Memorandum

To:	Stephanie Aho, EQB
Cc:	Kayla Walsh, EQB
From:	Emily Golla, Katie O'Malley, Ajo Rabemiarisoa, Kaila Stein, Maris Welch, and Angus Dillon, ICF
Date:	October 4, 2024
Re:	Final Methodology for EQB Climate Calculator Tool

This memorandum details the approach ICF developed for the Climate Calculator Tool to quantify greenhouse gas (GHG) emissions from major development projects in Minnesota. The memorandum summarizes the agreed upon scope and boundaries of the tool as well as the proposed methodology for quantifying emissions from each emissions source.

This memorandum is organized as follows:

- Climate Calculator Tool Quantification Boundaries
- Emissions Quantification Methods
- Appendix A: Acronyms
- Appendix B: Data Sources
- Appendix C: Applicability of Emission Sources

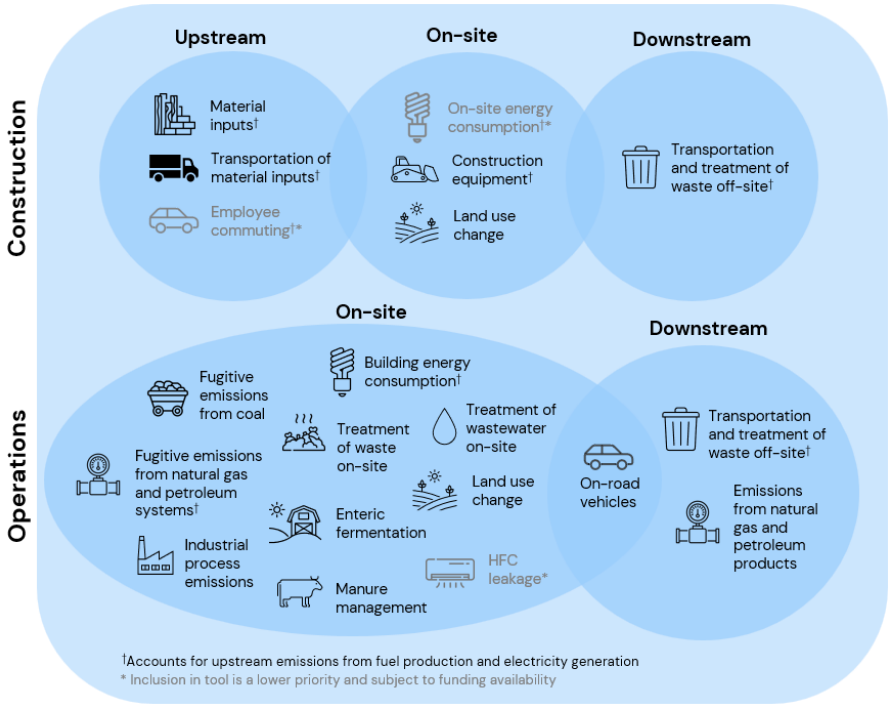
If you have any questions or comments, please contact Emily Golla at Emily.Golla@icf.com.

Climate Calculator Tool Quantification Boundaries

The tool provides a preliminary assessment of life cycle GHG emissions by evaluating the potential for direct and indirect impacts,[1] including emissions associated with fuel production and other material inputs. The tool is intended to be used to develop a reasonable emissions estimate, with the expectation that actual project emissions will vary. In the context of this tool, **life cycle assessment (LCA)** refers to the evaluation of the lifecycle GHG emissions impact of a project throughout the lifespan of the project, including the project's construction and operational stages. Emissions associated with decommissioning may also be considered as part of an LCA but are not included in the tool at this time. A comprehensive list of emission sources that were considered for inclusion in the tool and an assessment of their potential applicability to each mandatory project category is provided in Appendix C.

As agreed upon with EQB, the Climate Calculator Tool will initially consider emissions from 20 emission sources, as illustrated in Figure 1 and described further below. The applicability and degree of impact of each emissions source is heavily dependent on the specific project. Users of the tool should also assess and consider disclosing the applicability of emission sources not covered by the tool in their assessment of GHG emissions impact, to the extent possible.

Figure 1: Climate Calculator Tool Quantification Boundaries



Construction Phase

The construction phase includes all activities related to the initial development, building, and installation of infrastructure, buildings, or facilities that characterize the project. The scope of the tool includes emissions from on-site project activities such as construction equipment and

[1] **Direct emissions** are emissions that are caused by project activities that occur on-site. **Indirect emissions** are emissions that occur *upstream* and *downstream* of the project and are caused by activities that are related to the project which would not have occurred without the implementation of the project.

land use changes as well as emissions that occur upstream (e.g., transportation of materials to the project site and the embodied carbon of the materials used during construction) and downstream (e.g., transportation and treatment of waste) of the project. Contingent on funding availability, the tool will also quantify upstream emissions from employee commuting and other on-site energy consumption (e.g., generators, buildings) that occur during the construction phase. The upstream emissions associated with the production of fuel and electricity consumed are also accounted for within the tool and will be embedded within the emission factors[2] selected for each emissions source.

Operations Phase

The operations phase includes all activities and processes involved in the functional use and operation of the project and related infrastructure or facility. The scope of the tool includes emissions tied to building energy consumption (e.g., heating, cooling, and lighting), energy industries (e.g., fugitive emissions and combustion of fossil fuel products), industrial processes, on-road vehicle transportation, waste generation and treatment, and use changes, and agricultural activities (e.g., enteric fermentation and manure management). The majority of the operational emission sources included in the tool are emission sources that directly result from on-site activities; while, similar to the construction phase, upstream emissions associated with the production of fuel and electricity consumed are also accounted for within the emission factors selected for each emissions source as well as downstream emissions from on-road vehicles, the transportation and treatment of waste generated on-site, and the combustion of natural gas and oil products. Contingent on funding availability, the tool will also quantify hydrofluorocarbons (HFCs) that leak from refrigeration and air conditioning equipment. This phase also requires defining an operational lifespan for the project.

Emission Sources not Included in the Tool

In scoping out the emission sources to include in the tool, some sources were considered but deprioritized due to budget constraints and the following factors: difficulty in clearly defining the activities that contribute to the emissions source across the diversity of project types, the expected magnitude of emissions relative to other sources, the indirect (rather than direct) nature of the emissions source, the applicability of the emissions source across project types, and the feasibility of accurate quantification (e.g., due to data availability and/or complexity). Specifically, material inputs and transportation of material inputs during operation; sulfur hexafluoride (SF_6) leakage from electrical transmission lines;[3] transportation tied to routine maintenance, employee commuting, and changes in on-site or induced aircraft and watercraft activity during operation; and all decommissioning emissions (i.e., transportation tied to employee commuting, demolition equipment, and waste transit to disposal site; land use change; and waste treatment) are not included. These sources may be considered for inclusion into the tool in the future.

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[2] **Emission factors** are representative values that estimate the quantity of a pollutant released to the atmosphere per unit of activity associated with its release. These factors are usually expressed as the weight of a pollutant divided by a unit weight, volume, distance, or duration of the activity emitting the pollutant.

[3] Sulfur hexafluoride emissions are not currently accounted for in the environmental review of high voltage transmissions lines by Minnesota's Commerce Department. For consistency with this process, EQB decided to not include this emissions source in the tool.

Emissions Quantification Methods

This section provides the detailed proposed methodology for calculating GHG emissions from each emissions source included in the Climate Calculator Tool, including equations, descriptions of each data element, data sources we anticipate using to develop the required assumptions, and a discussion of limitations. The units identified are provided as an example and will be confirmed as data are compiled and assumptions are finalized. The equations are intended to be indicative of the proposed methodology and will be expanded to reflect final assumptions and unit conversions.

The table below summarizes the user inputs and key assumptions that are discussed in the subsequent subsections. Users will have the ability to override select assumptions or calculated values within the tool to accommodate the availability of project-specific information. Assumptions that can be replaced by a user input are highlighted by an asterisk.

Table 1: Summary of Required User Inputs and Calculator Assumptions by Emissions Source

#	Emissions Source	Phase	User Inputs	Calculator Assumptions
1A:	Material inputs	Construction	• Material quantity by type	• Emission factor by material type
1B:	Transportation of material inputs	Construction	• Material quantity by type • Material source	• Emission factors by transportation mode • Distance travelled by mode
1C:	Employee commuting	Construction	• Number of employees-commuting days	• Commuting distance* • Commuting mode breakdown* • Emission factors by mode
1D:	Construction equipment	Construction	• Number of construction days by equipment type	• Daily electricity consumption by equipment type* • Daily fuel consumption by equipment type* • Electricity emission factor* • Fuel-specific emission factors • Btu conversion factors
1E:	On-site energy	Construction	• Total electricity consumption by equipment type • Total fuel consumption by equipment type	• Electricity emission factor* • Fuel-specific emission factors • Btu conversion factors
1F:	Land use change	Construction	• Land area by land use type, pre- and post-transition • Land use management	• Carbon stocks by land use type • Wood product carbon stock by land use type

#	Emissions Source	Phase	User Inputs	Calculator Assumptions
1G:	Transportation and treatment of waste off-site	Construction	• Material quantity by type	• Loss rate • Emission factors by material type
2A:	Building energy consumption	Operation	• Building square footage by building type	• Non-electric energy building intensity by building type* • Electricity building intensity by building type* • Electricity emission factor* • Fuel-specific emission factors
2B:	Fugitive emissions from coal	Operation	• Coal production by mine type • Ventilation emissions from underground mining • Degasification system emissions • Methane recovery rate of degasification system • Surface mining emission factor • Post-mining emission factors by mine type	
2C:	Fugitive emissions from natural gas and petroleum systems	Operation	• Incremental throughout by fuel type	• Emission factors by fuel type
2D:	Emissions from natural gas and oil products	Operation	• Incremental throughout by fuel type	• Emission factors by fuel type
2E:	Industrial process emissions	Operation	• Annual production by industrial process	• Emission factors by product type*
2F:	HFC leakage	Operation	• Building square footage by building type • Building area not utilized	• Equipment type per building type • Refrigerant type per equipment type • Refrigerant capacity by equipment type • Annualized HFC leak rate by equipment type
2G:	Land use change	Operation	• Land area by land use type, pre- and post-transition • Land use management	• Carbon stocks by land use type • Wood product carbon stock by land use type

#	Emissions Source	Phase	User Inputs	Calculator Assumptions
2H:	On-road vehicles	Operation	• Vehicle miles traveled	• Emission factors by speed bin
2I:	Treatment of waste on-site	Operation	• Quantity of waste treated by management practice • Digestate type (AD facilities only)	• Emission factors by management practice
2J:	Treatment of wastewater on-site	Operation	• Population served (municipal) • Annual production by product type (industrial)	**Municipal** • BOD • BOD emission factor • Percent anaerobically digested • Protein consumption • Nitrogen content • Fraction of nitrogen not consumed • N_2O emission factor **Industrial** • Outflow by product type • BOD/COD by product type • BOD/COD emission factor by product type • Percent anaerobically digested by product type
2K:	Transportation and treatment of waste off-site	Operation	• Annual number of residents, visitors, and employees	• Resident, visitor, and employee generation rate • Waste treatment practice* • Emission factors by management practice
2L:	Enteric fermentation	Operation	• Number of animals by type	• Emission factors by animal type
2M:	Manure management	Operation	• Number of animals by type • Manure management system	• Emission factors by animal type

* Tool will also include the ability for the user to enter value directly.

Construction Emissions

1A: Material Inputs

This emissions source includes emissions that result from the extraction of raw materials, the transportation of raw materials to the manufacturing site, and the manufacturing of materials used during the construction phase of the project. Using standard Environmental Product Declaration (EPD) boundaries, these activities are described as A1-A3.

Equations

Equation 1 – Embodied Emissions of Material Input

$$\text{embodied emissions}_t = \text{material quantity}_t \times \text{emission factor}_t$$

Data Elements and Sources

Data Element	Description	Data Type	Data Source
Material type/product	Material type or product (t)	User Selection	NA
Material quantity by type	Total amount of material used as an input during construction (tons)	User Input	NA
Emission factor by material type/product	Emissions associated with the extraction of raw materials, transportation of raw materials, and manufacturing of the material per unit of material (CO_2e/ton)	Default	Databases that contain EPDs, such as EC3 or One Click LCA
Embodied emissions	Total emissions by material type (CO_2e)	Calculated	Equation 1

Limitations and Assumptions

The proposed methodology requires users to provide data on the total quantity of each material required for construction. If this information is not available or unknown, the user will need to use external sources to develop a rough estimate of material quantities. Proprietary tools and data sources such as Dodge Construction Data, One Click LCA or RS Means can provide bulk estimates of specific material quantities for a building type. However, due to the project-specific nature of this data input, budget constraints, and the availability of activity data, default assumptions are not feasible to develop at this time.

Additionally, the emissions data collected through EPDs are material product specific, thus implying further disaggregation per material type. For example, the emission factor for concrete can vary significantly depending on the concrete application type and its compressive strength. Since we do not expect the user to be able to identify the specific material product used (and its characteristics), we anticipate including in the tool one or multiple default values based on statistical averages provided through the EPD database, and assumptions gathered on potential market representation of variable products.

Finally, the material types and products that will be available in the tool for quantification will not be exhaustive. Rather, we anticipate including (at a minimum) the following key construction material types in the tool: concrete/cement, asphalt, steel, aluminum, glass, and wood products.

1B: Transportation of Material Inputs

This emissions source includes emissions that result from transportation of construction materials from the manufacturing facility location to the project site (for use or installation) during the construction phase of the project.

Equations

Equation 2 – Emissions from Transportation of Material Input

$$\text{GHG emissions}_t = \text{material quantity}_t \times \text{distance}_{m,s} \times \text{emission factor}_m$$

Data Elements and Sources

Data Element	Description	Data Type	Data Source
Material quantity by type	Total amount of material by type (t) used as an input during construction (tons)	User Input	See Section 1A:
Material source	The source (s) of each material type (i.e., domestic, import, or unknown).	User selection	NA
Emission factors by mode of transportation	Emissions intensity by transportation mode (m), including truck, rail, aircraft or watercraft (CO_2e/ton-mile)	Default	GREET
Distance travelled by mode	Average distance the material product travels from the manufacturing location to the project site by transportation mode (aircraft, watercraft, truck, etc.) or a combination of modes (miles), varies depending on the material source	Default	Census Commodity Flow Survey; WARM; MICE
GHG Emissions	Total emissions by material type (CO_2e)	Calculated	Equation 2

* Tool will also include the ability for the user to enter value directly.

Limitations and Assumptions

The variables that most significantly impact this emission source include the geographical sourcing (import vs domestic) of the material product, the distance travelled, and the mode or combination of modes of transportation. To enable the user to build the most accurate estimates, the tool will allow the user to specify if the material will be imported or sourced domestically. If unknown, the tool will include a default that assumes an average source breakdown for each material type. In general, the default values regarding distance by mode will be informed by multiple sources to derive a defensible assumption for each material type, recognizing that actual emissions may vary significantly.

1C: Employee Commuting

This emissions source includes emissions that result from employees commuting to the project site during the construction phase of the project. This includes emissions from driving personal vehicles, as well as taking public transit or using alternate modes of transportation.

Equations

Equation 3 – Emissions from Empoyee Commuting

$$\text{GHG emissions} = \text{number of employee\_commuting days} \times \text{commuting distance} \times \sum \text{emission factor}_{\text{m}} \times \text{percent of employees}_{\text{m}}$$

Data Elements and Sources

Data Element	Description	Data Type	Data Source
Number of employee-commuting days	A sum of the total number of days during the construction phase that each employee will commute to project site	User Input	NA
Commuting distance*	Average distance that employees travel to reach project site (miles/day)	Default	Local GHG Inventory Tool
Commuting mode breakdown*	The percent of employees that commute to work by each commuting mode (m) (i.e., single occupancy vehicle, carpool, motorcycle, public transit, bike, or walk)	Default	Local GHG Inventory Tool
Emission factors by mode	Amount of fuel or electricity consumed per mile by commuting mode (CO_2e/mile)	Default	MICE; MOVES; GREET
GHG emissions	Total emissions from employee commuting (CO_2e)	Calculated	Equation 3

* Tool will also include the ability for the user to enter value directly.

Limitations and Assumptions

The proposed methodology requires users to provide data on the expected total number of employee-commuting days. The methodology is based on employee-commuting days rather than the average number of employees and total number of commuting days due to expected variation in the number of employees commuting to the project site across the construction phase. Key assumptions made by the tool include average commuting distance and the mode by which employees travel to the project site. These assumptions may be directly provided by the user to further tailor the results to their project.

1D: Construction Equipment

This emissions source includes emissions from electricity and fuel used in off-road construction equipment (e.g., dozers, excavators, loaders, etc.) during the construction phase.

Equations

Equation 4 – Electricity and Fuel Consumption by Construction Equipment Type

$$\text{electricity consumption}_{\text{t}} = \text{number of construction days}_{\text{t}} \times \text{daily electricty consumption}_{\text{t}}$$

$$\text{fuel consumption}_{\text{t}} = \text{number of construction days}_{\text{t}} \times \text{daily fuel consumption}_{\text{t}}$$

Equation 5 – GHG Emissions from Electricity and Fuel Consumption in Construction Equipment

$$\text{GHG emissions} = (\text{total electricity consumed} \times \text{electricity emission factor}) + (\text{total fuel consumed}_{f} \times \text{heat content conversion factor}_{f} \times \text{fuel emission factor}_{f})$$

Data Elements and Sources

Data Element	Description	Data Type	Data Source
Equipment type	The type of construction equipment (t) used during construction, including fuel source (e.g., diesel, electricity)	User Selection	NA
Number of construction days by equipment type	Total number of construction days each equipment type will be used	User Input	NA
Daily electricity consumption by equipment type	Average electricity consumption per day by construction equipment type (kWh/day)	Default	TBD
Daily fuel consumption by equipment type	Average fuel consumption per day by construction equipment type (gallons/day)	Default	TBD
Electricity emissions factor*	GHG emissions per unit of electricity consumed (CO_2e/kWh)	Default	GREET
Fuel-specific emissions factors	GHG emissions per unit of fuel (f) consumed (CO_2e/Btu)	Default	GREET
Btu (heat content) conversion factors	Heat content per unit of fuel (e.g., Btu/gallon)	Default	EIA
Electricity consumption*	Total electricity consumption (kWh) by construction equipment	Calculated	Equation 4
Fuel consumption*	Total fuel consumption (gallons) by fuel type by construction equipment	Calculated	Equation 4
GHG emissions	GHG emissions from construction equipment (CO_2e)	Calculated	Equation 5

* Tool will also include the ability for the user to enter value directly.

Limitations and Assumptions

The proposed methodology relies on users to provide an estimate of the number of days each type of construction equipment will be utilized during the construction phase. It also requires the development of an assumption regarding the amount of electricity and/or fuel consumed on average per day by equipment type. Additional research is required to develop these assumptions and to confirm the viability of this approach. Due to the expected difficulty in users providing information on the number of construction days by equipment type, ICF will also explore the feasibility of developing highly conservative assumptions on daily equipment use. As an alternative option, the tool will also allow users to directly provide data on the estimated quantity of total fuel and/or electricity consumed by construction equipment during the construction phase of the project.

1E: On-site Energy

This emissions source includes emissions that result from a project's stationary energy consumption during the construction phase of the project. This includes on-site combustion of fuels (e.g., diesel used in generators) as well as emissions from the generation of electricity consumed on-site.

Equations

Equation 6 – GHG Emissions from Energy and Electricity Consumption from Stationary Equipment

$$\text{GHG emissions} = (\text{total electricity consumed} \times \text{electricity emissions factor}) + (\text{total fuel consumed}_f \times \text{heat content conversion factor}_f \times \text{fuel emission factor}_f)$$

Data Elements and Sources

Data Element	Description	Data Type	Data Source
Total electricity consumption	Total electricity consumption (kWh) by construction equipment type	User Input	NA
Total fuel consumption	Total fuel consumption by fuel type (gallons) by construction equipment type	User Input	NA
Electricity emission factor*	GHG emissions per unit of electricity consumed (CO_2e/kWh)	Default	GREET
Fuel-specific emission factors	GHG emissions per unit of fuel (f) consumed (CO_2e/Btu)	Default	GREET
Btu (heat content) conversion factors	Heat content per unit of fuel (e.g., Btu/gallon)	Default	EIA
GHG emissions	GHG emissions from construction equipment (CO_2e)	Calculated	Equation 6Equation 10

* Tool will also include the ability for the user to enter value directly.

Limitations and Assumptions

To estimate emissions from stationary energy consumption, users will need to estimate the total quantity of electricity and fuel consumption consumed during construction. For many projects, this emission source may not be relevant. Emission source 1D: Construction Equipment likely accounts for most fuel and electricity emissions occurring during construction.

1F: Land Use Change

This emissions source (or sink) includes the net carbon change from the transition of one land use type to another due to project construction. This may include clearing land for construction or otherwise converting it to another land type.

Equations

Equation 7 – Net Change in Carbon Stock

$$\Delta carbon\ stock = \sum(\text{carbon stock}_t \times \text{land area post\_conversion}_t) - \sum(\text{carbon stock}_{t,m} \times \text{land area pre\_conversion}_t) + \sum(\text{wood product carbon stock}_t \times \text{land area pre\_conversion}_t)$$

Data Elements and Sources

Data Element	Description	Data Type	Data Source
Land area by land use type, pre- and post-transition	Land area (acres) by type of land (t) before and after conversion (settlement soils, forested lands, wetlands, etc.)	User Input	NA
Land use management	Whether land is managed or unmanaged pre-conversion (m)	User Selection	NA
Carbon stocks by land use type	Average carbon stock per acre by land use type (forested land, wetland, settlement soils, etc.) for the Minnesota region (C/acre) by management type (m)	Default	iTree, EPA SIT, COMET-Farm, COMET-Planner
Wood product carbon stock	Average carbon stock per acre that remains sequestered in wood products after a forest is leveled by land type (C/acre)	Default	TBD
Net change in carbon stock	The net change in carbon stock from the conversion of land (C)	Calculated	Equation 7

Limitations and Assumptions

Assumptions regarding carbon stocks by land use type are based on several variables, including ecoregion, soil characteristics, and land-management practices. For the purposes of this tool, the assumed defaults will consider both the climate and soil types relevant to Minnesota. Users will specify the management practices of the pre-converted land if applicable. Values will be derived that align with the land use types that are identified in the environmental assessment worksheet (EAW), taking into account potential variation within a single land use type (e.g., coniferous vs. deciduous forest), which also impacts the average carbon stock per acre. Variation due to forest age may also be considered. For select land types that produce harvested wood products, an assumption regarding the average carbon stock of the resulting wood products produced per acre will also be developed to account for the carbon that remains sequestered after the land conversion.

To account for lifecycle emissions, the net carbon change calculations assume full realization of the land transition and attributes the lifetime changes to the year in which the land is converted. Therefore, the results assume that no further changes to the converted land will occur during the operational phase of the project. The lost sequestration potential of converting forests is not directly accounted for in this methodology.

1G: Transportation and treatment of waste off-site

This emissions source includes emissions from the transportation and treatment of construction waste that is landfilled at a facility off-site.

Equations

Equation 8 – GHG Emissions from the Transportation and Treatment of Waste Off-Site

$$\text{GHG emissions} = \text{material quantity}_t \times \text{loss rate}_t \times \text{emission factor}_t$$

Data Elements and Sources

Data Element	Description	Data Type	Data Source
Material quantity by type	Amount of material used as an input during construction by type (t) (tons)	User input	Section 1A:
Loss rate	The percent of each material input that is discarded as waste	Default	WARM, TBD
Emissions factor	The emissions associated with the transportation and treatment of waste by type (CO_2e/ton)	Default	EPA Emissions Factors Data Hub
GHG emissions	GHG emissions from the treatment of waste generated during construction (CO_2e)	Calculated	Equation 8

Limitations and Assumptions

Estimating emissions from transportation and treatment of waste off-site is driven by the amount of material disposed, which is derived using a loss rate assumption by material type and material input quantities provided by the user. Limitations related to users providing data on the total quantity of each material are discussed under Section 1A:. Since the types of materials covered under Section 1A: will not be exhaustive, the tool may also accommodate entry of mixed C&D waste that is not derived from data on material inputs. Allowing for the direct entry of waste quantities would also allow the tool to capture waste generated from the deconstruction of existing buildings that may occur during the construction phase. Loss rate assumptions for some material types are identified in WARM documentation, though additional research is required to confirm and identify assumptions for all material types.

The tool will assume that all waste generated during construction will be disposed of at a landfill. The emissions factors from EPA's Emission Factors Hub include emissions from the decomposition of waste as well as the transportation of waste to the waste treatment facility, but do not include avoided emissions associated with energy recovery or landfill carbon sequestration. Emissions from the transportation of waste are based on a default assumption regarding the distance traveled from the project site to the waste management facility, which may vary from the actual distance traveled for a specific project.

Operational Emissions

2A: Building Energy Consumption

This emissions source includes emissions that result from a project's building energy consumption during the operational phase of the project. This includes on-site combustion of fuels (e.g., natural gas) as well as emissions from the generation of electricity consumed on-site.

Equations

Equation 9 – Annual Building Energy Consumption

$$\text{annual non\_electric energy consumed} = \sum(\text{building square footage}_t \times \text{building non\_electric energy intensity}_t)$$

$$\text{annual electricity consumed} = \sum(\text{building square footage}_t \times \text{building electricity intensity}_t)$$

Equation 10 – Annual Emissions from Non-Electric Energy and Electricity Consumption

$$\text{annual GHG emissions} = \text{annual non\_electric energy consumed} \times \text{fuel\_specific emission factor} + \text{annual electricity consumed} \times \text{electricity emission factor}$$

Data Elements and Sources

Data Element	Description	Data Type	Data Source
Building square footage	Square footage by building type (t) of all buildings in the project (square feet)	User Input	NA
Building non-electric energy use intensity*	Average annual non-electric energy consumed per square foot by building type (GJ/square foot/year)	Default	EIA RECS, CBECS, MECS
Building electricity intensity*	Average annual electricity consumed per square foot by building type (MWh/square foot/year)	Default	EIA RECS, CBECS, MECS
Electricity emission factor*	GHG emissions per unit of electricity consumed (CO_2e/kWh)	Default	GREET
Fuel-specific emission factors	GHG emissions per unit of fuel consumed (CO_2e/Btu)	Default	GREET
Annual energy consumed	Building non-electric energy consumed (GJ)	Calculated	Equation 9
Annual electricity consumed	Building electricity consumed (MWh)	Calculated	Equation 9
Annual GHG emissions	Annual GHG emissions from buildings (CO_2e)	Calculated	Equation 10

* Tool will also include the ability for the user to enter value directly.

Limitations and Assumptions

To simplify the user input process, the proposed methodology estimates annual electricity and non-electric energy consumption by assuming an average non-electric energy and electricity building intensity by building type. The building types defined in the tool will be dependent on the availability of data to estimate building intensities. These assumptions may not capture the nuances of different building types or project-specific operations. As a result, the tool will also allow users to directly input their target building energy use intensity.

2B: Fugitive Emissions from Coal

This emissions source includes fugitive emissions from underground mining, surface mining, and post-mining activities (processing, storage, and transportation of coal).

Equations

Equation 11 – Annual Emissions from Underground Mining Activities

$$\text{annual GHG emissions}_{\text{underground}} = \text{ventilation} + \left(\text{degasification system} \times (1 - \text{methane recovery rate})\right) \times \text{GWP}_{\text{CH4}}$$

Equation 12 – Annual Emissions from Surface Mining Activities

$$\text{annual GHG emissions}_{\text{surface}} = \text{coal production}_{\text{surface}} \times \text{emission factor}_{\text{surface}} \times \text{GWP}_{\text{CH4}}$$

Equation 13 – Annual Emissions from Underground and Surface Post-Mining Activities

$$\text{annual GHG emissions}_{\text{post-mining}} = \text{coal production}_{\text{post-mining}} \times \text{emission factor}_{\text{post-mining}} \times \text{GWP}_{\text{CH4}}$$

Data Elements and Sources

Data Element	Description	Data Type	Data Source
Coal production by mine type	Annual underground or surface coal production (tons) by mine type	User input	NA
Ventilation emissions from underground mining	Estimated annual CH_4 ventilation emissions from underground mining (ft^3)	User input	NA
Degasification system emissions	Estimated annual CH_4 emissions from degasification systems in underground mining (ft^3)	User input	NA
Methane recovery rate of degasification system	Estimated percent of annual CH_4 recovered from degasification system (ft^3)	User input	NA
Surface mining emission factor	Methane emissions from surface mining per unit of coal produced (ft^3 CH_4/ton)	User input	NA
Post-mining emission factors by mine type	Methane emissions from post-mining activities by mine type per unit of coal produced (ft^3 CH_4/ton)	User input	NA
Annual GHG emissions from surface mining	Emissions from surface mining activities (CO_2e)	Calculated	Equation 11
Annual GHG emissions from underground mining	Emissions from underground mining activities (CO_2e)	Calculated	Equation 12
Annual GHG emissions from post-mining	Emissions from surface and underground post-mining activities (CO_2e)	Calculated	Equation 13

Limitations and Assumptions

Emissions from coal mining are heavily dependent on the characteristics of the coal and the way it is handled after leaving the mine. As a result, the proposed methodology relies entirely on user inputs to quantify emissions from this source. The inclusion of default emission factors will be considered based on data availability and applicability to Minnesota.

2C: Fugitive Emissions from Natural Gas and Petroleum Systems

This emissions source includes fugitive emissions from natural gas and petroleum production, transmission, and distribution. These emissions are applicable to projects that expand the delivery capacity of these fuels (e.g., pipelines, storage, refineries).

Equations

Equation 14 – Annual GHG Emissions from Natural Gas and Petroleum Systems

$$\text{annual GHG emissions} = \text{throughput}_t \times \text{emission factor}_t$$

Data Elements and Sources

Data Element	Description	Data Type	Data Source
Incremental throughout by fuel type	Amount of additional throughput expected by fuel type (t) (e.g., natural gas, diesel, gasoline) resulting from the project (Btu)	User input	NA
Emission factors by fuel type*	Fugitive emissions per quantity of fuel associated with recovery, processing, transmission, storage, and distribution (CO_2e/Btu)	Default	GREET
Annual GHG emissions from natural gas and petroleum systems	Total emissions from the leakage of natural gas and petroleum (CO_2e)	Calculated	Equation 14

* Tool will also include the ability for the user to enter value directly.

Limitations and Assumptions

The proposed methodology accounts for fugitive emissions from the recovery, processing, refining, transmission, storage, and distribution of natural gas and petroleum products. Users must provide data on incremental fuel throughput by fuel type. Emissions will be quantified using emission factors from the GREET model. Users will also have the ability to adjust the default emission factors to account for measures being taken by the developer to reduce and/or capture methane leakage.

2D: Emissions from Natural Gas and Petroleum Products

This emissions source includes emissions from the combustion of natural gas and petroleum products that are delivered and consumed as an indirect result of project implementation (e.g., pipeline expansion).

Equations

Equation 15 – Annual GHG Emissions from Natural Gas and Petroleum Products

$$\text{annual GHG emissions} = \text{throughput}_t \times \text{emission factor}_t$$

Data Elements and Sources

Data Element	Description	Data Type	Data Source
Incremental annual throughout by fuel type	Amount of additional throughput expected by fuel type (t) (e.g., natural gas, diesel, gasoline) resulting from the project (Btu)	User input	NA
Emission factors by fuel type	Emissions from the combustion of each fuel type (CO_2e/Btu)	Default	EPA Emissions Factors Data Hub
Annual GHG emissions from natural gas and petroleum products	Total emissions from the combustion of natural gas and petroleum products (CO_2e)	Calculated	Equation 15

Limitations and Assumptions

The proposed methodology accounts for emissions from the direct combustion of fuel that is delivered and consumed as an indirect, downstream impact of the project. Users must provide data on the additional quantity of fuel consumed due to project implementation.

2E: Industrial Process Emissions

This emissions source includes emissions from the production of metals, minerals, chemicals, and other industrial activities.

Equation 16 – Annual GHG Emissions from an Industrial Activity

$$\text{annual GHG emissions}_{p} = \text{quantity of product}_{p} \times \text{emission factor}_{p}$$

Data Elements and Sources

Data Element	Description	Data Type	Data Source
Annual production by industrial process	Amount of product produced annually by industrial process (p) (MT/year)	User input	NA
Emission factors by product type*	GHG emissions per unit of product (e.g., cement, lime, glass, limestone, magnesium, soda ash, iron and steel, ammonia, aluminum, nitric acid) (CO_2e/MT product)	Default	GREET, EPA SIT, IPCC
Annual GHG emissions	Annual GHG emissions from industrial activity (CO_2e)	Calculated	Equation 16

* Tool will also include the ability for the user to enter value directly.

Limitations and Assumptions

Emissions from industrial activities are dependent on product output. Users are therefore required to provide estimates on the annual production output. The tool will include default emission factors by product type for industries that are applicable to Minnesota. Users will have the ability to tailor these assumptions based on the availability of project-specific data.

2F: HFC Leakage

This emissions source includes emissions from hydrofluorocarbons (HFCs) that are used in air conditioning and refrigeration equipment during project operation. Leakage occurs from this equipment during installation, operation (including servicing), and disposal.

Equations

Equation 17 – Refrigerant Charge of HFC Equipment

$$\text{refrigerant charge}_{HFC} = (\text{building area}_{t} - \text{building area not utilized}_{t}) \times \text{refrigerant capacity}_{HFC}$$

Equation 18 – GHG Emissions from HFCs

$$\text{annual GHG emissions} = \text{refrigerant charge}_{HFC} \times \text{HFC leak rate} \times \text{GWP}_{HFC}$$

Data Elements and Sources

Data Element	Description	Data Type	Data Source
Building area by type	Area by building type (t) of all buildings in the project (square feet)	User Input	NA
Building area not utilized	Area of the buildings that are not actively utilized (i.e., does not contain refrigeration and A/C equipment) (square feet)	User Input	NA
Equipment type per building type	The type of refrigeration and air conditioning equipment found in each building type	Default	EPA HFC Accounting Tool
Refrigerant type per equipment type	The type of HFC used in each type of refrigeration and air conditioning equipment	Default	EPA HFC Accounting Tool
Refrigerant capacity	Refrigerant capacity per square foot (kg HFC/square foot)	Default	EPA HFC Accounting Tool
Refrigerant charge	Total charge of refrigerant in the equipment (kg HFC)	Calculated	Equation 17
HFC leak rate	HFC charge leaked per year by equipment type (%)	Default	EPA HFC Accounting Tool
Annual GHG emissions	Total emissions from HFCs (CO_2e)	Calculated	Equation 18

Limitations and Assumptions

This approach applies default assumptions for the type of equipment, refrigerant capacity, refrigerant type, and leak rate. Actual emissions will vary based on management practices and the type of equipment installed. In addition, the EPA tool used as the main source for these assumptions is almost a decade old and does not consider recent regulations that require the phasedown of HFCs in the United States.

2G: Land Use Change

This emissions source (or sink) includes the net carbon change from the transition of one land use type to another due to project operation. While most land use changes are expected to occur during the construction phase of the project, this emissions source would cover activities like land use change due to surface mining that occur during project operation.

Equations

Equation 19 – Change in Carbon Stock by Land Type

$$\Delta carbon\ stock = \sum(\text{carbon stock}_t \times \text{land area post\_conversion}_t) - \sum(\text{carbon stock}_{t,m} \times \text{land area pre\_conversion}_t) + \sum(\text{wood product carbon stock}_t \times \text{land area pre\_conversion}_t)$$

Data Elements and Sources

Data Element	Description	Data Type	Data Source
Land area by land use type, pre- and post-transition	Type of land (t) before and after conversion (settlement soils, forested lands, wetlands, etc.) (acres)	User Input	NA
Land use management	Whether land is managed or unmanaged pre-conversion (m)	User Selection	NA
Carbon stocks by land use type	Average carbon stock per acre by land use type (forested land, wetland, settlement soils, etc.) for the Minnesota region (C/acre) by management type (m)	Default	iTree, EPA SIT, COMET-Farm, COMET-Planner
Wood product carbon stock	Average carbon stock per acre that remains sequestered in wood products after a forest is leveled by land type (C/acre)	Default	TBD
Net change in carbon stock	The net change in carbon stock from the conversion of land (C)	Calculated	Equation 19

Limitations and Assumptions

Assumptions regarding carbon stocks by land use type are based on several variables, including ecoregion, soil characteristics, and land-management practices. For the purposes of this tool, the assumed defaults will consider both the climate and soil types relevant to Minnesota. Users will specify the management practices of the pre-converted land if applicable. Values will be derived that are align with the land use types that are identified in the EAW, taking into account potential variation within a single land use type (e.g., coniferous vs. deciduous forest), which also impacts the average carbon stock per acre. Variation due to forest age may also be considered. For select land types that produce harvested wood products, an assumption regarding the average carbon stock of the resulting wood products produced per acre will also be developed to account for the carbon that remains sequestered after the land conversion.

The net carbon change calculations assume full realization of the land transition and attributes the lifetime changes to the year in which the land is converted. The results assume that no further changes to the converted land will occur following the completion of the project. The lost sequestration potential of converting forests is not directly accounted for in this methodology.

2H: On-Road Vehicles

This emissions source includes emissions from on-road vehicles that are used during the operational phase of the project. This includes emissions generated on-site from vehicles that are driven on project roadways and downstream from vehicles driven to and from the project site by visitors or residents.

Equations

Equation 20 – Emissions from On-Road Vehicles

$$\text{GHG emissions} = \sum \text{vehicle miles traveled}_s \times \text{emission factor}_s$$

Data Elements and Sources

Data Element	Description	Data Type	Data Source
Vehicle miles traveled	Number of additional miles traveled by speed bin (s)	User Input	NA
Emission factors	Emissions per mile traveled by speed bin (CO_2e/mile)	Default	MICE; MOVES; GREET
GHG emissions	Total emissions from on-road vehicles (CO_2e)	Calculated	Equation 22

Limitations and Assumptions

The proposed methodology requires users to provide data on the estimated number of vehicle miles driven that otherwise would not have occurred in absence of the project. The tool will allow users to specify miles traveled by speed bin or default to an average emissions factor if data by speed bin are not known or available. While projects may also impact traffic congestion in addition to trip generation, the proposed methodology focuses only on emissions from trip generation. The proposed methodology is also limited to on-road vehicles and does not account for maintenance activities or the movement of goods to and from the project site.

2I: Treatment of waste on-site

This emissions source includes emissions from the on-site treatment of waste during project operations. This emissions source is applicable to landfills, waste incineration facilities, composting facilities, and anaerobic digesters.

Equations

Equation 21 – GHG Emissions from the Treatment of Waste On-Site

$$\text{annual GHG emissions} = \sum \text{quantity of waste treated}_{\text{p}} \times \text{emission factor}_{\text{p}}$$

Data Elements and Sources

Data Element	Description	Data Type	Data Source
Quantity of waste treated by management practice	Annual amount of solid waste treated by management practice (p) (i.e., landfilled, incinerated, composted, anaerobically digested) (tons)	User input	NA
Digestate type	For anaerobic digestion facilities, identification of the digestate type (i.e., wet or dry)	User selection	NA
Emission factors by management practice	Total emissions per mass of municipal solid waste treated under each management practice (CO_2e/ton)	Default	EPA Emissions Factors Data Hub
Annual GHG emissions	The amount of GHG emissions from the on-site treatment of waste each year (CO_2e)*	Calculated	Equation 21

*Although methane emissions from the decomposition of waste at a landfill are generated over many years, for the purposes of this tool, all methane emissions from landfilled waste will be attributed to the year in which the waste is landfilled.

Limitations and Assumptions

Emissions from the treatment of waste depend on a variety of factors, including waste composition, the distance from the project site to the waste management facility, the landfill conditions, and the gas collection practices. The emission factors from EPA's Emission Factors Hub include emissions from the decomposition and combustion of waste as well as the transportation of waste to the waste treatment facility, but do not include avoided emissions associated with displaced electric utility generation, landfill carbon sequestration, soil carbon storage, or avoided fertilizer application. Emissions from the transportation of waste are based on a default assumption regarding the distance traveled from the project site to the waste management facility. The emission factors for landfilling are based on typical landfill gas collection practices and average landfill moisture conditions. Finally, the emission factors reflect assumptions regarding the typical composition of municipal solid waste and organic waste. Defaults associated with the treatment of hazardous waste are not included. Anerobic digestion of manure is also not covered by this emissions source; rather, these emissions are captured under the manure management emissions source.

2J: Treatment of wastewater on-site

This emissions source includes emissions from municipal and industrial wastewater treatment plants including direct methane emissions from the wastewater treatment process and indirect nitrous oxide emissions from wastewater effluent.

Equations

Equation 22 – Methane emissions from municipal wastewater treatment process

$$\text{annual } CH_4 \text{ emissions} = \text{population} \times \text{BOD} \times \text{emision factor}_{\text{BOD}} \times \% \text{ anaerobically digested}$$

Equation 23 – Nitrous oxide emissions from municipal wastewater treatment process

$$\text{annual } N_2O \text{ emissions} = \text{population} \times \text{protein} \times \text{nitrogen content} \times \text{fraction} \times \text{emision factor}_{\text{N2O}} \times \frac{\text{N20}}{\text{N2}}$$

Equation 24 – Annual GHG emissions from municipal wastewater treatment process

$$\text{annual GHG emissions} = (\text{annual } CH_4 \text{ emissions} \times \text{GWP}_{\text{CH4}}) + (\text{annual } N_2O \text{ emissions} \times \text{GWP}_{\text{N2O}})$$

Equation 25 – Annual GHG emissions from industrial wastewater treatment process

$$\text{annual GHG emissions} = \text{production}_p \times \text{outflow}_p \times \text{BOD/COD}_p \times \text{emision factor}_{\text{p}} \times \% \text{ anaerobically digested} \times \text{GWP}_{\text{CH4}}$$

Data Elements and Sources

Data Element	Description	Data Type	Data Source
Municipal Wastewater Treatment			
Population served	Population served by the wastewater treatment plant	User input	NA
BOD	Per capita 5-day biological oxygen demand (kg/person/year)	Default	EPA SIT
BOD emission factor	Methane emissions per unit of BOD production (kg CH_4/kg BOD)	Default	IPCC

Percent anaerobically digested	Fraction of wastewater anaerobically digested	Default	EPA SIT
Protein consumption	Annual per capita protein consumption (kg/person/year)	Default	EPA SIT
Nitrogen content	Fraction of nitrogen in protein (kg N/kg protein)	Default	EPA SIT
Fraction of nitrogen not consumed	Factor to adjust for the fraction of nitrogen in the protein not consumed	Default	EPA SIT
N_2O emission factor	Nitrous oxide emissions per nitrogen treated (kg N_2O-N/kg sewage N-produced)	Default	EPA SIT
Annual CH_4 emissions	Annual methane emissions from the treatment of municipal wastewater during operations (CO_2e)	Calculated	Equation 22
Annual N_2O emissions	Annual nitrous oxide emissions from the treatment of municipal wastewater during operations (CO_2e)	Calculated	Equation 23
Annual GHG emissions	Annual GHG emissions from the treatment of municipal wastewater during operations (CO_2e)	Calculated	Equation 24
Industrial Wastewater Treatment			
Annual production by product type	Amount of product produced annually by product type (e.g., produce, meats, poultry, pulp and paper) (p) (MT/year)	User input	NA
Wastewater outflow	Amount of water consumed per unit output by product type (m^3/MT)	Default	EPA SIT
BOD/COD	Biochemical or chemical oxygen demand per wastewater outflow by product type (kg/ m^3)	Default	EPA SIT
BOD/COD emission factor	Methane emissions per unit of BOD/COD production (kg CH_4/kg BOD/COD)	Default	EPA SIT
Percent anaerobically digested	Fraction of wastewater anaerobically digested	Default	EPA SIT
Annual GHG emissions	Annual methane emissions from the treatment of industrial wastewater during operations (CO_2e)	Calculated	Equation 25

Limitations and Assumptions

Estimating the emissions from treatment of municipal wastewater on-site is driven by the population served, treatment system, biological oxygen demand (BOD), and protein content of the population served. Users will be required to provide an estimate of the population served by the treatment plant. Actual emissions will vary based on the treatment system, BOD, and protein content of the population served.

Emissions from industrial wastewater treatment are limited to select industries for which default assumptions are readily available. Users will be encouraged to independently estimate emissions from industrial wastewater treatment if their industry is not covered by the tool.

2K: Transportation and treatment of waste off-site

This emissions source includes emissions from the transportation and treatment of waste during project operation that is landfilled, combusted, or recycled at a facility off-site.

Equations

Equation 26 – Annual Waste Generation

$$\text{annual waste generation amount} = (\text{residents} \times \text{resident per capita generation rate}) + (\text{visitors} \times \text{visitor per capita generation rate}) + (\text{employees} \times \text{employee per capita generation rate})$$

Equation 27 – Annual GHG Emissions from the Transportation and Treatment of Waste Off-Site

$$\text{annual GHG emissions} = \sum(\text{annual waste generation amount} \times \%\ \text{waste treament practice} \times \text{emission factor}_{p})$$

Data Elements and Sources

Data Element	Description	Data Type	Data Source
Residents	Number of people living on-site	User input	NA
Visitors	Number of visitors each year	User input	NA
Employees	Number of employees working on-site	User input	NA
Waste treatment practice*	The percentage of waste treated by each management practice (p) (i.e., landfilled, incinerated, and recycled)	Default	EQB, WARM, TBD
Resident per capita waste generation rate	The amount of waste generated on average by each resident per year (tons)	Default	EPA SIT
Visitor per capita waste generation rate	The amount of waste generated on average by each visitor per year (tons)	Default	TBD
Employee waste generation rate	The amount of waste generated on average by each worker per year (tons)	Default	TBD
Annual waste generation amount*	Average annual amount of waste generated during project operations (tons)	Calculated	Equation 26
Emission factor	The emissions associated with the treatment of mixed MSW waste by treatment practice (CO_2e/ton)	Default	EPA Emissions Factors Data Hub
Annual GHG emissions	GHG emissions from the treatment of waste generated annually during operations (CO_2e)**	Calculated	Equation 27

* Tool will also include the ability for the user to enter value directly.

**Although methane emissions from the decomposition of waste at a landfill are generated over many years, for the purposes of this tool, all methane emissions from landfilled waste will be attributed to the year in which the waste is landfilled.

Limitations and Assumptions

Estimating emissions from the transportation and treatment of waste off-site is dependent on user inputs regarding the number of people living, visiting, or working on the project site as well as per capita waste generation estimates that will be estimated based on available literature. The tool will allow users to directly input estimates on the amount of waste generated per year to accommodate the potential availability of project-specific information.

Based on the project location, the tool will use data provided by EQB on the percentage of waste by county that goes to a landfill vs. an incineration facility to determine a default breakout of the waste treatment practice of the generated waste. The tool will also include a

default recycling rate, that will be tailored based on project type. The emissions factors from EPA's Emission Factors Hub include emissions from the decomposition, combustion, and recycling of waste as well as the transportation of waste to the waste treatment facility, but do not include avoided emissions associated with energy recovery, displaced electric utility generation, landfill carbon sequestration, process energy, transportation energy, process non-energy, or forest carbon storage. Emissions from the transportation of waste are based on a default assumption regarding the distance traveled from the project site to the waste management facility, which may vary from the actual distance traveled for a specific project. The emission factor for landfilling is based on typical landfill gas collection practices and average landfill moisture conditions, which also may differ from the characteristics of the landfill where the waste is ultimately disposed.

2L: Enteric Fermentation

This emissions source includes methane emissions from enteric fermentation, or the digestive process of ruminant livestock, during project operation. Livestock categories include cattle (beef or dairy), swine, horses and ponies, mules and donkeys, sheep (including lambs and wool hair crosses), and goats.

Equations

Equation 28 – Methane emissions from enteric fermentation by livestock type

$$\text{annual GHG emissions}_t = \text{number of livestock}_t \times \text{emission factor}_t$$

Data Elements and Sources

Data Element	Description	Data Type	Data Source
Livestock by type	Number of animals by type (t)	User input	NA
Emission factors by livestock type	Annual emissions per animal by livestock type (i.e., cattle, swine, horses and ponies, mules and donkeys, sheep, goats, and chickens) in Minnesota (CO_2e/head)	Default	Cool Farm Tool, COMET Farm, EPA US Greenhouse Gas Inventory, EQB Feedlot GHG Calculator
Annual GHG Emissions	Annual GHG emissions from enteric fermentation (CO_2e)	Calculated	Equation 28

Limitations and Assumptions

A variety of factors impact emissions from enteric fermentation, including species type, livestock diet, temperature, and management practices. For the purposes of this tool, emission factors for each livestock type will be derived by dividing emissions estimates from enteric fermentation for the state of Minnesota by total livestock head (by type). Since the number of animals may change from year to year, the tool will allow flexibility to enter the number of livestock by year or an annual average.

2M: Manure Management

This emissions source includes emissions from the process of managing livestock manure in solid or liquid systems during project operation. Livestock categories include cattle (beef or dairy), swine, horses and ponies, mules and donkeys, sheep (including lambs and wool hair crosses), goats, and chickens (broilers, layers, pullets, and roosters).

Equations

Equation 29 – Emissions from manure management by livestock type

$$\text{annual GHG emissions}_t = \text{number of livestock}_t \times \text{emissions factor}_{t,s}$$

Data Elements and Sources

Data Element	Description	Data Type	Data Source
Livestock by type	Number of animals by type (t)	User input	NA
Management System	The type of manure management system (s) used to treat the manure	User selection	NA
Emission factors by livestock type	Annual emissions per animal by livestock type (i.e., cattle, swine, horses and ponies, mules and donkeys, sheep, goats, and chickens) in Minnesota (CO_2e/head) by system (s) type	Default	Cool Farm Tool, COMET Farm, EPA US Greenhouse Gas Inventory, EQB Feedlot GHG Calculator
Annual GHG Emissions	Annual GHG emissions from manure management (CO_2e)	Calculated	Equation 29

Limitations and Assumptions

A variety of factors impact emissions from manure management, including species type, livestock diet, temperature, and management practices. For the purposes of this tool, emission factors for each livestock type will be derived by dividing emissions estimates from manure management by manure management system for the state of Minnesota by total livestock head (by type). Since the number of animals may change from year to year, the tool will allow flexibility to enter the number of livestock by year or an annual average. This calculation does not include emissions or offsets from the application of manure as fertilizer for crop production or other uses.

Appendix A: Acronyms

BOD	Biological oxygen demand
Btu	British Thermal Unit
CBECS	Commercial Buildings Energy Consumption Survey
CH_4	Methane
CO_2	Carbon dioxide
EAW	Environmental assessment worksheet
EIA	Energy Information Administration
EPD	Environmental product declaration
GHG	Greenhouse gas
GJ	gigajoule
GREET	Greenhouse Gases, Regulated Emissions, and Energy Use in Technologies
GWP	global warming potential
HFC	Hydrofluorocarbon
IPCC	Intergovernmental Panel on Climate Change
kg	kilogram
kWh	kilowatt-hour
LCA	Lifecycle assessment
MECS	Manufacturing Energy Consumption Survey
MICE	Minnesota Infrastructure Carbon Estimator
MOVES	Motor Vehicle Emission Simulator
MT	metric ton
MWh	megawatt hour
N_2O	Nitrous oxide
NA	Not applicable
RECS	Residential Energy Consumption Survey
SF_6	Sulfur hexafluoride
SIT	State Inventory Tool
TBD	To be determined
WARM	Waste Reduction Model

Appendix B: Data Sources

Argonne National Laboratory (2024) *The Greenhouse Gases, Regulated Emissions, and Energy Use in Technologies (GREET®) Model*. Available at: https://greet.anl.gov/

C-Change Labs (2024) *Embodied Carbon in Construction Calculator (EC3) Tool*. Available at: https://buildingtransparency.org/ec3 (Accessed: 9 August 2024).

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One Click LCA (2024) *One Click LCA*. Available at: https://oneclicklca.com/en-us/

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U.S. Energy Information Administration (EIA) (2018) *Manufacturing Energy Consumption Survey (MECS)*. Available at: https://www.eia.gov/consumption/manufacturing/

U.S. Environmental Protection Agency (EPA) (2024). Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2022 U.S. Environmental Protection Agency, EPA 430R-24004. Available at: https://www.epa.gov/system/files/documents/2024-04/us-ghg-inventory-2024-main-text_04-18-2024.pdf

U.S. Environmental Protection Agency (EPA) (2024) *GHG Emission Factors Hub*. Available at: https://www.epa.gov/climateleadership/ghg-emission-factors-hub

U.S. Environmental Protection Agency (EPA) (2024) *Local Greenhouse Gas Inventory Tool*. Available at: https://www.epa.gov/statelocalenergy/local-greenhouse-gas-inventory-tool

U.S. Environmental Protection Agency (EPA) (2024) *State Inventory and Projection Tool*. Available at: https://www.epa.gov/statelocalenergy/state-inventory-and-projection-tool

U.S. Environmental Protection Agency (EPA) (2023) *MOVES4 (Version 4.0.1): Latest Version of Motor Vehicle Emission Simulator*. Available at: https://www.epa.gov/moves/latest-version-motor-vehicle-emission-simulator-moves

U.S. Environmental Protection Agency (EPA) (2023) Waste Reduction Model (WARM), Version 16. Available at https://www.epa.gov/warm.

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Appendix C: Applicability of Emission Sources

The following table summarizes the emission sources that were considered for inclusion in this tool and an assessment of applicability to each mandatory project category. The actual applicability of each emissions source will vary based on the specific characteristics of a given project. Emission sources that are not currently included in the tool but are anticipated to be a significant source of emissions should also be assessed by project developers to the extent possible.

Emission Source	Subp. 2, Nuclear fuels and nuclear waste	Subp. 3, Electric-generating facilities	Subp. 4, Petroleum Refineries	Subp. 5, Fuel conversion Facilities	Subp. 6, Transmission lines
Construction					
Material inputs	X	X	X	X	X
Transportation of material inputs	X	X	X	X	X
Employee commuting	X	X	X	X	X
Construction equipment	X	X	X	X	X
On-site energy	X	X	X	X	X
Land use change	X	X	X	X	X
Transportation and treatment of waste off-site	X	X	X	X	X
Operation					
Material inputs	-	-	-	-	-
Transportation of material inputs	-	-	-	-	-
Building energy consumption	X	X	X	X	
Fugitive emissions from coal				X	
Fugitive emissions from natural gas and petroleum systems			X		
Emissions from natural gas and oil products			X		
Industrial process emissions					
Electric power transmission and distribution					-
HFC leakage		X	X	X	
Land use change					
Routine maintenance		-	-	-	-
Employee commuting	-	-	-	-	-
Change in vehicle operation/aircraft usage/watercraft operation					
Treatment of waste on-site				X	
Treatment of wastewater on-site					
Transportation and treatment of waste off-site	X	X	X	X	
Enteric fermentation					
Manure management				X	
Decommissioning					
On-site energy	-	-	-	-	-
Employee commuting	-	-	-	-	-
Demolition equipment	-	-	-	-	-
Land use change	-	-	-	-	-
Transportation and treatment of waste off-site	-	-	-	-	-

Included in Tool (priority)	X
Included in Tool (lower priority)	X
Not included in Tool	-
Not Applicable	

Emission Source	Subp. 7, Pipelines	Subp. 8, Transfer facilities	Subp. 9, Underground storage	Subp. 10, Storage facilities	Subp. 11, Metallic mineral mining and processing	Subp. 12, Nonmetallic mineral mining
Construction						
Material inputs	X	X	X	X	X	X
Transportation of material inputs	X	X	X	X	X	X
Employee commuting	X	X	X	X	X	X
Construction equipment	X	X	X	X	X	X
On-site energy	X	X	X	X	X	X
Land use change	X	X	X	X	X	X
Transportation and treatment of waste off-site	X	X	X	X	X	X
Operation						
Material inputs	-	-	-	-	-	-
Transportation of material inputs	-	-	-	-	-	-
Building energy consumption		X		X	X	X
Fugitive emissions from coal	X	X		X		
Fugitive emissions from natural gas and petroleum systems	X		X	X		
Emissions from natural gas and oil products	X					
Industrial process emissions					X	X
Electric power transmission and distribution						
HFC leakage		X		X	X	
Land use change					X	X
Routine maintenance	-	-			-	-
Employee commuting		-		-	-	-
Change in vehicle operation/aircraft usage/watercraft operation						
Treatment of waste on-site						
Treatment of wastewater on-site						
Transportation and treatment of waste off-site		X		X	X	X
Enteric fermentation						
Manure management						
Decommissioning						
On-site energy	-	-	-	-	-	-
Employee commuting	-	-	-	-	-	-
Demolition equipment	-	-	-	-	-	-
Land use change	-	-	-	-	-	-
Transportation and treatment of waste off-site	-	-	-	-	-	-

Included in Tool (priority)	X
Included in Tool (lower priority)	X
Not included in Tool	-
Not Applicable	

Emission Source	Subp. 13, Paper or pulp processing mills	Subp. 14, Industrial, commercial, institutional facilities	Subp. 15, Air pollution	Subp. 16, Hazardous waste	Subp. 17, Solid waste	Subp. 18, Wastewater
Construction						
Material inputs	X	X	X	X	X	X
Transportation of material inputs	X	X	X	X	X	X
Employee commuting	X	X	X	X	X	X
Construction equipment	X	X	X	X	X	X
On-site energy	X	X	X	X	X	X
Land use change	X	X	X	X	X	X
Transportation and treatment of waste off-site	X	X	X	X	X	X
Operation						
Material inputs	-	-	-	-	-	-
Transportation of material inputs	-	-	-	-	-	-
Building energy consumption	X	X	X	X	X	X
Fugitive emissions from coal						
Fugitive emissions from natural gas and petroleum systems						
Emissions from natural gas and oil products						
Industrial process emissions	X		X			
Electric power transmission and distribution						
HFC leakage	X	X				
Land use change						
Routine maintenance						
Employee commuting	-	-	-	-	-	-
Change in vehicle operation/aircraft usage/watercraft operation		X				
Treatment of waste on-site				X	X	
Treatment of wastewater on-site	X	X				X
Transportation and treatment of waste off-site	X	X	X			
Enteric fermentation						
Manure management						
Decommissioning						
On-site energy	-	-	-	-	-	-
Employee commuting	-	-	-	-	-	-
Demolition equipment	-	-	-	-	-	-
Land use change	-	-	-	-	-	-
Transportation and treatment of waste off-site	-	-	-	-	-	-

Included in Tool (priority)	X
Included in Tool (lower priority)	X
Not included in Tool	-
Not Applicable	

Emission Source	Subp. 19, Residential Development	Subp. 19a, Residential Development in shoreland outside of the Twin Cities	Subp. 20, Campgrounds and RV Parks	Subp. 20a, Resorts, campgrounds, and RV parks in shorelands	Subp. 21, Airport projects
Construction					
Material inputs	X	X	X	X	X
Transportation of material inputs	X	X	X	X	X
Employee commuting	X	X	X	X	X
Construction equipment	X	X	X	X	X
On-site energy	X	X	X	X	X
Land use change	X	X	X	X	X
Transportation and treatment of waste off-site	X	X	X	X	X
Operation					
Material inputs	-	-	-	-	-
Transportation of material inputs	-	-	-	-	-
Building energy consumption	X	X	X	X	
Fugitive emissions from coal					
Fugitive emissions from natural gas and petroleum systems					
Emissions from natural gas and oil products					
Industrial process emissions					
Electric power transmission and distribution					
HFC leakage	X	X	X	X	
Land use change					
Routine maintenance	-	-	-	-	-
Employee commuting					
Change in vehicle operation/aircraft usage/watercraft operation	X	X	X	X	-
Treatment of waste on-site					
Treatment of wastewater on-site					
Transportation and treatment of waste off-site	X	X	X	X	
Enteric fermentation					
Manure management					
Decommissioning					
On-site energy	-	-	-	-	-
Employee commuting	-	-	-	-	-
Demolition equipment	-	-	-	-	-
Land use change	-	-	-	-	-
Transportation and treatment of waste off-site	-	-	-	-	-

Included in Tool (priority)	X
Included in Tool (lower priority)	X
Not included in Tool	-
Not Applicable	

Emission Source	Subp. 22, Highway projects	Subp. 23, Barge fleeting	Subp. 24, Water appropriation and impoundments	Subp. 25, Marinas	Subp. 26, Stream diversion	Subp. 27, Wetlands and public waters
Construction						
Material inputs	X	X	X	X	X	X
Transportation of material inputs	X	X	X	X	X	X
Employee commuting	X	X	X	X	X	X
Construction equipment	X	X	X	X	X	X
On-site energy	X	X	X	X	X	X
Land use change	X		X		X	X
Transportation and treatment of waste off-site	X	X	X	X	X	X
Operation						
Material inputs	-	-	-	-	-	-
Transportation of material inputs	-	-	-	-	-	-
Building energy consumption						
Fugitive emissions from coal						
Fugitive emissions from natural gas and petroleum systems						
Emissions from natural gas and oil products						
Industrial process emissions						
Electric power transmission and distribution						
HFC leakage						
Land use change						
Routine maintenance	-	-	-	-	-	-
Employee commuting						
Change in vehicle operation/aircraft usage/watercraft operation	X	-		-		
Treatment of waste on-site						
Treatment of wastewater on-site						
Transportation and treatment of waste off-site						
Enteric fermentation						
Manure management						
Decommissioning						
On-site energy	-	-	-	-		
Employee commuting	-	-	-	-		
Demolition equipment	-	-	-	-		
Land use change	-	-	-	-		
Transportation and treatment of waste off-site	-	-	-	-		

Included in Tool (priority)	X
Included in Tool (lower priority)	X
Not included in Tool	-
Not Applicable	

Emission Source	Subp. 28, Forestry	Subp. 29, Animal feedlots	Subp. 30, Natural areas	Subp. 31, Historical places	Subp. 32, Mixed residential and industrial-commercial projects	Subp. 33, Communications towers
Construction						
Material inputs		X			X	X
Transportation of material inputs		X			X	X
Employee commuting	X	X		X	X	X
Construction equipment	X	X		X	X	X
On-site energy	X	X		X	X	X
Land use change	X	X	X	X	X	X
Transportation and treatment of waste off-site	X	X		X	X	X
Operation						
Material inputs		-			-	-
Transportation of material inputs		-			-	-
Building energy consumption		X			X	
Fugitive emissions from coal						
Fugitive emissions from natural gas and petroleum systems						
Emissions from natural gas and oil products						
Industrial process emissions						
Electric power transmission and distribution						
HFC leakage					X	
Land use change						
Routine maintenance	-	-	-		-	-
Employee commuting		-			-	-
Change in vehicle operation/aircraft usage/watercraft operation					X	
Treatment of waste on-site						
Treatment of wastewater on-site						
Transportation and treatment of waste off-site		X			X	
Enteric fermentation		X				
Manure management		X				
Decommissioning						
On-site energy		-			-	-
Employee commuting		-			-	-
Demolition equipment		-			-	-
Land use change		-			-	-
Transportation and treatment of waste off-site		-			-	-

Included in Tool (priority)	X
Included in Tool (lower priority)	X
Not included in Tool	-
Not Applicable	

Emission Source	Subp. 34, Sports or entertainment facilities	Subp. 35, Release of genetically engineered organisms	Subp. 36, Land use conversion, including golf courses	Subp. 36a, Land conversions in shoreland	Subp. 37, Recreational trails
Construction					
Material inputs	X		X	X	X
Transportation of material inputs	X		X	X	X
Employee commuting	X		X	X	X
Construction equipment	X		X	X	X
On-site energy	X		X	X	X
Land use change	X		X	X	X
Transportation and treatment of waste off-site	X		X	X	X
Operation					
Material inputs	-		-	-	-
Transportation of material inputs	-		-	-	-
Building energy consumption	X		X	X	
Fugitive emissions from coal					
Fugitive emissions from natural gas and petroleum systems					
Emissions from natural gas and oil products					
Industrial process emissions					
Electric power transmission and distribution					
HFC leakage	X		X	X	
Land use change					
Routine maintenance	-		-	-	-
Employee commuting	-		-	-	
Change in vehicle operation/aircraft usage/watercraft operation	X		X	X	X
Treatment of waste on-site					
Treatment of wastewater on-site					
Transportation and treatment of waste off-site	X		X	X	
Enteric fermentation					
Manure management					
Decommissioning					
On-site energy	-		-	-	
Employee commuting	-		-	-	
Demolition equipment	-		-	-	
Land use change	-		-	-	
Transportation and treatment of waste off-site	-		-	-	

Included in Tool (priority)	X
Included in Tool (lower priority)	X
Not included in Tool	-
Not Applicable	