

Appendix J

Greenhouse Gas Emission Calculations

Great River Energy
Kimball Substation and 115-kV Transmission Line
Construction Emission Calculations

Summary of Potential Construction Emissions (tons)						
Description	Emissions					
	Criteria Pollutants					
	NOx	CO	VOC	SO ₂	PM ₁₀	PM _{2.5}
Off-Road Engine Emissions	3.46	0.73	0.22	0.00	0.13	0.13
Unpaved Roads	--	--	--	--	0.23	0.02
Earthmoving	--	--	--	--	4.12	0.44
PROJECT TOTAL	3.46	0.73	0.22	0.00	4.48	0.58

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Emission Factors for Construction Engines														
Equipment	Quantity ^a	Total Hours Used	Max Power (HP)	Load Factor ^b	Loaded Power (HP)	VOC	CO	NOx	Emission Factors ^{c,d} (g/hp hr)					
									PM ₁₀	PM _{2.5}	SO ₂	CO ₂	CH ₄	N ₂ O
Air Compressor	2	120	80	1	80	0.367	2.366	4.700	0.240	0.240	0.002	188.262	0.008	0.002
Backhoe	2	200	75	0.8	60	0.367	2.366	4.700	0.240	0.240	0.002	188.262	0.008	0.002
Bulldozer	1	160	250	1	250	0.309	0.748	4.000	0.132	0.132	0.002	188.262	0.008	0.002
Compactor	1	160	300	1	300	0.167	0.843	4.335	0.132	0.132	0.002	188.262	0.008	0.002
Fork Lift	2	150	120	1	120	0.167	0.843	4.335	0.132	0.132	0.002	188.262	0.008	0.002
Concrete Mixer Truck	6	560	325	1	325	0.338	0.867	4.100	0.180	0.180	0.002	188.262	0.008	0.002
Dump Truck	2	320	325	0.8	260	0.338	0.867	4.100	0.180	0.180	0.002	188.262	0.008	0.002
Generator	2	160	250	0.5	125	0.167	0.843	4.335	0.132	0.132	0.002	188.262	0.008	0.002
Manlift	1	80	50	1	50	0.338	0.867	4.100	0.180	0.180	0.002	188.262	0.008	0.002
Pickup Truck	8	3,840	150	0.25	38	0.167	0.843	4.335	0.132	0.132	0.002	188.262	0.008	0.002
Skid steer loader	1	480	50	1	50	0.309	0.748	4.000	0.132	0.132	0.002	188.262	0.008	0.002
Water truck	1	80	100	0.5	50	0.637	2.366	4.700	0.240	0.240	0.002	188.262	0.008	0.002
Welding machine	1	80	35	0.8	28	0.367	2.366	4.700	0.240	0.240	0.002	188.262	0.008	0.002
Grader	1	40	35	0.8	28	0.438	2.161	4.44	0.267	0.259	0.002	188.262	0.008	0.002
Medium Crane	2	320	450	0.7	315	0.3085	0.7475	4.0	0.132	0.128	0.002	188.262	0.008	0.002
Hydrovac Truck	2	80	200	0.59	118	0.3085	0.7475	4.0	0.132	0.128	0.002	188.262	0.008	0.002
Semitruck/Trailer	2	160	500	0.59	295	0.167	0.843	4.335	0.132	0.132	0.002	188.262	0.008	0.002
^a Equipment counts estimated based on current construction plan														
^b Load Factors from Appendix A of EPA 420_P 04 005, Median Life, Annual Activity, and Load Factor														
^c EPA 420 P 04 009, Exhaust and Crankcase Emission Factors for Nonroad Engine Modeling Compression Ignition, USEPA, April 2004 Tier 2 Engines.														
^d GHG emission factors from EPA's 2024 GHG Emission Factors Hub. Available online at https://www.epa.gov/climateleadership/ghg-emission-factors-hub .														

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Criteria Pollutant Emission Estimates from Construction Engines						
Equipment	Potential Emissions (ton)					
	VOC	CO	NOx	PM ₁₀	PM _{2.5}	SO ₂
Air Compressor	3.89E-03	0.025	0.050	0.003	0.003	0.000
Backhoe	4.86E-03	0.031	0.062	0.003	0.003	0.000
Bulldozer	1.36E-02	0.033	0.176	0.006	0.006	0.000
Compactor	8.83E-03	0.045	0.229	0.007	0.007	0.000
Fork Lift	3.31E-03	0.017	0.086	0.003	0.003	0.000
Concrete Mixer Truck	6.79E-02	0.174	0.823	0.036	0.036	0.000
Dump Truck	3.10E-02	0.079	0.376	0.017	0.017	0.000
Generator	3.68E-03	0.019	0.096	0.003	0.003	0.000
Manlift	1.49E-03	0.004	0.018	0.001	0.001	0.000
Pickup Truck	2.65E-02	0.134	0.688	0.021	0.021	0.000
Skid steer loader	8.16E-03	0.020	0.106	0.003	0.003	0.000
Water truck	2.81E-03	0.010	0.021	0.001	0.001	0.000
Welding machine	9.07E-04	0.006	0.012	0.001	0.001	0.000
Grader	5.41E-04	0.003	0.005	0.000	0.000	0.000
Medium Crane	3.43E-02	0.083	0.444	0.015	0.014	0.000
Hydrovac Truck	3.21E-03	0.008	0.042	0.001	0.001	0.000
Semitruck/Trailer	8.69E-03	0.044	0.226	0.007	0.007	0.000
TOTAL	0.22	0.73	3.46	0.13	0.13	0.00

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Fugitive Dust Emissions From Earthmoving Activities							
Construction Activity	Daily Material Handling		Average Exposed Area (acres)	Emission Factors ^{b - f} (lb/ton)		Emissions (ton)	
	Construction Rate ^a (ton/day)	Handling Time ^b (days)		PM ₁₀	PM _{2.5}	PM ₁₀	PM _{2.5}
Transmission Line and Substation							
Topsoil removed by scraper ^g	1,690.6	60	---	0.058	0.0061	2.94	0.31
Topsoil replacement	1,690.6	60	---	0.012	0.0013	0.61	0.07
Wind erosion of exposed areas	--	60	50.3	0.38	0.03999	0.57	0.06
PROJECT TOTAL	--	--	--	--	--	4.12	0.44
Notes and Assumptions:							
^a Soil density: 1.25 tons per yard							
^b Conservatively assumes handling time is the maximum amount of days a construction equipment is used on the portion of the project.							
^c Backfilling and topsoil replacement emission factor: AP 42 Section 11.9 Western Surface Coal Mining, Table 11.9 4, July 1998, overburden replacement							
^d As worst case, PM ₁₀ is set equal to Total Particulate Matter. PM _{2.5} is set to 0.105 times PM ₁₀ per Table 11.9 1							
^e Emission factor: AP 42 Section 11.9 Western Surface Coal Mining, Table 11.9 4, July 1998, topsoil removal by scraper							
^f Wind Erosion Exposed Areas emission factor: AP 42 Section 11.9 Western Surface Coal Mining, Table 11.9 4, July 1998, wind erosion of exposed areas (ton/yr/acre)							
^g Assumes the entire right-of-way is cleared to 1 foot deep, 1.25 tons per cubic yard.							

Construction Schedule		
	Transmission Line	Substation
Work hours per day	10	10
Work days per week	5	5
Hours per week	50	50
Number of weeks	12	12
Total Days:	60	60

Topsoil Removed by Scraper ^a				
Facility	Total (Acres)	Soil Volume (yd ³)	Soil Weight (ton)	Daily Material Handling Rate (ton/day)
Transmission line and substation	50.3	81,151	101,438	1,690.6
TOTAL	50.3	81,151	101,438	

^a Conservatively assumes that the entire right-of-way will be cleared to a depth of 1 foot. Acreage from RPA, Section

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Fugitive Dust Emissions from Unpaved Roads								
Equipment	Quantity ^a	Total Days Used	VMT ^b	Emission Factor (lb/VMT) ^c			Project Emissions (ton)	
				W	PM ₁₀	PM _{2.5}	PM ₁₀	PM _{2.5}
Backhoe	2	40	15	50	2.83	0.28	0.02	0.00
Bulldozer	1	20	0	20	1.88	0.19	0.00	0.00
Fork Lift	2	40	10	20	1.88	0.19	0.01	0.00
Concrete Mixer Truck	4	10	20	20	1.88	0.19	0.02	0.00
Dump Truck	2	30	10	21	1.92	0.19	0.01	0.00
Excavator	2	15	0	22	1.96	0.20	0.00	0.00
Pickup Truck	5	80	120	24	2.04	0.20	0.12	0.01
Skid steer loader	1	60	30	26	2.11	0.21	0.03	0.00
Water truck	1	10	0	20	1.88	0.19	0.00	0.00
Medium Crane	1	20	10	21	1.92	0.19	0.01	0.00
Semitruck/Trailer	2	20	5	20	1.88	0.19	0.00	0.00
TOTAL	--	--	--	--	--	--	0.23	0.02
^a Equipment counts are estimated based current construction plan.								
^b Each vehicle is assumed to travel 0.5 mile per day on site.								
^c AP-42 Section 13.2.2 Unpaved Roads, dated November 2006, Equations 1a and 2 TOTALS 11.19 1.12 Surface Silt content based on Table 13.2.2 1 construction sites.								

Eq 1a: $E = k * (s/12)^a * (W/3)^b$

Eq 2: $E_{ext} = E * [(365-P)/365]$

where:

VMT = Vehicle Miles Traveled

W = Mean Vehicle Weight, tons

S = Mean Vehicle Speed, mph

P = 100 days with at least 0.01 inches rain, EPA's AP-42 Figure 13.2.2-1

s = 8.5 surface material silt content (%) for construction sites, EPA's AP-42 Table 13.2.2-1

E = size-specific emission factor, lb/ VMT

E_{ext} = annual size-specific emission factor extrapolated for natural migration, lb/VMT

Constants	PM	PM ₁₀	PM _{2.5}
k (lb/VMT)	4.9	1.5	0.15
a	0.7	0.9	0.9
b	0.45	0.45	0.45

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Greenhouse Gas Emissions Summary (tons)				
	CO ₂	CH ₄	N ₂ O	CO ₂ e ^a
Coneflower Transmission Line				
Off-Road Engine Emissions	155.56	0.01	0.00	156.07
On-Road Engine Emissions	28.06	0.00	0.00	28.06
PROJECT TOTAL	183.62	0.01	0.00	184.13

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Greenhouse Gas Emissions from On Road Construction Traffic					
	Vehicles per day	Miles per vehicle	Number of Days	Fuel Used (gallons)	CO ₂ Emissions ^a (tons)
Transmission Line					
Commuter Vehicles - Gasoline ^{b,c}	7	60	60	1,050	10.29
Delivery Trucks - Diesel ^d	1	60	10	92	1.04
Concrete Mixer Trucks - Diesel ^e	4	60	10	706	7.92
Transmission Line Subtotal					19.24
Substation					
Commuter Vehicles - Gasoline ^{b,c}	6	60	60	900	8.82
Delivery Trucks - Diesel ^d	1	60	10	92	1.04
Concrete Mixer Trucks - Diesel ^e	2	60	15	529	5.94
Substation Subtotal					15.79
PROJECT TOTAL					28.06
^a Assumes 1 gallon of gasoline = 8,887 grams CO ₂ and 1 gallon of diesel = 10,180 g CO ₂ , per US EPA's "Greenhouse Gas Emissions from a Typical Passenger Vehicle," available online at: https://nepis.epa.gov/Exe/ZyPDF.cgi?Dockkey=P100U8YT.pdf					
^b Assumes commuters travel 30 miles each way (60 miles round trip) per day, with a fuel economy of 24 miles per gallon, per US EPA and US Department of Energy Fuel Economy data for combined city and highway driving in 2023, available online at: https://www.fueleconomy.gov/feg/download.shtml .					
^c Commuter counts and number of days based on current construction plan.					
^d Assumes delivery trucks travel 30 miles each way (60 miles round trip) per day, with a fuel economy of 6.5 miles per gallon, industry average.					
^e Assumes concrete mixer trucks travel 30 miles each way (60 miles round trip) per day, with a fuel economy of 3.4 miles per gallon, industry average. http://ascpro0.ascweb.org/archives/cd/2012/paper/CPRT221002012.pdf#:~:text=The%20National%20Ready%20Mix%20Concrete%20Association%20%28NRMCA%29%20in,average%203.4%20miles%20per%20gallon%20of%20diesel%20fuel.					

Greenhouse Gas Emission Factors for Construction Engines								
Equipment	Quantity ^a	Total Hours Used	Max Power (HP)	Load Factor ^b	Loaded Power (HP)	Emission Factors ^{c,d} (g/hp hr)		
						CO ₂	CH ₄	N ₂ O
Air Compressor	2	120	80	1	80	188.262	0.008	0.002
Backhoe	2	200	75	1	60	188.262	0.008	0.002
Bulldozer	1	160	250	1	250	188.262	0.008	0.002
Compactor	1	160	300	1	300	188.262	0.008	0.002
Fork Lift	2	150	120	1	120	188.262	0.008	0.002
Concrete Mixer Truck	6	560	325	1	325	188.262	0.008	0.002
Dump Truck	2	320	325	1	260	188.262	0.008	0.002
Generator	2	160	250	1	125	188.262	0.008	0.002
Manlift	1	80	50	1	50	188.262	0.008	0.002
Pickup Truck	8	3,840	150	0	38	188.262	0.008	0.002
Skid steer loader	1	480	50	1	50	188.262	0.008	0.002
Water truck	1	80	100	1	50	188.262	0.008	0.002
Welding machine	1	80	35	1	28	188.262	0.008	0.002
Grader	1	40	35	1	28	188.262	0.008	0.002
Medium Crane	2	320	450	1	315	188.262	0.008	0.002
Hydrovac Truck	2	80	200	1	118	188.262	0.008	0.002
Semitruck/Trailer	2	160	500	1	295	188.262	0.008	0.002
^a Equipment counts estimated based on current construction plan								
^b Load Factors from Appendix A of EPA 420_P 04 005, Median Life, Annual Activity, and Load Factor Values for Nonroad Engine Emissions Modeling , USEPA, April 2004.								
^c EPA 420 P 04 009, Exhaust and Crankcase Emission Factors for Nonroad Engine Modeling Compression Ignition, USEPA, April 2004 Tier 2 Engines.								
^d GHG emission factors from EPA's 2024 GHG Emission Factors Hub. Available online at https://www.epa.gov/climateleadership/ghg-emission-factors-hub .								

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Greenhouse Gas Emission Estimates from Construction Engines				
Equipment	Potential Emissions (ton)			
	CO ₂	CH ₄	N ₂ O	CO ₂ e ^a
Air Compressor	1.99	0.00	0.00	2.00
ATV	0.00	0.00	0.00	0.00
Backhoe	2.49	0.00	0.00	2.50
Bulldozer	8.30	0.00	0.00	8.33
Compactor	9.96	0.00	0.00	9.99
Compactor, Vibratory	0.00	0.00	0.00	0.00
Fork Lift	3.74	0.00	0.00	3.75
Concrete Mixer Truck	37.77	0.00	0.00	37.89
Concrete Pump	0.00	0.00	0.00	0.00
Dump Truck	17.27	0.00	0.00	17.32
Excavator	0.00	0.00	0.00	0.00
Front End Loader	0.00	0.00	0.00	0.00
Generator	4.15	0.00	0.00	4.16
Guided Bore Machine	0.00	0.00	0.00	0.00
Light Tower	0.00	0.00	0.00	0.00
Manlift	0.83	0.00	0.00	0.83
Pickup Truck	29.88	0.00	0.00	29.98
Piping Truck	0.00	0.00	0.00	0.00
Skid steer loader	4.98	0.00	0.00	5.00
Water truck	0.83	0.00	0.00	0.83
Welding machine	0.46	0.00	0.00	0.47
Grader	0.23	0.00	0.00	0.23
Large Crane	0.00	0.00	0.00	0.00
Medium Crane	20.92	0.00	0.00	20.99
Fuel Truck	0.00	0.00	0.00	0.00
Hydrovac Truck	1.96	0.00	0.00	1.97
Road Bore Machine	0.00	0.00	0.00	0.00
6-inch Water Pump	0.00	0.00	0.00	0.00
4-inch Water Pump.	0.00	0.00	0.00	0.00
2-inch Water Pump	0.00	0.00	0.00	0.00
Pile Driver	0.00	0.00	0.00	0.00
100 HP Tractor	0.00	0.00	0.00	0.00
Semitruck/Trailer	9.80	0.00	0.00	9.83
TOTAL	155.56	0.01	0.00	156.07

^a Calculated using global warming potentials from EPA's 2024 GHG Emission Factors Hub.

Global Warming Potentials		
CO ₂	CH ₄	N ₂ O
1	28	265