BOWEN ISLAND MUNICIPALITY

CLIMATE LENS - GHG MITIGATION ASSESSMENT

COMMUNITY CENTER

February 27, 2020

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VERSION 1

PROJECT NO.: 201-00437-00
DATE: FEBRUARY 27, 2020

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1 ATTESTATION OF COMPLETENESS

We the undersigned attest that this Greenhouse Gas (GHG) Mitigation Assessment was undertaken using recognized assessment tools and approaches (i.e. ISO 14064-2 (second edition, 2019-04): Specification with guidance at the project level for quantification, monitoring, and reporting of greenhouse gas emissions reductions or removal enhancements and the GHG Protocol for Project Accounting) and complies with the General Guidance issued by Infrastructure Canada for use under the Climate Lens.

Prepared by: _____ Date: February 27, 2020

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2 EXECUTIVE SUMMARY

The Bowen Island Municipality (BIM) stated in February 2020: "We recognize that climate change represents an emergency for Bowen Island, and commit to developing a strategy to reduce emissions in alignment with the targets to limit global warming to 1.5°C above pre-industrial levels." To outline the strategies to be undertaken a draft Bowen Island 2050 Climate Change Strategy is currently under review by Municipal staff. This plan includes a commitment to net zero GHG emissions target by 2050.

With no heavy industry and no natural gas service, the municipality has identified their primary source of GHG emissions as the emissions associated with transport on/off the island, including ferry and driving emissions, to regional destinations for such purposes as work, school, health, recreation, and entertainment. One strategy to reduce GHG emissions will be to encourage the development of on-island services and reduce the need for off-island transportation. Current elements of this strategy include an on-island composting system, a health centre, shared office space in Snug Cove and the development of a community centre.

BIM is initiating an infrastructure Project for their Community Centre Project (the Project). The Project is located on Trunk Road, Bowen Island, BC, which is to provide a community space for various types of events and activities. The Project requires Climate Lens Assessment[1] during the application/design phase of the Project. WSP was retained by BIM to conduct Climate Lens Assessment for evaluation impacts of GHG emissions on climate change. The Climate Lens has two components:

1. The Greenhouse Gas (GHG) Mitigation assessment, which estimates the anticipated GHG emissions impact of an infrastructure project; and
2. The Climate Change Resilience assessment, which employs a risk management approach to anticipate, prevent, withstand, respond to, and recover from a climate change related disruption or impact.

This is the Greenhouse Gas (GHG) Mitigation Assessment Report, which details the Project's GHG emissions inventory in 2030 and over the asset's lifespan, including both construction as well as operations and maintenance (O & M) phases. This report includes a list of GHG emissions sources, and the quantity of emissions anticipated to be released from each source during the asset's lifespan.

The proposed community centre is expected to provide a venue for activities and events that would otherwise be occurring off island. This could represent a reduction in the indirect GHG emissions resulting from a reduced number of trips off island for activities that will occur at the community centre in the future. Without information on the number of visits off island that would be avoided due to the community centre and the number that would be added due to people off island coming to the community centre for events/activities there is no way to estimate if this represents an increase or decrease in GHG emissions. Consequently, this source of indirect emissions was not included in the GHG Mitigation Assessment report for the community centre project.

The Project is designed to implement "green" technologies and optimize building envelope performance that is beyond the baseline/business as usual (BAU) case. The anticipated net GHG reduction relative to the BAU emissions baseline in the year 2030 and cumulatively over the anticipated lifespan of the project are shown in Table 2-1.

[1] Infrastructure Canada, Climate Lens General Guidance Version 1.2- September 6, 2019

Table 2-1: Net Reduction in GHG Emissions in 2030 and Cumulative Over 25-Years of Lifespan

GHG Mitigation Assessment					
2030 GHG Results (tonnes of CO_2e)			**Lifetime GHG Results (tonnes of CO_2e)**		
Baseline Scenario Emissions in 2030		8.28	Baseline Scenario Emissions, Lifetime (cumulative)		1349.4
Estimated Project Emissions in 2030		3.34	Estimated Project Emissions, Lifetime (cumulative)		1,226.0
Net Emissions	4.93	**4.93**	**Net Emissions**	**Reduction**	**123.4**

For the baseline case, the Project is anticipated to emit approximately 1,142 tonnes of CO_2-equivalent (tCO_2e) during the land clearing and construction phase from 2020 to 2021, and 207 tCO_2e during the operation and maintenance phase, spanning 25 years from 2022 to 2046. For the project case, emissions from the operation and maintenance phase are expected to be 84 tCO_2e over the lifespan of the project. The Project is anticipated to result in 4.9 tonnes of CO_2e reduction in 2030 (non-cumulative basis), and a Project lifespan GHG reduction of 123.4 tCO_2e relative to the baseline scenario.

The annul O&M emissions are 8.3 tonnes of CO_2e for the baseline case and 3.3 tonnes of CO_2e for the project case, which is equivalent to 7.2 and 2.9 kg of CO_2e per m^2 building footage respectively. The GHG reduction cost for 2030 is 1,613,300 Federal Contribution dollar per tonne of CO_2e removed (non-cumulative basis). For the Project lifespan, the GHG reduction cost is 88,000 Project dollar per tonne of tCO_2e removed.

This GHG Assessment has been developed in accordance with CAN/CSA-ISO Standard 14064-2 (Second edition, 2019-04): Greenhouse Gases – Part 2: Specification with guidance at the project level for quantification, monitoring and reporting of greenhouse gas emission reductions or removal enhancements. In addition, the team has consulted with the World Resource Institute (WRI)/ World Business Council for Sustainable Development (WBCSD) protocol: The GHG Protocol for Project Accounting and additional resources. The GHG assertions presented in this report have not undergone third-party verification.

3 PROJECT OVERVIEW

3.1 PROJECT BACKGROUND

The proposed Bowen Island Community Center is located on Trunk Road, Bowen Island, BC, British Columbia. The overall building size is 16,436 sq. ft. Among them, 12,299 sq. ft, is for the community center facility and 4,137 sq. ft is for the municipal hall. The community center is designed to provide a community space for various types of events and activities. It consists of a large multi-purpose room, a small multi-purpose room, a weight room and fitness studio, community kitchen, coffee kiosk, community living room and gallery lounge, etc. The building uses electricity and propane as energy supply to meet the proposed design conditions.

3.2 PROJECT SCHEDULE AND LIFETIME

The project includes construction of structural, mechanical, and electrical assets. Land clearing and construction is scheduled to begin in 2020 with scheduled completion by the end of 2021. For this analysis, the lifetime for structural assets was set as approximately 50 years, while mechanical and electrical assets were set at approximately 25 years. Regular maintenance is planned to achieve and extend these projected lifetimes.

4 METHODOLOGY

4.1 QUANTIFICATION PROTOCOL

Quantification of baseline and Project emissions adheres to the six principles for project GHG accounting set out in CAN/CSA-ISO Standard 14064-2[2] and The GHG Protocol for Project Accounting[3]. These include:

- **Relevance:** This GHG assessment appropriately reflects the baseline and project case for the Project and serves the needs of its owners to communicate GHG emissions impacts of this development. Emissions factors and estimates used are sourced from British Columbia's Methodological Guidance or IPCC sources where possible and are referenced in detail.
- **Completeness:** WSP has accounted for all significant GHG emission sources and activities within the chosen boundaries, referencing the Climate Lens guidance. Any exclusion of emissions sources is disclosed and justified.
- **Consistency:** WSP has completed this assessment using consistent methodologies to enable meaningful comparisons of GHG emissions with other projects and over time. Methodological decisions are transparently documented.
- **Accuracy:** Quantification of the Project's anticipated baseline and Project emissions is made as accurate as possible, based on available data, emissions factors and estimation methodologies used, recognizing that uncertainties exist due to the early stage of Project development, and the limited emissions factors available for the relevant activities. Where there is uncertainty, a conservative approach has been taken and described in detail.
- **Transparency:** WSP has produced this report in a factual and coherent manner. Any assumptions are stated, and calculation methodologies are referenced to ensure transparency.
- **Conservativeness:** Assumptions, estimations, and emissions and conversion factors are selected with the aim of avoiding under-estimating GHG emissions from the Project.

4.2 BOUNDARY OF THE ASSESSMENT

The Project boundary includes GHG emissions associated with project activities resulting from the construction and use of the building. The assessment considers construction, O&M emissions from the beginning of construction (including land clearing and construction anticipated to start by 2020, and be completed by the end of 2021), operations in 2022 and over a 25-year operational lifetime ending in 2046. Emission sources include direct and indirect emissions during the construction phase and the operational period. Detailed methodology and parameters of the assessment including GHGs and emission scopes are summarized in the following sections.

4.3 GREENHOUSE GASES CONSIDERED

This assessment considers the six gases defined as GHGs under the United Nations Intergovernmental Panel on Climate Change (IPCC):

[2] ISO 14064-2: Specification with Guidance at the Project Level for Quantification, Monitoring, and Reporting of Greenhouse Gas Emission Reductions or Removal Enhancements, Second edition, 2019-04
[3] World Business Council for Sustainable Development (WBCSD)/World Resources Institute (WRI) – The GHG Protocol for Project Accounting

- Carbon dioxide (CO_2),
- Methane (CH_4),
- Nitrous oxide (N_2O),
- Hydrofluorocarbons (HFCs – a family of gases),
- Fluorocarbons (PFCs – another family of gases) and
- Sulfur hexafluoride (SF_6).

The majority of emissions are CO_2. Small amounts of CH_4 and N_2O are anticipated and are quantified where an appropriate emissions factor exists. All emissions are converted into tonne of CO_2 equivalent (tCO_2e) using global warming potentials (GWP) sourced from the IPCC 4th Assessment Report (Table 4-1).

Table 4-1 Global Warming Potential (100 year) of Common GHG

Greenhouse Gas	Global Warming Potential (100 year)
Carbon dioxide (CO_2)	1
Methane (CH_4)	25
Nitrous oxide (N_2O)	298

In some cases, available emissions factors are provided in units of tCO_2e, encompassing CH_4 and N_2O emissions. No or trace amounts of HFCs, PFCs and SF_6 are anticipated to be emitted.

4.4 GHG ASSESSMENT SCENARIOS

The building is designed to provide a community space for various types of events and activities. In the absence of the Project, the most likely business as usual (BAU) scenario is the construction (to the minimum requirements of the building code at the time of construction) and operation of a regular Community Center without implementing "green" technologies or practices to reduce GHG emissions. At the design stage of the project, the ASHRAE 90.1-2016 was the Standard for minimum Building Energy Efficiency requirements. Thus, the baseline case is the application of the ASHRAE 90.1-2016 standard, which represents the conditions most likely to occur in the absence of the proposed Project.

The Project case represents the GHG reduction scenario that considered "green" technologies and practices for energy efficiency and energy saving. The BIM Community Center has implemented a number of energy conservation measures (ECMs) by optimizing engineering designs to improve building envelope performance, including insulation, lighting power densities (LPD), and energy efficiency, etc. Methods to quantify anticipated emissions associated with this Baseline case/Project case are described in the following sections.

4.5 EMISSION SCOPES

Anticipated emissions are quantified both for the construction phase and for the O & M phase over the lifespan of the asset. Sources of direct and indirect energy emissions are summarized in Table 4-2.

Table 4-2: Assessment Boundary Emission Sources and Scopes

Source Scope	Activities
Scope 1 – Direct Emissions	– Land Use Change (Forest Clearing) – Construction Equipment – Propane usage
Scope 2 – Energy Indirect Emissions	– Electricity Consumption
Scope 3 – Other Indirect Emissions	N/A

As stipulated in the Climate Lens Guideline[1], supply chain emissions are not required to be included. Likewise, emissions associated with future major refit and/or decommissioning of the Project are not quantified. No emissions or emissions removals associated with this Project are anticipated to occur outside of Canada.

4.6 DATA COLLECTION AND CALCULATION PROCEDURES

GHG emissions anticipated for the Project were estimated based on the best data available at the time of data analysis. GHG emissions wee quantified using the following equation:

GHG Emissions = Activity Data × Emission Factor

Activity data associated with land clearing area, capital cost associated with construction, O & M activities was provided by the Project design team. There are potential differences between projected and actual emissions, which may arise due to actual materials used, activities undertaken during construction and O&M practices. Emission factors are taken from various sources, such as Intergovernmental Panel on Climate Change (IPCC) and 2018 BC GHG Quantification Methodological Guidance[4].

4.7 EXCLUSIONS FROM THE ASSESSMENT

Fugitive emissions could result from the use of refrigerant-containing equipment on-site, during construction and/or operations and maintenance. Given the uncertainty on the types and details of refrigerant-containing equipment that could be used, fugitive emissions for refrigerants have not been quantified in this assessment.

Per Climate Lens direction, upstream and downstream supply chain emissions are not quantified or assessed. Other supply chain emissions that are not quantified, but could exist for this type of project, include emissions resulting from production and transportation of construction materials, workers and staff commuting to site, production and transportation of consumables (e.g. chemicals, supplies), and upstream emissions associated with fuel and energy. Emissions associated with future major refit and/or decommissioning of the Project are also not quantified.

4.8 ASSUMPTIONS

The Project is being delivered through a Design-Bid-Build model. As such, availability of data at the current indicative design stage requires that assumptions be made to estimate some activities, yielding results that are associated with greater

[4] BC Ministry of Environment, 2018 B.C. Methodological Guidance for Quantifying Greenhouse Gas Emissions for Public Sector Organizations, Local Governments and Community Emissions, January 2019 (Draft)

uncertainty. If greater certainty is desired, this calculation and results may be revisited to incorporate new data following construction.

4.8.1 LAND CLEARING

The Community Center site will have a footprint approximately 2,500 m^2 based on the landscape plan[5]. CO_2 emissions due to clearing of forest land to develop the site were estimated using the following equation[6]:

CO_2 (tonne/year) = Forest Area (ha)* biomass load (ha/year) * carbon fraction of biomass * 44/12

Where: 44/12 = molar ratio of CO_2 to carbon

The biomass load was taken from Table 7 of the Canada's Forest Biomass Resources for BC at 158 tonne/ha[7]. The carbon fraction of the biomass was estimated at 0.5 tonnes/dry matter [6]. This is a conservative approach as the biomass from cleared areas maybe used for other purposes. Parameters used for land clearing emission quantification are shown in Table 4-3.

Table 4-3: Parameters Used for Land Clear Up

Parameters	Number	Unit
Land Clearance Area	2,500	m^2
CF = Carbon fraction of dry matter tonnes C	0.5	C tonne/dry matter
Biomass load (above ground)	158	dry matter tonne/ha
C to CO_2 conversion	3.667	tonne CO_2 /tonne C
CO_2 EF due to conversion of forest Land	289.7	tonne CO_2/ha

The following is an example of calculating CO_2 emissions from land clearing:

$$CO_2 = 2{,}500m^2 * \frac{ha}{10{,}000m^2} * \frac{158\ dry\ matter\ tonne}{ha} * \frac{0.5\ C\ tonne}{dry\ matter} * \frac{44\ tonne\ CO_2}{12\ tonne\ C} = 72.42\ tonne\ CO_2$$

4.8.2 CONSTRUCTION

Construction emissions include activities associated with the use of heavy equipment and electricity for site preparation, structure build up, and the installation of plumbing, drainage, mechanical and electrical services. For this project, it was assumed that the construction emissions for the baseline case and the project case are same since the differences for capital cost and construction equipment are insignificant between these two cases.

At current stage, the project is still under design/bid process, detailed construction activity is not finalized. As a result, construction cost was used as a proxy to calculate construction emissions. Emissions from the construction phase were estimated based on cost estimates using an energy intensity index related to construction value. The GHG intensity data

[5] HAPA Collaborative, Preliminary Costing for Bowen Island Community Center, April 9, 2018
[6] Intergovernmental Panel on Climate Change (IPCC), Good Practice Guidance for Land Use, Land-Use Change and Forest, Chapter 3.2 Forest Land, https://www.ipcc-nggip.iges.or.jp/public/gpglulucf/gpglulucf_files/Chp3/Chp3_2_Forest_Land.pdf, accessed in November 2019
[7] Natural Resources Canada & Canadian Forest Service, Canada's Forest Biomass Resources: Deriving Estimates from Canada's Forest Inventory, https://cfs.nrcan.gc.ca/pubwarehouse/pdfs/4775.pdf, accessed in February 2020

was taken from a US EPA study for reducing GHG emissions in the construction sector[8]. The US EPA study characterized the GHG emissions from various construction activities, relying on the North American Industry Classification System (NAICS) codes to segregate construction types. The emission intensities for the construction industry were evaluated using metric tonnes of CO_2 equivalents per thousand 2002 US dollar (tCO_2e/2002K US$). To convert 2002 US dollar to 2002 CAD dollar, an exchange rate of 1.57 sourced from the Bank of Canada[9] was used for the Canadian dollar value in 2002 with respect to 2002 US dollar. The 2002 CAD$ were then adjusted for inflation using the historical British Columbia (BC) price index data from the inflation calculator for BC[10] to obtain the most current Canadian dollar equivalent value, which is the 2019 CAD$. Emission parameters used to calculate anticipated emissions from construction activities are summarized in Table 4-4.

The following is an example of calculating CO_2e emissions from construction of mechanical and electrical components:

$$CO_{2e} = 0.049 \frac{tonne\ CO_{2e}}{2019k\ CAD\$} * 2{,}434.023\ (2019k\ CAD\$) = 119\ tonne\ CO_{2e}$$

Table 4-4: Emissions Intensities for Quantifying GHG Emissions from Mechanical Construction Activity (2020-2021)

Construction Description	2002 NAICS Code	Intensity CO_2e (tonne)/ 2002k US$	Intensity CO_2e (tonne)/2019k CAD$	Cost (2019k CAD$)
Commercial & institutional building Construction	23622	0.23	0.113	$8,422.279
Plumbing, heating and air condition contractors	23822	0.10	0.049	$2,434.023

4.8.3 O & M EMISIONS

The annual energy consumption for the building was obtained from the Energy Modelling Report[11] for a total building size of 1,441 m^2. The Energy Modelling Report provided annual energy consumption estimation for the baseline case and the project case during the O & M phase of the project. Energy usage includes electricity consumption for space heating and cooling, domestic hot water (DHW), ventilation fans, interior lighting, plug load, pumps and auxiliaries, as well as propane usage for the space heating.

The Energy Modelling Report applied ASHRAE 90.1-2010 as a minimum energy efficiency design standard for the baseline energy consumption estimation. For the GHG mitigation assessment, the annual energy consumption for the baseline was adjusted to the minimum building code compliant at the design stage of the project, which is the ASHRAE 90.1-2016 standard. The 2016 standard had an overall 14.3% energy improvement relative to the 2010 standard

[8] US EPA, Potential for Reducing Greenhouse Gas Emissions in the Construction Sector, 2009
[9] Government of Canada, Average Exchange Rates for 2002, https://www.canada.ca/en/revenue-agency/services/forms-publications/previous-year-forms-publications/archived-rc4152/archived-average-exchange-rates-2002.html, accessed in April 2019
[10] Inflation Calculator, https://inflationcalculator.ca/british-columbia/, accessed in December 2019
[11] Rocky Point Engineering Ltd., Energy Modelling Study for the Bowen Island Community Centre, July 12, 2018

according to building envelop performance analysis[12]. For the project case, the energy modelling predicted energy usage by implementing eight cumulative ECMs as building energy saving measures. The energy demand for GHG mitigation assessment has been adjusted to a community center area of 1,143 m^2 for the baseline and project case. Detailed calculations for the emissions from electricity and propane are illustrated below.

4.8.3.1 *ELECTRICITY*

Electricity consumption from the energy modelling data for the baseline case was first reduced to 14.3% following the ASHRAE 90.1-2016 standard [12]. Then the electricity usage was adjusted to a building size of 1,143 m^2 reflecting the actual energy demand for the Community Center. The adjusted breakdown of electricity usage for the baseline and the project case is summarized in Table 4-5.

Table 4-5: Electricity Consumption for the Baseline Case and Project Case

Energy End Use	Baseline (kWh) – ASHRAE 2010	Baseline (kWh) ASHRAE 2016	Baseline (kWh) - ASHRAE 2016 Community Center	Project - Energy Modeling (kWh)	Project - Community Center (kWh)
Space Heating	109,287	93,659	74,250	15,568	12,342
Space Cooling	12,475	10,691	8,476	8,533	6,765
DHW	24,918	21,355	16,929	24,915	19,752
Fans	8,439	7,232	5,733	8,691	6,890
Pumps	5,595	4,795	3,801	4,539	3,598
Plug Loads	18,853	16,157	12,809	18,853	14,946
Interior Lighting	90,103	77,218	61,216	63,190	50,095
Sum	**269,670**	**231,107**	**183,214**	**144,289**	**114,388**

GHG emissions from electricity were quantified using emission factors taken from Table 3 of the 2018 BC GHG Quantification Methodological Guidance[4]. Activity and emission factors used for the electricity are shown in Table 4-6. The following is an example calculation of the annual CO_2e emissions from electricity consumption for the baseline case:

$$CO_{2e} = 183{,}214 \frac{kWh}{yr} * 10.67 \frac{CO_{2e} tonne}{GWh} * \frac{GWh}{10^6 kWh} = 1.95\ tonne\ CO_{2e}$$

Table 4-6: Electricity Consumption and Emission Factors Associated with O & M Phase (2022-2046)

Energy Type	Baseline	Project	Emission Factor[4] (kg CO_2e/GWh)			
			CO_2	CH_4	N_2O	CO_2e
Electricity (kWh/year)	183,214	114,388	-	-	-	10.67

[12] Liu et al., National Impact of ANSI/ASHRAE/IES Standard 90.1-2016, 2018 Building Performance Analysis Conference and SimBuild co-organized by ASHRAE and IBPSA-USA, September 26-28, 2018

4.8.3.2 *PROPANE*

Propane is used for space heating and the emergency generator. The propane energy demand for space heating for the baseline case and project case were taken from Energy Modelling Report[11]. Similar to the electricity consumption, propane usage was adjusted using the ASHRAE 90.1-2016 standard and building area of 1,143 m^2 to reflect the design criteria of community center.

The community center is equipped with a 140-kW emergency propane generator for emergency and standby back-up power usage[13]. The propane generator was assumed to be operated once per month for 30 minutes each time as an equipment maintenance and testing requirement[14]. The annual propane consumption was estimated at 184 L based on a generator energy efficiency of 35% and engine size for the current design stage. Emissions from the consumption of propane were quantified using emission factors taken from Table 1 of the 2018 BC GHG Quantification Methodological Guidance[4]. Activity and emission factors used for propane are shown in Table 4-7.

Table 4-7: Propane Consumption and Emission Factors Associated with O & M Phase (2022-2046)

Propane Usage	Baseline	Project	Emission Factor (kg/GJ)[4]			
			CO_2	CH_4	N_2O	CO_2e
Space Heating (GJ)	98.7	30.05	59.86	0.0009	0.0043	61.16
Propane Usage	**Baseline**	**Project**	**Emission Factor(kg/L)[4]**			
			CO_2	CH_4	N_2O	CO_2e
Propane (L) - Generator	183.8	183.8	1.515	0.000024	0.000108	1.55

The following is an example of calculating annual baseline CO_2 emissions from the usage of propane for building space heating:

$$CO_2 = 98.7 \frac{GJ}{yr} * 59.86 \frac{kg}{GJ} * \frac{tonne}{1{,}000\ kg} = 5.91\ tonne\ CO_2$$

[13] AES Engineering Ltd., Design Development for Bowen Island Community Center, April 6, 2018
[14] Inspection and Testing of Emergency Generator, National Fire Protection Association (NFPA), https://www.health.state.mn.us/facilities/regulation/engineering/docs/lscgensets.pdf, accessed in February 2020

5 BASELINE ESTIMATED GHG EMISSIONS

5.1 LAND CLEARING

Total CO_2 emissions from land clearing were estimated at 72.4 tonne CO_2e /year using the method described in Section 4.8.1. Emissions from land clearing represent 5.4% of the total emissions over the project lifespan for the Baseline case.

5.2 CONSTRUCTION

Emissions from construction phase activities are shown in Table 5-1. GHG emissions during construction phase are estimated at 1,070 tCO_2e, which represent 81% of emissions over the lifespan of the Project. Given the planned timing of each construction phase activity, 44% of construction emissions are assumed to be released in 2021, and 56% in 2022.

Table 5-1: Construction Emissions

Project Components	Emissions (tonne CO_2e/year)	
	2020	2021
Construction	475.3	594.7

5.3 OPERATIONS & MAINTENANCE

Normal operation and maintenance activities are anticipated to result in 8.3 tonnes of CO_2e emissions annually, which is equivalent to 7.24 kg of CO_2e per m^2 building footage. Breakdown of emissions by energy types are shown in Table 5-2. Emissions from propane usage is the largest contributor, which account for 73% of total baseline O & M emissions. The total emissions from O&M represents 15.3% of total emissions over the lifespan of the Project for the baseline case (Table 5-3).

Table 5-2: Baseline O& M Emissions

Baseline O & M Emission Sources	GHG Emissions (tonne/year)				GHG Emission Contribution (%)
	CO_2	CH_4	N_2O	CO_2e	
Electricity	-	-	-	1.95	23.6%
Propane -Space Heating	5.91	0.00009	0.00042	6.04	72.9%
Propane - Genset	0.28	0.000004	0.00002	0.28	3.4%
Total	-	-	-	**8.28**	100.0%

5.4 ANNUAL AND CUMMULATIVE EMISSIONS OVER PROJECT LIFETIME

Annual and cumulative emissions for the baseline case are summarized in Table 5-3. Construction emissions represent approximately 79.3% of the lifetime GHG emissions, followed by O & M emissions, which account for 15.3% of the total lifetime emissions, and land clearance emissions amounting to approximately 5.4%.

Table 5-3: GHG Emission Summary for Baseline Case

Project Year	Calendar Year	Land Clearing	Construction	O & M	Annual Total	Cumulative
		tonne of CO_2e				
Construction Year 1	2020	72.4	475.3	-	513.3	547.7
Construction Year 2	2021	-	594.7	-	594.7	1,142.4
O & M Year 1	2022	-	-	8.3	8.3	1,150.7
O & M Year 2	2023	-	-	8.3	8.3	1,159.0
O & M Year 3	2024	-	-	8.3	8.3	1,167.3
O & M Year 4	2025	-	-	8.3	8.3	1,175.5
O & M Year 5	2026	-	-	8.3	8.3	1,183.8
O & M Year 6	2027	-	-	8.3	8.3	1,192.1
O & M Year 7	2028	-	-	8.3	8.3	1,200.4
O & M Year 8	2029	-	-	8.3	8.3	1,208.6
O & M Year 9	**2030**	**-**	**-**	**8.3**	**8.3**	**1,216.9**
O & M Year 10	2031	-	-	8.3	8.3	1,225.2
O & M Year 11	2032	-	-	8.3	8.3	1,233.5
O & M Year 12	2033	-	-	8.3	8.3	1,241.8
O & M Year 13	2034	-	-	8.3	8.3	1,250.0
O & M Year 14	2035	-	-	8.3	8.3	1,258.3
O & M Year 15	2036	-	-	8.3	8.3	1,266.6
O & M Year 16	2037	-	-	8.3	8.3	1,274.9
O & M Year 17	2038	-	-	8.3	8.3	1,283.1
O & M Year 18	2039	-	-	8.3	8.3	1,291.4
O & M Year 19	2040	-	-	8.3	8.3	1,299.7
O & M Year 20	2041	-	-	8.3	8.3	1,308.0
O & M Year 21	2042	-	-	8.3	8.3	1,316.3
O & M Year 22	2043	-	-	8.3	8.3	1,324.5
O & M Year 23	2044	-	-	8.3	8.3	1,332.8
O & M Year 24	2045	-	-	8.3	8.3	1,341.1
O & M Year 25	2046	-	-	8.3	8.3	1,349.4
Total Emissions	-	**72.4**	**1,070**	**206.9**	**1,349.4**	-
Emission Percent	-	**5.4%**	**79.3%**	**15.3%**	-	-

6 PROJECT EMISSIONS

6.1 LAND CLEARING

Total CO_2 emissions from land clearing for the project case is identical to the baseline case. GHG emission was estimated at 72.4 CO_2e /year using method described in Section 4.8.1. Emissions from land clearing represents approximately 5.9% of the total emissions over the project lifespan for the Project Case.

6.2 CONSTRUCTION

Emissions from construction phase activities are the same for the baseline case and project case as shown in Table 5-1. GHG emissions during the construction phase are estimated at 1,070 tCO_2e, which represent 87.3% of emissions over the lifespan of the Project.

6.3 OPERATIONS & MAINTENANCE

For the project case, normal operation and maintenance activities are anticipated to result in 3.3 tonnes of CO_2e emissions annually, which is equivalent to 2.93 kg of CO_2e per m^2 building footage. The breakdown of emissions by energy type is shown in Table 6-1. Emissions from propane usage is the largest contributor, which account for 55% of total Project O & M emissions. The O&M emissions represent 6.8% of total emissions over the lifespan of the Project (Table 6-2).

Table 6-1: Project O& M Emissions

Baseline O & M Emission Sources	GHG Emissions (tonne/year)				GHG Emission Contribution (%)
	CO_2	CH_4	N_2O	CO_2e	
Electricity	-	-	-	1.22	36.5%
Propane -Space Heating	1.80	0.00003	0.00013	1.84	55.0%
Propane - Genset	0.28	0.000004	0.00002	0.28	8.5%
Total	-	-	-	**3.34**	100.0%

6.4 ANNUAL AND CUMULATIVE EMISSIONS OVER PROJECT LIFETIME

Annual and cumulative emissions for the Project case are summarized in Table 6-2. Construction emissions represent 87.3% of lifetime GHG emissions, followed by O&M emissions, which account for approximately 6.8% of the total lifetime emissions.

Table 6-2: GHG Emission Summary for Project Case

Project Year	Calendar Year	Land Clearing	Construction	O & M	Annual Total	Cumulative
		tonne of CO_2e				
Construction Year 1	2020	72.4	475.3	-	547.7	547.7
Construction Year 2	2021	-	594.7	-	594.7	1,142.4
O & M Year 1	2022	-	-	3.3	3.3	1,145.8
O & M Year 2	2023	-	-	3.3	3.3	1,149.1
O & M Year 3	2024	-	-	3.3	3.3	1,152.5
O & M Year 4	2025	-	-	3.3	3.3	1,155.8
O & M Year 5	2026	-	-	3.3	3.3	1,159.1
O & M Year 6	2027	-	-	3.3	3.3	1,162.5
O & M Year 7	2028	-	-	3.3	3.3	1,165.8
O & M Year 8	2029	-	-	3.3	3.3	1,169.2
O & M Year 9	**2030**	**-**	**-**	**3.3**	**3.3**	**1,172.5**
O & M Year 10	2031	-	-	3.3	3.3	1,175.9
O & M Year 11	2032	-	-	3.3	3.3	1,179.2
O & M Year 12	2033	-	-	3.3	3.3	1,182.5
O & M Year 13	2034	-	-	3.3	3.3	1,185.9
O & M Year 14	2035	-	-	3.3	3.3	1,189.2
O & M Year 15	2036	-	-	3.3	3.3	1,192.6
O & M Year 16	2037	-	-	3.3	3.3	1,195.9
O & M Year 17	2038	-	-	3.3	3.3	1,199.3
O & M Year 18	2039	-	-	3.3	3.3	1,202.6
O & M Year 19	2040	-	-	3.3	3.3	1,205.9
O & M Year 20	2041	-	-	3.3	3.3	1,209.3
O & M Year 21	2042	-	-	3.3	3.3	1,212.6
O & M Year 22	2043	-	-	3.3	3.3	1,216.0
O & M Year 23	2044	-	-	3.3	3.3	1,219.3
O & M Year 24	2045	-	-	3.3	3.3	1,222.7
O & M Year 25	2046	-	-	3.3	3.3	1,226.0
Total Emissions	-	**72**	**1,070**	**84**	**1,226.0**	**-**
Emission Percent	-	**5.9%**	**87.3%**	**6.8%**	-	**-**

7 ESTIMATED NET REDUCTION IN EMISSIONS

The cumulative emission reduction over the lifetime of the project is summarized in Table 7-1.

Table 7-1: Annual and Cumulative Project Emissions

Project Year	Calendar Year	Baseline Emissions	Project Emissions	Total Net Change - Annual	Total Net Change – Cumulative
		tCO_2e	tCO_2e	tCO_2e	tCO_2e
Construction Year 1	2020	547.7	547.7	0.0	0.0
Construction Year 2	2021	594.7	594.7	0.0	0.0
O & M Year 1	2022	8.3	3.3	4.9	4.9
O & M Year 2	2023	8.3	3.3	4.9	9.9
O & M Year 3	2024	8.3	3.3	4.9	14.8
O & M Year 4	2025	8.3	3.3	4.9	19.7
O & M Year 5	2026	8.3	3.3	4.9	24.7
O & M Year 6	2027	8.3	3.3	4.9	29.6
O & M Year 7	2028	8.3	3.3	4.9	34.5
O & M Year 8	2029	8.3	3.3	4.9	39.5
O & M Year 9	**2030**	**8.3**	**3.3**	**4.9**	**44.4**
O & M Year 10	2031	8.3	3.3	4.9	49.3
O & M Year 11	2032	8.3	3.3	4.9	54.3
O & M Year 12	2033	8.3	3.3	4.9	59.2
O & M Year 13	2034	8.3	3.3	4.9	64.1
O & M Year 14	2035	8.3	3.3	4.9	69.1
O & M Year 15	2036	8.3	3.3	4.9	74.0
O & M Year 16	2037	8.3	3.3	4.9	79.0
O & M Year 17	2038	8.3	3.3	4.9	83.9
O & M Year 18	2039	8.3	3.3	4.9	88.8
O & M Year 19	2040	8.3	3.3	4.9	93.8
O & M Year 20	2041	8.3	3.3	4.9	98.7
O & M Year 21	2042	8.3	3.3	4.9	103.6
O & M Year 22	2043	8.3	3.3	4.9	108.6
O & M Year 23	2044	8.3	3.3	4.9	113.5
O & M Year 24	2045	8.3	3.3	4.9	118.4
O & M Year 25	2046	8.3	3.3	4.9	123.4
Total		**1,349.4**	**1,226.0**	**123.4**	

8 ESTIMATED COST-PER-TONNE

As shown in Table 7-1, GHG reduction emissions in the year 2030 were expected to be 4.9 tonnes of CO_2e (non-cumulative). The accumulated GHG reduction in the Project's lifetime is expected to be 123.4 tonnes of CO_2e. The total eligible project costs are $10,856,302. Of these costs, $7,960,925 is from Federal contribution. Thus, the GHG reduction cost for 2030 is $1,613,300 Federal Contribution dollar per tonne of CO_2e removed (non-cumulative basis). For the Project lifespan, the GHG reduction cost is $88,000 Project dollar per tonne of tCO_2e removed.

9 CONCLUSION

The BIM Community Center Building is designed to implement "green" technologies and optimize building envelope performance that is beyond the baseline/business as usual case. In the baseline, the emissions associated with the Community Centre Building are estimated at 72, 1,070 and 207 tonnes of CO_2e for the land clearing, construction and O&M respectively, over the lifespan of the project. For the project case, the Building emissions are anticipated to be 72, 1,070 and 84 tonnes of CO_2e for the land clearing, construction and O&M respectively, over the lifespan of the project. The annul O&M emissions are 8.3 and 3.3 tonnes of CO_2e for the baseline case and the project case, which is equivalent to 7.2 and 2.9 kg of CO_2e per m^2 building footage. This Project is anticipated to result in 4.9 tonnes of CO_2e reduction in 2030 (non-cumulative basis), and a Project lifespan GHG reduction of 123.4 tCO_2e relative to the baseline scenario. The GHG reduction cost for 2030 is 1,613,300 Federal Contribution dollar per tonne of CO_2e removed (non-cumulative basis). For the Project lifespan, the GHG reduction cost is 88,000 Project dollar per tonne of tCO_2e removed.

A REPORTING INFORMATION

APPENDIX A

No.	ISO14064-2: 2019, Section 6.2 Describe the Project	Declaration
A	Project title, purpose(s) and objectives;	COMMUNITY CENTER The purpose and objectives of the project are to provide a community space for various types of events and activities.
B	Type of GHG project; including descriptions of how the project will achieve GHG emission reductions and/or removal enhancements and specific GHGs targeted;	The Project will emit GHG emissions as a result of land clearing, construction, operation and maintenance of the Community Center. The Project has implemented a number of energy conservation measures (ECMs) by optimizing engineering designs to improve building envelope performance, including insulation, lighting power densities (LPD), and energy efficiency, etc.
C	Project location, including geographic and physical information allowing the unique identification and delineation of the specific extent of the project;	The Project will be located on Trunk Road, Bowen Island, BC, British Columbia.
D	Conditions prior to project initiation;	There is no community building at BIM.
E	Project technologies, products, services and the expected level of activity;	The BIM Community Center Building is approximately 12,300 sq. ft consists of a large multi-purpose room, a small multi-purpose room, a weight room and fitness studio, community kitchen, coffee kiosk, community living room and gallery lounge, etc. The building uses electricity and propane as energy supply to meet the proposed design conditions.
F	Aggregated GHG emissions reductions and removal enhancements, stated in tonnes of CO_2e, likely to occur from the GHG project;	123.4 tCO_2e
G	Identification of risks that could substantially affect the project's GHG emissions reductions or removal enhancements;	The Project is anticipated to achieve emissions reductions or removal enhancements from implementation of several ECMs. Risks that could result in a significant difference between anticipated and actual emissions, from forecast emissions, include: changes to Project construction, operations and/or maintenance activities.

APPENDIX A

H	Roles and responsibilities, including contact information of the project proponent, other project participants, relevant regulator(s) and/or administrators of any GHG programme(s) to which the GHG project subscribes;	This GHG Mitigation Assessment has been completed as part of the Project's Climate Lens. Further inquiries can be directed to the following contacts: Hong Zhang, M.A.Sc., P.Eng. WSP Canada Inc. Senior Environmental Engineer 840 Howe Street, Suite 1000 Vancouver, V6Z 2M1 Canada Hong.Zhang@wsp.com (604) 601-6780
I	A summary of environmental impact assessment when such an assessment related to the project or GHG programme is required by applicable legislation or regulation	Environmental impact assessment is not a requirement of the Climate Lens application. The proponent has submitted application to infrastructure Canada – Investing in Canada Plan.
J	Relevant outcomes from interested party consultations and mechanisms for ongoing communication, if applicable	Not applicable
K	A chronological plan or actual dates and justification for the following: 1) for the date of initiating project activities; 2) GHG baseline time period; 3) Date of terminating the project; 4) Frequency of monitoring and reporting and the project period, including relevant project activities in each step of the GHG project cycle, as applicable; 5) Frequency of verification and validation, as applicable	Land clearing and construction will occur from 2020 to 2021, and operations will commence in 2022, running for 25 years to 2046 for mechanical and electrical assets. Lifetime for structural assets has been projected at 30 -50 years.