

Greenhouse Gas Emissions Calculation Estimates - Project Construction

Assumed Schedule (27 Months)	
Trailer Mob	days
Civil	6 Months
Foundations	4 Months
Steel/Envelope/Mechanical	12 Months
Equipment Install	5 Months

Construction Trailer Mobilization, Survey, General Labour

Construction period:	0	Months
Total work days:	4	Days
Hours worked per day:	10	Hours per day
Total equipment useage time:	40	Hours

Emission Equipment	#	Fuel Usage (L/h)	Emission Factors (g/L)			Assumptions	Emission Estimates (tonnes)			
			CO ₂	CH ₄	N ₂ O		CO ₂	CH ₄	N ₂ O	CO _{2e}
¹ Semi-Trailer truck (moving trailers)	2	40	2680.5	0.14	0.082	Table A6.1-14 HDDV, moderate control	9	4.48E-04	2.62E-04	9
² Pick-up support truck/van	2	17	2680.5	0.14	0.082	Table A6.1-14 HDDV, moderate control	4	1.90E-04	1.12E-04	4
TOTALS							12	6.38E-04	3.74E-04	12

NOTES:

1 Fuel usage - NRCAN's average fuel efficiency was utilized for semi-trailer truck - 39.5L/100 km. <https://www.nrcan.gc.ca/energy/efficiency/transportation/commercial-vehicles/reports/7607>. Assuming 100 km would be equivalent to an hour of operation based on average highway speed of 100km/h.

2 Fuel usage for pick-up trucks - US Department of Energy. Took the average of the highest and lowest mileage rates, and averaged. 18 mpg (3.8 mL, 6KM/L, 16.7L/100KM). Assuming 100 km would be equivalent to an hour of operation based on average highway speeds of 100km/h. https://www.fueleconomy.gov/feg/byclass/Standard_Pickup_Trucks_4WD2021.shtml

Estimated GHG Emissions for On-Site Construction Equipment - Services & Excavations

Construction period:	6	Months	*Assumes 4 weeks in a month, 4 days a week
Total work days:	96	Days	
Hours worked per day:	12	Hours per day	
Total equipment useage time:	1152	Hours	

Emission Equipment	#	Fuel Usage (L/h)	Emission Factors (g/L)			Assumptions	Emission Estimates (tonnes)			
			CO ₂	CH ₄	N ₂ O		CO ₂	CH ₄	N ₂ O	CO _{2e}
¹ Dump Trucks	4	53	2680.5	0.14	0.082	Table A6.1-14 HDDV, moderate control	655	3.42E-02	2.00E-02	661
² Semi-Trailer truck and float	1	40	2680.5	0.14	0.082	Table A6.1-14 HDDV, moderate control	124	6.45E-03	3.78E-03	125
¹ Compactor/Roller	1	51	2680.5	0.14	0.082	Table A6.1-14 HDDV, moderate control	157	8.23E-03	4.82E-03	159
¹ Loaders	1	8	2680.5	0.073	0.022	Table A6.1-14 Offroad Diesel (Tier 1-3)	25	6.73E-04	2.03E-04	25
¹ Bulldozers	1	8	2680.5	0.073	0.022	Table A6.1-14 Offroad Diesel (Tier 1-3)	25	6.73E-04	2.03E-04	25
¹ Tracked Excavators	3	13	2680.5	0.073	0.022	Table A6.1-14 Offroad Diesel (Tier 1-3)	120	3.28E-03	9.88E-04	121
³ Micro-Tunneling Machine	1	150	2680.5	0.073	0.022	Table A6.1-14 Offroad Diesel (Tier 1-3)	463	1.26E-02	3.30E-06	464
⁴ Drill Rigs	1	40	2680.5	0.073	0.022	Table A6.1-14 Offroad Diesel (Tier 1-3)	124	3.36E-03	8.80E-07	124
TOTALS							1692	6.95E-02	3.00E-02	1703

NOTES:

- 1 Fuel usage - Caterpillar Performance Handbook (Edition 29) was used; assumed mid-range, normal load/haul times - with exception to dump trucks, which were assumed mid range, short to medium haul
 - 2 Fuel usage - Fuel usage - NRCAN's average fuel efficiency was utilized for semi-trailer truck - 39.5L/100 km. <https://www.nrcan.gc.ca/energy/efficiency/transportation/commercial-vehicles/reports/7607>. Assuming 100 km would be equivalent to an hour of operation based on average highway speed of 100km/h.
 - 3 No fuel efficiency reference found. Assumed it was 3X that of highest fuel usage 'equipment' established for this project (i.e., dump truck).
 - 4 No fuel efficiency reference found. Assumed the same as semi-trail truck and float (i.e., 40 L/h).
- Assumes equipment is in operation 100% of the time during the hours worked per day

Emission Factors obtained from Environment Canada's National Inventory Report (1990-2013) of Greenhouse Gas Sources and Sinks in Canada (ISSN: 1719-0487)

Estimated GHG Emissions for On-Site Construction Equipment - Structural Foundations

Construction period:	4	Months	
Total work days:	64	Days	*Assumes 4 weeks in a month, 4 days a week
Hours worked per day:	12	Hours per day	
Total equipment useage time:	768	Hours	

Emission Equipment	#	Fuel Usage (L/h)	Emission Factors (g/L)			Assumptions	Emission Estimates (tonnes)			
			CO ₂	CH ₄	N ₂ O		CO ₂	CH ₄	N ₂ O	CO _{2e}
¹ Crawler Crane (27t to 400t) equipped	1	50	2680.5	0.073	0.022	Table A6.1-14 Offroad Diesel (Tier 1-3)	103	2.80E-03	8.45E-04	103
¹ Carry Deck (8 to 22 t)	1	50	2680.5	0.073	0.022	Table A6.1-14 Offroad Diesel (Tier 1-3)	103	2.80E-03	8.45E-04	103
² Semi-Trailer Truck and Float	2	40	2680.5	0.14	0.082	Table A6.1-14 HDDV, moderate control	165	8.60E-03	5.04E-03	166
³ Welding Truck	2	17	2680.5	0.14	0.082	Table A6.1-14 HDDV, moderate control	70	3.66E-03	2.14E-03	71
⁴ Forklift / Loader	1	8	2680.5	0.073	0.022	Table A6.1-14 Offroad Diesel (Tier 1-3)	16	4.49E-04	1.35E-04	17
⁵ Concrete Truck	4	40	2680.5	0.14	0.082	Table A6.1-14 HDDV, moderate control	329	1.72E-02	1.01E-02	333
⁵ Concrete Pumper Truck	2	40	2680.5	0.14	0.082	Table A6.1-14 HDDV, moderate control	165	8.60E-03	5.04E-03	166
⁶ Concrete Pumps and Vibratory Equiprr	4	6	2680.5	0.14	0.082	Table A6.1-14 HDDV, moderate control	49	2.58E-03	1.51E-03	50
TOTALS							1000	4.67E-02	2.56E-02	1009

NOTES:

- 1 No fuel efficiency reference found. Estimated near the highest fuel usage 'equipment' established for this Project (i.e., dump truck).
 - 2 Fuel usage - Fuel usage - NRCAN's average fuel efficiency was utilized for semi-trailer truck - 39.5L/100 km. <https://www.nrcan.gc.ca/energy/efficiency/transportation/commercial-vehicles/reports/7607>. Assuming 100 km would be equivalent to an hour of operation based on average highway speed of 100km/h.
 - 3 Fuel usage for pick-up trucks - US Department of Energy. Took the average of the highest and lowest mileage rates, and averaged. 18 mpg (3.8 mL, 6KM/L, 16.7L/100KM). Assuming 100 km would be equivalent to an hour of operation based on average highway speeds of 100km/h. https://www.fueleconomy.gov/feg/byclass/Standard_Pickup_Trucks_4WD2021.shtml
 - 4 Fuel usage - Caterpillar Performance Handbook (Edition 29) was used; assumed mid-range, normal load/haul times - with exception to dump trucks, which were assumed mid range, short to medium haul
 - 5 Assumes a fuel efficiency same of semi-trail truck (see note 3)
 - 6 Assumes same efficiency as compressor (Compressor Fuel Efficiency: <http://www.americawestdrillingsupply.com/Downloads/Compressors/Portable%20Compressors%20Full%20Line.pdf>)
- Assumes equipment is in operation 100% of the time during the hours worked per day
- Emission Factors obtained from Environment Canada's National Inventory Report (1990-2013) of Greenhouse Gas Sources and Sinks in Canada (ISSN: 1719-0487)

Estimated GHG Emissions for On-Site Construction Equipment - Steel Member and Building Envelope & Mechanical Installation

Construction period:	12	Months	
Total work days:	192	Days	*Assumes 4 weeks in a month, 4 days a week
Hours worked per day:	12	Hours per day	
Total equipment useage time:	2304	Hours	

Emission Equipment	#	Fuel Usage (L/h)	Emission Factors (g/L)			Assumptions	Emission Estimates (tonnes)			
			CO ₂	CH ₄	N ₂ O		CO ₂	CH ₄	N ₂ O	CO _{2e}
¹ Semi-Trailer Truck and Trailer	2	40	2680.5	0.14	0.082	Table A6.1-14 HDDV, moderate control	494	2.58E-02	1.51E-02	499
¹ Semi-Trailer Truck and Float	2	40	2680.5	0.14	0.082	Table A6.1-14 HDDV, moderate control	494	2.58E-02	1.51E-02	499
² Crane (110 to 650 t)	1	50	2680.5	0.073	0.022	Table A6.1-14 Offroad Diesel (Tier 1-3)	309	8.41E-03	2.53E-03	310
² Truck Crane (40t to 90 t)	1	50	2680.5	0.073	0.022	Table A6.1-14 Offroad Diesel (Tier 1-3)	309	8.41E-03	2.53E-03	310
³ Hydraulic Boom Truck (10 t to 40 t)	1	40	2680.5	0.14	0.082	Table A6.1-14 HDDV, moderate control	247	1.29E-02	7.56E-03	250
⁴ Welding Truck	2	17	2680.5	0.14	0.082	Table A6.1-14 HDDV, moderate control	210	1.10E-02	6.42E-03	212
⁵ Self Propelled Elevating Work Platform	2	8	2753	0.026	0.031	Table A6.1-5 Light Fuel Oil, Forestry/Construction	101	9.58E-04	1.14E-03	102
⁶ Forklift / Loader	1	8	2680.5	0.073	0.022	Table A6.1-14 Offroad Diesel (Tier 1-3)	49	1.35E-03	4.06E-04	50
TOTALS							2214	9.46E-02	5.08E-02	2231

NOTES:

- 1 Fuel usage - NRCAN's average fuel efficiency was utilized for semi-trailer truck - 39.5L/100 km. <https://www.nrcan.gc.ca/energy/efficiency/transportation/commercial-vehicles/reports/7607>. Assuming 100 km would be equivalent to an hour of operation based on average highway speed of 100km/h.
- 2 No fuel efficiency reference found. Estimated near the highest fuel usage 'equipment' established for this Project (ie., dump truck).
- 3 Assumes a fuel efficiency same of semi-trail truck (see note 1)
- 4 - Assumes the same fuel efficiency as those identified for pick-up trucks -US Department of Energy. Took the average of the highest and lowest mileage rates, and averaged. 18 mpg (3.8 mL, 6KM/L, 16.7L/100KM). Assuming 100 km would be equivalent to an hour of operation based on average highway speeds of 100km/h. https://www.fueleconomy.gov/feg/byclass/Standard_Pickup_Trucks_4WD2021.shtml
- 5 Assumes same fuel efficiency as a loader (see note #6)
- 6 Diesel Fuel Efficiency of Forklift: <http://www.yale.com/emea/en-gb/our-products/product-overview/internal-combustion-trucks/diesel-lpg-forlift-truck-2000-3500kg/>
- Assumes equipment is in operation 100% of the time during the hours worked per day
- Emission Factors obtained from Environment Canada's National Inventory Report (1990-2013) of Greenhouse Gas Sources and Sinks in Canada (ISSN: 1719-0487)

Estimated GHG Emissions for On-Site Construction Equipment - Equipment Installation

Construction period:	<input type="text" value="5"/>	Months	
Total work days:	<input type="text" value="80"/>	Days	*Assumes 4 weeks in a month, 4 days a week
Hours worked per day:	<input type="text" value="12"/>	Hours per day	
Total equipment useage time:	<input type="text" value="960"/>	Hours	

Emission Equipment	#	Fuel Usage (L/h)	Emission Factors (g/L)			Assumptions	Emission Estimates (tonnes)			
			CO ₂	CH ₄	N ₂ O		CO ₂	CH ₄	N ₂ O	CO _{2e}
¹ Semi-Trailer Truck and Trailer	2	40	2680.5	0.14	0.082	Table A6.1-14 HDDV, moderate control	206	1.08E-02	6.30E-03	208
² Container Handler	1	8	2680.5	0.073	0.022	Table A6.1-14 Offroad Diesel (Tier 1-3)	21	5.61E-04	1.69E-04	21
¹ Semi-Trailer Truck and Tiltbed Trailer	1	40	2680.5	0.14	0.082	Table A6.1-14 HDDV, moderate control	103	5.38E-03	3.15E-03	104
¹ Semi-Trailer Truck and flatbed Trailer	1	40	2680.5	0.14	0.082	Table A6.1-14 HDDV, moderate control	103	5.38E-03	3.15E-03	104
³ Rough Terrain Crane (130 t)	1	50	2680.5	0.073	0.022	Table A6.1-14 Offroad Diesel (Tier 1-3)	129	3.50E-03	1.06E-03	129
³ Crawler Crane (100 t)	1	50	2680.5	0.073	0.022	Table A6.1-14 Offroad Diesel (Tier 1-3)	129	3.50E-03	1.06E-03	129
⁴ Transporter	1	8	2680.5	0.073	0.022	Table A6.1-14 Offroad Diesel (Tier 1-3)	21	5.61E-04	1.69E-04	21
³ Crane (50 t)	1	50	2680.5	0.073	0.022	Table A6.1-14 Offroad Diesel (Tier 1-3)	129	3.50E-03	1.06E-03	129
³ Rough Terrain Crane (150 t)	1	50	2680.5	0.073	0.022	Table A6.1-14 Offroad Diesel (Tier 1-3)	129	3.50E-03	1.06E-03	129
³ Hydraulic Crane (500 t)	1	50	2680.5	0.073	0.022	Table A6.1-14 Offroad Diesel (Tier 1-3)	129	3.50E-03	1.06E-03	129
⁵ Warehouse forklift	1	8	2680.5	0.073	0.022	Table A6.1-14 Offroad Diesel (Tier 1-3)	21	5.61E-04	1.69E-04	21
⁶ Self-propelled elevating work platform	1	8	2753	0.026	0.031	Table A6.1-5 Light Fuel Oil, Forestry/Construction	21	2.00E-04	2.38E-04	21
⁷ Telehandler	1	12	2753	0.026	0.031	Table A6.1-5 Light Fuel Oil, Forestry/Construction	32	3.00E-04	3.57E-04	32
TOTALS							1170	4.12E-02	1.90E-02	1176

NOTES:

- 1 Fuel usage - NRCAN's average fuel efficiency was utilized for semi-trailer truck - 39.5L/100 km. <https://www.nrcan.gc.ca/energy/efficiency/transportation/commercial-vehicles/reports/7607>. Assuming 100 km would be equivalent to an hour of operation based on average highway speed of 100km/h.
 - 2 Assumes the same efficiency as a loader/ Diesel Fuel Efficiency of Forklift: <http://www.yale.com/emea/en-gb/our-products/product-overview/internal-combustion-trucks/diesel-lpg-forklift-truck-2000-3500kg/>
 - 3 No fuel efficiency reference found. Estimated near the highest fuel usage 'equipment' established for this Project (ie., dump truck).
 - 4 Assuming same fuel efficiency as a forklift (see note 5 below)
 - 5 Diesel Fuel Efficiency of Forklift: <http://www.yale.com/emea/en-gb/our-products/product-overview/internal-combustion-trucks/diesel-lpg-forklift-truck-2000-3500kg/>
 - 6 Assumes the same efficiency as a loader/ Diesel Fuel Efficiency of Forklift: <http://www.yale.com/emea/en-gb/our-products/product-overview/internal-combustion-trucks/diesel-lpg-forklift-truck-2000-3500kg/>
 - 7 Fuel usage for telehandler - CAT Performance Handbook, June 2018 - average of medium column
- Assumes equipment is in operation 100% of the time during the hours worked per day
 Emission Factors obtained from Environment Canada's National Inventory Report (1990-2013) of Greenhouse Gas Sources and Sinks in Canada (ISSN: 1719-0487)

Estimated GHG Emissions for On-Site Construction Equipment - General Construction Equipment

Construction period:	27 Months	
Total work days:	432 Days	<i>*Assumes 4 weeks in a month, 4 days a week</i>
Hours worked per day:	12 Hours per day	
Total equipment useage time:	5184 Hours	

Emission Equipment	#	Fuel Usage (L/h)	Emission Factors (g/L)			Assumptions	Emission Estimates (tonnes)			
			CO ₂	CH ₄	N ₂ O		CO ₂	CH ₄	N ₂ O	CO _{2e}
¹ Compressors	4	6	2753	0.026	0.031	Table A6.1-5 Light Fuel Oil, Forestry/Construction	343	3.23E-03	3.86E-03	344
² Pumps	4	6	2753	0.026	0.031	Table A6.1-5 Light Fuel Oil, Forestry/Construction	343	3.23E-03	3.86E-03	344
² Generators	4	6	2753	0.026	0.031	Table A6.1-5 Light Fuel Oil, Forestry/Construction	343	3.23E-03	3.86E-03	344
² Heaters	4	6	2753	0.026	0.031	Table A6.1-5 Light Fuel Oil, Forestry/Construction	343	3.23E-03	3.86E-03	344
² Lighting Plants	4	6	2753	0.026	0.031	Table A6.1-5 Light Fuel Oil, Forestry/Construction	343	3.23E-03	3.86E-03	344
³ Loader with Sweeper	1	9	2680.5	0.073	0.022	Table A6.1-14 Offroad Diesel (Tier 1-3)	125	3.41E-03	1.03E-03	125
TOTALS							1838	1.96E-02	2.03E-02	1844

NOTES:

- 1 Compressor Fuel Efficiency: <http://www.americawestdrillingsupply.com/Downloads/Compressors/Portable%20Compressors%20Full%20Line.pdf>
 - 2 Assumes same efficiency as compressor source as identified in note 1
 - 3 Fuel usage for loaders - CAT Performance Handbook, June 2018 - average of medium column
- Assumes equipment is in operation 100% of the time during the hours worked per day
 Emission Factors obtained from Environment Canada's National Inventory Report (1990-2013) of Greenhouse Gas Sources and Sinks in Canada (ISSN: 1719-0487)

Estimated GHG Emissions for Construction Workers Travelling to and From Work

Workers:	75 #	<i>*On average, 40-100 contractors on site, peak of 130. Using average.</i>
Construction period:	27 Months	
Total work days:	432 Days	<i>*Assumes 4 weeks in a month, 4 days a week.</i>
Vehicle occupants:	1 Workers per vehicle	
Average round trip distance:	75 km	
Total distance travelled:	2,430,000 km	
Gas consumed:	364,500 L	

Air Emission	EF (g/L)	Emissions (tonnes)
CO ₂	2307.3	841
CH ₄	0.23	8.38E-02
N ₂ O	0.47	1.71E-01
CO _{2e}		894

NOTES:

Assuming a 15L/100 km gas consumption based on the middle ground of the most and least fuel efficient vehicle

<http://oee.nrcan.gc.ca/fcr-rcf/public/index-e.cfm>

Emission Factors from EC NIR - Table A6.1-14 Assumes Tier I Light Duty Gasoline Vehicles (2004-2019)

Adjustment to Account for Assumption that all equipment would be running 100% of the time

	Total Emissions (tonnes)	% Adjustmnet Reduction	Total (tonnes)
Total Construction Equipment Emissions	7964	0.25	5972.887947
Travel Emissions	907	0	907
Total CO _{2e} Emissions for Construction Duration	N/A	N/A	6879

Other Notes

Global warming potentials from National Inventory Report 1990-2019 Greenhouse Gas Sources and Sinks in Canada, Canada's Submission to the United Nations Framework Convention on Climate Change, Part I.

https://publications.gc.ca/collections/collection_2021/eccc/En81-4-2019-1-eng.pdf

Greenhouse Gas Emissions Annual Calculation Estimates - Operation

Operational Activities

Electricity Requirements	4	MW/day
Electricity Requirements	1460	MW/year
Generation intensity*:	280	g CO _{2eq} per kWh
Electricity generation emissions:	1.12	tonnes CO _{2eq} per day
Electricity generation emissions**:	408.8	tonnes CO _{2eq} annually
Additional Operators	5	
Operator shifts per day	3	
Distance Travelled into work	75	km (roundtrip)
Sludge/Fibre Removal Frequency	182.5	Year (based on one every two days)
Distance from Mill to Envirem	240	km (roundtrip)

Emission Equipment	#	Fuel Usage (L/km)	Emission Factors (g/L)			Assumptions	Emission Estimates (tonnes)			
			CO ₂	CH ₄	N ₂ O		CO ₂	CH ₄	N ₂ O	CO _{2e}
¹ Additional Workers Travelling for Shift	1095	0.17	2680.5	0.14	0.082	Table A6.1-14 HDDV, moderate control	37.4231	0.0020	0.0011	37.8132
^{2,3} Sludge/Fiber Removal Delivery	182.5	0.4	2680.5	0.14	0.082	Table A6.1-14 HDDV, moderate control	5.0876	0.0003	0.0002	5.1406
⁴ Electricity Usage										408.8000
TOTALS (additional workers, sludge, & electricity only)							49	2.55E-03	1.49E-03	452

NOTES:

1 Fuel usage for pick-up trucks - US Department of Energy. Took the average of the highest and lowest mileage rates, and averaged. 18 mpg (3.8 mL, 6KM/L, 16.7L/100KM). Assuming 100 km would be equivalent to an hour of operation based on average highway speeds of 100km/h. https://www.fueleconomy.gov/feg/byclass/Standard_Pickup_Trucks_4WD2021.shtml

2 Not accounting for weight differences between drop off and return trip

3 Fuel usage - NRCAN's average fuel efficiency was utilized for semi-trailer truck - 39.5L/100 km. Assumed travel at 100km/hour (<https://www.nrcan.gc.ca/energy/efficiency/transportation/commercial-vehicles/reports/7607>)

4 Generation intensity factor from: <http://www.publications.gc.ca/site/eng/9.506002/publication.html>