

APPENDIX F: Greenhouse Gas Calculations



Table 1-1. Summary of Construction GHG Emissions

Emission Source	CO₂ (metric tons)	CH₄ (metric tons)	N₂O (metric tons)	CO₂e^[1] (metric tons)
Greenfield Construction	220.95	0.02	0.01	225.39
Install Second Circuit	1,454.32	0.11	0.09	1,480.50
Total	1,675.27	0.13	0.10	1,705.90
[1] CO ₂ e calculated from global warming potentials from the Intergovernmental Panel on Climate Change (IPCC), Fifth Assessment Report (AR5), 2013. The GWP for CO ₂ is 1, CH ₄ is 28, and N ₂ O is 265.				



Table 1-2. Summary of Operations GHG Emissions

Emission Source	CO₂ (metric tons/year)	CH₄ (metric tons/year)	N₂O (metric tons/year)	CO₂e^[1] (metric tons/year)
Operation and Maintenance Activities	11.11	1.15E-03	7.27E-04	11.34
[1] CO ₂ e calculated from global warming potentials from the Intergovernmental Panel on Climate Change (IPCC), Fifth Assessment Report (AR5), 2013. The GWP for CO ₂ is 1, CH ₄ is 28, and N ₂ O is 265.				



Table 2-1. Conversions

Unit	Amount	Unit
ton	2000	lbs
ton	0.907185	metric tons
ton	907.185	kg
ton	907185	grams
lb	0.453592	kg
lb	453.592	grams
MWh	1000	kWh
hectare	2.47105	acres
1 MJ	0.372506136	hp-h
US gallon (diesel) ^[1]	144.945	MJ
US gallon (diesel)	53.993	hp-h
US gallon (gasoline) ^[1]	126.833	MJ
US gallon (gasoline)	47.246	hp-h
US gallon (jet fuel) ^[2]	142.2	MJ
US gallon (jet fuel)	52.970	hp-h

[1] US Energy Information Administration, 2023.

<https://www.eia.gov/energyexplained/units-and-calculators/energy-conversion-calculators.php>

[2] [https://www.convertunits.com/from/MJ/to/gallon+\[U.S.\]+of+kerosene+type+jet+fuel#google_vignette](https://www.convertunits.com/from/MJ/to/gallon+[U.S.]+of+kerosene+type+jet+fuel#google_vignette)



Table 2-2. Global Warming Potentials

Greenhouse Gas Name	CAS Number	Chemical Formula	Global Warming Potential (100-yr.)
Carbon dioxide	124-38-9	CO ₂	1
Methane	74-82-8	CH ₄	28
Nitrous oxide	10024-97-2	N ₂ O	265
Sulfur Hexafluoride	2551-62-4	SF ₆	23,500
Intergovernmental Panel on Climate Change (IPCC), Fifth Assessment Report (AR5), 2013.			

Xcel Energy
Alexandria to Big Oaks 345 KV Transmission Line Project
GHG Calculations

Table 3-1. Construction Emissions from Mobile Combustion Sources - Greenfield

Equipment Type ^[1]	Number of Units ^[1]	Horsepower ^[1]	Total Operation Time (hr) ^[1]	Fuel Type ^[2]	CO ₂ Emission Factor ^[3] (kg/gal)	CH ₄ Emission Factor ^[4] (g/gal)	N ₂ O Emission Factor ^[4] (g/gal)	CO ₂ Emission Factor ^[5] (lb/hr)	CH ₄ Emission Factor ^[5] (lb/hr)	N ₂ O Emission Factor ^[5] (lb/hr)	CO ₂ (metric tons)	CH ₄ (metric tons)	N ₂ O (metric tons)	CO ₂ e ^[6] (metric tons)
ATV 4 TO 6 WHEEL, W/ DUMP	1	13.5	48	Gasoline (4 stroke) - Recreational	8.78	2.72	1.48	5.53	1.71E-03	9.32E-04	0.12	3.73E-05	2.03E-05	0.13
BACKHOE W/ LOADER 4X4	2	94	48	Diesel Equipment	10.21	1.01	0.94	39.19	3.88E-03	3.61E-03	0.85	8.44E-05	7.86E-05	0.88
BUCKET 105' WORK HEIGHT	2	300	320	Diesel Off-Road Trucks	10.21	0.91	0.56	125.07	1.11E-02	6.86E-03	18.15	1.62E-03	9.96E-04	18.46
BUCKET 125' WORK HEIGHT 8X6	1	350	320	Diesel Off-Road Trucks	10.21	0.91	0.56	145.91	1.30E-02	8.00E-03	21.18	1.89E-03	1.16E-03	21.54
CRANE TRUCK 45 T HYDRAULIC 6 AXLE	4	450	320	Diesel Equipment	10.21	1.01	0.94	187.60	1.86E-02	1.73E-02	27.23	2.69E-03	2.51E-03	27.97
DIGGER DERRICK 15 T CAP	3	330	320	Diesel Off-Road Trucks	10.21	0.91	0.56	137.57	1.23E-02	7.55E-03	19.97	1.78E-03	1.10E-03	20.31
DOZER 10 THRU 12 T, W/ WINCH	1	80	96	Diesel Equipment	10.21	1.01	0.94	33.35	3.30E-03	3.07E-03	1.45	1.44E-04	1.34E-04	1.49
DOZER 18 T W/ WINCH	3	190	96	Diesel Equipment	10.21	1.01	0.94	79.21	7.84E-03	7.29E-03	3.45	3.41E-04	3.18E-04	3.54
FORKLIFT 11,000 THRU 12,000# TELESCOPIC BOOM	2	142	160	Diesel Equipment	10.21	1.01	0.94	59.20	5.86E-03	5.45E-03	4.30	4.25E-04	3.96E-04	4.41
FRONT END LOADER 68,000# 4X4	2	386	160	Diesel Equipment	10.21	1.01	0.94	160.92	1.59E-02	1.48E-02	11.68	1.16E-03	1.08E-03	12.00
HYDRAULIC BULLWHEEL BUNDLE TENSIONER	1	80	30	Diesel Equipment	10.21	1.01	0.94	33.35	3.30E-03	3.07E-03	0.45	4.49E-05	4.18E-05	0.47
PULLER ROPE TRAILER 4,000# CAP W/ SPLIT REEL TOW TYPE TANDEM AXLE	1	74	30	Diesel Off-Road Trucks	10.21	0.91	0.56	30.85	2.75E-03	1.69E-03	0.42	3.74E-05	2.30E-05	0.43
PULLER CABLE TRAILER 30,000# CAP TOW TYPE TANDEM AXLE	1	400	30	Diesel Off-Road Trucks	10.21	0.91	0.56	166.76	1.49E-02	9.15E-03	2.27	2.02E-04	1.24E-04	2.31
PULLER ROPE TRAILER 4 DRUM 3,500# CAP TOW TYPE TANDEM AXLE	1	115	30	Diesel Off-Road Trucks	10.21	0.91	0.56	47.94	4.27E-03	2.63E-03	0.65	5.81E-05	3.58E-05	0.66
300T AT Setting Crane	1	577	150	Diesel Equipment	10.21	1.01	0.94	240.55	2.38E-02	2.21E-02	16.37	1.62E-03	1.51E-03	16.81
60T RT Crane	2	320	160	Diesel Equipment	10.21	1.01	0.94	133.41	1.32E-02	1.23E-02	9.68	9.58E-04	8.91E-04	9.94
SKID STEER LOADER TRACK MTD 80 > 75 HP	3	95	160	Diesel Equipment	10.21	1.01	0.94	39.60	3.92E-03	3.65E-03	2.87	2.84E-04	2.65E-04	2.95
DUMP BOX TRUCK 2-1/2 T 6X6	2	505	80	Diesel Off-Road Trucks	10.21	0.91	0.56	210.53	1.88E-02	1.15E-02	7.64	6.81E-04	4.19E-04	7.77
DUMP BOX TRUCK 1-1/4 & 1-1/2 T	2	420	160	Diesel Off-Road Trucks	10.21	0.91	0.56	175.09	1.56E-02	9.60E-03	12.71	1.13E-03	6.97E-04	12.92
FLATBED (FRAMING) TRUCK 1-1/4 & 1-1/2 T	4	420	160	Diesel Off-Road Trucks	10.21	0.91	0.56	175.09	1.56E-02	9.60E-03	12.71	1.13E-03	6.97E-04	12.92
PICKUP TRUCK 3/4 T	14	420	320	Diesel Off-Road Trucks	10.21	0.91	0.56	175.09	1.56E-02	9.60E-03	25.41	2.27E-03	1.39E-03	25.85
Helicopter	1	370	194	Jet Fuel	9.75	0.00	0.30	150.14	0.00E+00	4.62E-03	13.21	0.00E+00	4.07E-04	13.32
TRUCK TRACTOR 2-1/2 T 6X4 & 5 T 6X6	7	450	96	Diesel Off-Road Trucks	10.21	0.91	0.56	187.60	1.67E-02	1.03E-02	8.17	7.28E-04	4.48E-04	8.31
TOTAL	--	--	--	--	--	--	--	--	--	--	220.95	1.93E-02	1.47E-02	225.39

[1] Information provided by Xcel on 8/16/2023. Helicopter horsepower was estimated based on 206B-3 Jet Ranger, <https://www.helis.com/database/model/Bell-206B-3/>.

[2] Fuel type assumed based on equipment type.

[3] CO₂ emissions calculated using the EPA CCCL emission factors for mobile combustion, Table 2: Mobile Combustion CQ 2024. <https://www.epa.gov/system/files/documents/2024-02/ghg-emission-factors-hub-2024.pdf>

Fuel Type	CO ₂ Emission Factor (kg/gal)
Diesel Fuel	10.21
Motor Gasoline	8.78
Kerosene-Type Jet Fuel	9.75

[4] CH₄ and N₂O emissions calculated using the EPA CCCL emission factors for construction/mining equipment, Table 5: Mobile Combustion CH₄ and N₂O for Non-Road Vehicles, 2024. <https://www.epa.gov/system/files/documents/2024-02/ghg-emission-factors-hub-2024.pdf>

Vehicle Type	Fuel Type	CH ₄ Emission Factor (g/gal)	N ₂ O Emission Factor (g/gal)
Construction/Mining Equipment	Diesel Equipment	1.01	0.94
Construction/Mining Equipment	Diesel Off-Road Trucks	0.91	0.56
Recreational Equipment	Gasoline (4 stroke) - Recreational	2.72	1.48
Aircraft	Jet Fuel	-	0.30

[5] Emission factors converted to lb/hr using conversion rates of 53.993 hp-hr/gal for diesel and jet fuel, and 47.246 hp-hr/gal for gasoline.

[6] CO₂e calculated from global warming potentials from the Intergovernmental Panel on Climate Change (IPCC), Fifth Assessment Report (AR5), 2013. The GWP for CO₂ is 1, CH₄ is 28, and N₂O is 265.

Xcel Energy
Alexandria to Big Oaks 345 KV Transmission Line Project
GHG Calculations

Table 3-2. Construction Emissions from Mobile Combustion Sources - Second Circuit Install

Equipment Type ^[1]	Number of Units ^[1]	Horsepower ^[1]	Total Operation Time (hr) ^[1]	Fuel Type ^[2]	CO ₂ Emission Factor ^[3] (kg/gal)	CH ₄ Emission Factor ^[4] (g/gal)	N ₂ O Emission Factor ^[4] (g/gal)	CO ₂ Emission Factor ^[5] (lb/hr)	CH ₄ Emission Factor ^[5] (lb/hr)	N ₂ O Emission Factor ^[5] (lb/hr)	CO ₂ (metric tons)	CH ₄ (metric tons)	N ₂ O (metric tons)	CO ₂ e ^[6] (metric tons)
ATV 4 TO 6 WHEEL, W/ DUMP	1	13.5	264	Gasoline (4 stroke) - Recreational	8.78	2.72	1.48	5.53	1.71E-03	9.32E-04	0.66	2.05E-04	1.12E-04	0.70
BACKHOE W/ LOADER 4X4	2	94	264	Diesel Equipment	10.21	1.01	0.94	44.78	4.43E-03	4.12E-03	5.36	5.31E-04	4.94E-04	5.51
BUCKET 105' WORK HEIGHT	1	300	1760	Diesel Off-Road Trucks	10.21	0.91	0.56	142.93	1.27E-02	7.84E-03	114.10	1.02E-02	6.26E-03	116.05
BUCKET 125' WORK HEIGHT 8X6	1	350	1760	Diesel Off-Road Trucks	10.21	0.91	0.56	166.75	1.49E-02	9.15E-03	133.12	1.19E-02	7.30E-03	135.39
CRANE TRUCK 45 T HYDRAULIC 6 AXLE	4	450	1760	Diesel Equipment	10.21	1.01	0.94	214.39	2.12E-02	1.97E-02	171.15	1.69E-02	1.58E-02	175.80
DIGGER DERRICK 15 T CAP	3	330	1760	Diesel Off-Road Trucks	10.21	0.91	0.56	157.22	1.40E-02	8.62E-03	125.51	1.12E-02	6.88E-03	127.65
DOZER 10 THRU 12 T, W/ WINCH	1	80	528	Diesel Equipment	10.21	1.01	0.94	38.11	3.77E-03	3.51E-03	9.13	9.03E-04	8.40E-04	9.38
DOZER 18 T W/ WINCH	2	190	528	Diesel Equipment	10.21	1.01	0.94	90.52	8.95E-03	8.33E-03	21.68	2.14E-03	2.00E-03	22.27
FORKLIFT 11,000 THRU 12,000# TELESCOPIC BOOM	1	142	880	Diesel Equipment	10.21	1.01	0.94	67.65	6.69E-03	6.23E-03	27.00	2.67E-03	2.49E-03	27.74
FRONT END LOADER 68,000# 4X4	1	386	880	Diesel Equipment	10.21	1.01	0.94	183.90	1.82E-02	1.69E-02	73.41	7.26E-03	6.76E-03	75.40
HYDRAULIC BULLWHEEL BUNDLE TENSIONER	1	80	264	Diesel Equipment	10.21	1.01	0.94	38.11	3.77E-03	3.51E-03	4.56	4.51E-04	4.20E-04	4.69
PULLER ROPE TRAILER 4,000# CAP W/ SPLIT REEL TOW TYPE TANDEM AXLE	1	74	264	Diesel Off-Road Trucks	10.21	0.91	0.56	35.26	3.14E-03	1.93E-03	4.22	3.76E-04	2.32E-04	4.29
PULLER CABLE TRAILER 30,000# CAP TOW TYPE TANDEM AXLE	1	400	264	Diesel Off-Road Trucks	10.21	0.91	0.56	190.57	1.70E-02	1.05E-02	22.82	2.03E-03	1.25E-03	23.21
PULLER ROPE TRAILER 4 DRUM 3,500# CAP TOW TYPE TANDEM AXLE	1	115	264	Diesel Off-Road Trucks	10.21	0.91	0.56	54.79	4.88E-03	3.01E-03	6.56	5.85E-04	3.60E-04	6.67
60T RT Crane	1	320	528	Diesel Equipment	10.21	1.01	0.94	152.46	1.51E-02	1.40E-02	36.51	3.61E-03	3.36E-03	37.50
SKID STEER LOADER TRACK MTD 80 > 75 HP	2	95	880	Diesel Equipment	10.21	1.01	0.94	45.26	4.48E-03	4.17E-03	18.07	1.79E-03	1.66E-03	18.56
DUMP BOX TRUCK 2-1/2 T 6X6	1	505	440	Diesel Off-Road Trucks	10.21	0.91	0.56	240.59	2.14E-02	1.32E-02	48.02	4.28E-03	2.63E-03	48.84
DUMP BOX TRUCK 1-1/4 & 1-1/2 T	2	420	880	Diesel Off-Road Trucks	10.21	0.91	0.56	200.10	1.78E-02	1.10E-02	79.87	7.12E-03	4.38E-03	81.23
FLATBED (FRAMING) TRUCK 1-1/4 & 1-1/2 T	3	420	880	Diesel Off-Road Trucks	10.21	0.91	0.56	200.10	1.78E-02	1.10E-02	79.87	7.12E-03	4.38E-03	81.23
PICKUP TRUCK 3/4 T	9	420	1760	Diesel Off-Road Trucks	10.21	0.91	0.56	200.10	1.78E-02	1.10E-02	159.74	1.42E-02	8.76E-03	162.46
Helicopter	3	370	3841	Jet Fuel	9.75	0.00	0.3	150.14	0.00E+00	4.62E-03	261.59	0.00E+00	8.05E-03	263.72
TRUCK TRACTOR 2-1/2 T 6X4 & 5 T 6X6	3	450	528	Diesel Off-Road Trucks	10.21	0.91	0.56	214.39	1.91E-02	1.18E-02	51.35	4.58E-03	2.82E-03	52.22
TOTAL	--	--	--	--	--	--	--	--	--	--	1,454.32	0.11	0.09	1,480.50

[1] Information provided by Xcel on 8/16/2023. Helicopter horsepower was estimated based on 206B-3 Jet Ranger, <https://www.helis.com/database/model/Bell-206B-3/>.

[2] Fuel type assumed based on equipment type.

[3] CO₂ emissions calculated using the EPA CCCL emission factors for mobile combustion, Table 2: Mobile Combustion CO₂, 2024. <https://www.epa.gov/system/files/documents/2024-02/ghg-emission-factors-hub-2024.pdf>

Fuel Type	CO ₂ Emission Factor (kg/gal)
Diesel Fuel	10.21
Motor Gasoline	8.78
Kerosene-Type Jet Fuel	9.75

[4] CH₄ and N₂O emissions calculated using the EPA CCCL emission factors for construction/mining equipment, Table 5: Mobile Combustion CH₄ and N₂O for Non-Road Vehicles, 2024. <https://www.epa.gov/system/files/documents/2024-02/ghg-emission-factors-hub-2024.pdf>

Vehicle Type	Fuel Type	CH ₄ Emission Factor (g/gal)	N ₂ O Emission Factor (g/gal)
Construction/Minning Equipment	Diesel Equipment	1.01	0.94
Construction/Minning Equipment	Diesel Off-Road Trucks	0.91	0.56
Recreational Equipment	Gasoline (4 stroke) - Recreational	2.72	1.48
Aircraft	Jet Fuel	-	0.30

[5] Emission factors converted to lb/hr using conversion rates of 53.993 hp-hr/gal for diesel and jet fuel, and 47.246 hp-hr/gal for gasoline.

[6] CO₂e calculated from global warming potentials from the Intergovernmental Panel on Climate Change (IPCC), Fifth Assessment Report (AR5), 2013. The GWP for CO₂ is 1, CH₄ is 28, and N₂O is 265.

Table 4-1. Operations Emissions from Mobile Combustion Sources

Equipment Type ^[1]	Number of Units ^[1]	Horsepower ^{[1][2]}	Total Operation Time (hr) ^[1]	Fuel Type ^[3]	CO ₂ Emission Factor ^[4] (kg/gal)	CH ₄ Emission Factor ^[5] (g/gal)	N ₂ O Emission Factor ^[5] (g/gal)	CO ₂ Emission Factor ^[6] (lb/hr)	CH ₄ Emission Factor ^[6] (lb/hr)	N ₂ O Emission Factor ^[6] (lb/hr)	CO ₂ (metric tons)	CH ₄ (metric tons)	N ₂ O (metric tons)	CO ₂ e ^[7] (metric tons)
E4_OTL_EQP_PICKUP TRUCK-F350_CREW CAB_8001-11K_4X4	1	310	10	Diesel Off-Road Trucks	10.21	0.91	0.56	147.69	1.32E-02	8.10E-03	0.67	5.97E-05	3.67E-05	0.68
K8_OTL_EQP_HEAVY BUCKET TRUCK 100 FT_RUBBER TIRE_6X6	1	375	10	Diesel Off-Road Trucks	10.21	0.91	0.56	178.66	1.59E-02	9.80E-03	0.81	7.22E-05	4.44E-05	0.82
N4_OTL_EQP_TRUCK MOUNTED CRANE_45T/50T_RUBBER TIRE	1	365	10	Diesel Equipment	10.21	1.01	0.94	173.90	1.72E-02	1.60E-02	0.79	7.80E-05	7.26E-05	0.81
S2_OTL_EQP_BACKHOE-LOADER_RUBBER TIRE_4X4	1	66	10	Diesel Equipment	10.21	1.01	0.94	31.44	3.11E-03	2.89E-03	0.14	1.41E-05	1.31E-05	0.15
U1_OTL_EQP_SKID STEER LOADER_TRACKED	1	77	10	Diesel Equipment	10.21	1.01	0.94	36.88	3.65E-03	3.39E-03	0.17	1.65E-05	1.54E-05	0.17
W2_OTL_EQP_ATV/UTV POLARIS/CAN AM/ARGO_RUBBER TIRE/TRACKED_4X4	1	90	40	Gasoline (4 stroke) - Recreational	8.78	2.72	1.48	36.87	1.14E-02	6.22E-03	0.67	2.07E-04	1.13E-04	0.70
R1_OTL_EQP_TRAILER UTV/FRAMING/ENCLOSED_<=12K_RUBBER TIRE_TANDEM	1	400	40	Diesel Off-Road Trucks	10.21	0.91	0.56	190.57	1.70E-02	1.05E-02	3.46	3.08E-04	1.90E-04	3.52
D2_OTL_EQP_PICKUP TRUCK-F150_6001-8K_4X4	1	310	40	Diesel Off-Road Trucks	10.21	0.91	0.56	147.69	1.32E-02	8.10E-03	2.68	2.39E-04	1.47E-04	2.73
R2_OTL_EQP_TRAILER MEDIUM EQUIP_12001-20K_RUBBER TIRE_TANDEM	1	400	10	Diesel Off-Road Trucks	10.21	0.91	0.56	190.57	1.70E-02	1.05E-02	0.86	7.70E-05	4.74E-05	0.88
R3_OTL_EQP_TRAILER LARGE EQUIP_>20K_RUBBER TIRE_TANDEM	1	400	10	Diesel Off-Road Trucks	10.21	0.91	0.56	190.57	1.70E-02	1.05E-02	0.86	7.70E-05	4.74E-05	0.88
TOTAL	--	--	--	--	--	--	--	--	--	--	11.11	1.15E-03	7.27E-04	11.34

[1] Information provided by Xcel 8/17/2023

[2] Horsepower estimates based on information below for each equipment type.

Equipment Type	Estimated Horsepower	Estimated Horsepower Reference
ATV	90	https://www.polaris.com/en-us/off-road/shop-by-use/utility/property-maintenance/
Pickup Truck	310	https://www.gmc.com/trucks/sierra/1500
Bucket Truck	375	https://www.trailer-bodybuilders.com/archive/article/21730986/kenworth-offers-advice-on-specs-for-dump-trucks
Skidsteer	77	https://www.deere.com/en/loaders/skid-steers/
Truck Mounted Crane	365	www.jflomainc.com/cranes/(1)%20Hydraulic%20Truck%20Cranes/Hydraulic%20Truck%20Crane%20Specs/htc8650.pdf
Bakehoe	66	https://www.deere.com/assets/pdfs/common/products/backhoes/Backhoe-410.pdf

[3] Fuel type assumed based on equipment type.

[4] CO₂ emissions calculated using the EPA CCCL emission factors for mobile combustion, Table 2: Mobile Combustion CO₂ 2024. <https://www.epa.gov/system/files/documents/2024-02/ghg-emission-factors-hub-2024.pdf>

Fuel Type	CO ₂ Emission Factor (kg/gal)
Diesel Fuel	10.21
Motor Gasoline	8.78

[5] CH₄ and N₂O emissions calculated using the EPA CCCL emission factors for construction/mining equipment, Table 5: Mobile Combustion CH₄ and N₂O for Non-Road Vehicles, 2024. <https://www.epa.gov/system/files/documents/2024-02/ghg-emission-factors-hub-2024.pdf>

Vehicle Type	Fuel Type	CH ₄ Emission Factor (g/gal)	N ₂ O Emission Factor (g/gal)
Construction/Mining Equipment	Diesel Equipment	1.01	0.94
Construction/Mining Equipment	Diesel Off-Road Trucks	0.91	0.56
Recreational Equipment	Gasoline (4 stroke) - Recreational	2.72	1.48

[6] Emission factors converted to lb/hr using conversion rates of 53.993 hp-hr/gal for diesel and jet fuel, and 47.246 hp-hr/gal for gasoline.

[7] CO₂e calculated from global warming potentials from the Intergovernmental Panel on Climate Change (IPCC), Fifth Assessment Report (AR5), 2013. The GWP for CO₂ is 1, CH₄ is 28, and N₂O is 265.