Forest Carbon Stewardship at the Site Level

(Interim progress report)

Prepared for: **Forest Enhancement Society of BC**

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Executive Summary

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Table of Contents

List of Figures

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Definitions and Acronyms

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Introduction

Westland Resources Limited, through funding provided by the Forest Enhancement Society of BC, and in partnership with BC Timber Sales and the BC Ministry of Forests, Lands, Natural Resource Operations and Rural Development (FLNRORD), has undertaken a project to review opportunities and barriers related to carbon management through Site Plans required under the *Forest and Range Practices Act*.

This report looks at the current situation around site-level forest carbon management and the potential for introduction or implementation of site-level strategies. In addition, a discussion of the policy or regulatory barriers and opportunities will point to where change can be undertaken to improve carbon stewardship.

Method

A non-statistical sampling of site plans from around the province and from different operators will be reviewed to identify (a) existing activities or prescriptions that manage for carbon, whether intentionally or otherwise, and (b) activities or prescriptions that with adjustment could result in a carbon benefit. Field visits to some of these sites will be undertaken.

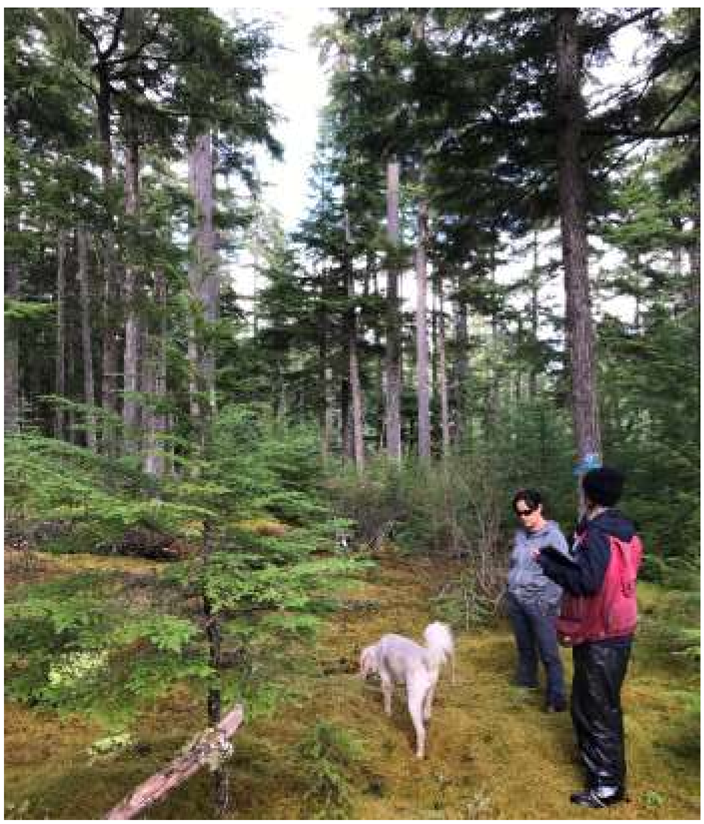

Figure 1: Field visit, Date Creek Research Forest (Northwest BC)

Additionally, the field visits and/or review of the site plans may also inspire potential innovations to plans or operations that could result in site-level carbon benefits. Where an innovation may not be implementable in the current regulatory framework, a discussion of the barrier(s) to implementation will be provided.

Background

Human activities, such as burning of fossil fuels and changes in land use patterns, have led to an increase of greenhouse gases in the atmosphere, which is a key driver of climate change (Dymond et al, 2009).

The primary greenhouse gas emitted through human activities is carbon dioxide (CO_2) (ECC Canada, 2017). Throughout the past couple of decades, CO_2 emissions have increased globally which contributes to a rise in average global temperatures and subsequently affecting the earth's climate (Dymond et al, 2009). The expected effects are that weather patterns will change and extreme weather events and disturbances will become more common; forested areas will be diminished; and areas that currently do not support forests may become suitable for forest growth (Ryan et al, 2010).

Forest ecosystems may help reduce CO_2 emissions since they are a significant part of the carbon cycle. Through photosynthesis, trees have the ability to absorb carbon from the atmosphere as they grow and sequester it in living biomass, soil, and dead organic matter (Greig et al, 2008). At the same time carbon is emitted back into the atmosphere during plant respiration, decomposition, and fires (Greig et al, 2008). Whether a forest emits or removes more carbon to or from the atmosphere determines upon whether it is a carbon source or a carbon sink[1] (St-Laurent et al, 2017). Young forests, when rapidly growing, can sequester carbon at a higher rate than older forests but they do not immediately store large amounts of carbon (Dymond et al, 2009). Older forests can act like a reservoir and store a larger quantity of carbon since they have been growing longer (Sedjo, 2001). Older stands with a multiple age stand structure (i.e. consisting of a mix of old trees with young and middle aged trees growing in the understory) may be a considerable carbon sink. Each forest has a different potential to store carbon depending on factors such as species, productivity, age, decomposition rates, wildfire frequency and geographic location (Ryan et al, 2010).

To reduce the impact of climate change, carbon emissions need to be reduced; one way to do this is by increasing the forests' ability to absorb and store carbon. However, warmer temperatures due to higher atmospheric CO_2 concentrations can result in higher frequency and intensity of disruptions to the forest. More trees will die and more CO_2 will be released into the atmosphere. Carbon dioxide is the largest contributor to Canada's greenhouse gas emissions (ECC Canada, 2017). For the past century, Canada's forests have been a carbon sink; however, in recent decades Canada's forests have started to become a carbon source. Young stands that are established after a disturbance can be carbon sources – at least in the short term - because the decomposition of woody debris and soil dead organic matter left over after the disturbance is greater than the uptake of carbon through new growth (Dymond et al, 2009).

Various countries worldwide are in the process of developing, or have implemented, forest carbon mitigation strategies and policies to reduce their greenhouse gas emissions or increase carbon sequestration (Parker et al, 2009). For example, the government of Finland has recently made climate change mitigation one of its forest management goals leading to the development, or modification of policies associated with forest-related activities such as bioenergy, harvesting waste management, forest conservation, and silviculture (Holberg et al, 2016). Similarly, Sweden has also implemented various forest carbon policies including bioenergy, waste management and carbon sequestration in harvested wood products (Holberg et al, 2016). Additionally, to help with climate change mitigation, countries such as New Zealand, Australia, the United States, and numerous developing countries use forest carbon offsets and the trade of carbon credits in carbon market trading schemes. Implementation of this strategy is through the climate mitigation mechanism of the United Nations known as reducing

[1] A forest is considered a carbon source when it emits more carbon than it removes from the atmosphere and a carbon sink when it stores more carbon than it emits.

emissions from deforestation and forest degradation in developing countries (REDD+)[2] (Parker et al, 2009).

After fossil fuel combustion, forest degradation[3] and deforestation[4] are two of the largest contributors to CO_2 emissions globally. Forest degradation is a result of livestock grazing, forest fires, and excessive harvesting of forest products, such as timber and firewood. Deforestation is typically caused by converting forests for other land uses and exploitation of natural resources (Hosonuma et al, 2012). Both of these activities reduce the amount of forest available for carbon sequestration making this a significant problem. Deforestation and forest degradation are responsible for about 17-25% of global greenhouse gases every year (Ryan et al, 2010). Reducing forest degradation and deforestation, and increasing reforestation and afforestation are important ways to increase forest carbon sequestration.

In Canada, deforestation is not a significant problem. Canada has approximately 348 million hectares of forested land, which means that Canada has 9% of the world's forests, yet, Canada only accounts for 0.3% of global deforestation (Bernier et al, 2012). Therefore, Canada is a substantial contributor to the global carbon pool. Deforestation that does occur is mainly from forestland being converted to settlements and industrial development (Dymond et al, 2009).

The province of British Columbia has seen similar trends to the rest of Canada in that forests were a carbon sink until 2002 (BC MFLNRO, 2013). In 2003, B.C. forests became a carbon source and have been one ever since, primarily due to the mountain pine beetle outbreak, and significant seasons of wildfires. Climate change has led to warmer winters, warmer summers, and less precipitation in winter creating optimal conditions for pests like the mountain pine beetle and the spruce bark beetle, and for forest fires (Kurz et al, 2008). These disturbances can drastically increase tree mortality, increasing the amount of decomposition and the amount of CO_2 being emitted into the atmosphere. They are also hard to control making their effects even more devastating.

British Columbia has committed to reduce its greenhouse gas emissions by 33% by 2020 and 80% by 2050 compared to 2007 levels (St-Laurent et al, 2017). Therefore, mitigation and management strategies will be required to reduce carbon emissions.

Current Situation

One of the biggest activities that adds to B.C.'s CO_2 emissions is logging, especially where that logging results in high post-harvest waste levels. The burning of slash, which is the woody debris left behind after logging, also provides for an immediate input of CO_2 to the atmosphere. From 2009-2014, average net emissions from forests and forest harvesting activities were 29 million tonnes of CO_2 equivalent: this was almost half of B.C's total emissions during that time period (St-Laurent et al, 2017). During logging, 40-60% of the carbon in cut trees remains in the forest and the rest is transferred to mills and turned into products (BC MFLNRO, 2013). Waste left behind is either left to decompose or is collected into piles for disposal, generally by burning. Additionally, when trees are removed, the sites potentially become sources of CO_2 emissions due to the release of stored gas from the exposed soils. Eventually, when the logging site has been replanted, the trees will start absorbing carbon again, changing the area from a carbon source to a carbon sink, but only when the growing trees get large enough (Sedjo, 2001).

[2] REDD+ stands for countries efforts to reduce emissions from deforestation and forest degradation in developing countries. It is a framework where developing countries are rewarded financially for reducing emissions associated with decreasing forest conversion to other land uses.

[3] Forest degradation is the decrease in condition or quality of forests by some factor or a combination of factors.

[4] Deforestation is the conversion of area covered by forest to a non-forested state.

Harvested wood products are another pool of carbon and can store carbon either for short term or long term depending on the product (BC MFLNRO, 2013). When a wood product is not used anymore it can be recycled, repurposed or used for energy instead of disposing it into landfills. Harvested wood products play an important role in climate change mitigation by being a pool of stored carbon, a substitute for more energy intensive material such as steel, plastics and concrete, and a renewable material for energy generation (BC MFLNRO, 2013).

Figure 2: Typical logging block (Northwest BC)

Forest management and changing forest practices can influence the gains and losses of carbon in the forest ecosystem. Therefore, reducing the amount of waste would be a useful strategy to help meet targets.

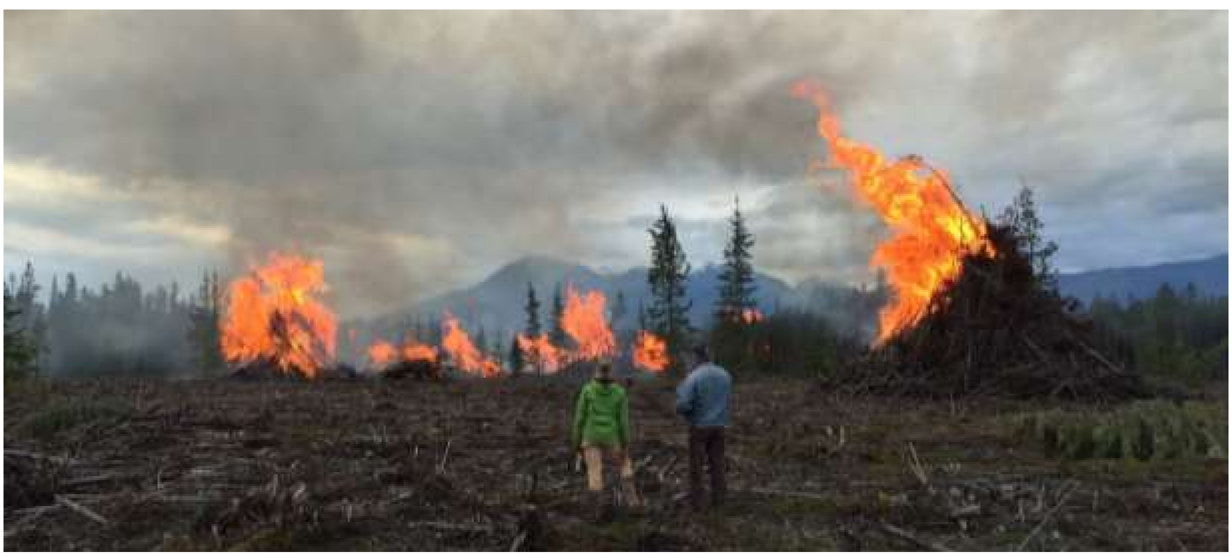

Figure 3: Burning to reduce fire hazard in the urban interface (Northwest BC)

Slash burning has been practiced in British Columbia since the early 1900s (Kamf, 2003). The primary reason slash burning is a common practice is to reduce the risk of forest fires. Slash burning is also carried out to assist tree planting, eliminate disease, and provide an advantageous environment for seedlings (Kamf, 2003). If the slash was not burned, it would eventually decompose and release around the same amount of carbon into the atmosphere. Furthermore, collecting the slash in piles and burning them has become habit for forest practitioners: it is what we have always done. If reducing slash levels is the objective, then burning is the most cost-effective option. All other options are seen to be more expensive, especially when potential long-term impacts are not considered.

The Problem

If carbon emissions are not reduced, there may be significant impacts on timber supply and forestry operations. A warmer climate could lead to changes in species composition, distribution, abundance, and forest structure. Forestry operations may be impacted in terms of changes in wood quality, productivity, volume, and size (Dymond et al, 2009). A longer fire season and thaw period will also affect forestry operations (BC MFLNRO, 2013). Access to timber may also be limited because an increase in storms due to climate change would likely impact logging roads and increase the likelihood of debris flows and landslides (Dymond et al, 2009).

Figure 4: Helicopter logging area with trees felled to meet silviculture objectives and left for waste (Coastal BC)

The Approach to the Solution

This report looks to identify solutions to reduce the amount of woody residue that is left behind after forestry operations. Solutions can be applied on the ground or applied as part of the planning framework prior to cutting a tree. The intent is that the results of these solutions, when compared to status quo practices, will have a positive carbon benefit. If a solution does not fit within the existing regulatory framework, then adjusting the framework would have to be part of the solution.

Carbon benefits are expected to occur through avoidance or reduction of CO_2 emissions or sequestration of carbon.

Ideally, solutions should identify where they are applicable. British Columbia has extremely diverse forests and ecosystems, so an approach that works in one region may not work in another, or even work adversely. Therefore a suite of solutions may be necessary for application to different parts of the province.

If potential solutions add cost or could be perceived as inconvenient, the value proposition for this increased cost or inconvenience needs to be clear. In some cases, incentives might be needed to motivate change.

Regulatory Context

Operational forestry activities in British Columbia are primarily regulated by three statutes: the *Forest Act*, the *Forest and Range Practices Act (FRPA)*, and the *Wildfire Act*. These acts and their associated regulations (such as the Forest Planning and Practices Regulation (FPPR), the Cut Control Regulation, or the Wildfire Regulation) provide direction to regulators and to licensees as to requirements and responsibilities for activities on public forest lands.

Additional high-level documents can be developed and approved under the authority of the statutes, and these become binding on the regulated users of the forest. Examples of high level documents include Sustainable Resource Management Plans, Wildlife Habitat Areas, Ungulate Winter Ranges.

The acts, regulations, and high-level documents are the Legal part of the regulatory structure, and are intended to be difficult to change.

Licensees develop a Forest Stewardship Plan (FSP) to describe and demonstrate how their operations will be consistent with the requirements of the statutes and the legal objectives set in the high-level documents.

In some cases, regulators provide additional interpretation or guidance, so that licensees have clarity on how aspects of the statutes or plans are applied. This information can be in the form of Policies or Manuals, and often takes on a quasi-legal status. Contracts can also be set with licensees and forest operators.

The FSP, Policies, Manuals and contracts are the Policy part of the regulatory structure: they can be changed, but not without some effort.

Guidelines can be developed by regulators or forest licensees or field operators to provide additional information on how to implement or carry out plans or activities. Standard operating procedures (SOPs) are a special form of guidance for oft-repeated items, or where consequences can be of special concern, e.g. safety or environmental damage.

Environmental conditions, whether physical, economic, or cultural, can have an impact on operational activities.

Guidelines, SOPs and environmental conditions are considered to be the Corporate part of the regulatory structure: they can change relatively quickly.

Regulatory Influences at the Site Level

The following table describes how, at different forest development stages, site-level field operational or planning items can influence the amount of woody residue on an area, and the portion of the regulatory structure that drives that item.

Phase/ Activity	**Initiatives/ directives that will influence the amount of residue on an area**		
	Item	Directed by	Part of Regulatory Framework
Pre-Harvest			
Reconnaissance/ Site selection	FSP strategy/ result (e.g. under timber objective) *Influences:* • *Conditions or constraints that promote (or prevent) access to the forested land base*	FRPA & FPPR	Legal
	Forest Tenure Licence document *Influences:* • *Conditions or constraints that promote (or prevent) access to the forested land base*	Forest Act	Legal
	Markets *Influences:* • *The type of forest selected for harvesting*	Log purchasers/ consumers	Corporate
	Manufacturing facility needs, capacity, capability *Influences:* • *The type of forest selected for harvesting*	Log purchasers/ consumers	Corporate
Layout	FSP strategy/ result *Influences:* • *Conditions or constraints that promote (or prevent) access to the forested land base* • *The type of forest selected for harvesting or for retention*	FRPA & FPPR	Legal
	Internal guidance re harvest area vs Retention % and quality of timber in retained areas *Influences:* • *Conditions or constraints that promote (or prevent) access to the forested land base* • *The type of forest selected for harvesting*	SOPs, guidelines	Corporate
	Road layout *Influences:* • *whether chip trucks can get on/off site* • *cycle time and therefore economics*	SOPs, guidelines	Corporate
	WTRA, timber reserve requirements *Influences:* • *Conditions or constraints that promote (or prevent) access to the forested land base*	Land Use Plans, Higher Level Plans	Legal

Phase/ Activity	Initiatives/ directives that will influence the amount of residue on an area		
	Item	Directed by	Part of Regulatory Framework
	• *The type of forest selected for harvesting or for retention*		
Cruise	Measurement factors, Quality calls *Influences:* • *Knowledge of physical aspects and attributes of the forest* • *Expectations of the value of the timber*	Cruise Manual	Policy
	Pre-Harvest Waste Assessment *Influences:* • *Knowledge of physical aspects and attributes of the forest* • *Expectations around waste levels and therefore carbon stewardship concerns or opportunities. Expectations may have a positive or negative influence on carbon stewardship.*	Waste & Residue Manual	Policy
Permit preparation/ application	Data collections, submission, tracking *Influences:* • *Knowledge of physical aspects and attributes of the forest* • *Expectations of the value of the timber* • *Expectations regarding the cost and profitability of the forest*	Appraisal Manuals; District Direction	Policy
	Licensee obligations *Influences:* • *Conditions or constraints that promote (or prevent) access to the forested land base*	Forest Act - Forest Tenure documents	Legal
Site Plan	FSP Strategies/ Results/ Measures *Influences:* • *Conditions or constraints that promote or prevent or modify access to the forested land base* • *The type of forest selected for harvesting or for retention* • *The means and methods for renewal of the forest*	FRPA	Legal
	Silviculture system/ selection *Influences:* • *The type of forest selected for harvesting or for retention* • *The means and methods for renewal of the forest*	Guidelines	Corporate
Harvest Operations			
Road construction	Quality of construction (road subgrade, road surface, slopes, switchbacks) *Influences:* • *whether chip trucks can get on/off site* • *cycle time and therefore economics*	SOPs, guidelines	Corporate

Phase/ Activity	Initiatives/ directives that will influence the amount of residue on an area		
	Item	Directed by	Part of Regulatory Framework
	Training of operators *Influences:* • *whether chip trucks can get on/off site* • *cycle time and therefore economics*	SOPs, Guidelines Training Programs	Corporate Policy
Falling	Log lengths, top diameters *Influences:* • *Utilization and log value, and therefore amount of residue left on-site*	Log specifications	Corporate
	Markets *Influences:* • *Utilization and log value, and therefore amount of residue left on-site*	Log purchasers/ consumers	Corporate
	Training of fallers, buckers, and feller-buncher operators *Influences:* • *Utilization and log value, and therefore amount of residue left on-site*	SOPs, Guidelines Training Programs	Corporate Policy
Yarding	Balancing Utilization and Costs VS Stumpage implications (e.g. lowest cost operator) *Influences:* • *Logging cost and therefore economics* • *Conditions or constraints that promote or prevent or modify access to the forested land base* • *The type of forest selected for harvesting or for retention (i.e. Packaging of blocks for maximum stumpage benefit)*	FRPA, Forest Act	Legal
	Training of yarding crews, yarding machine operators *Influences:* • *Logging cost and therefore economics* • *Utilization and therefore amount of residue left on-site*	SOPs, Guidelines Training Programs	Corporate Policy
Processing	Log Trading (i.e. being able to send the right log to the right mill) *Influences:* • *Logging cost and therefore economics* • *Conditions or constraints that promote or prevent or modify access to the forested land base* • *The type of forest selected for harvesting or for retention*	Log purchasers/ consumers	Corporate
	Bucking standards (long-butting, trim, etc) *Influences:* • *Utilization and log value, and therefore amount of residue left on-site*	Log specifications, Training, SOPs, Guidelines	Corporate

Phase/ Activity	Initiatives/ directives that will influence the amount of residue on an area		
	Item	Directed by	Part of Regulatory Framework
	Markets *Influences:* • *Utilization and log value, and therefore amount of residue left on-site*	Log purchasers/ consumers	Corporate
	Training of processor operators, chasers, buckers *Influences:* • *Utilization and log value, and therefore amount of residue left on-site*	SOPs, Guidelines Training Programs	Corporate Policy
Utilisation	Definitions of merchantable log *Influences:* • *Utilization, and therefore amount of residue left on-site*	Cutting Permits	Legal
	Log lengths, top diameters, bucking standards *Influences:* • *Utilization and log value, and therefore amount of residue left on-site*	Permits	Legal
	Waste benchmarks *Influences:* • *Utilization, and therefore amount of residue left on-site*	Waste & Residue Manual	Policy
	Stumpage rates for different log grades *Influences:* • *Utilization and log value, and therefore amount of residue left on-site*	Appraisal Manuals	Policy
	Cut Control obligations *Influences:* • *Utilization, and therefore amount of residue left on-site*	Forest Act & Cut Control Regulation	Legal
	Proximity of work area to facilities that can process residue *Influences:* • *Utilization and log value, and therefore amount of residue left on-site*	Log purchasers/ consumers	Corporate
	Take or Pay requirements *Influences:* • *Utilization and log value, and therefore amount of residue left on-site* • *Incentives/ disincentives to utilization*	Appraisal Manuals; Waste & Residue Manual	Policy
Loading	Breakage *Influences:* • *Utilization, and therefore amount of residue left on-site*	Permits Waste & Residue Manual SOPs, Guidelines	Legal Policy Corporate
	Training of loader operators *Influences:* • *Utilization and log value, and therefore amount of residue left on-site*	SOPs, Guidelines Training Programs	Corporate Policy

Phase/ Activity	Initiatives/ directives that will influence the amount of residue on an area		
	Item	Directed by	Part of Regulatory Framework
Piling	Pile shape *Influences:* • *quality of burn;* • *whether pile can be taken apart if it turns out that waste/ residue can be utilized (i.e. pile to burn vs pile to recover)*	SOPs, Guidelines	Corporate
	Program to cover incremental costs to allow residue that would otherwise be piled to instead be chipped & delivered to a facility *Influences:* • *Utilization, and therefore amount of residue left on-site*	FESBC	Policy
	Training of machine operators *Influences:* • *Utilization and log value, and therefore amount of residue left on-site*	SOPs, Guidelines	Corporate
		Training Programs	Policy
Post-Harvest			
Waste Assessment	Qualified waste assessors to confirm accurate information *Influences:* • *Accuracy of measurements of carbon left on site* • *Measurement of carbon stewardship opportunity*	Waste & Residue Manual	Policy
	Waste benchmarks *Influences:* • *Utilization, and therefore amount of residue left on-site* • *Incentives/ disincentives to utilization*	Waste & Residue Manual	Policy
Deactivation	Deactivated road acting as a barrier to returning to an area to access woody residue *Influences:* • *Utilization, and therefore amount of residue left on-site* • *Incentives/ disincentives to utilization*	FRPA, FPPR	Legal
	Good deactivation keeping a road bed available for reactivation *Influences:* • *Utilization, and therefore amount of residue left on-site* • *Incentives/ disincentives to utilization*	SOPs, Guidelines	Policy
Burning/ disposition	Fire Hazard Assessment *Influences:* • *Measurement of carbon stewardship opportunity* • *Incentives/ disincentives to utilization*	Wildfire Act/ Reg'n	Legal
	Hazard abatement period	Wildfire Reg'n	Legal

Phase/ Activity	Initiatives/ directives that will influence the amount of residue on an area		
	Item	Directed by	Part of Regulatory Framework
	Influences: • *removes residue possibly available for future utilization* • *six-month period for "non-qualified holders" means residue burned quicker*		
Reforestation	Planting when not needed (i.e. when natural regeneration will work, or planting of small voids) *Influences:* • *carbon expenditure of planting*	Silviculture Guidelines	Policy
	Prompt planting to remove the need for a brushing treatment *Influences:* • *start fixing carbon at earliest date* • *carbon expenditure of brushing*	SOPs, Guidelines	Corporate
	Species selection/ species mix *Influences:* • *opportunity to fix more carbon*	Silviculture Guidelines	Policy
		SOPs, Guidelines	Corporate
Silviculture treatments	Thinning/ spacing *Influences:* • *creation of woody residue*	SOPs, Guidelines	Corporate
	Commercial thinning *Influences:* • *possible capture of mortality*	SOPs, Guidelines	Corporate
	Brushing *Influences:* • *creation of woody residue*	SOPs, Guidelines	Corporate
	Fertilizer *Influences:* • *potential to fix additional carbon in the stems (have to balance with carbon budget of manufacturing fertilizer)*	SOPs, Guidelines	Corporate
ALL PHASES			
	Training of forestry staff, machine operators, workers (University, Tech School, Apprenticeship) *Influences:* • *Knowledge and awareness of personal contribution to success "on the ground"* • *Knowledge and awareness of the role and impact of carbon stewardship*	SOPs, Guidelines	Corporate
		Educational Institutions	Policy
	Training Requirements for Professionals *Influences:* • *Knowledge and awareness of market forces, ecology, and the regulatory framework, particularly in relation to the role and impact of carbon stewardship* • *Knowledge and awareness of professional*	Foresters Act, College of Applied Biology Act, Engineers and Geoscientists Act	Legal

Phase/ Activity	Initiatives/ directives that will influence the amount of residue on an area		
	Item	Directed by	Part of Regulatory Framework
	contribution to success "on the ground,"		
		ABCFP, APEGBC, CAB, etc	Policy

Site Plan Reviews

Blocks reviewed to date

The following table lists blocks **reviewed to date** for this project, and identifies aspects from those plans that provide food for thought and further investigation. The list is non-random, and includes both "typical" blocks as well as blocks which were specifically identified as of interest from a carbon management standpoint. As additional blocks are reviewed, the results will be included in this section. The actual block-by-block review details may be presented in an appendix.

Block identifier	**Location**	**Management Unit**	**Resource District**	**Forest "licensee"**
TElm014	Limonite	Cascadia TSA	Coast Mountains	BCTS – Skeena
Block 1	Copper FDU Caribou FSR			BCTS – Babine
Block 6	Verney Passage		Coast Mountains	BCTS – Skeena
VPmp001	Verney Passage		Coast Mountains	BCTS – Skeena
VPmp019	Verney Passage		Coast Mountains	BCTS – Skeena

Review results to date

Site Plan item	**Why this is of interest**	**Consequence to Carbon Stewardship**	**Action/ Suggestion/ Reconciliation**
Ground based harvesting and clear cut in all SU.	• Ground-based harvesting could lend itself to selection harvest or retention of non-merchantable stems. • Clearcutting means that all stems are felled, potentially increasing waste levels	• Possible retention of non-desired or non-merchantable stems • Possible reduction in waste levels	• Look into opportunities for incorporating different types of retention into planning • Consider cost implications versus savings related to reduced waste bills

Site Plan item	Why this is of interest	Consequence to Carbon Stewardship	Action/ Suggestion/ Reconciliation
Minimum WTRA requirement.	WTRA distribution potential	Potential to place WTRAs over non-merchantable, non-desirable forest types to limit/ reduce waste	Look into opportunities for locating WTRAs for carbon benefits during planning
Removal of cedar from retention areas.	Concerns about “high-grading” versus economics of harvesting	Selective removal prevents waste of non-desired stems	Look into reconciliation of “high-grading” concerns versus carbon retention – may need to be (at least) a Policy discussion
Basal area retention	Basal area retention can be focused on keeping poorer quality stems	Potential to focus retention over non-merchantable, non-desirable forest types to limit/ reduce waste	Look into opportunities for locating basal area retention for carbon benefits during planning
Slashing of all hemlock regeneration above 2.0m due to mistletoe.	• Unhealthy stands may not acquire carbon as well as healthy stands. • Uninfected stems will be wasted and release carbon	Cut stems will contribute to carbon emissions.	For mistletoe knockdown, reconcile growth reduction from mistletoe and potential health concerns with carbon reduction/ sequestration opportunities
No 3 meter knockdown required within 30m RMZ.	Retained trees will benefit carbon sequestration.	Mistletoe knockdown “exemptions” are considered for riparian management, so why not for carbon management?	For mistletoe knockdown, reconcile growth reduction from mistletoe and potential health concerns with carbon reduction/ sequestration opportunities
Landing and roadside slash accumulations will be disposed.	• Methods of disposal of slash accumulations • Can slash be processed or otherwise utilized	Burning of slash is a significant and immediate carbon emission.	• Look into the benefit (if any) of limiting burning of slash accumulations (versus letting slash rot) • Look into current research for processing and transporting slash

Site Plan item	Why this is of interest	Consequence to Carbon Stewardship	Action/ Suggestion/ Reconciliation
Windthrow assessment completed.	• Amount of windthrow in block is important to limit when possible • Existing windthrow may increase the amount of waste in the block.	Waste in the block leads to increased carbon emissions.	Look into whether there are prescriptions related to wind and windthrow that can influence net waste
Non-merchantable trees less than 17.5cm within 10m of stream will be retained.	Retained trees will benefit carbon sequestration.	Retained trees will benefit carbon sequestration.	Consider if there should be guidance provided to influence planners to prescribe this practice
Hemlock with signs of mistletoe should be felled.	Unhealthy stands will not acquire carbon as well as healthy stands.	Cut stems will contribute to carbon emissions.	Reconcile growth reduction from mistletoe and potential health concerns with carbon reduction/ sequestration opportunities
Retain preferred and acceptable conifers of good form and vigour as per advanced regeneration standards.	Retained trees will benefit carbon sequestration.	Retained trees will benefit carbon sequestration.	Consider if there should be guidance provided to influence planners to prescribe this practice
If prompt reforestation does not occur, establishment brushing will likely be required.	• Planting is a carbon source (versus natural reforestation); • Establishment brushing is a carbon source.	No clear whether or when planting versus naturals and brushing is the “right” carbon prescription.	Consider a carbon decision tree to compare carbon benefits of different treatments on different ecotypes
Mechanical site preparation is not expected to be required provided acceptable harvesting practices are followed.	Site preparation is likely a carbon source.	Site preparation is likely a carbon source.	Consider a carbon decision tree to compare carbon benefits of different treatments on different ecotypes

Site Plan item	Why this is of interest	Consequence to Carbon Stewardship	Action/ Suggestion/ Reconciliation
Falling portions of a stand to waste to facilitate establishment of desired species (e.g. cedar).	One of the largest contributions to carbon emissions.	High amounts of waste will contribute to carbon emissions.	Look into reconciliation of silviculture objectives versus carbon retention – may need to be (at least) a Policy discussion
Coastal Tailed frog	Site Plan includes a voluntary discussion about an ecological (wildlife) factor that is already protected elsewhere.	If discussion about coastal tailed frog is voluntary, then there is no reason not to have discussion about carbon stewardship. Such discussions may have an influence on planners and planning, even without regulatory direction	General information and suggestions for carbon stewardship could be developed, which may have an influence on planners and planning, even without regulatory direction.
In Machine Free Zone (MFZ), retain 15-25 sph mature spruce and balsam with 30cm dbh or less where they exist.	Good example of prescription that provides carbon benefit, i.e. retained trees will benefit carbon sequestration.	Retained trees will benefit carbon sequestration.	Consider if there should be guidance provided to influence planners to prescribe this practice
Where a riparian management zone (RMZ) has been established, an effort must be made to minimize machinery traffic in order to reduce damage to residual trees and shrubs. Retain 15-25 sph mature spruce and balsam where they exist.	Good example of prescription that provides carbon benefit, i.e. retained trees along with less machine damage will benefit carbon sequestration.	Retained trees will benefit carbon sequestration.	Consider if there should be guidance provided to influence planners to prescribe this practice

Site Plan item	Why this is of interest	Consequence to Carbon Stewardship	Action/ Suggestion/ Reconciliation
Retain as much advanced regeneration as possible. Retain a minimum of 150-300 stems per hectare of saplings and poles where they exist. Retain patches of immature or non-merchantable timber throughout block to increase ecosystem, habitat and structural diversity in the future stand. Patch retention of poles/saplings is intended to minimize damage to poles/saplings and larger CWD pieces.	Good example of prescription that provides carbon benefit, i.e. retained saplings and poles along with less damage to them will benefit carbon sequestration.	Retained trees will benefit carbon sequestration.	Consider if there should be guidance provided to influence planners to prescribe this practice
Retain approximately 15-25 sph of mature spruce and balsam trees >25cm dbh	Good example of prescription that also provides carbon benefit	Retained trees will benefit carbon sequestration.	Consider if there should be guidance provided to influence planners to prescribe this practice
Retain mature aspen or other deciduous species for wildlife trees and for diversity unless removal is necessary.	Good example of prescription that also provides carbon benefit	Retained trees will benefit carbon sequestration.	Consider if there should be guidance provided to influence planners to prescribe this practice
Heli-logging in all SU.	Tradeoff between cost of heli-logging and carbon/environmental benefits. Heli-logging may increase waste, or may reduce it, depending on the prescription	Waste will contribute to carbon emissions Selection logging will contribute to carbon sequestration	Consider if there should be guidance or information provided to planners with respect to the carbon benefits (or impacts) from heli-logging practices

Site Plan item	**Why this is of interest**	**Consequence to Carbon Stewardship**	**Action/ Suggestion/ Reconciliation**
Large over mature hemlock is not considered worthy of flying out, but is prescribed to be felled anyway.	Unhealthy trees are not going to benefit carbon sequestration, however the carbon impact of felling the tree so that it rots or is burned is significant.	Waste will contribute to carbon emissions, retention will contribute to carbon stewardship.	Consider if there should be guidance or information provided to planners with respect to the carbon benefits (or impacts) from heli-logging practices
Individual or groupings of wildlife trees will be retained wherever possible throughout <licensee> development areas provided that their retention is both technically feasible and will not adversely impact worker safety.	Retained trees will benefit carbon sequestration.	Retained trees will benefit carbon sequestration.	Consider if there should be guidance or information provided to planners with respect to the carbon benefits (or impacts) from retention prescriptions and practices
100% basal area removal within proposed block except for WTP to maintain structural diversity and meet Partial Retention VQOs.	Allow for retention of poorer wood to address visual quality objectives and carbon.	Improves economic argument for carbon stewardship	Investigate/ describe/ communicate to licensees and planners how carbon management can be used as a positive tool that will also provide economic and/or environmental benefits

Additional information may be compiled and reported on in the final report.
Alternatively, this information may be moved to an Appendix, and discussion may focus more on general observations and items deserving specific attention for Carbon Stewardship.

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Site Plan documents reviewed and site visits/ interviews conducted will be included in the final report.

Natural Resource Solutions:

Practical - Professional - Innovative