APPENDIX J AIR EMISSIONS CALCULATIONS

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Project: Magellan Pipestone Reroute Project
Subject: Constructions Emissions Calculations
Task: Construction Emission Totals for Entire Project

Prepared by: CGW
Date: 1/6/2023

Total Emissions	Emissions [tons]										
	VOC	CO	NO_X	PM_{10}	$PM_{2.5}$	SO_2	CO_2	CH_4	N_2O	CO_2e[1]	HAPs
Off-Road Construction Equipment	0.58	2.2	5.5	0.38	0.37	0.0060	2000	0.032	6.8E-05	2100	0.28
Construction Activity Fugitive Dust	--	--	--	4.4	0.7	--	--	--	--	--	--
Project Emission Totals:	**0.58**	**2.2**	**5.5**	**4.8**	**1.0**	**0.0060**	**2000**	**0.032**	**6.8E-05**	**2100**	**0.28**

[1] CO_2e is the sum of CO_2, CH_4, and N_2O multiplied by the applicable global warming potential expressed in tons.

[2] All values reported with appropriate significant figures. Totals may not match sum of addends due to rounding.

Excavation and Backfilling	Soil Moved [tons]	PM_{10} Emissions [tons]	$PM_{2.5}$ Emissions [tons]
Excavation	2,091	0.061	0.01
Pipeline Backfilling	1,986	0.012	0.001
Total Emissions		**0.073**	**0.007**

Windblowing	Project Area [acres]	PM_{10} Uncontrolled Emissions [tons]	$PM_{2.5}$ Uncontrolled Emissions [tons]	PM_{10} Controlled Emissions [tons]	$PM_{2.5}$ Controlled Emissions [tons]
Permanent ROW	6.35	2.4	0.4	1.7	0.2
Temporary ROW	3.44	1.3	0.2	0.9	0.1
ATWS Planned	5.65	2.1	0.3	1.5	0.2
Access Road 1	0.44	0.17	0.0	0.11	0.02
Access Road 2	0.38	0.14	0.0	0.10	0.01
Access Road 3	0.37	0.14	0.0	0.10	0.01
Total Emissions		**6.3**	**0.9**	**4.3**	**0.6**

$PM_{2.5}$ / PM_{10} Factors	
Pipeline Installation	
$PM_{2.5}$ / PM_{10} Ratio[1] (construction & demolition)	0.1
Excavation	
PM_{10} Emission Factor[2] [lb/ton]	0.058
$PM_{2.5}$ Emission Factor [lb/ton]	0.0058
Backfilling	
PM_{10} Emission Factor[2] [lb/ton]	0.012
$PM_{2.5}$ Emission Factor [lb/ton]	0.0012
Windblowing	
$PM_{2.5}$ / PM_{10} Ratio[1] (industrial wind erosion)	0.15
PM_{10} Emission Factor[2] [ton/acre]	0.38
$PM_{2.5}$ Emission Factor [ton/acre]	0.057
Control Efficiency[3]	69%

Pipeline Installation Details[4]	
Assumptions:	
Pipeline Installation Length [ft]	3,907
Pipeline Diameter [in]	8
Pipeline Padding Thickness [in]	2
Average Excavation Width at Surface [ft]	2.8
Average Excavation Width at Trench Bottom [ft]	2.8
Average Excavation Depth [ft]	5.5
Soil Density[5] [lb/cf]	68.7

Conversion Factors	
lb/ton	2000
in/ft	12

[1] $PM_{2.5}/PM_{10}$ ratios based on USEPA AP-42 Chapter 13.2.2 Background Document for Revisions to Fine Fraction Ratios Used for USEPA AP-42 Fugitive Dust Emission Factors, Table 1, November 2006.

[2] Emission factors are based on topsoil removal, overburden replacement and wind erosion assuming TSP=PM_{10}, USEPA AP-42 Chapter 11.9 Western Surface Coal Mining, Table 11.9-4, October 1998.

[3] Control efficiency based on project measures to minimize dust utilizing water truck to dampen the material handling and storage locations under dry-dusty conditions, "Control of Open Fugitive Dust Sources", USEPA EPA-450/3-38-008, Section 5.3.2.1, September 1988.

[4] Pipeline and trench dimensions provided by Magellan.

[5] Soil density of 68.7 lb/cf (1.1 g/cm^3) for organic silts / clays taken from "The Compaction of Urban Soils: Technical Note #107" from Watershed Protection Techniques. 3(2): 661-665 (Schueler, T. 2000).

Total Emissions	Pollutant [tons]										
	VOC	CO	NO_x	PM_{10}	$PM_{2.5}$	SO_2	CO_2	CH_4	N_2O	CO_2e [1]	HAP
Bulldozer (Cat D8T)	1.6E-02	1.0E-01	2.7E-01	1.6E-02	1.6E-02	6.4E-04	2.3E+02	1.2E-03	3.0E-06	2.3E+02	8.0E-03
Motor Grader (Cat 150)	8.8E-04	3.9E-03	1.2E-02	8.6E-04	8.3E-04	6.4E-05	2.4E+01	6.7E-05	1.9E-06	2.4E+01	4.1E-04
Frontend Loader (Cat 950GC)	1.0E-01	3.1E-01	6.5E-01	6.0E-02	5.8E-02	5.7E-04	1.9E+02	6.0E-03	2.1E-06	1.9E+02	5.2E-02
Backhoe Loader (Cat 416F2)	4.1E-03	1.2E-02	2.5E-02	2.3E-03	2.3E-03	2.2E-05	7.3E+00	2.4E-04	4.6E-07	7.3E+00	2.0E-03
Skid-steer Loader (Cat 249D)	7.9E-02	4.0E-01	4.2E-01	5.9E-02	5.7E-02	2.0E-04	6.1E+01	2.8E-03	6.9E-07	6.1E+01	3.6E-02
Trackhoe (Cat336GC)	6.4E-02	1.9E-01	4.0E-01	3.7E-02	3.6E-02	3.5E-04	1.1E+02	3.7E-03	2.4E-06	1.1E+02	3.2E-02
Trackhoe (Wolfe 7000)	1.1E-01	3.2E-01	6.8E-01	6.2E-02	6.0E-02	6.0E-04	1.9E+02	6.3E-03	4.1E-06	1.9E+02	5.5E-02
Guided Bore Machine (D220X500)	6.3E-03	3.0E-02	1.2E-01	4.4E-03	4.2E-03	6.4E-05	1.9E+01	3.1E-04	1.9E-06	1.9E+01	3.1E-03
Guided Bore Machine (D100x140))	4.2E-03	2.0E-02	7.8E-02	2.9E-03	2.8E-03	4.2E-05	1.3E+01	2.1E-04	1.3E-06	1.3E+01	2.0E-03
Bending Machine (6"-12")	1.6E-03	7.9E-03	1.2E-02	1.1E-03	1.1E-03	6.4E-06	2.1E+00	6.8E-05	3.5E-07	2.1E+00	7.6E-04
Sideboom (Cat PL83)	7.2E-03	4.8E-02	1.3E-01	7.4E-03	7.1E-03	2.5E-04	9.1E+01	5.4E-04	9.0E-06	9.1E+01	3.6E-03
Dump Truck (58,000 GVWR)	1.2E-03	5.3E-03	1.7E-02	1.1E-03	1.1E-03	1.1E-04	4.0E+01	8.0E-05	3.3E-06	4.0E+01	5.1E-04
Water Truck (4000-gal)	5.0E-04	2.3E-03	7.2E-03	4.8E-04	4.6E-04	4.5E-05	1.7E+01	3.4E-05	1.4E-06	1.7E+01	2.2E-04
Welding Rig (RT6)	3.2E-02	1.2E-01	1.9E-01	2.2E-02	2.2E-02	1.3E-04	4.3E+01	1.6E-03	1.2E-06	4.3E+01	1.5E-02
Welding Machine (20-400 A)	4.1E-03	1.5E-02	2.5E-02	2.9E-03	2.8E-03	1.7E-05	5.5E+00	2.1E-04	1.7E-07	5.5E+00	2.0E-03
Air Compressors (1800 CFM)	2.0E-02	9.6E-02	3.5E-01	1.5E-02	1.5E-02	3.3E-04	1.1E+02	1.4E-03	3.6E-06	1.1E+02	1.0E-02
Air Compressors (185 CFM)	2.6E-03	1.2E-02	4.5E-02	1.9E-03	1.9E-03	4.2E-05	1.4E+01	1.8E-04	5.1E-07	1.4E+01	1.3E-03
Generator (145REOZT4)	2.0E-02	6.4E-02	2.4E-01	1.2E-02	1.2E-02	1.8E-04	5.6E+01	1.0E-03	1.9E-06	5.6E+01	9.5E-03
Generator (55REOTZ4)	7.3E-03	2.4E-02	8.8E-02	4.6E-03	4.5E-03	6.5E-05	2.1E+01	3.7E-04	7.7E-07	2.1E+01	3.5E-03
Pickup Truck (3/4 ton)	1.6E-02	7.4E-02	2.4E-01	1.6E-02	1.5E-02	1.5E-03	5.6E+02	1.1E-03	2.3E-05	5.6E+02	7.1E-03
ATV	3.3E-03	1.1E-02	8.2E-02	1.0E-03	1.0E-03	5.1E-05	1.9E+01	4.2E-04	3.1E-07	1.9E+01	1.8E-03
American Auger 440 (HDD Rig)	7.4E-02	3.5E-01	1.4E+00	5.1E-02	5.0E-02	7.5E-04	2.3E+02	3.6E-03	5.1E-06	2.3E+02	3.6E-02
Total Emissions	**0.58**	**2.2**	**5.5**	**0.38**	**0.37**	**0.0060**	**2000**	**0.032**	**6.8E-05**	**2100**	**0.28**

Conversion Factors	
g/lb	453.59
lb/ton	2,000
kg/ton	907.2

Global Warming Potentials[2]	
CO_2	1
CH_4	25
N_2O	298

[1] CO_2e is the sum of CO_2, CH_4, and N_2O multiplied by the applicable global warming potential expressed in tons.
[2] 100-year global warming potential are taken from 40 CFR Part 98, Table A-1.

ERM

Project: Magellan Pipestone Reroute Project
Subject: Constructions Emissions Calculations
Task: Non-Road Construction Equipment Details

Prepared by: CGW
Date: 12/27/2022

Equipment Type[1]	MOVES Equipment Category	Fuel Type	MOVES HP Class	Engine Rating[2] [hp]	Quantity[1]	Hours Per Week of Operation[1]	Weeks of Construction[1]	Total Operating Hours	BSFC Factor[3] [lb/hp-hr]	Estimated Fuel Consumption [lbs/hr]	Estimated Fuel Consumption [MMBtu/hr]	Emission Factors[4]									
												VOCs [g/hp-hr]	CO [g/hp-hr]	NOx [g/hp-hr]	PM_{10} [g/hp-hr]	$PM_{2.5}$ [g/hp-hr]	SO_2 [g/hp-hr]	CO_2 [g/hp-hr]	CH_4 [g/hp-hr]	N_2O[5] [kg/MMBtu]	HAP [g/hp-hr]
Bulldozer (Cat D8T)	Crawler Tractor/Dozers	Diesel	300 < hp <= 600	325	2	50	12	1200	0.367	239	4.6	0.036974	0.236891	0.638904	0.03805	0.036909	0.001494	536.7238	0.002863	0.0006	0.01857968
Motor Grader (Cat 150)	Graders	Diesel	175 < hp <= 300	200	2	50	2	200	0.367	147	2.8	0.020013	0.088742	0.282162	0.019456	0.018872	0.001441	536.7725	0.001512	0.0006	0.0093228
Frontend Loader (Cat 950GC)	Tractors/Loaders/Backhoes	Diesel	175 < hp <= 300	225	2	50	12	1200	0.367	165	3.2	0.352367	1.044989	2.174878	0.200845	0.19482	0.00192	625.5395	0.020289	0.0006	0.17591459
Backhoe Loader (Cat 416F2)	Tractors/Loaders/Backhoes	Diesel	75 < hp <= 100	88	1	10	12	120	0.408	36	0.7	0.352367	1.044989	2.174878	0.200845	0.19482	0.00192	625.5395	0.020289	0.0006	0.17591459
Skid-steer Loader (Cat 249D)	Skid Steer Loaders	Diesel	50 < hp <= 75	66	2	50	12	1200	0.408	54	1.0	0.909451	4.553634	4.834123	0.678156	0.657812	0.002278	693.3718	0.031806	0.0006	0.41431538
Trackhoe (Cat336GC)	Tractors/Loaders/Backhoes	Diesel	175 < hp <= 300	259	2	40	8	640	0.367	190	3.7	0.352367	1.044989	2.174878	0.200845	0.19482	0.00192	625.5395	0.020289	0.0006	0.17591459
Trackhoe (Wolfe 7000)	Tractors/Loaders/Backhoes	Diesel	300 < hp <= 600	440	2	40	8	640	0.367	323	6.2	0.352367	1.044989	2.174878	0.200845	0.19482	0.00192	625.5395	0.020289	0.0006	0.17591459
Guided Bore Machine (D220X500)	Bore/Drill Rigs	Diesel	300 < hp <= 600	415	1	40	2	80	0.367	152	2.9	0.17279	0.813541	3.223465	0.119649	0.116059	0.001746	530.5468	0.008472	0.0006	0.08338574
Guided Bore Machine (D100x140))	Bore/Drill Rigs	Diesel	175 < hp <= 300	275	1	40	2	80	0.367	101	1.9	0.17279	0.813541	3.223465	0.119649	0.116059	0.001746	530.5468	0.008472	0.0006	0.08338574
Bending Machine (6"-12")	Other Material Handling Eqp	Diesel	50 < hp <= 75	67	1	10	4	40	0.408	27	0.5	0.5561	2.660311	4.018544	0.370512	0.359397	0.002182	694.3903	0.023173	0.0006	0.25721204
Sideboom (Cat PL83)	Off-Highway Tractors	Diesel	300 < hp <= 600	319	6	40	2	480	0.367	702	13.6	0.042571	0.281437	0.759034	0.043642	0.042332	0.001509	536.7086	0.003175	0.0006	0.02145035
Dump Truck (58,000 GVWR)	Off-highway Trucks	Diesel	300 < hp <= 600	350	2	8	12	192	0.367	257	5.0	0.015673	0.071354	0.226244	0.0151	0.014647	0.001432	536.7842	0.001085	0.0006	0.00686041
Water Truck (4000-gal)	Off-highway Trucks	Diesel	300 < hp <= 600	300	1	8	12	96	0.367	110	2.1	0.015673	0.071354	0.226244	0.0151	0.014647	0.001432	536.7842	0.001085	0.0006	0.00686041
Welding Rig (RT6)	Welders	Diesel	100 < hp <= 175	155	2	50	4	400	0.367	114	2.2	0.46305	1.684919	2.79635	0.325632	0.315862	0.001967	625.2183	0.023358	0.0006	0.22525429
Welding Machine (20-400 A)	Welders	Diesel	16 < hp <= 25	20	2	50	4	400	0.408	16	0.3	0.46305	1.684919	2.79635	0.325632	0.315862	0.001967	625.2183	0.023358	0.0006	0.22525429
Air Compressors (1800 CFM)	Air Compressors	Diesel	300 < hp <= 600	380	2	20	12	480	0.367	279	5.4	0.100991	0.478033	1.743634	0.075005	0.072755	0.00162	530.7542	0.006985	0.0006	0.05105317
Air Compressors (185 CFM)	Air Compressors	Diesel	40 < hp <= 50	49	2	20	12	480	0.408	40	0.8	0.100991	0.478033	1.743634	0.075005	0.072755	0.00162	530.7542	0.006985	0.0006	0.05105317
Generator (145REOZT4)	Generator Sets	Diesel	175 < hp <= 300	201	2	20	12	480	0.367	148	2.8	0.186243	0.601921	2.251057	0.117509	0.113984	0.001664	530.5072	0.009477	0.0006	0.089503
Generator (55REOTZ4)	Generator Sets	Diesel	50 < hp <= 75	74	2	20	12	480	0.408	60	1.2	0.186243	0.601921	2.251057	0.117509	0.113984	0.001664	530.5072	0.009477	0.0006	0.089503
Pickup Truck (3/4 ton)	Off-highway Trucks	Diesel	300 < hp <= 600	410	12	16	12	2304	0.367	1,806	34.8	0.015673	0.071354	0.226244	0.0151	0.014647	0.001432	536.7842	0.001085	0.0006	0.00686041
ATV	Other Construction Equipment	Diesel	25 < hp <= 40	30	2	40	12	960	0.408	24	0.5	0.104129	0.3389	2.586251	0.032363	0.031392	0.001592	595.8489	0.013283	0.0006	0.0571017
American Auger 440 (HDD Rig)	Bore/Drill Rigs	Diesel	300 < hp <= 600	540	2	60	6	720	0.367	396	7.6	0.17279	0.813541	3.223465	0.119649	0.116059	0.001746	530.5468	0.008472	0.0006	0.08338574

Constants & Factors	
BSFC for 0-100 hp engines [lb/hp-hr]	0.408
BSFC for 100-600 hp engines [lb/hp-hr]	0.367
Density of diesel fuel[6] [lb/gal]	7.1
Heating value of diesel[7] [Btu/gallon]	137,000
Btu/MMBtu	1,000,000

[1] Equipment types, quantities, and hours of operation provided by Magellan.

[2] Engine ratings of equipment are taken from supplier websites and product specification sheets.

[3] Brake Specific Fuel Consumption (BSCF) factors come from Table A4 of USEPA's "Exhaust and Crankcase Emission Factors for Nonroad Engine Modeling - Compression-Ignition", Report No. NR-009d. July 2010.

[4] Emission factors (except for N_2O) come from MOVES3 Emission Runs for Pipestone County, MN for the year 2023. All emission factors were calculated using the sum of running exhaust processes.

[5] Emission factor for N_2O is taken from 40 CFR Part 98, Table C-2.

[6] Density of diesel from USEPA AP-42 Chapter 3.4: Large Stationary Diesel And All Stationary Dual-fuel Engines. October 1996.

[7] Heating value of diesel from USEPA AP-42 Appendix A Typical Parameters of Various Fuels. January 1995.