QUANTIFICATION PROTOCOL FOR COMMERCIAL AND INSTITUTIONAL GREEN BUILDING PROJECTS

Submitted to:

Alberta Environment

and

Alberta Agriculture, Food and Rural Development

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Suite 610, 700 – 6th Avenue SW, Calgary, AB T2P 0T8 Ph. 403.262.3026 Fax 403.750.7601

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1.0 Project and Methodology Scope and Description

This quantification protocol is written for those familiar with building construction and retrofit projects. Some familiarity with, or general understanding of, the operation of these practices and processes is expected.

The opportunity for generating carbon offsets with this protocol arises from the direct and indirect reductions of greenhouse gas (GHG) emissions resulting from the implementation of new building methods, and facility retrofits that result in overall efficiencies in energy use per unit of productivity. Process changes may include the mechanical, biological and/or chemical components of the operation and may impact upon on-site heat, electrical and power requirements.

1.1 Protocol Scope and Description

This quantification protocol is applicable to the quantification of direct reductions of greenhouse gas (GHG) emissions resulting from overall energy efficiencies in new commercial and institutional (CI) buildings or the retrofit of existing CI buildings. It includes reductions in GHG emissions due to any heat/power savings and/or production, and electricity generation related to the process.

This protocol does not prescribe the configuration or nature of the processes that result in energy efficiencies. Rather, this protocol serves as a generic 'recipe' for project proponents to follow in order to meet the measurement, monitoring and GHG quantification requirements. **FIGURE 1.1** offers a typical process flow diagram for a typical project as defined in this protocol.

FIGURE 1.1: Process Flow Diagram for Project Condition

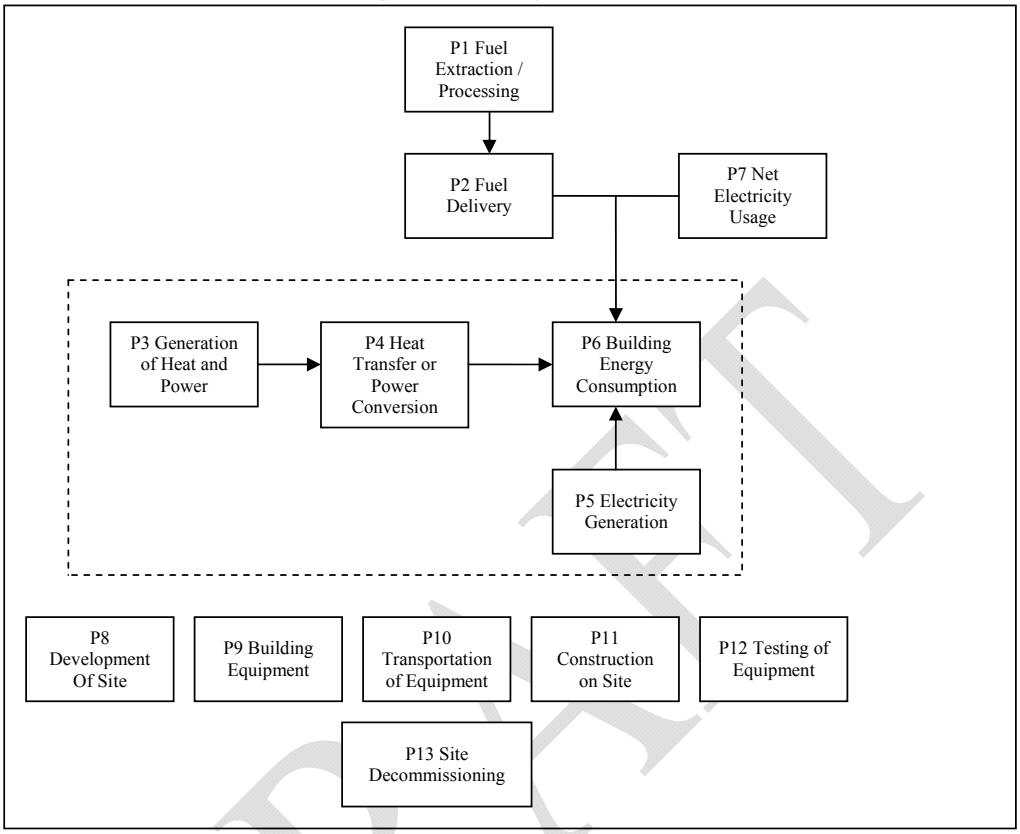
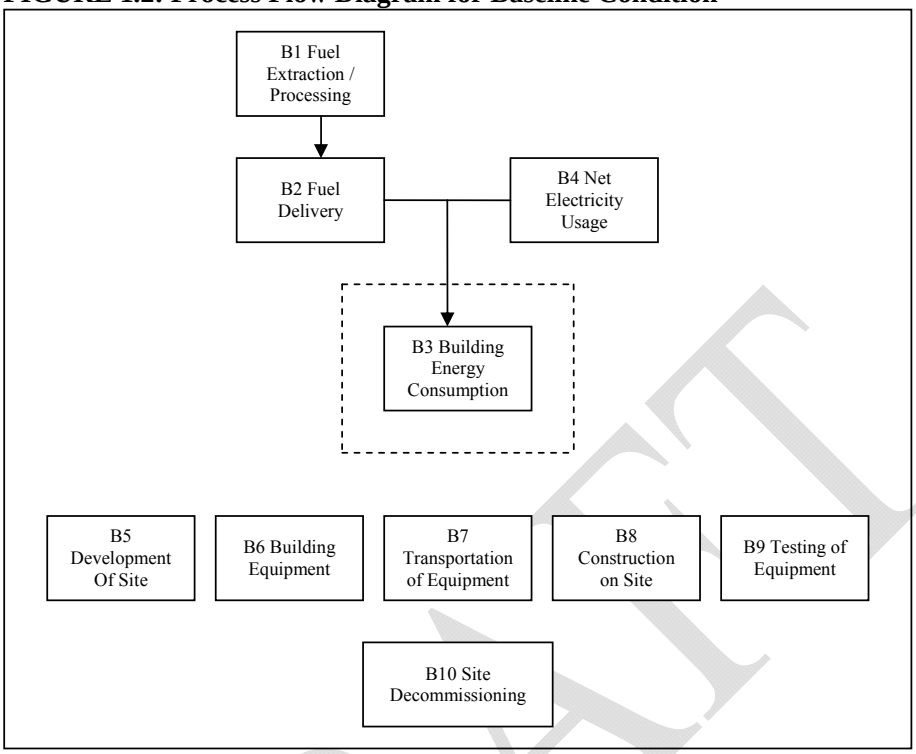


FIGURE 1.2: Process Flow Diagram for Baseline Condition



Protocol Applicability:

To demonstrate that a project meets the requirements under this protocol, the project proponent must supply sufficient evidence to demonstrate that:

1. New buildings meet or exceed the MNECB by at least 25 percent[1] as confirmed by an energy audit;
2. Retrofits to existing buildings must improve energy efficiency by 10% as established by the difference between pre- and post-retrofit energy audit;
3. The quantification of reductions achieved by the project is based on actual measurement conducted in energy audits. For existing buildings this will include both a pre-project and post-project energy audit. New buildings reductions will be established based on a post-project energy audit and compared to the established baseline for new buildings of the energy consumption levels for the MNECB;
4. The quantification of reductions achieved by the project is based on actual measurement and monitoring (except where indicated in this protocol) as indicated by the proper application of this protocol; and
5. The project must meet the requirements for offset eligibility as specified in the applicable regulation and guidance documents for the Alberta Offset System.

Comment [d1]: Comments on appropriateness of using this standard?

Comment [d2]: Comments on appropriateness of using this standard?

Flexibility in applying the quantification protocol is provided to project developers in the following ways.

1. The project proponent may use a different green building standard than the MNECB standards described in this protocol provided they can justify that the selected standard provides an equivalent or more conservative baseline and that there is the same standard of quality and general practice acceptance;
2. The requirement for an energy audit may be waived in situations were the baseline energy use per unit of production can be justified using available records;
3. New processes and/or facilities may be included under this protocol where a justification of a baseline condition can be made with reasonable certainty based on current industry practise, per unit of production;
4. Sources, sinks and reservoirs that can be shown to be functionally equivalent or not applicable for the project condition can be excluded from the analysis by the project proponent;
5. For the purpose of this protocol, the unit of production will be m2. Another suitable unit of production can be defined for incorporating functional equivalence within the calculation methodology as indicated by reasoned qualitative and quantitative analysis; and

[1] This 25% improvement in energy efficiency should be benchmarked for the proposed CI project against the appropriate Model National Energy Code for Buildings. NRCan's Office of Energy Efficiency has published several benchmarking studies for different catagories of CI buildings and can be found at http://oee.nrcan.gc.ca/commercial/technical-info/benchmarking.cfm?attr=20

6. Site specific emission factors may be substituted for the generic emission factors indicated in this protocol document. The methodology for generation of these emission factors must be sufficiently robust as to ensure reasonable accuracy..

If applicable, the proponent must indicate and justify why flexibility provisions have been used.

This quantification protocol is written for those familiar with building construction and retrofit projects. Some familiarity with, or general understanding of, the operation of these practices and processes is expected.

1.2 Glossary of New Terms

Energy Audit	Is an assessment of how much energy a building consumes and includes details on efficiency of the building's insulation, heating and cooling systems, and can include recommendations on ways to make the building more energy-efficient
EnerGuide/EcoEnergy programs	Are Government of Canada programs program that offer Canadians financial incentives and information on retrofitting their homes to make them more energy efficient.
Green building	Are buildings that incorporate practices that increase the efficiency of buildings and their use of energy, water, and materials, and reduce building impacts on human health and the environment, through better siting, design, construction, operation, maintenance, and removal.
Unit of Productivity	For the purpose of this protocol, the unit of production will be m^2. As mentioned in the flexibility provisions, with thorough justification the project proponent may change the unit of production to a more appropriate unit.

2.0 Quantification Development and Justification

The following sections outline the quantification development and justification.

2.1 Identification of Sources, Sinks and Reservoirs (SSRs) for the Project

SSRs were identified for the project by reviewing the seed protocol document and relevant process flow diagram. This process confirmed that the SSRs in the process flow diagrams covered the full scope of eligible project activities under the protocol.

Based on the process flow diagrams provided in **FIGURE 1.1**, the project SSRs were organized into life cycle categories in **FIGURE 2.1**. Descriptions of each of the SSRs and their classification as controlled, related or affected are provided in **TABLE 2.1.**

FIGURE 2.1: Project Element Life Cycle Chart

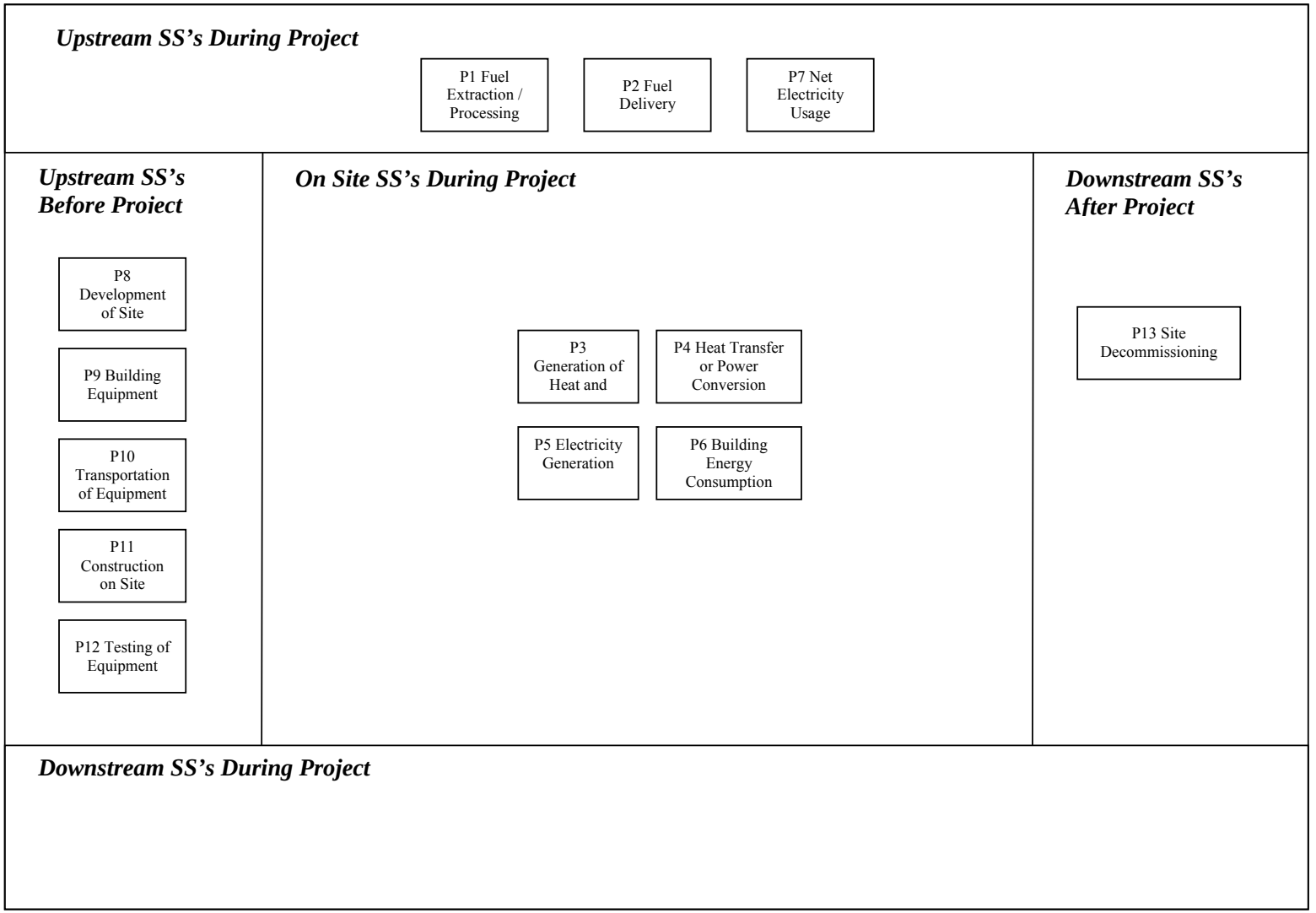


TABLE 2.1: Project SS's

1. SS	2. Description	3. Controlled, Related or Affected
Upstream SS's during Project Operation		
P1 Fuel Extraction and Processing	Each of the fuels used throughout the project will need to sourced and processed. This will allow for the calculation of the greenhouse gas emissions from the various processes involved in the production, refinement and storage of the fuels. The total volumes of fuel for each of the SS's are considered under this SS. Volumes and types of fuels are the important characteristics to be tracked.	Related
P2 Fuel Delivery	Each of the fuels used throughout the project will need to be transported to the site. This may include shipments by tanker or by pipeline, resulting in the emissions of greenhouse gases. It is reasonable to exclude fuel sourced by taking equipment to an existing commercial fuelling station as the fuel used to take the equipment to the sites is captured under other SS's and there is no other delivery.	Related
P7 Net Electricity Usage	Electricity may be required for operating the Project Unit. This power may be sourced either from internal generation, connected facilities or the local electricity grid. Metering of electricity may be netted in terms of the power going to and from the grid. Quantity and source of power are the important characteristics to be tracked as they directly relate to the quantity of greenhouse gas emissions.	Related
Onsite SS's during Project Operation		
P3 Generation of Heat and Power	The generation of heat and power may be for the project site. This generation could require the combustion of fossil fuels precipitating greenhouse gas emissions. Volumes and types of fuels are the important characteristics to be tracked.	Controlled
P4 Heat Transfer or Power Conversion	Mechanical or other processes may be required to transfer the heat and power to a usable form at the project site. All relevant characteristics of the heat transfer or power conversion would need to be tracked including volumes and types of fuels are the important characteristics to be tracked.	Controlled
P5 Electricity Generation	Electricity may be generated to meet internal project demand or for export from the project site. The generation of this electricity may yield incremental greenhouse gas emissions. Quantities and types for each of the energy inputs would be tracked.	Controlled
P6 Building Energy Consumption	Greenhouse gas emissions may occur that are associated with the operation and maintenance of the overall building. This may include the energy used in the heating and cooling of the building, lighting the building, etc. Quantities and types for each of the energy inputs would be tracked.	Controlled
Downstream SS's during Project Operation		
None		
Other		

P8 Development of Site	The site of the building may need to be developed. This could include civil infrastructure such as access to electricity, gas and water supply, as well as sewer etc. This may also include clearing, grading, building access roads, etc. There will also need to be some building of structures for the facility such as storage areas, storm water drainage, offices, vent stacks, firefighting water storage lagoons, etc., as well as structures to enclose, support and house the equipment. Greenhouse gas emissions would be primarily attributed to the use of fossil fuels and electricity used to power equipment required to develop the site such as graders, backhoes, trenching machines, etc.	Related
P9 Building Equipment	Equipment may need to be built either on-site or off-site. This includes all of the components of the storage, handling, processing, combustion, air quality control, system control, and safety systems. These may be sourced as pre-made standard equipment or custom built to specification. Greenhouse gas emissions would be primarily attributed to the use of fossil fuels and electricity used to power equipment for the extraction of the raw materials, processing, fabricating and assembly.	Related
P10 Transportation of Equipment	Equipment built off-site and the materials to build equipment on-site will all need to be delivered to the site. Transportation may be completed by truck, barge and/or train. Greenhouse gas emissions would be primarily attributed to the use of fossil fuels to power the equipment delivering the equipment to the site.	Related
P11 Construction on Site	The process of construction at the site will require a variety of heavy equipment, smaller power tools, cranes and generators. The operation of this equipment will have associated greenhouse gas emission from the use of fossil fuels and electricity.	Related
P12 Testing of Equipment	Equipment may need to be tested to ensure that it is operational. This may result in running the equipment using test anaerobic digestion fuels or fossil fuels in order to ensure that the equipment runs properly. These activities will result in greenhouse gas emissions associated with the combustion of fossil fuels and the use of electricity.	Related
P13 Site Decommissioning	Once the facility is no longer operational, the site may need to be decommissioned. This may involve the disassembly of the equipment, demolition of on-site structures, disposal of some materials, environmental restoration, re-grading, planting or seeding, and transportation of materials off-site. Greenhouse gas emissions would be primarily attributed to the use of fossil fuels and electricity used to power equipment required to decommission the site.	Related

2.2 Identification of Baseline

The baseline condition for this protocol is defined as the process configuration prior to the process changes or facility retrofits. The energy and emissions footprint, per unit of production, of the baseline configuration would be established as part of an energy audit or similar. The unit of production must be thoroughly justified in its application of incorporating functional equivalence across the calculations of emissions under the baseline and project conditions.

The approach to quantifying the baseline will be projection based as there are suitable models for the applicable baseline condition that can provide reasonable certainty. The baseline scenario for this protocol is dynamic as the emissions profile for the baseline activities would be expected to change materially relative to the defined unit of production which may fluctuate relative to supply and demand dynamics, as well as other market conditions.

The baseline condition is defined, including the relevant SSRs and processes, as shown in **FIGURE 1.2**. More detail on each of these SSRs is provided in Section 2.3, below.

2.3 Identification of SSRs for the Baseline

Based on the process flow diagrams provided in **FIGURE 1.2**, the project SSRs were organized into life cycle categories in **FIGURE 2.2**. Descriptions of each of the SSRs and their classification as either 'controlled', 'related' or 'affected' is provided in **TABLE 2.2.**

FIGURE 2.2: Baseline Element Life Cycle Chart

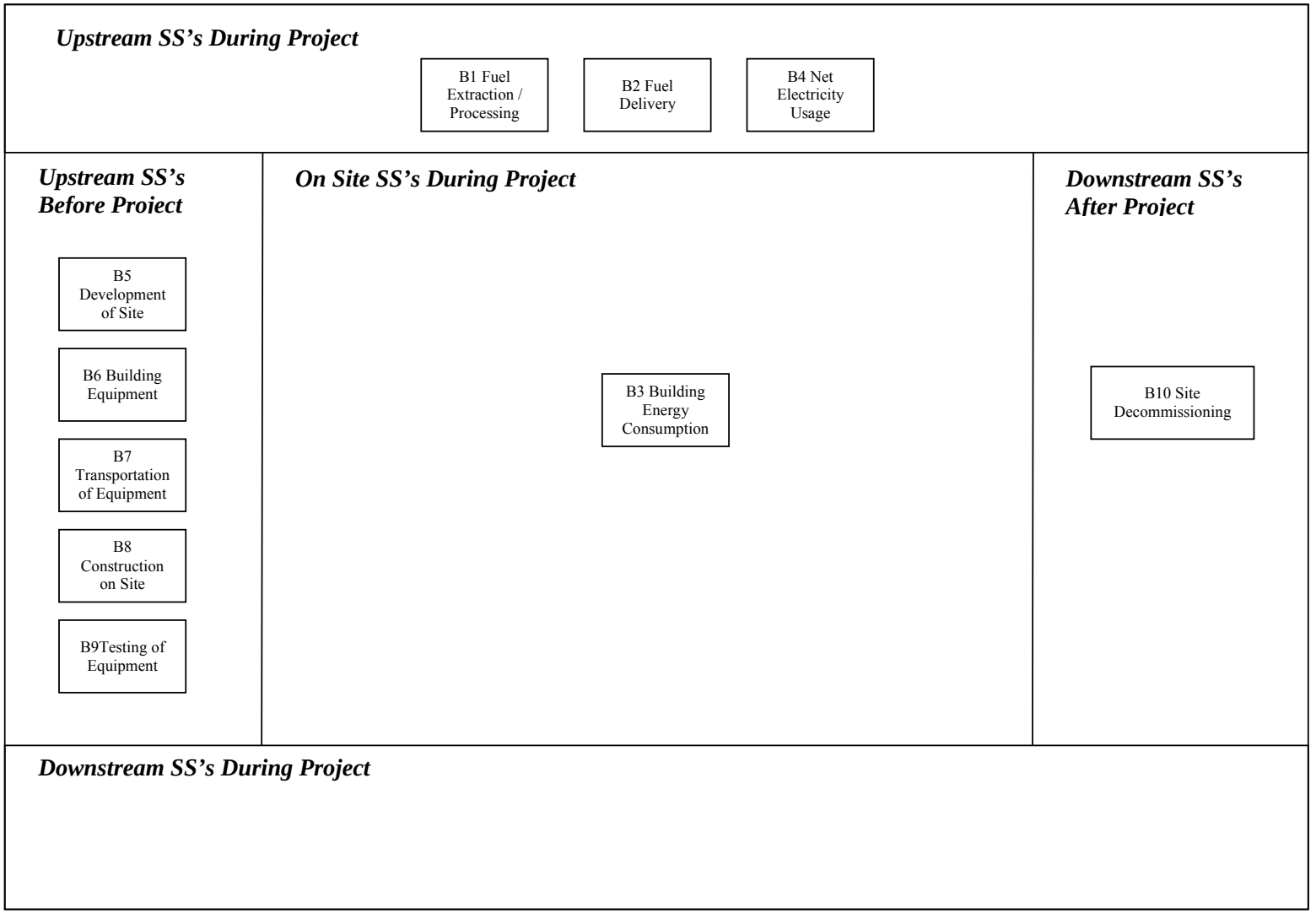


TABLE 2.1: Project SS's

1. SS	2. Description	3. Controlled, Related or Affected
Upstream SS's during Project Operation		
B1 Fuel Extraction and Processing	Each of the fuels used throughout the project will need to sourced and processed. This will allow for the calculation of the greenhouse gas emissions from the various processes involved in the production, refinement and storage of the fuels. The total volumes of fuel for each of the SS's are considered under this SS. Volumes and types of fuels are the important characteristics to be tracked.	Related
B2 Fuel Delivery	Each of the fuels used throughout the project will need to be transported to the site. This may include shipments by tanker or by pipeline, resulting in the emissions of greenhouse gases. It is reasonable to exclude fuel sourced by taking equipment to an existing commercial fuelling station as the fuel used to take the equipment to the sites is captured under other SS's and there is no other delivery.	Related
B4 Net Electricity Usage	Electricity may be required for operating the Project Unit. This power may be sourced either from internal generation, connected facilities or the local electricity grid. Metering of electricity may be netted in terms of the power going to and from the grid. Quantity and source of power are the important characteristics to be tracked as they directly relate to the quantity of greenhouse gas emissions.	Related
Onsite SS's during Project Operation		
B3 Building Energy Consumption	Greenhouse gas emissions may occur that are associated with the operation and maintenance of the overall building. This may include the fossil fuel energy used in the heating and cooling of the building, lighting the building, etc. Quantities and types for each of the energy inputs would be tracked.	Controlled
Downstream SS's during Project Operation		
None		
Other		
B5 Development of Site	The site of the facility may need to be developed. This could include civil infrastructure such as access to electricity, gas and water supply, as well as sewer etc. This may also include clearing, grading, building access roads, etc. There will also need to be some building of structures for the facility such as storage areas, storm water drainage, offices, vent stacks, firefighting water storage lagoons, etc., as well as structures to enclose, support and house the equipment. Greenhouse gas emissions would be primarily attributed to the use of fossil fuels and electricity used to power equipment required to develop the site such as graders, backhoes, trenching machines, etc.	Related
B6 Building Equipment	Equipment may need to be built either on-site or off-site. This includes all of the components of the storage, handling, processing, combustion, air quality control, system control and safety systems. These may be sourced as pre-made standard equipment or custom built to specification. Greenhouse gas emissions would be primarily attributed to the use of fossil fuels and electricity used to power equipment for the extraction of the raw materials, processing, fabricating and assembly.	Related

B7 Transportation of Equipment	Equipment built off-site and the materials to build equipment on-site will all need to be delivered to the site. Transportation may be completed by truck, barge and/or train. Greenhouse gas emissions would be primarily attributed to the use of fossil fuels to power the equipment delivering the equipment to the site.	Related
B8 Construction on Site	The process of construction at the site will require a variety of heavy equipment, smaller power tools, cranes and generators. The operation of this equipment will have associated greenhouse gas emission from the use of fossil fuels and electricity.	Related
B9 Testing of Equipment	Equipment may need to be tested to ensure that it is operational. This may result in running the equipment using test anaerobic digestion fuels or fossil fuels in order to ensure that the equipment runs properly. These activities will result in greenhouse gas emissions associated with the combustion of fossil fuels and the use of electricity.	Related
B10 Site Decommissioning	Once the facility is no longer operational, the site may need to be decommissioned. This may involve the disassembly of the equipment, demolition of on-site structures, disposal of some materials, environmental restoration, re-grading, planting or seeding, and transportation of materials off-site. Greenhouse gas emissions would be primarily attributed to the use of fossil fuels and electricity used to power equipment required to decommission the site.	Related

2.4 Selection of Relevant Project and Baseline SSRs

Each of the SSRs from the project and baseline condition were compared and evaluated as to there relevancy using the guidance provided in Annex VI of the "Guide to Quantification Methodologies and Protocols: Draft", dated March 2006. The justification for the exclusion, or conditions upon which SSRs may be excluded is provided below. All other SSRs listed previously are included. This information is summarized in **TABLE 2.3**, below

TABLE 2.3: Comparison of SS's

1. Identified SS	2. Baseline (C, R, A)	3. Project (C, R, A)	4. Include or Exclude from Quantification	5. Justification for Exclusion
Upstream SS's				
P1 Fuel Extraction and Processing	N/A	Related	Include	N/A
B1 Fuel Extraction and Processing	Related	N/A	Include	
P2 Fuel Delivery	N/A	Related	Exclude	Excluded as the emissions from transportation are likely greater under the baseline condition.
B2 Fuel Delivery	Related	N/A	Exclude	
P7 Net Electricity Usage	N/A	Related	Include	N/A
B4 Net Electricity Usage	Related	N/A	Include	
Onsite SS's				
P3 Generation of Heat and Power	N/A	Controlled	Include	N/A
P4 Heat Transfer or Power Conversion	N/A	Controlled	Include	N/A
P5 Electricity Generation	N/A	Controlled	Include	N/A
P6 Building Energy Consumption	N/A	Controlled	Include	N/A
B3 Building Energy Consumption	Controlled	N/A	Include	
Downstream SS's				
None				
Other				
P8 Development of Site	N/A	Related	Exclude	Emissions from transportation of equipment are not material given the long project life, and the minimal transportation of equipment typically required
B5 Development of Site	Related	N/A	Exclude	
P9 Building Equipment	N/A	Related	Exclude	Emissions from transportation of equipment are not material given the long project life, and the minimal transportation of equipment typically required
B6 Building Equipment	Related	N/A	Exclude	
P10 Transportation of	N/A	Related	Exclude	Emissions from transportation of equipment are not material given the long

Equipment				project life, and the minimal transportation of equipment typically required
B7 Transportation of Equipment	Related	N/A	Exclude	
P11 Construction on Site	N/A	Related	Exclude	Emissions from construction on site are not material given the long project life, and the minimal construction on site typically required.
B8 Construction on Site	Related	N/A	Exclude	
P12 Testing of Equipment	N/A	Related	Exclude	Emissions from testing of equipment are not material given the long project life, and the minimal testing of equipment typically required.
B9 Testing of Equipment	Related	N/A	Exclude	
P13 Site Decommissioning	N/A	Related	Exclude	Emissions from decommissioning are not material given the long project life, and the minimal decommissioning typically required.

2.5 Quantification of Reductions, Removals and Reversals of Relevant SSRs

2.5.1 Quantification Approaches

Quantification of the reductions, removals and reversals of relevant SSRs for each of the greenhouse gases will be completed using the methodologies outlined in **TABLE 2.4**, below. A listing of relevant emission factors is provided in **Appendix A**. These calculation methodologies serve to complete the following three equations for calculating the emission reductions from the comparison of the baseline and project conditions.

$$\text{Emission Reduction} = \text{Emissions}_{\text{Baseline}} - \text{Emissions}_{\text{Project}}$$

$$\text{Emissions}_{\text{Baseline}} = \text{Emissions}_{\text{Fuel Extraction / Processing}} + \text{Emissions}_{\text{Net Electricity Usage}} + \text{Emissions}_{\text{Building Energy Consumption}}$$

$$\text{Emissions}_{\text{Project}} = \text{Emissions}_{\text{Fuel Extraction / Processing}} + \text{Emissions}_{\text{Gen Heat and Power}} + \text{Emissions}_{\text{Transfer / Conversion}} + \text{Emissions}_{\text{Electricity Generation}} + \text{Emissions}_{\text{Building Energy Consumption}} + \text{Emissions Net}_{\text{Net Electricity Usage}}$$

Where:

$\text{Emissions}_{\text{Baseline}}$ = sum of the emissions under the baseline condition.

- $\text{Emissions}_{\text{Fuel Extraction / Processing}}$ = emissions under SSR B1 Fuel Extraction and Processing
- $\text{Emissions}_{\text{Building Energy Consumption}}$ = emissions under SSR B3 Household Energy Consumption
- $\text{Emissions}_{\text{Net Electricity Usage}}$ = emissions under SSR B4 Net Electricity Usage

$\text{Emissions}_{\text{Project}}$ = sum of the emissions under the project condition.

- $\text{Emissions}_{\text{Fuel Extraction / Processing}}$ = emissions under SSR P1 Fuel Extraction and Processing
- $\text{Emissions}_{\text{Gen Heat and Power}}$ = emissions under SSR P3 Generation of Heat and Power
- $\text{Emissions}_{\text{Transfer / Conversion}}$ = emissions under SSR P4 Heat Transfer or Power Conversion
- $\text{Emissions}_{\text{Electricity Generation}}$ = emissions under SSR P5 Electricity Generation
- $\text{Emissions}_{\text{Building Energy Consumption}}$ = emissions under SSR P6 Household Energy Consumption
- $\text{Emissions}_{\text{Net Electricity Usage}}$ = emissions under SSR P7 Electricity Usage

TABLE 2.4: Quantification Procedures

1. Project / Baseline SSR	2. Parameter / Variable	3. Unit	4. Measured / Estimated	5. Method	6. Frequency	7. Justify measurement or estimation and frequency
Project SSRs						
P1 Fuel Extraction and Processing	Emissions $_{\text{Fuel Extraction / Processing}} = \sum$ (Vol. Fuel $_i$ * EF Fuel $_{i\,CO2}$) ; $\sum$ (Vol. Fuel $_i$ * EF Fuel $_{i\,CH4}$) ; $\sum$ (Vol. Fuel $_i$ * EF Fuel $_{i\,N2O}$)					
	Emissions $_{\text{Fuel Extraction / Processing}}$	kg of CO2e	N/A	N/A	N/A	Quantity being calculated in aggregate form as fuel and electricity use on site is likely aggregated for each of these SSRs.
	Volume of Fuel Combusted for P4 and P6 / Vol. Fuel	L, m^3 or other	Measured	Direct metering or reconciliation of volume in storage (including volumes received).	Continuous metering or monthly reconciliation.	Both methods are standard practise. Frequency of metering is highest level possible. Frequency of reconciliation provides for reasonable diligence.
	CO_2 Emissions Factor for Fuel Including Production and Processing / EF Fuel $_{CO2}$	kg CO_2 per L, m^3 or other	Estimated	From Environment Canada reference documents.	Annual	Reference values adjusted annually as part of Environment Canada reporting on Canada's emissions inventory.
	CH_4 Emissions Factor for Fuel Including Production and Processing / EF Fuel $_{CH4}$	kg CH_4 per L, m^3 or other	Estimated	From Environment Canada reference documents.	Annual	Reference values adjusted annually as part of Environment Canada reporting on Canada's emissions inventory.
	N_20 Emissions Factor for Fuel Including Production and Processing / EF Fuel $_{N2O}$	kg N_2O per L, m^3 or other	Estimated	From Environment Canada reference documents.	Annual	Reference values adjusted annually as part of Environment Canada reporting on Canada's emissions inventory.
P3 Generation of Heat and Power	Emissions $_{\text{Gen Heat and Power}} = \sum$ (Vol. Fuel $_i$ * EF Fuel $_{i\,CO2}$); $\sum$ (Vol. Fuel $_i$ * EF Fuel $_{i\,CH4}$) ; $\sum$ (Vol. Fuel $_i$ * EF Fuel $_{i\,N20}$)					
	Emissions $_{\text{Gen Heat and Power}}$	kg of CO_2 ; CH_4 ; N_2O	N/A	N/A	N/A	Quantity being calculated in aggregate form as fuel and electricity use on site is likely aggregated for each of these SSRs.

	Volume of Each Type of Fuel Consumed to Generate Heat and Power / Vol. Fuel $_i$	L, m^3 or other	Measured	Direct metering or reconciliation of volume in storage (including volumes received).	Continuous metering or monthly reconciliation.	Both methods are standard practise. Frequency of metering is highest level possible. Frequency of reconciliation provides for reasonable diligence.
	CO_2 Emissions Factor for Combustion of Each Type of Fuel / EF Fuel $_{i\ CO2}$	kg CO_2 per L, m^3 or other	Estimated	From Environment Canada reference documents.	Annual	Reference values adjusted annually as part of Environment Canada reporting on Canada's emissions inventory.
	CH_4 Emissions Factor for Combustion of Each Type of Fuel / EF Fuel $_{i\ CH4}$	kg CH_4 per L, m^3 or other	Estimated	From Environment Canada reference documents.	Annual	Reference values adjusted annually as part of Environment Canada reporting on Canada's emissions inventory.
	N_20 Emissions Factor for Combustion of Each Type of Fuel / EF Fuel $_{i\ N2O}$	kg N_2O per L, m^3 or other	Estimated	From Environment Canada reference documents.	Annual	Reference values adjusted annually as part of Environment Canada reporting on Canada's emissions inventory.
P4 Heat Transfer or Power Conversion	Emissions $_{Transfer\ /\ Conversion}$ = $\sum$ (Vol. Fuel $_i$ * EF Fuel $_{i\ CO2}$); $\sum$ (Vol. Fuel $_i$ * EF Fuel $_{i\ CH4}$) ; $\sum$ (Vol. Fuel $_i$ * EF Fuel $_{i\ N20}$)					
	Emissions $_{Transfer\ /\ Conversion}$	kg of CO_2 ; CH_4 ; N_2O	N/A	N/A	N/A	Quantity being calculated in aggregate form as fuel and electricity use on site is likely aggregated for each of these SSRs.
	Volume of Each Type of Fuel Consumed for Heat Transfer or Power Conversion / Vol. Fuel $_i$	L, m^3 or other	Measured	Direct metering or reconciliation of volume in storage (including volumes received).	Continuous metering or monthly reconciliation.	Both methods are standard practise. Frequency of metering is highest level possible. Frequency of reconciliation provides for reasonable diligence.
	CO_2 Emissions Factor for Combustion of Each Type of Fuel / EF Fuel $_{i\ CO2}$	kg CO_2 per L, m^3 or other	Estimated	From Environment Canada reference documents.	Annual	Reference values adjusted annually as part of Environment Canada reporting on Canada's emissions inventory.

	CH_4 Emissions Factor for Combustion of Each Type of Fuel / EF Fuel $_{i\ CH4}$	kg CH_4 per L, m^3 or other	Estimated	From Environment Canada reference documents.	Annual	Reference values adjusted annually as part of Environment Canada reporting on Canada's emissions inventory.
	N_20 Emissions Factor for Combustion of Each Type of Fuel / EF Fuel $_{i\ N2O}$	kg N_2O per L, m^3 or other	Estimated	From Environment Canada reference documents.	Annual	Reference values adjusted annually as part of Environment Canada reporting on Canada's emissions inventory.
P6 Household Energy Consumption	Emissions $_{Unit\ Operation} = \sum$ (Vol. Fuel $_i$ * EF Fuel $_{i\ CO2}$); $\sum$ (Vol. Fuel $_i$ * EF Fuel $_{i\ CH4}$) ; $\sum$ (Vol. Fuel $_i$ * EF Fuel $_{i\ N20}$)					
	Emissions $_{Unit\ Operation}$	kg of CO_2 ; CH_4 ; N_2O	N/A	N/A	N/A	Quantity being calculated in aggregate form as fuel and electricity use on site is likely aggregated for each of these SSRs.
	Volume of Each Type of Fuel for Unit Operation / Vol. Fuel $_i$	L, m^3 or other	Measured	Direct metering or reconciliation of volume in storage (including volumes received).	Continuous metering or monthly reconciliation.	Both methods are standard practise. Frequency of metering is highest level possible. Frequency of reconciliation provides for reasonable diligence.
	CO_2 Emissions Factor for Combustion of Each Type of Fuel / EF Fuel $_{i\ CO2}$	kg CO_2 per L, m^3 or other	Estimated	From Environment Canada reference documents.	Annual	Reference values adjusted annually as part of Environment Canada reporting on Canada's emissions inventory.
	CH_4 Emissions Factor for Combustion of Each Type of Fuel / EF Fuel $_{i\ CH4}$	kg CH_4 per L, m^3 or other	Estimated	From Environment Canada reference documents.	Annual	Reference values adjusted annually as part of Environment Canada reporting on Canada's emissions inventory.
	N_20 Emissions Factor for Combustion of Each Type of Fuel / EF Fuel $_{i\ N2O}$	kg N_2O per L, m^3 or other	Estimated	From Environment Canada reference documents.	Annual	Reference values adjusted annually as part of Environment Canada reporting on Canada's emissions inventory.

P5 Electricity Generation	Emissions $_{Elec\ Gen}$ = ∑ (Vol. Fuel $_i$ * EF Fuel $_{i\ CO2}$); ∑ (Vol. Fuel $_i$ * EF Fuel $_{i\ CH4}$) ; ∑ (Vol. Fuel $_i$ * EF Fuel $_{i\ N20}$)					
	Emissions $_{Elec\ Gen}$	kg of CO_2 ; CH_4 ; N_2O	N/A	N/A	N/A	Quantity being calculated in aggregate form as fuel and electricity use on site is likely aggregated for each of these SSRs.
	Volume of Each Type of Fuel for Electricity Generation / Vol. Fuel $_i$	L, m^3 or other	Measured	Direct metering or reconciliation of volume in storage (including volumes received).	Continuous metering or monthly reconciliation.	Both methods are standard practise. Frequency of metering is highest level possible. Frequency of reconciliation provides for reasonable diligence.
	CO_2 Emissions Factor for Combustion of Each Type of Fuel / EF Fuel $_{i\ CO2}$	kg CO_2 per L, m^3 or other	Estimated	From Environment Canada reference documents.	Annual	Reference values adjusted annually as part of Environment Canada reporting on Canada's emissions inventory.
	CH_4 Emissions Factor for Combustion of Each Type of Fuel / EF Fuel $_{i\ CH4}$	kg CH_4 per L, m^3 or other	Estimated	From Environment Canada reference documents.	Annual	Reference values adjusted annually as part of Environment Canada reporting on Canada's emissions inventory.
	N_20 Emissions Factor for Combustion of Each Type of Fuel / EF Fuel $_{i\ N2O}$	kg N_2O per L, m^3 or other	Estimated	From Environment Canada reference documents.	Annual	Reference values adjusted annually as part of Environment Canada reporting on Canada's emissions inventory.
P7 Net Electricity Usage	Emissions $_{Electricity}$ = Electricity * EF $_{Elec}$					
	Emissions $_{Electricity}$	kg of CO2e	N/A	N/A	N/A	Quantity being calculated.
	Incremental Electricity Used at the Site for Unit Operation / Electricity	kWh	Measured	Direct metering.	Continuous metering	Continuous direct metering represents the industry practise and the highest level of detail.
	Emissions Factor for Electricity / EF $_{Elec}$	kg of CO2e per kWh	Estimated	From Environment Canada reference documents.	Annual	Reference values adjusted annually as part of Environment Canada reporting on Canada's emissions inventory.

Comment [d3]: How are we capturing renewable energy production in/bldg

Baseline SSRs						
B1 Fuel Extraction and Processing	$Emissions_{Fuel\ Extraction\ /\ Processing} = \sum (Vol.\ Fuel_i * EF\ Fuel_{i\ CO2}) ; \sum (Vol.\ Fuel_i * EF\ Fuel_{i\ CH4}) ; \sum (Vol.\ Fuel_i * EF\ Fuel_{i\ N2O})$					
	$Emissions_{Fuel\ Extraction\ /\ Processing}$	kg of CO2e	N/A	N/A	N/A	Quantity being calculated in aggregate form as fuel and electricity use on site is likely aggregated for each of these SSRs.
	Volume of Fuel Combusted for B4 / Vol. Fuel	L, m^3 or other	Measured	Direct metering or reconciliation of volume in storage (including volumes received).	Continuous metering or monthly reconciliation.	Both methods are standard practise. Frequency of metering is highest level possible. Frequency of reconciliation provides for reasonable diligence.
	CO_2 Emissions Factor for Natural Gas / $EF\ Fuel_{CO2}$	kg CO_2 per L, m^3 or other	Estimated	Values provided in Appendix A.	Annual	Reference values adjusted annually as part of Environment Canada reporting on Canada's emissions inventory.
	CH_4 Emissions Factor for Natural Gas / $EF\ Fuel_{CH4}$	kg CH_4 per L, m^3 or other	Estimated	Values provided in Appendix A.	Annual	Reference values adjusted annually as part of Environment Canada reporting on Canada's emissions inventory.
	N_20 Emissions Factor for Natural Gas / $EF\ Fuel_{N2O}$	kg N_2O per L, m^3 or other	Estimated	Values provided in Appendix A.	Annual	Reference values adjusted annually as part of Environment Canada reporting on Canada's emissions inventory.
B3 Household Energy Consumption	$Emissions_{Unit\ Operation} = \sum (Vol.\ Fuel_i * EF\ Fuel_{i\ CO2}); \sum (Vol.\ Fuel_i * EF\ Fuel_{i\ CH4}) ; \sum (Vol.\ Fuel_i * EF\ Fuel_{i\ N20})$					
	$Emissions_{Unit\ Operation}$	kg of CO_2 ; CH_4 ; N_2O	N/A	N/A	N/A	Quantity being calculated in aggregate form as fuel and electricity use on site is likely aggregated for each of these SSRs.
	Volume of Each Type of Fuel for Unit Operation / $Vol.\ Fuel_i$	L, m^3 or other	Measured	Direct metering or reconciliation of volume in storage (including volumes received).	Continuous metering or monthly reconciliation.	Both methods are standard practise. Frequency of metering is highest level possible. Frequency of reconciliation provides for reasonable diligence.

	CO_2 Emissions Factor for Combustion of Each Type of Fuel / EF Fuel $_{i\ CO2}$	kg CO_2 per L, m^3 or other	Estimated	From Environment Canada reference documents.	Annual	Reference values adjusted annually as part of Environment Canada reporting on Canada's emissions inventory.
	CH_4 Emissions Factor for Combustion of Each Type of Fuel / EF Fuel $_{i\ CH4}$	kg CH_4 per L, m^3 or other	Estimated	From Environment Canada reference documents.	Annual	Reference values adjusted annually as part of Environment Canada reporting on Canada's emissions inventory.
	N_20 Emissions Factor for Combustion of Each Type of Fuel / EF Fuel $_{i\ N2O}$	kg N_2O per L, m^3 or other	Estimated	From Environment Canada reference documents.	Annual	Reference values adjusted annually as part of Environment Canada reporting on Canada's emissions inventory.
B4 Net Electricity Usage	Emissions $_{Electricity}$ = Electricity * EF $_{Elec}$					
	Emissions $_{Electricity}$	kg of CO2e	N/A	N/A	N/A	Quantity being calculated.
	Incremental Electricity Exported from the Site / Electricity	kWh	Measured	Direct metering.	Continuous metering	Continuous direct metering represents the industry practise and the highest level of detail.
	Emissions Factor for Electricity / EF $_{Elec}$	kg of CO2e per kWh	Estimated	From Environment Canada reference documents.	Annual	Reference values adjusted annually as part of Environment Canada reporting on Canada's emissions inventory.

2.5.2. Contingent Data Approaches

Contingent means for calculating or estimating the required data for the equations outlined in section 2.5.1 are summarized in **TABLE 2.5**, below.

2.6 Management of Data Quality

In general, data quality management must include sufficient data capture such that the mass and energy balances may be easily performed with the need for minimal assumptions and use of contingency procedures. The data should be of sufficient quality to fulfill the quantification requirements and be substantiated by company records for the purpose of verification.

The project proponent shall establish and apply quality management procedures to manage data and information. Written procedures should be established for each measurement task outlining responsibility, timing and record location requirements. The greater the rigour of the management system for the data, the more easily an audit will be to conduct for the project.

2.6.1 Record Keeping

Record keeping practises should include:

a. Electronic recording of values of logged primary parameters for each measurement interval;
b. Printing of monthly back-up hard copies of all logged data;
c. Written logs of operations and maintenance of the project system including notation of all shut-downs, start-ups and process adjustments;
d. Retention of copies of logs and all logged data for a period of 7 years; and
e. Keeping all records available for review by a verification body.

2.6.2 Quality Assurance/Quality Control (QA/QC)

QA/QC can also be applied to add confidence that all measurements and calculations have been made correctly. These include, but are not limited to:

a Protecting monitoring equipment (sealed meters and data loggers);
b Protecting records of monitored data (hard copy and electronic storage);
c Checking data integrity on a regular and periodic basis (manual assessment, comparing redundant metered data, and detection of outstanding data/records);
d Comparing current estimates with previous estimates as a ‘reality check’;
e Provide sufficient training to operators to perform maintenance and calibration of monitoring devices;
f Establish minimum experience and requirements for operators in charge of project and monitoring; and
g Performing recalculations to make sure no mathematical errors have been made.

TABLE 2.5: Contingent Data Collection Procedures

1. Project / Baseline SSR	2. Parameter / Variable	3. Unit	4. Measured / Estimated	5. Contingency Method	6. Frequency	7. Justify measurement or estimation and frequency
Project SSRs						
P1 Fuel Extraction and Processing	Volume of Each Type of Fuel / Vol Fuel $_i$	L, m^3 or other	Measured	Reconciliation of volume of fuel purchased within given time period.	Monthly	Provides reasonable estimate of the parameter, when the more accurate and precise method cannot be used.
P3 Generation of Heat and Power	Volume of Each Type of Fuel / Vol Fuel $_i$	L, m^3 or other	Measured	Reconciliation of volume of fuel purchased within given time period.	Monthly	Provides reasonable estimate of the parameter, when the more accurate and precise method cannot be used.
P4 Heat Transfer or Power Conversion	Volume of Each Type of Fuel / Vol Fuel $_i$	L, m^3 or other	Measured	Reconciliation of volume of fuel purchased within given time period.	Monthly	Provides reasonable estimate of the parameter, when the more accurate and precise method cannot be used.
P5 Electricity Generation	Volume of Each Type of Fuel / Vol Fuel $_i$	L, m^3 or other	Measured	Reconciliation of volume of fuel purchased within given time period.	Monthly	Provides reasonable estimate of the parameter, when the more accurate and precise method cannot be used.
P6 Household Energy Consumption	Volume of Each Type of Fuel / Vol Fuel $_i$	L, m^3 or other	Measured	Reconciliation of volume of fuel purchased within given time period.	Monthly	Provides reasonable estimate of the parameter, when the more accurate and precise method cannot be used.
P7 Electricity Usage	Incremental Electricity Exported from the Site / Electricity	kWh	Measured	Reconciliation of power requirements for facility as per equipment output ratings.	Monthly	Provides reasonable estimate of the parameter, when the more accurate and precise method cannot be used.
Baseline SSRs						
B1 Fuel Extraction and Processing	Volume of Each Type of Fuel / Vol Fuel $_i$	L, m^3 or other	Measured	Reconciliation of volume of fuel purchased within given time period.	Monthly	Provides reasonable estimate of the parameter, when the more accurate and precise method cannot be used.

B3 Household Energy Consumption	Volume of Each Type of Fuel / Vol Fuel $_i$	L, m^3 or other	Measured	Reconciliation of volume of fuel purchased within given time period.	Monthly	Provides reasonable estimate of the parameter, when the more accurate and precise method cannot be used.

APPENDIX A: Emission Factors for Fuel Production and Processing

Emission Factors for Fuel Production and Processing

All values interpreted from volume 1 of the technical report: A National Inventory of Greenhouse Gas (GHG), Criteria Air Contaminant (CAC) and Hydrogen Sulphide (H2S) Emissions by the Upstream Oil and Gas Industry dated September 2004 completed by Clearstone Engineering Ltd. on behalf of the Canadian Association of Petroleum Producers (CAPP).

Table A1: Emission Factors for Gasoline and Diesel Production

	Approximate Proportionate Amount in Year of Emission Factor Generation		Emission Factors			
			CO_2	CH_4	N_2O	Units
Light / Medium Crude Oil Production	55,588	10^3 m^3 / yr	86.3	4.41	0.0038	t / 10^3 m^3
Heavy Crude Oil Cold Production	30,924	10^3 m^3 / yr	75	25.1	0.0033	t / 10^3 m^3
Heavy Crude Oil Thermal Production	10,589	10^3 m^3 / yr	594.2	3.75	0.009	t / 10^3 m^3
Weighted Average			0.1381	0.0109	4.208E-6	kg / L