Tumbler Ridge Community Forest Agreement (K2O) Timber Supply Analysis Data Package

Presented To: Tumbler Ridge Community Forest Corp.

TUMBLER RIDGE COMMUNITY FOREST

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6	4 Sept 2020	Grace Zheng	Duncan McKellar/Jay Greenfield	Revised Base Case Assumption on Deciduous-leading Harvest

Limitations of Report

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Acronyms and Abbreviations

AAC	Allowable Annual Cut
BC	British Columbia
BCLCS	British Columbia Land Classification Scheme
BEC	Biogeoclimatic Ecosystem Classification
BWBS	Boreal White and Black Spruce Zone
CF	Community Forest
CFA	Community Forest Agreement
CFLB	Crown Forested Landbase
DBH	Diameter at Breast Height
DC	Dawson Creek
EM	Ecosystem Mapping
ESSF	Engelmann Spruce – Subalpine Fir Zone
FPPR	Forest Planning and Practice Regulations
FTEN	Forest Tenure
FSP	Forest Stewardship Plan
Ha	Hectares
LEWR	Low Elevation Winter Range
LiDAR	Light Detection and Ranging
LRDW	Land and Resource Data Warehouse
LRMP	Land and Resource Management Plan
LU	Landscape Unit
MFLNRORD	Ministry of Forest, Lands, Natural Resource Operation and Rural Development
MHV	Minimum Harvest Volume
MOF	Ministry of Forest
MPB	Mountain Pine Beetle
MSYT	Managed Stand Yield Tables
NDT	Natural Disturbance Type
NRL	Non-Recoverable Losses
NSYT	Natural Stand Yield Tables
OGMA	Old Growth Management Area
PFT	Problem Forest Type
PSPL	Provincial Site Productivity Layer
RESULTS	Reporting Silviculture Updates and Land Status Tracking System
SPAR	Seed Planning & Registry Application
THLB	Timber Harvesting Landbase
TIPSY	Table Interpolation Program for Stand Yields
TRCF	Tumbler Ridge Community Forest
TSA	Timber Supply Area
TSR	Timber Supply Review
VDYP	Variable Density Yield Prediction Growth and Yield Model
VEG	Visually Effective Green-up
VLI	Visual Landscape Inventory
VQO	Visual Quality Objectives
VRI	Vegetation Resources Inventory
VRIEM	Vegetation Resource Inventory and Ecosystem Mapping
WF	West Fraser Mills Ltd.
WTP	Wildlife Tree Patch

1. Introduction

Tumbler Ridge Community Forest Corp. contracted Ecora Engineering & Resource Group Ltd. (Ecora) to undertake a timber supply analysis in support of an updated Annual Allowable Cut (AAC) determination for the Tumbler Ridge Community Forest (TRCF) landbase. The TRCF is situated in the Dawson Creek (DC) Timber Supply Area (TSA), and was awarded a Community Forest Agreement (CFA) License # K2O in January 2011 with an initial AAC of 20,000 m^3/year for the original CF area of 19,852 hectares (ha). On June 27, 2019, an expansion area of 20,134 ha was awarded to the CFA in addition to the original CF area. The selection of the expansion area was developed through an iterative process in conjunction with Ministry of Forest, Lands, Natural Resource Operations and Rural Development (MFLNRORD). Initially, an area of interest of approximately 27,394 ha around the existing K2O license area was identified. The area was then divided into planning cells so that smaller defined areas could be removed from the initial area of interest until the timber supply analysis results closely matched the awarded AAC of 15,500 m^3 of conifer and 2,000 m^3 of deciduous volume. The timber supply analysis project described herein covers a total area of 39,986 ha. In 2020, a new Vegetation Resource Inventory (VRI) for the combined TRCF landbase was completed and has now begun a formal timber supply review process with the objective of determining a new AAC that reasonably reflects current management as well as the productive capacity of the landbase.

This data package documents the information sources and assumptions to be used in the base case timber supply analysis and discusses potential sensitivity analyses. The assumptions used are based on the most recent *Dawson Creek Timber Supply Area Timber Supply Review – Data Package* (DC 2011 TSR Data Package; MFLNRORD, 2011), *Dawson Creek TSA Timber Supply Analysis Technical Report* (MFLNRORD, 2013), *Dawson Creek Land and Resource Management Plan* (LRMP; MFLNRORD,1999), and the *Chetwynd Multi Licensees Forest Stewardship Plan* (FSP; BC Timber Sales et al., 2019).

2. Data Input

This section summarizes the data used to support this timber supply review (TSR). The data layers were derived from several sources, including the Land and Resource Data Warehouse (LRDW) of the Government of BC, Ecora-derived products including an updated Vegetation Resource Inventory (VRI) and riparian classification. Major improvements to the TRCF data sources since the last TSR include an updated VRI and a classified stream layer for the combined landbase, both completed by Ecora in spring 2020.

2.1 Spatial Data

Table 2-1 provides a list of input data layers considered in the analysis.

Table 2-1: **Data Sources**

Description	Layer Name	Source	Year
Archaeology zone	arc_sites	MFLNRORD	2015
Recreation trails	FTEN_RECREATION_LINES_SVW	LRDW	2015
Wind road	wind_road	TRCF	2015
West Fraser blocks 2016	wf_blocks	WF	2016
West Fraser roads	wf_roads	WF	2016
West Fraser WTP areas	wf_wtp	WF	2016
Biogeoclimatic zones	bec_v11	basedata	2018
Pipelines	pipe_buff	TRCF	2018
Caribou low elevation winter range	caribou_lewr	Gov FTP	2018
Caribou high elevation winter range	caribou_hewr	Gov FTP	2018
Caribou high elevation summer range	caribou_hesr	Gov FTP	2018
CF boundary (original and expansion area)	Bdy_and_exp	TRCF	2019
Ownership	FOREST_VEGETATION_F_OWN	basedata	2019
West Fraser blocks 2019	wf_blocks_2019	WF	2019
Digital road atlas	DRA_DGTL_ROAD_ATLAS_MPAR_SP	LRDW	2020
Lakes	BASEMAPPING_FWA_LAKES_POLY	LRDW	2020
Wetlands	BASEMAPPING_FWA_WETLANDS_POLY	LRDW	2020
Streams	BASEMAPPING_FWA_RIVERS_POLY	LRDW	2020
Ecora classified streams	streams	Ecora	2020
VRI	Combined_final	Ecora	2020
LiDAR	lidar	Ecora	2019
Archaeology overview assessment	RAAD_AOA_PROVINCIAL	LRDW	2020
BC historical fires	WHSE_LAND_AND_NATURAL_RESOURCE_PROT_HISTORICAL_FIRE_POLY	LRDW	2020
Recreation areas	FTEN_RECREATION_POLY_SVW	LRDW	2020
Permanent sample plots	FOREST_VEGETATION_GRY_PSP_STATUS_ACTIVE	LRDW	2020
Woodlots	FTEN_MANAGED_LICENCE_POLY	LRDW	2020
Legal OGMA	OGMA_LEGAL_CURRENT_SVW	LRDW	2020
Landscape units	LAND_USE_PLANNING_RMP_LANDSCAPE_UNIT_SVW	LRDW	2020
RESULTS forest cover reserves	RSLT_FOREST_COVER_RESERVE_SVW	LRDW	2020

Description	Layer Name	Source	Year
RESULTS openings	RSLT_OPNGS_polygon	LRDW	2020
FTEN cutblocks	WHSE_FOREST_TENURE_FTEN_CUT_BLOCK_POLY_SVW	LRDW	2020
Visual sensitivity polygons	WHSE_FOREST_VEGETATION_REC_VISUAL_LANDSCAPE_INVENTORY	LRDW	2020
Ungulate winter range	WILDLIFE_MANAGEMENT_WCP_UNGULATE_WINTER_RANGE_S	LRDW	2020
LRMP non-legal	RMP_PLAN_NON_LEGAL_POLY_SVW	LRDW	2020
Pulpwood agreement 7,10,13	FADM_PULPWOOD_AGREEMENT	LRDW	2020
Slope	DEM	Ecora	2020
Provincial site productivity layer	pspl_si	LRDW	2020
Legally designated areas	WHSE_ADMIN_BOUNDARIES_FADM_DESIGNATED_AREAS	LRDW	2020
Pipeline areas	PASR_pipeline_area_py	LRDW	2020
Pipeline roads	PASR_road_area_py	LRDW	2020
Section 11 area	Draft_Partnership_Agreement	Gov FTP	2020
TLE/TLA lands	Tenure_application	TRCF	2020

2.2 Inventory Information

Ecora completed new Vegetation Resources Inventory with Ecosystem Mapping (VRIEM) covering the expansion area of TRCF in April 2020 using 2019 aerial photographs and Light Detection and Ranging (LiDAR) data. At the same time, the 2015 VRIEM covering the original CF area was reviewed and updated with the new remote sensing data. The new VRI was compared to the 1991 Forest Cover inventory, which was completed under the Forest Inventory Planning (FIP) standard, to identify changes to the inventory data. The results for the new VRIEM are summarized in the *Tumbler Ridge Community Forest Vegetation Resources Inventory with Ecosystem Mapping Project Report* (VRI Report; Ecora, 2020).

Based on the findings from the VRI report, there are several differences between the 2020 VRI and the FIP Forest Cover inventory:

- Higher pine volume, and lower black and white spruce volume in the Forest Cover inventory;
- Lower non-treed area in the VRI;
- Greater area in age class 1,2,3,7,8 and lower area in age class 4,5,6 in the VRI;
- Overall higher inventory site index in the 2020 VRI;
- Lower inventory site index in black spruce and white spruce-leading stands that were previously attributed as pine-leading in FIP; and,
- Higher live merchantable volume in the VRI.

The new VRI provides an updated forest inventory that incorporates comprehensive use of high-resolution false colour aerial photos, delineation reflecting the current distribution of vegetation cover, improved species composition and stand attribute estimates, the latest available Reporting Silviculture Updates and Land Status Tracking System (RESULTS) silviculture attribute data, photogrammetrically measured height values improving volume estimation, and an average polygon size that supports both timber supply analysis and operational planning activities.

2.3 Riparian Classification

Ecora conducted a stream classification project for TRCF based on aerial imagery, Fresh Water Atlas data, and slope data. Stream classification was completed through photointerpretation with distance and slope references. Aerial photographs used in this classification process were the same images used for the VRI. Distance and slope were the main features used to assign classifications to streams. Assigned stream classes followed the criteria indicated in the *Forest Planning and Practice Regulation* (FPPR) Section 47 (MFLNRORD, 2004). The assigned effective riparian buffers followed the 2019 FSP.

In the classification process, all streams were broken into 100 m segments starting from each confluence. Each segment was assigned an average slope based on the elevation of its start and end points. Fish barriers were identified for segments where the slope is greater than or equal to 20% as stated in the *Fish-stream Identification Guidebook* (MOF,1998). Streams segments upstream of the fish barrier were automatically classified as non-fish-bearing and were assigned as S5 or S6 depending on the stream width. Segments with an average slope of less than 20% were assigned with the appropriate stream classes by the average width of the active flood plain. Fish barriers and fish-bearing streams that exist outside of the CF boundary and is upstream from the streams within the boundary were identified for accuracy purpose. The average width of the active flood plain was measured photogrammetrically in a virtual environment using DAT/EM Summit Evolution Lite v.7.1 softcopy software on an ESRI ArcMap 10.2 platform. Streams that were too narrow under the current image resolution were assigned as S4 when they originated from a fish-bearing stream or lake and did not have fish barriers along the channel up to the measured segment.

Lakes and wetlands were classified with the appropriate class based on the criteria stated in FPPR Sections 48 and 49. The riparian classes for lakes and wetlands were assigned under an automated process when the feature area met the FPPR classification size criteria. This riparian classification allowed for the proper designation of riparian buffers and provided an accurate representation of the riparian features at the timber supply level for TRCF. It is recognized that photo interpreting stream classifications cannot be completed with 100% accuracy, and these classifications should be verified in the field prior to undertaking any management actions on the ground. However, this approach likely provides a reasonable estimation of the timber supply impacts of riparian features and represents a significant improvement over the method used in the DC 2011 TSR as smaller streams were not classified and were not assigned with a riparian buffer.

2.4 Logging History

Logging history for the analysis was derived from VRI disturbance history, West Fraser (WF) blocks, RESULTS, and Forest Tenure (FTEN) cutblock data sets. VRI disturbance history was updated to June 2019; WF blocks were updated to December 2019; RESULTS openings were updated to January 2020; and FTEN cutblock data were updated to March 2020. The end date of the operation was used when available. Most of the areas with a logging history were harvested after 2015, while 43% of the landbase had no logging history. The current age was updated by subtracting the harvest completion year (hereby referred to as the log year) from 2020 when the log year is later than the VRI reference year. The VRI reference year is the year of the reference data that the VRI attribution is based on. If the VRI attribution is interpreted from the aerial photography, then the reference year is the year which the photo is taken. Reference year can also be the year of the RESULTS data if a stand has been logged prior to when the aerial photography was taken.

3. Landbase Classification

The crown forested landbase (CFLB) is the forested land that contributes to meeting the non-timber objectives; whereas the timber harvesting landbase (THLB) is defined as all productive forest expected to support timber harvesting within TRCF. The CFLB was determined by excluding the non-community forest area, non-forested areas, and existing roads from the CF boundary. The THLB was determined by systematically removing categories of land that do not contribute to timber harvesting. The landbase classification process classifies the total area into three broad categories:

- **Non-productive**: areas that are not managed by TRCF for forest values, either non-forested or unable to grow viable timber.
- **Productive non-THLB or CFLB**: productive treed areas that are unlikely to be harvested for reasons such as inoperability or special environmental protections.
- **THLB**: productive landbase that is expected to be available for timber harvest over the long-term.

Table 3-1 summarizes the landbase classification, and Sections 3.1 to Section 3.19 detail the assumptions and criteria used to arrive at the net removal area.

Table 3-1: Landbase Classification

Landbase Classification	Area (ha)	% of CFLB
Total Area	**39,986**	
Non-community Forest Agreement Area	1,083	
Non-forested and Non-productive	2,132	
Existing Roads, Trails, Landings, and Seismic Lines	1,552	
Archeological Sites	7	
CFLB	**35,212**	
Recreational Trails	10	0%
Riparian Areas	1,869	5%
Isolated Patches	76	0%
Old Growth Management Areas	4,134	12%
Section 11 Moratorium Areas	275	1%
Physical Inoperability	242	1%
Problem Forest Types	3,787	11%
Non-Economic Operability	964	3%
Existing Wildlife Tree Patch (WTP)	405	1%
Future Roads	528	2%
Future WTP Retention	802	2%
THLB	**22,120**	**63%**

3.1 Total Area

The TRCF covers 39,986 ha within the DC TSA. The CF includes the original CF area of 19,852 hectares (ha) as well as an expansion area of 20,134 ha. The townsite of Tumbler Ridge is situated at the intersection of Highway 52 and Highway 29 overlooking the confluence of the Murray and Wolverine Rivers. Figure 3-1 illustrates the geographical location of TRCF.

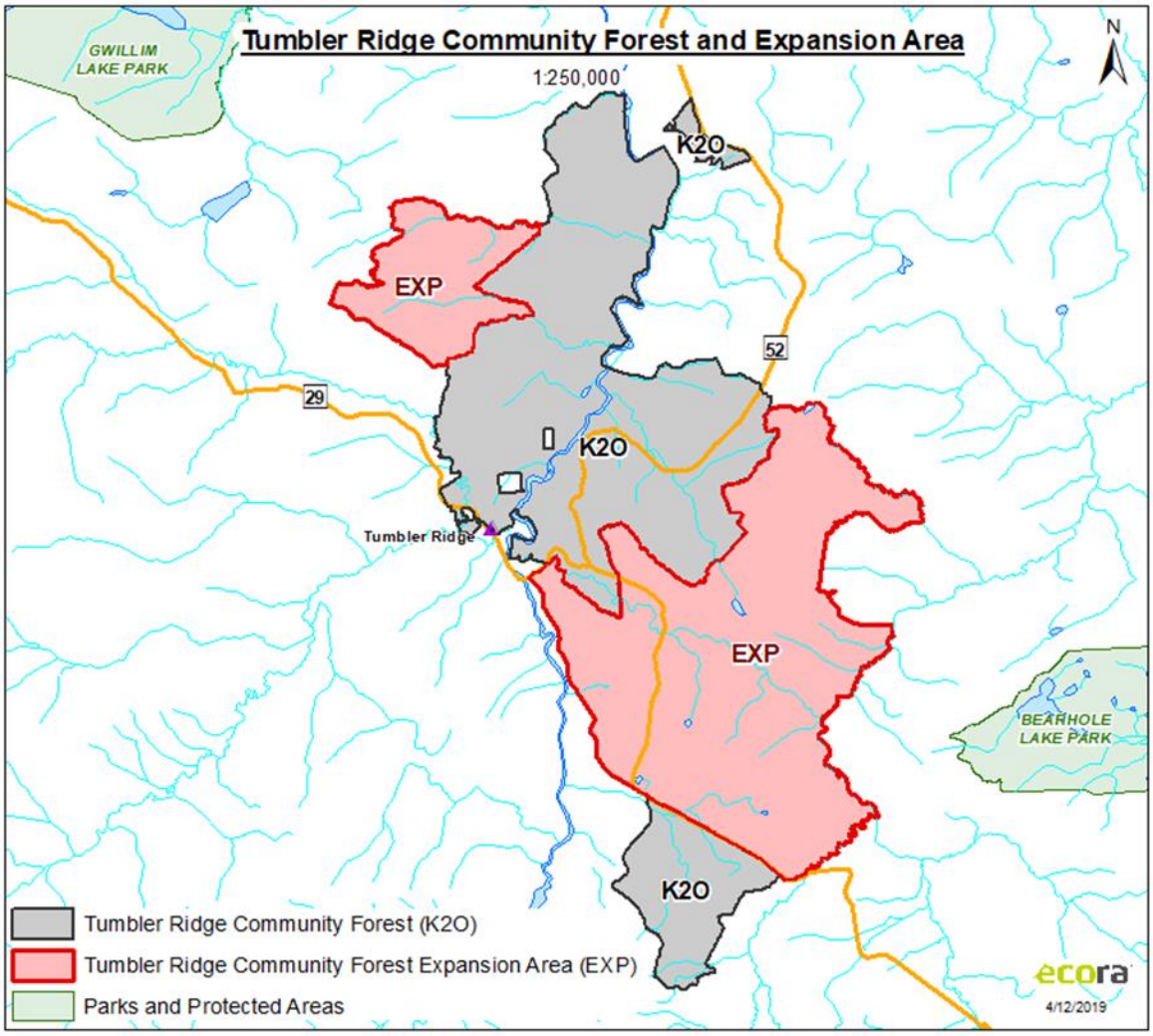

Figure 3-1 Tumbler Ridge Community Forest and Expansion Area Overview Map

3.2 Non-Community Forest Agreement Area

Land not administered by TRCF was removed from the CFLB using ownership codes. These included private lands and woodlot licenses. The net removal area occupied by the different types of ownership is summarized in Table 3-2. Municipal parcels not captured in the ownership layer were identified by the CF Manager and manually selected in the resultant dataset and removed from the CFLB.

Table 3-2: Non-CFA Ownership Types

Ownership	Description	Reduction (%)
40	Private Land	100
54	Federal Parcels	100
77	Woodlot License	100
80	Municipal Parcels	100
81	Local/Regional Park	100
99	Misc. lease	100

3.3 Parks and Protected Area

There are no parks or protected areas overlapping TRCF.

3.4 Non-Forest and Non-Productive Land

The British Columbia Land Cover Classification Scheme (BCLCS) was used to identify areas that are not forested such as rocks and water as well as vegetated, but non-treed polygons. These areas were excluded from the CFLB. Table 3-3 describes the non-forest land classifications.

Ecosystem Mapping (EM) was completed for TRCF using the provincial Terrestrial Ecosystem Mapping methodology. The EM provided more detailed and accurate site series information for the landbase. Areas classified as non-productive but not necessarily non-treed was to be removed from the CFLB initially. However, after careful consideration this criterion was dropped because most of the non-productive forest contributes to non-timber objectives.

Areas classified as non-treed in the BCLCS Level 2, but with logging history between 1987 and the VRI reference year, have a demonstrated capacity to support a forest and had legal requirements for reforestation (British Columbia Environmental Reporting, 2018). Therefore, these areas were not removed from the CFLB. If a stand without logging history is scheduled to be harvested shortly after the reference year, but it is a non-treed polygon, then it was removed from the CFLB as it will not have trees at the scheduled log year. Typically, these areas are roads, landings, or wildlife tree patch (WTP) within a planned block.

Table 3-3: Non-Forest and Non-Productive

BCLCS Levels	Description	Reduction (%)
Level 1= ‘N’	Non-vegetated	100
Level 1= ‘V’ Level 2 = ‘N’	Vegetated-non-treed	100

3.5 Roads, Trails, Landings and Seismic Lines

A combined road layer was created from the Digital Road Atlas, WF road layers, TRCF provided pipeline layer, LRDW pipeline layers (activities that have been permitted), and TRCF provided wind road layer. The road buffer widths were assigned and determined based on the road class, road surface, number of lanes, and description if provided. The criteria for road classification and buffer widths follow the DC 2011 TSR Data Package. The road buffer areas for the existing roads were removed from the CFLB according to the applied buffer widths described in Table 3-4.

Table 3-4: Road Buffer Width

Road Classification Type	Buffer Width (m)	Reduction (%)
Paved road	50	100
Double-lane gravel road (secondary/logging)	25	100
Single-lane gravel road	20	100
Petroleum development roads	25	100
Trails	5	100
Pipelines	20	100
Seismic lines	7	100

3.6 Archaeological Sites

The existing archaeological sites were removed from the CFLB.

3.7 Crown Forested Landbase

The CFLB resulting from removing non-community forest areas, non-treed areas, and existing roads, trails, landings and seismic lines from the gross area is 35,212 ha. This is the area that supports tree growth and can contribute to meeting non-timber objectives for seral stage distribution, visual quality objectives (VQOs), integrated resource management, and wildlife habitat requirements.

The Timber Harvesting Landbase (THLB) is determined by removing components of the landbase that are not considered harvestable. The following sections describe the assumptions associated with each of these exclusions.

3.8 Recreational Trails

The FTEN Recreation Sites and Trails layers were used to identify the active recreational features in TRCF. A 5 m buffer was applied to the trails, and the area was excluded from the THLB.

3.9 Riparian Areas

Ecora completed a digital riparian classification for TRCF in the data assembly process in order to assign the proper buffer width for the riparian features. The classification methodology is described in Section 2.3. The DC 2011 TSR Data Package followed the *Riparian Management Area Guidebook* of the Forest Practice Code for accounting the riparian areas in the netdown process, which does not require riparian reserve zones for smaller streams (MOF,1995a). Therefore, the riparian areas of the S4, S5, and S6 streams were not accounted for in the netdown removal process in the DC 2011 TSR. The riparian reserve zone and riparian management zone for streams, wetlands, and lakes in this analysis are specified based on Sections 4.3 in the 2019 FSP. This represents the current practice in TRCF. For each classification, an effective buffer width was calculated by adding the riparian reserve zone width to the product of the riparian management zone width and the minimum basal area retention percent. The effective buffer widths for existing riparian features were removed from the THLB regardless of logging history. Buffer widths are presented in Table 3-5.

Table 3-5: Riparian Buffer Width (From the 2019 FSP)

Feature	Riparian Class	Riparian Reserve Zones (m)	Riparian Management Zone (m)	Minimum Basal Area Retention (%)	Effective Buffer Width (m)	THLB reduction (%)
Rivers and Streams	S1-A	0	100	25	25	100
	S1-B	50	20	25	55	100
	S2	30	20	25	35	100
	S3	20	20	25	25	100
	S4	0	30	20	6	100
	S5	0	30	10	3	100
	S6	0	20	5	1	100
Wetlands	W1	10	40	25	20	100
	W3	0	30	10	3	100
Lakes	L1-B	10	0	10	10	100
	L3	0	30	10	3	100

3.10 Isolated Patches

After the riparian areas netdown, there were several small patches of THLB isolated by the riparian reserves. These areas were requested to be removed from the THLB by the CF Manager as isolated patches due to operational feasibility. Small patches of THLB near the boundary of the CF that were isolated by Old Growth Management Areas (OGMA), Ungulate Winter Range (UWR) no harvest zones, and/or Section 11 Moratorium Areas were manually selected and removed from the THLB as well.

3.11 Old Growth Management Area

The most current OGMA layer from LRDW were incorporated into the resultant dataset. There are 4,514 ha of CFLB that falls within OGMA, these areas were removed from the THLB.

3.12 Section 11 Moratorium Areas

On February 21, 2020, the Governments of BC and Canada signed the Canada British Columbia Conservation Agreement for Southern Mountain Caribou in British Columbia. Section 11 of the federal Species at Risk Act legalizes the commitments, measures, and strategies contained in the conservation agreement. Subsequently, a Draft Section 11 Agreement was established. The Draft Section 11 Agreement in the DC TSA overlaps with TRCF. The draft agreement itself would not have any affect on the timber supply of TRCF as it does not prescribe any specific measures. The Partnership Agreement for the Conservation of the Southern Mountain Caribou – Central Group (hereby referred to as the Partnership Agreement) signed by the Government of BC and Canada, the West Moberly First Nations, and the Saulteau First Nation, which focuses on maintaining the caribou population does have specific measures that will likely impact the timber supply of TRCF (MFLNRORD,2020).

The most current requirements of the Partnership Agreement were provided by the Species at Risk Recovery Branch. Areas designated as the “Interim Moratorium on New Industrial & Commercial Development Proposals while Long Term Protection Plan is Developed” were removed from the THLB as a no harvest zone. Further caribou conservation measures are outlined in Section 4.4.

3.13 Physical Inoperability

Areas with physical limitations to harvesting equipment or risk to the terrain are considered inoperable and excluded from the THLB. In this analysis, physical inoperability was defined as all slopes greater than 60%. This is consistent with how physical inoperability as been specified in the TRCF and was reconfirmed with the CF Manager.

3.14 Problem Forest Types

Problem forest types (PFT) are stands that are physically operable, but not currently utilized or have marginal merchantability and are considered uneconomic. Table 3-6 details the PFT that were removed from the THLB.

Table 3-6: Problem Forest Types Criteria

Leading Species	Leading Species Percent	Secondary Species	Secondary Species Percent	THLB reduction (%)
Non-commercial conifer (SB, LT, LW)	>50%	Any	Any	100
Non-commercial conifer (SB, LT, LW)	<=50%	Non-commercial conifer (PLI, SE, SW, SX)	Any	100

3.15 Non-Economic Operability

The minimum economic operability threshold mimics the non-merchantable forest types criteria in the DC 2011 TSR Data Package (Section 5.2.11, Table 10). The minimum volume at maturity age is 120 m^3/ha for conventional harvesting and 200 m^3/ha for cable harvesting. The maturity age was set to 120 years old based on discussion with the CF Manager. Conventional harvesting in TRCF is assumed for slopes less than or equal to 40%. Cable harvesting is assumed for slopes between 40% and 60%.

Table 3-7 describes the criteria used to exclude uneconomic mature stands from the THLB.

Table 3-7: Non-Economic Operability Criteria – Mature Stands

Logging History	Leading Species	Minimum Age (years)	Minimum Volume (m^3/ha)	Harvest System	THLB Reduction (%)
No	All	120	120	Conventional	100
No	All	120	200	Cable	100

Table 3-8 describes the criteria used to exclude immature stands that are expected to be uneconomic to harvest based on the site index cut-off values calculated in Table Interpretation Program for Stand Yields (TIPSY). A cut-off site index was determined for each leading species group as the site index at which the stand could not reach the minimum harvestable volume within the 250-year window under a set of reasonable regeneration conditions (e.g., regeneration pattern, initial planting density, regeneration delay). This approach prevented the netdown process from excluding too much immature area from the THLB, as some stands on the less productive sites do reach the minimum harvestable volume later than the estimated rotation age of the species.

Table 3-8: Non-Economical Operability Criteria – Immature Stands

Logging History	Leading Species	Existing Age (years)	Minimum Site Index	Harvest System	THLB Reduction (%)
No	All	<120	8	Conventional	100
	All	<120	9.5	Cable	100

3.16 Existing Wildlife Tree Patch

Existing WTPs were located from the WF WTP layer and the RESULTS Reserves data. All mapped WTPs were removed from the THLB regardless of logging history.

3.17 Future Roads

Existing roads occupy 2,016 ha of the gross area in TRCF, providing access to 17,994 ha of THLB. The accessibility ratio was determined by assuming that the existing roads allow access to a 350 m buffer on either side from the road centerline. The THLB within the 350m buffer is referred to as the accessible THLB. Based on this assumption, existing roads represent 11% of the accessible THLB. An estimated 528 ha of future roads will be constructed on the TRCF landbase to provide access to the currently inaccessible areas of TRCF. These areas were therefore excluded from the THLB aspatially.

3.18 Future WTP Retention

The future WTP retention assumption in TRCF follows Section 66 of the FPPR. The total area covered by the WTPs that relate to the cutblocks is a minimum 7% of the total area of the cutblocks in a 12-month period. In this analysis, the total WTP retention in TRCF is assumed to be 7% of the CFLB, and this includes the existing WTPs. Furthermore, half of the total WTP retention (3.5%) was assumed to be coming from the THLB portion of the landbase.

3.19 Timber Harvestable Landbase

The total THLB resulting from removing the non-harvestable landbase is 22,120 ha, which represents 63% of the CFLB.

4. Current Forest Management Assumptions

4.1 Forest Cover Constraint

Resource management zones are grouped areas that support the non-timber resource requirements. Each resource management zone has its own set of forest cover objectives. These objectives are consistent with the DC 2011 TSR Data Package and the 2019 FSP.

4.2 Ungulate Winter Range Conditional Harvest

There are two ungulate winter range (UWR) orders that overlap the TRCF boundary. They are Order U-9-001 for elk, mule deer and moose, and Order U-9-002 for caribou, mountain goat and bighorn sheep. When operating within the spatially delineated UWR areas, TRCF will operate in a manner consistent with the general wildlife measures described in Schedule 1- General Wildlife Measures established by the Ministry of Environment Order – Ungulate Winter Range #U-9-001 effective December 1, 2005 and #U-9-002 effective November 2, 2006.

4.2.1 UWR U-9-001

The UWR Order #U-9-001 requires a minimum retained area of 20% mature + old coniferous leading forest. Coniferous leading stands are defined as stands with greater than 50% coniferous composition mature + old forest is defined as greater than 100 years for the Boreal White and Black Spruce BEC zone (BWBS) and greater than 120 years for Engelmann Spruce – Subalpine Fir (ESSF) zone (Ministry of Environment, 2005). Under the current regeneration regime, all future managed stands will be regenerated with coniferous species regardless of the existing species, therefore, deciduous leading stands were not excluded when modelling for the UWR target.

4.2.2 UWR U-9-002

Under the UWR Order U-9-002 requirement for “Caribou: Low Elevation Winter Ranges polygon SPC-009 (Redwillow)”, a maximum of 33% of the CFLB can be under 3 meters in height at a given time (Ministry of Environment, 2006).

4.3 Grizzly Bear Early Seral Retention

TRCF includes important habitat for grizzly bear. Early seral forest cover objectives will be presented using DC TSA TSR 2 base case assumptions to simulate management objectives for grizzly bear habitat (MFLNRORD, 2011). These requirements are consistent with the DC LRMP. The grizzly bear zone is represented within the DC TSA as a non-standard inventory; the zone has an intermediate biodiversity emphasis in natural disturbance types (NDT) 1 and 2, in mountainous terrain along the western portion of the TSA. However, this data layer was not available for this analysis; therefore, the modelling constraint was applied to the entire intermediate biodiversity emphasis in NDT 2 as a conservative approach. This resource management zone covers 3,254 ha of CFLB and 2,356 ha of THLB. The forest cover objective for the early seral retention is a maximum 33% of the CFLB with height less than 3 meters. In addition, the grizzly bear habitat is managed to retain early seral forest based on percentages specified in the *Biodiversity Guidebook* (MOF, 1995b) for the intermediate biodiversity emphasis in NDT2.

4.4 Low Elevation Winter Range

The Low Elevation Winter Range (LEWR) of the Section 13 Ministerial Order that supports the Caribou Partnership Agreement covers 14,135 ha of CFLB in TRCF. Based on the *Tumbler Ridge Community Forest Expansion Area Timber Supply Analysis Report* (Ecora, 2019), the modelling constraint for the LEWR is to maintain a minimum of 65% of CFLB greater than 80 years old. This was established based on the guidance provided by the Major Projects Team Lead of the Omineca Region in a meeting with TRCF Manager and Ecora in 2018. The management guidance provided by the North Eastern Caribou Team Lead and the spatial location of the LEWR remained consistent with the last analysis, which is to follow the overall disturbance parameters cited for LEWR and Type 1 matrix range within the *Recovery Strategy for the Woodland Caribou, Southern Mountain Population (Rangifer tarandus caribou) in Canada. Species at Risk Act Recovery Strategy Series* (Recovery Strategy; Environment Canada, 2014).The specified overall disturbance parameters is “in general, across the LEWR and Type 1 matrix, strive for and maintain a perpetual state of a minimum of 65% undisturbed and minimize new disturbances that will attract primary prey such as moose, deer and elk.” (Environment Canada, 2014). Note that management objectives detailed in the Recovery Strategy are not legal directions but rather best practice guidelines. The success in the recovery of southern mountain caribou depends on the commitment and cooperation of many stakeholders. As one of the stakeholders, it is good stewardship to follow the Recovery Strategy.

4.5 Integrated Resource Management

The modelling criteria for the integrated resource management areas follows the DC 2011 TSR Data Package which is maximum 33% of the THLB can be under 3 meters.

4.6 Landscape-level Retention and Patch Size Objectives

In the 2011 DC TSR, OGMA that were spatially established in 2008 have replaced the non-spatial old growth objectives present in DC TSR 2. The non-spatial old growth objectives reflect the natural range in occurrence of old forest retention and patch size as documented in Technical Report 059, *Land Units and Benchmarks for Developing Natural-disturbance Based Forest Management Guidance for Northeastern British Columbia* (DeLong, 2011). These objectives will not be included in the base case of this analysis as 4,514 ha of CFLB in TRCF are spatially located in OGMA. For information purposes, a sensitivity will assess the timber supply impact from the non-spatial old growth forest retention targets and the patch size distributions targets in Table 4-1 and Table 4-2.

Table 4-1: Old Forest Retention Criteria

Natural Disturbance Type	Minimum Old Forest Retention (%)	Minimum Age of Old Forest (years)	Maximum Young Forest Retention (%)	Maximum Age of Young Forest (years)
NDT2 Boreal Foothills-Mountain	33	140	36	40
NDT3 Boreal Plains-Upland	17		50	

Table 4-2: Patch Size Distribution Criteria

Natural Disturbance Type	Patch Size Distribution (%)		
	>1000 ha	101-1000 ha	<101 ha
NDT2 Boreal Foothills-Mountain	40	30	30
NDT3 Boreal Plains-Upland	70	20	10

4.7 Visual Quality Objectives

Visual Quality Objectives (VQOs) are designed to minimize the visual impacts of logging in the areas for which visual quality has been identified as an important value that requires specific management. There are 12,495 ha of CFLB that overlap with known VQO polygons, primarily near Highway 52 and Highway 29. Visual quality is managed within these areas by restricting the proportion of the area that has not achieved a visually effective green-up (VEG) height at a point in time. The time to achieve VEG height is affected by several factors including the slope of the landscape, the height of adjacent trees, and the rate at which individual trees grow.

To manage the visual impacts of harvesting on Crown land, the government delineates and classifies visually sensitive areas for scenic management as part of the Visual Landscape Inventory (VLI). In this timber supply analysis, visual modeling was implemented according to DC 2011 TSR Data Package.

Polygons selected to achieve VQOs were identified in the VLI and were classified based on their permissible visually effective disturbance level. The criteria in Table 4-3 were applied for all VLI polygons.

Table 4-3: Visual Quality Objective Criteria

Effective VQO	Maximum Allowable Disturbance (% Area)	VEG Height (m)
R	5	4.9
PR	10	4.9
M	20	4.9

5. Modeling Approach

5.1 Forest Estate Model

The spatial analysis will be conducted using the Patchworks spatial optimization model. Patchworks is a spatially explicit harvest scheduling optimization model developed by Spatial Planning Systems in Ontario. It is capable of developing spatially explicit harvest allocations that explore trade-offs between a broad range of conflicting management and harvest goals.

For this analysis, Patchworks will be formulated to maximize harvest volume while meeting all the required management objectives.

Harvest scheduling decisions are based on maximizing the harvest forecast over the long-term, subject to meeting non-timber and other management objectives on the landbase. As such, there are no explicit harvest rules other than minimum merchantability limits applied to the model. All scenarios must maintain a sustainable growing stock level in the long term.

The model utilizes 5-year planning periods over a 250-year planning horizon.

5.2 Harvest Flow Objectives

The objective of the timber supply analysis is to determine the capacity of the TRCF landbase to sustain timber harvesting over the short, mid, and long-term and to identify any risks to this flow resulting from uncertainty in the underlying data or assumptions. The analysis goes beyond simply calculating the growth potential of the landbase. The biological capacity of the forest to grow trees and non-timber requirements dictate the sustainable harvest level for an area. Within this, there are a few alternative harvest flows possible. In this analysis, we will establish a harvest level that best meets the needs of TRCF over a 250-year planning horizon and examine alternative rates of harvest.

5.3 Silviculture System

The base case assumes a clearcut with reserves silviculture system.

5.4 Utilization Levels

The utilization specifications define minimum diameter at breast height (DBH) by species and are used in the analysis to calculate the merchantable volume. The utilization specifications are listed in Table 5-1.

Table 5-1: Merchantable Timber Specifications

Leading Species	Minimum DBH (cm)
Pine	12.5
Deciduous	12.5
Spruce/Balsam	17.5
Other Coniferous	12.5

5.5 Minimum Harvest Volume

In the base case, stands will only be harvested once they achieve a net merchantable volume of 120 m^3/ha or greater. This will determine the minimum harvest age for each stand.

5.6 Unsalvaged Losses

Non-recoverable losses (NRL) reflect volume losses due to wind, fire, insect, and disease not otherwise captured through existing and managed stand yields. For this analysis, the post salvage NRL estimates from DC 2011 TSR Data Package were pro-rated based on the THLB within the proposed area relative to the entire TSA as outlined in Table 5-2. The harvest levels in the subsequent analysis report will be reported with the removal of NRLs totalling 2,277 m^3/yr for coniferous volume. Mountain Pine Beetle (MPB) losses are not included in the NRLs because the assumptions on MPB are separately addressed in Section 6.4.

Table 5-2: Unsalvaged Losses Estimate

Cause of Loss	TSA Annual NRL (m^3/yr)	CF/TSR THLB Ratio	CF Total (m^3/yr)
Fire	8,464 coniferous + 4,690 deciduous = 13,154 total	22,120 ha/ 758,335 ha	245 coniferous + 136 deciduous = 381 total
Wind	7,336 coniferous + 4,064 deciduous = 11,400 total		213 coniferous + 118 deciduous = 331 total
Tomentosus root rot	4,698 coniferous		136 coniferous
Spruce beetle	58,033 coniferous		1,683 coniferous
Total	**78,531 coniferous + 8754 deciduous = 87,285 total**	**2.9%**	**2,277 coniferous + 254 deciduous = 2,531 total**

5.7 Deciduous Leading Stands

TRCF currently does not target deciduous as a marketable species because there is little to no market for deciduous species in the economically accessible range. To reflect the current operational management strategy, deciduous leading stands are not harvested for the first 20 years in the base case. Deciduous leading stands are not restricted for harvest after year 20 as market condition could change for deciduous species.

Sensitivity scenarios will be conducted to assess the impact on the harvest level when harvest of deciduous-leading stands are restricted or unrestricted in the 250 years planning period.

6. Growth and Yield

6.1 Analysis Units

The THLB is divided into three sets of analysis units (AUs), based on harvest history: natural existing, existing managed, and future managed. Natural existing AUs have no harvest history or were last harvested prior to 1987 (before the reforestation obligation on Crown land). Existing managed AUs are previously harvested stands, younger than 33 years old. These stands were planted according to the stocking standards at the time. Future managed AUs are the stands that regenerate after being harvested by the timber supply model. These future managed AUs are defined by site productivity averages and the regeneration assumption are based on the current silviculture practice of TRCF.

6.2 Natural Stand Yield Tables

VRI measured height, VRI measured age, basal area, density and species composition from the VRI are used to generate the yield curves for each existing natural stand using Variable Density Yield Prediction Growth and Yield Model (VDYP) 7. These polygon-level yield tables were carried into the timber supply model. Due to the large size of the VDYP yield table, it is not possible to include them in this data package. Digital versions of the yield tables can be provided.

6.3 Managed Stand Yield Tables

Yield curves for all recently harvested (post-1986) and future regenerated stands are modelled using TIPSY version 4.4. Definitions and regeneration assumptions of managed stands established prior to 2015 (Analysis units 1112 to 7432) are consistent with the Section 6.8 of the DC 2011 TSR Data Package. Stands established since 2015 as well as future managed stands (Analysis units 8001 to 8003) follow a more localized regeneration assumption provided by the CF Manager. In addition, all managed stand yield curves have been developed using the Provincial Site Productivity Layer (PSPL) site indexes. PSPL was developed to better represent the site productivity of the managed stands. All coniferous leading stands are assumed to be planted with standard operational adjustment factors (OAF1 and OAF2 - 15% and 5% respectively). The deciduous components of a managed stand are assumed to be regenerated through natural ingress. Table 6–1 describes the base case managed stand input assumptions. The DC 2011 TSR Data Package indicated that genetic gains were not applied due to Class A seed being limited to silviculture trials within the ESSF zone Misinchinka Wet Cool subzone (wk2). The Seed Planning & Registry Application (SPAR) report of TRCF from 2010 to 2019 was requested and the seed use history was examined to capture the changes in seed use since the last TSR. Class A spruce seeds were used since 2014, and 94% of the planted spruce trees used Class A seeds; the weighted average genetic worth was 22%. This was applied to the stands planted since 2015. Genetic gain was not applied to managed stands regenerated prior 2015 in this analysis.

Table 6–1: Base case Managed Stand Input Assumptions

Analysis Unit	Regen Delay	Stems	Sp1	Sp1 %	Sp2	Sp2 %	Sp3	Sp3 %	Sp4	Sp4 %
1112/1122/1132	1	1,335	SX	63	PLI	21	BL	15	AT	1
1212/1222/1232	1	1,212	PLI	50	BL	22	SX	26	AT	12
2122	1	1,022	BL	91	AT	6	PLI	3		
3112/3122/3132	1	1,219	PLI	63	SX	27	BL	8	AT	2
3212/3222	1	1,189	PLI	66	AT	15	SX	11	BL	4
6312/6322/6332	5	1,272	AT	85	PLI	13	SX	2		
6412/6422/6432	1	3,134	AT	100						
7412/7422/7432	1	2,235	AT	95	PLI	4	SX	1		
8001/8002/8003	1	1,600	PLI	51	SX	49				

6.4 Salvage Logging

The 2020 VRI provided a more accurate estimate of the remaining dead volume from the MPB impact by leveraging 2019 high resolution aerial photographs and LiDAR data. There are 81,156 m^3 of dead volume where the leading species is pine, this represent 56% of the total dead volume on the landbase. The total available dead pine volume was adjusted to 50% of the 81,156 m^3 and remain available for harvest from 2019 to 2022 upon discussion with the CF Manager. This assumes not all dead pine volume was operationally available or salvageable.

7. Sensitivity Analysis

Sensitivity analyses help quantify the degree to which uncertainty in the analysis might affect the resulting timber supply for the landbase. The sensitivities listed in Table 7-1 will be conducted in the analysis. This list may be refined in consultation with other stakeholders as the analysis is conducted.

Table 7-1: Sensitivity Analysis Scenarios

Sensitivity	Range Tested	Scenario Description
VQO	Assess the impact on harvest level with reduced VQO target applied	Reduce VQO target by one class
Yield Assumption	Increase / decrease both managed and natural stand yields	Natural Stand Yield Tables (NSYT) +/- 10%
		Managed Stand Yield Tables (MSYT) +/- 10%
Minimum Harvest Volume (MHV)	Assess the impacts of increasing MHV	Increase MHV to 140 m^3/ha
LEWR	Assess the impact of altering LEWR related targets	Exclude LEWR from THLB
		Turn off LEWR target
Non-spatial seral target and patch size targets	Assess the impact to harvest level when applying the non-spatial seral target and the patch target from TSR 2	Apply landscape level non-spatial old forest retention targets and patch distribution target
Site Index Adjustment Assumption	Assess the change in harvest level when applying a potential site index adjustment	Managed stand site index +2m
		Managed stand site index +4m
Deciduous-leading Stand Harvest	Assess the change in harvest level when restricting or relaxing harvest in deciduous-leading stands	No harvest of deciduous-leading stands
		Harvest of deciduous-leading stands is unrestricted

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