Arrow Timber Supply Area
Timber Supply Review

Data Package

April 2016

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1. Introduction

Under Section 8 of the *Forest Act* the chief forester must review the timber supply for each timber supply area (TSA) at least once every 10 years. Under the same section the chief forester may extend the current allowable annual cut (AAC) up to 15 years if the current timber supply is stable and any new developments would unlikely change the AAC. For more information about the AAC process please visit the following internet site: https://www.for.gov.bc.ca/hts/pubs.htm

This data package summarizes the information and assumptions that are used to conduct timber supply analysis for the Arrow Timber Supply Area (TSA). The information and assumptions represent current performance, which is defined by:

- the current forest management regime, the productive forest land available for timber harvesting, the silviculture treatments, the harvesting systems and the integrated resource management practices used in the area, including objectives and practice requirements contained in the *Forest and Range Practices Act*;
- land-use plans approved by Cabinet (i.e., Kootenay Boundary Higher Level Plan Order);
- orders issued through the Government Actions Regulation (GAR) of the *Forest and Range Practices Act* (FRPA);
- the order establishing provincial non-spatial old growth objectives and landscape units pursuant to the *Forest Practices Code of British Columbia Act*; and,
- legal objectives established under the *Forest and Range Practices Act* and the *Land Act*.

Analysis within the timber supply review models "what is" as opposed to "what if." Changes in forest management objectives and data, when and if they occur, are captured in future timber supply analyses.

Each section of this data package contains:

1) a short explanation of the data required;
2) data table or list of modelling assumptions, and;
3) description of data sources and other comments.

The information in this data package represents the best available knowledge at the time of publication, but is subject to change. A First Nations consultation and public review period has been established to allow submission of comments and concerns about the data package to the Ministry of Forests, Lands and Natural Resource Operations (FLNR). The information and assumptions in the data package that have been revised to incorporate First Nations and public input will be used to determine the timber harvesting land base (THLB) – the productive Crown forest land in the TSA available for timber harvesting. Until the THLB is determined, it is not possible to finalize the values shown in some of the tables in this document. In addition, should any major changes in management practices occur during the next few months, the timber supply analysis will attempt to capture them.

2. Background Information

2.1 Overview of the Arrow Timber Supply Area

The Arrow Timber Supply Area (TSA) is located in southern British Columbia in the Kootenay Boundary Natural Resource Region (Figure 1). The Monashee Mountains are to the west and the Selkirk Mountains are to the east; the TSA is bounded in the south by the Canada – U.S.A. border. The Arrow TSA is administered from FLNR Selkirk Natural Resource District offices located in Nelson, Castlegar, Grand Forks and Revelstoke.

The Arrow TSA covers a total area of approximately 1.28 million hectares. The four major communities within the Arrow TSA, along with their populations as reported by Statistics Canada (2011), are Trail (9,276), Castlegar (8,992), Fruitvale (3,628) and Rossland (3,491). Other communities include Warfield (1,700), Nakusp (1,574), Salmo (1,139), Montrose (1,030), New Denver (504), Slocan (296), and Silverton (195).

Figure 1. Arrow Timber Supply Area map.

Forests in the Arrow TSA are among the most productive and diverse in the interior of the province. The predominant tree species at lower elevations are Douglas-fir, lodgepole pine, western larch, western hemlock and western redcedar, and at higher elevations they are subalpine fir and Engelmann spruce. White pine, ponderosa pine, grand fir, aspen, black cottonwood and paper birch are also common in the TSA. The distinct ecological features and the unique nature of the Arrow TSA contribute to high biodiversity values. The diverse forests host a wide variety of wildlife species consequently; most BC ungulate species are present, including bighorn sheep, white-tailed and mule deer, moose, mountain goats, elk and caribou. The diverse ecology and mountainous terrain and lakes provide a wide range natural resource values within the Arrow TSA including timber, fish, wildlife habitat, water, recreation and tourism.

The current AAC for Arrow TSA is 513 700 cubic metres, reduced from the 2005 determination AAC level of 550 000 after the issuance of a community forest agreement (CFA) licence. In 1981, the AAC for the Arrow TSA was determined to be 640 000 cubic metres. In 1983, the AAC was reduced to 619 000 cubic metres to reflect the creation of Valhalla Provincial Park and this AAC level was maintained in the 1995 determination. The 2001 AAC determination reduced the AAC to 550 000 cubic metres, and this AAC level remained in the 2005 determination.

2.2 First Nations

The Crown has a duty to consult with, and accommodate if warranted, those First Nations for whom it has knowledge of the potential existence of aboriginal interests that may be impacted by a proposed decision, including strategic-level decisions such as AAC determinations. The chief forester must consider information arising from the consultation process with First Nations respecting aboriginal interests and treaty rights that may be affected by the AAC determination.

The Arrow TSA is located within all or portions of twelve First Nations' territories however none of their communities are located within it. The First Nations with whom consultation on this decision will take place are: Adams Lake Indian Band, Ktunaxa Nation Council, Lower Similkameen Indian Band, Neskonlith Indian Band, Okanagan Indian Band, Okanagan Nation Alliance (ONA), Osoyoos Indian Band, Penticton Indian Band, Shuswap Indian Band, Splatsin, Upper Nicola Band, Westbank First Nation.

All of these First Nations, with the exception of the ONA, have entered into one or more of the following agreements with the province of British Columbia: Economic Development Agreements (ECDA), Forestry Consultation and Revenue Sharing Agreements (FCRSA), Forest Tenure Opportunity Agreements (FTOA), Interim Agreement on Forest and Range Opportunities (IAFRO), Mountain Pine Beetle Agreements (MPB), Reconciliation Framework Agreement (SRFA), Strategic Engagement Agreement (SEA).

These agreements are designed to aid in improving the government to government relationship between the province and each First Nation and to close the social and economic gap between First Nations and other British Columbians.

Ktunaxa Nation Council is currently in treaty negotiations with the Province of British Columbia and Government of Canada. The treaty is nearing completion of Stage 4 – Agreement-in-Principle.

2.3 Archaeological assessments

Archaeological overview assessments (AOAs) have been completed for the TSA. Archaeological overview assessments are the basis for determining areas and sites that may require further assessment in the form of an archaeological impact assessment (AIA). AIAs are carried out as part of operational planning. The timber supply modelling assumptions for known archaeological and other First Nations' cultural heritage resources are discussed in more detail in the Section 6.2.10, "Cultural heritage resources".

2.4 Climate change

One of the government's goals to address climate changes is to establish resilient forests. Many adaptation strategies are being assessed, considered and implemented as shown in the following examples. New stocking standards guidance, informed by climate change research, is slowly being implemented across the province. Three sites in the Arrow TSA are part of a province-wide Assisted Migration Adaptation Trial (AMAT) which is contributing to understanding seedlot migration to maximize adaptation of future forest plantations. These adaptation strategies are difficult to incorporate into the TSR process as they have yet to emerge into clearly identifiable current forest management practices.

Climate change is predicted to impact forest ecosystems in a number of ways including a general increase in temperatures, change in precipitation patterns and an increase in frequency and severity of disturbances. Climate change is evident in the Arrow TSA by warmer and dryer summers and is impacting the forests resulting in increased frequency, severity and size of natural disturbances such as wildfire and insect outbreaks.

Information about the 2015 FLNR Climate Change Strategy, BC's overarching Climate Change Adaptation Strategies are available at the following internet sites:

https://www.for.gov.bc.ca/het/climate/index.htm

https://www.for.gov.bc.ca/het/climate/strategy/index.htm

2.5 Innovative Forestry Practices Agreements

Innovative Forestry Practices Agreements (IFPA) were signed in the Fall of 1998 between the Minister of Forests and five licensees within the Arrow TSA: Slocan Forest Products Ltd. (recently held by Springer Creek Forest Products and now held by International Forest Products Ltd.), Atco Lumber Ltd. (now named ATCO Wood Products Ltd.), Kalesnikoff Lumber Company Ltd., Bell Pole Company (now held by Stella-Jones Inc.) and Riverside Forest Products Ltd. (now held by Tolko Industries Ltd.). The agreements signed in 1998 were for a 10-year term. In January 2007, the Minister of Forests and Range enabled the extension of agreements to August 31, 2011. Subsequently the Regional Executive Director amended the Arrow IFPA agreements in December 2011, extending them to December 31, 2015. The most recent extension was for a 22 000 cubic metre increase in the allowable annual cut of the IFPA holders' forest licences and expired on December 31, 2015. The primary drivers for the IFPA will be fully incorporated in this TSR modelling.

Data source and comments:

The 2013 *Rationale for Increase in Allowable Annual Cut (AAC)* under the Innovative Forestry Practices Agreements is available at the following internet site: https://www.for.gov.bc.ca/rsi/IFPA/IFPA.htm

3. Current Forest Management Considerations and Issues

3.1 Base case management assumptions

The timber supply analysis base case assumptions reflect current performance with respect to the status of forest land, forest management practices, and knowledge of timber growth and yield. The harvest forecast developed from these assumptions is termed the base case harvest forecast and will be used as a reference to which other development scenarios are compared. Uncertain assumptions will be quantitatively examined through sensitivity analysis which assesses the potential timber supply implications of different assumptions (see Section 10, "Sensitivity Analysis").

3.2 Major forest management considerations and issues

Table 1 lists major forest management issues, considerations, and changes since last TSR (July 1, 2005) that, where possible, are considered directly in the base case of the timber supply analysis. If an issue does not fall within the definition of current management the related timber supply impacts will be considered during the AAC determination.

Table 1. Major forest management considerations and changes since last TSR

Consideration/issue	Description
Land use zones	The Kootenay Boundary Higher Level Plan Order (KBHLPO) was established January 31, 2001 (updated October 26, 2002). The KBHLPO establishes Resource Management Zones and objectives for these zones. Resource Management Zones correspond to old district boundaries. Objectives for the zones include Biodiversity, Connectivity, Consumptive Use Streams, Green-up and Enhanced Resource Development.
Biodiversity	The KBHLPO (October 26, 2002) establishes legal objectives and targets for old forest retention, old- and mature-forest retention, temporal and spatial distribution of cutblocks, and landscape connectivity.
Old-growth management areas	Licensees and FLNR have mutually agreed on the location of the non-legalized OGMAs. Licensees have incorporated language to manage and respect the spatial, non-legalized OGMAs in their respective Forest Stewardship Plans (FSP). Consequently, spatial non-legalized OGMAs are removed from the THLB.
Wildlife habitat areas	Several new Wildlife Habitat Areas (WHA) have been established under the Government Actions Regulation (GAR) for the protection of identified wildlife. Species with established WHAs include Western Screech Owl, Grizzly Bear, and data sensitive species.
Ungulate winter range	New Ungulate Winter Ranges (UWR) were established under the GAR on December 13, 2005 for the protection of Mule Deer, white tailed deer, Rocky Mountain elk and moose, winter habitat.
Caribou no-harvest area	New GAR was established on February 12 and 19, 2009 for the protection of mountain caribou habitat.
Visual resources	Scenic areas and visual quality objectives were established under the GAR on December 31, 2005.

(continued)

Table 1. Major forest management considerations and changes since last TSR (concluded)

Consideration/issue	Description
VRI phase 2 validation	Vegetation Resource Inventory (VRI) Phase 2 inventory adjustment sampling which was undertaken in 2004 and 2005 suggests the overall volumes in the Arrow TSA inventory are underestimated.
Site productivity estimates	Increased confidence in productivity estimates since last TSR as a result of new Predictive Ecosystem Mapping (PEM) with accompanying site index by BEC (SIBEC) estimates of Site Productivity (SI) which were recommended for use for the Arrow TSA on June 3, 2015.
Slocan Valley	There has been a long history of forest operational planning delays and harvesting deferrals in the Slocan Valley due to a number of issues. Approximately half of the "contentious area" identified in the Slocan Valley in previous TSRs is now included in a new Community Forest Agreement (CFA).
New Community Forest Agreements	Two Community Forest Agreements were awarded since the previous timber supply review. The lands within the Community Forest Agreements are excluded from the land base of the TSA.
Woodlot areas increase	Woodlot areas have increased in the TSA due to area top-up. These new woodlot area increases are excluded from the land base of the TSA.
Cascadia TSA	The Cascadia TSA, established in 2011, comprises area that was formerly within the Arrow TSA. The boundaries of the Arrow TSA were changed to remove Crown land that was added the Cascadia TSA.
Log grade	Interior log grades implemented in 2006 are based on a log's size and quality without regard to whether it was alive or dead at harvest. Since yield estimates used in the analysis do not incorporate grade 3 endemic and grade 5 log volumes, information will be gathered about the potential timber volume available in these grades.
Climate change	Experienced increased impact to forests due to climate change by increased frequency, severity and size of natural disturbances like wildfire and insect outbreaks.
Timber licence reversions	There are no active timber licences in the Arrow TSA: the last active timber licences within the TSA were amended to expire on November 30, 2013.

4. Inventories

4.1 Data base information

Table lists the main data sets that will be used to determine the timber harvesting land base (THLB) and to model forest management activities either in the base case management scenario or sensitivity scenarios.

Table 2. Inventory information

Data	Source	Filename	Currency of file
Timber supply area	BCGW	WHSE_ADMIN_BOUNDARIES.FADM_TSA	2015-08-19
Land ownership	BCGW FAIB	WHSE_FOREST_VEGETATION.F_OWN	2014-12-11
Community forest agreement	BCGW	WHSE_FOREST_TENURE.FTEN_MANAGED_LICENCE_POLY_SVW	2015-08-17
Vegetation resource inventory	BCGW FAIB	WHSE_FOREST_VEGETATION.VEG_COMP_LYR_R1_POLY	2015-08-19
Forest cover depletion	FAIB	TBD	TBD
Biogeoclimatic ecosystem classification	BCGW	WHSE_FOREST_VEGETATION.BEC_BIOGEOCLIMATIC_POLY	2015-08-19
Predictive ecosystem mapping	FLNR (Region)	ArrowTSA01_localData.gdb\TSR4\PEM_TEI_longTbl	2015-01-26
Terrain stability mapping	FLNR (compiled)	ArrowTSA01_localData.gdb\TSR4\arr_terrain_potentially_unstable; arr_esa90_noTSM	2015-09-01
Harvesting operability	BCGW REG	REG_LAND_AND_NATURAL_RESOURCE.OPERABILITY_TAR_POLY	2014-12-17
Landscape units	BCGW	WHSE_LAND_USE_PLANNING.RMP_LANDSCAPE_UNIT_SVW	2015-08-19
Old growth management areas	FLNR (compiled)	ArrowTSA01_localData.gdb\TSR4\OGMA	2015-09-01
Goal 2 areas of the protected area strategy	FLNR (compiled)	ArrowTSA01_localData.gdb\TSR4\arr_PAS2goals_2015	2015-09-03
Wildlife habitat areas	BCGW	WHSE_WILDLIFE_MANAGEMENT.WCP_WILDLIFE_HABITAT_AREA_POLY	2015-08-19
Ungulate winter range	BCGW	WHSE_WILDLIFE_MANAGEMENT.WCP_UNGULATE_WINTER_RANGE_SP	2015-08-19
Caribou areas	BCGW	WHSE_WILDLIFE_MANAGEMENT.WCP_UNGULATE_WINTER_RANGE_SP	2015-08-19

(continued)

Table 2. Inventory information (continued)

Data	Source	Filename	Currency of file
Buffered riparian	FLNR (compiled)	\ArrowTSA01_localData.gdb\TSR4\riparian_W1_W3_W5; riparian_L1_L3; riparian_S1_S5	2015-05-01
Community watersheds	BCGW	WHSE_WATER_MANAGEMENT.WLS_COMMUNITY_WS_PUB_SVW	2015-08-19
Domestic watersheds	BCGW REG	REG_LAND_AND_NATURAL_RESOURCE.DOMESTIC_WATERSHED_KBLUP_POLY	2015-08-19
Visual landscape inventory	BCGW	WHSE_FOREST_VEGETATION.REC_VISUAL_LANDSCAPE_INVENTORY	2015-08-19
Forest recreation sites	BCGW	WHSE_FOREST_TENURE.FTEN_RECREATION_POLY_SVW	2015-08-19
Forest recreation trails	BCGW	WHSE_FOREST_TENURE.FTEN_RECREATION_LINES_SVW	2015-08-19
Dewdney Trail buffer	FLNR (compiled)	ArrowTSA01_localData.gdb\TSR4\dewdney_trail_buffer_100m	2015-04-01
Forest research installations	BCGW	WHSE_FOREST_VEGETATION.RESPROJ_RSRCH_INSTLTNS_GOV_SVW	2014-12-02
Growth and yield	BCGW	WHSE_FOREST_VEGETATION.GRY_PSP_STATUS_ACTIVE	2015-08-19
Archaeological sites	BCGW	WHSE_ARCHAEOLOGY.RAAD_TFM_SITES_SVW	2014-12-17
Power transmission lines	FLNR (compiled)	ArrowTSA01_localData.gdb\TSR4\electric_transmission	2015-05-28
Gas transmission lines	FLNR (compiled)	ArrowTSA01_localData.gdb\TSR4\gas_transmission	2015-05-28
Wildlife tree reserves	BCGW	WHSE_FOREST_VEGETATION.RSLT_FOREST_COVER_RESERVE_SVW	2015-08-19
Slocan Valley contentious area	FLNR (compiled)	ArrowTSA01_localData.gdb\TSR4\SVCA	2015-04-01
Roads	FLNR (compiled)	ArrowTSA01_localData.gdb\TSR4\arrow_roads_buffered	2015-05-28
Railways	FLNR (compiled)	ArrowTSA01_localData.gdb\TSR4\arrow_rail_buffer_15m	2015-05-28
Connectivity	BCGW	WHSE_LAND_USE_PLANNING.RMP_PLAN_NON_LEGAL_POLY_SVW.	2015-08-19
Controlled recreation areas	BCGW REG	REG_LEGAL_AND_ADMIN_BOUNDARIES.CONTROLLED_REC_AREAS_BC	2014-12-11

(continued)

Table 1. Inventory information (concluded)

Data	Source	Filename	Currency of file
Silviculture results	BCGW	WHSE_FOREST_VEGETATION.RSLT_OPENING_SVW	2015-08-19
Harvesting authorizations	BCGW	WHSE_FOREST_TENURE.FTEN_HARVEST_AUTH_POLY_SVW	2015-08-19
Fire history	BCGW	WHSE_LAND_AND_NATURAL_RESOURCE.PROT_HISTORICAL_FIRE_POLYS_SP	2015-07-16
Seed planning units (SPU)	BCGW	WHSE_FOREST_VEGETATION.SEED_PLAN_UNIT_POLY_SVW	2015-12-15
Habitat supply analysis	FAIB	TBD	TBD
Ktunaxa Treaty Parcels	BCGW	WHSE_TANTALIS.TA_CROWN_TENURES_SVW	2015-08-19

Data source and comments:

The 'Currency of File' is the date of the latest file update as indicated either by meta-data, by attributes within the data set, by the 'Currency of File' date received from the data custodian, when a record in the provincial dataset was last modified, when the data was created, or by other documentation. An update of a file does not necessarily imply that a new inventory was completed; it may simply reflect a small change, verification, or modification of the data.

The data identified above is from a number of sources. Corporate level data in the provincial geographic data warehouse (BCGW) and regional datasets (BCGW REG) which also reside in the geographic data warehouse (BCGW). Datasets that are maintained by Forest Analysis and Inventory Branch (FAIB) were either extracted from the geographic data warehouse (BCGW FAIB), or were accessed directly from data servers managed by FAIB. Local data is either maintained at the local district level (FLNR District), or compiled from a number of different sources, or processed for the purposes of the analysis (FLNR compiled). The following provides further explanation for those datasets that require it.

The timber supply area boundary is extracted from a provincial layer. The boundary polygon includes all ownership and administrative types within its bounds. The timber supply area boundary changed in September 14, 2011 with the Minister's Designation and Order, *Forest Act*, Section 7. This order removed crown lands from the Arrow Timber Supply Area and added them to the Cascadia Timber Supply Area, and therefore the boundary has significantly changed from previous timber supply reviews.

Land ownership is a custom layer created by FAIB using information from the Crown Land Registry and the Integrated Cadastral Information Society. It identifies UREP/recreation reserves, private lands, federal lands, Indian Reserves, parks and other protected areas, tree farm licences, woodlot licences and community forest licences. This layer was compared with local data and a status was completed on a few larger lots; based on this, it was determined this layer was the best available data for private land.

The vegetation resource inventory polygons have a reference year indicating the year the interpretation for that polygon was done. Within the Arrow TSA, the reference year ranges from 1956 to 2013. The 2015 update of this provincial data set was used.

A forest cover depletion layer is used to update the forest cover for recent harvesting and other disturbances. An updated layer will be created by FAIB staff from a recent remote sensing change detection layer and silvicultural reporting information (RESULTS).

The most current predictive ecosystem mapping for the Arrow TSA was obtained from the Regional Ecologist as the latest version was not yet loaded to the provincial dataset.

The best available terrain stability mapping (TSM) for the Arrow TSA was compiled in 2015 from a previous FLNR compilation completed in 2001 together with the most current available data from Atco, BCTS, Interfor, Kalesnikoff, and Tolko. From that layer, those areas identified as unstable or potentially unstable (arr_terrain_potentially_unstable) were used. Where TSM mapping was not available, environmentally sensitive area (ESA) mapping used in the previous TSR (TSR 3), and identified as soil (ES1), was used in the analysis and modelled as 100% unharvestable. These areas were coded as 90 in the ESAO_ND attribute in the previous analysis (arr_esa90_noTSM).

Old growth management areas (OGMAs) for the Arrow TSA were compiled from the non-legal OGMA provincial layer, WHSE_LAND_USE_PLANNING.RMP_OGMA_NON_LEGAL_CURRENT_SVW, together with available data from BCTS, Kalesnikoff, Atco, Tolko, and Stella Jones.

The Goal 2 areas of the Protected Area Strategy that have not been established as parks or have not been deleted from consideration were identified by Parks and Protected Areas, Ministry of Environment, and compiled by FLNR Selkirk Natural Resource District geomatics staff. The two datasets of the boundaries were sourced from are WHSE_MINERAL_TENURE.MTA_SITE_SP (Bremner, Renata, Summit Lake, and Waldie Lake), and WHSE_TANTALIS.TA_CROWN_RSRV_NOTATIONS_SVW (Slocan Lake).

There are two GAR orders ungulate winter range, u-4-012 and u-4-014, that identify no harvest caribou areas within the Arrow TSA.

The riparian layer was compiled from district data together with all available data from Atco, Interfor, Kalesnikoff, Stella Jones, and Tolko. The riparian class L1 and L3 were buffered from lakes sourced from BCGW: WHSE_BASEMAPPING.TRIM_EBM_WATERBODIES

The section of the Dewdney trail within the Arrow TSA was extracted from the provincial trails layer and then buffered by 100m on both sides.

Power transmission lines within Arrow TSA were compiled from data extracted from BCGW WHSE_BASEMAPPING.TRIM_CULTURAL_LINES and data supplied from Fortis. A buffer of 25m was applied on each side of the compiled lines.

Gas transmission lines within the Arrow TSA were extracted from BCGW: WHSE_BASEMAPPING.TRIM_CULTURAL_LINES, and a buffer of 15m was applied on each side of the line.

The area identified as Slocan valley contentious area in the last timber supply review in the Arrow TSA was extracted from the Arrow TSA previous resultant.

A consolidated layer for roads within the Arrow TSA was compiled by FLNR regional geomatics staff. The compilation combined manual digitization with data from provincial sources including: TRIM transportation, Digital Roads Atlas, and FTEN road sections. The compiled data was classified and buffered by road type: highways were buffered on either side by 15 metres, side roads and main forest roads were buffered by on either side by 10 metres, and operational forest roads were buffered on either side by five metres.

A railway layer was compiled by FLNR regional geomatics staff. The rail lines in the Arrow TSA were exported from BCGW: WHSE_BASEMAPPING.TRIM_TRANSPORTATION_LINES and a buffer of 7.5 metres was applied on each side of the line.

The wildlife habitat supply layer is the resultant from a provincial model which has yet to be produced.

An agreement-in-principle is in place for the Ktunaxa treaty parcels, and it is current practice to treat the agreement as finalized.

4.2 Forest cover inventory

A new Vegetation Resources Inventory (VRI) Phase I photo interpretation was completed for the Arrow TSA in 2002. VRI Phase 2 ground sampling was carried out in 2004 and 2005, with destructive sampling for net volume adjustment factor (NVAF) completed in 2005. An analysis for VRI statistical adjustment, which also incorporated the analysis and development of net volume adjustment factors (NVAF), was undertaken late in 2005. The VRI Phase 2 inventory adjustment suggested that the overall volumes in the Arrow TSA were 16% higher than the current inventory and this was the key element in the Regional Manager's decision to grant an IFPA uplift in 2004.

Data source and comments:

Documentation on the analysis for VRI statistical adjustment is available at the following internet site: https://www.for.gov.bc.ca/hts/vri/planning_reports/tsa_analysis/arrowtsa_vri_adjustment.pdf

4.3 Site index biogeoclimatic inventory

A new Predictive Ecosystem Mapping (PEM) was completed for the Arrow TSA in 2015 and met the minimum provincial accuracy assessment standards (Meidinger and Moon protocols where applicable) with an overall score of 69%, including alternate calls.

An extensive field program to collect and derive Site Index by BEC (SIBEC) estimates of productivity was initiated as a parallel project to the PEM. SIBEC sampling was led by Nona Phillips Consulting and met all provincial standards. Calculation of both first and second approximations was completed by Deb McKillop, Ray Coupe, and Shirley Mah. New SIBEC approximations include calculated values (2^{nd} approximations) for 124 tree species by site series combinations. New sampling focused on the most common sites series (typically submesic, mesic, subhygric) and covered the ICHdw1, ICHmw2, ICHmw4, ICHmw5, ESSFmh, ESSFwh1, ESSFwh3, ESSFwm3, ESSFwc4, and ESSFdc1. It did not include the ICHxw, ICHwk1, ICHvk1, ESSFvk, ESSFvc, or woodland and parkland areas.

The new PEM and SIBEC data use updated BEC mapping and site classification for forested site series which are expected to be published in the near future. The PEM also mapped non-forest ecosystems using the BEC of Non-forested Ecosystems of British Columbia framework (TR068; MacKenzie 2012).

Data source and comments:

Potential site index estimates from SIBEC are only used to estimate the yields of managed stands. Forest inventory based site index estimates are used to estimate the yields of natural stands.

The Arrow PEM was completed by Maureen Ketcheson (RPBio) of JMJ Holdings Inc. An independent third party external accuracy assessment was led by Pam Dysktra (RPBio,PAg) of Dykstra and Associates Resource Management Ltd. - Deb McKillop Letter to Albert Nussbaum, June 3, 2015.

5. Division of the Area into Management Zones

5.1 Management zones and tracking of multiple objectives

The concept of management zones is used to differentiate areas with different management objectives. For example, a zone may be based on a harvesting system, silviculture system, visual quality objectives, wildlife consideration or more than one management objective. In the timber supply analysis, each type of zone can be tracked separately, thereby allowing application of overlapping management objectives. Forest land that is unavailable for timber harvesting may contribute toward meeting objectives for other forest values.

Table 3 outlines the zones or objectives incorporated into the timber supply model. Further information on the forest cover requirements to be applied to these areas can be found in Section 7.5, "Integrated resource management".

Table 3. Objectives or management zones to be tracked

Objective or zone	Inventory definition or source
Landscape-level biodiversity	As per the Kootenay-Boundary Land Use Plan Order (KBLUPO).
Stand-level biodiversity	As per the KBLUPO - reductions will be applied the THLB as the location of these have not been entered into the VRI.
Cutblock adjacency	As per the KBLUPO.
Community watersheds	*Forest Practices Code of BC Act.*
Domestic watersheds	As per the KBLUPO.
Ungulate winter ranges	As per the KBLUPO.
Scenic areas / visual quality objectives	As per Visual Quality Objectives GAR order December 31, 2005.

5.2 Analysis units

In a timber supply analysis, the use of analysis units (AU) simplifies the model either for computational requirements or user understanding. An analysis unit is typically composed of forest stands with similar tree species composition, timber growing potential, treatment regimes, and other management considerations. Each analysis unit is assigned its own timber volume projection (yield table).

For this analysis, the analysis units will be divided into two general forest management classes, existing natural and managed stands that reflect the different growth and yield models used to project the timber volume in British Columbia. The managed, which were established after 1974, will be further subdivided into managed stands equal or greater than 20 years old, managed stands under 20 years and future managed stands.

The AU basis for both natural and managed stands will be by BEC Unit grouping (using the new PEM BEC units); by leading species; by site index as follows:

Table 4 BEC subzone/variants grouping

BEC	Group	BEC	Group
ICHxw	Dry ICH	ESSFwc4	Moist/Wet ESSF
ICHdw1	Dry ICH	ESSFwm3	Moist/Wet ESSF
ICHmw2	Moist ICH	ESSFwh1	Lower ESSF
ICHmw3	Moist ICH	ESSFwh3	Lower ESSF
ICHmw4	Moist ICH	ESSFmh	Lower ESSF
ICHmw5	Moist ICH	ESSFwmw	Woodland
ICHwk1	Wet ICH	ESSFwcw	Woodland
ICHvk1	Wet ICH	ESSFvcw	Woodland
ESSFdc1	Dry ESSF	ESSFdcw	Woodland

From the above grouping there is a further subdivision by leading species by site index as follows:

Table 5 Consolidation of Table 4 to analysis unit group

Group	Leading species	Site productivity – (SI)	Potential number of AUs
Moist ICH	Fd/Lw, Cw, Hw, Sxw, Pl	Hi, Med, Low	15
Wet ICH	Fd/Lw, Cw, Hw, Sxw/Bl	Hi, Med, Low	12
Dry ICH	Fd/Lw, Fd/Py, Cw, Hw, Pl	Hi, Med, Low	15
Moist/Wet ESSF	Sxw, Bl	Hi, Med, Low	6
Woodland	Sxw, Bl	Hi, Med, Low	6
Lower ESSF	Sxw, Bl, Fd/Lw, Cw/Hw, Pl	Hi, Med, Low	15
Dry ESSF	Sxw, Bl, Pl	Hi, Med, Low	9

The potential number of analysis units is 78. Should an AU be very small, it will be combined into closest AU by productivity and leading species within the respective group. See Tables 20 and 21 for actual analysis unit make-up.

The timber volume projections for existing natural stands are created for each forest inventory polygon. These yield tables are aggregated by leading species and BEC. The timber volume projections for managed stands are assigned to analysis units based on site series and the primary species regenerated (see Tables 19 and 20). In the analysis, it is assumed that a polygon will maintain its original leading species.

Some small areas are harvested with retention. They will be treated as clearcut.

6. Timber Harvesting Land Base Definition

This section outlines the steps used to identify the timber harvesting land base (THLB) which is the productive forest expected to support timber harvesting within the Arrow TSA. Land may be unavailable for timber harvesting for four principle reasons:

- it is not administered by the BC Ministry of Forests, Lands and Natural Resource Operations (FLNR) for timber supply purposes (e.g., private land, parks, etc.);
- it is not suitable or uneconomic for timber production purposes (e.g., non–forested areas);
- it is unavailable for timber harvesting (e.g., recreation areas);
- areas without legally established boundaries where timber harvesting is incompatible with management objectives for other resource values.

Land may also be added to the THLB:

- by management activities which improve productivity or operability (e.g., the stocking of land currently classified as non–commercial brush);
- by the acquisition of productive forest land (e.g., timber license reversions).

The THLB for the Arrow TSA will be determined by a process of delineating the categories of land (described in subsections below) that are not expected to contribute to timber harvesting in the TSA. Land is considered outside the THLB only where harvesting is not expected to occur. Any area in which some timber harvesting will occur remains in the THLB, even if the area is subject to other management objectives, such as wildlife habitat and biodiversity. These objectives are modelled in the timber supply analysis, as forest cover constraints. The Crown forest land base (CFLB) outside of the THLB also contributes to meeting these other objectives. CFLB is the portion of the total timber supply area with forest cover that contributes to Crown forest management objectives in the context of TSA timber supply, such as landscape-level biodiversity or visual quality objectives.

It is not uncommon for specific areas to be identified by more than one land category; for example, deciduous stands within riparian reserve zones. These areas will be classified as deciduous, prior to the riparian classification. Therefore, in most cases the net area reduction for a particular category will be less than its gross area due to overlap with areas previously excluded from the THLB under other categories.

The above definitions for THLB, and its complement, non-THLB, are land base simplifications used for modelling purposes. Operationally, areas classified as non-THLB are sometimes harvested and areas classified as THLB may never be harvested.

Table 6, which is known as the netdown table, summarizes the classification of the CFLB and THLB. This table will be included in the *Discussion Paper* that will be released following the timber supply analysis. Factors in this table are further described in following sections.

Table 6. Crown forested and timber harvesting land base determination for the Arrow TSA

Factor	Gross land base (hectares)	Unique area excluded from THLB
Arrow TSA gross	TBD	
Land not administered for timber supply purposes		
Non-provincial lands	TBD	TBD
Area based forest tenures and Crown miscellaneous leases	TBD	TBD
Controlled recreation area	TBD	TBD
Non-forested, non-productive, and non-commercial cover	TBD	TBD
Current roads, trails, landings, and other access structures	TBD	TBD
Crown forested land base (CFLB)		
Parks and miscellaneous reserves	TBD	TBD
Terrain stability[1]	TBD	TBD
Areas with high recreation values	TBD	TBD
Areas considered inoperable	TBD	TBD
Sites with low timber growing potential	TBD	TBD
Stands older than 140 years old with less than 150 m^3	TBD	TBD
Problem forest types	TBD	TBD
Wildlife habitat areas	TBD	TBD
Ungulate winter range - Mountain Caribou	TBD	TBD
Cultural heritage resources	TBD	TBD
Riparian reserve and management areas	TBD	TBD
Wildlife tree patches	TBD	TBD
Research installations	TBD	TBD
Growth and yield permanent sample plots	TBD	TBD
Timber harvesting land base (THLB)		

[1] Terrain stability mapping includes unstable and potentially unstable and environmentally sensitive areas (soil and snow avalanche outside community watersheds.

Data source and comments:

'Gross land base' is the total land base for that portion of the factor that is relevant. For some factors (e.g., wildlife habitat areas) the value does not include areas that remain within the timber harvesting land base.

'Unique area excluded from Timber Harvesting Land Base (THLB)' shows the area for each factor that is uniquely excluded from the THLB due to this factor. This table does not show the sequential netdown of each factor as is often shown in netdown tables in previous timber supply reviews.

6.1 Land excluded from crown forest land base

6.1.1 Lands not administered for timber supply purposes

Lands not administered by the Ministry of Forests, Lands and Natural Resource Operations (FLNR) for timber supply in the TSA are identified in Table 6, netdown table, and are excluded from the Crown forest land base when they do not contribute to TSA objectives for wildlife habitat, biodiversity or visual quality in the context of timber supply. Such land includes private land, municipal land, federal land and Indian Reserves.

Parks and protected areas are included in the CFLB because they can be relied on to continually contribute to forest cover management objectives such as landscape-level biodiversity, visual quality and wildlife habitat objectives.

Table 7 shows the potential contribution of each FAIB ownership code to the CFLB and the THLB.

Table 7. Ownership contributions

Ownership code	Crown forest land base	Timber harvesting land base
40 Private Crown Grant	No	No
41 Treaty Land, Status Transfer Land	No	No
52 Indian Reserve	No	No
60 Crown Ecological Reserve	Yes	No
61 Crown Use, Recreation and Enjoyment of the Public (UREP) Reserves	Yes	No
62 Crown Forest Management Unit (TSA) or Crown Timber Agreement Lands	Yes	Yes
63 Crown Provincial Park Class A	Yes	No
65 Crown Provincial Park Class C, park board	Yes	No
67 Crown Provincial Park equivalent or reserve, regional parks, etc.	Yes	No
68 Crown BMTA (Biodiversity, Mining and Tourism Area)	Yes	No
69 Crown Miscellaneous Reserves – C	Yes	Yes
69 Crown Miscellaneous Reserves – N	Yes	No
72 Crown and Private Schedule “A” Lands in a TFL	No	No
72 Crown and Private Schedule “B” Lands in a TFL	No	No
77 Crown Woodlot Licence (Schedule “A”)	No	No
77 Private Woodlot Licence (Schedule “B”)	No	No
79 Community Forest	No	No
99 Crown Misc. lease (e.g., fairground, R and G Club site, recreation cottage site)	Yes	No

Data source and comments:

A spatial data set of land ownership has been developed by FAIB using information from the Crown land registry and the Integrated Cadastral Information Society, with each ownership category given its own unique code. These ownership codes are referenced in the discussion below.

6.1.2 Non-provincial Crown lands

These include private land, municipal land, federal land, Indian Reserves and treaty lands. For the purposes of the Arrow TSA netdown Table 6, the private lands ownership in Arrow TSA includes private land (ownership code 40) whereas treaty lands (included in ownership code 52), and Ktunaxa treaty parcels are identified individually. Arrow TSA does not contain any federal reserves, national parks, or Indian Reserves, but includes one expired reserve, Arrow Lake Indian Reserve.

6.1.2.1 Treaty reduction

Within Arrow TSA, the parcels identified by ownership code 52 are a subset of the Ktunaxa treaty parcels, which are better represented in the Crown tenures layer. In 2010, the Province and Canada made a treaty land and cash offer to the Ktunaxa Nation as part of the treaty negotiation process. The treaty land offer, which was accepted by the Ktunaxa in 2012, includes a few Crown land parcels located within the Arrow Timber Supply Area. Although Ktunaxa treaty parcels are not finalized, there is an agreement-in-principle in place, and it is current practice to treat them as finalized. Forest resources on these areas will be owned by the Ktunaxa Nation and will not be available for harvesting by timber tenure holders. Therefore they are removed from the CFLB for the purpose of this TSR.

Data source and comments:

Treaty parcels are identified in the FAIB ownership layer by code 52. In the Arrow TSA, code 52 represents a subset of the Ktunaxa treaty parcels. The correct boundaries for the treaty land offer are represented in the Crown Tenures layer, crown land dispositions that are issued for specific purposes and periods of time. In this analysis, the source for the treaty parcels is the Crown Tenures layer.

6.1.2.2 Arrow Lake Indian Reserve

The expired Arrow Lake Indian Reserve is acknowledged by the land managers as a no-harvest area and is being treated as excluded from the CFLB.

6.1.3 Area based forest tenures and miscellaneous Crown leases

These include Tree Farm Licences (ownership code 72), Community Forest Agreements (ownership code 79), Woodlot Licences (ownership code 77), and miscellaneous Crown leases (ownership code 99). These land bases are excluded from contributing to all forest management objectives considered in determining the AAC for the TSA. Except for Crown miscellaneous leases, separate AAC determinations are made for these excluded tenures. A minor reduction in the Arrow TSA boundary resulted from the designation of the Cascadia TSA on September 14, 2011.

6.1.4 Controlled recreation area (CRA)

CRA are excluded from the CFLB in the Arrow TSA. They are administered under the *Resort Timber Administration Act*.

Table 8. Controlled recreation area

Category	Gross land base (ha)	CFLB Reduction (%)
Red Mountain CRA	TBD	100%
Summit Lake CRA	TBD	100%

Data source and comments:

CRA boundaries are a regional data layer stored in the BCGW.

6.1.5 Land classified as non-forest, non-productive forest or non-commercial

Table 9 shows criteria used to remove non-forested areas and non-productive forest cover from the CFLB. Previously harvested vegetated areas will not be removed as non-forest.

Table 9. Description of non-forest, non-productive forest and non-commercial cover

Attributes	Description
Non-forest	
BCLCS level 1 equal 'N'	Non-vegetated and no logging history
BCLCS level 2 = 'N' AND BCLCS level 4 not equal to 'ST' or 'SL'	Vegetated but non-treed, excluding shrub areas and no logging history
BCLCS level 2 = 'N' AND BCLCS level 3 = 'W'	Non-treed wetlands
BCLCS level 3 = 'A'	Alpine
Non-productive forest	
FMLB indicator = "N" AND no logging history	Land base that is not considered forested and not productive
Non-commercial forest	
VRI: BCLCS level 2 = 'T' AND BCLCS level 3 = 'W'	Treed wetlands
VRI: BCLCS level 4 = 'ST or 'SL' AND no logging history	Shrub and no logging history

Data source and comments:

The Arrow TSA forest inventory consists of a full photo interpreted Vegetation Resource Inventory (VRI) in 2002. The criteria above are more specific criteria for identifying a productive forest land base than the more generalized forest management land base identified within the VEG_COMP_POLY layer in the BCGW.

BC land classification system (BCLCS) attributes identify non-vegetated and various classes of vegetated areas. Non-forested areas include water and non-vegetated land such as rock, ice and bare land. It is assumed that non-forested areas are not capable of growing forests. Non-commercial areas are generally covered by brush species and are also not considered suitable for timber production. All of these areas are excluded from both the CFLB and the THLB; they do not contribute to objectives modelled for wildlife habitat or biodiversity. As young managed stands have Crown closures of less than 10% (the differentiation between vegetated and non-vegetated polygons in the BCLCS) all areas with a harvest history are excluded from the netdown.

Non-productive forest is comprised of areas where the forest management land base (FMLB) indicator attribute is coded as "No". FMLB is coded "No" if the land base has no harvest history and a site index <5 metres. These areas of low site productivity are considered non-productive and do not contribute to modelled objectives for wildlife habitat and biodiversity. This contrasts with sites with "low timber growing potential" (Section 6.2.5) and "stands greater than 140 years old with less than 150 m^3" (Section 6.2.6) that are considered to still contribute to modelled objectives for wildlife habitat and biodiversity.

6.1.6 Current roads, trails, landings and other access structures

Productive forest land is lost due to permanent roads, trails and landings and other access structures. Existing estimates of this area are applied as reductions to the current THLB. Table 10 shows the access structure types and widths within the Arrow TSA and associated reductions.

Table 10. Summary of classified/ existing roads, trails, and landings and other access structures

Roads type	Modelled total width (m)	% reduction	Gross land base (ha)
Highway	30	100	TBD
Main (side roads and 2 lane mainlines)	20	100	TBD
Operational (spur roads/other 1 lane)	10	100	TBD
Landings	N/A	2.8[1]	TBD
Trails	3	100	TBD
Pipelines	30	100	TBD
Railways	30	100	TBD
Transmission lines	50	100	TBD

[1] Based on previous (TSR 3) value and reduced slightly for last 10 years harvest practices estimate. Estimated by district staff.

Data source and comments:

FLNR regional geomatics staff built a consolidated road layer using available data sources: Digital Road Atlas, FTEN Road Sections and TRIM. Each road was classified, or eliminated, by comparing sections against ortho photos and the latest 2014 satellite imagery. Main roads are community/public roads and major Forest Service roads. Operational / Spur roads are permanent access roads that provide continuity to multiple cutblocks and future harvesting opportunities. Trails are narrow in-block features that are not well accounted for in the digital data.

The electrical power transmission lines layer was compiled by FLNR Regional Geomatics staff using data from the provincial dataset in the BCGW representing cultural human made features, TRIM Cultural Lines, and data from supplied by Fortis in May, 2015.

Gas pipeline transmission lines were retrieved from the provincial dataset in the BCGW representing cultural human made features, TRIM cultural lines. Railway lines were retrieved from the provincial dataset in the BCGW representing transportation features, TRIM transportation lines.

The various widths used to buffer features in each category were determined by reviewing recently completed TSRs, Arrow TSA's previous (TSR 3) data, and, if necessary, adjusted based on operational knowledge.

6.2 Identification of timber harvesting land base

The following factors will be considered to identify the THLB within the CFLB.

6.2.1 Parks and miscellaneous reserves

These include provincial parks (ownership code 63) and other protected areas that are excluded from timber harvesting, but contribute to the modelled objectives for wildlife habitat and biodiversity. Recreational areas and reserves are discussed in Section 6.2.3.

6.2.2 Terrain stability

Terrain stability mapping (TSM) provides a more accurate assessment of slope stability than environmentally sensitive area mapping (ESA) for sensitive soils (Es). TSM may be conducted to various standards.

Terrain stability may reduce or preclude harvesting on identified sites. Areas with a high risk of landslide are less likely to be harvested, while often areas with a moderate risk of landslide prove to be harvestable when field reviewed. Table 11 shows the proportion of terrain stability polygons in various categories that are excluded from the THLB.

Table 11. Description of terrain stability

Terrain stability category	Gross land base (hectares)	ESA description	Reduction (%)
TSM class U or V	TBD	Unstable slopes – high likelihood of landslide initiation following timber harvesting or road construction	80%
TSM class P or IV	TBD	Potentially unstable slopes – moderate likelihood of landslide initiation following timber harvesting or road construction	13%
ESA 1	TBD	Environmentally Sensitive Areas (soils and avalanches)	100%

Data source and comments:

Land base exclusions for ESAs as completed during the last TSR for watersheds (H), recreation (R), and wildlife (W) are not used because they are obsolete.

Terrain Stability Mapping (TSM) has been completed for parts of the TSA to either level C or level D. For the remainder of the TSA, ESA soil (ES1) will be used and modelled as 100% unharvestable. These areas were identified in the previous (TSR 3) resultant as having a value of 90 in the attribute ESAO_ND.

The terrain stability mapping data for Arrow TSA was compiled in 2001 from the best available data at that time. For this analysis, we requested that all licensees within the Arrow TSA contribute their current best available data. BCTS, Interfor, Kalesnikoff, Atco, and Tolko all contributed data to the final layer.

Areas classified in TSM as class U or V terrain (unstable slopes) are generally unsuitable for harvest. However, TSM tends to overestimate the amount of class U or V terrain because of limited field sampling for some levels of survey intensity. TSM is inherently conservative to ensure that all unstable areas are identified and subjected to field assessment. Terrain class U or V is modelled as 80% unharvestable.

Areas classified in TSM as class P or IV terrain (potentially unstable slopes) are generally suitable for harvesting. These areas often require more expensive road construction techniques to mitigate the potential for subsequent landslides. Where construction costs are prohibitive and alternative road locations are not available (i.e., either above or below the Class IV terrain), areas may become unavailable for harvesting due to access limitations. Terrain class P or IV is modelled as 13% unharvestable.

6.2.3 Areas with high recreation values

To maintain the integrity of the historic Dewdney Trail, a 100-metre reserve on either side of the Dewdney Heritage Trail is excluded from the THLB.

Other recreational features are assumed to contribute and are available for harvest including Recreation sites, trails and the Salmo ski hill, which is not a CRA. Areas designated as Use, Recreation and Enjoyment of the Public (UREP/recreation reserves) fall under *Land Act* reserves, but without having designation under other legislation they are not reserved from harvest. UREPs are not modelled in this analysis.

Table 12. Recreation sites and trails

Category	Gross land base (hectares)	THLB reduction (%)
Dewdney heritage trail	TBD	100%

Data source and comments:

The Dewdney Trail was created by applying a 100 metre buffer on either side of the Arrow TSA portion of the Dewdney Trail, retrieved from the Forest Tenure Recreation Lines layer stored in the BCGW.

6.2.4 Areas considered inoperable

Areas in the Arrow TSA are considered inoperable where there are physical barriers or limitations to harvesting; for example, where timber harvesting becomes uneconomic and/or operationally unfeasible due to hauling distance, steep slopes, soil instability, timber quality, and/or environmental concerns. Areas considered inoperable can change over time as a function of changing harvesting technologies and economics.

For the analysis all areas identified as inoperable (1991 mapping) are removed from the THLB unless previously harvested.

The Enterprise Creek drainage is currently inaccessible due to a major slide on the highways portion of the road. Highways, Parks and FLNR have essentially abandoned the road in the short term. The model will be blocked from harvesting timber in the drainage for 20 years.

Small, isolated areas of operable forest (operable slivers) have been a concern in the district for over 10 years. In the previous TSR determination, the chief forester considered a 0.5% reduction in THLB for the slivers. As this trend was expected to continue the chief suggested that licensees and BCTS monitor harvest performance above and below the operability line with the view of tracking this trend. No process was ever set up to track this. In lieu of this, the district is carrying out a GIS exercise to determine the scope of the operable slivers.

Data source and comments:

The area considered inoperable was mapped in 1991. Given the dynamic definition of inoperable, this layer is in need of review. A request for funding to update the operability mapping has been submitted to the Selkirk District Management Team.

6.2.5 Sites with low timber growing potential

Sites may have low productivity because of inherent site factors such as nutrient availability, exposure, excessive moisture, etc. These stands are unlikely to grow a merchantable crop of trees or alternatively provide mature stand non-timber characteristics in a reasonable amount of time.

For stands less than 140 years old, "Site Tools" is used to project a site index at which the stands will not achieve 150 cubic metres per hectare by 140 years of age. These stands are 100% netted out. The criteria are presented in Table 14.

Table 13. Low productivity criteria

Leading species	SI 50	Volume (m^3/ha)	Reduction	Area removed (hectares)
Douglas-fir/larch	TBD		100%	TBD
Western redcedar	TBD		100%	TBD
Hemlock/balsam	TBD		100%	TBD
Spruce	TBD		100%	TBD
Lodgepole pine	TBD		100%	TBD
Total				TBD

Stands with previous harvest history will not be included in this netdown.

6.2.6 Stands older than 140 years with less than 150 m^3

There are a variety of reasons that sites may have less than 150 cubic metres in volume at 140 years of age. They are not always low productivity sites. There may have been blowdown or beetle kill or it may be a naturally open grown stand. These types of sites will be removed from the THLB.

6.2.7 Problem forest types

Problem forest types are stands that are physically operable but are not currently utilized or have marginal merchantability. Problem forest types are excluded from the THLB but included in the CFLB. The reductions are listed in Table 14.

Table 14. Problem type criteria

Leading species	Age (years)	% reduction	Area removed
Pure hemlock (=>80%)	> 140	80%	TBD
Hemlock leading (<80%)	> 140	40%	TBD
Balsam pure & leading	> 250	100%	TBD
Balsam pure & leading	> 140	25%	TBD
Deciduous	>40	100%	TBD
Total			

Balsam: Bl, B, excluding Bg

Leading species: VRI species 1

Data source and comments

In the previous TSR, Western redcedar leading types in Inventory Type Group 11, in the Edgewood PSYU were 50% netted out. This resulted in a 71 hectares removal. This line was taken out of the above table for the current TSR (TSR 4) as inventory type group and PSYU boundaries are no longer used in the VRI. The netdown was negligible. In the previous TSR all deciduous-leading stands were netted out regardless of age. For the current TSR only deciduous stands over 40 years of age are netted out as it is assumed that stands under 40 years are managed stands – most of them with free-growing obligations.

6.2.8 Wildlife habitat areas

Wildlife habitat areas may be identified and managed through several processes including the *Identified Wildlife Management Strategy*, identification and approval of ungulate winter range (UWR), and management practices specified in plans that establish legal objectives, such as the Kootenay Boundary Higher Level Plan order.

Several Wildlife Habitat Areas (WHAs) have been established under the Government Actions Regulation (GAR) over the past decade for the protection of identified wildlife. Species with established WHAs include Western Screech Owl, Grizzly Bear, and data sensitive species. Management of these areas can exclude, limit or permit timber harvesting. The table below describes the WHAs to be removed from the THLB.

WHAs that do not have a timber supply impact are included in the THLB. In the Arrow TSA, WHA # 8-373, the Specified Area Order for the Kettle-Granby Grizzly Bear, General Wildlife Measures Order, is the only order that provides protection of wildlife but does not impact timber supply. This specific order is discussed in Section 7.5.3 and is not modelled in the current analysis.

Table 15. Wildlife habitat area exclusions

Wildlife species and communities	Inventory description	Reduction (%)
Grizzly Bear	WHA# 8-140, 4,104, 4-093, 4-094, 4-095, 4-096, 4-097	100%
Western Screech Owl	WHA # 4-113	100%
Data sensitive	WHA # 4-036	100%

Data source and comments:

Wildlife habitat areas are available on the BCGW as a single provincial data set. Individual wildlife habitat areas information (spatial data set, approved order and general wildlife measures) are available from http://www.env.gov.bc.ca/wld/frpa/iwms/wha.html

6.2.9 Ungulate winter range - Mountain Caribou

GAR Orders U-4-012 and U-4-014 were originally established on February 12 and 19, 2009 for the protection of mountain caribou habitat. The order restricts timber harvesting and road construction and consequently the areas of mountain caribou habitat is completely removed from the THLB.

In order to facilitate the implementation of GAR Orders U-4–012 and U-4-014, variance number KBHLP-09, effective February 13, 2009, cancelled objective 3 relating to the requirement for caribou habitat management.

Data source and comments:

Ungulate winter range orders are available on the Ministry of Environment web page at http://www.env.gov.bc.ca/wld/frpa/uwr/approved_uwr.html

Variance # KBHLP-09 to objective 3 (Caribou) available at:

https://www.for.gov.bc.ca/tasb/slrp/lrmp/cranbrook/kootenay/pdf/KBHLP09_final_20090114.pdf

6.2.10 Cultural heritage resources

Archaeological sites identified under the *Heritage Conservation Act* cannot be harvested, and as such are excluded from the timber harvesting land base. Current data indicates a total of 376 sites covering 631.2 hectares. To address unknown archaeological sites, Archaeological Overview Assessments (AOAs) within the Arrow TSA were completed in 1996 and 2000. The AOA used a predictive model to delineate areas where the potential for finding archaeological sites is medium or high. Licensees are responsible for using the AOA to determine where more detailed field assessments need to be done in advance of harvesting. Since the completion of the AOAs, few new archaeological sites have been found in the TSA. Most archaeological sites are small, and many are included in areas with additional ecological or environmental constraints. These constrained areas are typically excluded from THLB through placement of reserve or no-harvest zones. Alternatively, the licensees assess the areas and if appropriate, acquire site alteration permits under the *Heritage Conservation Act*.

The Ktunaxa Kinbasket Tribal Council completed a traditional use site inventory project for their asserted traditional territories in 1998: part of the Arrow TSA is within this area.

Data source and comments:

Archaeological sites within Arrow TSA were clipped from the provincial data set published by FLNR Archaeology Branch. The site number and area was queried from this dataset on February 24, 2015.

6.2.11 Riparian reserve and management areas

Riparian reserve zones and management zones by stream, wetland and lake class are set out in the Forest Planning and Practices Regulation. Reserve zones represent a 100% reduction of the THLB. Management zone tree retention is guided by results and strategies within Forest Stewardship Plans formulated by licensees and BCTS.

Licensees will often locate wildlife tree patches (WTP) in riparian areas. The poor quality of the WTP data in RESULTS makes it impossible to conduct a mapped review of the overlap between WTP and RMZ. The district has not conducted any other review of riparian retention practices. Licensees agree that the stream widths approximate current management.

Table 16 lists the area reductions applied to streams, wetlands, and lakes in order to account for riparian reserve zones and riparian management zones.

Table 16. Riparian management area buffer determination

Stream, wetland or lake class	Riparian reserve zone width[1] (metres)	RRZ retention[1] (%)	Riparian management zone width [1] (metres)	RMZ BA retention[2] (%)	Total reserve width[3] (metres)
S1-A	0	N/A	100	20	20
S1-B	50	100	20	20	54
S2	30	100	20	20	34
S3	20	100	20	20	24
S4	0	N/A	30	10	3
S5	0	N/A	30	10	3
S6	0	N/A	20	0	0
W1	10	100	40	10	14
W3	0	N/A	30	10	3
W5	10	100	40	10	14
L1-A (area ≥ 1000 ha)	0	N/A	0	10	0
L1-B (area < 1000 ha)	10	100	0	10	10
L3	0	N/A	30	10	3

[1] Consistent with FPPR Section 47, 48, 49 and 51.

[2] Consistent with licensees and BCTS FSPs.

[3] Total reserve width: reserve zone width + (management zone width X retention % / 100).

Data source and comments:

The riparian layer was compiled from all currently available data from Atco, Interfor, Kalesnikoff, Stella Jones, and Tolko and where not available, district data compiled from the previous TSR (TSR 3). The riparian L1 and L3 were buffered from lakes sourced from the provincial layer. S1A was generated from the BC Geographic warehouse.

6.2.12 Wildlife tree patches

The *Forest and Range Practices Act* (FRPA) establishes an objective to maintain structural diversity in managed stands by retaining wildlife tree patches in each cutblock. The default value under FRPA is a minimum of 3.5% retention in each block and 7% retention overall for blocks logged in a 12-month period. Licensees may vary from this requirement by specifying an acceptable alternative in their Forest Stewardship Plan, but to date no licensees have chosen to retain less than 7% at the cutting permit level.

Wildlife tree patches (WTP) are often located in already constrained areas, such as riparian or inoperable areas, OGMAs, or unstable terrain, and therefore the impact to the THLB is likely less than the 7% minimum retention requirement. To account for this practice, the previous TSR used a 2.5% reduction for WTPs. Based on a small sample of WTP's, district staff recommends increasing the reduction to 5%. In addition, RESULTS data for the last 10 years shows that non-timber group reserves, or WTPs, range from approximately 8 to 12%, suggesting that 5% may still be conservative. Also, there is a slight upward pressure from dispersed retention areas that are not accurately tracked, but these are likely less than 1% overall.

Wildlife tree patches are modelled as an area reduction of 5% based on the information above.

A sensitivity analysis will explore the consequence of using a higher WTP netdown amount of 7% given current practices indicate higher than required retention rates are being applied in the TSA.

Data source and comments:

Current estimates are based on RESULTS summary reports (1995-2014 data, tabulated March 2015) and adjusted to a lower number given the assumptions that a portion of the land base is otherwise constrained, numerous blocks have been identified with WTPs incorrectly coded, and older RESULTS openings have poor quality WTP data for summary reports. Therefore, at any given time there may be a number of blocks with no corresponding WTP reported. The neighboring TSA, Kootenay Lake, used a value of 5.1% for WTPs in their current TSR.

6.2.13 Research installations

Many forest research installations are present within the Arrow TSA. Harvesting within active research installations is currently avoided, and only done after consultation with the research team. Research scientists with FLNR confirmed that these research installations will be excluded from the THLB.

6.2.14 Growth and yield permanent sample plots

FLNR maintains a network of growth and yield permanent sample plots across the province for the purposes of understanding forest growth and for growth and yield model calibration. Harvesting within the buffer area of active permanent sample plots is currently avoided. FLNR FAIB staff identified that a 68 metres buffered area would be reasonable to exclude from the THLB.

7. Current Forest Management Assumptions

7.1 Harvesting

7.1.1 Utilization levels

The Interior Timber Merchantability Specifications of the *Provincial Logging Residue and Waste Measurement Procedures Manual* specifies the utilization levels for timber harvested on Crown land.

The utilization levels define the maximum stump height, minimum top diameter inside bark and minimum diameter at breast height by species. Table 17 shows the utilization levels used in the analysis to calculate merchantable volume.

Table 17. Utilization levels

Analysis unit	Utilization		
	Corresponding minimum DBH (cm)	Maximum stump height (cm)	Minimum top dib (cm)
Pine	12.5	30	10
All other	17.5	30	10

Data source and comments:

The table above reflects current practices and is consistent with the *Provincial Logging Residue and Waste Measurement Procedures Manual*.

7.1.2 Mixed deciduous

Deciduous species (not leading) are not typically utilized within the Arrow TSA. For this analysis the deciduous component of mixed stands is excluded from the yield tables.

7.1.3 Log grade changes

On April 1, 2006 new log grades were implemented for the BC Interior. Under this system, grades are based on a log's size and quality at the time it is scaled without regard to whether it was alive or dead at harvest. Standard yield tables generated for natural and managed stands do not incorporate the new grade 3 endemic and grade 5 log volumes. Information will be presented to the chief forester for use in the AAC determination from several studies including inventory audits about these dead potential grades. The log grade changes (SAFs) will become obsolete following the new AAC determination.

Data source and comments:

Ministry of Forests and Range. 2006. Summary of dead potential volume estimates for management units within the Northern and Southern Interior Forest Regions. More information on how new log grades are considered in cut control practices is available at the following internet site:

https://www.for.gov.bc.ca/ftp/hth/external/!publish/web/timber-tenures/cut-control/methodology-to-determine-adjustment-factor.pdf

7.1.4 Minimum harvestable age (MHA)

The minimum harvestable criteria are the earliest age or volume at which a stand is considered to be harvestable within the timber supply model. While harvesting in the model may occur in stands at the minimum criteria in order to meet forest level objectives, most stands are not harvested until well beyond the minimum harvestable criteria because of management objectives for other resource values (e.g., requirements for the retention of older forest).

In this analysis, this criterion will be different for natural stands and managed stands.

In natural stands a minimum volume of 150 cubic metres per hectare will be used as a surrogate for minimum age in the model.

In managed stands the age at which the stands reaches 95% culmination of mean annual increment will be used as minimum harvestable age.

Data source and comments:

Licensees have indicated that they are currently harvesting in natural stands as young as 60 years old. As there is currently only about 1000 hectares of natural stands under the age of 60 in the THLB, the district agreed to use 150 m^3 with no minimum age for natural stands. For managed stands the decision was made to use the achievement of 95% culmination of mean annual increment as the minimum harvest age. With genetic gain and new PEM/SIBEC site indices, using only a volume of 150 m^3 is unrealistic as some of the higher SI sites could achieve this in as little as 40 years.

7.1.5 Harvest scheduling priorities

The order in which stands are harvested can impact timber supply. Licensee choice of stands to harvest depends on many factors. The Spatial Woodstock Forest Model will be used to optimize the flow of timber within the applied constraints.

Data source and comments:

Spatial Woodstock is a flexible forest modelling tool and has an allocation optimizer which will be used to optimize the timber flow.

7.1.6 Silvicultural systems

Most harvesting within the Arrow TSA involves an even-aged silviculture system. Over 90% of the area is harvested using clearcut, clearcut with reserves, patch cut or seed tree systems. The remaining percentage is harvested using uneven-aged silviculture systems: selection, retention or variable shelterwood systems.

For the current timber supply analysis, only clearcut harvesting will be modelled given that it is the dominant silviculture system.

RESULTS queries indicate that no commercial thinning has been completed in the Arrow TSA in the last 10 years. Commercial thinning is not modelled in this determination.

Data source and comments:

Disturbance reporting for the silviculture data base RESULTS for January 1, 2005 to December 31, 2014 was used to summarize the silviculture system. Patch cuts were classified as small clearcuts, and may also be over reported due to some inaccuracies around area reporting.

7.1.7 Future roads, trails, and landings/ permanent access structures

It is assumed that road access will be developed in all stands older than age 50 at time of harvest. For future harvested stands, the THLB will be reduced by 5.6 % to account for Permanent Access Structures (Roads, Landings, and Trails). This percent is based on 2003-2013 RESULTS weighted average for the actual permanent access structures percentage which represents current practices. Area reductions representing permanent access structures will be made in the timber supply modelling after the model harvests the stand (volume).

7.2 Unsalvaged losses

Table 18 shows the estimated average annual unsalvaged volume loss to insect and disease epidemics, wildfires, wind damage or other agents on the timber harvesting land base. The unsalvaged loss column only reflects those areas in which the volume is not recovered or salvaged. The objective is to include in the average annual estimate, events that are known to occur periodically, consequently, wildfire which occurred in 2007 will be excluded from the table and discussed in separate sections.

Table 18. Unsalvaged losses

Cause of loss	Annual unsalvaged loss (m³/year)
Mountain Pine Beetle	16,715[1]
Spruce Bark Beetle	165
Douglas-fir Bark Beetle	1,933
Balsam Bark Beetle	1,875
Blowdown and landslides	1,982
Wildfire	12,779[1,2]
Total	35,449

[1] Average of previous 20 years.

[2] 2007 wildfire excluded from the annual unsalvaged losses calculation as the impact to THLB was outside normal expected range.

Data source and comments:

Unsalvaged losses are calculated using cumulative years of district overview flight information between 2007 and 2014. Each disturbance polygon within the THLB that is not salvaged is tallied only once. Polygons that intersect with a harvesting unit do not contribute to the tally. The volume loss is determined using only the tree species volume derived from the Vegetation Resources Inventory (VRI) that is susceptible to the disturbance type. Volumes are adjusted based on local knowledge of disturbance severity and likelihood of future salvage.

The small scale salvage program issues an average of 19 938 cubic metres per year in the Arrow TSA. Because small scale salvage openings are less than a hectare they are generally not tracked spatially, and therefore are not accounted as harvested areas in Arrow TSA. Significant portions of the volume logged under the small scale salvage program over the last 10 years have not targeted unsalvaged losses with the exception of a minor volume for Douglas–fir bark beetle and some blowdown. Therefore the small scale salvage program does not have a substantial impact on the volume associated with unsalvaged losses.

7.3 Natural disturbances

7.3.1 Wildfire

In 2007, it is estimated that over 600 000 cubic metres of THLB volume were impacted by wildfire, which far exceeds the normal expected annual range. The impact of the wildfires in 2007 have been accounted in the VRI and therefore not included in the NRL adjustments.

7.3.2 Mountain pine beetle

The Mountain pine beetle has been active in the Arrow TSA for decades. Infestation levels peaked in 2006 and have since been steadily declining. District staff notes that the mountain pine beetle infestation has basically run its course within the TSA. Forests susceptible to mountain pine beetle contribute only 20% of the THLB and there is an abundance of mixed-stand and secondary-stand structure in Lodgepole pine stand in the Arrow TSA.

The licensees are confident that they have proactively logged infested stands and consequently they have captured most of the mortality attributed to the mountain pine beetle. The BC Provincial Scale Mountain Pine Beetle (BCMPB) model is showing otherwise but the BCMPB model has not been able to accurately reflect the spread of mountain pine beetle in the Arrow TSA. As such, no additional analysis of the mountain pine beetle infestation will be undertaken since residual impacts have been accounted for in the VRI and yield curves for existing stands.

Adjustment will be made to the provincial forest cover for the 2015 projection to account for stand changes due to mountain pine beetle (MPB) mortality.

No young stand mortality has been noted in Arrow TSA during the last mountain pine beetle outbreak. Therefore, there is no need to model for this type of disturbance.

Data source and comments:

Documents and data sets for the provincial level projection of the current mountain pine beetle outbreak developed by the Ministry of Forests, Lands, and Natural Resource Operations can be found at the following internet site: http://www.for.gov.bc.ca/hre/bcmpb/

7.4 Silviculture

7.4.1 Basic silviculture

For the purposes of the current analysis, current practice is considered to be the last 10 years. The basic silviculture practice in the Arrow TSA over the last 10 years is described below.

- 23 729 hectares logged;
- 5000 hectares of natural disturbance (mainly by fires) - managed by the Forest for Tomorrow program (FFT);
- 457 hectares broadcast burned;
- 19 800 hectares spot burned or piled and burned (including landing piles) - mainly for hazard abatement;
- 6311 hectares mechanically site prepared;
- 19 368 hectares planted;
- 4243 hectares fill planted;
- 26,299,657 seedlings planted;
- 587 hectares of planting have included “tea bag” fertilization;
- 95% of the area logged is planted;
- 10 568 hectares brushed.

Genetically improved seed is regularly planted. Since 2005, 100% of the western white pine planted has been rust resistant. Since 2008, 100% of the spruce planted has been class A seed. For the last five years, over 95% of western larch, and about 60% of the lodgepole pine, planted has been class A seed. There is still not enough class A Interior Douglas-fir seed available to meet planting needs, however over the last four years there has been an average of about 40% class A seed planted.

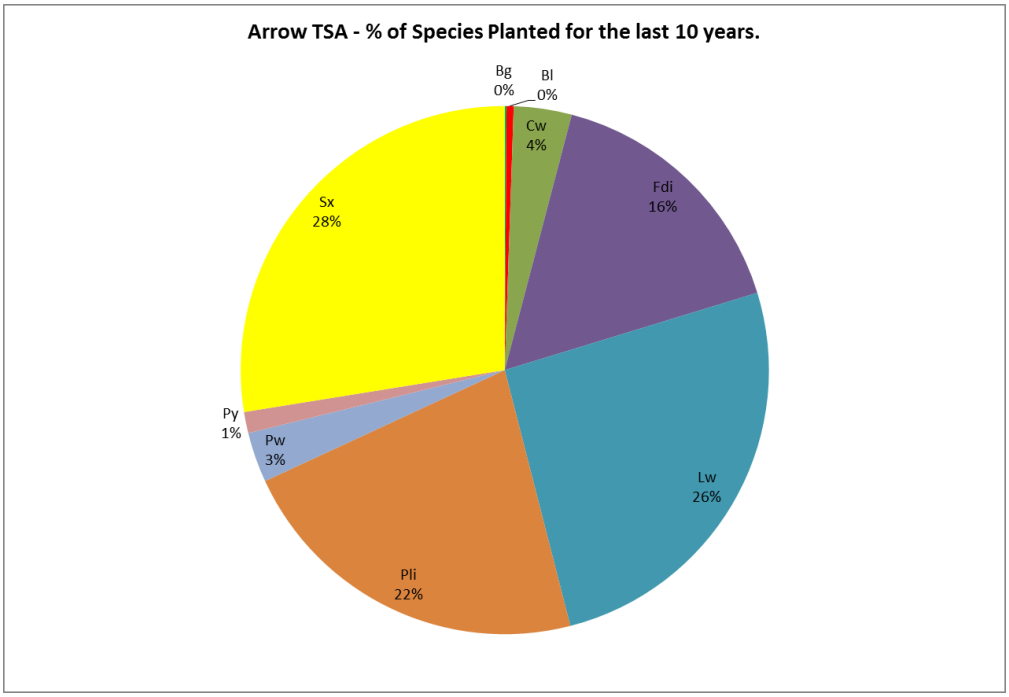

Figure 2. Percent (%) of species planted for the last 10 years.

7.4.2 Incremental silviculture

The total history of incremental silviculture activities carried out in the Arrow TSA, (not just the last 10 years), is described below:

- 2748 hectares juvenile spaced;
- 320 hectares pruned for wood quality;
- 0 hectares fertilized.

The juvenile spacing was completed during three distinct time periods identified by separate funding sources: EBAP (Employment Bridging Assistance Program), FRDA (Forest Resource Development Agreement) and FRBC (Forest Renewal BC). The pruning was completed during the FRBC era.

The past spacing and pruning activity is not modelled in the base case. Sensitivity analysis will be run for the 2748 hectares of juvenile spacing to understand the effect of this treatment on the TSA timber supply.

7.4.3 Silviculture assumption for managed stands yield table

The Forest Resource Evaluation Program (FREP) Stand Development Monitoring (SDM) Protocol collects information on post free-growing stands. Using the FREP SDM protocol data and the above silviculture information, the managed stands were divided up into three groups:

1) managed stands between 20 years of age and 40 years (between 1994 and 1974);

2) managed stands less than 20 years old;

3) future managed stands.

Recent plantations and future stands will be grown on managed stand yield tables (MSYT) produced using the table interpolation program for stand yields (TIPSY). The regeneration composition inputs required in TIPSY are shown in Tables 19 and 20. The inputs are slightly different for the three groups as shown in the two tables.

7.4.3.1 Managed stands greater than or equal 20 years of age (< 1994) up to 1974 (40 years)

General yield assumptions:

- Standard operational adjustment factors – OAF 1 15% and OAF 2 5% will be used;
- A ratio of 60% planted and 40% natural will be assumed for each AU;
- Regeneration delay for Planted (P) is two years and for Natural (N) is seven years;
- Improved stock was not planted until 1999 so there is no genetic gain applied to any species.

Table 19. TIPSY regeneration composition inputs for stands greater than 20 years of age

AU #	BEC	Leading species	Avg SI for AU	SI cutoffs	Regen species and weighting	Initial density P/N
			23.9	Fdi>22/Lw>24	Fdi30 Lw20 Cw20 Pli15 Sx15	1400 / 2000
		Fdi/Lw	22.2	Fdi>19 to <=22Lw>20 to <=24	Fdi30 Lw20 Cw20 Pli15 Sx15	1400 / 2000
			18.5	Fdi<=19/Lw<=20	Pli30 Fdi20 Lw20 Hw20 Cw10	1400 / 2000
			20.4	>18	Fdi20 Lw20 Pli20 Sx20 Cw20	1400 / 2000
		Cw	18.0	17 to <=18M	Fdi20 Lw20 Pli20 Sx20 Cw20	1400 / 2000
			14.8	<=17	Pli30 Fdi20 Lw20 Bl20 Hw10	1400 / 2000
			21.1	>20	Fdi20 Lw20 Pli20 Sx20 Cw20	1400 / 2000
		Hw	20.0	>15 to <=20M	Fdi20 Lw20 Pli20 Sx20 Hw20	1400 / 2000
	Moist ICH		15.0	<=15	Pli30 Fdi20 Lw20 Bl15 Hw15	1400 / 2000
			23.0	>19	Fdi20 Lw20 Pli20 Sx20 Bl20	1400 / 2000
		Sxw	16.2	>12 to <=19	Fdi20 Lw20 Pli20 Sx20 Bl20	1400 / 2000
			10.8	<=12	Pli30 Sx20 Fdi20 Bl15 Pw15	1400 / 2000
			18.8	>17	Sx30 Pl30 Bl20 Lw10 Fd10	1400 / 2000
		Bl	14.8	>12 to <=17	Sx30 Pl30 Bl20 Lw10 Fd10	1400 / 2000
			10.2	<=12	Sx40 Pl40 Bl20	14000 / 2000
			22.2	>21	Pli30 Lw30 Fdi20 Bl10 Pw10	1400 / 2000
		Pli	20.9	>18 to<=21	Pli30 Lw30 Fdi20 Bl10 Pw10	1400 / 2000
			16.6	<=18	Pli40 Lw30 Fdi20 Bl0	1400 / 2000
		Fdi/Lw	24.0	All SI	Fdi30 Sx20 Pli20 Lw15 Hw15	1400 / 2000
	Wet ICH	Bl/Cw/Hw	19.4	All SI	Sx30 Fdi20 Cw20 Hw15 Pli15	1400 / 2000
		Sxw/Pli	15.8	All SI	Sx40 Fdi20 Pw15 Hw15 Cw10	1400 / 2000
			24.6	Fdi>23/Lw>24	Fdi30 Lw30 Pli20 Py10 Pw10	1400 / 2000
	Dry ICH	Fdi/Lw	22.7	Fdi>17 to <=23 Lw >22 to <=24	Fdi30 Lw30 Pli20 Py10 Pw10	1400 / 2000
			17.8	Fdi<=17/Lw<=22	Fdi30 Pli30 Lw20 Py10 Pw10	1200 / 1800
		Fdi/Py	19.9	All SI	Fdi50 Lw30 Py10 Pli10	1400 / 2000
		Cw	18.7	All SI	Lw40 Fdi30 Pli10 Pw10 Cw10	1400 / 2000
		Hw	18.6	All SI	Lw40 Fdi30 Pli10 Pw10 Hw10	1400 / 2000

(continued)

Table 19. TIPSY regeneration composition inputs for stands greater than 20 years of age

AU #	BEC	Leading species	Avg SI for AU	SI cutoffs	Regen species and weighting	Initial density P/N
		Pli	23.1	>21	Fdi30 Lw30 Pli20 Py10 Pw10	1400 / 2000
			20.9	<=21	Fdi30 Lw30 Pli20 Py10 Pw10	1400 / 2000
		Sx		>21	Included with Fdi/Lw >24	
				>16<=21	Included with Hw all	
				<=16	Included with Fdi/Lw <=22	
		*A small amount of Bg and Bl leading types were added to Fdi/Lw 22.7				
	Moist/Wet ESSF	Sxw	18.1	>17	Sxw70 Bl20 Pli10	1400 / 2000
			*16.0	<=17	Sxw70 Bl20 Pli10	1400 / 2000
		Bl	15.1	>14	Sxw 70 Bl20 Pli10	1400 / 2000
			14.0	<=14	Sxw 70 Bl20 Pli10	1400 / 2000
		Pli		>17	Included with Sxw <=17	
				<=17	Included with Sxw <=17	
		A small amount of Fdi, Cw, Bg, Hw and Lw leading types were included in Sxw <=17				
	Woodland	Sx/Bl	13.0	All SI	Sx80 BL20	1400 / 2000
		Sxw	21.7	>20	Sx30 Pli30 Bl20 Lw10 Fdi10	1400 / 2000
			18.4	15 to <=20	Sx30 Pli30 Bl20 Lw10 Fdi10	1400 / 2000
			14.5	<=15	Sx40 Pli40 Bl20	1400 / 2000
		Bl	21.0	>20	Sx30 Pli30 Bl20 Lw10 Fdi10	1400 / 2000
			17.6	<=20	Sx30 Pli30 Bl20 Lw10 Fdi10	1400 / 2000
		Fdi/Lw	21.3	Fdi>18/Lw>19	Sx30 Pli30 Fdi15 Lw15 Bl10	1400 / 2000
	Lower ESSF		18.0	Fdi>15 to<=18 Lw>16 to <=19	Sx30 Pli30 Fdi15 Lw15 Bl10	1400 / 2000
			14.5	Fdi<=15/Lw<=16	Sx40 Pli40 Bl20	1400 / 2000
		Hw	*16.9	>17	Sx30 Pli30 Bl20 Lw10 Fdi10	1400 / 2000
			16.4	>15 to <=17	Sx30 Pli30 Bl20 Lw10 Fdi10	1400 / 2000
			13.8	<=15	Sx40 Pli40 Bl20	1400 / 2000
		Pli	20.6	>19	Sx30 Pli30 Fdi15 Lw15 Bl10	1400 / 2000
			18.0	>16 to <=19	Sx30 Pli30 Fdi15 Lw15 Bl10	1400 / 2000
			15.5	<=16	Sx40 Pli40 Bl20	1400 / 2000
			*A small amount of Cw leading was added to the Hw>17.0 hence the SI average is slightly below the SI cutoff			

(continued)

Table 19. TIPSY regeneration composition inputs for stands greater than 20 years of age (concluded)

AU #	BEC	Leading species	Avg SI for AU	SI cutoffs	Regen species and weighting	Initial density P/N
	Dry ESSF	Sxw	17.9	>16	Sxw50 Pli30 Bl20	1400 / 2000
			14.6	<=16	Sxw50 Pli30 Bl20	1400 / 2000
		Bl	18.8	>15	Sxw50 Pli30 Bl20	1400 / 2000
			15.0	<=15	Sxw50 Pli30 Bl20	1400 / 2000
		Pli	18.9	>17	Pli60 Sx20 Bl20	1400 / 2000
			*16.0	<=17	Pli60 Sx20 Bl20	1400 / 2000
		*A small amount of Cw, Fdi, Lw and Hw leading types were added to Pli <=17				
	Deciduous		18.0	All	Pli30Fdi20Lw20Hw20Cw10	1400 / 2000

7.4.3.2 Managed stands younger than 20 years old / future managed stands

General yield assumptions:

- Standard OAF 1 15% and OAF 2 5% will be used;
- A ratio of 80% Planted and 20% Natural will be assumed for all AUs;
- Regen Delay for Planted (P) is two years and for Natural (N) is seven years;
- Genetic gain is applied to the Planted but not the Natural. Genetic gain differs between stands < 20 years and future stands as per the Tables 28, 29 and 30 in Section 8.3.1.

Table 20. TIPSY regeneration composition inputs for stands less than 20 years old and future stands

AU #	BEC	Leading species	Avg SI for AU's	SI cutoffs	Regen species and weighting	Initial density P/N
	Moist ICH	Fdi/Lw	23.9	Fdi>22/Lw>24	Fdi30 Pli20 Lw20 Sx15 Cw15	1500 / 2000
			22.2	Fdi>19 to <=22 Lw>20 to <=24	Fdi30 Pli20 Lw20 Sx15 Cw15	1500 / 2000
			18.5	Fdi<=19/Lw<=20	Pli30 Fdi20 Lw20 Hw20 Cw10	1500 / 2000
		Cw	20.4	>18	Fdi20 Lw20 Pli20 Sx20 Cw20	1500 / 2000
			18.0	17 to <=18M	Fdi20 Lw20 Pli20 Sx20 Cw20	1500 / 2000
			14.8	<=17	Pli30 Fdi20 Lw20 Bl10 Cw20	1500 / 2000
		Hw	21.1	>20	Fdi20 Lw20 Pli20 Sx20 Hw20	1500 / 2000
			20.0	>15 to <=20M	Fdi20 Lw20 Pli20 Sx20 Hw20	1500 / 2000
			15.0	<=15	Pli30 Fdi20 Lw20 Bl10 Hw20	1500 / 2000
		Sxw	23.0	>19	Fdi20 Lw20 Pli20 Sx20 Pw20	1500 / 2000
			16.2	>12 to <=19	Fdi20 Lw20 Pli20 Sx20 Bl20	1500 / 2000
			10.8	<=12	Pli30 Sx20 Fdi20 Bl15 Pw15	1500 / 2000
		Bl	18.8	>17	Sx30 Pl30 Bl20 Lw10 Fd10	1400 / 2000
			14.8	>12 to <=17	Sx30 Pl30 Bl20 Lw10 Fd10	1400 / 2000
			10.2	<=12	Sx40 Pl40 Bl20	14000 / 2000

(continued)

Table 20. TIPSY regeneration composition inputs for stands less than 20 years old and future stands

AU #	BEC	Leading species	Avg SI for AU's	SI cutoffs	Regen species and weighting	Initial density P/N
			22.2	>21	Pli40 Lw20 Fdi20 Bl10 Pw10	1500 / 2000
		Pli	20.9	>18 to<=21	Pli40 Lw20 Fdi20 Bl10 Pw10	1500 / 2000
			16.6	<=18	Pli40 Lw30 Fdi20 Bl0	1500 / 2000
		Fdi/Lw	24.0	All SI	Fdi30 Sx20 Pli20 Lw15 Hw15	1500 / 2000
	Wet ICH	Bl/Cw/Hw	19.4	All SI	Sx40 Fdi20 Cw20 Hw10 Pw10	1500 / 2000
		Sxw/Pli	15.8	All SI	Sx40 Fdi20 Pw15 Hw15 Cw10	1500 / 2000
			24.6	Fdi>23/Lw>24	Fdi30 Lw30 Pli20 Py10 Bg10	1500 / 2000
		Fdi/Lw	22.7	Fdi>17 to <=23 Lw >22 to <=24	Fdi30 Lw30 Pli20 Py10 Bg10	1500 / 2000
			17.8	Fdi<=17/Lw<=22	Fdi30 Pli30 Lw20 Py10 Pw10	1200 / 1800
	Dry ICH	Fdi/Py	19.9	All SI	Fdi50 Lw30 Py10 Pli10	1500 / 2000
		Cw	18.7	All SI	Lw40 Fdi30 Pli10 Cw10 Bg10	1500 / 2000
		Hw	18.6	All SI	Lw40 Fdi30 Pli10 Pw10 Cw10	1500 / 2000
		Pli	23.1	>21	Fdi30 Lw30 Pli20 Py10 Bg10	1500 / 2000
			20.9	<=21	Fdi30 Lw30 Pli20 Py10 Bg10	1500 / 2000
				>21	Included with Fdi/Lw >24	
		Sx		>16<=21	Included with Hw all	
				<=16	Included with Fdi/Lw <=22	
		A small amount of Bg and Bl leading types were added to Fdi/Lw 17.7				
		Sxw	18.1	>17	Sxw70 Bl20 Pli10	1500 / 2000
	Moist/Wet ESSF		16.1	<=17	Sxw70 Bl20 Pli10	1500 / 2000
		Bl	15.1	>14	Sxw70 Bl20 Pli10	1500 / 2000
			14.0	<=14	Sxw70 Bl20 Pli10	1500 / 2000
		Pli		>17	Included with Sxw <=17	
				<=17	Included with Sxw <=17	
		A small amount of Fdi, Cw, Bg, Hw and Lw leading types were included in Sxw <=17				
	Woodland	Sx/Bl	13.0	All SI	Sx80 BL20	1500 / 2000
			21.7	>20	Sx30 Pli30 Bl20 Lw10 Fdi10	1500 / 2000
		Sxw	18.4	>15 to <=20	Sx30 Pli30 Bl20 Lw10 Fdi10	1500 / 2000
			14.5	<=15	Sx40 Pli40 Bl20	1500 / 2000
		Bl	21.0	>20	Sx30 Pli30 Bl20 Lw10 Fdi10	1500 / 2000
	Lower ESSF		17.6	<=20	Sx30 Pli30 Bl20 Lw10 Fdi10	1500 / 2000
			21.3	Fdi>18/Lw>19	Sx30 Pli30 Fdi15 Lw15 Bl10	1500 / 2000
		Fdi/Lw	18.0	Fdi>15 to<=18 Lw>16 to <=19	Sx30 Pli30 Fdi15 Lw15 Bl10	1500 / 2000
			14.5	Fdi<=15/Lw<=16	Sx40 Pli40 Bl20	1500 / 2000

(continued)

Table 20. TIPSY regeneration composition inputs for stands less than 20 years old and future stands (concluded)

AU #	BEC	Leading species	Avg SI for AU's	SI cutoffs	Regen species and weighting	Initial density P/N
			*16.9	>17	Sx30 Pli30 Bl20 Lw10 Fdi10	1500 / 2000
		Cw/Hw	16.4	>15 to <=17	Sx30 Pli30 Bl20 Lw10 Fdi10	1500 / 2000
			13.8	<=15	Sx40 Pli40 Bl20	1500 / 2000
			20.6	>19	Sx30 Pli30 Fdi15 Lw15 Bl10	1500 / 2000
		Pli	18.0	>16 to <=19	Sx30 Pli30 Fdi15 Lw15 Bl10	1500 / 2000
			15.5	<=16	Pli40Sx20 Bl20 Fdi10 Lw10	1500 / 2000
	* A small amount of Cw leading area was added to the Hw>17.0 hence the SI average is slightly below the SI cutoff for Hw					
		Sxw	17.9	>17	Sxw60 Pli30 Bl10	1500 / 2000
			14.6	<=17	Sxw60 Pli30 Bl10	1500 / 2000
	Dry ESSF	Bl	18.8	>15	Sxw70 Pli20 Bl10	1500 / 2000
			15.0	<=15	Sxw70 Pli20 Bl10	1500 / 2000
		Pli	18.9	>17	Pli50 Sx40 Bl10	1500 / 2000
			*16.0	<=17	Pli50 Sx40 Bl10	1500 / 2000
	*A small amount of Cw, Fdi, Lw and Hw leading types were added to Pli <=17					
		Deciduous	18.1	All SI	Pli30Fdi20Lw20Hw20Cw10	1500 / 2000

Data source and comments:

The managed stand analysis units were determined as explained in Section 5.2, Analysis units. Site index grouping with less than 200 hectares may be combined with neighboring site index cutoff. The genetic gain tables are in Section 8.3.1.

There were 31 stand development monitoring (SDM) samples (310 plots) established in the Arrow TSA between 2010 and 2014 as part of the Forest and Range Evaluation Program (FREP). The SDM plots are completed in stands greater than 20 years old. Results from the SDM sampling guided the species composition and other table inputs. Between 90% and 95% of the SDM sampled blocks were planted with a regular tree distribution at establishment. However, SDM results shows that the distribution and composition of the existing trees looked more like a natural stand than the original establishment distribution. In fact, 40% of the well-spaced trees counted in the SDM plots were small natural trees, and not the large planted species. This resulted in the ratio of 60% planted and 40% natural being chosen for the distribution of the stands equal or greater than 20 years in the above table. It is assumed that the stands younger than 20 years of age have better survival due to the improved stock being planted during this era. Consequently a ratio of 80% planted and 20% natural was chosen for these stands. A reduced genetic gain was calculated for stands younger than 20 years as explained in Section 8.3.1 and shown in Table 28. All table inputs for future stands are the same as the 0 to 20 year old stands except for the genetic gain as shown Section 8.3.1, Table 30.

7.4.4 Regeneration delay

Harvested stands are required to be reforested. Operationally there may be a delay between the harvest of a stand and when the site is in a fully regenerated state.

Using RESULTS data available for declared regeneration, the minimum and maximum planting dates were compared to the disturbance start date in RESULTS (between 2004 and 2014). The average difference between them was calculated to be 1.17 to 1.92 years. District staff recommends using two years, the average of these two values after rounding up from 1.6 years.

Data source and comments:

Average regeneration delay was summarized based on RESULTS data using an average of the earliest and latest planted dates in an opening less disturbance start date for the period from January 1, 2004, to December 31, 2014.

7.5 Integrated resource management

Integrated resource management objectives are set by government in FRPA's Forest Planning and Practices Regulation (FPPR) and other legislation, in the Arrow TSA, additional guidance is provided by the Kootenay Boundary Higher Level Plan Order (KBHLPO) and subsequent amendments.

Forest cover requirements may be examined at a number of different scales and for a number of different values, for example: landscape units, ungulate winter range areas and visual quality areas. With the requirement to retain different forest characteristics across the landscape, it is important to identify how forest outside of the THLB but within the CFLB may be considered in the forest cover requirements (i.e., maximum allowable disturbance or minimum area retention). Table 21 describes the forest attribute requirements to be applied in the analysis.

Although the new BEC is nearing completion for the Arrow TSA, the current BEC will continue to be used for all integrated resource management.

Table 21. Forest cover attribute requirements

Resource objective	Area target (%)	Condition target	Affected land base
Cutblock adjacency	Maximum 33%	Height ≤ 2.5 m	THLB by landscape unit
Community watersheds	Maximum 30%	Height ≤ 6 m	Crown forested land base by community watershed for watersheds
Domestic watersheds	Maximum 30%	Height ≤ 6 m	Crown forested land base by domestic watershed for watersheds
Visual quality objectives	See Table 23	Height ≤ visually effective green-up height in Table 24	Crown forested land base for each visual unit
Ecosystem connectivity corridors	See Table 25	Mature plus old seral requirement	Crown forested land base by landscape unit and BEC variant within ecosystem connectivity corridor
Ungulate winter range	See Section 7.5.4 Ungulate winter range	See Table 22 UWR forest cover objectives	Planning unit definition

7.5.1 Cutblock adjacency

Maximum cutblock size and adjacency in the Arrow TSA are governed by constraints in the Forest Planning and Practices Regulation. It is current practice that, licensees comply with FPPR Section 64 and limit block size to 40 hectares. Larger blocks may be harvested with an appropriate forest health or natural disturbance rationale. Most licensees have also chosen to comply with Section 65, which limits harvesting adjacent to an existing cutblock that has not achieved green-up. The block size constraint is applied to the integrated resource management (IRM) area outside of ungulate winter range (U-4-001), community watersheds and scenic areas, but the adjacency is not.

Patch size distribution expectations are modelled using a proxy. Integrated resource management (IRM) areas are generally large contiguous areas of harvestable forest. The use of a maximum disturbance of 33% as the patch size proxy adequately describes the cutting pattern used at this time.

Over the last 10 years, 691 openings were created (harvested) in Arrow TSA with an average net area to be Reforested (NAR) of 23.3 hectares. Approximately 10% (70) of the openings were greater than 40 hectares and ranged from 40.2 to 326.1 hectares. Over half of the 70 openings greater than 40 hectares were pine-leading stands suggesting that these openings exceeded 40 hectares due to mountain pine beetle management. An additional, 10 openings resulted from a selective or retention silviculture system. Therefore it is safe to assume that based on current practices, block size exceeding 40 hectares is not common and consequently using 40 hectares as a maximum target in the base case is appropriate.

Patch size distribution expectations are modelled using a proxy. Integrated resource management (IRM) areas are generally large contiguous areas of harvestable forest. The use of a maximum disturbance of 33% as the patch size proxy adequately describes the cutting pattern used at this time.

Data source and comments:

RESULTS query 2005 to 2014 harvest blocks TSR 4 dated March 2015.

7.5.2 Water for human consumption

7.5.2.1 Community watersheds

There are 34 community watersheds within the Arrow TSA. Under the *Forest and Range Practices Act*, licensees are required to specify results and strategies that meet the objective set by government for water quality. In general, licensees have committed in their FSPs to complete hydrologic assessments, similar to what was done under the *Forest Practices Code Act*. While maximum equivalent clearcut areas (ECA) recommended in these assessments is specific for each watershed, an ECA 'red flag' threshold, based on a hydrological green-up recovery height has been agreed to by all licensees and will be modelled in the base case. This threshold was agreed to be no more than 30% of the Crown forest land base within each community watershed is allowed to be less than six metres in height at any one time during the forecast period.

Current hydrological recovery estimates used for operational purposes originates from the 1995 Interior Watershed Assessment Procedure and proposed that harvested stands are assumed to have a 60% recovered hydrological function at six metres in height and full hydrologic recovery is attained when stands reach nine metres in height. A recent study by Winkler and Boon[1] suggests that the 1995 Interior Watershed Assessment Procedure should no longer be used. Rather, Winkler and Boon suggest that 60% hydrological recovery is attained at nine metres and full recovery at 20 metres. However, this recent study cautions that these new estimates are derived from limited data and specific forest types, mainly lodgepole pine and spruce dominated stands, on flat ground. The study cites that Kim Green suggests for the Kootenays, that 60% hydrological recovery is reached at 15 metres in height.

As a result, sensitivity analysis will explore the effect of a nine metre and a 15 metre hydrological green-up recovery rather than the current six metres.

Revised Snow Recovery Estimates for Pine-dominated Forests in Interior British Columbia[1]
https://www.for.gov.bc.ca/hfd/pubs/Docs/En/En116.htm

7.5.2.2 Domestic watersheds

There are 428 domestic watersheds in the Arrow TSA and licensees' current practices use the same ECA 'red flag' threshold as for community watersheds. Consequently domestic watersheds will be modelled the same way as the community watersheds in the base case i.e., no more than 30% of the Crown forest land base within each domestic watershed is allowed to be less than six metres in height at any one time during the forecast period.

Streamside management provisions within consumptive use streams are legally established under Objective 6 of the KBHLO. Specifically, S5 and S6 stream riparian management zones of the upstream from water intakes are required to have at least a 30 metre (slope distance) management zone with site specific measures to safeguard water used for human consumption. Minimum retention targets within the management zones are consistent with Section 8 of the Forest Planning and Practices Regulation and are described in Section 6.2.11 and Table 16. These buffers were excluded from the THLB as a surrogate for the reserve zone and management zone stand retention requirements.

Similar to the community watersheds, a sensitivity analysis will explore the effect of a nine metre and a 15 metre hydrological green-up recovery rather than the current six metres.

7.5.3 Grizzly bear habitat

A Specified Area Order for the Kettle-Granby Grizzly Bear, WHA # 8-373 General Wildlife Measures Order, provides additional protection for the conservation of grizzly bear. It was established on August 25, 2010 under the Government Actions Regulation. Provisions include restricted timing of road use and silviculture adjacent to avalanche chutes, retention of large woody debris and maintenance of huckleberry production. The requirements under this order are assumed not to restrict timber supply above other existing objectives or current management practices. These General Wildlife Measures were therefore not modelled in the base case harvest forecast.

7.5.4 Ungulate winter range - Mule Deer, white tailed deer, Rocky Mountain elk and moose

GAR Order U-4-001 was established on December 13, 2005 for the protection of winter habitat for Mule Deer, white tailed deer, Rocky Mountain elk and moose. The order establishes objectives for the retention of snow interception cover and forage area and sets a minimum requirement for mature seral stand structure and a maximum level of denudation. The GAR order U-4-001 is located in various low elevation areas (generally below 1200 metres) throughout the TSA.

The objectives for the order are modelled as minimum retention constraints. To model them as such requires simplifying the interpretation of the order more than is done operationally. The simplification may result in lesser or greater constraints to the timber supply. Guidance with respect to the possible difference will be provided to the chief forester for consideration in the AAC determination.

Table 22. Ungulate winter range forest cover objectives

Species	BEC	Minimum forest cover area	Age (years)	Management unit
Mule Deer	ICHxw	20%	>=81	Refer to the order for the applicable management units
	ICHdw	30%	>=81	
	ICHmw, ICHwk	40%	>=101	
White-tailed deer	ICHdw	40%	>=81	
Elk	ICHdw	20%	>=81	
	ICHmw	30%	>=101	
Moose	All subzones	20%	>=61	
Forage area all species	All subzones	10%	>=81	

7.5.5 Visual quality objectives

Visual quality objectives (VQOs) were established for scenic areas in the Arrow TSA through an order GAR on December 31, 2005. Table 23 shows the maximum allowable percent alteration for each VQO in perspective view. Percentages are taken from the Timber Supply Analysis Bulletin, *Modelling Visuals in TSR III*, and modified to reflect the mid-point for each visual absorption capacity (VAC) percentage alteration categories.

Table 23. Assignment of visual quality objectives

Recommended VQO	% alteration by VAC (perspective view)		
	Low	Medium	High
Retention	2	3	4
Partial retention	6.7	10	13.3
Modification	16.7	20	23.3

Visually effective green-up (VEG) requirements vary by slope class as per the following table. For the purposes of the analysis, an area-weighted mean slope was calculated for each VQO of each landscape unit (LU) to determine the area weighted green-up height.

Table 24. Visual effective green-up (VEG) heights by slope class

	Slope classes (%)														
	0 - 5	5.1 - 10	10.1 - 15	15.1 - 20	20.1 - 25	25.1 - 30	30.1 - 35	35.1 - 40	40.1 - 45	45.1 - 50	50.1 - 55	55.1 - 60	60.1 - 65	65.1 - 70	70.1+
VEG height (m)	3.0	3.5	4.0	4.5	5.0	5.5	6.0	6.5	6.5	7.0	7.5	8.0	8.5	8.5	8.5

Data source and comments:

Information and documents on visual resource management are available on the FLNR Resource Practices Branch website at https://www.for.gov.bc.ca/hfp/values/visual/index.htm

7.5.6 Landscape-level biodiversity

Maintaining and managing for old- and mature-forests contributes to the conservation of landscape-level biodiversity. The Kootenay Boundary HLPO has legal requirements for the amount of old- and mature-forests that must be retained on the landscape called biodiversity targets. These targets are expressed as the amount of area (%) that must retain old- and mature-seral stage characteristics within the crown forested land base (CFLB) for each biogeoclimatic variant for specific landscape units (LUs).

Old growth management areas (OGMAs) are used to achieve biodiversity targets and contribute to the legal biodiversity objective of the KBHLPO. Non-legalized OGMAs have been spatially identified and mutually agreed upon by licensees and the ministry. Licensees have incorporated language to manage and respect the spatial, non-legalized OGMAs in their respective forest stewardship plans (FSPs). Consequently, it is reasonable to model spatial OGMAs in the base case, and model aspatial old-growth targets as a sensitivity analysis.

OGMAs meet 100% of the old forest requirements in all LUs except in low biodiversity emphasis LUs. The KBHLPO allows for old-seral stage requirements to be reduced to one-third of the required target in low biodiversity emphasis areas, but the full target for old forests must be met by the end of the third rotation. However, government used Section 12(7) of the Forest Planning and Practices Regulation (FPPR) to exempt licensees from the requirement to prepare a recruitment strategy. To date, government has not re-visited the issue. In addition, the proposed timber supply model does not permit temporal changes in constraints, as such; the step-up to the full target will not be modelled. A sensitivity analysis will investigate applying the full old-seral targets from initiation.

Seral requirements are currently calculated and monitored based on the Biogeoclimatic Ecosystem Classification (BEC) information that was in place at the time of the establishment of the KBHLPO. For the purpose of this timber supply analysis, the seral targets are applied using current landscape unit and BEC information. This use simplifies the analysis and is expected to have minimal timber supply or seral target implications at this strategic level.

Table 25. Old- and mature-seral requirement

Landscape unit	BEC subzone/variant	NDT[a]	Biodiversity emphasis	Old[b] requirement (minimum retained area percentage)	Amount of mature[c]+ old for ecosystem connectivity corridor requirement (minimum retained area percentage)
N501 Sheep Creek	ICH dw	3	Intermediate	14	23
N504 Pend' Oreille	ICH dw	3	Intermediate	14	23
N505 Stagleap	ICH dw	3	Intermediate	14	23
N508 Blueberry	ICH dw	3	Intermediate	14	23
N509 Dog	ICH dw	3	Intermediate	14	23
N511 Cayuse	ICH dw	3	Intermediate	14	23
N513 Pedro	ICH dw	3	Intermediate	14	23
N514 Perry	ICH dw	3	Intermediate	14	23
N518 Gladstone	ICH dw	3	Intermediate	14	23
N515 Lemon	ESSF wc1, ESSF wc4	2	High	13	42
	ICH mw2	2	High	13	46
	ICH dw	3	High	21	34
	ICH wk1	1	High	19	51
N525 Wilson	ESSF wc1, ESSF wc4,	2	High	13	42
	ICH mw2	2	High	13	46
	ICH dw	3	High	21	34
N528 Kuskanax	ESSF wc1, ESSF wc4,	2	High	13	42
N529 Halfway	ESSF wc1, ESSF wc4,	2	High	13	42
	ICH vk1, ICH wk1	1	High	19	51
N530 Trout	ESSF wc1, ESSF wc4	2	High	13	42
	ICH mw2	2	High	13	46

(a) Natural Disturbance Type.

(b) Retention age for old forests: ICHdw >140yrs; ESSFwc1, ESSFwc4, ICHwm2, ICHvk1, ICHwk1 >250 years.

(c) Retention age for mature forests: ESSFwc1, ESSFwc4 >120yrs; ICHdw, ICHwm2, ICHvk1, ICHwk1 >100 years.

Data source and comments:

Kootenay Boundary Higher Level Plan Order available at https://www.for.gov.bc.ca/tasb/slrp/lrmp/cranbrook/kootenay/pdf/KBHLPOrder0925.pdf

7.5.7 Connectivity corridor

A regional forest ecosystem connectivity corridor is legally established under the KBHLPO Objectives 5. Only forested slopes ≤80% contribute to the connectivity component in the corridor. Where mature and old requirements exist, they must be preferentially located inside mapped connectivity corridors.

Old forest cover targets are used to address the connectivity corridor. As per the KBHLPO, protected areas are used first within each BEC variant to reduce the seral target proportions outside the protected areas. Fourteen landscape units have mature requirements in the Arrow TSA (Table 25). Connectivity corridor will be modelled in the base case.

Data source and comments:

Kootenay Boundary Higher Level Plan Order available at
https://www.for.gov.bc.ca/tasb/slrp/lrmp/cranbrook/kootenay/pdf/KBHLPOrder0925.pdf

7.5.8 Disturbance outside of the timber harvesting land base

As forested stands in the non-THLB contribute toward several forest cover objectives (i.e., landscape-level biodiversity, visuals, etc.), it is important that the age class distributions in these stands remain consistent with natural processes. By implementing disturbance in these stands, a natural age class distribution can be maintained in the model and a realistic contribution toward seral stage goals ensured.

The document, *Modelling Options for Disturbance Outside the THLB – Working Paper*, provides direction for disturbing areas of the landscape outside of the THLB. There are a variety of possible approaches to applying a disturbance in the contributing non-timber harvesting land base. While each approach has its strengths and weaknesses there remains a significant amount of uncertainty as to what the most appropriate methodology would be. The age reset by variant for the contributing, non-timber harvesting land base methodology is proposed for the base case analysis. The methodology (*Modelling Options for Disturbance Outside the THLB – Working Paper*) is as follows:

1. List the estimated return interval for disturbance in each variant and NDT in the TSA (*Landscape Unit Planning Guide Appendix 2*).
2. Establish the estimated minimum target % of old seral that would be expected (*Landscape Unit Planning Guide Appendix 2*).
3. Calculate a rotation age based on the age distribution described in step 2 (target age/(1- target %).
4. Divide the contributing non-THLB area in the variant by the calculated rotation age to determine the annual minimum disturbance target for each variant.
5. Establish the estimated minimum target % of old seral (bullet 2) as well as the annual minimum disturbance target for each variant (bullet 4).

Table 26 identifies the minimum target area to be disturbed annually within each BEC variant for the Arrow TSA. This analysis was completed based on the BEC variants present and their associated natural disturbance intervals and old seral definitions as outlined in the *Landscape Unit Planning Guide Appendix 2*. The minimum area to disturb annually will be applied across each NDT based on the representation of each BEC unit. The area target will be achieved by randomly selecting stands (without replacement) to be disturbed in each period and then hardwiring this into the model. Stands of all ages had equal opportunity to be disturbed.

Modelling of disturbance at the BEC variant level was simplified to the NDT level (excluding landscape unit) in order to minimize the number of modelled zones while ensuring that each zone would have a single, old-seral age. No minimum amount of old was implemented because disturbance was selected randomly - independent of modelled harvest priority.

Table 26. Calculation of area to be disturbed annually in forested non-THLB by NDT/BEC

NDT	BEC	Disturbance interval (years)	"OLD" Defn (years)	%area >OLD	Effective rotation age (years)	Contributing non-THLB area (ha)	Annual area disturbed (ha)
1	ICHvk1 ICHwk1	250	250	TBD	TBD	TBD	TBD
	ESSFvc, ESSFwc1[1] ESSFwc4[1]	350	250	TBD	TBD	TBD	TBD
2	ICH mw2 ESSFwc1[2] ESSFwc4[2]	200	250	TBD	TBD	TBD	TBD
3	ICHdw1 ESSFdc1	150	140	TBD	TBD	TBD	TBD
4	ICHxw, IDFu	250	250	TBD	TBD	TBD	TBD

[1]ESSF wc1 – North of the West arm of Kootenay Lake & ESSF wc4 - North of the West arm of Kootenay Lake.

[2]ESSFwc1 - South of the West arm of Kootenay Lake & ESSFwc4 - South of the West arm of Kootenay Lake.

7.5.9 Slocan Valley

Historically, licensees have had limited ability to access timber in the Slocan Valley due to pressure from local water users and environmental organizations. This has led to a more intense harvest in the remainder of the TSA. The contentious areas in the previous TSR included segments of five landscape units: Hills, Idaho, Lemon, Pedro and Perry. In 2008, a community forest was established over roughly half of the contentious area in the Slocan Valley. Consequently, the current impact is much reduced compared to historical impact. Rather than completing a harvest performance analysis over the remaining contentions area, a sensitivity analysis will assess the impact of removing the remaining contentious area in the Slocan Valley from the THLB.

7.5.10 Protected area strategy-Goal 2

BC's Protected Areas Strategy (PAS) identified numerous 'Goal 2' areas for the protection of natural, cultural and recreational features. In recent years, the Kootenay Boundary Manager's Committee approved the list of Goal 2 areas, and recommended their establishment as protected areas. The establishment of these parks has not been finalized; however, there is a high degree of certainty that they will be established in the near future and forest licensees have not been harvesting in these areas. Goal 2 areas will be explored in a sensitivity analysis.

Table 27 Protected area strategy - Goal 2

Name	Area (hectares)	Reduction (%)
Bremner	TBD	100%
Renata Natural Arch	TBD	100%
Summit Lake	TBD	100%
Slocan Lake	TBD	100%
Waldie Lake	TBD	100%

Data source and comments:

In the interim, the approved Goal 2 sites are stored in two data layers in the provincial data warehouse (BCGW) to give them a degree of protection until government officially designates them as parks. The Mineral Reserve Site is a layer that defines areas where mineral, placer and coal titles are restricted, and placer titles are permitted. This layer was the source for the boundaries of Bremner, Renata, Summit Lake, and Waldie Lake Goal 2 areas. The fifth Goal 2 boundary, Slocan Lake, was sourced from the Crown Land Reserves and Notations layer, which contains active and applied for reserves and notation boundaries.

8. Growth and Yield

8.1 Natural stand yield tables

Yield tables for existing natural stands are derived using the Variable Density Yield Prediction (VDYP7 console) model. Input information for the VDYP7 model will be based on the vegetation resources inventory attributes of individual polygons.

Data source and comments:

Information on VDYP is available at http://www.for.gov.bc.ca/hts/vdyp/

8.2 Decay, waste, and breakage

Default values in VDYP7 are used and are based on past survey work.

8.3 Managed stand yield tables

Yield tables for managed stands are derived using the Table Interpolation Program for Stand Yields (TIPSY).

Data source and comments:

Information on TIPSY is available at http://www.for.gov.bc.ca/hre/gymodels/TIPSY/index.htm

Initial regeneration conditions are in the silviculture section (see Tables 19 and 20).

8.3.1 Tree improvement

Licensees are obliged to use the best available seed source when regenerating sites with planted stock. Planted stock may have faster growth than natural trees that may regenerate on the site. The faster growth may be due to either use of high-quality genetically improved seed from seed orchards or use of seed harvested from superior wild trees.

Analysis units (AU) have been created for stands equal or greater than 20 years of age, younger than 20 years of age, and future managed stands. Current genetic gain information is incorporated as a weighted average within the managed stand yield curves for each AU. For stands equal or greater than 20 years of age no genetic gain was applied as the first improved seed was planted in 1999. The weighted genetic worth for stands younger than 20 years of age and future managed stands is shown in the tables below. Further, as natural regeneration contributes in part, the genetic worth will only be applied to the percentage of the AUs that is planted.

Table 28. Current genetic worth for managed stand yield table younger than 20 years (1994-2014)

Species	Percentage of select seedling planted	Weighted genetic worth (%)	Proportionate genetic worth to percent select seed use (%)
FDI	11	20	3.1
LW	56	24	13.1
PLI	32	12	3.6
SX	67	12	7.3

Table 29. Projected genetic worth for future managed stands - forecast summary by species

Species	SPU	niche	Genetic worth
FDI	21	Nelson 400-1200	25%
FDI	22	Nelson1000-1800	34%[1]
LW	13	Nelson700-1600	30%
LW	50	Nelson 1200-1800	13%
PLI	07	Nelson 700-1600	15%
PLI	20	Nelson 1600-2000	15%
SX	44	Nelson 1-1000	23%
SX	4	Nelson 1000-1700	21%
SX	5	Nelson 1700-2100	16%

Future genetic worth was weighted by SPU area (in the THLB) for a given species in order to simplify a single genetic gain value which can be applied to the future managed stand tables in TIPSY. Approximately 700 hectares of the Arrow TSA fall in Thompson/Okanagan SPUs which was considered too small to include in the genetic gain calculation.

Table 30. THLB SPU area-weighted genetic worth for future managed stands

Species	Weighted genetic worth
FDI	31%[1]
LW	27%
PLI	15%
SX	21%

[1] Modelling capped at 30%.

These genetic worth forecasts are very optimistic and they have a large effect on the minimum harvest age. A sensitivity analysis will be completed using the current weighted genetic worth in Table 28, for future stands.

Data source and comments:

Seed use and genetic worth values for the last 10 years provided by Tree Improvement Branch, FLNR. Data derived from Seed Planning and Registry Application (SPAR) Reports 2015-01-19.

Seed use and genetic worth values for 10-20 years from RESULTS report RDD007 July 2015.

Breeding and orchard production report for future genetic worth supplied by Tree Improvement Branch, FLNR. Data, July, 2014 for all SPUs except SPU 13, May 7, 2014.

No genetic gain is applied to Pw as the "genetic worth" relates to the resistance to blister rust.

8.3.2 Operational adjustment factors

Yield projections in TIPSY are based upon potential yields where a site is fully occupied with trees. Because a stand may not fully occupy a site or be able to reach its potential growth (e.g., due to forest health issues), TIPSY enables two different operational adjustment factors (OAF) to be applied. OAF 1 is used to represent reduced yield due to gaps in the distribution pattern of trees on a site. OAF 2 is used to represent tree decay and tree mortality due to diseases and pests. OAF 1 is a constant reduction factor that shifts the yield curve down whereas the influence of OAF 2 increases with age and therefore alters the shape of the yield curve.

For the timber supply review, the typical standard OAF of 15% for OAF 1 and 5% for OAF 2 will be applied.

There are limitations to OAF 1 as small gaps in tree distribution pattern are only one of the many reasons why the yields achieved under operational conditions may differ from those predicted by yield models like TIPSY.

OAF 1 does not account for many other factors that can cause achieved yields to fall below TIPSY-predicted yields. These factors include: 1) biotic and abiotic damage agents such as insects, disease, wind, and snow; 2) decay, waste, and breakage at harvest; 3) the effect of species mixes.

The FREP Stand Development Monitoring (SDM) data collected in stands greater than 20 years old provides information on gaps in tree distribution pattern, biotic and abiotic damages and the effect of species mixes. The Arrow SDM data showed that biotic and abiotic damage agents were affecting the stands, and the distribution pattern of the trees was more reflective of a natural stand distribution than a planted stand distribution. The data showed that a significant percentage of planted trees (40%) no longer contributed to crop tree yield. Rather than adjust the OAF, the distribution pattern of the trees was adjusted from 100% planted distribution to a combination of 60% planted and 40% natural distribution in the regeneration composition inputs shown in Tables 20 and 21 (Section 7.4.3). In addition, by decreasing the planted tree distribution pattern in favor of increasing the natural tree distribution pattern, this results in extending the length of regeneration delay (from two years to seven years) and decreases the genetic gain (genetic gain is not applied to natural regeneration).

Since the previous TSR, no work has been completed on refining OAF 2 in Douglas-fir leading stands as was instructed by the chief forester to account for higher incidence of Armillaria. However, as explain in Section 7.4.3, managed stand yield tables, adjusting the spatial distribution pattern of the trees in the model will help to account for Armillaria losses. In addition, a sensitivity analysis will be completed with the moist ICH Douglas-fir leading stands to model "clumped" rather than "natural" spatial distribution pattern to further assess the impact of Armillaria volume losses on timber supply. It is believed that "clumped" distribution more closely simulates the currently observed distribution pattern of Armillaria tree mortality.

Data source and comments:

FREP SDM raw summary Arrow(31)_08Jan2015;

Arrow TSA polygon data summary 2015;

OAF 1 Project – Report British Columbia Ministry of Forests and Forest Renewal BC October 1998.

9. Emerging Management Practices

To account for emerging trends in silviculture practices in the Arrow TSA, the following will be included as sensitivity analysis road

9.1 Planting density and increased stand resiliency

One of the soundest strategies to produce resilient stands that can adapt to climate change is to start with an ecologically appropriate species mix using the best genetic stock available and a higher planting density than previously used. This gives the land manager more options to adjust to uncertainty. There is a trend across the province to increase planting densities – especially in pine-leading stands where there is a high risk of mortality due to pine rusts. This density change is incorporated through modifications to stocking standards. The potential impact of this trend on timber supply will be explored in a sensitivity analysis by modelling 2000 per hectare in all stands on good and medium sites in moist, wet ICH/ESSF and lower ESSF analysis units.

9.2 Teabag fertilizer at seedling establishment

There is a trend of increased use of teabag fertilizer province-wide. Licensees report decreased brushing requirements, increased survival against forest pests and less planting shock after using teabag fertilizer. Preliminary results from industry trials indicate increased average height and increased ground level diameter between treated and untreated trees 10-year post-planting. This could translate to an increase of two site index units. The potential impact of this trend on timber supply will be explore in a sensitivity analysis by modelling an increase of the site index by two units on all stands on good and medium sites in moist, wet ICH/ESSF and lower ESSF analysis units.

9.3 Stumping as a treatment for Armillaria

Thirteen trials of stumping treatment in the Kootenay/Boundary and Thompson/Okanagan regions were recently re-measured. Preliminary results from the trials shows that within the ICH moist group, there is estimated to be 63% higher volume at 31 years of age with stump removal as compared to a control area with no stumping treatment. In addition, trees had greater diameters and height on stumped treatments. Although promising, further information is required to justify a sensitivity analysis.

Although district staff believes that stumping treatment is under reported, a RESULTS data base query indicates at least 670 hectares of stumping treatment has been completed since 1995. Licensees have recently reported an increasing use of this treatment.

10. Sensitivity Analysis

Sensitivity analysis can assess the timber supply impact of uncertainty in data and management assumptions and help to determine which variables have the greatest influence on harvest forecasts. Issues can also be investigated to provide further understanding. Table 31 lists the base sensitivity analyses to be performed.

Table 31. Sensitivity analyses to assess influence and issue analyses

Issue to be tested	Sensitivity levels
Enterprise creek access (Section 6.2.4)	Add the Enterprise Creek.
Wildlife tree retention (Section 6.2.12)	Increase wildlife tree retention to 7%.
Juvenile spacing (Section 7.4.2)	Add 2748 hectares of juvenile spacing to understand the effect of this treatment on the TSA timber supply.
Community and domestic Watersheds (Section 7.5.2)	Increase minimum hydrological green-up recovery height from 6 m to 9 m and to 15 m.
Old-growth management areas (Section 7.5.6)	Apply an aspatial old-seral objective in lieu of spatial non-legal old-growth management areas.
Old-seral requirement (Section 7.5.6)	Apply full old-growth target amount in landscape unit with a low biodiversity emphasis.
Slocan Valley contentious area (Section 7.5.9)	Remove the Slocan Valley contentious area from the THLB.
Protected Area Strategy-Goal 2 (Section 7.5.10)	Remove the Protected Area Strategy-Goal 2 from the THLB.
Genetic gain (Section 8.3.1)	Use the current weighted genetic worth values for future stands.
Armillaria Root Disease (Section 8.3.2)	Apply “clumped” distribution in TYPSY on the moist ICH Fdi leading analysis units.
Planting density (Section 9.1)	Increase planting density to 2000 seedling per hectare in all stands on good and medium sites in moist, wet ICH/ESSF and lower ESSF analysis units.
Teabag fertilizer (Section 9.2)	Increase the site index by two units on all stands on good and medium sites in moist, wet ICH/ESSF and lower ESSF analysis units.

Data source and comments:

Further sensitivity analyses will be completed as needs are identified.

11. Habitat Supply Analysis

This timber supply review will include a habitat availability analysis for a select group of wildlife species. For this analysis, a habitat supply model will be used to project the amount of suitable habitat available for each of the species selected if harvesting occurs at the levels projected in the base case and if forest management and harvest priorities are the same as assumed in the base case.

Some modelling assumptions are required in order to establish a baseline for this process. For the Arrow TSA it is assumed that OGMAs will age throughout time without periodic disturbance and will therefore provide old forest attributes once they meet the old forest age criteria. Each species modelled will be reported out in a graphical format showing how habitat supply (in hectares of suitable habitat) is influenced by the projected timber harvesting.

Five wildlife species will be assessed: Grizzly Bear, American Marten, Rocky Mountain Elk, Mule Deer and Northern Goshawk. The objective for selecting these species was to evaluate a number of local species that occur across the Arrow TSA which have life requisites which can be measured by available forest inventory information. Mountain caribou have been left out of this analysis because the GAR orders have specific direction to address their habitat requirements and the protection has been strengthened through the provincial species at risk recovery process.