KING COUNTY RURAL FOREST CARBON PROJECT

King County
Department of Natural Resources and Parks

RAIN CLOUD FORESTS

Document Prepared By: RainCloud Forests

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1 PROJECT DETAILS

1.1 Summary Description of the Project

The King County Rural Forest Carbon Project is a set of dispersed properties located within King County (Figure 1), in western Washington State near the city of Seattle, WA. The county has a total area of about 2,301.7 sq. mi. (5,980 km^2), of which 91.7% is land and 8.3% water. The project is led and managed by the King County Department of Natural Resources and Parks (DNRP).

With over 2.23 million residents (as of 2018), King County is the most populous county in Washington State. Seattle and the surrounding King County area is one of the fastest growing jurisdictions in the United States. This growth has generated significant urban and rural residential development and expansion pressure throughout the County.

King County has a longstanding and ongoing parks land acquisition program, and currently owns and manages approximately 28,000 acres. However, the County and regional partners have recognized the need to expand and accelerate their land conservation efforts in the face of the very high growth and development pressures. In 2018 King County formally launched the Land Conservation Initiative (LCI), which aims to rapidly accelerate land acquisitions and conservation, with the goal of protecting an additional 65,000 acres in the next 30 years. This initiative involves the use of a combination of financing sources and new and innovative market-based funding mechanisms, a key one of which is the development of forest carbon financing (see: King County Forest Carbon Program). King County has been exploring forest carbon for over a decade, and began actively attempting to develop carbon financing avenues in 2015, which has culminated in the launch of the King County Rural Forest Carbon Project in 2019. A key objective of this project is to use carbon financing to expand and accelerate the land conservation and protection goals of the Land Conservation Initiative within King County. This includes generating carbon financing from King County fee-simple and title-right acquisitions to fund further acquisitions as well as including 3rd Party Landowners in the project to expand the conservation impact of the LCI further. The project is expected to add new properties within the project geographic area annually over the duration of the project.

The project is therefore a Grouped Project that includes a combination of properties or title rights acquired and managed by King County, and properties or title rights owned and managed by 3rd Party Landowners. Specific properties included in the project may include a variety of ownership and/or contractual structures that may include fee simple ownership, title easements, or long term contracts that establish carbon rights and project activities consistent with the project. Properties may be managed by the King County DNRP, or 3rd Party individuals or entities. Properties joining the project will generally be managed for conservation, recreation, ecological values, and/or improved forest management. This project is primarily focused outside the King County Urban Growth Boundary Area and involves lands with forestry and rural residential potential and zoning.

The King County Rural Forest Carbon Project achieves net GHG emissions reductions and removals through the avoidance of emissions due to commercial logging and forest removal for rural residential development expected in the baseline scenario.

The baseline scenarios are applied at a property level, and are based on representative scenarios generally derived from one or more of, acquisition appraisal documentation, forest plans, typical practice, and/or a comparative analysis of nearby properties.

The project scenario is conservation-based or ecosystem-based forest management. Most properties within the project are managed for conservation, ecological objectives, and/or outdoor recreation use. Some properties have timber and silvicultural activities with the objective of enhancing forest health, reducing disturbance risks, and/or improving the long term ecological values and function on the property.

This is a Grouped Project with King County serving as the project proponent. The project start date is January 1, 2015, when King County began actively working to develop carbon finance opportunities. The initial verification period project instances include properties acquired or joining the project between 2015 and 2018, inclusive. At the time of validation/initial verification, the project will include 880.9 acres, of which 100% are King County acquisitions at the time of validation. The project is projected to add an average of 250-500 acres per year or more, which will be made up of forest-based King County acquisitions and new 3rd Party Landowner participation.

Average ex-ante gross annual GHG emission reductions based on the starting 2015 through 2018 acquisitions is projected at 9,383 tCO_2e for a total of 93,834 tCO_2e for the first 10-year period[1].

1.2 Sectoral Scope and Project Type

Sectoral scope 14. Agriculture Forestry and Other Land Use (AFOLU)

Improved Forest Management (IFM)

Logged to Protected Forest

This is a Grouped Project.

1.3 Project Proponent

Organization name	King County Department of Natural Resources and Parks
Contact person	Kathleen Farley Wolf
Title	Forestry Program Manager
Address	201 S Jackson Street, Suite 600, Seattle, WA 98104
Telephone	+1 206-477-4363
Email	kfarleywolf@kingcounty.gov

1.4 Other Entities Involved in the Project

Organization name	RainCloud Forests

[1] Noting that the project expects to expand acreage annually as new project instances are added to the project, which will impact the average annual and total expected GHG emission reductions in the first 10 years and ongoing.

Role in the project	Project Developer
Contact person	Mike Vitt
Title	President
Address	3516 Skylark Loop, Bellingham, WA, 98226
Telephone	+1 206-307-7096
Email	mike.vitt@raincloudforests.com

Organization name	3rd Party Land Owner[2]
Role in the project	Project Participant
Contact person	Various – see current 3rd Party Landowner List
Title	n/a
Address	Various – see current 3rd Party Landowner List
Telephone	Various – see current 3rd Party Landowner List
Email	Various – see current 3rd Party Landowner List

1.5 Project Start Date

January 1, 2015.

The overall project start date is set to match the launch of the Land Conservation Initiative and related staffing and resource allocations in 2014-15.The start date of Individual project instances are set at the start of year for the date of acquisition (for King County properties) or the date of signing a participation agreement (for 3rd Party Landowners).

1.6 Project Crediting Period

January 1, 2015 to December 31, 2114. A period of 100 years.

1.7 Project Scale and Estimated GHG Emission Reductions or Removals

Project Scale	
Project	X
Large project	

[2] The project will involve 3rd Party Landowners who participate through a contractual agreement. King County will maintain an updated list of contact information for all participating 3rd Party Landowners in the project. At the time of validation, no 3rd Party Landowners have joined the project, but are expected in future verification periods.

Year	Estimated GHG emission reductions or removals (tCO_2e)
2015	0
2016	11,482
2017	8,348
2018	18,421
2019	33,961
2020	3,914
2021	4,427
2022	4,427
2023	4,427
2024	4,427
Total estimated ER's[3]	93,834
Total number of crediting years	100
Average annual ER's	**9,383**

1.8 Description of the Project Activity

The King County Rural Forest Carbon Project will achieve net GHG emissions reductions and removals on each project instance (participating property) by conserving the carbon contained in the current forest biomass, sequestering additional carbon in retained forests, and avoiding emissions from logging and associated transportation and processing of harvested wood, in comparison to the net emissions under the relevant baseline scenario.

As a conservation-based VCS Improved Forest Management – Logged to Protected Forest (IFM-LtPF) project, there are no specific emission reducing technologies, products, or services involved in the implementation of the project.

The primary project activity is the conservation of forests and conservation-based management for the sequestration of carbon, improvement of ecological function and services, forest health, and recreational access. Project activities can include a wide variety of forest management and stewardship activities, some of which may have non-de minimis impacts on carbon stocks. Forest management activities that impact carbon on project instances within the project geographic area may include:

[3] Only the first 10 years of the crediting period are shown, with values based on ex-ante projections from only the initial project instances (participating properties) added to the project between 2015-2018. The project is expected to add new project instances annually over time, which will significantly affect future ex-ante projections and expected ex-post results. For example the project estimates expansion to ~5,000 acres over the first 10 years of the project.

1. Timber harvesting and tree removals: This may include thinning, group or individual tree selective harvest, salvage, and/or other forest management strategies. These activities will typically be implemented to restore or enhance natural forest composition and structure, create or accelerate future forest or ecosystem features and development, and/or to mitigate or manage forest health, fire, or forest disturbance risks or events, and/or for other ecosystem-based objectives.
2. Access development: The project will manage road development and access at a property level with an objective of limiting road development while allowing access for project activities including road maintenance, forest management, forest health and fire management, recreational access and/or other access requirements.
3. Tree planting or other silvicultural activities to improve and/or accelerate ecological function and forest ecological development towards desired future conditions.

Other project activities that will not materially affect carbon stocks include:

1. Monitoring – monitoring is primarily undertaken using a combination of site supervision, remote sensing, and the establishment and measurement of non-destructive permanent sample plots.
2. Recreational Access Development – DNRP manages the installation and maintenance of trails for non-motorized recreational access. This activity may involve limited single tree removals, hazard tree or other safety removals, and/or other limited management activities related to public hiking and access that are anticipated to have a de minimis impact on carbon stocks across the project.

Project activities on King County properties are planned and managed by DNRP Parks Division staff, with input and technical support from other divisions. Participating 3rd Party Landowners will plan project activities in conjunction with DNRP forestry staff in the Water and Land Resources Division and 3rd party consultants under the terms of the Participation Agreement each 3rd Party Landowner has entered into. As sole Project Proponent, DNRP is the sole contact for the project and will maintain and oversee all project monitoring and reporting responsibilities and activities for all project instances.

The project is not located within a jurisdiction covered by a jurisdictional REDD+ program.

1.9 Project Location

The project geographic area encompasses King County, an area of 2,302 sq. mi (5,980 km^2) located in the State of Washington in the northwest coast of the United States; on and about 47° 28' 12.00" N, -121° 50' 24.00" W (Figure 1). Approximately 2,111 mi^2 (5,484 km^2) or 91.7% of King County is land and 191 mi^2 (490 km^2) is open water. King County extends from Puget Sound on the west to the crest of the Cascade Mountains in the east. King County is bounded by Kitsap County on the west, Kittitas and Chelan Counties on the east, Snohomish County to the north and Pierce County to the south. King County encompasses the major cities of Seattle, Tacoma, and Bellevue along with many smaller towns and municipalities. Washington state is located in the Pacific Northwest (PNW), a geographic region in western North America bounded by the Pacific Ocean to the west and by the Cascade Mountain Range on the east.

King County supports a population of approximately 2.23 million residents (2018) and encompasses the major cities of Seattle (2018 population: 730,400), Bellevue (141,400), Kent (127,500) and Renton (101,000) along with many smaller cities and unincorporated areas. King County is the most populous county in Washington, and has experienced a significant increase in growth in recent decades; the county added approximately 300,000 residents since 2010. Although population growth in King County has apparently slowed somewhat recently, net population increase between 2017 and 2018 was still 80 people per day.

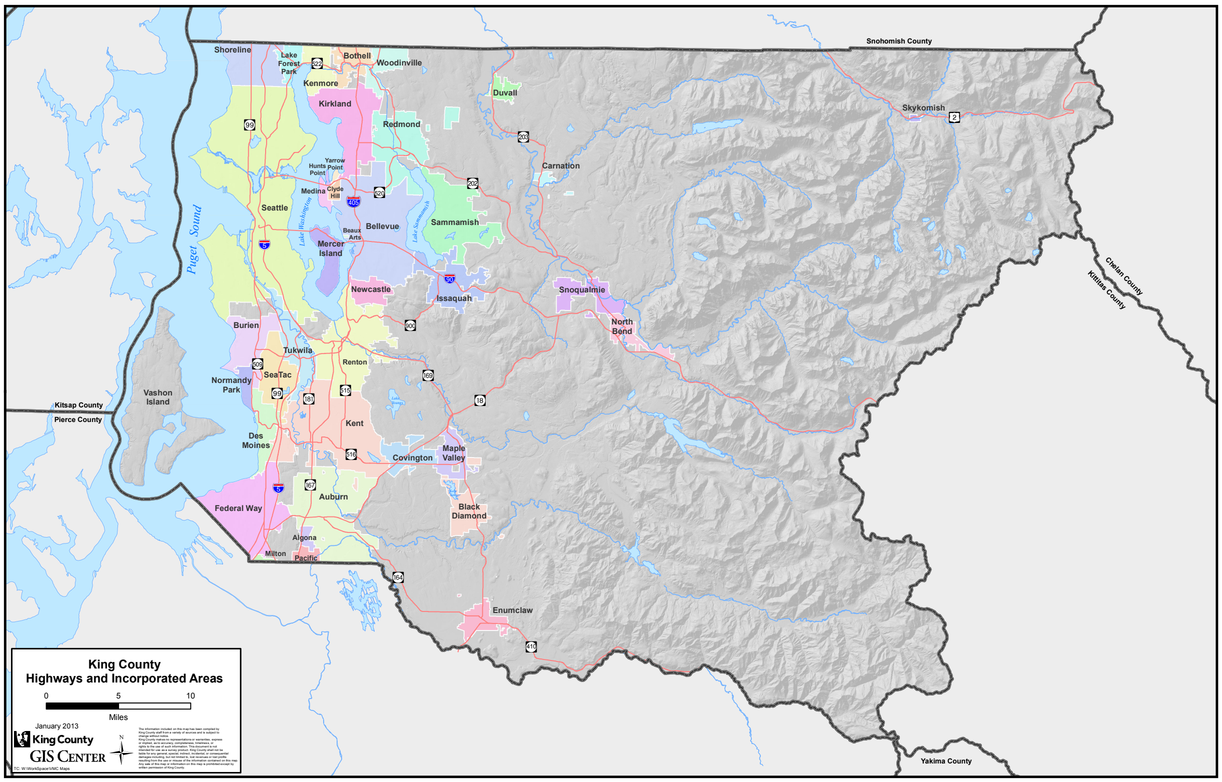

Figure 1. The Project Geographic Area: King County, Washington, USA.

1.10 Conditions Prior to Project Initiation

Generally, most rural forested private lands in King County are either managed for timber production or for rural residential acreages. Properties managed for timber can have a variety of management activities and intensities, but predominantly forests are clearcut at age ~40 years old and then replanted to conifer. Outside of protected private land, most forests have been heavily cut and regenerated one or more times since the late 1800s. Most managed properties undergo additional silvicultural activities including a pre-commercial thin, hardwood management, and fill planting understocked areas, etc. The general objective is fast timber growth to reduce rotation ages and maximize financial returns. The forest industry is large and well established throughout most of Washington State and King County.

Much of the privately owned forest land that is not managed for commercial timber is developed for rural residential use. Often financial returns are maximized by harvesting valuable timber, followed by selling or developing the property to maximize residential home development up to the limits allowed under the land zoning applicable to each property. There is some variability in how rural lots are prepared for sale, with some being fully cleared, some partially cleared and/or selectively harvested depending on the developers' goals. Some forested properties fall outside of designated forestland or low-density rural zoning and are converted to high density urban housing or commercial developments.

Although King County's Comprehensive Plan has been successful in focusing much of the high-density development within cities and designated Urban Growth Areas, the dramatic regional growth continues development pressure in more rural areas, which has resulted in a rapid and ongoing decline in forested acreage. In 1996, King County's Farm and Forests Report[4] laid the foundation for its Forestry Program[5], citing the reduction of forested land by one third between 1972 and 1996 and calling for steps to conserve forests. The Program focuses on the retention of forestland for its environmental, social, and economic benefits, and provides education, technical assistance, and economic incentives to private landowners aimed at retaining the forest resources of King County. It is guided by the King County Comprehensive Plan[6], which establishes policies on the management of rural land and uses that are suitable to the rural area. The Plan directs that strategies be developed to maintain forest cover and the practice of sustainable forestry.

In 2018, King County passed legislation supporting a new Land Conservation Initiative (LCI) to accelerate investments to protect key open spaces before they are lost to development or become too expensive, and to improve public access to green spaces. The initiative is intent on preserving more than 65,000 acres of remaining important open space lands within a generation (30 years – as compared to 75 years at the previous rate of acquisition). Although significant funding for LCI has been identified, additional funding will be needed to meet the goal and capturing and marketing value from ecosystem assets, most notably forest carbon, is considered important to LCI success.

Geography

King County is geographically diverse. Its eastern boundary follows the divide of the Cascade Mountains for some 70 miles north to south. Some of the highest peaks in the Cascade range are found in the northern section of the divide; Mt. Daniel, with an elevation of 7,959 ft (2,426 m) is the highest point in the county. One hundred kilometers to the west, the County borders on Puget Sound, a fjord-like body of saltwater between the Olympic Mountains further west. Glacial action has resulted in a series of long, low gravel ridges across the lowlands, numerous kettle lakes, two large lakes (Lake Washington and Lake Sammamish, the largest and 5th largest natural lakes in Washington, respectively), Mercer Island in southern Lake Washington, and Vashon-Maury Island, about 3 miles offshore of mainland King County.

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4 https://www.kingcounty.gov/services/environment/water-and-land/forestry/forest-policy/farm-and-forest-report-1996.aspx
5 https://www.kingcounty.gov/depts/dnrp/wlr/sections-programs/rural-regional-services-section/forestry-program.aspx
6 https://kingcounty.gov/depts/executive/performance-strategy-budget/regional-planning/king-county-comprehensive-plan.aspx

Variation in geography and climate have generated a diversity of ecoregions across King County[7] Patterns in land use (Figure 2) show a predominance of densely-populated urban areas in the Puget Lowlands and transitioning easterly towards mixed forest in the Eastern Puget Uplands and Riverine Lowlands. Further east, lands in the Cascade Mountain foothills and at higher elevations are largely forested with a mix of deciduous-conifer and pure conifer stands.

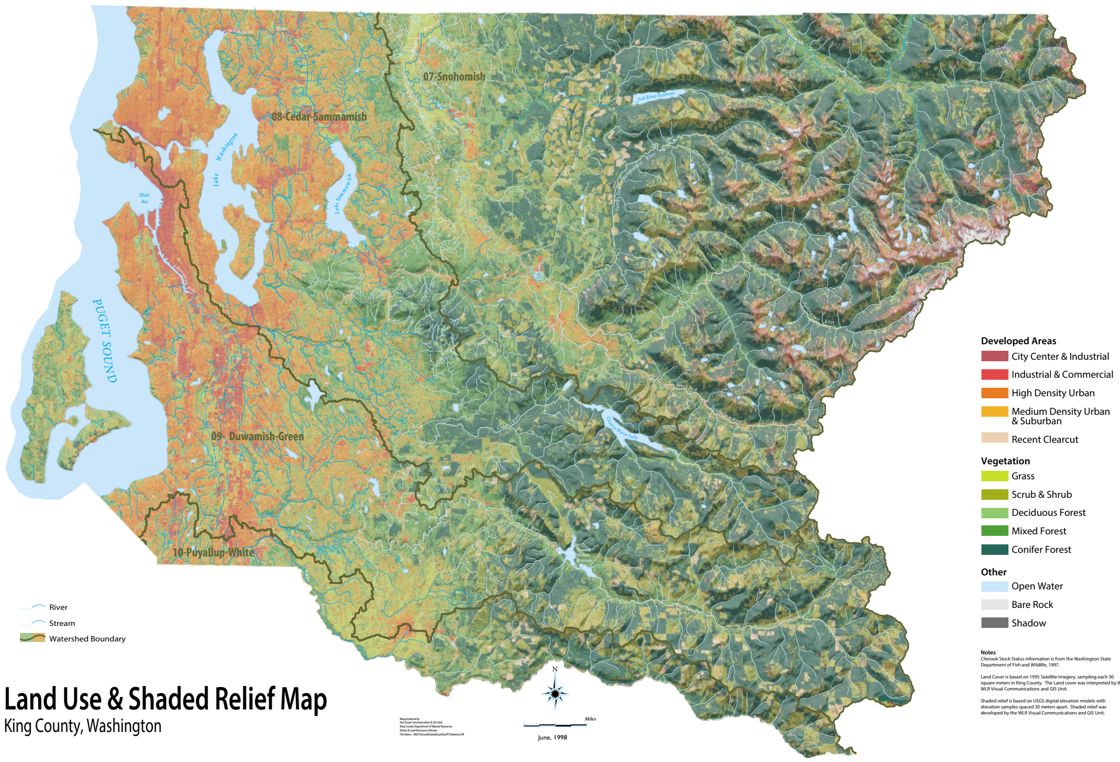

Figure 2. King County landcover and topographic relief map.

1.11 Compliance with Laws, Statutes and Other Regulatory Frameworks

The King County Rural Forest Carbon Project is compliant with applicable U.S., State of Washington, and County laws in both the baseline and forest carbon project scenarios.

The following laws are regulations are relevant to the project:

1. Washington State Forest Practices Act (FPA – WA State Department of Natural Resources (WA DNR) & King County)[8] – include forest management and harvesting regulations including harvesting, silvicultural, and riparian protection requirements. WA DNR and King County exercise jurisdiction of various parts of the FPA in the project

[7] Ecoregions are areas where ecosystems (and the type, quality, and quantity of environmental resources) are generally similar.
[8] https://www.dnr.wa.gov/programs-and-services/forest-practices

geographic area[9]. All project instances and scenarios follow state and county regulations related to the FPA.

2. Washington State Environmental Policy Act (SEPA – WA Dept of Ecology (WA DOE))[10] – SEPA is a review process that requires government agencies to identify environmental impacts that may result from agency actions. Generally this is an environmental review act that relates to policy, development approvals, and other governmental decision making. The project complies in general by following State and County regulations, policies, and permitting in both the baseline and project scenarios.
3. Federal Endangered Species Act (16 U.S.C. 1531 et seq.) – protects threatened and endangered species and regulates management of their habitats. There are no known instances of threatened or endangered species currently inhabiting project properties that materially affect carbon stocks. King County DNRP monitors and consults with staff and state wildlife biologists and undertakes a variety of species and habitat assessment programs, and will manage any occurrences on project properties as needed.
4. Federal Water Pollution Control Act (33 U.S.C § 1251 et seq.) - establishes objectives to improve water quality and regulates pollution into waterways. The project follows State and County regulations and best management practices to protect water quality.
5. National Environmental Policy Act (42 U.S.C. § 4321 et seq.) - establishes national goals for protection and enhancement of the environment. The project is in compliance with these regulations and looks to improve the health and ecological functions of forests in the project.
6. Hydraulics Code Guidelines (WA Dept of Fish and Wildlife) - requires people planning hydraulic projects in or near state waters to get a Hydraulic Project Approval (HPA). The project may involve Forest Practice Hydraulic Project (FPHP) approval as equivalent for in-stream work, although this does not affect carbon emissions.
7. WA Clean Air Act (WA DNR and WA DOE) – protects air quality. The project does not anticipate air quality impacts related to this act.
8. WA Clean Water Acts (WA DNR) – regulations related to water discharges. The project does not anticipate any water discharge impacts related to this act.
9. WA Salmon Recovery Act of 1999 (WA DNR) – covers all salmon bearing waters and requires conservation of the species. The project is compliant via following WA DNR and King County forest practices.

9 Prior to 1997 all forest practices on non-federal lands were regulated by the Washington State Department of Natural Resources (WA DNR). In 1997, the FPA was amended giving authority to each city and county to exercise jurisdiction over all Class IV-General forest practices. On August 10, 1999, WA DNR transferred the administration and enforcement of Class IV-General forest practices conducted within unincorporated King County to King County. DNR retained jurisdiction over Class I and II forest practices outside of the Urban Growth Area and over Class III and IV-Special forest practices. Forest practices classes are summarized: https://www.kingcounty.gov/depts/local-services/permits/permits-inspections/land-use-permits/forest.aspx

10 https://ecology.wa.gov/Regulations-Permits/SEPA/Environmental-review/SEPA-guidance/Basic-overview

10. WA Shoreline Management Act (WA DOE) – mandates protection of valuable shorelines. The project does not involve any substantial developments within shoreline areas. The project is compliant via following state and county forest practices.

1.12 Ownership and Other Programs

1.12.1 Project Ownership

The project includes a variety of ownership structures that demonstrate either Proof of Right or Right of Use ownership of carbon rights in accordance with VCS requirements:

1. King County – this can include fee simple ownership, title rights, carbon rights, conservation easements, or other controlling ownership structures.
2. 3rd Party Landowners – this can include a private individuals, for-profit entities, or not-for-profit entities with fee simple ownership, title rights, carbon rights, conservation easements, or other controlling ownership structures compatible with the project.

King County will retain records of legal Proof of Right and Right of Use documentation for each property participating in the project.

1.12.2 Emissions Trading Programs and Other Binding Limits

Project GHG emission reductions are not included in an emissions trading program or any other mechanism that includes GHG allowance trading.

1.12.3 Other Forms of Environmental Credit

The project has not sought nor received any other form of GHG-related environmental credit.

Certain project instances (participating properties) participate voluntarily in a King County Transfer of Development Rights (TDR) Program[11] which buys and extinguishes residential development rights and resells them to urban densification projects. The TDR program does not restrict forest biomass rights or timber harvesting in any way, only residential development for house sites through use of a Conservation Easement restricting real estate development. Project properties generally join the carbon project and the TDR program simultaneously and the TDR program conservation easement is fully supportive of the carbon project goals and project activities. Note also this TDR program will potentially be used as a leakage mitigation/management program in the project (see Section 1.13).

Although not an environmental crediting program, note that certain project properties participate in King County Current Use Tax Incentive Programs[12], which are voluntary property tax reduction programs aimed at incentivizing rural landowners to keep lands in forest or managed forest

[11] https://www.kingcounty.gov/services/environment/stewardship/sustainable-building/transfer-development-rights/overview.aspx

[12] https://kingcounty.gov/services/environment/stewardship/sustainable-building/resource-protection-incentives.aspx

conditions. These programs are voluntary and do not legally restrict property development, nor restrict forest and carbon biomass rights or timber harvesting.

1.12.4 Participation under Other GHG Programs

The project has not been registered, nor is it seeking registration under any other GHG programs.

1.12.5 Projects Rejected by Other GHG Programs

The project has not been rejected by any other GHG programs.

1.13 Additional Information Relevant to the Project

Eligibility Criteria

The King County Rural Forest Carbon Project and its constituent properties will meet the criteria for VCS Improved Forest Management – Logged to Protected Forest (IFM-LtPF) eligible projects, as defined in the VCS Standard v4.0:

1. Protecting currently logged or degraded forests from further logging.
2. Protecting forests that would be logged in the absence of carbon finance

Project instances (participating properties) will be eligible to be added to the project when they meet the following eligibility criteria specified in VCS Methodology VM0012 v1.2 (see Section 2.2):

1. The project instance is located within the King County geographic boundaries
2. The project instance meets the eligibility criteria specified in Methodology VM0012 (see Section 2.2).
3. Evidence exists that the project instance fits one the Baseline Scenario Strata described in Section 2.4.
4. The property is consistent with the assessment of additionality, as described in Section 2.5.
5. In the case of a 3rd Party Landowner, a property may be eligible for inclusion if the owner has executed a project Participation Agreement with King County.

The project instances also must use the technologies or measures specified in the project description to meet the VCS grouped project requirements.

Leakage Management

Leakage management and mitigation is optional under the VCS AFOLU Guidelines v3.6. King County has developed a Transfer of Development Rights (TDR) program that works in conjunction with the carbon project on some of the current participating project properties. This TDR program buys and transfers rural residential developments rights from rural areas in King County to urban densification projects. This results in a reduction in the risk of leakage from at least the project instances involved in the TDR program (and perhaps additional). This transfer mitigates the risk that there are increases in the demand for rural residential properties that result in leakage of avoided timber harvesting in the project geographic area. The project has not included this leakage mitigation in the initial verification period, but will monitor the TDR program in relation to the project and potential leakage impacts and will develop this mitigation program to potentially claim reduced leakage risks at a future verification.

Commercially Sensitive Information

The contents of this document are not considered confidential. However, the project proponents may identify reference and supplemental evidence materials as commercially sensitive and confidential at the time of validation and/or verification.

Sustainable Development

Not applicable to the project.

Further Information

Intentionally blank.

2 APPLICATION OF METHODOLOGY

2.1 Title and Reference of Methodology

VM0012 Improved Forest Management in Temperate and Boreal Forests (LtPF) v1.2

2.2 Applicability of Methodology

Applicability Criteria	Project Fit
Meets current VCS IFM-LtPF criteria	Project meets criteria
Projects located in FAO Temperate and Boreal Ecological Zones; and have Tier III inventory data available.	Project is located in the Temperate Ecological Zone. Project utilizes detailed site level inventory meeting Tier III criteria.
Projects meets the most current approved VCS Standard requirements for ownership	The project can demonstrate Proof of Right and Right of Use for all criteria required by the VCS Standard v3.7.
Project has starting average annual illegal, unplanned, and fuelwood removals <5% of annual harvest (tCO_2e);	The project has no *non-de minimis* illegal or unplanned harvesting, or fuelwood removals.
Projects without managed peatland forests	Project does not contain managed peatland forests.
Projects where % wetlands are not expected to change as part of project activities	Project will not materially alter the % of wetlands on project instances within the project geographic area.
Projects can demonstrate no activity shifting leakage occurs to other proponent lands at the start of the project.	The project can demonstrate that activity shifting leakage has not occurred.

Projects do not include *non-de minimis* application of organic or inorganic fertilizer in the project scenario.	Project does not include any application of *non-de minimis* fertilizer in either the baseline or project scenarios.

2.3 Project Boundary

Source		Gas	Included?	Justification/Explanation
Baseline	Above Ground Tree Biomass (Live)	CO_2	Yes	Required by VCS. Major carbon pool subject to changes from the baseline to the project scenario.
		CH_4	No	Sources and sinks are *de minimis*
		N_2O	No	Sources and sinks are *de minimis*
		Other	No	
	Above-Ground Non-Tree Biomass (Live)	CO_2	No	Excluded by VCS. Minor carbon pool subject to changes from the baseline to the project scenario.
		CH_4	No	
		N_2O	No	
		Other	No	
	Below Ground Biomass Pool (Live and Dead)	CO_2	Yes	Required by VCS. Major carbon pool subject to changes from the baseline to the project scenario.
		CH_4	No	Sources and sinks are *de minimis*
		N_2O	No	Sources and sinks are *de minimis*
		Other	No	
	Dead Wood Pool	CO_2	Yes	Required by VCS. Minor carbon pool subject to changes from the baseline to the project scenario.
		CH_4	No	Sources and sinks are *de minimis*
		N_2O	No	Sources and sinks are *de minimis*
		Other	No	
	Litter Pool	CO_2	No	Excluded by VCS for AFOLU projects. Minor carbon pool subject to changes from the baseline to the project scenario – generally considered as a transitional pool only.
		CH_4	No	
		N_2O	No	
		Other	No	
	Soil Carbon Pool	CO_2	No	Optional in VCS AFOLU IFM projects, but excluded in this methodology. As a conservative approach, changes to soil carbon from harvesting

Source		Gas	Included?	Justification/Explanation
				are assumed to be *de minimis*. Monitoring is difficult.
		CH_4	No	Sources and sinks are *de minimis*
		N_2O	No	Sources and sinks are *de minimis*
		Other	No	
	Wood Products Pool	CO_2	Yes	Required by VCS. All baseline scenarios that include timber harvesting account for this pool.
		CH_4	No	Sources and sinks are *de minimis*
		N_2O	No	Sources and sinks are *de minimis*
		Other	No	
	Use of Fertilizers	CO_2	No	Neither the project nor the baseline scenario includes the use of fertilizer, and hence these emission sources are excluded. These exclusion assumptions do not increase the emission reductions in the project.
		CH_4	No	Neither the project nor the baseline scenario includes the use of fertilizer
		N_2O	No	Neither the project nor the baseline scenario includes the use of fertilizer
		Other	No	
	Combustion of Fossil Fuels by Vehicles / Equipment	CO_2	No	Carbon emissions from harvesting equipment, log transport, and primary forest product manufacturing are excluded in both scenarios. This exclusion does not increase the emission reductions in the project.
		CH_4	No	Sources and sinks are *de minimis.* These exclusion assumptions do not increase the emission reductions in the project.
		N_2O	No	Sources and sinks are *de minimis.* These exclusion assumptions do not increase the emission reductions in the project.
		Other	No	
	Burning of Biomass (on site slash burning)	CO_2	No	Emissions from burning of biomass are not included specifically in either scenario; however, carbon stock decreases due to burning are accounted as a carbon stock change. These exclusion assumptions do not increase the emission reductions in the project.
		CH_4	No	

Source		Gas	Included?	Justification/Explanation
		N_2O	No	
		Other	No	

Project	Above Ground Tree Biomass (Live)	CO_2	Yes	Required by VCS. Major carbon pool subject to changes from the baseline to the project scenario.
		CH_4	No	Sources and sinks are *de minimis*
		N_2O	No	Sources and sinks are *de minimis*
		Other	No	
	Above-Ground Non-Tree Biomass (Live)	CO_2	No	Excluded by VCS. Minor carbon pool subject to changes from the baseline to the project scenario
		CH_4	No	
		N_2O	No	
		Other	No	
	Below Ground Biomass Pool (Live and Dead)	CO_2	Yes	Required by VCS. Major carbon pool subject to changes from the baseline to the project scenario.
		CH_4	No	Sources and sinks are *de minimis*
		N_2O	No	Sources and sinks are *de minimis*
		Other	No	
	Dead Wood Pool	CO_2	Yes	Required by VCS. Minor carbon pool subject to changes from the baseline to the project scenario.
		CH_4	No	Sources and sinks are *de minimis*
		N_2O	No	Sources and sinks are *de minimis*
		Other	No	
	Litter Pool	CO_2	No	Excluded by VCS for AFOLU projects. Minor carbon pool subject to changes from the baseline to the project scenario – generally considered as a transitional pool only.
		CH_4	No	
		N_2O	No	
		Other	No	
	Soil Carbon Pool	CO_2	No	Excluded in VM0012 methodology.
		CH_4	No	Sources and sinks are *de minimis*
		N_2O	No	Sources and sinks are *de minimis*
		Other	No	

	Wood Products Pool	CO_2	Yes	Required by VCS. All baseline scenarios involve logging.
		CH_4	No	Sources and sinks are *de minimis*
		N_2O	No	Sources and sinks are *de minimis*
		Other	No	
	Use of Fertilizers	CO_2	No	Neither the project nor the baseline scenario includes the use of fertilizer, and hence these emission sources are excluded. This exclusion does not increase the emission reductions in the project.
		CH_4	No	Neither the project nor the baseline scenario includes the use of fertilizer
		N_2O	No	Neither the project nor the baseline scenario includes the use of fertilizer
		Other	No	
	Combustion of Fossil Fuels by Vehicles / Equipment	CO_2	No	Carbon emissions from harvesting equipment, log transport, and primary forest product manufacturing are excluded in both scenarios. This exclusion does not increase the emission reductions in the project.
		CH_4	No	Sources and sinks are *de minimis.* These exclusion assumptions do not increase the emission reductions in the project.
		N_2O	No	Sources and sinks are *de minimis.* These exclusion assumptions do not increase the emission reductions in the project.
		Other	No	
	Burning of Biomass (on site slash burning)	CO_2	No	Emissions from burning of biomass are not included specifically in either scenario; however, carbon stock decreases due to burning are accounted as a carbon stock change. These exclusion assumptions do not increase the emission reductions in the project.
		CH_4	No	
		N_2O	No	
		Other	No	

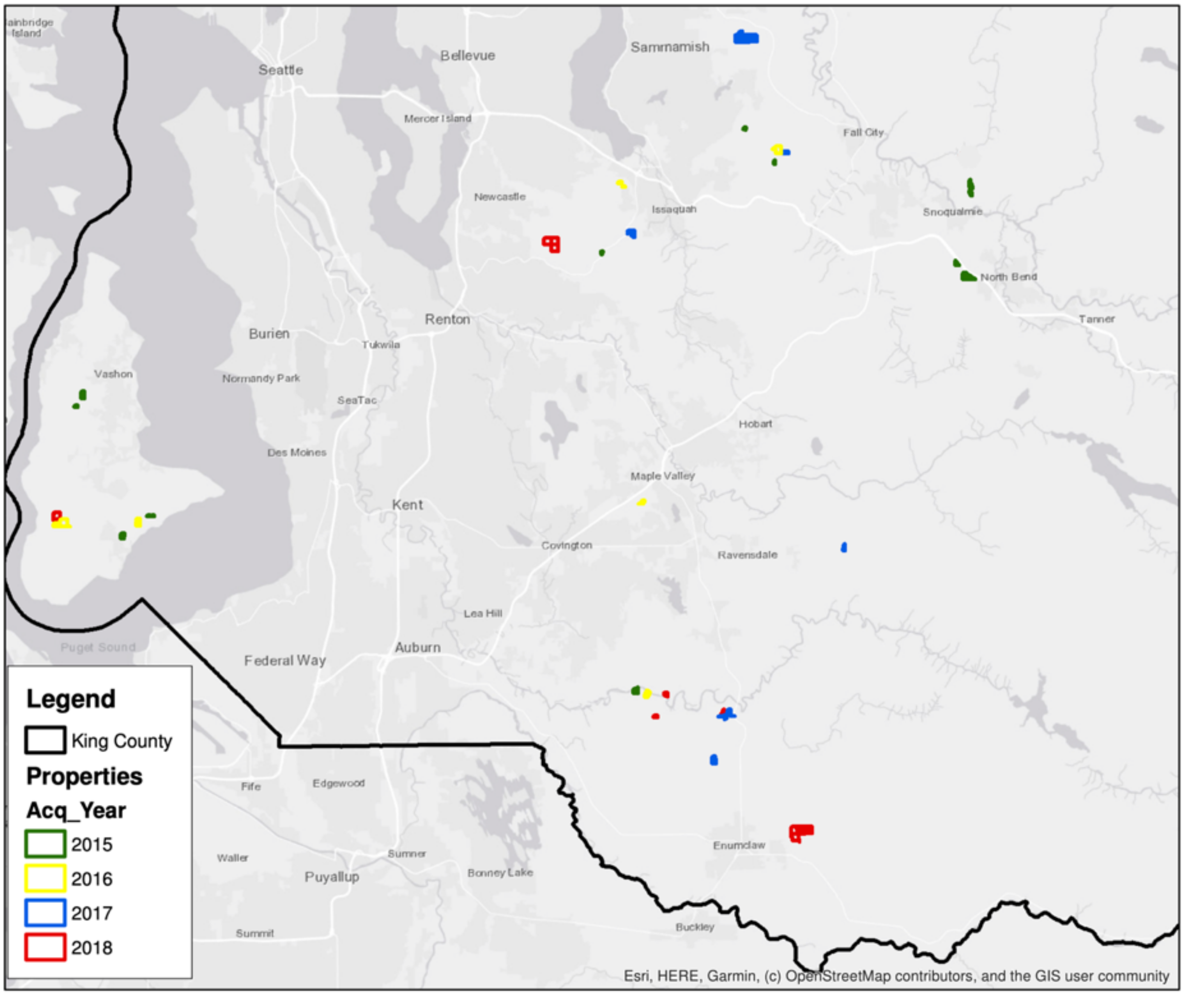

Figure 3. Map showing the location of the initial period (2015-18) project instances (properties) by inclusion/acquisition year.

2.4 Baseline Scenario

The King County Carbon Project is a Grouped Project that stratifies project instances (participating properties) into one of multiple baseline scenario strata, based on the most plausible scenario for a given property. Therefore the project is selecting a single most plausible baseline scenario for each strata, but includes multiple strata across the project, and hence multiple baselines. Each project instance is uniquely assigned to a specific baseline scenario strata, and carbon calculations are made and tracked by baseline strata.

VM0012 includes a 3 step process to identify the most plausible baseline scenario:

1. Step 1: Identify at least three (3) plausible alternative Baseline Scenarios to the Project Activity, including at minimum a historical practice and common practice scenarios.

2. Step 2: Select the most plausible Baseline Scenario. The King County Rural Forest Carbon Project is structured to stratify project instances (participating properties) into a set of most plausible baseline scenario strata. Therefore in this step the project is selecting multiple baseline scenarios that are each the most plausible baseline scenario for each strata of project instances in the project geographic area. Each project instance is best fit to the most plausible baseline scenario strata using evidence as described under each baseline scenario below.
3. Step 3: Test the selected Baseline Scenario against the results of the Additionality assessment. This additionality test is applicable to each baseline scenario strata independently.

The King County Rural Forest Carbon Project has identified five (5) potential baseline scenarios that were evaluated in this baseline selection process, of which three (3) have been selected as most plausible baseline strata (Step 2 in VM0012[13]):

Potential Baseline Strata 1 - Historical Practice

A historical practice baseline is required within VM0012 Step 2a. This baseline scenario is applicable when the project instance has at least 5 years of historical management practices for a specific parcel under the current management control/ownership, and no formal change in use plans (such as approved re-zoning, or approved development plans) exist to clearly demonstrate another baseline scenario is more plausible. Under this scenario, the baseline is a customized projection of either the current owners historical harvest levels or most recent forward looking forest management plan. This baseline scenario is Additional (Step 3, VM0012) as per Section 2.5). This baseline has been selected as a most plausible baseline scenario for certain project instances, and is referenced as **Baseline Strata 1 – Custom**.

Potential Baseline Strata 2 – Timber Harvesting for Rural Residential:

This baseline scenario includes properties zoned for development as rural residential land under the King County zoning code[14] (i.e. RA-2.5, RA-5, RA-10, etc.). Generally these are developed for sales as “acreages” with one house per 2.5 or 5 or 10 acres, respectively. Baseline activities under this scenario include preparing the properties for sale as acreages and future development through harvesting or thinning timber (usually with tree retention for regulatory and aesthetic purposes), clearing timber for potential yard/pasture, access roads and future building sites. This is a common occurrence in the King County project geographic area, constituting the Highest and Best Use (HBU) on many property appraisals. When defined as the HBU for the project instance (typically in a 3rd party independent appraisal or similar analysis specific to that property), this scenario

[13] The multiple baseline strata used in this grouped project anticipates baseline scenarios that are consistent with the step-wise baseline selection process in VM0012. As below, project instances with at least 5 years of historical harvest level data (Step 2a) will be considered under Baseline Strata 1 – Custom, where historical harvest levels and management plans may guide the baseline scenario. All other baseline strata follow Step 2c. Step 2b could be considered under Baseline Stata 1 – Custom if prior owners historical harvest levels are deemed most appropriate for that project instance. Any new project instances are assumed to be defined under Step 2c unless otherwise noted in the applicable period Monitoring Report for properties using Baseline Strata 1 – Custom.

[14] The zoning codes for King County can be found at the following link: https://www5.kingcounty.gov/sdc/Metadata.aspx?Layer=zoning

generates the most financially attractive return (Step 2c.1, VM0012), and can be compliant with legal requirements, market capacity, operational practices, and operational feasibility (Step 2c.2, VM0012). This baseline scenario is Additional (Step 3, VM0012) as per Section 2.5). This baseline has been selected as a most plausible baseline scenario for certain project instances in the project, and is referenced as **Baseline Strata 2 – Rural Residential**.

Potential Baseline Strata 3 – Timber Harvesting for Common Practice Forestry:

This baseline scenario include properties zoned for timberland management under the King County zoning code (F), or those for which forest management has been identified as the Highest and Best Use (HBU). Such properties are typically managed for timber production under common practice timber management regimes. Harvesting in the Pacific Northwest is highly mechanized, usually by clearcutting with some tree retention patterns, followed by tree planting. Regional harvesting equipment is versatile (wheeled, tracked, and cable systems are in common use), and capable of operating in most ground conditions. Landowners manage for fast rotation conifer forests based on well-established rotation ages and silvicultural treatments. This baseline scenario is focused on economic efficiency and involves harvesting mature timber as the target rotation age is realized. The proportion of forest area cleared and/or harvested in this scenario is based upon forest regulations, local experience and other regional property data. When defined as the HBU for the project instance (typically in a 3rd party independent appraisal or similar analysis specific to that property), this scenario generates the most financially attractive return (Step 2c.1, VM0012), and can be compliant with legal requirements, market capacity, operational practices, and operational feasibility (Step 2c.2, VM0012). This baseline scenario is Additional (Step 3, VM0012) as per Section 2.5). This baseline has been selected as a most plausible baseline scenario for certain project instances, and is referenced as **Baseline Strata 3 – Forestry**.

Potential Baseline Strata 4 - Development as Suburban Residential

The HBU for this scenario is the conversion of forest for development of the property for densified residential sub-divisions. These can include properties zoned (or re-zoned) for residential land use under the King County zoning code (i.e. R-1, R-4, R-6, etc.). Activities include timber harvesting, clearing of forest biomass, and development of residential structures, yard, roads and other access features. Property appraisals, appropriate zoning approvals, or documented development plans would serve as evidence of this baseline. This potential baseline scenario has been excluded because: 1. In many circumstances potential properties that might fit this baseline would not meet the eligibility criteria of forests remaining forests (i.e. would be forest conversions into housing subdivisions); 2. To date no property appraisals for King County parks acquisition targets have clearly identified re-zoning and development as the most likely highest and best use for land valuation purposes[15]; and, 3. In the case of properties potentially fitting this baseline and eligibility criteria, it is more conservative to include any potential applicable project instances under Baseline Strata 2 – Rural Residential (which results in significantly lower emission reductions claims by the project).

[15] Generally this is due to the uncertainty of successfully re-zoning for suburban development, but also because the lands already zoned or valued as likely developable for this use are well beyond the target value for King County acquisitions.

Potential Baseline Strata 5 – Project Scenario as Conservation-Based Management:

Properties under this baseline scenario would be managed for conservation purposes without carbon finance. This scenario was included to meet mandatory element 2.1.1 a), item ii) in the VCS Additionality Tool VT0001. There are examples of previous land conservation acquisitions by NGO's and State/County government with conservation activities without carbon finance; however, these acquisitions are only completed with grant financing or other non-commercial finance. Without carbon finance, there is no feasible material revenue sources from the land, and no means to generate any rate of return on private capital. This baseline scenario has been excluded because there is no market-based business model under this baseline scenario that would provide reasonable financial returns for private investment capital, and hence there are clearly other more financially attractive baseline scenarios and this scenario is therefore not additional as a baseline scenario.

Baseline Scenario Eligibility - all 5 potential baseline scenarios meet the baseline eligibility requirements listed in VM0012 (under Step 1):

1. Includes activities and areas where forests are remaining forests. All selected baseline scenarios would retain forest (crown cover) of at least 10-30% of the total land area with trees having the potential to reach minimum heights of 2-5m at maturity, as defined in the 2006 IPCC guidelines for National Greenhouse Gas Inventories (p. 4.74)[16].
2. Complies with the legal requirements of forest management and land use in the area – all baseline scenarios could be operated in compliance with Washington State Forest Practices and other related laws and regulations.
3. The projected baseline scenario environmental practices equal or exceed those commonly considered a minimum standard among landowners in the area - all baseline scenarios are consistent with the minimum environmental practices of landowners in the project geographic area.

Project instances are assigned to a best fit Baseline Scenario Strata at the time of entry into the project. The project proponents will provide evidence and justification for the assignment of each project instance to a Baseline Scenario Strata. Evidence can include, but is not limited to, reference to a recent 3rd party appraisal, ownership records and information related to forest management plans and historical harvests, comparable proximal properties in the project geographic area with similar conditions and situations, and/or property specific evaluations/assessments.

2.5 Additionality

As per VM0012, the project has utilized the VT0001 Tool for the Demonstration and Assessment of Additionality in VCS Agriculture, Forestry and Other Land Use (AFOLU) Project Activities v3.0 (Voluntary Carbon Standard, 2012).

[16] Note that the project evaluates a potential baseline scenario (#4) which might result in project instances which do not result in forests remaining forests, and which would therefore not meet this eligibility criteria. This potential baseline scenario has been excluded during the selection process, and included project instances will meet the forest remaining forests criteria in both the baseline and project scenarios throughout the project lifespan.

This PDD meets the eligibility requirements of this tool:

1. The project activities are not in violation of any applicable law;
2. The project followed the VM0012 step-wise method to determine the most plausible baseline scenario for each strata, as per Section 2.4.

Following the VT0001 Tool:

STEP 1a – Identification of plausible baseline scenarios

The project has identified five (5) potential baseline scenarios. See Section 2.4 for further details.

Baseline Scenario Strata 1 – Historical Practice and/or Continuation of Pre-project Land Use and Plans (VT0001 Step 1 a.i). Evidence can include previously developed harvest or development plans/zoning and/or new land use/management plans developed for each applicable project instance that are consistent with regional common practice.

Baseline Scenario Strata 2 - Timber Harvesting for Rural Residential (VT0001 Step 1 a.iii). Substantial evidence of land development for rural residential is available across the project geographic area and clearly visible using Google Earth historical imagery (see, for example, Appendix 2), and supported by project staff observation and other regional land use change studies and data.

Baseline Scenario Strata 3 - Timber Harvesting for Common Practice Forestry (VT0001 Step 1 a.iii). Common practice timber harvesting is widespread across the project geographic area, and various evidence exists including historical Google Earth imagery and WA State harvest permitting records.

Baseline Scenario Strata 4 - Development as Suburban Residential (VT0001 Step 1 a.iii). Substantial evidence of land development for suburban residential is available across the project geographic area and clearly visible using Google Earth historical imagery; and supported by project staff field observation and other regional land use change studies and data.

Baseline Scenario Strata 5 - Project Scenario (without carbon) as Conservation-Based Management (VT0001 Step 1 a.ii; and indirectly a.iii). There are no legal requirements for conservation of forests similar to the project scenario activities. Evidence does exist of forest conservation acquisitions in the project geographic area by NGO’s and government entities, but only using grant or other non-commercial finance.

Step 1b – Legal tests

All plausible baseline scenarios could be undertaken within the legal requirements of private timberland and residential land zoning.

Step 1c – Selection of Most Plausible Baseline Scenario

The outcome for this grouped project is a set of 3 Baseline Scenarios Strata. See Section 2.4 for details. The most suitable baseline scenario is determined for each project instance (participating property) based upon the criteria specified in Section 2.4.

STEP 2 - Investment Analysis

The Project Scenario is clearly less financially attractive than each of the selected Baseline Scenarios Strata. A focus on conservation of ecological values to enhance carbon storage means that commercial returns are highly constrained or non-existent within the Project Scenario for every project instance. Any management activities in the Project Scenario are designed to improve forest ecological function, development and health, and are not driven by commercial objectives. The majority of project instances in the Project Scenario will have no commercial activity affecting carbon stocks and no revenue generating capability to create financial returns. Any commercial timber removals during project activities will (at best) be used to partially offset property, project and/or parkland management costs. Hence, implementing the project scenario will generate materially lower financial returns as compared to the development options that comprise each of the Baseline Scenario Strata.

Step 2a – Analysis Method. The Project Scenario generates no net economic returns, and hence uses the simple cost analysis (Option I).

The conservation-based management baseline (see section 2.4, potential baseline #5) has no commercial activity and thus would not provide any economic returns without carbon revenue. Any conservation-based project activities will not produce any tangible net financial benefits except carbon related income and has been excluded as a baseline scenario in relation to this additionality test.

An example simple cost analysis for a representative project instance(s) is shown in Section 7.1 (Appendix 1).

Step 2b-2d – Not applicable to Option I.

Step 3. Barrier Analysis

The project scenario produces no material financial benefits other than VCS related income. Hence, the additionality analysis can thus proceed to Step 4 (Common practice analysis), as per the VT0001 additionality tool.

However, note that a basic barrier analysis is a supportive extension of the Simple Cost Analysis as it demonstrates an investment barrier to the project without carbon finance: Step 2.3.1 b) i) would apply as similar conservation acquisition activities have only been implemented with grants or other non-commercial finance terms (i.e. obviously commercially driven financing is not available to projects with no revenue and negative returns); and similarly Step 2.3.1 b) ii) would apply, as without economic returns debt funding would also obviously not be available to the project.

Comparably, the baseline scenarios are not subject to these barriers, as evidenced by valuation and returns documented within property appraisals on each project activity.

Step 4. Common Practice Analysis

The Common Practice Analysis is a credibility check on the project's conclusions in the Investment and/or Barrier Analysis. The project is potentially comparable to some forms of forest conservation land acquisitions that occur in the region. Forest conservation in Washington generally takes two forms: 1. a focus on retaining forest as forest/avoiding land conversion, where lands are managed for sustainable timber production and generate revenue and economic returns, and; 2. conservation based on forest protection/park creation where lands are managed for the protection/enhancement of natural functioning ecosystems and do not generate revenue and economic returns. The project activities and economic drivers between these two types of conservation are distinctly different.

Washington Department of Natural Resources (WA DNR) and The Nature Conservancy (TNC), for example, both acquire significant amounts of timberland with the intent of retaining forest cover and preventing land conversion. But both typically manage for timber returns under various management regimes to generate revenues from timber harvesting, and hence have different project activities and different financial conditions. For example, in the case of the WA DNR, forest acquisitions that are part of 'trust' lands are managed for economic return from forest management and timber revenue, which then goes to support various state funding objectives, while 'conservation' lands are acquired for the natural heritage and are non-revenue generating. TNC's property acquisitions in the Northwest since 2000 are all managed for revenue from sustainable timber production. Although conservation oriented, these projects undertake very different project activities (primarily commercial timber harvesting), and generate revenue that creates an economic return and a different investment and barrier analysis outcome.

The King County project is consistent with the second form of conservation as a Logged to Protected Forest project, where project activities do not entail commercial timber harvesting and do not generate net economic returns without carbon.

Therefore, the common practice analysis is focused on identifying and comparing the project to the second form of conservation property where timber harvesting is not a material part of project activities, and the project activities do not generate revenue and economic returns. The project has then undertaken the Common Practice analysis based on two angles: 1) evidence of similar activities by commercial finance; and 2) evidence of similar project activities with non-commercial finance.

Analysis of Common Practice with Similar Non-Revenue Activities

To identify and analyze comparable common practice, the project has undertaken several steps to review professional opinion, anecdotal data, and the available data in Washington. Steps 1-3 in the VT0001 tool perform tests to compare the project activities against indicators of the attractiveness of financial returns of baseline alternatives, as such the project has first looked for evidence of similar project activities (conservation without revenue) using commercial finance; and second looked to compare with evidence of non-commercially driven similar project activities.

1. Comparable commercially financed project activities:

King County and project staff were unable to locate any examples of commercially driven forest conservation in Washington with similar project activities (i.e. no revenue), and no known programs create attractive financial returns from conservation without timber harvest or carbon revenue. This follows the logic that commercial finance is not available for projects without revenue potential.

This is supported by a review of independently prepared property appraisals on the initial 60 project instances. None of the appraisals identified any potential revenue or value derived from conservation of properties without timber or real estate development revenue.

The project has concluded that there is no evidence of commercially driven conservation with similar project activities, which directly supports the conclusions made in the Investment and Barrier Analysis steps.

2. Comparable non-commercial project activities.

Although small scale in relation to commercially driven land transactions, there is evidence of conservation-based acquisition and management similar to the project activities in the region. These lands are acquired by government and not-for-profit organizations using various forms of non-commercial grant and public finance sources.

King County contacted (via phone and email) representatives from the WA DNR, Forterra (a regional NGO), TNC (a national NGO), and the WA Association of Land Trusts, which collectively represent the majority of large-scale expertise in land conservation in Washington.

The respondents all confirmed that there is no database or published information related to conservation timberland acquisition, financing, or management activities in King County or Washington State. Specific data across conservation properties in the region is not tracked or readily available for direct analysis, and the sources/uses of funding and management plans are often proprietary and/or would not be readily available. Therefore the project cannot list or undertake an analysis by comparable property in the region, although certain data was available from WA DNR and TNC, and anecdotally from the other sources.

But these expert sources were able to provide general information on their conservation activities in the region and insights into the general conditions surrounding comparable conservation acquisitions, including:

1. Comparable non-revenue conservation projects are financed using ‘one-off’ grant or government funding that are directed to specific properties, projects, or organizations in a given budget or grant cycle.

The permanent lack of revenue in these types of forest conservation acquisitions means they are only achievable with grant/public funds which are sourced from unique ‘one-off’ pools of grant or public funds that must fully replace the lack of commercial finance. These funds are limited and typically are fully allocated in each funding or budget cycle. Accessing these conservation funds is competitive and difficult, and perpetually underfunded in comparison to demand.

The project therefore cannot access the same funds or programs that are available to other conservation acquisitions once those funds are allocated. King County does compete for these sources of grant capital when feasible and new funds are available, but as outlined below, the project (and all conservation) faces significant funding gaps that create significant barriers to funding new property acquisitions in the project.

2. Comparable non-revenue conservation funding is highly constrained and carbon finance would be beneficial to funding the gap.

Grant and other non-commercial funding is extremely limited in comparison to demand. King County staff and the experts consulted agree that many potentially high value conservation properties are not acquired each year due to a lack of funding; that ongoing property management funding is a significant additional ongoing funding challenge for all conservation organizations; and that carbon finance could be important to enabling and supporting conservation in the region that otherwise would not be funded.

The primary source analysis and data to support these two key observations related to the financing challenges for conservation projects comes from the King County Land Conservation Initiative. In 2018, King County Council approved legislation to protect approximately 65,000 acres of the County's most vulnerable forests (50,000 acres), farmlands and shorelines within 30 years. It is estimated that approximately $1.4 billion will be needed to meet that 30-year goal, of which approximately 80% is likely to come from traditional land conservation sources (e.g., Conservation Futures Tax, King County Parks Levy, Real Estate Excise Tax and state/federal land acquisition grants). The remaining 20% will need to be generated from a number of far less secure and innovative sources, including private philanthropy and capturing value in ecosystem markets, such as carbon. Without those additional funding sources, the conservation goal will not be achieved and high-priority forestland will not be conserved. The December 2017 final report from the King County Land Conservation Advisory Group stated the challenge clearly *"Based on analysis presented by the County, we recommend pursuing the development of these carbon credit and stormwater funding streams, and planning on approximately $33 million…of private funding for conservation priorities from all potential future ecosystem service credit programs over the multidecade timeframe of this initiative. This projected funding cannot be realized without new efforts by the County and its partners in the near-term; these next steps are summarized in Exhibit F"*.[17]

In summary, the Common Practice analysis has shown that a significant portion of conservation in the region has different project activities and financial benefits which make them distinctly different than the project. For conservation properties with similar project activities in the region (i.e. conservation without revenue), there is no evidence of commercial financing or revenue from properties with similar project activities. Further, the project faces barriers in the sourcing and availability of non-commercial funding for the project without carbon finance.

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[17] https://your.kingcounty.gov/dnrp/library/water-and-land/land-conservation/business-documents/king-county-land-conservation-advisory-group-final-report.pdf

The project therefore concludes the Common Practice Analysis is consistent with the findings in the Investment Analysis and supporting Barrier Analysis.

Based on the application of this VCS tool, the King County Rural Forest Carbon Project is Additional.

2.6 Methodology Deviations

The King County project deviates from the methodology VM0012 in that it uses US imperial measures, which are most appropriate for the project location In the United States. Where the methodology references metric units the project has replaced or converted using standard published factors without specific notation. Metric to Imperial conversions are made using standard conversions and applied using settings within GIS software and FVS model outputs. This change does not affect emission reduction calculations.

3 QUANTIFICATION OF GHG EMISSION REDUCTIONS AND REMOVALS

Inventory and modeling are completed simultaneously and using the same inventory, models, and parameters in the Baseline and Project Scenarios. The following sections apply to both scenario unless otherwise specified. Further detail on the calculation GHG emission reductions specifically in each scenario are described in Section 3.1 and 3.2.

Properties Included in Grouped Project

The list of initial project instances (participating properties) is provided in Table 1. A total of 60 parcels encompassing 880.9 acres have been included in the initial project period with property acquisition/participation dates ranging between 2015-2018. Table 1 includes a description of the zoning, project start date by project instance, size, ownership, and assigned baseline strata. A summary of parcels by acquisition date and zoning category is shown in Table 2 and Table 3, respectively.

Table 1. Description of Properties Included as the Initial Project Instances[18].

PIN	Acres	Acquisition ID	Name	Start Date	Zoning[19]	Baseline Strata[20]	Owner
0623069003	3.46	CougS-2015-0623069003	Cougar-Squak Corridor	2015	RA5	Res	KC
2122039117	4.62	DockF-2015-2122039117	Dockton Forest	2015	RA10	Res	KC
2122039118	4.64	DockF-2015-2122039118	Dockton Forest	2015	RA10	Res	KC
2922039006	5.08	DockF-2015-2922039006	Dockton Forest	2015	RA10	Res	KC
2922039007	5.13	DockF-2015-2922039007	Dockton Forest	2015	RA10	Res	KC
2922039026	1.95	DockF-2015-2922039026	Dockton Forest	2015	RA5	Res	KC
2922039027	2.90	DockF-2015-2922039027	Dockton Forest	2015	RA5	Res	KC
1324069042	5.20	DuthH-2015-1324069042	Duthie Hill Park	2015	RA5	Res	KC
7327710080	10.15	GreeR-2015-7327710080	Green River Natural Area	2015	RA10	Res	KC
7327710090	9.97	GreeR-2015-7327710090	Green River Natural Area	2015	RA10	Res	KC
0122029001	5.17	IslaC-2015-0122029001	Island Center Forest	2015	RA5	Res	KC
3123039162	20.03	IslaC-2015-3123039162	Island Center Forest	2015	RA10	Res	KC
1924079091	4.20	MitcH-2015-1924079091	Mitchell Hill Connector Forest	2015	RA5	Res	KC
0523089043	9.61	RattM-2015-0523089043	Rattlesnake Mountain Scenic Area	2015	RA10	Res	KC
0823089003	9.44	RattM-2015-0823089003	Rattlesnake Mountain Scenic Area	2015	RA10	Res	KC
0823089007	19.96	RattM-2015-0823089007	Rattlesnake Mountain Scenic Area	2015	RA10	Res	KC
0823089023	13.99	RattM-2015-0823089023	Rattlesnake Mountain Scenic Area	2015	RA10	Res	KC
2924089002	10.93	SnoqT-2015-2924089002	Snoqualmie Valley Trail Site	2015	RA5	Res	KC
2924089003	15.62	SnoqT-2015-2924089003	Snoqualmie Valley Trail Site	2015	RA5	Res	KC

[18] Future project instances are expected to be added to the project annually as King County acquires new fee simple properties, additional 3rd Party Landowners join the project, etc.

[19] King County Zoning: RA2.5 = Rural Area, one Domestic Unit (DU) per 2.5 acres; RA5 = Rural Area, one DU per 5 acres; RA10 = Rural Area, one DU per 10 acres

[20] Res = Rural Residential Baseline Strata; For = Forestry Baseline Strata

PIN	Acres	Acquisition ID	Name	Start Date	Zoning[19]	Baseline Strata[20]	Owner
2022069035	7.94	CedaC-2016-2022069035	Cedar Creek Park	2016	RA5	Res	KC
2924069011	2.47	CougM-2016-2924069011	Cougar Mountain Regional Wildland Park	2016	RA5	Res	KC
2924069015	4.84	CougM-2016-2924069015	Cougar Mountain Regional Wildland Park	2016	RA5	Res	KC
2922039001	19.70	DockF-2016-2922039001	Dockton Forest	2016	RA10	Res	KC
2522029016	59.95	FrogH-2016-2522029016	Frog Holler Forest	2016	RA10	Res	KC
1824079016	36.63	MitcH-2016-1824079016	Mitchell Hill Connector Forest	2016	RA5	Res	KC
6626300060	4.90	ParaL-2016-6626300060	Paradise Lake Natural Area	2016	RA5	Res	KC
7327710020	9.94	WhitB-2016-7327710020	Whitney Bridge Park	2016	RA10	Res	KC
7327710030	10.04	WhitB-2016-7327710030	Whitney Bridge Park	2016	RA10	Res	KC
0220069009	19.35	BassL-2017-0220069009	Bass Lake Complex Natural Area	2017	RA5	Res	KC
2621069071	8.91	BassL-2017-2621069071	Bass Lake Complex Natural Area	2017	RA5	Res	KC
2621069072	3.40	BassL-2017-2621069072	Bass Lake Complex Natural Area	2017	RA5	Res	KC
2621069073	8.85	BassL-2017-2621069073	Bass Lake Complex Natural Area	2017	RA10	Res	KC
2621069074	8.22	BassL-2017-2621069074	Bass Lake Complex Natural Area	2017	RA5	Res	KC
3224069015	23.18	CougS-2017-3224069015	Cougar-Squak Corridor	2017	RA5	Res	KC
1724079011	10.24	MitcH-2017-1724079011	Mitchell Hill Connector Forest	2017	RA5	Res	KC
2525069011	5.07	SoarE-2017-2525069011	Soaring Eagle Regional Park	2017	RA5	Res	KC
2525069013	20.53	SoarE-2017-2525069013	Soaring Eagle Regional Park	2017	RA5	Res	KC
2525069017	20.43	SoarE-2017-2525069017	Soaring Eagle Regional Park	2017	RA5	Res	KC
2525069018	20.25	SoarE-2017-2525069018	Soaring Eagle Regional Park	2017	RA10	Res	KC
2525069082	4.96	SoarE-2017-2525069082	Soaring Eagle Regional Park	2017	RA5	Res	KC
2525069092	20.16	SoarE-2017-2525069092	Soaring Eagle Regional Park	2017	RA5	Res	KC
2525069093	20.27	SoarE-2017-2525069093	Soaring Eagle Regional Park	2017	RA10	Res	KC

PIN	Acres	Acquisition ID	Name	Start Date	Zoning[19]	Baseline Strata[20]	Owner
2525069094	20.18	SoarE-2017-2525069094	Soaring Eagle Regional Park	2017	RA5	Res	KC
3422079091	8.15	SugaM-2017-3422079091	Sugarloaf Mountain Forest	2017	RA5	Res	KC
2621069011	5.02	BassL-2018-2621069011	Bass Lake Complex Natural Area	2018	RA5	Res	KC
2621069069	5.89	BassL-2018-2621069069	Bass Lake Complex Natural Area	2018	RA5	Res	KC
2621069079	5.79	BassL-2018-2621069079	Bass Lake Complex Natural Area	2018	RA5	Res	KC
0223059001	35.42	CougM-2018-0223059001	Cougar Mountain Regional Wildland Park	2018	RA5	Res	KC
0223059002	35.12	CougM-2018-0223059002	Cougar Mountain Regional Wildland Park	2018	RA5	Res	KC
0223059004	38.74	CougM-2018-0223059004	Cougar Mountain Regional Wildland Park	2018	RA5	Res	KC
2821069004	9.32	FlamG-2018-2821069004	Flaming Geyser Natural Area	2018	RA10	Res	KC
2422029016	38.52	FrogH-2018-2422029016	Frog Holler Forest	2018	RA10	Res	KC
2522029115	12.48	FrogH-2018-2522029115	Frog Holler Forest	2018	RA5	Res	KC
2020079002	47.65	LittL-2018-2020079002	Little Lake Forest	2018	F	For	KC
2020079006	19.83	LittL-2018-2020079006	Little Lake Forest	2018	F	For	KC
2020079007	35.44	LittL-2018-2020079007	Little Lake Forest	2018	F	For	KC
2020079008	36.83	LittL-2018-2020079008	Little Lake Forest	2018	F	For	KC
2020079020	3.18	LittL-2018-2020079020	Little Lake Forest	2018	F	For	KC
2020079023	9.96	LittL-2018-2020079023	Little Lake Forest	2018	F	For	KC
3321069025	5.71	NewaC-2018-3321069025	Lower Newaukum Creek Natural Area	2018	RA10	Res	KC

Table 2. Summary of Property Instances by Start Date.

Start Date	Count	Acres
2015	19	162.1
2016	9	156.4
2017	16	222.2
2018	16	340.3
Total	**60**	**880.9**

Table 3. Summary of Project Instances by Baseline Strata.

Zone	Forestry count	Forestry Acres	Rural Residential count	Rural Residential Acres	All count	All Acres
F	6	152.9	1	20.0	7	172.9
RA10	0	0	20	295.1	20	295.1
RA5	0	0	33	412.9	33	412.9
Total	**6**	**152.9**	**54**	**728.1**	**60**	**880.9**

Development of Forest Inventory

The King County Forest Project has created a forest inventory process based on County and State GIS spatial data, county-wide LiDAR data, high-resolution orthoimagery, and other data to create a consistent forest and carbon inventory across any current or future project instance within the entire project geographic area. To create and simplify the forest inventory across all project instances to support carbon modeling and accounting, the King County Rural Forest Project was first stratified into discrete Analysis Units (AU's) based on leading forest type groupings in which the growth and accumulation of biomass can be expected to be relatively similar. In combination with other spatial and inventory data, each AU can be modeled and monitored for forest growth and carbon biomass accumulations and changes across time in the Project and Baseline Scenarios.

Inventory Spatial Data Resources

The initial step in the preparation of the forest inventory was to assemble the underlying spatial datasets. Specifically, the following spatial data[21] were utilized in the inventory stratification.

1. Lot boundary and property data – GIS shape files of lot boundary data and parcel PIN identification numbers identify the boundary and related property information for each project instance.
2. High Resolution Orthophotos – King County maintains and periodically updates orthophoto imagery across the entire project geographic area. Initial analysis was made using leaf-on and leaf-off conditions from imagery in 2015 and 2017.
3. LiDAR Data - 1m resolution LiDAR data from 2016. King County maintains and periodically updates LiDAR imagery across the entire project geographic area.
4. Various spatial data available that are maintained and periodically updated across the entire project geographic areas by King County and/or the WA DNR, including LiDAR/Ortho-based Canopy (species type) data analysis, various hydrological, slope, landform, and other typical GIS data layers, forest site index, and other spatial data layers. These data are available across the entire project geographic area.

Development of Forest Carbon Analysis Units (AU)

[21] The projected coordinate system of the data is: NAD_1983_HARN_StatePlane_Washington_North_FIPS_4601_Feet

A set of representative forest Analysis Units were developed (Table 4) and manually digitized (using ArcGIS software) after reviewing leaf-on and leaf-off orthophotos, LiDAR data, LiDAR-derived canopy data, other GIS data layers, and from project staff knowledge of the dominant forest types and ecoregions found within King County.

The timber harvesting landbase was established by simultaneously identifying any clearly identifiable/material areas that were not available for harvest (i.e. lakes, wetlands, agriculture, large stream buffers, shoreline buffers, other non-forest landuse types), which were assigned an analysis unit of AU 5[22].

LiDAR data were used to delineate forest polygons by differences in top height, after which these polygons were then sub-stratified by age class and AU forest type (further described below).

A 10 foot by 10 foot point grid was then created across the entire ownership (excluding AU 5) and was intersected with the following GIS layers:

1. Forest polygons – digitized forest polygons
2. Site Class – polygons from state of Washington
3. LiDAR – raster of elevations
4. CANOPY – raster of conifer vs. deciduous cover developed in-house by King County

The resulting point grid was imported into a custom Access database table (the King County Carbon Access Database file) for analysis. The table was used to assign a Site Class and AU designation to each polygon. The AU designation was determined by calculating the percent conifer in each forest polygon using the point grid and the LiDAR-based canopy dataset. A visual check of ortho-imagery was used to assess the forest type assigned by this analysis, and in a few cases data was manually adjusted for obvious errors in interpreting hardwood vs. softwood canopy

The top height for each stand was determined by averaging the 40% highest of the LIDAR height readings in each polygon, excluding all height readings less than 5 feet. The crown cover percent was calculated by determining the proportion of LIDAR heights that were less than 25% of the top height of each stand. The crown cover percent is used as a multiplier against the carbon volumes calculated later to account for actual polygon level stand stocking levels.

All of the area within each parcel (project instance) boundary was identified as belonging to one of the analysis units shown in Table 4. An example of the forest cover mapping for a subsection of the landbase is shown in Section 7.4, Figures A1 and A2. Shape files of the forest cover database and related data layers are available for all initial project instances. A breakdown of forest area for all project instances by analysis unit is provided in Table 5.

Carbon curves were developed for and assigned to each of the analysis units as described below.

[22] Note that the assumed retention and polygon level stocking analysis (discussed below) are used to account for additional small stream buffers, tree retention, and small non-forest areas or unmerchantable areas within each non-AU 5 polygon.

Table 4. Description of Forest Analysis Units Defined in the Project Geographic Area

AU	Name	Description
1	Conifer-dominated	> 75% conifer by volume
2	Conifer-mixed	50 to 75% conifer with deciduous component
3	Deciduous-mixed	50 to 75% deciduous with conifer component
4	Deciduous-dominated	> 75% deciduous by volume
5	Non-forest	Water, agriculture or other non-forest landuse type

Table 5. Example of Area (ac) by Analysis Unit and Age Class for the Initial Project Instances

	Acres by 20 Year Age Classes								
AU	0	1	2	3	4	5	6	7	Total
1	0.0	0.0	0.0	78.4	6.7	2.5	0.0	0.0	87.6
2	0.0	0.0	31.2	58.4	62.8	29.0	7.5	0.0	189.0
3	0.0	0.0	63.7	89.6	90.9	8.2	0.0	0.0	252.4
4	0.0	0.0	66.3	82.8	42.2	29.0	0.0	0.0	220.3
5	131.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	131.0
	131.0	0.0	161.2	309.1	202.7	68.7	7.5	0.0	880.3

Overview of the Application of Forest Modelling tools for Carbon Calculations

Model Selection and Use

The U.S. Forest Service Forest Vegetation Simulator (FVS) Fire and Fuels Extension (FFE) were the principal modelling tools used for the carbon storage and harvested wood products calculations. The FVS FFE[23] model meets all six criteria for model selection as specified in the VM0012 methodology. Additionally, they satisfy the VM0012 preferred criteria. Further detailed information on FVS model can be found at https://www.fs.fed.us/fvs/ (also see Dixon, 2018) and information on the FFE extension model can be found at https://www.fs.fed.us/fmsc/ftp/fvs/docs/gtr/FFEguide.pdf. (also see Rebain, 2015).

Preparation of Stand-level Carbon Curves in FVS

The FVS-FFE model was used to create a series of stand attribute curves for each analysis unit to predict/simulate forest development, merchantable timber volume, and carbon storage and dynamics by carbon pool over time. Data from project inventory monitoring permanent carbon plots (see Section 4.3) were used to set a representative species mix for the four analysis units. The objective was to calibrate the FVS-FFE forest type for each Analysis Unit to generally match the actual species mix found in the carbon monitoring plots (at age ~60 years), which are then being represented by the simplified AU groupings with forest types based on conifer, hardwood leading percentages.

[23] The FVS-FFE model was run using the FVS 'Component Ratio Method' settings (not the Jenkins settings).

Carbon curves were then generated using FVS-FFE for these representative stand types by AU for site class 2 (site 125) and site class 3 (site 104). Site class spatial data was acquired from publicly available WA DNR GIS data downloads.

FVS-FFE is regionally calibrated using selected model Variants and local project instance inventory and location data (i.e. lat/long, elevation, aspect, etc.). The King County project geographic area is covered by two FVS Variants – the Pacific Northwest Coast Variant (PN)[24] (Keyser, 2018) and the Westside Cascades (WC) Variant (Keyser, 2019). The FVS variant map is an estimated spatial extent that is useful in the absence of more refined data. After discussion with the USFS FVS support staff, the primary difference between the applicability of the PN and WC variant is elevation, with the PN variant using lowland Douglas Fir yield curve calibrations, and the WC variant using high elevation Douglas Fir yield curve calibrations. Therefore, the project has further refined the FVS variant map for the project geographic area to apply the PN Variant to project instances occurring below 2000' in elevation, and applying the WC Variant on properties above 2000'[25], as shown in Figure 4.

The FVS-FFE model and applicable Variant calibration was used and each analysis unit and each site class was grown out in 10 year increments for 40 cycles. FVS-FFE is a robust model pre-populated with many well-referenced default settings for the PNW Coast timber variant. These model assumptions, algorithms, and default values are well tested and based on USFS experts, referenced research, and data from the USFS Forest Inventory and Analysis Program (FIA) permanent plots. Unless otherwise specified, the project has used the default parameter settings in FVS and FFE for this forest variant.

All results and outputs from FVS-FFE were exported to the King County Carbon Access Database, where additional analysis and data tracking are completed in this customized database application.

Within the King County Carbon Access Database, each polygon is then assigned to a carbon curve (FVS_Summary table) based on AU, polygon dominant site class, and polygon LiDAR-based average Top Height (a proxy for age), and various baseline and project scenarios modeled along with the resulting carbon balances and flows over time in each scenario.

[24] For the initial verification period the project contains only project instances within the PN Variant area, and less than 2000' of elevation. Future project instances may occur in the WC Variant area, at which time these parcels will be modeled using the same assumptions and processes, but using the WC Variant.
[25] Where project instances occur across the 2000' elevation line, the project will either prorate the parcel area into analysis using each Variant by elevation, or apply the Variant to the entire parcel(s) where field observations indicate the site is more similar to lowland or high elevation conditions.

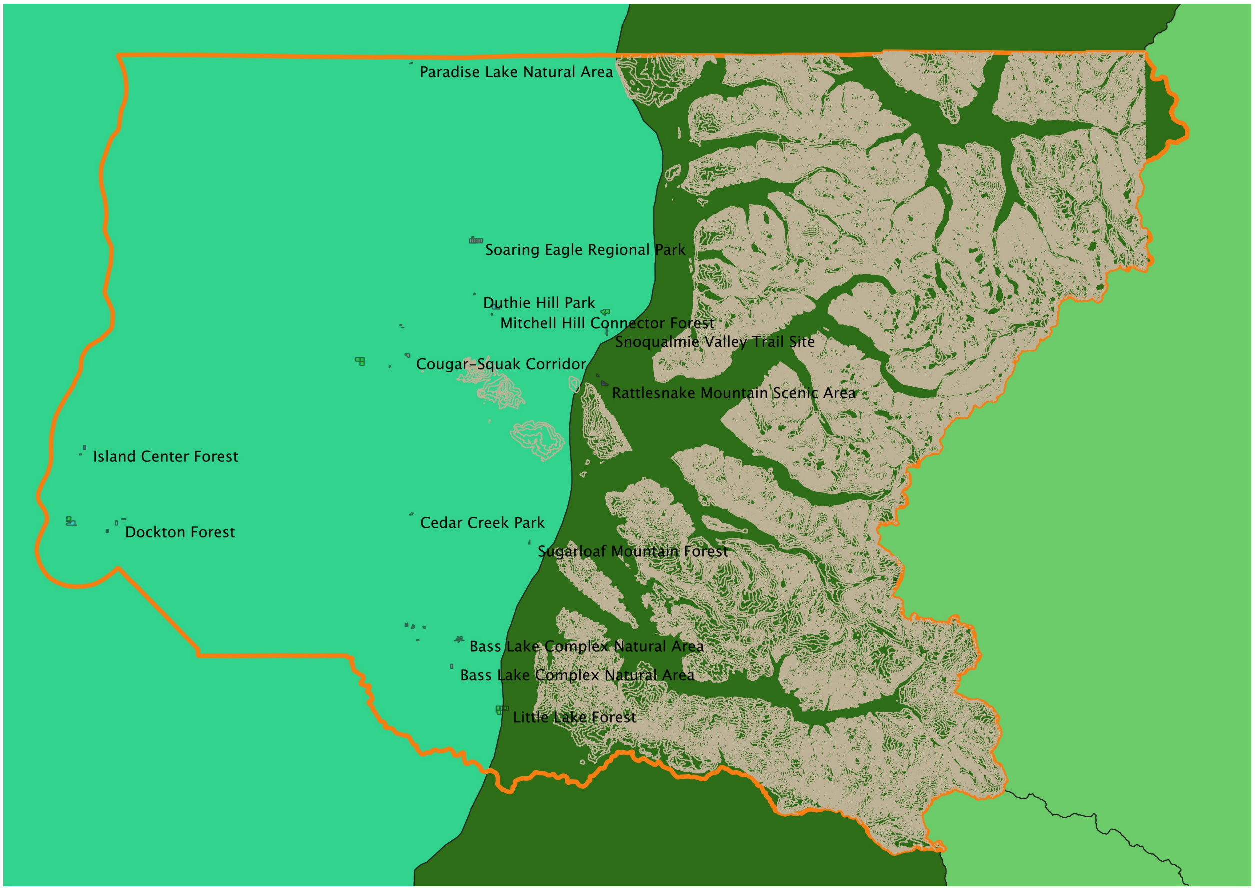

Figure 4. King County FVS-FFE Variant application map showing the overlay of the >2000' elevation lines (tan) over the PN (light green) and WC (dark green) Variant Map.

Overview of Modeling of Biomass Carbon and Harvested Wood Products in FVS-FFE

Biomass Carbon Modeling:

Total biomass flows for each analysis unit were calculated using equations embedded in the FVS FFE and output by representative carbon curves and tracked by carbon pool. The FVS model simulates detailed forest growth and development over time, and the FFE extension links this forest development to detailed biomass accumulation and decay functions to track carbon biomass by pool through time. The PN Variant includes widely accepted and referenced default parameters well suited to the project geographic area.

Forest carbon pools are divided into seven categories in the FVS FFE extension, of which this project considers the following five carbon pools:

1. Standing live trees (above ground) (and the subset Merchantable Carbon pool)
2. Below ground live

3. Standing dead trees
4. Below ground dead
5. Downed dead wood

The FVS FFE extension simulates and tracks carbon pool estimates and dynamics by AU and period, which are then output into the King County Carbon Database for further summary and analysis by these carbon pools, polygon and year under the baseline and project scenarios described below.

Harvested Wood Product Modeling:

The FFE extension calculates and tracks harvested wood products in six pools based on the data found in the "1605(b)" referenced in VM0012 (Smith, et al 2006). However, these calculations do not match the requirements listed in the VCS AFOLU Guidebook (specifically for the treatment of the landfill pool), nor the VCS AFOLU and VM0012 approach to use short-, medium-, and long-lived harvested wood product pools. Therefore, the FFE calculations have been mostly replaced with the following:

VM0012 requires calculation of 3 harvested wood pools:

1. Short-lived wood products (SL HWP), which are defined as wood products in use for <3 years; and assumed to be emitted immediately.

2. Medium-lived wood products (ML HWP), which are defined as wood products in use for 3-100 years; and assumed to be emitted on a 20 year straight line decay curve

3. Long-lived wood products (LL HWP), which are wood products in use for 100+ years.

Note products in landfill are assumed to be "in use" and treated as per these 3 HWP pools.

Smith, et al (2006) provides a methodology and reference tables and factors to calculate all harvested wood products pools as described further in Section 3.1. The result is a fraction of the harvested wood products being emitted or stored annually based on each In-Use category based on product, decay and storage factors in Smith, et al (2006) and the approach in VM0012.

These HWP modelling calculations are applied equally to any timber harvesting in either the Baseline or Project Scenario.

Overview of Baseline and Project Scenarios using FVS-FFE Outputs and a Microsoft Access Database Application

A custom Microsoft Access database application (the King County Carbon Access Database) was developed to house the data and perform and track the carbon modeling results by polygon and carbon pool over time and across the Baseline Scenario (and Project Scenario) activities by project instance. Data from the FVS-FFE output Stand Carbon Report and Harvested Wood Products Report were imported into this Access application. These carbon reports consist of tables that contain carbon pool and harvested wood products pool information in 10 year increments across both site classes and all four analysis units, which are interpolated evenly to 1 year increments when necessary. They include both project and baseline scenarios. Polygon-based forest inventory data, exported from ArcGIS in a tabular format, were used to spatially drive the model. Each polygon included the following information: polygon area, the assigned analysis unit (Table 4), top height (derived from LiDAR), crown cover % (derived from LiDAR-based Canopy layer), and the parcel identification number (PIN). The PIN field was used to link each specific polygon with other descriptive tables including ownership, acquisition/participation year, and a given baseline scenario (Table 6). The analysis unit field was used in combination with polygon area, top height (and stand age, by proxy), and crown cover to match up the modeled polygon forest to the correct carbon yield curve data.

The FVS-FFE derived stand and carbon curves are modeled on an assumed fully stocked representative stand in each AU. A polygon specific crown closure adjustment factor was developed based on GIS analysis of LiDAR data and applied to the carbon and merchantable volume outcomes for each polygon based on the analyzed percentage of full stocking. The model includes discrete sections that represent the project and specific baseline activities (the proportions of clearing, harvesting, and retention). The King County Carbon Access Database then simulates and tracks the fate of carbon in all applicable carbon pools over time by polygon, including for HWP after any scheduled or monitored activity in either scenario. Carbon calculations can then be summarized for the project and baseline scenarios for each project year across all project instances.

3.1 Baseline Emissions

Baseline emissions are calculated against all project instances by applying a Baseline Scenario Strata to each, and then modeling the baseline activities and the related carbon flows using FVS-FFE and the King County Carbon Access model. The methods described are equivalent to the equations and processes outlined in VM0012.

Development of Baseline Strata Scenario Assumptions and Sub-Scenarios

For each Baseline Scenario Strata (as described in Section 2.4), a set of assumed baseline activities was developed based on common practice, analysis of comparable proximal property developments (see Section 7.2 (Appendix 2)), property appraisal documents, and project staff professional judgement. The Rural Residential baseline scenario was further broken into 'sub-scenarios' that further refine baseline activities based on property zoning (i.e. the number of developable units per acre logically affects the proportion of property developed, etc.). Each project instance is assigned to both a Baseline Scenario Strata (see Table 1).

Each Baseline Scenario Strata has different proportions allocated to expected baseline management activities on a per acre basis by polygon as shown in Table 6 under the following assumptions[26]:

[26] Note that these baseline management activities are assumed to be implemented on average across all eligible project instances, and would be expected to be variable on any specific property or area, but representative on average across all properties.

1. Clear – these areas are cleared of biomass in preparation[27] for future rural residential development of permanent structures, roads, lawns, gardens, pastures and other open spaces. These areas are assumed to be clearcut and not re-grown. Resulting harvested wood products are tracked normally, while non-merchantable biomass is assumed cleared and emitted immediately.
2. Harvest – these areas are assumed harvested when of mature timber age (defined as > 40 years old[28]), and then re-planted to meet minimum regulatory requirements primarily to Douglas-fir (with some bigleaf maple, red alder). All resulting carbon pool dynamics (including forest re-growth) and harvested wood products are tracked over time. Although the harvest is simplified to represent a clearcut area in modeling, this harvest removal also is representative of single tree and/or group selection harvests that impact an equivalent volume of biomass as a clearcut when aggregated.
3. Retention – this proportion of the area is assumed to be retained as fully (currently) stocked, and forest growth and related carbon dynamics tracked over time. These retention areas conservatively represent, on average, regulatory single tree retention requirements, in-polygon fish stream and waterbody buffering requirements, aesthetic retention, etc.

All baseline management activities are assumed to occur/begin 1 year after the project instance is incorporated into the project (i.e. typically this is the date of acquisition for King County owned properties, or date of joining the project for 3rd Party Landowners).

Table 6. Baseline Activity Descriptions by Baseline Scenario Strata (see Section 2.4). The proportion (%) by Activity is applied on a polygon and area basis to AU1-4 (AU 5 areas are additionally fully retained).

Strata Number	Baseline Strata[1]	Zoning	Clear	Harvest	Retention
1	Historical/Custom	Any	Custom[29]	Custom	Custom
2	Forestry	F[30] or Any	5%	80%	15%
3a	Rural Residential	RA10	40%	20%	40%
3b	Rural Residential	RA5	45%	15%	40%
3c	Rural Residential	RA2.5	50%	15%	35%

[27] Note the project does not contemplate the conversion of these areas from forest to non-forest, but rather anticipates the removal of above-ground biomass to prepare future sale or development of rural residential areas. Specifically, these "Clear" areas are still forest remaining forest in the context of each development parcel overall.
[28] On the Forestry Baseline Scenarios, harvests occur when polygons reach Age 40. On Rural Residential Baseline Scenarios harvests occur at the current polygon age as the harvesting is more related to preparing the site for residential usage. There are no sub-merch age stands in the initial project instances, but if present the harvesting assumed in these situations would generally represent even or uneven pre-commercial or commercial thinning.
[29] Baseline Scenario Strata 1 – Custom is a customizable baseline with parameters determined from specific project instance historical practice or management plans. Each property in this baseline strata will have documentation and rationale supporting the customized baseline scenario parameters.
[30] The Forestry baseline is not limited to properties zoned F, and it is possible that certain properties zoned as RA2.5, RA5, or RA10 are best fit to the Forestry Baseline scenario based on property specific conditions.

Calculating Baseline Scenario Live Biomass Gain

Live biomass gain ($\Delta C_{BSL,G,t}$, Eqn 4,5a-b[31]) is calculated by FVS-FEE based on the project geographic area stratifications, regionally specific forest dynamics (PN or WC Variant), and the related carbon curves discussed above, and tracked and reported by carbon pool (Aboveground Live, Belowground Live), and reported in the Stand Carbon Report, which is then tracked by polygon, by year in the Access database. Additional details about related model default values, functionality, and parameters are found in Rebain (2015), Dixon (2018) and Keyser (2018).

Calculating Baseline Scenario Live Biomass Loss

Live biomass loss ($\Delta C_{BSL,L,t}$, Eqn 6,7,8,9) is calculated by FVS-FFE based on the project geographic area stratifications, regionally specific forest dynamics (PN or WC Variant) and the related carbon curves discussed above. Default parameters and algorithms within FVS-FFE model and track all stand dynamics, including natural tree mortality, harvesting scenario fellings/removals, blowdown, and any other biomass loss. Generally mortality related live biomass is shifted into dead biomass pools by FVS-FFE (Aboveground Standing Dead (snags), Aboveground Downed and Dead Wood (DDW), Belowground Dead), which are reported in the Stand Carbon Report. Harvesting related biomass loss is tracked and reported as Biomass Removed (Stand Carbon Report) and Merch Carbon Removed (Harvested Products Report) by FVS-FFE. Additional details about related model default values, functionality, and parameters are found in Rebain (2015), Dixon (2018) and Keyser (2018).

Calculating Baseline Scenario Dead Organic Matter Dynamics

Dead organic matter dynamics ($\Delta C_{BSLDOM,t}$, Eqn 10,11a-b,12,13,14a-b,15,16,17a-d) are calculated by FVS-FFE based on the project geographic area stratifications, regionally specific forest dynamics (PN or WC Variant) and the related and carbon curves discussed above. Default parameters and algorithms within FVS-FFE model and track all stand dead wood dynamics, including standing dead, downed dead, and below ground dead organic matter. FVS-FFE uses the PN or WC Variant data and related parameters to model and track dead organic matter between carbon pools[32] (Aboveground Dead (i.e. Snags), Belowground Dead, DDW (VM0012 calls this LDW)), and decay within each pool. Additionally FVS-FFE tracks dead organic matter dynamics related to harvesting or other events when applied. The project uses the default decay factors and dead matter dynamics that are set within the FVS-FFE model and specific to the PN or WC Variant dataset. The results of fdead organic matter dynamics are reported in the Carbon Stand Report, and tracked by polygon and year within the project Access database. Additional details about related model default values, functionality, and parameters are found in Rebain (2015), Dixon (2018) and Keyser (2018). Generally carbon stocks are transitioned between dead biomass pools, and emitted as they decayed.

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[31] See also Appendix 5 for further discussion of VM0012 equations references.

[32] Note that although FVS-FFE also tracks and reports on Forest Floor (litter) carbon, this pool is not included in the project carbon calculations.

Calculating Baseline Scenario Harvested Wood Products (HWP)

Harvested Wood Product dynamics ($\Delta C_{BSLHWP,t}$, Eqn 18,19,20,21,22,23a-c,24) are calculated with a combination of FVS-FFE output and additional calculations in the project Access database following regional factors derived from Smith, et al (2006)[33]. FVS-FFE uses the Smith, et al (2006) data and approach in calculating the Harvested Wood Products Report. As noted above, this report does not match the requirements of VM0012, and as such the project has adapted FVS-FFE outputs for application against the relevant factors in Smith, et al (2006) to follow VM0012.

The project utilizes FVS-FFE data to begin the HWP calculations and to connect to FVS-FFE carbon pool tracking and reporting, then transitions into using the Smith, et al (2006) data and factors. The project starts with Merch Carbon Removed (from the FFE Harvested Wood Products Report output) as a starting HWP removal quantity, which is then tracked by polygon and year in the Access database. FVS-FFE outputs HWP using the same categories and measures for product type categories described in VM0012 Step 1, and uses species specific wood densities.

Note this is conservative as Merch Carbon Removed is a gross carbon volume in merchantable log sizes (before deductions for waste and utilization), whereas the Smith analysis starts with removed timber volume (i.e. after waste and utilization). All table references below are from Smith, et al (2006) which are the equivalent tables referred to in VM0012.

The project also uses FVS-FFE data to calculate actual average stand species percentages by Analysis Unit for a more accurate calculation than the regional forest type factors given Table.

From there, HWP are then calculated using Smith, et al (2006) data using the following factors for Pacific Northwest West:

1. Table 4 – Fraction of Softwood growing stock volume that is sawtimber. The Alder-Maple forest type is applied to Analysis Units 3 & 4, while the Douglas-fir forest type is applied to AU 1 & 2. This calculates tC by product type – sawlog and pulpwood.
2. Table 4 – Fraction of Hardwood growing stock volume that is sawtimber. The Alder-Maple forest type is applied to Analysis Units 3 & 4, while the Douglas-fir forest type is applied to AU 1 & 2. This calculates tC by product type – sawlog and pulpwood.
3. Table 5 – the Pacific Coast factors were applied from the 4th column – Ratio of industrial roundwood to growing-stock volume removed as roundwood. This calculates a net down from roundwood removed from the site and roundwood processed in manufacturing, by product type and species group, and results in the amount of carbon In-Use by species and product type.
4. Table 6 – the Pacific Northwest, West, Softwoods, Saw Logs and Pulpwood; along with the Pacific Northwest, West, Hardwood tables were applied. The respective volumes calculated by species type and product above (noting hardwood sawlog and pulpwood are added back together to use these tables). For each of the following the factor found in

[33] Smith, et al (2006) is this document is the same as the documents referenced related to “1605(b)” in VM0012 as recognized in VM0012 Footnote 22. Note referenced tables and data are the same, but table numbers differ.

the relevant In Use column is added to the factor found in the relevant Landfill column, as per VCS AFOLU requirements. Then the following calculations were made:

a. Short-lived HWP – multiplied (1 – Year 3 look-up factor) for each of the tables against the respective remaining In-Use carbon volumes. This calculates the fraction of net Merch Carbon Removed that is In-Use as Short-lived HWP. Following VM0012, the sum of all Short-lived HWP is assumed to be emitted immediately.

b. Long-lived HWP – applied the look-up factor for Year 100 for each of the tables against the respective remaining In-Use carbon volumes. This calculates the fraction of net Merch Carbon Removed that is In-Use as Short-lived HWP. Following VM0012, the sum of all Long-lived HWP is assumed to be permanently stored.

c. Medium-Lived HWP – the difference between the carbon remaining In-Use at Year 3 and at Year 100 is then calculated using each table look-up factors and carbon volumes, respectively to calculate the Medium-Lived HWP. The sum of all Medium-Lived HWP is then modelled to emit on a straight line 20-year decay curve, starting in year 0 and being fully emitted in year 20.

d. Note that the remaining Merch Carbon Removed after accounting for Short-, Medium-, and Long-lived HWP is emitted immediately as a combination of emissions due to waste carbon being used for Energy and Emitted w/o Energy.

These calculations and related tracking by polygon and year are made in the King County Carbon Access Database.

Note that the project has not included the optional emissions from equipment fossil fuels ($\Delta C_{BSL,EMITFOSSIL,t}$, Eqn 25,26a-b,27), and any related variable is assumed to be zero.

Baseline Scenario GHG Emissions Calculation Summary

The FVS-FFE model and the King County Carbon Access Database were used in combination with the spatial forest inventory data to calculate and track all annual changes in both the live biomass ($\Delta C_{BSL,LB,t}$) and dead organic matter pools ($\Delta C_{BSL,DOM,t}$) for the baseline scenario in a manner consistent with the formulas in VM0012. Changes in carbon storage in harvested wood products ($\Delta C_{BSl,HWP,t}$) and summarized net carbon balances and other deductions and buffer discounts were determined within the King County Carbon Access Database application.

The total annual carbon balance in year, t, for the baseline scenario (∆CBSL,t, in t C yr-1) was calculated as:

$$\Delta C_{BSL,t} = \Delta C_{BSL,P,t} \qquad (1)$$

where:

∆CBSL,P,t is the annual change in carbon stocks in all pools in the baseline across the project activity area (including all project instances); t C yr-1.

The annual change in carbon stocks in all pools in the baseline across the project activity area ($\Delta C_{BSL,P,t}$; t C yr^{-1}) was calculated as:

$$\Delta \mathbf{C_{BSL,P,t}} = \Delta \mathbf{C_{BSL,LB,t}} + \Delta \mathbf{C_{BSL,DOM,t}} + \Delta \mathbf{C_{BSl,HWP,t}} \quad \textbf{(2)}$$

where:

$\Delta C_{BSL,LB,t}$ = annual change in carbon stocks in living tree biomass (above- and belowground); t C yr^1

$\Delta C_{BSL,DOM,t}$ = annual change in carbon stocks in dead organic matter; t C yr^{-1}

$\Delta C_{BSl,HWP,t}$ is the annual change in carbon stocks associated with harvested wood products, t C yr^{-1}.

The annual change in carbon stocks in living tree biomass (above- and belowground) in the baseline scenario ($\Delta C_{BSL,LB,t}$; t C yr^{-1}) was calculated as:

$$\Delta \mathbf{C_{BSL,LB,t}} = \Delta \mathbf{C_{BSL,G,t}} - \Delta \mathbf{C_{BSL,i,t}} \quad \textbf{(3)}$$

where:

$\Delta C_{BSL,G,t}$ = annual increase in tree carbon stock from growth; t C yr^{-1}

$\Delta C_{BSL,L,t}$ = annual decrease in tree carbon stock from a reduction in live biomass; t C yr^{-1}.

The annual change in carbon stocks in dead organic matter (DOM) ($\Delta C_{BSL,DOM}$; t C yr^{-1}) in the baseline scenario was calculated as:

$$\Delta \mathbf{C_{BSL,DOM,t}} = \Delta \mathbf{C_{BSL,LDW,t}} + \Delta \mathbf{C_{BSL,SNAG,t}} + \Delta \mathbf{C_{BSL,DBG,t}} \quad \textbf{(10)}$$

where:

$\Delta C_{BSL,LDW,t}$ = change in lying dead wood (LDW) carbon stocks in year, t; t C yr^{-1}

$\Delta C_{BSL,SNAG,t}$ = change in snag carbon stock in year, t; t C yr^{-1}

$\Delta C_{BSL,DBG,t}$ = change in dead below-ground biomass carbon stock in year, t; t C yr^{-1}.

The annual change in emissions associated with the production of harvested wood products (HWP), $\Delta C_{BSl,HWP,t}$, is calculated as:

$$\Delta \mathbf{C_{BSl,HWP,t}} = \Delta \mathbf{C_{BSL,STORHWP,t}} - \Delta \mathbf{C_{BSL,EMITFOSSIL,t,}} \quad \textbf{(18)}$$

$\Delta C_{BSL,STORHWP,t}$ = the annual change in harvested carbon that remains in storage after conversion to wood products (t C yr^{-1})

$\Delta C_{BSL,EMITFOSSIL,t}$ = the annual change in fossil fuel emissions from harvesting (logging and log transport) and processing of the various wood products. The project has not included the optional equipment emissions carbon pool and hence this variable = 0.

3.2 Project Emissions

Project emissions and carbon flows are calculated in the same manner as the baseline emissions discussed in the Section 3.1, using the same project instances (Table 1), forest inventory data, analysis units and polygons, and modeling tools under the Project Scenario activities. Project and Baseline Scenarios and polygon versions of each are tracked and calculated simultaneously in the King County Carbon Access Databases using the same parameters, outputs, and analysis under each scenario. In the project scenario, carbon flows are modeled using project activities on each project instance.

The were no project activities affecting GHG emissions on the project instances included during the initial project period (2015-2018), and no project scenario activities were projected on an ex-ante basis. Future years may include various project forest management activities that affect ex-post carbon stock and that will be monitoring and reported on in future verifications. Project activities will be based on actual monitoring results (see Section 4) and any resulting emissions netted against emission reductions.

The methods described are equivalent to the equations and processes outlined in VM0012.

Development of Project Scenarios and Assumptions

Currently the project scenario is modeled as conservation with no project activities affecting carbon stocks other than normal forest growth and development as modeled by FVS-FFE on an ex-ante basis.

Determination of Actual Onsite Carbon Stocks

Ex-ante Project Scenario carbon stocks are calculated in the same manner as the baseline emissions discussed in the Section 3.1, using the same forest inventory data, analysis units and polygons, and modeling tools under the Project Scenario activities. Project and Baseline Scenarios and polygon versions of each are tracked and calculated simultaneously in the King County Carbon Access Databases using the same parameters, outputs, and analysis under each scenario.

Ex-Post Calculations of Carbon Stocks

Ex-post carbon stocks in the Project Scenario are determined at each verification following the steps outlined in VM0012. Each monitoring report will detail the data and calculations for ex-post onsite carbon stocks at the time of verification. However, as the project start date (2015) is prior to validation, the initial period (2015-18) ex-ante carbon stocks are also the ex-post carbon stocks. Project carbon stocks from 2019 forward are on an estimated ex-ante basis.

The ex-post carbon calculations are made for the Baseline and Project Scenarios as outlined in Section 3.1 and 3.2, with updates to carbon inventory, spatial data, project instances, and other data for each verification period.

For the 2015-2018 period, the project begins from, and carbon stocks are calculated from, the latest set of inventory and spatial data, which inherently include ex-post monitoring for that period. 35 permanent carbon plots were installed in 2018-2019 (See Section 4.1) with representation across all Analysis Units to monitor inventory and model accuracy. Additional permanent carbon plots may be installed to improve inventory accuracy, spatial coverage, and Analysis Unit representation prior to initial verification in 2019. The initial ex-post carbon stock spatial forest inventory and analysis is using the latest available ortho-imagery, LiDAR data, and other GIS datasets, in conjunction with King County staff periodic field supervision and site visits to confirm the current status of project activities and disturbances during the initial period. The modeling related to these data has been applied across both the Project Scenario and Baseline Scenarios. The uncertainty calculations (see below) in the first verification period are up to date for the latest inventory plot data and modeling results.

In future verification periods the project will calculate ex-post carbon stocks by first adding any new project instances that have been acquired or joined the project during the verification period, then will update the forest inventory and carbon modeling results across all project instances in that period, including for any other monitoring results updates, as described in Section 4.3. Additional carbon plots may be installed to improve inventory accuracy, spatial coverage, and/or Analysis Unit representation as new project instances are added to the project. Ex-post carbon calculations will be undertaken using the latest imagery, LiDAR, and GIS datasets for the project geographic area. Project activities and disturbances will be monitored by remote sensing or field visits and updated into the forest inventory prior to the following verification period. All modeling and inventory updates and calibrations will be applied equally across the Project and Baseline Scenarios. The uncertainty factor, leakage assessments, and non-permanence risk factors will be recalculated using the latest forest inventory, plot data, and project information.

Calculations of ex-post carbon stocks ($C_{ACTUAL,i,t}$) are made within FVS-FFE using ex-post data as per VM0012 equations 28a-e, as equivalent to the following:

Calculating Project Scenario Live Biomass Gain

Live biomass gain ($\Delta C_{PRJ,G,t}$, Eqn 32,33a-b) is calculated the same as in the Baseline Scenario, Section 3.1, using project scenario polygons and data.

Calculating Project Scenario Live Biomass Loss

Live biomass loss ($\Delta C_{PRJ,L,t}$, Eqn 34,35,36,37) is calculated the same as in the Baseline Scenario, Section 3.1, using project scenario polygons and data.

Calculating Project Scenario Dead Organic Matter Dynamics

Dead organic matter dynamics ($\Delta C_{PRJ,DOM,t}$, Eqn 38,39a-b,40,41,42a-b,43,44,45a-d) are Calculated the same as in the Baseline Scenario, Section 3.1, using project scenario polygons and data.

Calculating Project Scenario Harvested Wood Products (HWP)

Harvested Wood Product dynamics ($\Delta C_{PRJ,HWP,t}$, Eqn 46,47,48,49,50a-c,51) are calculated the same as in the Baseline Scenario, Section 3.1 with respect to any timber harvesting in the project scenario. Currently there is no timber harvesting in the project scenario, although it may occur in the future. Note that the project has not included the optional emissions from equipment fossil fuels ($\Delta C_{PRJ,EMITFOSSIL,t}$, Eqn 52,53,54,55), and any related variable is assumed to be zero.

Project Scenario GHG Emissions Calculation Summary

The FVS-FFE model and the King County Carbon Access Database were used in combination with the spatial forest inventory data to calculate and track annual changes in both the biomass ($\Delta C_{PRJ,LB,t}$) and dead organic matter pools ($\Delta C_{PRJ,DOM,t}$) for the project scenario. Changes in carbon storage in harvested wood products ($\Delta C_{PRJ,HWP,t}$) and summarized net carbon balances and buffer discounts were determined within the King County Carbon Access Database application.

The total annual carbon balance in year, t, for the project scenario ($\Delta C_{PRJ,t}$, in t C yr^{-1}) was calculated as:

$$\Delta \mathbf{C}_{PRJ,t} = \Delta \mathbf{C}_{PRJ,P,t} \qquad \textbf{(29)}$$

where:

$\Delta C_{PRJ,P,t}$ is the annual change in carbon stocks in all pools in the baseline across the project activity area; t C yr^{-1}.

The annual change in carbon stocks in all pools in the project scenario across the project activity area ($\Delta C_{PRJ,P,t}$; t C yr^{-1}) was calculated as:

$$\Delta \mathbf{C}_{PRJ,P,t} = \Delta \mathbf{C}_{PRJ,LB,t} + \Delta \mathbf{C}_{PRJ,DOM,t} + \Delta \mathbf{C}_{PRJ,HWP,t} \qquad \textbf{(30)}$$

where:

$\Delta C_{PRJ,LB,t}$ = annual change in carbon stocks in living tree biomass (above- and belowground); t C yr^{1}

$\Delta C_{PRJ,DOM,t}$ = annual change in carbon stocks in dead organic matter; t C yr^{-1}

$\Delta C_{PRJ,HWP,t}$ is the annual change in carbon stocks associated with harvested wood products, t C yr^{1}.

The annual change in carbon stocks in living tree biomass (above- and belowground) in the project scenario ($\Delta C_{PRJ,LB,t}$; t C yr^{-1}) was calculated as:

$$\Delta \mathbf{C}_{PRJ,LB,t} = \Delta \mathbf{C}_{PRJ,G,t} - \Delta \mathbf{C}_{PRJ,L,t} \qquad \textbf{(31)}$$

where:

$\Delta C_{PRJ,G,t}$ = annual increase in tree carbon stock from growth; t C yr^{-1}

$\Delta C_{PRJ,L,t}$ = annual decrease in tree carbon stock from a reduction in live biomass; t C yr^{-1}.

The annual change in carbon stocks in dead organic matter (DOM) ($\Delta C_{PRJ,DOM}$; t C yr^{-1}) in the project scenario was calculated as:

$$\Delta \mathbf{C}_{PRJ,DOM,t} = \Delta \mathbf{C}_{PRJ,LDW,t} + \Delta \mathbf{C}_{PRJ,SNAG,t} + \Delta \mathbf{C}_{PRJ,DBG,t} \qquad \textbf{(38)}$$

where:

$\Delta C_{PRJ,LDW,t}$ = change in lying dead wood (LDW) carbon stocks in year, t; t C yr^{-1}

$\Delta C_{PRJ,SNAG,t}$ = change in snag carbon stock in year, t; t C yr^{-1}

$\Delta C_{BSL,DBG,t}$ = change in below-ground carbon stock in year, t; t C yr^{-1}.

The annual change in the carbon stored in harvested wood products (HWP), ($\Delta C_{PRJ,HWP,t}$; t C yr^{-1}) in the project scenario was calculated as:

$$\Delta C_{PRJ,HWP,t} = \Delta C_{PRJ,STORHWP,t} - \Delta C_{PRJ,EMITFOSSIL,t}, \quad (46)$$

$\Delta C_{PRJ,STORHWP,t}$ = the annual change in harvested carbon that remains in storage after conversion to wood products (t C yr^{-1})

$\Delta C_{PRJ,EMITFOSSIL,t}$ = the annual change in fossil fuel emissions from harvesting (logging and log transport) and processing of the various wood products. The project has not included the optional equipment emissions carbon pool and hence this variable = 0.

3.3 Leakage

Activity-shifting leakage

As per VM0012, the project does not employ activity-shifting mitigation or monitoring processes. Instead, participating project instances will demonstrate, by owner or controlling interest, that no activity shifting leakage is occurring to other properties controlled by that owner.

The project will report on the commercial harvesting activity of each owner for each verification period. Where commercial harvesting has occurred, the project will provide additional evidence that there has been no activity shifting leakage related to that harvest.

Market leakage[34]

VM0012 provides three options for the calculation of market leakage. The project has selected to apply the most current VCS market leakage tool (VCS AFOLU Guidelines v3.6, Page 26[35]).

Determining the Market Leakage Discount Factor ($MLf_{,y}$)

The VCS method involves assessing the ratio of merchantable biomass to total biomass in the project to the same ratio for the expected likely leakage area. The project has selected the State of Washington as the likely leakage area for the purpose of this calculation, as Washington is likely representative of the similar pacific coastal forest types across the Pacific Northwest.

The project leakage ratio is calculated using the FVS-FFE model to calculate the Merch Tree Biomass[36] and sum of the Aboveground Live and Belowground Live carbon pools from the actual carbon inventory plot data. The result of this calculation is a ratio of 0.588 at the time of validation.

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[34] Note that, as per Section 1.13, the project anticipates the possibility of developing a market leakage mitigation factor as part of the project design. This may be developed for a future verification. This additional process may result in modifications to the Market Leakage calculations or an adjustment thereafter.
[35] Alternatively, the latest version of the VCS Market Leakage defaults can be found in Table 2, VCS Standard v4.0 (page 36).
[36] The project notes that the Merch Biomass calculation in FVS-FFE is a raw log volume and does not account for operational utilization, waste, breakage or other factors relevant to the actual production of harvested volume from the project geographic area. These factors are important to the intent of this ratio and the project may choose to alter the ratio calculation method at a later verification to refine this leakage calculation include these factors.

The leakage area ratio is derived using the USFS FIA Database Evalidator tool[37], which produces comparable summarized regional data from the USFS National FIA inventory database. The tool outputs Merch Biomass and Aboveground and Belowground Total Biomass. Using Washington State as the area, and the Douglas-fir Forest Type, the resulting ratio is 0.661.

The VCS Market Leakage Tool specifies that if the ratio of the leakage area is higher than the project ratio, then the market leakage rate is 20%[38].

Therefore, the Market Leakage Discount Factor (MLF_y) was set to **0.20**

Equation 56 is used to calculate the market leakage for the project (LE_y, t CO_2e yr^{-1}):

$$\mathbf{LE_y = MLF_y \cdot ER_{y,GROSS}} \quad \textbf{(56)}$$

Where,

MLF_y = Market leakage factor, as determined above (dimensionless).

$ER_{y,GROSS}$ = the gross difference in the overall annual carbon change between the baseline and project scenarios in year 'y' (in tonnes CO_2e yr^{-1}). This term is calculated in equation 57.

3.4 Net GHG Emission Reductions and Removals

Calculation of the Uncertainty Factor[39]

As per the methodology monitoring section specification, the project has installed at least one field plot in each Analysis Unit (except AU 5, the non-timber harvesting landbase). The project has installed 38 permanent carbon plots in 2018 and 2019.

The project-level uncertainty factor is calculated by a function within the King County Carbon Access Database, following the formulas below:

Step 1 – the project calculated the average percent model error (E_M) for the project based on the average area-weighted difference between measured values in monitored plot observations and model-predicted values using Equations 60a,b.

$$\mathbf{E_M = 100 \cdot (\sum y_{d,h,i} / \sum(A_{PRJ,h} \cdot y_{m,h,i}))} \quad \textbf{(60a)}$$

where:

The summation is across all plot observations, i, and across all analysis units, h;

[37] https://apps.fs.usda.gov/Evalidator/evalidator.jsp

[38] See also Section 1.13 where the project proponent has a Transfer of Development Rights program in the project geographic area that acts as a leakage mitigation program. The project may choose to further document the impact of this program on expected leakage risks in a future verification period, which may reduce the market leakage risks and factor in the future.

[39] VM0012 makes reference to calculations using hectares – the project has replaced hectares with acres. This does not affect the uncertainty calculations.

$\mathbf{y_{d,h,i} = A_{PRJ,h} \bullet (y_{p,h,I} - y_{m,h,i})}$ **(60b)**[40]

E_M = Mean model error for the project (%)

$y_{d,h,i}$ = the area-weighted difference between measured and predicted carbon storage in analysis unit, h, plot observation, i (t C)

$y_{m,h,i}$ = carbon storage measured in analysis unit, h, plot observation, i (t C ac^{-1})

$y_{p,h,i}$ = carbon storage predicted by model for analysis unit , h, plot observation, i (t C ac^{-1})

$A_{PRJ,h}$ = area of project analysis unit, h (ac)

Step 2 – The project calculated the inventory error (E_I) at a 90 percent confidence interval expressed as a percentage of the mean area-weighted inventory estimate from the measured plots. Inventory error is estimated based upon the difference between modeled and measured values for monitoring plots established in polygons grouped within analysis units.

Inventory error, E_I, is estimated by first calculating the standard error of the area-weighted differences between the plot observation measurement and the associated model-predicted carbon storage (both on a per acre basis) for analysis units. The standard error is then multiplied by the *t*-value for the 90 percent confidence interval. Finally, E_I is expressed in relative terms (in Equation 60c) by dividing the 90% confidence interval of the area-weighted differences between predicted and measured values in all plots by the area-weighted average of the measured values in all monitoring plots.

$\mathbf{E_I = 100 \bullet [SE * 1.654 / ((1/N) \bullet \sum(A_{PRJ,h} \bullet y_{m,h,i}))]}$ **(60c)**

where:

E_I = Inventory error for the project (%)

SE = the project level standard error of the area weighted differences between measured plot observation and predicted values of carbon storage.

N = total number of plot observations in all analysis units

1.654 = the 90% confidence interval t-value

All other terms as defined in equation 60a.

$\mathbf{SE = S/ \sqrt{N}}$ **(60d)**

where:

N = total number of plot observations in all analysis units

[40] Note Formula 60b has been updated to reflect the Errata issued to VM0012.

S = the standard deviation of the area weighted differences between measured and predicted values of carbon storage across all analysis units.

$$\mathbf{S = \sqrt{[(1/ N-1) \cdot \sum(y_{d,h,i} - \bar{y}bar_d)^2]}} \qquad \textbf{(60e)}$$

where:

$ybar_d$ = the project-level mean of the area weighted differences between measured plot observation and predicted values of carbon storage. See equation 60b for the calculation of $y_{d,h,i}$

All other terms as defined in equation 60b and 60c.

Step 3 - The total error for the project (E_P; %)is calculated by adding the model and inventory error terms, as calculated in Steps 1 and 2.

$$\mathbf{E_P = E_M + E_I} \qquad \textbf{(60f)}$$

Step 4 – Compare the result of Step 3 against Table 7to determine the uncertainty factor.

Table 7. Uncertainty Factor calculation.

Estimated Project Error, E_P (%)	Uncertainty Factor (=$ER_{Y,ERR}$)
0 – 10%	= 1.5%
>10%	= 1.5% + E_P – 10%

Initial Estimate of Uncertainty

Carbon plot volumes were compiled using FVS. Those volumes were compared to the volumes generated by the FVS-FFE extension grouped by analysis unit. The inventory error term (E_I) was calculated to be 13.35% while the model error term (E_M) was -3.44%. As shown in Equation 60f, the project error term (E_P) was calculated as the sum of E_M and E_I (9.91%). Thus, the uncertainty factor ($ER_{Y,ERR}$) was calculated (based upon Table 7) to be 1.5%[41].

This uncertainty factor will be re-assessed at verification and adjusted annually to reflect improved field data from the project monitoring plot network.

Calculation of Gross Emissions Reductions

Gross carbon emissions reductions ($ER_{y,GROSS}$; t CO_2e yr^{-1}) created by the King County Rural Forest Carbon Project were calculated annually as the difference between the baseline and project scenario emission reductions/emissions:

$$\mathbf{ER_{y,GROSS} = (\Delta C_{BSL,t} - \Delta C_{PRJ,t}) \bullet 44/12} \qquad \textbf{(57)}$$

[41] This initial uncertainty factor will be reassessed at each verification to incorporate the latest plot and model data.

Where,

$\Delta C_{BSL,t}$ = total baseline scenario emissions calculated from equation 1 (t C yr^{-1}).

$\Delta C_{PRJ,t}$ = total project scenario emissions calculated from equation 29 (t C yr^{-1}).

44/12 = factor to convert C to CO_2e

The gross emissions reductions calculated for the King County project are shown in Table 8.

Table 8. Ex-Ante Estimate of Emission Reductions and Leakage Related to Project Activities.

Year	A Estimated baseline emissions or removals (tCO_2e)	B Estimated project emissions or removals (tCO_2e)	C Estimated leakage emissions (tCO_2e)	D Estimated net GHG emission reductions or removals (tCO_2e) (B-A)+C
2015	0	0	(0)	0
2016	40,882	52,365	(2,296)	9,186
2017	32,160	40,507	(1,670)	6,678
2018	65,461	83,882	(3,684)	14,737
2019	(29,309)	4,652	(6,792)	27,169
2020	738	4,652	(783)	3,131
2021	225	4,652	(885)	3,541
2022	225	4,652	(885)	3,541
2023	225	4,652	(885)	3,541
2024	225	4,652	(885)	3,541
Total	**110,832**	**204,666**	**(18,767)**	**75,067**

Table 9. Ex-Ante Estimate of Verified Carbon Units (VCUs) produced from project activities.

Year	A Estimated Gross Emissions reductions (tCO_2e)	B Estimated leakage emissions (tCO_2e)	C Uncertainty Risk Discount (tCO_2e)	D Non-Permanence Buffer Contribution (tCO_2e)	E Buffer release (tCO_2e)	F Annual Saleable VCU's (tCO_2e) A+B+C+D+E
2015	0	(0)	(0)	(0)		0
2016	11,482	(2,296)	(138)	(1,148)		7,900
2017	8,348	(1,670)	(100)	(835)		5,743
2018	18,421	(3,684)	(221)	(1,842)		12,674
2019	33,961	(6,792)	(408)	(3,396)		23,365
2020	3,914	(783)	(47)	(391)		2,693
2021	4,427	(885)	(53)	(443)		3,046
2022	4,427	(885)	(53)	(443)		3,046
2023	4,427	(885)	(53)	(443)		3,046
2024	4,427	(885)	(53)	(443)	1,408	4,453
Total	**93,834**	**(18,767)**	**(1,126)**	**(9,383)**	**1,408**	**65,965**

Calculation of Net Emissions Reductions

The annual net GHG emissions reductions are calculated each year using Equation 58.

$$\mathbf{ER_y = ER_{y,GROSS} - LE_y} \qquad \textbf{(58)}$$

where:

ER_y = the net GHG emissions reductions and/or removals in year y (the overall annual carbon change between the baseline and project scenarios, net all discount factors except the permanence buffer) ($t\ CO_2e\ yr^{-1}$).

$ER_{y,GROSS}$ =the difference in the overall annual carbon change between the baseline and project scenarios ($t\ CO_2e\ yr^{-1}$).

LE_y = Leakage in year y ($t\ CO_2e\ yr^{-1}$), as calculated in equation 56.

Calculation of Voluntary Credit Units (VCUs)

The number of VCU's the King County carbon project generates as available for issuance and sale in year, *y* (VCU_y; $t\ CO_2e\ yr^{-1}$), is calculated as:

$$\mathbf{VCU_y = ER_y \cdot (1 - ER_{y,ERR}) - BR_y} \qquad \textbf{(59)}$$

where:

ER_y = the net GHG emissions reductions and/or removals in year (t CO_2e yr^{-1}), as calculated in equation 58.

$ER_{y,ERR}$ = the uncertainty factor for year, y, (calculated in Section 3.4), expressed as a proportion.

BR_y = estimated VCU-equivalent tCO_2e issued to the VCS Buffer Pool in year, *y*, calculated using the latest version of the VCS Tool for AFOLU Non-Permanence Risk Analysis and Buffer (Voluntary Carbon Standard, 2008).

BRy is calculated by multiplying the most current verified permanence risk Buffer Withholding Percentage for the project by the change in carbon stocks (difference between baseline and project scenario) for the project geographic area.

The project VCS Buffer Discount Factor (BR_Y) was calculated as **10%**, as per the non-permanence risk assessment(s) referenced in Section 7.5 (Appendix 5). The BR factor will be re-assessed at each verification as necessary.

The uncertainty factor was determined to be **1.5%,** as calculated below. The uncertainty factor will be re-calculated from field plot data at each verification.

The annual VCUs projected for the King County Project are shown in Table 9.

4 MONITORING

4.1 Data and Parameters Available at Validation

Note that the King County project deviates from the methodology VM0012 in that it uses US imperial measures, which are most appropriate for the project location. Metric to Imperial conversions are made using standard conversions and applied using settings within GIS software and FVS model outputs. The following tables have been modified to reflect the use of imperial units.

All referenced Equations relate to equations listed in Appendix 5, and as described in further detail in the VM0012.

Table 10. Data and parameters at validation.

Data / Parameter	$A_{BSL,i}$
Data unit	Acres
Description	Area of baseline polygon, *i*
Source of data	GIS spatial inventory data
Value applied	Each polygon has an area
Justification of choice of data or description of	Best available data

measurement methods and procedures applied	
Purpose of Data	Used in calculation of baseline emissions. Used in various equations from Equation #4-17.
Comments	Includes delineation and identification of non-timber harvesting landbase area polygons (i.e. AU 5). Converted from hectares to acres natively within GIS software.

Data / Parameter	$\Delta C_{,t}$
Data unit	t C yr^{-1}
Description	The annual carbon balance in the baseline or project scenario for year, *t*. See Equation 57.
Source of data	Calculated following Equation 57 within the King County Carbon Database using FVS-FFE Stand Carbon Report outputs. Calculated from Equation 1 and Equation 29; with subscript BSL and PRJ, respectively.
Value applied	Calculated annually for baseline and project scenario.
Justification of choice of data or description of measurement methods and procedures applied	Best available data from FVS-FFE model output, used in the calculation of baseline and project emissions, respectively.
Purpose of Data	Calculating gross emission reductions ($ER_{y, GROSS}$).
Comments	

Data / Parameter	$\Delta C_{P,t}$
Data unit	t C yr^{-1}
Description	The annual change in carbon stocks in all pools in the baseline or project scenario across the project activity area for year, *t*
Source of data	Calculated within the King County Carbon Database using FVS-FFE Stand Carbon Report outputs, and following Equation 2 and 29, for the BSL and PRJ, respectively.
Value applied	Calculated annually for baseline and project scenario.
Justification of choice of data or description of measurement methods and procedures applied	Best available data from FVS-FFE model output, used in the calculation of baseline and project emissions, respectively.
Purpose of Data	Calculation of $\Delta \mathbf{C}_{,t}$
Comments	

Data / Parameter	$\Delta C_{LB,t}$

Data unit	$t\ C\ yr^{-1}$
Description	The annual change in carbon stocks in living tree biomass (above- and belowground) for year, *t*
Source of data	Calculated within the King County Carbon Database using FVS-FFE Stand Carbon Report outputs and following Equation 3 and 31, for the BSL and PRJ, respectively.
Value applied	Calculated annually for baseline and project scenario.
Justification of choice of data or description of measurement methods and procedures applied	Best available data from FVS-FFE model output, used in the calculation of baseline and project emissions, respectively.
Purpose of Data	Calculation of $\Delta \mathbf{C}_{\mathbf{P,t}}$
Comments	

Data / Parameter	$\Delta C_{DOM,\ t}$
Data unit	$t\ C\ yr^{-1}$
Description	The annual change in carbon stocks due to dead organic matter for year, *t*
Source of data	Calculated within the King County Carbon Database using FVS-FFE Carbon Report outputs and following Equation 10 and 38, for the BSL and PRJ, respectively.
Value applied	Calculated annually for baseline and project scenario.
Justification of choice of data or description of measurement methods and procedures applied	Best available data from FVS-FFE model output, used in the calculation of baseline and project emissions, respectively.
Purpose of Data	Calculation of $\Delta \mathbf{C}_{\mathbf{P,t}}$
Comments	

Data / Parameter	$\Delta C_{HWP,t}$
Data unit	$t\ C\ yr^{-1}$
Description	The annual change in carbon stocks in harvested wood products for year, *t*
Source of data	Calculated within the King County Carbon Database using FVS-FFE Carbon Report and Harvest Product Report outputs, following Equation 18 and 47, for the BSL and PRJ, respectively.
Value applied	Calculated within the King County Carbon Database using FVS-FFE Carbon Report and Harvested Wood outputs and following Equation 18 and 47, for the BSL and PRJ, respectively.

Justification of choice of data or description of measurement methods and procedures applied	Best available data from FVS-FFE model output, used in the calculation of baseline and project emissions, respectively.
Purpose of Data	Calculation of $\Delta \mathbf{C}_{\mathbf{P,t}}$
Comments	Fossil fuel emissions are optional and set to zero in this project (Equations 24-27, 52-55)

Data / Parameter	$\Delta C_{G,t}$
Data unit	t C yr^{-1}
Description	The annual change in carbon stocks due to live biomass gain for year, *t*
Source of data	Calculated within the King County Carbon Database using FVS-FFE Carbon Report outputs, which incorporate Equations 5a-5b and 33a-33b, for the BSL and PRJ, respectively.
Value applied	Calculated within the King County Carbon Database using FVS-FFE Carbon Report and Harvested Wood outputs and following Equation 4 and 32, for the BSL and PRJ, respectively.
Justification of choice of data or description of measurement methods and procedures applied	Best available data from FVS-FFE model output, used in the calculation of baseline and project emissions, respectively.
Purpose of Data	Calculation of $\Delta \mathbf{C}_{\mathbf{LB,t}}$
Comments	

Data / Parameter	$\Delta C_{L,t}$
Data unit	t C yr^{-1}
Description	The annual change in carbon stocks due to live biomass loss for year, *t*
Source of data	Calculated within the King County Carbon Database using FVS-FFE Carbon Report outputs, which incorporate Equations 7-9 and 35-37, for the BSL and PRJ, respectively.
Value applied	Calculated within the King County Carbon Database using FVS-FFE Carbon Report and Harvested Wood outputs and following Equation 6 and 34, for the BSL and PRJ, respectively.
Justification of choice of data or description of measurement methods and procedures applied	Best available data from FVS-FFE model output, used in the calculation of baseline and project emissions, respectively.
Purpose of Data	Calculation of $\Delta \mathbf{C}_{\mathbf{LB,t}}$

Comments	

Data / Parameter	$\Delta C_{LDW,t}$
Data unit	t C yr^{-1}
Description	The annual change in lying dead wood carbon stocks for year, *t*
Source of data	Calculated within the King County Carbon Database using FVS-FFE Carbon Report outputs, which incorporate Equations 11b-13 and 39b-41, for the BSL and PRJ, respectively.
Value applied	Calculated within the King County Carbon Database using FVS-FFE Carbon Report and Harvested Wood outputs and following Equation 11a and 39a, for the BSL and PRJ, respectively.
Justification of choice of data or description of measurement methods and procedures applied	Best available data from FVS-FFE model output, used in the calculation of baseline and project emissions, respectively.
Purpose of Data	Calculation of $\Delta \mathbf{C}_{\mathbf{DOM,t}}$
Comments	

Data / Parameter	$\Delta C_{SNAG,t}$
Data unit	t C yr^{-1}
Description	The annual change in standing dead wood carbon stocks for year, *t*
Source of data	Calculated within the King County Carbon Database using FVS-FFE Carbon Report outputs, which incorporate Equations 14b-16 and 42b-44, for the BSL and PRJ, respectively.
Value applied	Calculated within the King County Carbon Database using FVS-FFE Carbon Report and Harvested Wood outputs and following Equation 14a and 42a, for the BSL and PRJ, respectively.
Justification of choice of data or description of measurement methods and procedures applied	Best available data from FVS-FFE model output, used in the calculation of baseline and project emissions, respectively.
Purpose of Data	Calculation of $\Delta \mathbf{C}_{\mathbf{DOM,t}}$
Comments	

Data / Parameter	$\Delta C_{DBG,t}$
Data unit	t C yr^{-1}
Description	The annual change in dead belowground carbon stocks for year, *t*

Source of data	Calculated within the King County Carbon Database using FVS-FFE Carbon Report outputs, which incorporate Equations 17b-17d and 45b-45d, for the BSL and PRJ, respectively.
Value applied	Calculated within the King County Carbon Database using FVS-FFE Carbon Report and Harvested Wood outputs and following Equation 17a and 45a, for the BSL and PRJ, respectively.
Justification of choice of data or description of measurement methods and procedures applied	Best available data from FVS-FFE model output, used in the calculation of baseline and project emissions, respectively.
Purpose of Data	Calculation of $\Delta C_{DOM,t}$
Comments	

Data / Parameter	CF
Data unit	t C t^{-1} d.m.
Description	Carbon fraction of dry matter
Source of data	IPCC 2006
Value applied	0.5
Justification of choice of data or description of measurement methods and procedures applied	Best available data
Purpose of Data	Required for baseline and project calculations
Comments	Imbedded in FVS-FFE

Data / Parameter	R_i
Data unit	unitless
Description	Root:shoot ratio in polygon, i
Source of data	FVS-FFE defaults. Jenkins and others (2003)
Value applied	FVS-FFE Pacific Northwest Coast or Westside Cascades Variant calculates belowground biomass as a function of species and tree size. BgL carbon pool in FVS.
Justification of choice of data or description of measurement methods and procedures applied	FVS-FFE data is widely reviewed and accepted. Based on peer reviewed Jenkins (2003) estimates.
Purpose of the data	Required for calculation of baseline and project emissions
Comments	

Data / Parameter	BEF
Data unit	unitless
Description	Biomass expansion factors for conversion of productivity metrics to biomass.
Source of data	Modeled by FVS-FFE (FVS CRM setting)
Value applied	FVS-FFE default settings for the PN or WC Variant.
Justification of choice of data or description of measurement methods and procedures applied	FVS-FFE is widely accepted.
Purpose of the data	Required for calculation of baseline and project emissions
Comments	

Data / Parameter	$f_{BRANCH,i,t}$
Data unit	unitless ($0 < f_{BSL,BRANCHi}$, $f_{PRJ,BRANCH,i,t} < 1$)
Description	The annual proportion of aboveground tree biomass comprised of branches in polygon i, year t, in the baseline and project scenarios, respectively.
Source of data	Calculated in FVS using regional species specific crown biomass equations based on Brown and Johnston (1976) as described in Rebain (2015).
Value applied	Varies
Justification of choice of data or description of measurement methods and procedures applied	FVS-FFE data is widely reviewed and accepted, and the method is based on published source.
Purpose of the data	Required for calculation of baseline and project emissions.
Comments	

Data / Parameter	$f_{BUCKINGLOSS,i,t}$
Data unit	unitless ($0 < f_{BSL,BUCKINGLOSSi}$, $f_{PRJ,BUCKINGLOSS,i,t} < 1$)
Description	The proportion of the log bole biomass left on site after assessing and/or merchandizing the log bole for quality, in polygon, i, year, t, for the BSL and PRJ cases, respectively.
Source of data	Based on (Smith, Miles, Vissage, & Pugh, 2004)
Value applied	FVS-FFE default values for PN or WC Variant.
Justification of choice of data or description of measurement methods and procedures applied	The estimate is justified as it is based on top diameter limits.

Purpose of the data	Required for calculation of baseline and project emissions.
Comments	

Data / Parameter	$P_{3\text{-year}}$ and $P_{100\text{-year}}$
Data unit	Unitless
Description	The proportion of total carbon stored in wood products after 3 years ($P_{3\text{-year}}$); and the proportion of harvested wood stored for 100 years ($P_{100\text{-year}}$), for product type, *k,* for the BSL and PRJ, respectively.
Source of data	Calculated within the King County Carbon Database using FVS-FFE Carbon Report and Harvested Wood output reports. FVS-FFE natively tracks HWP pools according to the reference Forestry Appendix of the Technical Guidelines of the US Department of Energy's Voluntary Reporting of Greenhouse Gases Program (known as Section 1605(b).
Value applied	FVS-FFE default values for PN or WC Variant.
Justification of choice of data or description of measurement methods and procedures applied	FVS-FFE utilizes the reference HWP pool tracking method referenced by VCS requirements: Forestry Appendix of the Technical Guidelines of the US Department of Energy's Voluntary Reporting of Greenhouse Gases Program (known as Section 1605(b).
Purpose of the data	Required for calculation of baseline and project emissions.
Comments	Adjustments have been made in the King County Carbon Database to add biomass reported as Landfill by FVS-FFE back into the Wood Products pool proportionally by product for tracking by HWP pool, as per VCS guidance.

Data / Parameter	$P_{BSL,SLF}$, $P_{BSL,MLF}$, $P_{BSL,LLF}$
Data unit	Unitless
Description	The short-lived fraction (P_{SLF}), medium-lived fraction (P_{MLF}), and long-lived fraction (P_{LLF}), respectively, for product type, *k;* for the BSL and PRJ, respectively.
Source of data	Calculated within the King County Carbon Database using FVS-FFE Carbon Report and Harvested Wood output reports. FVS-FFE natively tracks HWP pools according to the reference Forestry Appendix of the Technical Guidelines of the US Department of Energy's Voluntary Reporting of Greenhouse Gases Program (known as Section 1605(b). This matches equations 22a-22c and 50a-50c in the baseline and project, respectively.
Value applied	FVS-FFE default values for PN or WC Variant.
Justification of choice of data or description of	FVS-FFE utilizes the reference HWP pool tracking method referenced by VCS requirements: Forestry Appendix of the Technical Guidelines of the US Department of Energy's Voluntary

measurement methods and procedures applied	Reporting of Greenhouse Gases Program (known as Section 1605(b).
Purpose of the data	Required for calculation of baseline and project emissions.
Comments	Adjustments have been made in the King County Carbon Database to add biomass reported as Landfill by FVS-FFE back into the Wood Products pool proportionally by product for tracking by HWP pool, as per VCS guidance.

Data / Parameter	f_{BARK}, f_{COARSE}, and f_{FINE}
Data unit	Unitless ($0 < f_{BARK}, f_{COARSE}, f_{FINE} < 1$)
Description	The proportions of bark, coarse, and fine residual biomass, respectively that comprise $B_{BSL,RESIDUAl,t}$ and $B_{PRJ,RESIDUAl,t}$ for the BSL and PRJ, respectively.
Source of data	Miles and Smith (2009)
Value applied	0%, for f_{BARK}. Bark is not included in FVS-FFE. Variable, for $f_{BSL,COARSE}$ and $f_{PRJ,COARSE}$ Variable, for $f_{BSL,FINE}$ and $f_{PRJ,FINE}$
Justification of choice of data or description of measurement methods and procedures applied	The estimates of these parameters are justified as they are derived from a relevant peer-reviewed study. Bark is excluded simply because it is not included in the FVS modelling. This is a conservative exclusion as it reduces overall biomass in both scenarios.
Purpose of the data	Required for calculation of baseline and project emissions.
Comments	

Data / Parameter	$C_{HARVEST}$, $C_{MANUFACTUREk}$, $C_{TRANSPORTk}$, $f_{TRANSPORTk}$, $d_{TRANSPORTk}$, $C_{TRANSPORT}$, $C_{MANUFACTURE}$, $C_{EMITTRANSPORT}$, $C_{EMITHARVEST}$, $C_{EMITMANUFACTURE,t}$ & $\Delta C_{EMITFOSSIL,t}$
Data unit	Various
Description	All used in the calculation of annual change in the carbon stored in harvested wood products (HWP), $\Delta C_{HWP,t}$,
Source of data	n/a
Value applied	Zero for all variables.
Justification of choice of data or description of measurement methods and procedures applied	Fossil fuel emissions from equipment and processing of wood products is an optional carbon pool that is not included in the project.
Purpose of the data	n/a
Comments	See Equations 18, 24-27 and 46, 52-55

Data / Parameter	$G_{AG,i,t}$
Data unit	t d.m. ha^{-1} yr^{-1}
Description	Annual increment rate in aboveground biomass (t d.m. ha^{-1} yr^{-1}), in polygon, *I;* for the BSL and PRJ, respectively.
Source of data	Modeled and compiled by FVS-FFE.
Value applied	Variable. Output by polygon by year in the Stand Carbon Report output. Further summarized by AU in the King County Carbon Database.
Justification of choice of data or description of measurement methods and procedures applied	Required for calculation of baseline and project emissions
Purpose of the data	Calculation of $\Delta \mathbf{C}_{\mathbf{G,t}}$
Comments	

Data / Parameter	$G_{BG,i,t}$
Data unit	t d.m. ha^{-1} yr^{-1}
Description	Annual increment rate in belowground biomass (t d.m. ha^{-1} yr^{-1}), in polygon, *I;* for the BSL and PRJ, respectively.
Source of data	Modeled and compiled by FVS-FFE.
Value applied	Variable. Output by polygon by year in the Stand Carbon Report output. Further summarized by AU in the King County Carbon Database.
Justification of choice of data or description of measurement methods and procedures applied	Required for calculation of baseline and project emissions
Purpose of the data	Calculation of $\Delta \mathbf{C}_{\mathbf{G,t}}$
Comments	

Data / Parameter	$LBL_{NATURALi,t}$
Data unit	t d.m. yr^{-1}
Description	Annual loss of live tree biomass due to natural mortality in polygon, i; t d.m. yr^{-1}; for the BSL and PRJ, respectively.
Source of data	Mortality functions modeled and compiled in FVS. (Wykoff and others (1982); Hamilton (1986). Represents calculation of Equation 7 and 35
Value applied	Variable. Density based mortality functions by species and stand using the PN or WC Variant defaults.

Justification of choice of data or description of measurement methods and procedures applied	Required for calculation of baseline and project emissions
Purpose of the data	Calculation of $\Delta \mathbf{C}_{\mathbf{L,t}}$
Comments	

Data / Parameter	$LBL_{FELLINGSi,t}$
Data unit	t d.m. yr^{-1}
Description	Annual loss of live tree biomass due to commercial felling in polygon, i; t d.m. yr^{-1}; for the BSL and PRJ, respectively.
Source of data	Modeled by FVS-FFE. FVS volume equations from the National Volume Estimator Library. Compiled and summarized by polygon harvest scenario (i.e. proportion removed) in the King County Carbon Database. Represents calculation of Equation 8 and 36
Value applied	Variable.
Justification of choice of data or description of measurement methods and procedures applied	Required for calculation of baseline and project emissions. FVS utilizes a national database of tree volume that is maintained by the Forest Products Measurements Group in the Forest Management Service Center of the USFS.
Purpose of the data	Calculation of $\Delta \mathbf{C}_{\mathbf{L,t}}$
Comments	

Data / Parameter	$LBL_{OTHERi,t}$
Data unit	t d.m. yr^{-1}
Description	Annual loss of live tree biomass from incidental sources in polygon, i; t d.m. yr^{-1}; for the BSL and PRJ, respectively.
Source of data	Modeled by FVS-FFE. FVS volume equations from the National Volume Estimator Library. Compiled and summarized by polygon harvest scenario (i.e. proportion removed) in the King County Carbon Database. Represents calculation of Equation 9 and 37
Value applied	Variable.
Justification of choice of data or description of measurement methods and procedures applied	Required for calculation of baseline and project emissions.
Purpose of the data	Calculation of $\Delta \mathbf{C}_{\mathbf{L,t}}$
Comments	At PD Validation this variable is not used, as all disturbances are captured by timber harvesting assumptions.

Data / Parameter	$LB_{i,t}$
Data unit	t d.m. yr^{-1}

Description	Average live tree biomass in polygon, *i*, for year, *t;* for the BSL and PRJ, respectively.
Source of data	Calculated from $G_{i,t}$. Modeled and tracked by FVS and the King County Carbon Database.
Value applied	Variable.
Justification of choice of data or description of measurement methods and procedures applied	Required for calculation of baseline and project emissions.
Purpose of the data	Calculation of $\Delta \mathbf{C}_{\mathbf{L,t}}$
Comments	

Data / Parameter	$f_{BSL,NATURAL,i,t}$
Data unit	unitless; $0 \leq f_{NATURAL,i,t} \leq 1$
Description	The annual proportion of biomass that dies from natural mortality in forest type analysis unit or polygon *i*, year *t*.
Source of data	Modeled and tracked by FVS.
Value applied	Variable.
Justification of choice of data or description of measurement methods and procedures applied	Required for calculation of baseline and project emissions.
Purpose of the data	Calculation of $\Delta \mathbf{C}_{\mathbf{L,t}}$
Comments	

Data / Parameter	$f_{BSL,HARVEST,i,t}$
Data unit	unitless; $0 \leq f_{BSL,HARVESTIi} \leq 1$
Description	The proportion of biomass removed by harvesting from polygon, *i*, in year, *t*.
Source of data	Modeled by FVS based on a harvest schedule modeled and compiled in the King County Carbon Database.
Value applied	Variable.
Justification of choice of data or description of measurement methods and procedures applied	Required for calculation of baseline and project emissions.
Purpose of the data	Calculation of $\Delta \mathbf{C}_{\mathbf{L,t}}$
Comments	

Data / Parameter	$f_{BSL,DAMAGE,i,t}$

Data unit	unitless; 0 $\leq$ $f_{BSL,HARVESTIi}$ $\leq$ 1
Description	The proportion of additional biomass removed for road and landing construction in polygon, *i,* year, *t*.
Source of data	Modeled by FVS based on a harvest schedule modeled and compiled in the King County Carbon Database.
Value applied	Zero at validation.
Justification of choice of data or description of measurement methods and procedures applied	Required for calculation of baseline and project emissions.
Purpose of the data	Calculation of $\Delta \mathbf{C}_{\mathbf{L,t}}$
Comments	At project validation no other biomass removal is modeled other than harvest removals.

Data / Parameter	$f_{BSL,BLOWDOWN,i,t}$
Data unit	unitless; 0 $\leq$ $f_{BSL,HARVESTIi}$ $\leq$ 1
Description	The annual proportion of live aboveground tree biomass subject to blowdown in polygon, *i*, year, t; for the BSL and PRJ, respectively.
Source of data	Episodic mortality such as stand blowdown is not modeled separately in FVS, however the mortality functions in FVS are representative of all types of individual tree mortality affecting stand density over time. Stand level lowdown events (>4 hectares/10 acres) will be captured by monitoring on an ex-ante basis.
Value applied	Zero at validation.
Justification of choice of data or description of measurement methods and procedures applied	Required for calculation of baseline and project emissions.
Purpose of the data	Calculation of $\Delta \mathbf{C}_{\mathbf{L,t}}$
Comments	

Data / Parameter	$f_{BSL,SNAGFALLDOWN,i,t}$
Data unit	unitless; 0 $\leq$ $f_{BSL,HARVESTIi}$ $\leq$ 1
Description	The annual proportion of snag biomass in polygon, *i*, year, *t*, that falls over and thus is transferred to the LDW pool.
Source of data	Modeled within FVS. Based on input by Bruce Marcot (USFS, Portland, OR, unpublished).
Value applied	Variable – modeled based on species and dbh class within FVS.
Justification of choice of data or description of measurement methods and procedures applied	Required for calculation of baseline and project emissions.

Purpose of the data	Calculation of $\Delta C_{L,t}$, via Equation 12, 14a-16 and Equation 40, 42a-44 for the BSL and PRJ, respectively.
Comments	

Data / Parameter	$f_{BSL,lwDECAY,i,t}$
Data unit	unitless; $0 \leq f_{BSL,lwDECAY,i,t} \leq 1$
Description	The annual proportional loss of lying dead biomass due to decay, in polygon *i,* year*, t.*
Source of data	Modeled within FVS. Default decay rates are based on Abbott and Crossley (1982).
Value applied	Variable – modeled within FVS.
Justification of choice of data or description of measurement methods and procedures applied	Required for calculation of baseline and project emissions.
Purpose of the data	Calculation of $\Delta C_{L,t}$
Comments	

Data / Parameter	$f_{BSL,SWDECAY,i,t}$
Data unit	unitless; $0 \leq f_{BSL,SWDECAY,i,t} \leq 1$
Description	The annual proportional loss of snag biomass due to decay, in polygon, *i*, year, *t*.
Source of data	Modeled within FVS. Default decay rates are based on Abbott and Crossley (1982).
Value applied	Variable – modeled within FVS.
Justification of choice of data or description of measurement methods and procedures applied	Required for calculation of baseline and project emissions.
Purpose of the data	Calculation of $\Delta C_{L,t}$
Comments	

Data / Parameter	$SNAG_{BSL,i,t}$
Data unit	t d.m. yr^{-1}
Description	The total amount of snag mass in polygon *i,* year*, t*
Source of data	Modeled within FVS. Reported in the Stand Carbon Report, Standing Dead. Compiled within the King County Carbon Database.
Value applied	Variable – modeled within FVS.
Justification of choice of data or description of	Required for calculation of baseline and project emissions.

measurement methods and procedures applied	
Purpose of the data	Calculation of $\Delta \mathbf{C}_{\mathbf{DOM,t}}$
Comments	

Data / Parameter	$DBG_{,i,t}$
Data unit	t d.m. yr^{-1}
Description	The total quantity of dead belowground biomass accumulated in polygon *i* since the project start; t biomass.
Source of data	Modeled within FVS. Reported in the Stand Carbon Report, Belowground Biomass. Compiled within the King County Carbon Database. For the BSL and PRJ scenario respectively.
Value applied	Variable – modeled within FVS.
Justification of choice of data or description of measurement methods and procedures applied	Required for calculation of baseline and project emissions.
Purpose of the data	Calculation of $\Delta \mathbf{C}_{\mathbf{DOM,t}}$
Comments	

Data / Parameter	$\Delta C_{STORHWP,t}$
Data unit	t C yr^{-1}
Description	Annual harvested carbon that remains in permanent storage after conversion to wood products during primary processing
Source of data	Modeled within FVS and output in the Harvest Products Report Stand Carbon Report. Compiled within the King County Carbon Database. For the BSL and PRJ scenario respectively.
Value applied	Variable – modeled within FVS.
Justification of choice of data or description of measurement methods and procedures applied	Required for calculation of baseline and project emissions.
Purpose of the data	Calculation of $\Delta HWP_{,t}$
Comments	

Data / Parameter	$C_{MILL,h,k}$
Data unit	t C
Description	The carbon contained in harvested timber after milling in period h, for product type *k*
Source of data	Modeled within FVS and output in the Harvest Products Report Stand Carbon Report. Compiled within the King County Carbon Database. For the BSL and PRJ scenario respectively.

Value applied	Variable – modeled within FVS.
Justification of choice of data or description of measurement methods and procedures applied	Required for calculation of baseline and project emissions.
Purpose of the data	Calculation of $\Delta HWP_{,t}$
Comments	

Data / Parameter	$C_{TIMBER,h}$
Data unit	t C
Description	The carbon contained in timber harvested in period *h*
Source of data	Modeled within FVS and output in the Harvest Products Report Stand Carbon Report. Compiled within the King County Carbon Database. For the BSL and PRJ scenario respectively.
Value applied	Variable – modeled within FVS.
Justification of choice of data or description of measurement methods and procedures applied	Required for calculation of baseline and project emissions.
Purpose of the data	Calculation of $\Delta HWP_{,t}$
Comments	

Data / Parameter	$C_{STORHWP,h,t}$
Data unit	t C
Description	The carbon stored in harvested wood products in year *t* summed for all product types *k* and then over all harvest periods *h*; t C
Source of data	Modeled within FVS and output in the Harvest Products Report Stand Carbon Report. Compiled within the King County Carbon Database. For the BSL and PRJ scenario respectively.
Value applied	Variable – modeled within FVS.
Justification of choice of data or description of measurement methods and procedures applied	Required for calculation of baseline and project emissions.
Purpose of the data	Calculation of $\Delta HWP_{,t}$
Comments	

Data / Parameter	$f_{RND,k}$
Data unit	dimensionless
Description	The fraction of growing stock volume removed as roundwood for product type *k*

Source of data	Modeled within FVS and output in the Harvest Products Report Stand Carbon Report. Compiled within the King County Carbon Database. For the BSL and PRJ scenario respectively.
Value applied	Variable – modeled within FVS.
Justification of choice of data or description of measurement methods and procedures applied	Required for calculation of baseline and project emissions.
Purpose of the data	Calculation of $\Delta HWP_{,t}$
Comments	

Data / Parameter	$r_{RND,k}$
Data unit	dimensionless
Description	The ratio of industrial roundwood to growing stock volume removed as roundwood for product type *k.*
Source of data	Modeled within FVS and output in the Harvest Products Report Stand Carbon Report. Compiled within the King County Carbon Database. For the BSL and PRJ scenario respectively.
Value applied	Variable – modeled within FVS.
Justification of choice of data or description of measurement methods and procedures applied	Required for calculation of baseline and project emissions.
Purpose of the data	Calculation of $\Delta HWP_{,t}$
Comments	

Data / Parameter	$ER_{y,GROSS}$
Data unit	t CO_2e yr^{-1}
Description	The gross difference in the overall annual carbon change between the baseline and project scenarios in year, *y*
Source of data	Calculated in equation 57.
Value applied	Variable.
Justification of choice of data or description of measurement methods and procedures applied	Required for calculation of baseline and project emissions.
Purpose of the data	Calculation of $\mathbf{LE_y}$
Comments	

Data / Parameter	MLF_y
Data unit	%

Description	The market leakage factor determined for year 'y'
Source of data	Determined based upon the approach defined in Section 3.3
Value applied	20%
Justification of choice of data or description of measurement methods and procedures applied	Value determined using the latest version of the VCS Market Leakage Tool as defined in Agriculture, Forestry and Other Land Use (AFOLU) Requirements v3.6 and specified in the VM0012 Methodology
Purpose of the data	Calculation of leakage
Comments	

Data / Parameter	LE_y
Data unit	t CO_2e yr^{-1}
Description	The project market leakage in year, *y*
Source of data	Calculated using Equation 56b.
Value applied	Variable.
Justification of choice of data or description of measurement methods and procedures applied	Required for calculation of baseline and project emissions.
Purpose of the data	Calculation of annual project market leakage.
Comments	

Data / Parameter	$ER_{y,}$
Data unit	t CO_2e yr^{-1}
Description	The net GHG emissions reductions and/or removals in year y (the overall annual carbon change between the baseline and project scenarios, net all discount factors except the permanence buffer)
Source of data	Calculated in equation 58
Value applied	Variable.
Justification of choice of data or description of measurement methods and procedures applied	Required for calculation of baseline and project emissions.
Purpose of the data	Calculation of $\mathbf{VCU_y}$
Comments	

Data / Parameter	$VCU_{y,}$
Data unit	t CO_2e yr^{-1}
Description	Amount of Verified Carbon Units the project estimates are available for issuance and sale in year 'y'

Source of data	Calculated in equation 59
Value applied	Variable.
Justification of choice of data or description of measurement methods and procedures applied	Required for calculation of baseline and project emissions.
Purpose of the data	Calculation of claimed VCU's.
Comments	

Data / Parameter	E_M
Data unit	%
Description	An estimate of model error based on the relative area-weighted difference between model-predicted values of carbon storage and those values measured in field plots
Source of data	Model output and field data (see Equation 60a)
Value applied	-3.44%
Justification of choice of data or description of measurement methods and procedures applied	Value determined using approach described in the VM0012 Methodology
Purpose of the data	Calculation of baseline & project emissions
Comments	

Data / Parameter	E_I
Data unit	%
Description	An estimate of Inventory sampling error calculated as the 90% confidence limit of the area-weighted differences between the model-predicted values of carbon storage and those values measured in field plots
Source of data	Model output and field data (see Equation 60c)
Value applied	13.35%
Justification of choice of data or description of measurement methods and procedures applied	Value determined using approach described in the VM0012 Methodology
Purpose of the data	Calculation of baseline & project emissions
Comments	

Data / Parameter	E_P

Data unit	%
Description	An estimate of total project error used to determine the uncertainty factor.
Source of data	Model output and field data (see Equation 60f)
Value applied	9.91%
Justification of choice of data or description of measurement methods and procedures applied	Value determined using approach described in the VM0012 Methodology
Purpose of the data	Calculation of baseline & project emissions
Comments	

Data / Parameter	$ER_{y,ERR,}$
Data unit	%
Description	The uncertainty factor calculated for year 'y' (See Section 4.4.3)
Source of data	Model output and field data (see Equation 60f)
Value applied	1.5%
Justification of choice of data or description of measurement methods and procedures applied	Value determined using approach described in the VM0012 Methodology
Purpose of the data	Calculation of baseline & project emissions
Comments	

Data / Parameter	$BR_{y,}$
Data unit	t CO2e yr^{-1}
Description	Estimated VCU-equivalent tCO_2e issued to the VCS Buffer Pool in year, *y*.
Source of data	Calculated using the latest version of the VCS AFOLU Non-Permanence Risk Tool
Value applied	10%
Justification of choice of data or description of measurement methods and procedures applied	Value determined using approach described in the VM0012 Methodology
Purpose of the data	Calculation of **VCU_y**
Comments	

4.2 Data and Parameters Monitored

Table 11. Data and parameters monitored.

Data / Parameter	$A_{PRJ,i}$
Data unit	Acres
Description	Area of forest land in polygon, i
Source of data	Latest version of the spatial inventory data and project instance list
Description of measurement methods and procedures to be applied	Compiled via GIS spatial inventory data
Frequency of monitoring/recording	Prior to every verification period
Value monitored	Variable, every polygon has an area.
Monitoring equipment	Visual, satellite, aerial photos, LiDAR data
QA/QC procedures to be applied	Standard GIS QA/QC procedures. KC Standard Operating Procedures (SOP)
Purpose of the data	Required for project calculations
Calculation method	Determined from GIS software
Comments	

Data / Parameter	$A_{p,i,t}$
Data unit	Acres
Description	Area of permanent sample plot in polygon, i
Source of data	Permanent sample plots
Description of measurement methods and procedures to be applied	Standard variable radius plot layout design
Frequency of monitoring/recording	Plot measurements are repeated on 5-year intervals
Value monitored	See Plot Data MS Excel file.
Monitoring equipment	GPS, measuring tape
QA/QC procedures to be applied	GPS of plot center. King County Standard Operating Procedures (SOP) followed, including check cruising processes.
Purpose of the data	Required for determination of Uncertainty Factor
Calculation method	Measured
Comments	

Data / Parameter	$DBH_{i,t}$
Data unit	Inches
Description	Diameter at breast height measured for each tree in the sample plots at time, t
Source of data	Permanent sample plots

Description of measurement methods and procedures to be applied	Field measurements in permanent sample plots. Measurement with DBH tape for trees > 2 in DBH.
Frequency of monitoring/recording	Individual plot tree re-measurements are repeated on 5-year intervals
Value monitored	See Plot Data MS Excel file.
Monitoring equipment	DBH tape, data logger
QA/QC procedures to be applied	King County Standard Operating Procedures (SOP).
Purpose of the data	Required for determination of Uncertainty Factor
Calculation method	Measured
Comments	

Data / Parameter	$Height_{i,t}$
Data unit	Feet
Description	Tree height measured for each tree in the sample plots at time, t
Source of data	Permanent sample plots
Description of measurement methods and procedures to be applied	Field measurements in permanent sample plots. Measurement with hypsometer or similar for trees > 2 inch DBH and >1.3 meters tall.
Frequency of monitoring/recording	Individual plot tree re-measurements are repeated on 5-year intervals
Value monitored	See Plot Data MS Excel file.
Monitoring equipment	Hypsometer, a transit, a clinometer, a relaskop, a laser or other instrument designed for the measuring height.
QA/QC procedures to be applied	King County Standard Operating Procedures (SOP).
Purpose of the data	Required for determination of Uncertainty Factor
Calculation method	Measured
Comments	

Data / Parameter	$B_{AG\ i,t}$
Data unit	t d.m. ac^{-1}
Description	Aboveground live tree biomass in polygon, i, year, t, in the project case.
Source of data	Permanent sample plots
Description of measurement methods and procedures to be applied	Calculated in FVS-FFE from plot tree data ($height_{i,t}$, $DBH_{i,t}$, and $A_{p,i,t}$)
Frequency of monitoring/recording	Upon establishment of PSP. Every 5 years, thereafter.
Value monitored	See Plot Data MS Excel file.

Monitoring equipment	
QA/QC procedures to be applied	King County Standard Operating Procedures (SOP).
Purpose of the data	Required for determination of Uncertainty Factor
Calculation method	Above ground biomass for each tree within a permanent sample plot will be calculated using plot data entered into FVS-FFE.
Comments	

Data / Parameter	$B_{BG\ i,t}$
Data unit	t d.m. ac^{-1}
Description	Belowground live tree biomass in polygon, i, year, t, in the project case.
Source of data	Derived from above ground biomass calculations within permanent sample plots.
Description of measurement methods and procedures to be applied	Calculated using plot data in FVS-FFE
Frequency of monitoring/recording	Upon establishment of PSP. Every 5 years, thereafter.
Value monitored	See Plot Data MS Excel file.
Monitoring equipment	
QA/QC procedures to be applied	King County Standard Operating Procedures (SOP).
Purpose of the data	Required for determination of Uncertainty Factor
Calculation method	Calculated using plot data in FVS-FFE
Comments	

Data / Parameter	$B_{TOTAL\ i,t}$
Data unit	t d.m. ac^{-1}
Description	Sum of $B_{AGi,t}$ and $B_{BGi,t}$
Source of data	Derived from above ground biomass calculations within permanent sample plots.
Description of measurement methods and procedures to be applied	Sum of $B_{AGi,t}$ and $B_{BGi,t}$
Frequency of monitoring/recording	Upon establishment of PSP. Every 5 years, thereafter.
Value monitored	Calculated using plot data in FVS-FFE
Monitoring equipment	
QA/QC procedures to be applied	King County Standard Operating Procedures (SOP).
Purpose of the data	Required for determination of Uncertainty Factor
Calculation method	Sum of $B_{AGi,t}$ and $B_{BGi,t}$

Comments	

Data / Parameter	$C_{LB\ i,t}$
Data unit	t C ac^{-1}
Description	Total carbon storage in live tree biomass in polygon, i, year, t, in the project case.
Source of data	Permanent sample plots.
Description of measurement methods and procedures to be applied	Calculated from $B_{TOTALi,t}$ and CF
Frequency of monitoring/recording	Upon establishment of PSP. Every 5 years, thereafter.
Value monitored	See Plot Data MS Excel file.
Monitoring equipment	
QA/QC procedures to be applied	King County Standard Operating Procedures (SOP).
Purpose of the data	Required for determination of Uncertainty Factor
Calculation method	As calculated by FVS-FFE from plot data, or $B_{TOTALi,t}$ * CF
Comments	

Data / Parameter	$C_{DOM\ i,t}$
Data unit	t C ac^{-1}
Description	Total carbon storage in dead organic matter in polygon, i, year, t, in the project case.
Source of data	Permanent sample plots.
Description of measurement methods and procedures to be applied	Calculated from $DOM_{SNAGi,t}$ and $DOM_{LDWi,t}$ and CF
Frequency of monitoring/recording	Upon establishment of PSP. Every 5 years, thereafter.
Value monitored	See Plot Data MS Excel file.
Monitoring equipment	
QA/QC procedures to be applied	KC Standard Operating Procedures (SOP).
Purpose of the data	Required for determination of Uncertainty Factor
Calculation method	As calculated by FVS-FFE from plot data. Or ($DOM_{SNAGi,t}$ + $DOM_{LDWi,t}$)* CF
Comments	

Data / Parameter	Mean tree age
Data unit	Years

Description	Mean tree age for a given permanent sampling plot in polygon, i, for the project case.
Source of data	Permanent sampling plots
Description of measurement methods and procedures to be applied	Plot age is estimated by coring a sample of dominant trees during plot establishment
Frequency of monitoring/recording	Once during plot installation
Value monitored	See Plot Data MS Excel file.
Monitoring equipment	Tree coring bit
QA/QC procedures to be applied	KC Standard Operating Procedures (SOP).
Purpose of the data	Used in determination of Uncertainty Factor
Calculation method	Counting visible tree rings
Comments	

Data / Parameter	$f_{PRJ,NATURAL,i,t}$
Data unit	unitless ($0 < f_{PRJ,NATURAL,i,t} < 1$)
Description	The proportion of biomass that dies from natural mortality in polygon, i, year, t, in the project case.
Source of data	Permanent sample plots
Description of measurement methods and procedures to be applied	Height and dbh of dead trees in permanent sample plots will be recorded.
Frequency of monitoring/recording	Every 5 years in the case of individual plot trees
Value monitored	See Plot Data MS Excel file.
Monitoring equipment	Observation
QA/QC procedures to be applied	KC Standard Operating Procedures (SOP).
Purpose of the data	Required for project calculations
Calculation method	Observation in plot
Comments	

Data / Parameter	$f_{PRJ,HARVEST,i,t}$
Data unit	unitless ($0 < f_{PRJ,HARVEST,i,t} < 1$)
Description	The proportion of biomass removed by harvesting from polygon, i, in year, t, in the project case.
Source of data	Permanent sample plots, and/or project instance harvest records or remote sensing.
Description of measurement methods	Volume derived from harvesting records or FVS harvest modeling. Modeled estimates of total biomass in polygon, i, used to derive parameter.

and procedures to be applied	
Frequency of monitoring/recording	Upon establishment of PSP. Every 5 years, thereafter. Remote sensing or harvesting records, annual.
Value monitored	Proportion.
Monitoring equipment	Plot remeasurement equipment, remote sensing.
QA/QC procedures to be applied	King County Plot Installation SOP, standard GIS practices.
Purpose of the data	Required for project calculations
Calculation method	Observation, and/or modeled by FVS-FFE based on estimated or actual removals.
Comments	

Data / Parameter	$f_{PRJ,DAMAGE,i,t}$
Data unit	unitless ($0 < f_{PRJ,DAMAGE,i,t} < 1$)
Description	The proportion of additional biomass removed for road and landing construction in polygon, i, year, t, in the project case.
Source of data	Remote sensing
Description of measurement methods and procedures to be applied	Areal estimate of removals derived from remote sensing data.
Frequency of monitoring/recording	Annually
Value monitored	See GIS delineations, or polygon estimations in data
Monitoring equipment	Aerial photos
QA/QC procedures to be applied	Data will be verified by ground-truthing or remote sensing information.
Purpose of the data	Required for project calculations
Calculation method	Areal estimate of removals is multiplied by average carbon density within a polygon.
Comments	

Data / Parameter	$f_{PRJ,BLOWDOWN,i,t}$
Data unit	unitless; $0 \leq f_{PRJ,BLOWDOWN,i,t} \leq 1$
Description	The annual proportion of live aboveground tree biomass subject to blowdown in polygon, *i*, year, t.
Source of data	Remote sensing
Description of measurement methods and procedures to be applied	Measured in plots. Areal estimate of removals derived from remote sensing data for areas >4 ha (10 acres).
Frequency of monitoring/recording	At plot remeasurement, or annually via remote sensing
Value monitored	See GIS delineations, or polygon estimations in data, or plot data

Monitoring equipment	Aerial photos or plot measurement equipment
QA/QC procedures to be applied	Data will be verified by ground-truthing or remote sensing information.
Purpose of the data	Required for project calculations
Calculation method	Areal estimate of removals is multiplied by average carbon density within a polygon or plot.
Comments	

Data / Parameter	$f_{PRJ,SNAGFALLDOWN,i,t}$
Data unit	unitless; $0 \leq f_{PRJ,SNAGFALLDOWN,i,t} \leq 1$
Description	The annual proportion of snag biomass in polygon, *i*, year, *t*, that falls over and thus is transferred to the LDW pool.
Source of data	Modeled by FVS. Also measured during plot remeasurements.
Description of measurement methods and procedures to be applied	Modeled by FVS, Also measured during plot remeasurements.
Frequency of monitoring/recording	Annually; every 5 years for plot remeasurements.
Value monitored	Variable.
Monitoring equipment	FVS software; standard plot remeasurement equipment.
QA/QC procedures to be applied	For plot remeasurements, see King County Standard Operating Procedures (SOP).
Purpose of the data	Required for project calculations
Calculation method	Modeled by FVS.
Comments	

Data / Parameter	$f_{PRJ,lwDECAY,i,t}$
Data unit	unitless; $0 < f_{PRJ,lwDECAY,i,t} < 1$
Description	The annual proportional loss of lying dead biomass due to decay, in polygon *i,* year*, t*,
Source of data	Permanent sample plots
Description of measurement methods and procedures to be applied	LDW decay is estimated naturally by changes in CWD remeasurements across multiple remeasurement periods.
Frequency of monitoring/recording	Every 5 years for plot remeasurements.
Value monitored	Variable.
Monitoring equipment	Standard plot remeasurement equipment.
QA/QC procedures to be applied	For plot remeasurements, see King County Standard Operating Procedures (SOP).
Purpose of the data	Required for project calculations
Calculation method	Calculated using the following field- measured parameters $L_{i,t}$, $dn_{i,t}$, $D_{LDWc,i,t}$, and $N_{i,t}$

Comments	

Data / Parameter	$\mathbf{f_{PRJ,SWDECAY,i,t}}$
Data unit	unitless; $0 < f_{PRJ,SWDECAY,i,t} < 1$
Description	The annual proportional loss of snag biomass due to decay, in polygon, *i*, year, *t*.
Source of data	Permanent sample plots
Description of measurement methods and procedures to be applied	Snag decay is estimated by changes in snag DBH across multiple remeasurement periods.
Frequency of monitoring/recording	Every 5 years for plot remeasurements.
Value monitored	Variable.
Monitoring equipment	Standard plot remeasurement equipment.
QA/QC procedures to be applied	For plot remeasurements, see King County Standard Operating Procedures (SOP).
Purpose of the data	Required for project calculations
Calculation method	Calculated by FVS-FFE from plot data
Comments	

Data / Parameter	$DOM_{SNAG,i,t}$
Data unit	t d.m. ac^{-1} (d.m. = dry matter)
Description	Total mass of dead organic matter contained in standing dead wood in polygon, i, year, t in the project case.
Source of data	Permanent sample plots
Description of measurement methods and procedures to be applied	Calculated from $Height_{i,t}$, $DBH_{i,t}$, and $A_{PSP,i}$ of dead trees measured in permanent sample plots
Frequency of monitoring/recording	Every 5 years
Value monitored	See Plot Data MS Excel file.
Monitoring equipment	n/a
QA/QC procedures to be applied	King County Standard Operating Procedures (SOP).
Purpose of the data	Required for determination of Uncertainty Factor
Calculation method	Calculated by FVS-FFE from plot data
Comments	

Data / Parameter	$DOM_{LDW,i,t}$
Data unit	t d.m. ac^{-1} (d.m. = dry matter)
Description	Total mass of dead organic matter contained in lying dead wood in polygon, i, year, t in the project case.
Source of data	Permanent sample plots

Description of measurement methods and procedures to be applied	Calculated from the line intersect method (See KC Standard Operating Procedures (SOP))
Frequency of monitoring/recording	Every 5 years
Value monitored	See Plot Data excel file
Monitoring equipment	Tape and visual inspection
QA/QC procedures to be applied	King County Standard Operating Procedures (SOP)
Purpose of the data	Required for determination of Uncertainty Factor
Calculation method	Calculated using the following field- measured parameters $L_{i,t}$, $dn_{i,t}$, $D_{LDWc,i,t}$, and $N_{i,t}$
Comments	

Data / Parameter	$V_{LDW,i,t}$
Data unit	$m^3\ ha^{-1}$
Description	Total volume of dead organic matter contained in lying dead wood in polygon, i, year, t in the project case.
Source of data	Permanent sample plots
Description of measurement methods and procedures to be applied	Calculated from the line intersect method (See King County Standard Operating Procedures (SOP)).
Frequency of monitoring/recording	Every 5 years
Value monitored	See Plot Data excel file
Monitoring equipment	Tape and visual inspection
QA/QC procedures to be applied	King County Standard Operating Procedures (SOP)
Purpose of the data	Required for determination of Uncertainty Factor
Calculation method	Calculated using the following field- measured parameters $L_{i,t}$, $D_{LDWc,i,t}$, and $N_{i,t}$
Comments	

Data / Parameter	$L_{i,t}$
Data unit	Meters (feet)
Description	Calculation of lying dead wood: Length of the transect used to determine volume of lying dead wood in the sample plot, at time, t (default 100m (328.1 feet)
Source of data	Permanent sample plots
Description of measurement methods and procedures to be applied	Field measurements

Frequency of monitoring/recording	Every 5 years
Value monitored	100 meters (328.1 feet)
Monitoring equipment	Tape
QA/QC procedures to be applied	KC Standard Operating Procedures (SOP)
Purpose of the data	Required for determination of Uncertainty Factor
Calculation method	
Comments	Proportional adjustments were made during calculations for any plot CWD transects installed less than 100m due to barriers, etc.

Data / Parameter	$d_{n,i,t}$
Data unit	inches
Description	Calculation of lying dead wood: Diameter of each piece n of dead wood along the transects in the sample plot at time, t
Source of data	Permanent sample plots
Description of measurement methods and procedures to be applied	Lying dead wood must be sampled using the line intersect method (Harmon & Sexton, 1996). Two 50-m lines are established bisecting each plot and the diameters of the lying wood (> 4 in diameter) intersecting the lines are measured. Minimum measurement diameter must not be less than 4 in.
Frequency of monitoring/recording	Every 5 years
Value monitored	See Plot Data MS Excel file.
Monitoring equipment	Caliper, diameter tape
QA/QC procedures to be applied	King County Standard Operating Procedures (SOP)
Purpose of the data	Required for determination of Uncertainty Factor
Calculation method	
Comments	

Data / Parameter	$N_{i,t}$
Data unit	unitless
Description	Total number of wood pieces intersecting the transect in the sample plot, in time t.
Source of data	Field Measurement
Description of measurement methods and procedures to be applied	Lying dead wood is sampled using the line intersect method (Harmon & Sexton, 1996). Two 50-m lines are established bisecting each plot and the total number of wood pieces intersecting transect are counted.
Frequency of monitoring/recording	Every 5 years
Value monitored	See Plot Data MS Excel file.
Monitoring equipment	Visual observation

QA/QC procedures to be applied	King County Standard Operating Procedures (SOP)
Purpose of the data	Required for determination of Uncertainty Factor
Calculation method	
Comments	

Data / Parameter	$D_{LDWc,i,t}$
Data unit	t d.m. m^{-3}
Description	Basic wood density of dead wood in the density class, c along the transect in polygon, i, at time, t .
Source of data	Two 50-m lines are established bisecting each plot and wood pieces > 10 cm diameter intersecting transect are measured.
Description of measurement methods and procedures to be applied	Decay class is determined from visual and tactile inspection (See KC Standard Operating Procedures (SOP))
Frequency of monitoring/recording	Every 5 years
Value monitored	See Plot Data MS Excel file.
Monitoring equipment	Visual and tactile inspection
QA/QC procedures to be applied	King County Standard Operating Procedures (SOP)
Purpose of the data	Required for determination of Uncertainty Factor
Calculation method	Lookup table
Comments	

Data / Parameter	E_M
Data unit	%
Description	An estimate of model error
Source of data	Model output and field data
Description of measurement methods and procedures to be applied	Calculated value determined difference between of model-predicted values of carbon storage and those values measured in field plots (see Equation 60a)
Frequency of monitoring/recording	At each verification
Value monitored	-3.44%
Monitoring equipment	N/A
QA/QC procedures to be applied	N/A
Purpose of the data	Required for determination of Uncertainty Factor
Calculation method	Equation (60a)
Comments	

Data / Parameter	E_I

Data unit	%
Description	An estimate of Inventory sampling error
Source of data	Model output and field data
Description of measurement methods and procedures to be applied	Calculated as the 90% confidence limit of the area-weighted differences between the model-predicted values of carbon storage and those values measured in field plots
Frequency of monitoring/recording	At each verification
Value monitored	13.35%
Monitoring equipment	
QA/QC procedures to be applied	
Purpose of the data	Required for determination of Uncertainty Factor
Calculation method	Equation (60c)
Comments	

Data / Parameter	E_P
Data unit	%
Description	An estimate of total project error calculated as the sum of the model and inventory error terms
Source of data	Model output and field data
Description of measurement methods and procedures to be applied	Calculated as the sum of E_M and E_I (Equation 60e)
Frequency of monitoring/recording	At each verification
Value monitored	9.91%
Monitoring equipment	
QA/QC procedures to be applied	
Purpose of the data	Required for determination of Uncertainty Factor
Calculation method	Equation (60f)
Comments	

Data / Parameter	$ER_{y,ERR}$
Data unit	%
Description	The uncertainty factor calculated for year ‘y’
Source of data	Model output and field data
Description of measurement methods and procedures to be applied	Calculated value
Frequency of monitoring/recording	At each verification
Value monitored	1.5%
Monitoring equipment	

QA/QC procedures to be applied	
Purpose of the data	Required for project calculations
Calculation method	
Comments	

Data / Parameter	MLF_y
Data unit	%
Description	The market leakage factor determined for year 'y'
Source of data	Model output and field data
Description of measurement methods and procedures to be applied	Determined based upon the approach defined in Section 3.3
Frequency of monitoring/recording	At each verification
Value monitored	20% at validation
Monitoring equipment	
QA/QC procedures to be applied	
Purpose of the data	Calculation of leakage
Calculation method	Value determined using the latest version of the VCS Market Leakage Tool as defined in Agriculture, Forestry and Other Land Use (AFOLU) Requirements v3.6 and specified in the VM0012 Methodology
Comments	

4.3 Monitoring Plan

Fundamentally, the King County project includes 4 monitoring activities, which will be managed by King County DNRP. The monitoring activities described in the following sections will be the focus of reporting at each verification in a Monitoring Report. A summary of key project personnel and organizational structure responsible for project monitoring is provided in Table 12.

Table 12. Summary of key personnel and organization structure for the King County Carbon Project.

Personnel	**Role**	**Qualifications**
Kathleen Farley Wolf, Program Manager, Forestry Program, King County	Forest Carbon Project Management, Overseeing all aspects of the project	PhD. experienced in conducting research in conservation biology.
Richard Martin, Program Supervisor, Agriculture, Forestry	Providing guidance for all aspects of the project	MSc. Supervisor at King County overseeing agriculture, forestry

and Incentives Unit, King County		and open space conservation work.
Mike Vitt, President, RainCloud Forests. Contractor.	Carbon project development and project advisory consulting	MBA, BSc Forestry. 25 years of forestry experience, 10 years of forest carbon project development and management.

Annualized Inventory Change Monitoring

At each verification, reported on an annualized basis, the project will make the following inventory updates, as applicable:

1. Add spatial and supporting data for any new project instances to the project databases
2. Review and incorporate the latest available forest inventory and GIS data on the project that overlaps all of the project instances.
3. Collect geo-referenced information on new project activities, including any forest management or silvicultural activities on any project instance that materially affects GHG emissions.
4. Annually monitor for forest disturbances through remote sensing, field observation, and/or aerial observation.

The inventory will be updated at a minimum, for:

1. Natural disturbance events > 10 acres (~4 ha) (for example, fires, high mortality pest and disease areas, blowdown areas, slides, etc.).
2. Project activities (e.g. timber harvesting/thinning, road construction/reclamation, reforestation/restoration, etc.). A minimum polygon size of 10 acres can be used, but is not a mandatory minimum.
3. Unplanned anthropogenic disturbances (for example, non-de minimis illegal or unplanned harvests) affecting a non-de minimis amount of carbon stocks.

These monitored spatial elements will be updated in the project GIS inventory database and the King County Carbon Access Database (or equivalent) annually, or at minimum at each verification on an annualized basis.

Other Monitoring Requirements

King County will also document other monitoring requirements of the PDD, including:

1. Activity shifting leakage (monitored annually, reported at each verification) – the project will report and assess the activity shifting leakage risks based on the timber harvest levels on lands owned or controlled by King County and 3rd Party Landowners that are outside the project geographic area.

2. Market leakage calculations (at each verification, applied annually) - market leakage calculations will be confirmed at each verification using the latest plot inventory data and best available regional leakage area analysis.

At verification, the project will update the inventory, uncertainty calculations, and carbon calculations from field plot measurement data as outlined in Sections 3.2 and 4.3 The project may also undertake the following monitoring related tasks as appropriate:

1. Refine the project analysis units based on new forest inventory data or to meet the needs of future project instances;
2. Refine or calibrate carbon models based on updated inventory data, as appropriate;
3. Update or modify inventory polygons base on updated remote sensing, forest inventory data, or field truthing, or as a result of project activities or disturbances.

All inventory, data, and modeling changes must be applied equally to the baseline and project carbon calculations, as applicable.

As per Section 1.13 , note that the project may choose to (but is not required to) claim a leakage mitigation credit in future verifications. This will require the determination of a monitoring program for this leakage mitigation process, which can be added and verified at the verification period where it becomes applicable.

Carbon Stock Field Plot Monitoring

The King County Rural Forest Carbon Project has installed a permanent fixed and geo-located plot network for monitoring changes in stand-level forest biomass stocks over time. The plot network at validation consists of 35 plots[42], installed in 2018 and 2019.

As part of ongoing project monitoring the project will periodically review the need for additional permanent sample plots or incorporation of other forest and carbon inventory updates or improvements over time.

Monitoring Carbon Plot Sampling Design Overview

Plot Layout - Permanent plot locations were located using UTM coordinates randomly selected via GIS analysis tools. Plots were selected sequentially from a randomized list of potential plot locations with an objective of maintaining approximate area proportional representation by AU (Table 13). Further details on the specific plot location and selection process will be made available to auditors in separate documentation for validation and at each relevant verification.

[42] The methodology does not specify a number of plots, with error over the target (10%@90%CI) being accounted for in the uncertainty factor deduction (Section 3.4).

Table 13. Initial plot allocation by Analysis Unit. AU 5 (non-THLB) is not sampled[43].

AU	Forested Area (ac)	% of Forested	Target Count	Actual Count
1	87.6	11.7%	4.4	6
2	189.0	25.2%	9.6	9
3	252.4	33.7%	12.8	12
4	220.3	29.4%	11.2	11
Total	**812.2**	**100%**	**38**	**38**

Size and Shape of Sample Plots - permanent sample plots are installed as a variable circular radius, with overlaying deadwood transects. Plot size radii (10 m (32.8 ft), 14 m (45.9 ft), or 20 m (65.6 ft)) were determined based upon the DBH range of the sample trees, such that a minimum of 40 trees were measured in each plot. In stands < 30 years old, or with tree counts > 150 on a 10-m plot, plots may be reduced to 4 m (16.4 ft).

Plot measurements – plots are installed, measured, and re-measured following the latest version of the King County Plot Installation (and Re-Measurement) Standard Operating Procedure. Plot measurements include: live trees (aboveground live biomass); standing dead trees (aboveground dead biomass); and lying dead wood (aboveground dead biomass).

Given the dynamics of forest processes, the permanent plots will be re-measured at intervals not exceeding 5 field season years[44], beginning at the year of installation. As noted, permanent plots may be established over multiple years, and such re-measurement schedules will be tracked on for each plot based on its establishment year.

Biomass Estimations from Plot Data:

Trees – standing live and dead tree biomass is calculated from plot data using the FVS-FFE model.

Lying Dead Wood – the mass of lying deadwood was measured in the plots using the line intersect method. Following the plot SOP, two permanently marked 164-ft (50m) transect lines were placed at right angles across the plot center. The diameters of all pieces of wood ≥ 2 in (5cm) diameter that intersect the line were measured and assigned to one of three density classes.

[43] Note the AU plot representation is based on a preliminary target of ~40 plots, with approximate representation by AU by forested acres, with plots located within project instances at validation. These initial plots were achieved inventory and model error terms close to the target of 10% error. Additional plots may be installed over time to maintain the approximate representation and to improve the inventory error term as new project instances are added, or otherwise to improve results.

[44] The project recognizes plot installation and measurements are typically done in a summer field season and re-measurements will be taken within the 5th year after installation, rather than at the specific calendar date 5 years after installation date.

Each piece of dead wood was assigned to one of three density classes, sound (1), intermediate (2), and rotten (3). The volume per unit area was calculated for each density class using Equations 60a-c, as described in the VM0012 methodology.

The density of LDW in the 3 classes was assumed to be 0.43, 0.34, and 0.19 (t m^{-3}), for the sound, intermediate, and rotten. These values are based upon the default values provided in (Pearson et al. 2007). The total mass of lying dead wood was calculated as the average of all transects.

Quality Assurance/Quality Control Measures (QA/QC)

King County has standard operating procedures for: (1) collecting reliable field measurements; (2) verifying laboratory procedures; (3) verifying data entry and analysis techniques; and (4) data maintenance and archiving.

QA/QC for Field Measurements - the plot network was installed by trained field crews with previous experience installing similar permanent plots. The plot installation SOP requires blind check-cruises of a minimum of 10% of the plots, with 100% re-measurement of all variables which meet met the minimum DBH, height, and tree count accuracy thresholds (+/- 10% standard error at 90% confidence interval). This meets the methodology QA/QC 10% check cruise requirement. Data results will be reported in the project monitoring plan for each verification.

QA/QC for Laboratory Measurements - no laboratory measurements were taken for the King County sampling, and so this section is not applicable.

QA/QC for Data Entry – Field data is collected on digital data recorders and is transferred electronically to minimize data entry and transfer errors. If there are anomalies that cannot be resolved noted within plot data, the plot will be re-measured or omitted from the analysis.

QA/QC for Data Archiving - King County has document control procedures which apply to the carbon monitoring data, including retaining all relevant project documentation for 2 years past the duration of the project, including the following: Project Design and Monitoring Report documents, original electronic copies of the field measurement, check plots, and related data summaries; copies of monitoring data analyses, models, model input and output files, carbon calculations required for this methodology, GIS inventory dated by year, and copies of the monitoring reports; records of the version and relevant change history of software or data storage media changed between monitoring periods.

5 SAFEGUARDS

5.1 No Net Harm

No significant potential negative environmental and socio-economic impacts are anticipated from the project.

5.2 Environmental Impact

There are no anticipated negative environmental impacts associated with the retention of natural forest. By retaining and protecting existing forest and managing for ecological function and enhancement this carbon project will protect or enhance aspects of biodiversity, water quality and quantity, and other ecosystem services.

5.3 Local Stakeholder Consultation

King County DNRP and other natural resource departments maintain extensive public communication, outreach and education programs. An extensive suite of modern and up to date websites and social media accounts are maintained related to a wide range of programs related to parks, ecosystem management, ecosystem services, regulatory issues, and also specifically for climate change and forest carbon. These websites are a primary method for broad communication with stakeholders across King County and the Region. Contact information is readily available on each webpage or via social media. Examples include:

Webpage for the forest carbon project: https://www.kingcounty.gov/services/environment/water-and-land/land-conservation/forest-carbon.aspx

King County also publishes various newsletters and program updates that are distributed to interested stakeholder email lists. Examples include:

a. https://content.govdelivery.com/accounts/WAKING/bulletins/248f742
b. https://content.govdelivery.com/accounts/WAKING/bulletins/2456f5e

King County DNRP and related departments host various stakeholder engagement events and meetings, including events open to the general public, media and targeted groups. Examples include:

1. Carbon program public launch event (May 9, 2019):
   a. Speakers: Dow Constantine, King County Executive; Lucas Joppa, Chief Environmental Officer, Microsoft; Helena Park, CEO, Fisherman's Finest; Mark McPherson, Executive Director, City Forest Credits; Stephen Killeen, CEO, Natural Capital Partners
   b. Attended by a range of King County staff and representatives from: WA Department of Natural Resources, Washington Environmental County, Mountains to Sound Greenway Trust, The Nature Conservancy, Trust for Public Land, and Forterra
   c. News release: http://bit.ly/307DnOk
   d. Local media coverage: https://www.king5.com/mobile/article/news/local/king-county-program-helps-companies-reduce-carbon-footprints-by-preserving-forests/281-22c36e37-2317-4df7-95a8-fa899af4a320
   e. Social media:
   - https://twitter.com/kcexec/status/1126560512488067072
   - https://twitter.com/kcexec/status/1126548565306724352
   - https://twitter.com/kcexec/status/1126887176443011077
   - https://www.instagram.com/p/BxQX9Djnvh2/

- https://twitter.com/JadDaley/status/1128404714117267456
- The motion graphic was watched on the Executive's Facebook page >2,500 times: https://www.facebook.com/ExecutiveConstantine/videos/434410517126708/?sw_fnr_id=375089526

2. A Follow-up to program launch event was included in King County Executive Dow Constantine's monthly newsletter on 6/4/19: sent to all local news media, all 15,000 county employees, and about 9,000 newsletter subscribers (https://content.govdelivery.com/accounts/WAKING/bulletins/248f742)

King County staff also consult and work extensively with other government agencies and agency advisory groups. Related examples include:

1. WA Department of Natural Resources
    a. Presentation at DNR June 12, 2019
    b. Conversations with DNR (Dan Stonington, Policy Director and Dan Siemann) in June 2018, October 2018, and December 2018
    c. General Scoping Meeting with WA DNR (Laurie Benson): March 20, 2017
    d. Conversations with Department of Natural Resources (Dan Stonington, Policy Director and Dan Siemann) in June 2018, October 2018, and December 2018
2. Presentation to the Land Conservation Initiative Advisory Group, October 5, 2017
3. King County Rural Forest Commission
    a. Formal presentations at RFC meetings: May 12, 2016 and January 18, 2018
    b. Other informal updates at other RFC meetings over the past 2 years, including January 17, 2019
4. Presentation to the Conservation Futures Tax Committee, March 27, 2018
5. Meetings with regional nonprofits and environmental consulting groups:
    a. Lunch and Learn at Northwest Natural Resource Group, attended by a wide range of environmental and forestry nonprofits: June 13
    b. Phone meeting with Kyle Braun, The Watershed Company, Kirkland, WA: May 15, 2019
    c. Meeting with Max Webster, Washington Environmental Council: March 8, 2019
    d. Meeting with Washington Environmental Council (Lisa Remlinger, Joe Kane): November 15, 2016
    e. Meeting with Nisqually Land Trust (Max Webster): October 24, 2017
    f. Meeting with Forterra (Charlie Raines, Darcy Hughes): December 18, 2018
    g. Meeting with Washington Environmental Council (Max Webster): March 8, 2019
6. Meetings and other communication with local corporations.

5.4 Public Comments

The documents were posted for the 30 day comment period by Verra and no comments were received.

6 LITERATURE CITED

Abbot DT, Crossley DA (1982) Wood litter decomposition following clear cutting. Ecology 63:35–42

Brown, J.K. and C.M. Johnston. (1976). Debris Prediction System. USDA Forest Service, Intermountain Forest and Range Experiment Station, Missoula, MT. Fuel Science RWU 2104. 28 pp.

Curtis, Robert O.; Herman, Francis R.; DeMars, Donald J. 1974. Height growth and site index for Douglas-fir in high-elevation forests of the Oregon-Washington Cascades. Forest Science 20(4):307-316.

Dixon, Gary E. comp. (2018). Essential FVS: A user's guide to the Forest Vegetation Simulator. Internal Rep. Fort Collins, CO: U. S. Department of Agriculture, Forest Service, Forest Management Service Center. 226p. (Originally published 2002, revised Sept. 24, 2018)

Hamilton, W. D. 1986. Tree wounds: their causes and treatment. Arbor Age 6(10):36-39.

Harmon, M., & Sexton, J. (1996). *Guidelines for measurements of woody detritus in forest ecosystems. US LTER Publication No. 20.* Seattle, WA: US LTER Network Office, University of Washington.

IPCC. (2006b). *2006 IPCC Guidelines for National Greenhouse Gas Inventories.* IGES, Japan: National Greenhouse Gas Inventories Programme.

Keyser, Chad E., comp. (2018). Pacific Northwest Coast (PN) Variant Overview – Forest Vegetation Simulator. Internal Rep. Fort Collins, CO: U. S. Department of Agriculture, Forest Service, Forest Management Service Center. (Originally published 2008, revised Sept. 24, 2018).

Keyser, Chad E., comp. 2008 (revised October 2, 2019). Westside Cascades (WC) Variant Overview – Forest Vegetation Simulator. Internal Rep. Fort Collins, CO: U. S. Department of Agriculture, Forest Service, Forest Management Service Center. 80p.

Pearson, T., Brown, S., & Birdsey, R. 2007. *Measurement guidelines for the sequestration of forest carbon.* USDA For Serv., North. Res. Station. Gen. Tech. Rep. NRS-18.

Rebain, Stephanie A. comp. (2015). The Fire and Fuels Extension to the Forest Vegetation Simulator: Updated Model Documentation. Internal Rep. Fort Collins, CO: U. S. Department of Agriculture, Forest Service, Forest Management Service Center. (Originally published 2010, revised Mar. 23, 2015).

Smith, J.E., et al. (2006). Methods for Calculating Forest Ecosystem and Harvested Carbon with Standard Estimates for Forest Types of the United States. General Technical Report NE-343. USDA Forest Service, Northeastern Research Station.

Smith, W. Brad; Miles, Patrick D.; Vissage, John S.; Pugh, Scott A. (2004). Forest Resources of the United States, 2002. General Technical Report NC-241. St. Paul, MN: U.S. Dept. of Agriculture, Forest Service, North Central Research Station

Voluntary Carbon Standard. (2008). *Tool for AFOLU Non-Permanence Risk Analysis and Buffer Determination.* Washington D.C.: VCS Association.

Wykoff, W. R.; Crookston, N. L.; Stage, A. R. (1982). User’s guide to the StandPrognosis Model. General Technical Report INT-133. Ogden, UT: U.S. Department of Agriculture, Forest Service, Intermountain Forest and Range Experiment Station. 112 p.

7 APPENDICES

7.1 APPENDIX 1: Example Comparative Investment Analysis

Rather than identify the additionality test by property, the project has conservatively undertaken the Investment Analysis using representative examples of potential commercial project activities to demonstrate overall project additionality for all properties under a commercial return scenario, which will capture all lessor commercial activity properties.

Examples of situations where the project activities might include commercial returns could include selective removal of limited amounts of timber:

a. for fire risk reduction, pest management, or another hazard management;
b. for commercial thinning of over-dense stands, towards the objectives of reducing hazard, improving large forest development, recreational improvement, and/or other conservation-based management goals
c. removal of select trees for species conversion or habitat development, etc.

Note that these project activities are limited in nature, rarely applied, and periodic activities. In most situations the project properties will simply be conserved and protected; in other cases, non-commercial management may be undertaken to achieve objectives (such as ‘drop and leave’ tree removals, etc.). In relatively rare situations, a property may include commercial harvesting in the form of selection harvesting or commercial thinning. The purpose of the activity is to create or accelerate desired habitat or ecosystem conditions. Generally, these activities will be more expensive than conventional forest operations and involve significantly lower volume removals. If profitable, these revenues will be more than offset by other conservation and property management costs in the project scenario on the property or across the portfolio. Importantly, when considering investment analysis, these project activities are not targeting or supporting a ‘final harvest’ which is the key driver for achieving typical investment returns in common practice (baseline) timberland management.

Similarly, the baseline rural residential land investment returns are driven by maximizing the return from both timber removals and residential lot development. The appraisals (available to auditors) on properties fitting this baseline clearly demonstrate the return to the landowner is related to the development value (plus timber value to a lesser degree). King County has high demand for residential properties near the city of Seattle and other municipalities, making this land increasingly valuable. Conversely, the project scenario precludes further rural residential development, and therefore dramatically reduces the investment return from residential land value (to essentially zero), along with removing most (or all) of the timber returns as well.

To demonstrate, an Investment Analysis was undertaken for a general Forestry baseline scenario versus a project scenario using a simplified Discounted Cashflow Analysis. This model is representative for the other baselines, as the same conclusions can be made where timber harvest is strongly reduced and the development value removed entirely.

Figure 5 shows a simplified 10-year discounted cashflow analysis to calculate comparative Internal Rates of Return (IRR) between an assumed Forestry Baseline Scenario and the Project Scenario for a property in the project (this is actually a Rural Residential property, but the appraisal includes a detailed forest valuation for demonstration purposes). This model represents a generalized comparative situation based on data and information from a detailed appraisal specific 136-acre timbered property (the Dyar Property) The first table showing the baseline scenario demonstrates a reasonable potential to generate an IRR between 3.6 - 19.2% - the large variance is related to the inclusion or omission of a terminal value (i.e. representing residual future timber and property value). This property is clearly able to achieve or surpass the industry cost of capital of 4.5-6.0% IRR (see references with the Dyar Property Appraisal) when the residual value is included. Comparatively, the project scenario shows an IRR of (-8.6%) - a negative financial return. Note also that this project scenario does not fully reflect the additional costs of conservation management due to complexity, but which would turn annual project cashflows strongly negative as well (and create an even more negative return). The project scenario is clearly not the most financially attractive scenario.

Additionally, as shown in appraisals with a higher and better use of rural residential, the investment returns are typically significantly higher for properties where rural residential is an option. This analysis is representative given the Rural Residential Baseline Scenario will be above the results of this timber example, and clearly the project scenario (which prevents development value) will not be the most financially attractive scenario.

The historical and customized baseline scenarios will follow the same trend, where historical/common practices driven by financial returns will clearly be more financially attractive than the project scenario with very low or negative returns. This analysis is representative of properties in this baseline strata, and the project scenario will not be the most financially attractive scenario here either.

Summarized, within this analysis the fundamental conclusion is that the selected baseline scenarios will always be financially more attractive because the baselines include volume-based timber removals and rural residential land development (which increases the land value and return to the owner). Removing significantly less commercially valuable timber and restricting development reduces the investment returns for project properties to negative returns. These conclusions are supported by the results of the highest and best use analysis across the properties, where the baseline scenarios are shown to be the most valuable alternative.

King County Additionality Comparative Investment Analysis: Baseline vs. Project Scenario NPV Comparison.

1. BASELINE FORESTRY SCENARIO - QUICK IRR ANALYSIS

NPV @ 5.5%: $2,461,020 | IRR : 19.2% | IRR w/o TV: 3.8%

		2008 1	2009 2	2010 3	2011 4	2012 5	2013 6	2014 7	2015 8	2016 9	2017 10	*Terminal Value: Annualized Average*	
Acres Harvested (ac)	135.5	40.65	0	27.10	0	40.65	0	0	27.10	0	0	*13.55*	
Harvest Type		Clearcut		CT 35%		Clearcut			CT 35%				
Volume Harvested (mbf)	26	1,063	-	248	-	1,063	-	-	248	-	-	*262.27*	
Wgt. Log Value ($/mbf)	706	750,543	-	175,127	-	750,543	-	-	175,127	-	-	*185,133.93*	
Log & Road Costs ($/mbf)	224	(238,170)	-	(55,573)	-	(238,170)	-	-	(55,573)	-	-	*(58,748.59)*	
Reforestation ($/ac)	200	(8,130)	-	-	-	(8,130)	-	-	-	-	-		
Management	$ 2,730.00	$ (2,730)	$ -	$ (2,730)	$ -	$ (2,730)	$ -	$ -	$ (2,730)	$ -	$ -	*(1,092.00)*	
Timber EBITDA		$ 501,513	$ -	$ 116,824	$ -	$ 501,513	$ -	$ -	$ 116,824	$ -	$ -	*$ 125,293*	
	Acquistion:												Terminal Value
	$ (1,092,080)	$ 501,513	$ -	$ 116,824	$ -	$ 501,513	$ -	$ -	$ 116,824	$ -	$ -		$ 2,518,396

Note: Scenario and data simplified/modified from 2017 Dyer Property Timber Appraisal using a Class III Forestry approach
The Terminal Value (which represents the potential future re-sale value on the land) is excluded for simplicity and to evaluate the timber returns on a more pure basis

2. PROJECT SCENARIO - QUICK IRR ANALYSIS

NPV @ 5.5%: -$381,245 | IRR : -8.6% | IRR w/o TV: -8.6%

		2008 1	2009 2	2010 3	2011 4	2012 5	2013 6	2014 7	2015 8	2016 9	2017 10	*Terminal Value: Annualized Average*	
Acres Harvested (ac)	135.5	33.88	0	0	0	33.88	0	0	0	0	0	*6.78*	
Harvest Type		Var Den CT				Var Den CT							
Volume Harvested (mbf)	8	886	-	-	-	886	-	-	-	-	-	*177.21*	
Wgt. Log Value ($/mbf)	706	625,452	-	-	-	625,452	-	-	-	-	-	*125,090.50*	
Log & Road Costs ($/mbf)	224	(198,475)	-	-	-	(198,475)	-	-	-	-	-	*(39,694.99)*	
Conservation Mngt:	$ 2,730.00	$ (2,730)	$ (2,730)	$ (2,730)	$ (2,730)	$ (2,730)	$ (2,730)	$ (2,730)	$ (2,730)	$ (2,730)	$ (2,730)	*(2,730.00)*	
Timber EBITDA		$ 424,248	$ (2,730)	$ (2,730)	$ (2,730)	$ 424,248	$ (2,730)	$ (2,730)	$ (2,730)	$ (2,730)	$ (2,730)	*$ 82,666*	
	Acquistion:												Terminal Value
	$ (1,092,080)	$ 424,248	$ (2,730)	$ (2,730)	$ (2,730)	$ 424,248	$ (2,730)	$ (2,730)	$ (2,730)	$ (2,730)	$ (2,730)		$ -

Note: Using same assumed Dyer property, undertaking conservation on 50% of area; Variable Density Commercial Thinning (30% mbf removal) as representative of most commercial operation contemplated by King County on similar properties.
- however, most properties in the project would have either no commercial activities or less harvest area/volume.
- the conservation-based management costs are not reflected in this table (simply showing a forestry management cost) - these costs are highly variable depending on the property and available budget. These costs could amount to an additional -$25,000-250,000/yr.
They have been excluded for simplicity and because the point has been made already that the project scenario is dramatically worse than the baseline, and dramatically below industry IRR expectations.
Note: Scenario and data simplified/modified from 2017 Dyer Property Timber Appraisal using a Class III Forestry approach
The Terminal Value (which represents the potential future re-sale value on the land) is excluded for simplicity and to evaluate the timber returns on a more pure basis

See individual cell comments for more detail on sources and assumptions.

Figure 5 - Quick IRR Analysis on a Representative Baseline and Project Instance.

7.2 APPENDIX 2: Assessment of Proximal Rural Residential Development Patterns

Individual property development patterns can be variable. The baseline scenario strata are intended to be representative of development patterns on average across the project geographic area for approximately similar property situations. The baseline scenarios for the Rural Residential baselines described in Table 6 are based on a combination of: review of an extensive selection of recent independent property appraisals related to several years of King County property acquisitions; a GIS digitizing and visual assessment of a selection of 50 similar properties located proximal to initial property instances; and a visual assessment of temporal ortho-imagery on various proximal properties using Google Earth historical imagery.

The appraisal documentation is confidential, but available to auditors upon request. Appraisals describe the certified appraisers' assessment of development opportunities and highest and best use for valuation purposes. Typically appraisals are a key driver in acquisition valuation which then creates the financial drivers leading toward the described highest and best use.

A GIS and visual assessment of a set of 50 RA-10, and RA-5 zoned post-development properties (~195 acres in total)) near the Soaring Eagle, Vashon Island, Bass Beaver Dandy, and Mitchell Hill areas/properties were variable, but resulted in the following average findings:

d. Avg. Developed (buildings, roads, etc.) = 14% (Range by area 9-17%)

e. Avg. Cleared (yards, pastures, other clearings, etc.) = 41% (32-61%)

f. Average Canopy Retained (visual canopy, stocking unknown) = 45% (31-52%).

Details by property are available to auditors in the file “KC Lots & Appraisals List”.

A visual assessment of representative recent development patterns using Google Earth historical imagery (variable availability from 1990 to 2018) and King County satellite imagery (various years, 2007-2017) and property parcel data (King County Parcel Viewer) provides visual context for proximal properties under similar to the Rural Residential baseline scenarios:

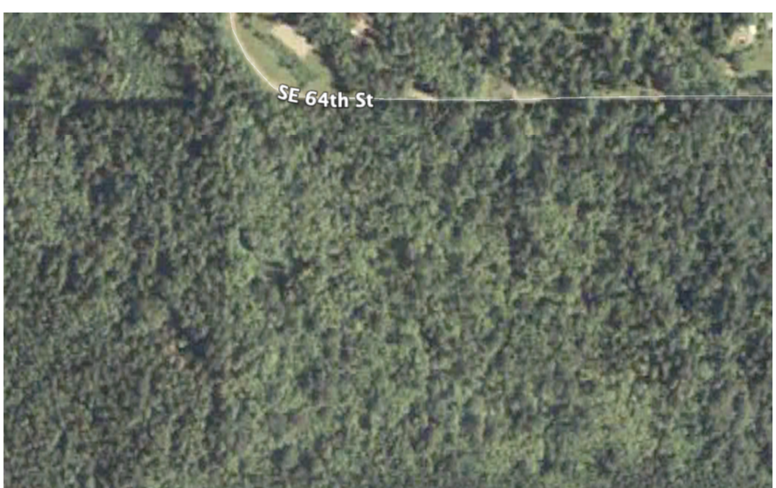

Figure 6. Original area has variable mature forest in 2005

Figure 7. Area showing 2 - 20 acre parcels in red. Logging on eastern parcel. Image: 2009

Figure 9. Developments for residential - roads, house site clearing. Image 2015.

Figure 10. First house construction begins. Image 2017

Figure 11. Current house developments. Notice the forest canopy has expanded and appears more forest coverage than earlier logging images. Image 2018.

7.3 APPENDIX 3: Supporting data files

The following table includes the key data files used in the PDD. Copies were provided to auditors during validation.

Description	Filename	Format	Date
Spatial inventory data for the King County landbase including forest cover, parcel boundaries and harvestable areas.	King County Carbon Database 2020-07-08.zip	Microsoft Access Database with features	07/08/2020
LiDAR Data for elevations and canopy	April2019_TransferData_C.gdb	File geodatabase	6/1/2019
LiDAR Data for elevations and canopy for the missing Li properties	AddlVegHgt_Jan2019.gdb	File geodatabase	6/1/2019
Carbon plot locations	Carbon_Plots.shp	Shape file	11/30/2019
MS Access model used to calculate storage and emissions from harvested wood products and to calculate to project VCUs from model output on emissions considering leakage, uncertainty, and buffers etc..	King County Carbon Database 2020-07-08.zip	Microsoft Access Database	07/08/2020
King County monitoring plot data	King County plot data Nov 2019 v2.xlsx	MS Excel	03/30/2020
King County Non-Permanence Risk Assessment	King County Non-Permanence Risk Report_2015-2018 v1.3.doc King County VCS Risk Report Calculation Tool(v3.1)_2015-2018 v1.3.xlsm	MS Word/Excel	06/30/2020

7.4 APPENDIX 4: Example Illustrations of Forest Cover Mapping

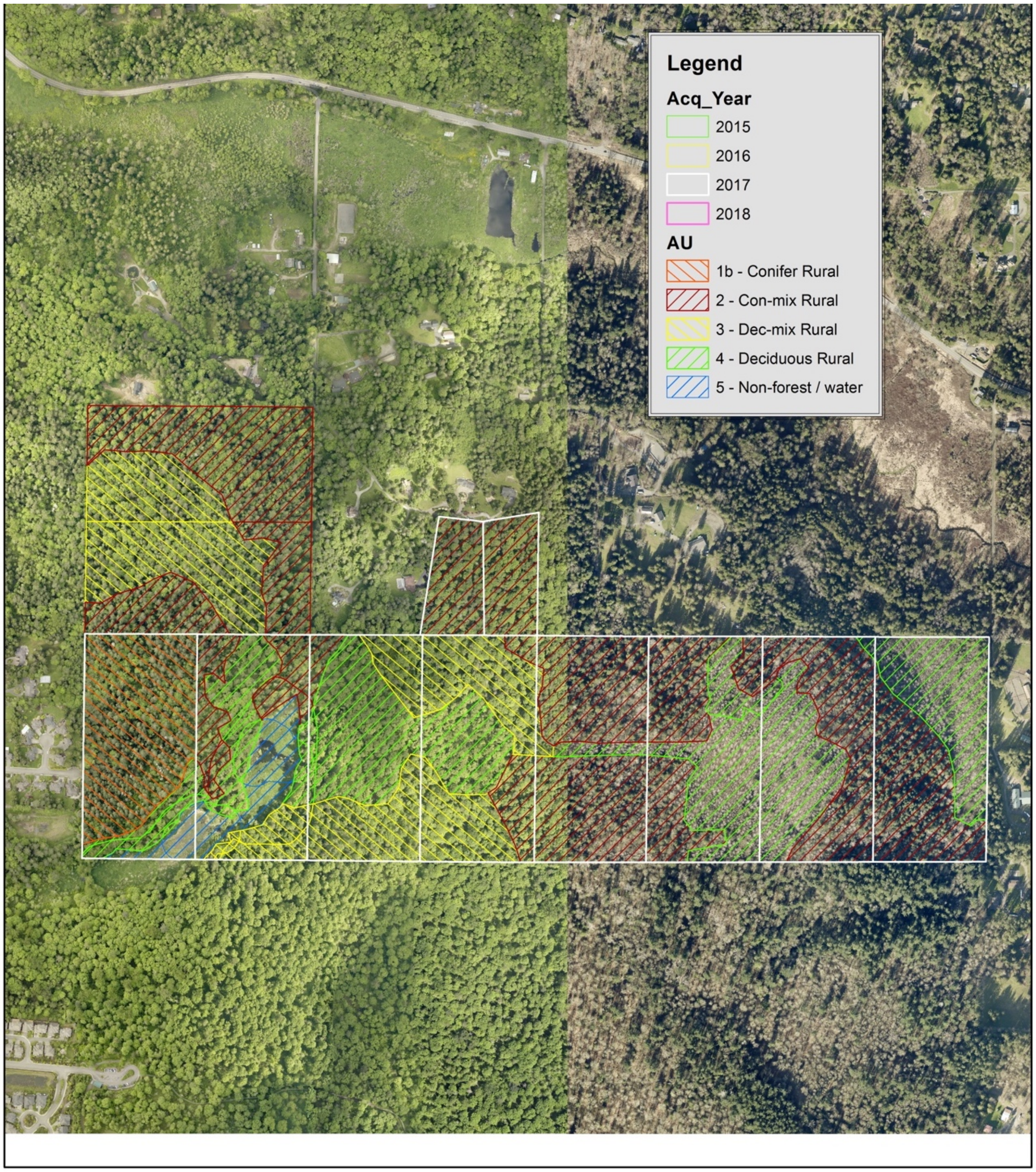

Figure A1. Example of digitized forest cover analysis units overlaid on 2015 orthophoto with parcel boundaries identified by acquisition year.

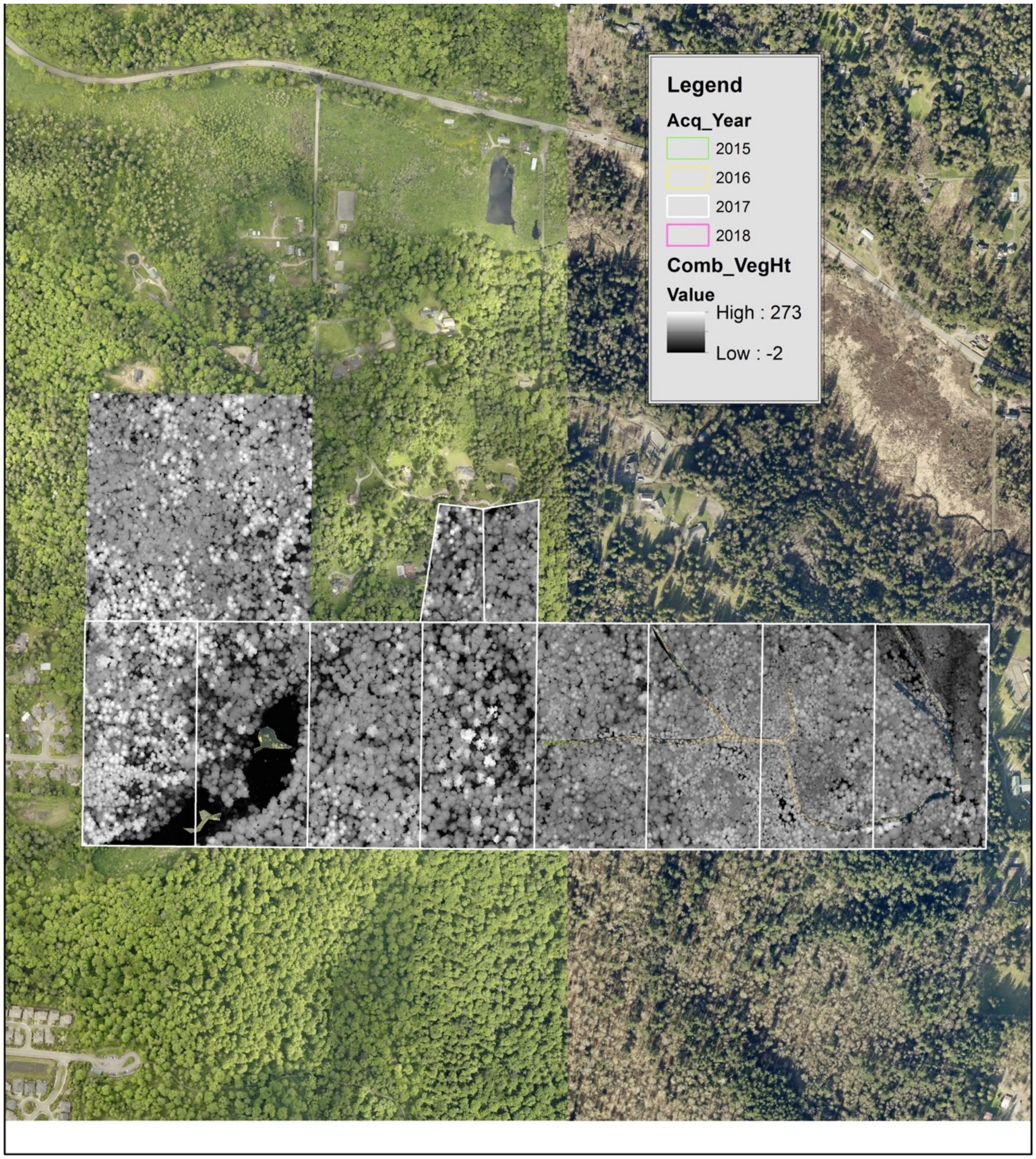

Figure A2. LiDAR-derived canopy height data with parcel boundaries identified by acquisition year. The height data were used to split polygons with similar species but different top heights. The height statistics for each polygon were used to estimate mean height of canopy dominants which was subsequently used to estimate tree age.

7.5 APPENDIX 5: VCS Non-Permanence Risk Assessment

The project is designed to stratify project instances into multiple Non-Permanence Risk Assessments if stratification will better represent the risks associated with groups of properties in the project. The resulting risk assessment results will then be averaged based on total acres in each strata to come up with a single Non-Permanence Risk Pool contribution percentage for the project in each verification period. For example, certain participating 3rd party project instances might have different long term legal agreements which result in a different risk rating result than King County owned properties. The need for multiple risk assessment strata (versus a single risk assessment) will be assessed at each verification and justified if different than the most recent previous verification.

The project's initial period Non-Permanence Risk Assessment is available in a separate documents.

The result of the current risk assessment at the time of validation across all project instance strata is a Non-Permanence Risk Buffer Pool contribution of **10%**.

7.6 APPENDIX 5: VM0012 Equation Reference List

The following is a list of the carbon calculation equations required by the methodology VM0012 that are referenced within this document. Additional description and variable details are available in the methodology document.

The King County project utilizes a combination of the FVS-FFE model and an MS Access Database file to complete all calculations. For additional clarity, direct commentary has been added beneath each formula describing where/how the calculation(s) is/are made that relates to each equation. Note that additional information about scenario assumptions, modeling processes, and data handling can be found in the related sections of the PD above and in further detail in referenced supporting descriptive documentation provided to auditors (in particular the KC Process for Modeling Stand Yields document provides step by step data preparation, modeling, and database function reference). Other supporting variable information can be found in the parameter tables in Section 4[45]..

BASELINE EMISSIONS EQUATIONS:

The total annual carbon balance in year, t, for the baseline scenario is calculated as ($\Delta C_{BSL,t}$, in t C yr^{-1}):

$$\Delta C_{BSL,t} = \Delta C_{BSL,P,t} \quad (1)$$

where:

$\Delta C_{BSL,P,t}$ = annual change in carbon stocks in all pools in the baseline across the project activity area; t C yr^{-1} .

Change in carbon stocks by pool by year is modeled by FVS-FFE by AU. The FVS stand data (Stand Carbon Report) outputs are imported to the KC Carbon Database where the data is compiled by AU, polygon and across the BSL scenario conditions. The Scenario Generator and Output PD Table queries complete the summarizing queries and calculations to accomplish Equation 1. See Footnote 36 for additional database information.

$$\Delta C_{BSL,P,t} = \Delta C_{BSL,LB,t} + \Delta C_{BSL,DOM,t} + \Delta C_{BSl,HWP,t} \quad (2)$$

where:

$\Delta C_{BSL,LB,t}$ = annual change in carbon stocks in living tree biomass (above- and belowground); t C yr^{-1}

$\Delta C_{BSL,DOM,t}$ = annual change in carbon stocks in dead organic matter; t C yr^{-1}

$\Delta C_{BSl,HWP,t}$ = annual change in carbon stocks associated with harvested wood products, t C yr^{-1}.

FVS models changes in carbon stocks by pool, which is then compiled and summarized by year and polygon across the BSL scenario conditions. The Scenario Generator and Output PD Table queries complete the summarizing queries and calculations, as per Equation 2. More specifically, the calculations are completed in the queries briefly described in Footnote 36 and the results found in the create the "QScenario_BaselineByYear" output query created by the Scenario Generator.

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[45] The process followed to prepare and compile the data related to the equations listed through this Appendix are detailed in the KC Process for Modeling Stand Yields Document. The more specific underlying functions of the KC Carbon Database can be seen by tracing the series of tables, queries, and functions found in the Access Database model. The primary functions of this database tool are activated using the buttons in the "Scenario Generator" form, which then completes the majority of these equations using underlying queries and tables. The key output is found in the Scenario_Baseline table for the baseline, and Scenario_Project for the project calculations. The Scenario_Baseline table, for example is populated from a series of Append queries all beginning with "QappSecenario_Baseline" that are executed when clicking the "Run Queries" button on the Scenario Generator form. These queries are performing the actual equation calculations to compile and summarize the data. The output query "QScenario_BaselineByYear" shows the data from the Scenario_Baseline table. All of the tables that go into those queries come from the GIS data and the property listings with the exception of the "FVS_Carbon_AllYears" table, which is generated when clicking the "Update FVS_Carbon_AllYears" button on the "Import AU FVS Summary and Carbon Data" form. It runs a function called "PopulateFVS".

$$\Delta C_{BSL,LB,t} = \Delta C_{BSL,G,t} - \Delta C_{BSL,i,t} \quad (3)$$

where:
$\Delta C_{BSL,G,t}$ = annual increase in tree carbon stock from growth; t C yr^{-1}
$\Delta C_{BSL,L,t}$ = annual decrease in tree carbon stock from a reduction in live biomass; t C yr^{-1}.
If the project geographic area has been stratified, carbon pools are calculated for each polygon, i, and then summed during a given year, t.

FVS models live tree gains and loss by AU, by year. The database tool compiles and summarizes the FVS carbon outputs across polygons and baseline scenario conditions, including calculating Equation 3. More specifically, the calculations are completed in the queries briefly described in Footnote 36 and the results found in the create the "QScenario_BaselineByYear" output query created by the Scenario Generator.

Live biomass gain in year, *t*, polygon, *i* ($\Delta C_{BSL,G,i.t}$) is calculated as:

$$\Delta C_{BSL,G,t} = \Sigma(A_{BSL,i} \bullet G_{BSL,i,t}) \bullet CF \quad (4)$$

where:
$A_{BSL,i,}$ = area (ha) of forest land in polygon, *i*;
$G_{BSL,i,t}$ = annual increment rate in tree biomass (t d.m. ha^{-1} yr^{-1}), in polygon, *i*, and;
CF = carbon fraction of dry matter t C t^{-1} d.m. (IPCC default value = 0.5).

$$G_{BSL,i,t} = G_{BSL,AG,i,t} + G_{BSL,BG,i,t} \quad (5a)$$

where:
$G_{BSL,AG,i,t}$ and $G_{BSL,BG,i,t}$ = annual above- and belowground biomass increment rates (t d.m. ha^{-1} yr^{-1});

$$G_{BSL,BG,i,t} = G_{BSL,AG,i,t} \bullet R_i \quad (5b)$$

Live biomass gain is modeled by FVS by AU and by year to accomplish Equations 5a & 5b. The database tool sums and tracks FVS outputs by polygon and year to accomplish Equation 4. More specifically, the calculations are completed in the queries briefly described in Footnote 36 and the results found in the create the "QScenario_BaselineByYear" output query created by the Scenario Generator.

Live biomass loss is calculated as:

$$\Delta C_{BSL,L,t} = \Sigma(LBL_{BSL,NATURALi,t} + LBL_{BSL,FELLINGS,i,t} + LBL_{BSL,OTHER,i,t}) \bullet CF \quad (6)$$

where:
$LBL_{BSL,NATURALi,t}$ = annual loss of live tree biomass due to natural mortality in polygon, *i*; t d.m. yr^{-1}
$LBL_{BSL,FELLINGS,i,t}$ = annual loss of live tree biomass due to commercial felling in polygon, *i*; t d.m. yr^{-1}
$LBL_{BSL,OTHER,i,t}$ = annual loss of live tree biomass from incidental sources in polygon, *i*; t d.m. yr^{-1}
CF = carbon fraction of dry matter; t C t^{-1} d.m. (IPCC default value = 0.5).

$$LBL_{BSL,NATURALi,t} = A_{BSL,i} \bullet LB_{BSL,i,t} \bullet f_{BSL,NATURAL,i,t} \quad (7)$$[46]

where
$A_{BSL,i}$ = area (ha) of forest land in polygon, *i*;
$LB_{BSL,i,t}$ = average live tree biomass (t d.m. ha^{-1}) in polygon, *i,* for year, *t*
$LB_{BSL,i,t}$ is calculated for year, *t*, beginning with biomass estimates in year *t*=1 (the project start year) and with annual biomass increments ($G_{BSL,i,t}$) added as per calculations in equation 5a.
$f_{BSL,NATURAL,i,t}$ = the annual proportion of biomass that dies from natural mortality in polygon , *i* (unitless; $0 \leq f_{BSL,NATURALi} \leq 1$), year, *t*.

$$LBL_{FELLINGS,i,t} = A_{BSL,i} \bullet LB_{BSL,i,t} \bullet f_{BSL,HARVEST,i,t} \quad (8)$$

where:
$A_{BSL,i}$ = area (ha) of forest land in polygon, *i*

[46] Note, for Equation 7, 8, and 9: $(f_{BSL,NATURAL,i,t} + f_{BSL,HARVEST,i,t} + f_{BSL,DAMAGE,i,t}) \leq 1.0$

$LB_{BSL,i,t}$ = average live tree biomass (t d.m. ha^{-1}) in polygon, *i,* for year, *t* (see equation 7 for its calculation).
$f_{BSL,HARVEST,i,t}$ = the proportion of biomass removed by harvesting from polygon, *i,* (unitless; $0 \leq f_{BSL,HARVESTIi} \leq 1$), in year, *t*. Data for this variable should be obtained from harvest schedule information. Values may be constrained by (a) the value of $f_{BSL,NATURAL,i,t}$ (i.e., $f_{BSL,HARVEST,i,t} < 1- f_{BSL,NATURAL,i,t}$), and/or (b) the area of timber available for commercial harvest.

$$LBL_{BSL,OTHER,i,t} = A_{BSL,i} \bullet LB_{BSL,i,t} \bullet f_{BSL,DAMAGE,i,t} \quad (9)$$

where:
$A_{BSL,i}$ = area (ha) of forest land in polygon, *i*;
$LB_{BSL,i,t}$ = average live tree biomass (t d.m. ha^{-1}) in polygon, *i,* for year, *t*
$f_{BSL,DAMAGE,i,t}$ = the proportion of additional biomass removed for road and landing construction in polygon, *i,* year, *t* (unitless; $0 \leq f_{BSL,DAMAGE,i,t} \leq 1$).

Live biomass loss is also modeled by FVS for each AU, by year. The database tool compiles and summarizes this data by polygon and year, and applies any baseline scenario harvest assumptions. FVS includes mortality functions to account for Equation 7, and accounts for the transition of biomass between various live and dead carbon pools, including the regeneration of new stands after harvest, and the removals of harvested timber into the Harvested Wood Products output reports (i.e. Equation 8). Currently there is no LBL_{OTHER} in use in the project, with roads and landings removed using spatial GIS data into AU5. The database tool tracks FVS stand carbon pool output by polygon and year, and also tracks the transition of stand carbon by pool into the newly regenerating stand. The database model applies harvesting to polygons as per the baseline scenario, and tracks FVS stand carbon data outputs accordingly. Equations 6-9 are all modeled by FVS, then compiled and summed in the database tool. More specifically, the calculations are completed in the queries briefly described in Footnote 36 and the results found in the create the "QScenario_BaselineByYear" output query created by the Scenario Generator.

Change in Dead Organic Matter (DOM) ($\Delta C_{BSL,DOM}$; t C yr^{-1}) is calculated as:

$$\Delta C_{BSL,DOM,t} = \Delta C_{BSL,LDW,t} + \Delta C_{BSL,SNAG,t} + \Delta C_{BSL,DBG,t} \quad (10)$$

where:
$\Delta C_{BSL,LDW,t}$ = change in lying dead wood (LDW) carbon stocks in year, t; t C yr^{-1}
$\Delta C_{BSL,SNAG,t}$ = change in snag carbon stock in year, t; t C yr^{-1}
$\Delta C_{BSL,DBG,t}$ = change in dead belowground biomass carbon stock in year, t; t C yr^{-1}.

The change in DOM derived from lying dead wood (LDW) carbon stock in year, t (t C yr^{-1}) is calculated as:

$$\Delta C_{BSL,LDW,t} = \Sigma(LDW_{BSL,IN,i,t} - LDW_{BSL,OUT,i,t}) \bullet CF \quad (11a)$$

$$LDW_{BSL,i,t+1} = LDW_{BSL,i,t} + (LDW_{BSL,IN,i,t} - LDW_{BSL,OUT,i,t}) \quad (11b)$$

where:
$LDW_{BSL,,i,t}$ = The total mass of lying dead wood accumulated in polygon *i* , at time, *t* (t d.m.).
$LDW_{BSL,IN,i,t}$ = annual increase in LDW biomass for polygon *i*, year, *t* (t d.m yr^{-1}). LDW increases occur as a result of natural mortality (typically, blowdown), and as a direct or indirect result of harvesting.
$LDW_{BSL,OUT,i,t}$ = annual loss in LDW biomass through decay, for polygon *i*, year, *t*, (t d.m yr^{-1})
$LDW_{BSL,IN,i,t}$ and $LDW_{BSL,OUT,i,t}$ are summed across polygons.
CF = carbon fraction of dry matter (IPCC default value = 0.5).

$$LDW_{BSL,IN,i,t} = (LBL_{BSL,NATURALi,t} - LBL_{BSL,NATURALi,t} \bullet R_i) \bullet f_{BSL,BLOWDOWN,i,t} + ((LBL_{BSL,FELLINGS,i,t} - LBL_{BSL,FELLINGS,i,t} \bullet R_i) + (LBL_{BSL,OTHER,i,t} - LBL_{BSL,OTHER,i,t} \bullet R_i)) \bullet f_{BSL,BRANCH,i,t} + ((LBL_{BSL,FELLINGS,i,t} - LBL_{BSL,FELLINGS,i,t} \bullet R_i) + (LBL_{BSL,OTHER,i,t} - LBL_{BSL,OTHER,i,t} \bullet R_i)) \bullet (1 - f_{BSL,BRANCH,i,t}) \bullet f_{BSL,BUCKINGLOSS,i,t} + SNAG_{BSL,,i,t} \bullet f_{BSL,SNAGFALLDOWN,i,t} \quad (12)$$

where:
$LBL_{BSL,NATURALi,t}$, $LBL_{BSL,FELLINGS,i,t,}$ and $LBL_{BSL,OTHER,i,t}$ are as calculated in equations 7, 8, and 9, respectively.

R_i is the root:shoot ratio in polygon, *i* (see equation 5b).
$f_{BSL,BLOWDOWN,i,t}$ = the annual proportion of live aboveground tree biomass subject to blowdown in polygon, *i,* year*, t* (unitless; $0 \leq f_{BSL,BLOWDOWN,i,t} \leq 1$).
$f_{BSL,BRANCH,i,t}$ = the annual proportion of aboveground tree biomass comprised of branches $\geq$ 5 cm diameter in polygon, *i* (unitless; $0 \leq f_{BSL,BRANCH,i,t} \leq 1$).
$f_{BSL,BUCKINGLOSS,i,t}$ = the annual proportion of the log bole biomass left on site after assessing and/or merchandizing the log bole for quality, in polygon, *i* (unitless; $0 \leq f_{BSL,BUCKINGLOSS,i,t} \leq 1$).
$f_{BSL,SNAGFALLDOWN,i,t}$ = the annual proportion of snag biomass in polygon, *i*, year, *t*, that falls over and thus is transferred to the LDW pool (unitless; $0 \leq f_{SNAGFALLDOWN,i,t} \leq 1$).

$$\mathbf{LDW_{BSL,OUT,i,t} = LDW_{BSL,,i,t} \bullet f_{BSL,lwDECAY,i,t}} \quad \mathbf{(13)}$$

where:
$LDW_{BSL,,i,t}$ = the total amount of lying deadwood mass in polygon *i,* year*, t (see equation 11b)*.
$f_{BSL,lwDECAY,i,t}$ = the annual proportional loss of lying dead biomass due to decay, in polygon *i,* year, *t* (unitless; ; $0 \leq f_{BSL,lwDECAY,i,t} \leq 1$).

The change in DOM derived from <u>standing dead wood (snag)</u> carbon stock in year, t (t C yr^{-1}) is calculated as:

$$\mathbf{\Delta C_{BSL,SNAG,t} = \Sigma(SNAG_{BSL,IN,i,t} - SNAG_{BSL,OUT,i,t}) \bullet CF} \quad \mathbf{(14a)}$$

$$\mathbf{SNAG_{BSL,i,t+1} = SNAG_{BSL,i,t} + (SNAG_{BSL,IN,i,t} - SNAG_{BSL,OUT,i,t})} \quad \mathbf{(14b)}$$

where:
$SNAG_{BSL,i,t}$ = The total mass of snags accumulated in polygon *i, at time t (t d.m.).*
$SNAG_{BSL,IN,i,t}$ = annual gain in snag biomass for polygon *i*, year, *t* (t d.m yr^{-1}). Snag biomass develops as a result of natural mortality. In cases where snags are created through management activities, these should be accounted for here.
$SNAG_{BSL,OUT,i,t}$ = annual loss in snag biomass through decay, or falldown (i.e, transfer to the LDW pool)(t d.m yr^{-1})
CF = carbon fraction of dry matter (IPCC default value = 0.5).
Note that $SNAG_{BSL,IN,i,t}$ and $SNAG_{BSL,OUT,i,t}$ are summed across polygons.

$$\mathbf{SNAG_{BSL,IN,i,t} = (LBL_{BSL,NATURALi,t} - LBL_{BSL,NATURALi,t} \bullet R_i) \bullet (1 - f_{BSL,BLOWDOWN,i,t})} \quad \mathbf{(15)}$$

where:
$LBL_{BSL,NATURALi,t}$ is as calculated in equation 7, and
$1 - f_{BSL,BLOWDOWN,i,t}$ is the proportion of live tree aboveground biomass that dies in polygon, *i*, year, *t*, but remains as standing dead organic matter (i.e., snags) (unitless; $0 \leq f_{BSL,BLOWDOWN,i,t} \leq 1$).

$$\mathbf{SNAG_{BSL,OUT,i,t} = SNAG_{BSL,i,t} \bullet f_{BSL,SWDECAY,i,t} + SNAG_{BSL,i,t} \bullet f_{BSL,SNAGFALLDOWN,i,t}} \quad \mathbf{(16)}$$

where:
$SNAG_{BSL,i,t}$ = the total amount of snag mass in polygon *i,* year*, t* (see equation 14b). $f_{BSL,SWDECAY,i,t}$ = the annual proportional loss of snag biomass due to decay, in polygon, *i*, year, *t* (unitless; $0 \leq f_{BSL,SWDECAY,i,t} \leq 1$).
$f_{BSL,SNAGFALLDOWN,i,t}$ = the annual proportion of snag biomass in polygon, *i*, that falls over and thus is transferred to the LDW pool (unitless; $0 \leq f_{BSL,SNAGFALLDOWN,i,t} \leq 1$).

The annual change in DOM derived from <u>dead belowground biomass</u> ($\Delta C_{BSL,DBG,\,,t}$; t C yr^{-1}) is calculated for each polygon as:.

$$\mathbf{\Delta C_{BSL,DBG,t} = \Sigma(DBG_{BSL,IN,i,t} - DBG_{BSL,OUT,i,t}) \bullet CF} \quad \mathbf{(17a)}$$

$$\mathbf{DBG_{BSL,i,t+1} = DBG_{BSL,i,t} + (DBG_{BSL,IN,i,t} - DBG_{BSL,OUT,i,t})} \quad \mathbf{(17b)}$$

where:
$DGB_{BSL,i,t}$ = The total quantity of dead belowground biomass accumulated in polygon *i,* at time*, t* (t d.m.)*.*
$DBG_{BSL,IN,i,t}$ = annual gain in dead belowground biomass for polygon *i*, year, *t* (t d.m yr^{-1}). Dead belowground biomass develops as a result of mortality through natural causes or through harvesting activities.

$DBG_{BSL,OUT,i,t}$ = annual loss in dead belowground biomass through decay, (t d.m yr^{-1})
CF = carbon fraction of dry matter (IPCC default value = 0.5).

$$\mathbf{DBG_{BSL,IN,i,t} = [(A_{BSL,i} \bullet LB_{BSL,i,t} \bullet R_i) \bullet (f_{BSL,NATURAL,i,t} + f_{BSL,HARVEST,i,t} + f_{BSL,DAMAGE,i,t})]} \quad \textbf{(17c)}$$

where:
$A_{BSL,i}$ = area (ha) of forest land in polygon, *i*;
$LB_{BSL,i,t}$ = average live tree biomass (t d.m. ha^{-1}) in polygon, *i,* for year, *t.* $LB_{BSL,i,t}$ is calculated for year, *t*, beginning with biomass estimates in year *t*=1 (the project start year) and with annual biomass increments ($G_{BSL,i,t}$) added as per calculations in equation 5 a, b. This value is then multiplied by $A_{BSL,i,}$ the area (ha) of forest land in polygon, *i*.
R_i is the root:shoot ratio in polygon, *i* (see equation 5b).
$f_{BSL,NATURAL,i,t}$ = the annual proportion of biomass that dies from natural mortality in polygon, *i* (unitless; $0 \leq f_{NATURALi} \leq 1$), year, *t* (see equation 7),
$f_{BSL,HARVEST,i,t}$ = the proportion of biomass removed by harvesting from polygon, *i,* (unitless; $0 \leq f_{HARVESTIi} \leq 1$), year, *t* (see equation 8),
$f_{BSL,DAMAGE,i,t}$ = the proportion of additional biomass removed or road and landing construction in polygon, *i* (unitless; $0 \leq f_{DAMAGE,i,t} \leq 1$), year, *t* (see equation 9)

$$\mathbf{DBG_{BSL,OUT,i,t} = DBG_{BSL,i,t} \bullet f_{BSL,dgbDECAY,i,t}} \quad \textbf{(17d)}$$

where:
$DBG_{BSL,i,t}$ = the total quantity of dead belowground in polygon *i,* year*,* *t* (see equation 17b).
$f_{BSL,dgbDECAY,i,t}$ = the annual proportional loss of dead belowground biomass due to decay, in polygon *i,* year*,* *t* (unitless; ; $0 \leq f_{BSL,lwDECAY,i,t} \leq 1$).

FVS-FFE models and tracks all dead organic matter dynamics by pool to accomplish Equations 10-17d. Stand mortality, snag dynamics, and down deadwood pools (including decay) are all tracked by FVS and reported for each AU stand. FVS stand and carbon pool data is imported into the KC Carbon Database, where the data is compiled and summarized by polygon and year, and any baseline scenario harvesting activities applied and tracked. More specifically, the calculations are completed in the queries briefly described in Footnote 36 and the results found in the create the "QScenario_BaselineByYear" output query created by the Scenario Generator.

<u>Harvested Wood Products</u>
The annual change in emissions associated with the production of harvested wood products (HWP) is calculated as:

$$\mathbf{\Delta C_{BSl,HWP,t} = \Delta C_{BSL,STORHWP,t} - \Delta C_{BSL,EMITFOSSIL,t,}} \quad \textbf{(18)}$$

Where:
$\Delta C_{BSL,STORHWP,t}$ = the annual change in harvested carbon that remains in storage after conversion to wood products (t C yr^{-1})
$\Delta C_{BSL,EMITFOSSIL,t}$ = the annual change in fossil fuel emissions from harvesting (logging and log transport) and processing of the various wood products.

The annual change in carbon storage in harvested wood products in year *t* ($\Delta C_{BSL,STORHWP,t}$; t C yr^{-1}) is determined based upon the following equation:

$$\mathbf{\Delta C_{BSL,STORHWP,t} = (C_{BSL,STORHWP,t2} - C_{BSL,STORHWP,t1}) / T} \quad \textbf{(19)}$$

where:
$C_{BSL,STORHWP,t2}$ = carbon storage in harvested wood products at t=2; t C
$C_{BSL,STORHWP,t1}$ = carbon storage in harvested wood products at t=1; t C
T = number of years between monitoring t1 and t2
t : 1,2,3…t years elapsed since the project start date

$$\mathbf{C_{BSL,TIMBER,h} = \Sigma[(LBL_{BSL,FELLINGS,i,h} - LBL_{BSL,FELLINGS,i,h} \bullet R_i + LBL_{BSL,OTHER,i,h} - LBL_{BSL,OTHER,i,h} \bullet R_i) \bullet (1 - f_{BSL,BRANCH,i,h}) \bullet (1 - f_{BSL,BUCKINGLOSS,i,h})] \bullet CF} \quad \textbf{(20)}$$

where:
$C_{BSL,TIMBER,h}$= carbon contained in timber harvested in period *h* (summed for all harvested polygons, *i*); t C

$LBL_{BSL,FELLINGS,i,h}$ = annual removal of live tree biomass due to commercial felling in polygon, *i*; t d.m. (equation 8)
$LBL_{BSL,OTHER,i,h}$ = annual removal of live tree biomass from incidental sources in polygon, *i*; t d.m. (equation 9)
R_i is the root:shoot ratio in polygon, *i* (see equation 5b).
$1 - f_{BSL,BRANCH,i,h}$ the proportion of live tree biomass remaining after netting out branch biomass, in polygon *i* (unitless; $0 \leq f_{BRANCH,i,t} \leq 1$)(see equation 12)
$1 - f_{BSL,BUCKINGLOSS,i,h}$ = the proportion of the log bole remaining after in-woods log processing/bucking for quality, length, etc., in polygon, *i* (unitless; $0 \leq f_{BUCKINGLOSS,i,t} \leq 1$) (equation 12)
h = harvest period ; yr

$$C_{BSL,MILL,h,k} = (C_{BSL,TIMBER,h,k} \bullet f_{RND,k} \bullet r_{RND,k}) \quad (21)$$

where:
$C_{BSL,MILL,h,k}$ = carbon contained in harvested timber after milling in period h, for product type *k*; t C
$C_{BSL,TIMBER,h,k}$ = carbon contained in timber harvested in period h, for product type *k*; t C
k = wood product type – (softwood saw log, softwood pulpwood, hardwood saw log, or hardwood pulpwood; proportions determined from Table 1.4 of 1605(b) document)
$f_{RND,k}$ = fraction of growing stock volume removed as roundwood for product type *k* (default values by region in Table 1.5 of the 1605(b) document); dimensionless
$r_{RND,k}$ = ratio of industrial roundwood to growing stock volume removed as roundwood for product type *k* (default values by region in Table 1.5 of the 1605(b) document); dimensionless

For each product type, *k* : the short-lived fraction ($P_{BSL,SLF,k}$), medium-lived fraction ($P_{BSL,MLF,k}$), and long-lived fraction ($P_{BSL,LLF,k}$) are calculated as:

$$P_{BSL,SLF,k} = 1 - P_{3\text{-}year} \quad (22a)$$
$$P_{BSL,LLF,k} = P_{100\text{-}year} \quad (22b)$$
$$P_{BSL,MLF,k} = P_{3\text{-}year} - P_{100\text{-}year} , \quad (22c)$$

$$C_{BSL,STORHWP,t,} = \Sigma\, \Sigma\, ((C_{BSL,MILL,h,k} \bullet P_{LLF,k}) + [(C_{BSL,MILL,h,k} \bullet P_{MLF,k}) \bullet ((20-h) / 20)]) \quad (23)$$

where:
$C_{BSL,STORHWP,t,}$ = carbon stored in harvested wood products in year *t* summed for all product types *k* and then over all harvest periods *h*; t C
k = wood product type – (softwood saw log, softwood pulpwood, hardwood saw log, or hardwood pulpwood; proportions determined from Table 1.4 of 1605(b) document)
h = year of harvest (the term (20-h) should not be allowed to drop below 0)

Fossil fuel emissions from equipment and manufacturing:
The annual change in fossil fuel emissions from harvesting and processing of the various wood products ($\Delta C_{BSL,EMITFOSSIL,t}$) are calculated as:

$$\Delta C_{BSL,EMITFOSSIL,t} = C_{BSL,EMITHARVEST,t} + C_{BSL,EMITMANUFACTURE,t} + C_{BSL,EMITTRANSPORT,t} \quad (24)$$

where:
$C_{BSL,EMITHARVEST,t}$ is the annual fossil fuel emissions associated with harvesting of raw material (t C yr^{-1})
$C_{BSL,EMITMANUFACTURE,t}$ is the annual fossil fuel emissions associated with the manufacturing of raw material (t C yr^{-1})
$C_{BSL,EMITTRANSPORT,t}$ is the annual fossil fuel emissions associated with the transport of raw material (t C yr^{-1})

$$C_{BSL,EMITHARVEST,t} = \Sigma[(LBL_{BSL,FELLINGS,i,t} - LBL_{BSL,FELLINGS,i,t} \bullet R_i + LBL_{BSL,OTHER,i,t} - LBL_{BSL,OTHER,i,t} \bullet R_i) \bullet (1 - f_{BSL,BRANCH,i,t}) \bullet (1 - f_{BSL,BUCKINGLOSS,i,t})] \bullet CF \bullet c_{HARVEST} \quad (25)$$

where:
$c_{HARVEST}$ is the carbon emission intensity factor (t C emitted/t C raw material) associated with harvesting (see for default values); all other terms are as defined in equation 20.

$$C_{BSL,EMITTRANSPORT,t} = \Sigma[(LBL_{BSL,FELLINGS,i,t} - LBL_{BSL,FELLINGS,i,t} \bullet R_i + LBL_{BSL,OTHER,i,t} - LBL_{BSL,OTHER,i,t} \bullet R_i) \bullet (1 - f_{BSL,BRANCH,i,t}) \bullet (1 - f_{BSL,BUCKINGLOSS,i,t})] \bullet CF \bullet \Sigma(f_{BSL,TRANSPORTk} \bullet d_{TRANSPORTk} \bullet c_{TRANSPORTk}) \quad (26)$$

where:

$f_{BSL,TRANSPORTk}$ = the fraction of raw material transported by transportation type, *k*. (unitless; $0 \leq f_{BSL,TRANSPORTk} < 1$).

$d_{TRANSPORTk}$ = the distance transported by transportation type, *k*. (km);

$c_{TRANSPORTk}$ is the carbon emission intensity factor (kg C emitted/t C raw material) associated with transportation type, k ; all other terms are as defined in equation 20.

$$C_{BSL,EMITMANUFACTURE,t} = \Sigma[(LBL_{BSL,FELLINGS,i,t} - LBL_{BSL,FELLINGS,i,t} \bullet R_i + LBL_{BSL,OTHER,i,t} - LBL_{BSL,OTHER,i,t} \bullet R_i) \bullet (1 - f_{BSL,BRANCH,i,t}) \bullet (1 - f_{BSL,BUCKINGLOSS,i,t})] \bullet \Sigma(f_{BSL,PRODUCTk} \bullet c_{MANUFACTUREk}) \bullet CF \quad (27)$$

Where:

$c_{MANUFACTUREk}$ is the carbon emission intensity factor (t C emitted/t C raw material) associated with manufacture of product type, *k*; all other terms are as defined in equation 20.

FVS-FFE models the transition of carbon removed from each polygon during harvest into the Harvested Products Report. FVS calculates and tracks harvested wood products pools following the reference 1605b documentation required by VCS, including the modeling of HWP pool decay by product type. The KC database tool compiles and tracks FVS outputs by polygon and year, including the application of any baseline harvesting activities. FVS-FFE also tracks assumed carbon flows into Landfills, but as per VCS guidelines, the landfill pool should be tracked instead in the HWP. The database makes additional calculations to proportionally distribute the Landfill output back into HWP by product type to accomplish this. Collectively, FVS and the database tool accomplish Equations 18-23. Fossil fuel emissions are optional and excluded by the project, and hence Equation 24-27 are zero and not used. More specifically, the HWP calculations are made in the “UpdateHWPNew” subroutine that is executed during the creation of the “FVS_Carbon_AllYears” table. That table is generated when clicking the “Update FVS_Carbon_AllYears” button on the “Import AU FVS Summary and Carbon Data” form. It runs a function called “PopulateFVS_Carbon_AllYears” that compiles all the FVS data and does many calculations including this one.

PROJECT EMISSIONS EQUATIONS:

Actual (ex post) annual net carbon stocks are calculated using the equations in this section.

$$C_{ACTUAL,i,t} = C_{LB,i,t} + C_{DOM,i,t} \quad (28a)$$

where:

$C_{ACTUAL,i,t}$ = carbon stocks in all selected carbon pools in polygon, *i*, year, *t*; t C

$C_{LB,i,t}$ = carbon stocks in living tree biomass in polygon, *i*, year, *t*; t C

$C_{DOM,i,t}$ = carbon stocks in dead organic matter in year, *t*; t C

Live biomass

$$B_{TOTAL,i,t} = (B_{AG,i,t} + B_{BG,i,t}) \quad (28b)$$

$$C_{LB,i,t} = (B_{TOTAL,i,t}) \bullet CF \quad (28c)$$

where:

$B_{AG,i,t}$ = aboveground tree biomass (t d.m. ha^{-1}) measured in polygon, *i,* year, *t*

$B_{BG,i,t}$ = belowground tree biomass (t d.m. ha^{-1}) measured in polygon, *i,* year, *t*.

$B_{TOTAL,i,t}$ = total tree biomass (t d.m. ha^{-1}) measured in polygon, *i,* year, *t*

$$B_{BG,i,t} = B_{AG,i,t} \bullet R_i \quad (28d)$$

CF = carbon fraction of dry matter (IPCC default value = 0.5)

Dead organic matter

Carbon stored in dead organic matter pools in measured polygon, *i*, year *t*, ($C_{DOM,i,t}$) is calculated as the sum of that stored in lying dead wood and standing snags.

$C_{DOM,i,t} = (DOM_{LDW,i,t} + DOM_{SNAG,i,t}) \bullet CF$ **(28e)**

where:

$DOM_{LDW,i,t}$ = average mass of dead organic matter contained in lying dead wood (t d.m. ha^{-1}) in measured in polygon, *i,* year, *t*

$DOM_{SNAG,i,t}$ = average mass of dead organic matter contained in standing snags (t d.m. ha^{-1}) in measured in polygon, *i,* year, *t*

The average quantity of dead organic matter contained in lying dead wood for measured polygon, *i,* in year, *t* ($DOM_{LDW,i,t}$) is calculated according to equations 60a-c).

The total annual carbon balance in year, t, for the project scenario is calculated as ($\Delta C_{PRJ,t}$, in t C yr^{-1}):

$\Delta C_{PRJ,t} = \Delta C_{PRJ,P,t}$ **(29)**

where:

$\Delta C_{PRJ,P,t}$ is the annual change in carbon stocks in all pools in the project across the project activity area; t C yr^{-1} .

$\Delta C_{PRJ,P,t} = \Delta C_{PRJ,LB,t} + \Delta C_{PRJ,DOM,t} + \Delta C_{PRJ,HWP,t}$ **(30)**

Where:

$\Delta C_{PRJ,LB,t}$ = annual change in carbon stocks in living tree biomass (above- and belowground); t C yr^{-1}

$\Delta C_{PRJ,DOM,t}$ = annual change in carbon stocks in dead organic matter; t C yr^{-1}

$\Delta C_{PRJ,HWP,t}$ is the annual change in carbon stocks associated with harvested wood products, t C yr^{-1}.

$\Delta C_{PRJ,LB,t} = \Delta C_{PRJ,G,t} - \Delta C_{PRJ,L,t}$ **(31)**

where:

$\Delta C_{PRJ,G,t}$ = annual increase in tree carbon stock from growth; t C yr^{-1}

$\Delta C_{PRJ,L,t}$ = annual decrease in tree carbon stock from a reduction in live biomass; t C yr^{-1}.

If the project geographic area has been stratified, carbon pools are calculated for each polygon, i, and then summed during a given year, t.

As above, change in carbon stocks by pool by year is modeled by FVS-FFE by AU. The FVS stand data (Stand Carbon Report) outputs are imported to the KC Carbon Database where the data is compiled by AU, polygon and across the PRJ scenario conditions. The Scenario Generator and Output PD Table queries complete the summarizing queries and calculations to accomplish Equation 28c-31, including after any ex-post monitoring updates to polygons in the project scenario[47].

Live biomass gain in year, *t*, polygon, *i* ($\Delta C_{PRJ,G,i,t}$) is calculated as:

$\Delta C_{PRJ,G,t} = \Sigma(A_{PRJ,i} \bullet G_{PRJ,i,t}) \bullet CF$ **(32)**

where:

$A_{PRJ,i,}$ = area (ha) of forest land in polygon, *i*;

$G_{PRJ,i,t}$ = annual increment rate in tree biomass (t d.m. ha^{-1} yr^{-1}), in polygon, *i*, and;

CF = carbon fraction of dry matter t C t^{-1} d.m. (IPCC default value = 0.5).

$G_{PRJ,i,t} = G_{PRJ,AG,i,t} + G_{PRJ,BG,i,t}$ **(33a)**

where $G_{PRJ,AG,i,t}$ and $G_{PRJ,BG,i,t}$ are the annual above- and belowground biomass increment rates (t d.m. ha^{-1} yr^{-1});

[47] The Scenario_Project table contains the output from the Scenario Generator. The Scenario_Project table is populated from a single of Append query called "QappSecenario_Project" that is executed when clicking the "Run Queries" button on the Scenario Generator form. These calculations are done in that append query. All of the tables that go into that query come from the GIS data and the property listings with the exception of the "FVS_Carbon_AllYears" table. That table is generated when clicking the "Update FVS_Carbon_AllYears" button on the "Import AU FVS Summary and Carbon Data" form. It runs a function called "PopulateFVS_Carbon_AllYears" that compiles all the FVS data and related calculations.

$$G_{PRJ,BG,i,t} = G_{PRJ,AG,i,t} \bullet R_i \quad (33b)$$

where R_i is the root:shoot ratio in polygon, *i*.

Equations 32 and 33 can be used directly to calculate $\Delta C_{PRJ,G,t}$ when all tree cover within a

<u>Live biomass loss</u> ($\Delta C_{PRJ,L,t}$; t C yr^{-1}) is the sum of losses from:

$$\Delta C_{PRJ,L,t} = \Sigma(LBL_{PRJ,NATURALi,t} + LBL_{PRJ,FELLINGS,i,t} + LBL_{PRJ,OTHERi,t}) \bullet CF \quad (34)$$

where:

$LBL_{PRJ,NATURALi,t}$ = annual loss of live tree biomass due to natural mortality in polygon, *i*; t d.m. yr^{-1}

$LBL_{PRJ,FELLINGS,i,t}$ = annual loss of live tree biomass due to commercial felling in polygon, *i*; t d.m. yr^{-1}

$LBL_{PRJ,OTHER,i,t}$ = annual loss of live tree biomass from incidental sources in polygon, *i*; t d.m. yr^{-1}

CF = carbon fraction of dry matter; t C t^{-1} d.m. (IPCC default value = 0.5).

$$LBL_{PRJ,NATURALi,t} = A_{PRJ,i} \bullet LB_{PRJ,i,t} \bullet f_{PRJ,NATURAL,i,t} \quad (35)$$

where

$A_{PRJ,i}$ = area (ha) of forest land in polygon, *i*;

$LB_{PRJ,i,t}$ = average live tree biomass (t d.m. ha^{-1}) in polygon, *i,* for year, *t*

$LB_{PRJ,i,t}$ is calculated for year, *t*, beginning with biomass estimates in year *t*=1 (the project start year) and with annual biomass increments ($G_{PRJ,i,t}$) added as per calculations in equation 33a.

$f_{PRJ,NATURAL,i,t}$ = the annual proportion of biomass that dies from natural mortality in forest type , *i* (unitless; $0 \leq f_{PRJ,NATURALi} \leq 1$), year, *t*.

$$LBL_{PRJ,FELLINGS,i,t} = A_{PRJ,i} \bullet LB_{PRJ,i,t} \bullet f_{PRJ,HARVEST,i,t} \quad (36)$$

where:

$A_{PRJ,i}$ = area (ha) of forest land in polygon, *i*

$LB_{PRJ,i,t}$ = average live tree biomass (t d.m. ha^{-1}) in polygon, *i,* for year, *t* (see equation 7 for its calculation).

$f_{PRJ,HARVEST,i,t}$ = the proportion of biomass removed by harvesting from polygon, *i,* (unitless; $0 \leq f_{PRJ,HARVESTIi} \leq 1$), in year, *t*.

$$LBL_{PRJ,OTHER,i,t} = A_{PRJ,i} \bullet LB_{PRJ,i,t} \bullet f_{PRJ,HARVEST,i,t} \bullet f_{PRJ,DAMAGE,i,t} \quad (37)$$

where:

$A_{PRJ,i}$ = area (ha) of forest land in polygon, *i*;

$LB_{PRJ,i,t}$ = average live tree biomass (t d.m. ha^{-1}) in polygon, *i,* for year, *t*

$f_{PRJ,HARVEST,i,t}$ = the proportion of biomass removed by harvesting from polygon, *i,* in year, *t* (unitless; $0 \leq f_{PRJ,HARVEST,i,t} \leq 1$).

$f_{PRJ,DAMAGE,i,t}$ = the proportion of additional biomass removed for road and landing construction in polygon, *i,* year, *t* (unitless; $0 \leq f_{PRJ,DAMAGE,i,t} \leq 1$).

Live biomass gain is modeled by FVS by AU and by year to accomplish Equations 32 & 37. The database tool sums and tracks FVS outputs by polygon and year to accomplish Equation 32. The FVS outputs include mortality and stand dynamics to accomplish Equation 35. The database and FVS outputs are used to account for any changes to project geographic area by harvesting or other activities for Equation 36 and 37 (noting that no 'other' live biomass mass losses are included at this time). More specifically, the calculations are completed in the queries briefly described in Footnote 37 and the results are found in the create the Scenario_Project table, which contains the output of an Append query created by the Scenario Generator using the Run Queries button.

<u>Dead Organic Matter DOM</u> ($\Delta C_{PRJ,DOM}$; t C yr^{-1}) is calculated as:

$$\Delta C_{PRJ,DOM,t} = \Delta C_{PRJ,LDW,t} + \Delta C_{PRJ,SNAG,t} + \Delta C_{PRJ,DBG,t} \quad (38)$$

where:

$\Delta C_{PRJ,LDW,t}$ = change in lying dead wood (LDW) carbon stocks in year, *t*; t C yr^{-1}

$\Delta C_{PRJ,SNAG,t}$ = change in snag carbon stock in year, *t*; t C yr^{-1}

$\Delta C_{BSL,DBG,t}$ = change in belowground carbon stock in year, *t*; t C yr^{-1}.

The change in DOM derived from lying dead wood (LDW) carbon stock in year, t (t C yr^{-1}) is calculated as:

$$\Delta C_{PRJ,LDW,t} = \Sigma(LDW_{PRJ,IN,i,t} - LDW_{PRJ,OUT,i,t}) \bullet CF \quad (39a)$$

$$LDW_{PRJ,i,t+1} = LDW_{PRJ,i,t} + (LDW_{PRJ,IN,i,t} - LDW_{PRJ,OUT,i,t}) \quad (39b)$$

where:

$LDW_{PRJ,i,t}$= The total mass of lying dead wood accumulated in polygon *i* at time t (t d.m.).

$LDW_{PRJ,IN,i,t}$ = annual increase in LDW biomass for polygon *i*, year, *t* (t d.m ha^{-1} yr^{-1}). LDW increases occur as a result of natural mortality (typically, blowdown), and as a direct or indirect result of harvesting.

$LDW_{PRJ,OUT,i,t}$ = annual loss in LDW biomass through decay, for polygon *i*, year, *t*, (t d.m ha^{-1} yr^{-1})

$LDW_{PRJ,IN,i,t}$ and $LDW_{PRJ,OUT,i,t}$ are summed across polygons.

CF = carbon fraction of dry matter (IPCC default value = 0.5).

$$LDW_{PRJ,IN,i,t} = (LBL_{PRJ,NATURALi,t} - LBL_{PRJ,NATURALi,t} \bullet R_i) \bullet f_{PRJ,BLOWDOWN,i,t} + ((LBL_{PRJ,FELLINGS,i,t} - LBL_{PRJ,FELLINGS,i,t} \bullet R_i) + (LBL_{PRJ,OTHER,i,t} - LBL_{PRJ,OTHER,i,t} \bullet R_i)) \bullet f_{PRJ,BRANCH,i,t} + ((LBL_{PRJ,FELLINGS,i,t} - LBL_{PRJ,FELLINGS,i,t} \bullet R_i) + (LBL_{PRJ,OTHER,i,t} - LBL_{PRJ,OTHER,i,t} \bullet R_i)) \bullet (1 - f_{PRJ,BRANCH,i,t}) \bullet f_{PRJ,BUCKINGLOSS,i,t} + SNAG_{PRJ,,i,t} \bullet f_{PRJ,SNAGFALLDOWN,i,t} \quad (40)$$

where:

$LBL_{PRJ,NATURALi,t}$, $LBL_{PRJ,FELLINGS,i,t,}$ and $LBL_{PRJ,OTHER,i,t}$ are as calculated in equations 35, 36, and 37, respectively.

R_i is the root:shoot ratio in polygon, *i* (see equation 33b).

$f_{PRJ,BLOWDOWN,i,t}$ = the annual proportion of live aboveground tree biomass subject to blowdown in polygon, *i,* year*, t* (unitless; $0 \leq f_{PRJ,BLOWDOWN,i,t} \leq 1$).

$f_{PRJ,BRANCH,i,t}$ = the annual proportion of aboveground tree biomass comprised of branches $\geq$ 5 cm diameter in polygon, *i* (unitless; $0 \leq f_{PRJ,BRANCH,i,t} \leq 1$).

$f_{PRJ,BUCKINGLOSS,i,t}$ = the annual proportion of the log bole biomass left on site after assessing and/or merchandizing the log bole for quality, in polygon, *i* (unitless; $0 \leq f_{PRJ,BUCKINGLOSS,i,t} \leq 1$).

$SNAG_{PRJ,i,t}$ = the total mass of the snag pool in polygon, *i*, year, *t* (see equation 42b).

$f_{PRJ,SNAGFALLDOWN,i,t}$ = the annual proportion of snag biomass in polygon, *i*, year, *t*, that falls over and thus is transferred to the LDW pool (unitless; $0 \leq f_{PRJ,SNAGFALLDOWN,i,t} \leq 1$).

$$LDW_{PRJ,OUT,i,t} = LDW_{PRJ,i,t} \bullet f_{PRJ,lwDECAY,i,t} \quad (41)$$

where:

$LDW_{PRJ,i,t}$ = the total amount of lying deadwood mass in polygon *i,* year*, t (see equation 39b)*.

$f_{PRJ,lwDECAY,i,t}$ = the annual proportional loss of lying dead biomass due to decay, in polygon *i,* year, *t* (unitless; ; $0 \leq f_{PRJ,lwDECAY,i,t} \leq 1$).

The change in standing dead wood (snag) carbon stock in year, *t* (t C yr^{-1}) is calculated as:

$$\Delta C_{PRJ,SNAG,t} = \Sigma(SNAG_{PRJ,IN,i,t} - SNAG_{PRJ,OUT,i,t}) \bullet CF \quad (42a)$$

$$SNAG_{PRJ,i,t+1} = SNAG_{PRJ,i,t} + (SNAG_{PRJ,IN,i,t} - SNAG_{PRJ,OUT,i,t}) \quad (42b)$$

where:

$SNAG_{PRJ,i,t}$ = The total mass of snags accumulated in polygon *i* at time *t* (t d.m.)

$SNAG_{PRJ,IN,i,t}$ = annual gain in snag biomass for polygon *i*, year, *t* (t d.m ha^{-1} yr^{-1}).

$SNAG_{PRJ,OUT,i,t}$ = annual loss in snag biomass through decay, or falldown (i.e, transfer to the LDW pool)(t d.m ha^{-1} yr^{-1})

CF = carbon fraction of dry matter (IPCC default value = 0.5).

Note that $SNAG_{PRJ,IN,i,t}$ and $SNAG_{PRJ,OUT,i,t}$ are summed across polygons.

$$SNAG_{PRJ,IN,i,t} = (LBL_{PRJ,NATURALi,t} - LBL_{PRJ,NATURALi,t} \bullet R_i) \bullet (1 - f_{PRJ,BLOWDOWN,i,t}) \quad (43)$$

where:

$LBL_{PRJ,NATURALi,t}$ is as calculated in equation 35, and

1 - $f_{PRJ,BLOWDOWN,i,t}$ is the proportion of live tree aboveground biomass that dies in polygon, *i*, year, *t*, but remains as standing dead organic matter (i.e. snags) (unitless; $0 \leq f_{PRJ,BLOWDOWN,i,t} \leq 1$).

$SNAG_{PRJ,OUT,i,t} = SNAG_{PRJ,i,t} \bullet f_{PRJ,SWDECAY,i,t} + SNAG_{PRJ,i,t} \bullet f_{PRJ,SNAGFALLDOWN,i,t}$ **(44)**

where:

$SNAG_{PRJ,i,t}$ = the total amount of snag mass in polygon *i,* year*, t (see equation 42b).* $f_{PRJ,SWDECAY,i,t}$ = the annual proportional loss of snag biomass due to decay, in polygon, *i*, year, *t* (unitless; $0 \leq f_{PRJ,SWDECAY,i,t} \leq 1$).

$f_{PRJ,SNAGFALLDOWN,i,t}$ = the annual proportion of snag biomass in polygon, *i*, that falls over and thus is transferred to the LDW pool (unitless; $0 \leq f_{PRJ,SNAGFALLDOWN,i,t} \leq 1$).

The change in dead belowground wood (DBG) carbon stock in year, *t* (t C yr^{-1}) is calculated as:

$\Delta C_{PRJ,DBG,t} = \Sigma(DBG_{PRJ,IN,i,t} – DBG_{PRJ,OUT,i,t}) \bullet CF$ **(45a)**

$DBG_{PRJ,i,t+1} = DBG_{PRJ,i,t} + (DBG_{PRJ,IN,i,t} – DBG_{PRJ,OUT,i,t})$ **(45b)**

where:

$DGB_{PRJ,i,t}$ = The total quantity of dead belowground biomass accumulated in polygon *i* at time *t* (t d.m.).

$DBG_{PRJ,IN,i,t}$ = annual gain in dead belowground biomass for polygon *i*, year, *t* (t d.m ha^{-1} yr^{-1}).

$DBG_{PRJ,OUT,i,t}$ = annual loss in dead belowground biomass through decay, (t d.m ha^{-1} yr^{-1})

CF = carbon fraction of dry matter (IPCC default value = 0.5).

$DBG_{PRJ,IN,i,t} = [(A_{PRJ,i} \bullet LB_{PRJ,i,t} \bullet R_i) \bullet (f_{PRJ,NATURAL,i,t} + f_{PRJ,HARVEST,i,t} + f_{PRJ,DAMAGE,i,t})]$ **(45c)**

where:

$A_{PRJ,i}$ = area (ha) of forest land in polygon, *i*;

$LB_{PRJ,i,t}$ = average live tree biomass (t d.m. ha^{-1}) in polygon, *i,* for year, *t.* $LB_{PRJ,i,t}$ is calculated for year, *t*, beginning with biomass estimates in year *t*=1 (the project start year) and with annual biomass increments ($G_{PRJ,i,t}$) added as per calculations in equation 33 a, b. This value is then multiplied by $A_{PRJ,i,}$ the area (ha) of forest land in polygon, *i*.

R_i is the root:shoot ratio in polygon, *i* (see equation 33b).

$f_{PRJ,NATURAL,i,t}$ = the annual proportion of biomass that dies from natural mortality in polygon, *i* (unitless; $0 \leq f_{NATURALi} \leq 1$), year, *t* (see equation 35),

$f_{PRJ,HARVEST,i,t}$ = the proportion of biomass removed by harvesting from polygon, *i,* (unitless; $0 \leq f_{PRJ,HARVESTIi} \leq 1$), year, *t* (see equation 36),

$f_{PRJ,DAMAGE,i,t}$ = the proportion of additional biomass removed by for road and landing construction in polygon, *i* (unitless; $0 \leq f_{PRJ,DAMAGE,i,t} \leq 1$), year, *t* (see equation 37)

$DBG_{PRJ,OUT,i,t} = DBG_{PRJ,i,t} \bullet f_{PRJ,dgbDECAY,i,t}$ **(45d)**

where:

$DBG_{PRJ,i,t}$ = the total quantity of dead belowground in polygon *i,* year*, t (equation 17b)*.

$f_{PRJ,dgbDECAY,i,t}$ = the annual proportional loss of dead belowground biomass due to decay, in polygon *i,* year*, t* (unitless; $0 \leq f_{PRJ,lwDECAY,i,t} \leq 1$).

FVS-FFE models and tracks all dead organic matter dynamics by pool to accomplish Equations 10-17d. Stand mortality, snag dynamics, and down deadwood pools (including decay) are all tracked by FVS and reported for each AU stand by year. FVS stand and carbon pool data is imported into the KC Carbon Database, where the data is compiled and summarized by polygon and year, and any project scenario activities applied and tracked to accomplish Equations 38-45d. More specifically, the calculations are completed in the queries briefly described in Footnote 37 and the results are found in the create the Scenario_Project table, which contains the output of an Append query created by the Scenario Generator using the Run Queries button.

Harvested Wood Products

The annual change in emissions associated with the production of harvested wood products (HWP), $\Delta C_{BSI,HWP,t}$, is calculated as:

$\Delta C_{PRJ,HWP,t} = \Delta C_{PRJ,STORHWP,t} – \Delta C_{PRJ,EMITFOSSIL,t,}$ **(46)**

Where:

$\Delta C_{PRJ,STORHWP,t}$ = the annual change in harvested carbon that remains in storage after conversion to wood products (t C yr^{-1})

$\Delta C_{PRJ,EMITFOSSIL,t}$ = the annual change in fossil fuel emissions from harvesting (logging and log transport) and processing of the various wood products.

The annual change in carbon storage in harvested wood products in year *t* ($\Delta C_{PRJ,STORHWP,t}$; t C yr^{-1}) is calculated as:

$$\Delta C_{PRJ,STORHWP,t} = (C_{PRJ,STORHWP,t2} - C_{PRJ,STORHWP,t1}) / T \quad (47)$$

where:

$C_{PRJ,STORHWP,t2}$ = carbon storage in harvested wood products at t=2; t C
$C_{PRJ,STORHWP,t1}$ = carbon storage in harvested wood products at t=1; t C
T = number of years between monitoring t1 and t2
t : 1,2,3…t years elapsed since the project start date

$$C_{PRJ,TIMBER,h} = \Sigma[(LBL_{PRJ,FELLINGS,i,h} - LBL_{PRJ,FELLINGS,i,h} \bullet R_i + LBL_{PRJ,OTHER,i,h} - LBL_{PRJ,OTHER,i,h} \bullet R_i) \bullet (1 - f_{PRJ,BRANCH,i,h}) \bullet (1 - f_{PRJ,BUCKINGLOSS,i,h})] \bullet CF \quad (48)$$

where:

$C_{PRJ,TIMBER,h}$= carbon contained in timber harvested in period *h* (summed for all harvested polygons, *i*); t C
$LBL_{PRJ,FELLINGS,i,h}$ = annual removal of live tree biomass due to commercial felling in polygon, *i*; t d.m. (equation 36)
$LBL_{PRJ,OTHER,i,h}$ = annual removal of live tree biomass from incidental sources in polygon, *i*; t d.m. (equation 37)
R_i is the root:shoot ratio in polygon, *i* (see equation 33b).
1 - $f_{PRJ,BRANCH,i,h}$ the proportion of live tree biomass remaining after netting out branch biomass, in polygon *i* (unitless; $0 \leq f_{BRANCH,i,t} \leq 1$)(see equation 12)
1 - $f_{PRJ,BUCKINGLOSS,i,h}$ = the proportion of the log bole remaining after in-woods log processing/bucking for quality, length, etc., in polygon, *i* (unitless; $0 \leq f_{BUCKINGLOSS,i,t} \leq 1$) (equation 40)
h = harvest period ; yr

$$C_{PRJ,MILL,h,k} = (C_{PRJ,TIMBER,h,k} \bullet f_{RND,k} \bullet r_{RND,k}) \quad (49)$$

where:

$C_{PRJ,MILL,h,k}$ = carbon contained in harvested timber after milling in period h, for product type *k*; t C
$C_{PRJ,TIMBER,h,k}$ = carbon contained in timber harvested in period h, for product type *k*; t C
k = wood product type – (softwood saw log, softwood pulpwood, hardwood saw log, or hardwood pulpwood; proportions determined from Table 1.4 of 1605(b) document)
$f_{RND,k}$ = fraction of growing stock volume removed as roundwood for product type *k* (default values by region in Table 1.5 of the 1605(b) document); dimensionless
$r_{RND,k}$ = ratio of industrial roundwood to growing stock volume removed as roundwood for product type *k* (default values by region in Table 1.5 of the 1605(b) document); dimensionless

For each product type, *k* : the short-lived fraction ($P_{PRJ,SLF,k}$), medium-lived fraction ($P_{PRJ,MLF,k}$), and long-lived fraction ($P_{PRJ,LLF,k}$):

$$P_{PRJ,SLF,k} = 1 - P_{3\text{-}year} \quad (50a)$$
$$P_{PRJ,LLF,k} = P_{100\text{-}year} \quad (50b)$$
$$P_{PRJ,MLF,k} = P_{3\text{-}year} - P_{100\text{-}year}\,, \quad (50c)$$

$$C_{PRJ,STORHWP,t,} = \Sigma\,\Sigma\,((C_{PRJ,MILL,h,k} \bullet P_{LLF,k}) + [(C_{PRJ,MILL,h,k} \bullet P_{MLF,k}) \bullet ((20-h) / 20)]) \quad (51)$$

where:

$C_{PRJ,STORHWP,t,}$ = carbon stored in harvested wood products in year *t* summed for all product types *k* and then over all harvest periods *h*; t C
k = wood product type – (softwood saw log, softwood pulpwood, hardwood saw log, or hardwood pulpwood; proportions determined from Table 1.4 of 1605(b) document)
h = year of harvest (the term (20-h) should not be allowed to drop below 0)

The annual change in <u>fossil fuel emissions from harvesting and processing</u> of the various wood products ($\Delta C_{PRJ,EMITFOSSIL,t}$) are calculated as:

$$\Delta C_{PRJ,EMITFOSSIL,t} = C_{PRJ,EMITHARVEST,t} + C_{PRJ,EMITMANUFACTURE,t} + C_{PRJ,EMITTRANSPORT,t} \quad (52)$$

Where

$C_{PRJ,EMITHARVEST,t}$ = the annual fossil fuel emissions associated with harvesting of raw material (t C yr^{-1})

$C_{PRJ,EMITMANUFACTURE,t}$ = the annual fossil fuel emissions associated with the manufacturing of raw material (t C yr^{-1})

$C_{PRJ,EMITTRANSPORT,t}$ = the annual fossil fuel emissions associated with the transport of raw material (t C yr^{-1})

$$\Delta C_{PRJ,EMITHARVEST,t} = \Sigma[(LBL_{PRJ,FELLINGS,i,t} - LBL_{PRJ,FELLINGS,i,t} \bullet R_i + LBL_{PRJ,OTHER,i,t} - LBL_{PRJ,OTHER,i,t} \bullet R_i) \bullet (1 - f_{PRJ,BRANCH,i,t}) \bullet (1 - f_{PRJ,BUCKINGLOSS,i,t})] \bullet CF \bullet c_{HARVEST} \quad (53)$$

where:

$c_{HARVEST}$ = carbon emission intensity factor (t C emitted/t C raw material) associated with harvesting; all other terms are as defined in equation 48.

$$C_{PRJ,EMITTRANSPORT,t} = \Sigma[(LBL_{PRJ,FELLINGS,i,t} - LBL_{PRJ,FELLINGS,i,t} \bullet R_i + LBL_{PRJ,OTHER,i,t} - LBL_{PRJ,OTHER,i,t} \bullet R_i) \bullet (1 - f_{PRJ,BRANCH,i,t}) \bullet (1 - f_{PRJ,BUCKINGLOSS,i,t})] \bullet CF \bullet \Sigma(f_{PRJ,TRANSPORTk} \bullet d_{TRANSPORTk} \bullet c_{TRANSPORTk}) \quad (54)$$

where:

$f_{PRJ,TRANSPORTk}$ = the fraction of raw material transported by transportation type, *k*. (unitless; $0 \leq f_{PRJ,TRANSPORTk} < 1$).

$d_{TRANSPORTk}$ = the distance transported by transportation type, *k*. (km);

$c_{TRANSPORTk}$ = the carbon emission intensity factor (kg C emitted/t C raw material) associated with transportation type, *k*; all other terms are as defined in equation 48.

$$C_{PRJ,EMITMANUFACTURE,t} = \Sigma[(LBL_{PRJ,FELLINGS,i,t} - LBL_{PRJ,FELLINGS,i,t} \bullet R_i + LBL_{PRJ,OTHER,i,t} - LBL_{PRJ,OTHER,i,t} \bullet R_i) \bullet (1 - f_{PRJ,BRANCH,i,t}) \bullet (1 - f_{PRJ,BUCKINGLOSS,i,t})] \bullet \Sigma(f_{PRJ,PRODUCTk} \bullet c_{MANUFACTUREk}) \bullet CF \quad (55)$$

Where:

$c_{MANUFACTUREk}$ = the carbon emission intensity factor (t C emitted/t C raw material) associated with manufacture of product type, k; all other terms are as defined in equation 48.

FVS-FFE models the transition of carbon removed from each polygon during harvest into the Harvested Products Report. FVS calculates and tracks harvested wood products pools following the reference 1605b documentation required by VCS, including the modeling of HWP pool decay by product type. The KC database tool compiles and tracks FVS outputs by polygon and year, including the application of any project harvesting or other activities. FVS-FFE also tracks assumed carbon flows into Landfills, but as per VCS guidelines, the landfill pool should be tracked instead in the HWP. The database makes additional calculations to proportionally distribute the Landfill output back into HWP by product type to accomplish this. Collectively, FVS and the database tool accomplish Equations 18-23. Fossil fuel emissions are optional and excluded by the project, and hence Equation 24-27 are zero and not used. More specifically, the HWP calculations are made in the "UpdateHWPNew" subroutine that is executed during the creation of the "FVS_Carbon_AllYears" table. That table is generated when clicking the "Update FVS_Carbon_AllYears" button on the "Import AU FVS Summary and Carbon Data" form. It runs a function called "PopulateFVS_Carbon_AllYears" that compiles all the FVS data and does many calculations including this one.

Market Leakage (Option 1):

The outcome of the VCS Leakage Discount Factor determination = the value for MLF_y (56a)

To calculate the project market leakage (LE_Y, t CO2e yr^{-1}):

$$LE_Y = MLF_y \bullet ER_{y,GROSS} \quad (56b)$$

Where,

MLF_y = Market leakage factor, as calculated above.

$ER_{y,GROSS}$ = the gross difference in the overall annual carbon change between the baseline and project scenarios in year 'y' (in tonnes CO_2e yr^{-1}). This term is calculated in equation 57.

Gross carbon emissions reductions (ER_y,gross; t CO_2e yr^{-1}) created by the carbon project are calculated annually as the difference between the baseline and project scenario net emission reductions/emissions:

$$ER_{y,GROSS} = (\Delta C_{BSL,t} - \Delta C_{PRJ,t}) \bullet 44/12 \quad (57)$$

Where,
$\Delta C_{BSL,t}$ = total net baseline scenario emissions calculated from equation 1 (t C yr^{-1}).
$\Delta C_{PRJ,t}$ = total net project scenario emissions calculated from equation 29 (t C yr^{-1}).
44/12 = factor to convert C to CO_2e

The annual *net* carbon emissions reductions is the actual net GHG removals by sinks from the project scenario minus the net GHG removals by sinks from the baseline scenario, were then calculated by applying the leakage and uncertainty discount factors (but not the VCS permanence buffer), on an annualized basis:

$$ER_y = ER_{y,GROSS} - LE_y \quad (58)$$

where:
ER_y = the net GHG emissions reductions and/or removals in year *y* (the overall annual carbon change between the baseline and project scenarios, net all discount factors except the permanence buffer) (t CO_2e yr^{-1}).
$ER_{y,GROSS}$ = the difference in the overall annual carbon change between the baseline and project scenarios (t CO_2e yr^{-1}).
LE_y = Leakage in year y (t CO_2e yr^{-1}), as calculated in equation 56b.

The number of VCU's the project available for issuance and sale in year, *y* (VCU_y; t CO_2e yr^{-1}), is calculated as:

$$VCU_y = ER_y \bullet (1 - ER_{y,ERR}) - BR_y \quad (59)$$

where:
ER_y = the net GHG emissions reductions and/or removals in year (t CO_2e yr^{-1}), as calculated in equation 58.
$ER_{y,ERR}$ = the uncertainty factor for year, y, (calculated in Section 3.4), expressed as a proportion.
BR_y = estimated VCU-equivalent tCO_2e issued to the VCS Buffer Pool in year, *y*, calculated using the latest version of the VCS AFOLU Non-Permanence Risk Tool. BRy is calculated by multiplying the most current verified permanence risk Buffer Withholding Percentage for the project by the change in carbon stocks (difference between baseline and project scenario) for the project geographic area as per the latest approved VCS AFOLU Requirements

The project-level uncertainty factor is calculated as follows:

$$E_M = 100 \bullet (\sum y_{d,h,i} / \sum(A_{PRJ,h} \bullet y_{m,h,i})) \quad (60a)$$

where:
The summation is across all plot observations, *i*, and across all analysis units , *h*;

$$y_{d,h,i} = A_{PRJ,h} \bullet (y_{m,h,i} - y_{p,h,i}) \quad (60b)$$

E_M = Mean model error for the project (%)
$y_{d,h,i}$ = the area-weighted difference between measured and predicted carbon storage in analysis unit, *h*, plot observation, *i* (t C)
$y_{m,h,i}$ = carbon storage measured in analysis unit, *h*, plot observation, *i* (t C ha^{-1})
$y_{p,h,i}$ = carbon storage predicted by model for analysis unit , *h*, plot observation, *i* (t C ha^{-1})
$A_{PRJ,h}$ = area of project analysis unit, *h* (ha)

$$E_I = 100 \bullet [SE * 1.654 / ((1/N) \bullet \sum(A_{PRJ,h} \bullet y_{m,h,i}))] \quad (60c)$$

Where,
E_I = Inventory error for the project (%)

SE = the project level standard error of the area weighted differences between measured plot observation and predicted values of carbon storage.
N = total number of plot observations in all analysis units or polygons
1.654 = the 90% confidence interval *t*-value
All other terms as defined in equation 60a.

$SE = S/\sqrt{N}$ **(60d)**

Where,
N = total number of plot observations in all analysis units or polygons (see Footnote 37)
S = the standard deviation of the area weighted differences between measured and predicted values of carbon storage across all analysis unit or polygons.

$S = \sqrt{[(1/N-1) \cdot \sum(y_{d,h,i} - \bar{y}bar_d)^2]}$ **(60e)**

Where,
$\bar{y}bar_d$ = the project-level mean of the area weighted differences between measured plot observation and predicted values of carbon storage. See equation 60b for the calculation of $\mathbf{y_{d,h,i}}$
All other terms as defined in equation 60b and 60c.

The total error for the project (E_P; %) is calculated by adding the model and inventory error terms, as calculated in Steps 1 and 2.

$E_P = E_M + E_I$ **(60f)**

The Market Leakage and Uncertainty Factor calculations are made within the King County Carbon Database tool. The analysis calculation for leakage is completed following the process described in Section 3.3 using the Leakage function buttons in the database main menu to accomplish Equations 56a – 56b. The uncertainty factor calculations are completed following the process described in Section 3.4 using the Uncertainty Factor buttons in the database main menu to accomplish equations 60a-60f. More specifically, the database queries used for the uncertainty factor calculations all begin with "QfrmUncertaintyFactor". The final query is "QfrmUncertaintyFactor_Calc09".

The summarizing calculations for Equations 57-59 (and output into Table 8 and Table 9 in this PD, and equivalent in MR's) are made within the database tool, and are made using the "Output PD Tables" button on the database main menu. Individual queries are run to output the information for each PD/MR table. The Table 8 (database queries PDD Table 8a-8c; final being Table 8c which is then used also as input for Table 9 queries) and Table 9 (database queries PDD Table 9a-9d; final being 9d) complete the final summarizing equations in 57-59 by year. The data that goes into the queries all come from the output from the Scenario Generator. Specifically the "Scenario_Baseline" and the "Scenario_Project" tables.