey) along with the non-forested portion of the polygon. For example if the polygon has between 6 to 10 percent 22m Aw over 30 percent 12m Sw over 50% 2m open shrub, Aw over Sw may not describe the polygon as well as an Sw9Aw1 over SO. These scenarios have not been penalized as technically they could be correct. It is understood that the interpreter wants to make sure that we recognize they are seeing the overstorey but sometimes it may be better to describe the what the polygons consists *mostly* of.

Appendix VIII Final Harvest Area Data Model

1.1 Objectives

The objective of this appendix is to provide an overview of Final Harvest Area entities/pseudo-entities and the relationships that exist between them in context of the Final Harvest Area business rules. This appendix details the digital format currently used within Alberta Agriculture and Forestry.

1.2 Final Harvest Area Logical Data Model

The Final Harvest Area Logical Data Model outlines the entity definition and relationships with other entities are governed by the business rules established for them.

1.3 Logical Entity Relationships

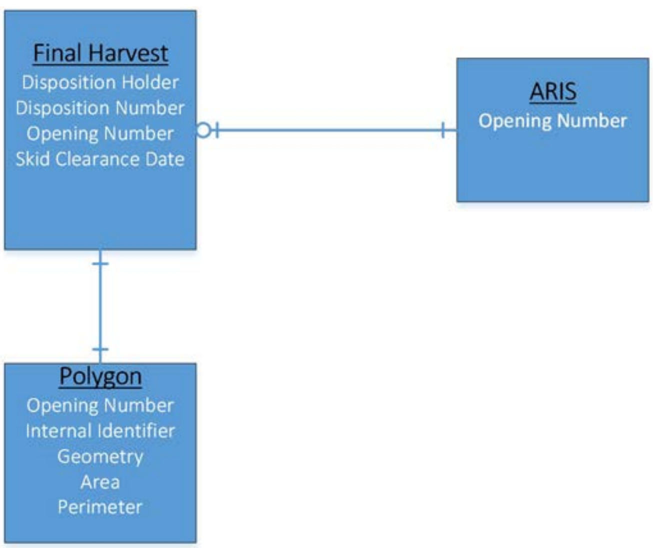


Figure 7-10: Logical Entity Model

1.3.1 Metadata

Description: Compilation information regarding disposition holder and authority to harvest.

Attributes:

Disposition Holder (**DISP_HOLDR**)
Description: Identifies the company or agency with the authority to harvest and to which reforestation responsibility is attached for the harvest area. The ARIS stakeholder code designation (see Appendix D – ARIS Industry Operations Manual) must be used.

Name	Alias	Type	Length	Domain Values
DISP_HOLDR	Disposition Holder	Text	4	Any text

Disposition Number (**DISP_NUM**)
Description: The disposition number (e.g. FMA, CTL, DTL) under which the disposition holder has the authority to harvest and to which reforestation responsibility is attached.

Name	Alias	Type	Length	Domain Values
DISP_NUM	Disposition Number	Text	10	Any text

ARIS Opening Number (**OPEN_NUM**)
Description: A unique identifier is assigned to a harvest area to enable tracking within the Alberta Regeneration Information System.

Name	Alias	Type	Length	Domain Values
OPEN_NUM	Opening Number	Text	11	Opening number registered in ARIS

Skid Clearance Date (**SKID_CLEARANCE_DATE**)
Description: Describes the date when timber skidding was completed in the opening. This is equivalent to the ARIS “skid clearance date”.

Name	Alias	Type	Length	Domain Values
SKID_CLEARANCE_DATE	Skid Clearance Date	Date		Valid date > 2000/01/01

1.3.2 Polygon

Description: An area that has been harvested that can be uniquely delineated from aerial imagery.

Attributes:

Object Identifier (**OBJECT-ID**)
Description: Uniquely system generated ID.

Name	Alias	Type	Length	Domain Values
OBJECT-ID		Integer	10	1 – 2147483646

Geometry (**SHAPE**)
Description: Polygon geometry.

Name	Alias	Type	Length	Domain Values
SHAPE		Blob		

Area (**SHAPE_Area**)
Description: Area of polygon in square metres.

Name	Alias	Type	Length	Domain Values
SHAPE_Area		Double		≥ Min Polygon Size

Length (**SHAPE_Length**)
Description: Length of feature in internal units (metres).

Name	Alias	Type	Length	Domain Values
SHAPE_Length		Real		> 0

1.3.3 Harvested Layer

Description: The external boundaries of harvest areas (treed areas harvested, usually in one season, for the purpose of obtaining wood for the production of various wood products such as lumber and pulp). Anthropogenic disturbances that occurred after harvesting must be identified.

Attributes:

Harvest Code (**HARV_CODE**)
Description: All harvested areas must designated with "H". Anthropogenic disturbances that occurred after harvesting must be designated with "A" and must have the ARIS opening number field populated.

Name	Alias	Type	Length	Domain Values
HARV_CODE	Harvest Code	Text	1	H, A

1.4 Valid Field Domain Values

The following is a summary of the physical Final Harvest Area fields and valid domain values associated with them.

Disposition holder: 4-character (uppercase) ARIS stakeholder code assigned to disposition holder

Disposition number: alpha-numeric (10) code issued by GoA, giving authority to harvest

ARIS opening number: Opening number registered in ARIS database

Harvest code: H, A

Skid clearance date: Valid date > 2000/01/01

Appendix IX Final Harvest Area Audit Protocols

Introduction

If the submitted data package meets the basic requirements for the zipfile it will be uploaded to the portal. The data package is then filtered through a basic Quality Control process that will immediately evaluate the content and structure of your data. If your data passes this step, it will be assigned to an auditor for further visual review and evaluation. An email will be sent to the data provider confirming that the data submission has successfully completed the submission audit. If the submission fails, an email will be sent to the data provider with a report detailing errors found. You will also be able to download a QC data package containing an FGDB with features classes and tables detailing spatial and attribute errors encountered. This will aid in locating and fixing errors.

In addition to the initial content and structure validation, geomatics and business audits will be performed on your submission. These are basically visual reviews to ensure the data meets the requirements of the SDD specifications. You can track the progress of your submission through the portal as it moves through these stages.

At any point in the audit process, disposition holders may be asked to provide the aerial imagery that was used to capture the harvest area.

Submission Audit

Zipfile Validation

- Cannot be password enabled
- Must contain a valid SDD FGDB named according to SDD standards
- Only one SDD FGDB can be contained in the zipfile

Schema Tests:

- Required Table not found in source
- Required Field not found in source
- Invalid Table (Feature Class) found in source.
- Invalid Field found in source
- Invalid Coordinate System
- Invalid field type and/or length
- Invalid Feature Type geometry type
- Invalid or missing domain code
- Invalid or missing domain values
- Invalid or Missing Version

Attribute Tests:

- Attribute Null Test
- Attribute Range Test
- Attribute Domain (Restricted) Test
- Number of Characters Test
- Case Test

- Same Value Test
- Sequential Test
- Regex Test

Conditional Attribute Tests:

- Valid Value
- Null or Blank
- Hard-Coded Value
- Test Negated

Spatial Tests:

- Overlaps
- Duplicate features

Geomatics Audit

- Alignment with ARIS
- Anthropogenic disturbance
- Slivers and gaps
- Coordinate system
- Skid clearance date

Business Audit

Satellite imagery used to verify:

- Completeness of the information
- Relative positioning of the disturbance boundaries