

**APPENDIX D**  
**GREEN HOUSE GASES**

**Metro's Regional Connector Transit Corridor  
Supplemental Environmental Impact Study -  
Greenhouse Gas Emission Calculations Appendix**

Prepared June 2014

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<b>Table 1-1: GHG Emissions Summary - Locally Preferred Alternative</b>						
<b>GHG Emission Source</b>	<b>Annual GHG Emissions (MTCO<sub>2</sub>e/yr)</b>				<b>Total Project</b>	<b>Amortized Emissions</b>
	<b>2014</b>	<b>2015</b>	<b>2016</b>	<b>2017</b>		
Construction Equipment	2,060	9,533	11,449	4,636	27,679	923
Construction Worker Commuting	31	132	147	69	379	13
Haul Trucks	68	339	390	152	948	32
<b>Total =</b>	<b>2,159</b>	<b>10,004</b>	<b>11,986</b>	<b>4,857</b>	<b>29,006</b>	<b>967</b>

Acronyms: MTCO<sub>2</sub>e = metric tons of carbon dioxide equivalent; MTCO<sub>2</sub>e/yr = metric tons of carbon dioxide equivalent per year



<b>Table 1-4: GHG Emissions Summary - Alternative A</b>						
<b>GHG Emission Source</b>	<b>Annual GHG Emissions (MTCO<sub>2</sub>e/yr)</b>				<b>Total Project</b>	<b>Amortized Emissions</b>
	<b>2014</b>	<b>2015</b>	<b>2016</b>	<b>2017</b>		
Construction Equipment	2,373	16,277	7,663	8,658	34,972	1,166
Construction Worker Commuting	20	148	86	94	348	12
Haul Trucks	0	119	288	305	712	24
<b>Total =</b>	<b>2,394</b>	<b>16,543</b>	<b>8,038</b>	<b>9,057</b>	<b>36,032</b>	<b>1,201</b>

Acronyms: MTCO<sub>2</sub>e = metric tons of carbon dioxide equivalent; MTCO<sub>2</sub>e/yr = metric tons of carbon dioxide equivalent per year

<b>Table 1-5: GHG Emissions Summary - Alternative B</b>						
<b>GHG Emission Source</b>	<b>Annual GHG Emissions (MTCO<sub>2</sub>e/yr)</b>				<b>Total Project</b>	<b>Amortized Emissions</b>
	<b>2014</b>	<b>2015</b>	<b>2016</b>	<b>2017</b>		
Construction Equipment	0	9,093	10,058	4,383	23,534	784
Construction Worker Commuting	0	81	335	262	678	23
Haul Trucks	0	119	508	305	931	31
<b>Total =</b>	<b>0</b>	<b>9,293</b>	<b>10,901</b>	<b>4,950</b>	<b>25,144</b>	<b>838</b>
Acronyms: MTCO <sub>2</sub> e = metric tons of carbon dioxide equivalent; MTCO <sub>2</sub> e/yr = metric tons						

Table 2-1: Hourly, Daily, Annual GHG Emissions Summary - Locally Preferred Alternative

**Locally Preferred Alternative/Baseline**

Phase	Description	Hours per Day	Start Month	End Month	Duration (months)				Number of Equipment							
					2014	2015	2016	2017	Dozer	Excavator	Crane	Drill	Grout Drill	Grout Comp	Grout Gen	Flatbed
1	EPBM Flower	20	May-15	Nov-16	--	7	11	--	2	4	2	0	0	0	0	5
2	Cut & Cover Along Flower Street	20	Sep-14	Sep-17	4	12	12	9	2	4	2	1	0	0	0	5

Work days per month 22

**Hourly Emissions by Equipment**

Phase	Description	Year	CO2 Emissions (pounds per hour)								CH4 Emissions (pounds per hour)							
			Dozer	Excavator	Crane	Drill	Grout Drill	Grout Comp	Grout Gen	Flatbed	Dozer	Excavator	Crane	Drill	Grout Drill	Grout Comp	Grout Gen	Flatbed
1	EPBM Flower	2015	377.84	430.55	287.24	0.00	0.00	0.00	0.00	1303.32	0.007	0.015	0.005	0.000	0.000	0.000	0.000	0.028
1	EPBM Flower	2016	377.83	430.54	287.18	0.00	0.00	0.00	0.00	1303.29	0.009	0.018	0.006	0.000	0.000	0.000	0.000	0.036
2	Cut & Cover Along Flower Street	2014	377.92	430.55	287.22	181.02	0.00	0.00	0.00	1303.29	0.006	0.011	0.004	0.002	0.000	0.000	0.000	0.020
2	Cut & Cover Along Flower Street	2015	377.84	430.55	287.24	180.98	0.00	0.00	0.00	1303.32	0.007	0.015	0.005	0.003	0.000	0.000	0.000	0.028
2	Cut & Cover Along Flower Street	2016	377.83	430.54	287.18	180.99	0.00	0.00	0.00	1303.29	0.009	0.018	0.006	0.003	0.000	0.000	0.000	0.036
2	Cut & Cover Along Flower Street	2017	377.93	430.54	287.14	181.03	0.00	0.00	0.00	1303.26	0.011	0.021	0.006	0.004	0.000	0.000	0.000	0.043

**Daily Emissions**

Phase	Description	Year	Emissions (pounds per day)	
			CO2	CH4
1	EPBM Flower	2015	47978.74	1.10
1	EPBM Flower	2016	47977.00	1.37
2	Cut & Cover Along Flower Street	2014	51599.76	0.86
2	Cut & Cover Along Flower Street	2015	51598.31	1.15
2	Cut & Cover Along Flower Street	2016	51596.84	1.43
2	Cut & Cover Along Flower Street	2017	51598.13	1.71

**Annual Emissions by Phase**

Phase	Description	Year	Emissions (tons per year)		CO2e Emissions (tons per year)			MTCO2e/Yr
			CO2	CH4	CO2	CH4:CO2	CO2e	
1	EPBM Flower	2015	3694.36	0.08	3694.36	1.77	3696.13	3352.39
1	EPBM Flower	2016	5805.22	0.17	5805.22	3.48	5808.69	5268.48
2	Cut & Cover Along Flower Street	2014	2270.39	0.04	2270.39	0.80	2271.18	2059.96
2	Cut & Cover Along Flower Street	2015	6810.98	0.15	6810.98	3.19	6814.17	6180.45
2	Cut & Cover Along Flower Street	2016	6810.78	0.19	6810.78	3.97	6814.76	6180.99
2	Cut & Cover Along Flower Street	2017	5108.22	0.17	5108.22	3.55	5111.76	4636.37

Note: Construction assumed to occur 22 days per month (i.e., 5 days per week).

Source:

Construction equipment emission factors from OFFROAD2007

21 GWP of CH4:CO2  
0.907 tons/MT

**Table 2-1: Hourly, Daily, Annual GHG Emissions Summary - Locally Preferred Alternative**  
**Annual GHG Emissions Summary**

Year	Description	MTCO <sub>2</sub> e
2014	Cut & Cover Along Flower Street	2059.96
	2014 Total, MTCO <sub>2</sub> e/Yr =	2059.96
2015	EPBM Flower	3352.39
	Cut & Cover Along Flower Street	6180.45
	2015 Total, MTCO <sub>2</sub> e/Yr =	9532.85
2016	EPBM Flower	5268.48
	Cut & Cover Along Flower Street	6180.99
	2016 Total, MTCO <sub>2</sub> e/Yr =	11449.47
2017	Cut & Cover Along Flower Street	4636.37
	2017 Total, MTCO <sub>2</sub> e/Yr =	4636.37

Table 2-4: Hourly, Daily, Annual GHG Emissions Summary - Alternative A

**Alternative 3**

Phase	Description	Hours per Day	Start Month	End Month	Duration (months)				Number of Equipment							
					2014	2015	2016	2017	Dozer	Excavator	Crane	Drill	Grout Drill	Grout Comp	Grout Gen	Flatbed
1	EPBM Flower WB	20	Jun-15	Mar-16	--	7	3	--	2	4	2	0	0	0	0	5
2	EPBM Flower EB	20	Oct-16	May-17	--	--	3	5	2	4	2	0	0	0	0	5
3	Grouting on Flower	20	Nov-14	Nov-15	2	11	--	--	0	0	0	0	4	4	4	5
4	Open Face/Shield on Flower	20	Mar-16	Dec-16	--	--	9	--	2	4	2	0	0	0	0	5
5	SEM on Flower	20	Dec-16	Dec-17	--	--	1	12	2	4	2	0	0	0	0	5
6	Cut & Cover Along Flower Street	20	Dec-17	Feb-18	--	--	--	1	2	4	2	1	0	0	0	5

Work days per month 22

**Hourly Emissions by Equipment**

Phase	Description	Year	CO2 Emissions (pounds per hour)							CH4 Emissions (pounds per hour)								
			Dozer	Excavator	Crane	Drill	Grout Drill	Grout Comp	Grout Gen	Flatbed	Dozer	Excavator	Crane	Drill	Grout Drill	Grout Comp	Grout Gen	Flatbed
1	EPBM Flower WB	2015	377.84	430.55	287.24	0.00	0.00	0.00	0.00	1303.32	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.03
1	EPBM Flower WB	2016	377.83	430.54	287.18	0.00	0.00	0.00	0.00	1303.29	0.01	0.02	0.01	0.00	0.00	0.00	0.00	0.04
2	EPBM Flower EB	2016	377.83	430.54	287.18	0.00	0.00	0.00	0.00	1303.29	0.01	0.02	0.01	0.00	0.00	0.00	0.00	0.04
2	EPBM Flower EB	2017	377.93	430.54	287.14	0.00	0.00	0.00	0.00	1303.26	0.01	0.02	0.01	0.00	0.00	0.00	0.00	0.04
3	Grouting on Flower	2014	0.00	0.00	0.00	0.00	2820.76	420.62	1400.03	1303.29	0.00	0.00	0.00	0.00	0.05	0.00	0.02	0.02
3	Grouting on Flower	2015	0.00	0.00	0.00	0.00	2762.11	420.57	1399.88	1303.32	0.00	0.00	0.00	0.00	0.06	0.01	0.02	0.03
4	Open Face/Shield on Flower	2016	377.83	430.54	287.18	0.00	0.00	0.00	0.00	1303.29	0.01	0.02	0.01	0.00	0.00	0.00	0.00	0.04
5	SEM on Flower	2016	377.83	430.54	287.18	0.00	0.00	0.00	0.00	1303.29	0.01	0.02	0.01	0.00	0.00	0.00	0.00	0.04
5	SEM on Flower	2017	377.93	430.54	287.14	0.00	0.00	0.00	0.00	1303.26	0.01	0.02	0.01	0.00	0.00	0.00	0.00	0.04
6	Cut & Cover Along Flower Street	2017	377.93	430.54	287.14	181.03	0.00	0.00	0.00	1303.26	0.01	0.02	0.01	0.00	0.00	0.00	0.00	0.04
2	Cut & Cover Along Flower Street	2015	377.84	430.55	287.24	0.00	0.00	0.00	0.00	1303.32	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.03
2	Cut & Cover Along Flower Street	2016	377.83	430.54	287.18	0.00	0.00	0.00	0.00	1303.29	0.01	0.02	0.01	0.00	0.00	0.00	0.00	0.04
2	Cut & Cover Along Flower Street	2017	377.93	430.54	287.14	0.00	0.00	0.00	0.00	1303.26	0.01	0.02	0.01	0.00	0.00	0.00	0.00	0.04

**Daily Emissions**

Phase	Description	Year	Emissions (pounds per day)	
			CO2	CH4
1	EPBM Flower WB	2015	47,978.74	1.10
1	EPBM Flower WB	2016	47,977.00	1.37
2	EPBM Flower EB	2016	47,977.00	1.37
2	EPBM Flower EB	2017	47,977.47	1.63
3	Grouting on Flower	2014	118,893.76	1.87
3	Grouting on Flower	2015	117,717.56	2.33
4	Open Face/Shield on Flower	2016	47,977.00	1.37
5	SEM on Flower	2016	47,977.00	1.37
5	SEM on Flower	2017	47,977.47	1.63
6	Cut & Cover Along Flower Street	2017	51,598.13	1.71



**Table 2-4: Hourly, Daily, Annual GHG Emissions Summary - Alternative A  
Annual Emissions by Phase - Alternative 3a (2nd/Hope Station (SEM))**

Phase	Description	Year	Emissions (tons per year)		CO2e Emissions (tons per year)			MTCO2e/Yr
			CO2	CH4	CO2	CH4:CO2	CO2e	
1	EPBM Flower WB	2015	3,694.36	0.08	3,694.36	1.77	3,696.13	3,352.39
1	EPBM Flower WB	2016	1,583.24	0.05	1,583.24	0.95	1,584.19	1,436.86
2	EPBM Flower EB	2016	1,583.24	0.05	1,583.24	0.95	1,584.19	1,436.86
2	EPBM Flower EB	2017	2,638.76	0.09	2,638.76	1.88	2,640.64	2,395.06
3	Grouting on Flower	2014	2,615.66	0.04	2,615.66	0.86	2,616.53	2,373.19
3	Grouting on Flower	2015	14,243.82	0.28	14,243.82	5.93	14,249.75	12,924.52
4	Open Face/Shield on Flower	2016	4,749.72	0.14	4,749.72	2.84	4,752.57	4,310.58
5	SEM on Flower	2016	527.75	0.02	527.75	0.32	528.06	478.95
5	SEM on Flower	2017	6,333.03	0.22	6,333.03	4.52	6,337.55	5,748.15
6	Cut & Cover Along Flower Street	2017	567.58	0.02	567.58	0.39	567.97	515.15

Note: Construction assumed to occur 22 days per month (i.e., 5 days per week).

Source:

Construction equipment emission factors from OFFROAD2007

21 GWP of CH4:CO2  
0.907 tons/MT

**Annual GHG Emissions Summary**

Year	Description	MTCO2e
2014	Grouting on Flower	2,373.19
	2014 Total, MTCO2e/Yr =	2,373.19
2015	EPBM Flower WB	3,352.39
	Grouting on Flower	12,924.52
	2015 Total, MTCO2e/Yr =	16,276.92
2016	EPBM Flower WB	1,436.86
	EPBM Flower EB	1,436.86
	Open Face/Shield on Flower	4,310.58
	SEM on Flower	478.95
	2016 Total, MTCO2e/Yr =	7,663.25
2017	EPBM Flower EB	2,395.06
	SEM on Flower	5,748.15
	Cut & Cover Along Flower Street	515.15
	2017 Total, MTCO2e/Yr =	8,658.37

Table 2-5: Hourly, Daily, Annual GHG Emissions Summary - Alternative B

**Alternative 4**

Phase	Description	Hours per Day	Start Month	End Month	Duration (months)			Number of Equipment									
					2014	2015	2016	2017	Dozer	Excavator	Crane	Drill	Grout Drill	Grout Comp	Grout Gen	Flatbed	
1	EPBM Flower	20	Jun-15	Feb-17	--	7	12	2	2	4	2	0	0	0	0	0	5
2	Grouting on Flower	20	Feb-15	Oct-15	--	8	--	--	0	0	0	0	2	2	2	5	5
3	SEM on Flower	20	Apr-16	May-17	--	--	9	5	2	4	2	0	0	0	0	5	5
4	Cut & Cover Along Flower Street	20	May-17	Jul-17	--	--	--	2	2	4	2	1	0	0	0	5	5

Work days per month 22

**Hourly Emissions by Equipment**

Phase	Description	Year	CO2 Emissions (pounds per hour)								CH4 Emissions (pounds per hour)							
			Dozer	Excavator	Crane	Drill	Grout Drill	Grout Comp	Grout Gen	Flatbed	Dozer	Excavator	Crane	Drill	Grout Drill	Grout Comp	Grout Gen	Flatbed
1	EPBM Flower	2015	377.837	430.546	287.238	0.000	0.000	0.000	0.000	1303.316	0.007	0.015	0.005	0.000	0.000	0.000	0.000	0.028
1	EPBM Flower	2016	377.834	430.544	287.184	0.000	0.000	0.000	0.000	1303.288	0.009	0.018	0.006	0.000	0.000	0.000	0.000	0.036
1	EPBM Flower	2017	377.933	430.544	287.140	0.000	0.000	0.000	0.000	1303.256	0.011	0.021	0.006	0.000	0.000	0.000	0.000	0.043
2	Grouting on Flower	2015	0.000	0.000	0.000	0.000	1381.056	210.286	699.939	1303.316	0.000	0.000	0.000	0.000	0.032	0.003	0.010	0.028
3	SEM on Flower	2016	377.834	430.544	287.184	0.000	0.000	0.000	0.000	1303.288	0.009	0.018	0.006	0.000	0.000	0.000	0.000	0.036
3	SEM on Flower	2017	377.933	430.544	287.140	0.000	0.000	0.000	0.000	1303.256	0.011	0.021	0.006	0.000	0.000	0.000	0.000	0.043
4	Cut & Cover Along Flower Street	2017	377.933	430.544	287.140	181.033	0.000	0.000	0.000	1303.256	0.011	0.021	0.006	0.004	0.000	0.000	0.000	0.043

**Daily Emissions**

Phase	Description	Year	Emissions (pounds per day)	
			CO2	CH4
1	EPBM Flower	2015	47978.74	1.10
1	EPBM Flower	2016	47977.00	1.37
1	EPBM Flower	2017	47977.47	1.63
2	Grouting on Flower	2015	71891.94	1.45
3	SEM on Flower	2016	47977.00	1.37
3	SEM on Flower	2017	47977.47	1.63
4	Cut & Cover Along Flower Street	2017	51598.13	1.71

**Annual Emissions - Alternative B**

Phase	Description	Year	Emissions (tons per year)		CO2e Emissions (tons per year)			MTCO2e/Yr
			CO2	CH4	CO2	CH4:CO2	CO2e	
1	EPBM Flower	2015	3694.36	0.08	3694.36	1.77	3696.13	3352.39
1	EPBM Flower	2016	6332.96	0.18	6332.96	3.79	6336.76	5747.44
1	EPBM Flower	2017	1055.50	0.04	1055.50	0.75	1056.26	958.03
2	Grouting on Flower	2015	6326.49	0.13	6326.49	2.67	6329.17	5740.55
3	SEM on Flower	2016	4749.72	0.14	4749.72	2.84	4752.57	4310.58
3	SEM on Flower	2017	2638.76	0.09	2638.76	1.88	2640.64	2395.06
4	Cut & Cover Along Flower Street	2017	1135.16	0.04	1135.16	0.79	1135.95	1030.30

Note: Construction assumed to occur 22 days per month (i.e., 5 days per week).

Source:

Construction equipment emission factors from OFFROAD2007

21 GWP of CH4:CO2  
0.907 tons/MT

**Table 2-5: Hourly, Daily, Annual GHG Emissions Summary - Alternative B**  
**Annual GHG Emissions Summary**

Year	Description	MTCO <sub>2</sub> e
2014	No Activity	0.00
	2014 Total, MTCO <sub>2</sub> e/Yr =	0.00
2015	EPBM Flower	3,352.39
	Grouting on Flower	5,740.55
	2015 Total, MTCO <sub>2</sub> e/Yr =	9,092.95
2016	EPBM Flower	5,747.44
	SEM on Flower	4,310.58
	2016 Total, MTCO <sub>2</sub> e/Yr =	10,058.02
2017	EPBM Flower	958.03
	SEM on Flower	2,395.06
	Cut & Cover Along Flower Street	1,030.30
	2017 Total, MTCO <sub>2</sub> e/Yr =	4,383.39

**Table 2-6: Daily and Annual GHG Emissions (Haul Trucks) - Locally Preferred Alternative**

**Locally Preferred Alternative/Baseline**

Phase	Description	Truck Trips	Daily VMT	Start Month	End Month	Total	Duration (months)			
							2014	2015	2016	2017
1	EPBM Flower	20	400	May-15	Nov-16	19	--	8	11	--
2	Cut & Cover Along Flower Street	20	400	Sep-14	Sep-17	37	4	12	12	9

Daily vehicle miles traveled (round-trip) 20 (estimated value) Default value from URBEMIS

**Daily Emissions**

Phase	Description	Year	Emissions (lb/day)	
			CO2	CH4
1	EPBM Flower	2015	1,696.86	0.03
1	EPBM Flower	2016	1,696.86	0.03
2	Cut & Cover Along Flower Street	2014	1,696.86	0.03
2	Cut & Cover Along Flower Street	2015	1,696.86	0.03
2	Cut & Cover Along Flower Street	2016	1,696.86	0.03
2	Cut & Cover Along Flower Street	2017	1,696.86	0.02

**Annual Emissions by Phase - Haul Trucks**

Phase	Description	Year	Emissions (tons per year)		CO2e Emissions (tons per year)			MTCO2e/Yr
			CO2	CH4	CO2	CH4:CO2	CO2e	
1	EPBM Flower	2015	149.32	2.56E-03	149.32	0.05	149.38	135.48
1	EPBM Flower	2016	205.32	3.20E-03	205.32	0.07	205.39	186.29
2	Cut & Cover Along Flower Street	2014	74.66	1.44E-03	74.66	0.03	74.69	67.75
2	Cut & Cover Along Flower Street	2015	223.98	3.84E-03	223.98	0.08	224.07	203.23
2	Cut & Cover Along Flower Street	2016	223.98	3.49E-03	223.98	0.07	224.06	203.22
2	Cut & Cover Along Flower Street	2017	167.99	2.44E-03	167.99	0.05	168.04	152.41

Note: Construction assumed to occur 22 days per month (i.e., 5 days per week).

**Comments:**

INDEX formula used to look-up emission factor from "EMFAC\_Construction.xlsx" spreadsheet.

MATCH formula used to identify row number and column number for each year-pollutant combination.

21 GWP of CH4:CO2  
0.907 tons/MT

**Annual GHG Emissions Summary - Haul Trucks**

Year	Description	MTCO2e
2014	Cut & Cover Along Flower Street	67.75
	2014 Total, MTCO2e/Yr =	67.75
2015	EPBM Flower	135.48
	Cut & Cover Along Flower Street	203.23
	2015 Total, MTCO2e/Yr =	338.71
2016	EPBM Flower	186.29
	Cut & Cover Along Flower Street	203.22
	2016 Total, MTCO2e/Yr =	389.51
2017	Cut & Cover Along Flower Street	152.41
	2017 Total, MTCO2e/Yr =	152.41

Table 2-9: Daily and Annual GHG Emissions (Haul Trucks) - Alternative A

**Alternative 3**

Phase	Description	Truck Trips	Daily VMT	Start Month	End Month	Total	Duration (months)			2017
							2014	2015	2016	
1	EPBM Flower WB	20	400	Jun-15	Mar-16	10	--	7	3	--
2	EPBM Flower EB	20	400	Oct-16	May-17	8	--	--	3	5
3	Grouting on Flower	0	0	Nov-14	Nov-15	13	2	11	--	--
4	Open Face/Shield on Flower	20	400	Mar-16	Dec-16	10	--	--	10	--
5	SEM on Flower	20	400	Dec-16	Dec-17	13	--	--	1	12
6	Cut & Cover Along Flower Street	20	400	Dec-17	Feb-18	3	--	--	--	1

Daily vehicle miles traveled (round-trip) 20 (estimated value) Default value from URBEMIS

**Daily Emissions**

Phase	Description	Year	Emissions (lb/day)	
			CO2	CH4
1	EPBM Flower WB	2015	1696.86	0.03
1	EPBM Flower WB	2016	1696.86	0.03
2	EPBM Flower EB	2016	1696.86	0.03
2	EPBM Flower EB	2017	1696.86	0.02
3	Grouting on Flower	2014	0.00	0.00
3	Grouting on Flower	2015	0.00	0.00
4	Open Face/Shield on Flower	2016	1696.86	0.03
5	SEM on Flower	2016	1696.86	0.03
5	SEM on Flower	2017	1696.86	0.02
6	Cut & Cover Along Flower Street	2017	1696.86	0.02

**Annual Emissions**

Phase	Description	Year	Emissions (tons per year)		CO2e Emissions (tons per year)			MTCO2e/Yr
			CO2	CH4	CO2	CH4:CO2	CO2e	
1	EPBM Flower WB	2015	130.66	2.24E-03	130.66	0.05	130.70	118.55
1	EPBM Flower WB	2016	56.00	8.73E-04	56.00	0.02	56.01	50.81
2	EPBM Flower EB	2016	56.00	8.73E-04	56.00	0.02	56.01	50.81
2	EPBM Flower EB	2017	93.33	1.36E-03	93.33	0.03	93.36	84.67
3	Grouting on Flower	2014	0.00	0.00E+00	0.00	0.00	0.00	0.00
3	Grouting on Flower	2015	0.00	0.00E+00	0.00	0.00	0.00	0.00
4	Open Face/Shield on Flower	2016	186.65	2.91E-03	186.65	0.06	186.72	169.35
5	SEM on Flower	2016	18.67	2.91E-04	18.67	0.01	18.67	16.94
5	SEM on Flower	2017	223.98	3.26E-03	223.98	0.07	224.05	203.22
6	Cut & Cover Along Flower Street	2017	18.67	2.72E-04	18.67	0.01	18.67	16.93

Note: Construction assumed to occur 22 days per month (i.e., 5 days per week).

**Comments:**

INDEX formula used to look-up emission factor from "EMFAC\_Construction.xlsx" spreadsheet.  
MATCH formula used to identify row number and column number for each year-pollutant combination.

21 GWP of CH4:CO2  
0.907 tons/MT

**Annual GHG Emissions Summary - Haul Trucks**

Year	Description	MTCO2e
2014	Grouting on Flower	0.00
	2014 Total, MTCO2e/Yr =	0.00
2015	EPBM Flower WB	118.55
	Grouting on Flower	0.00
	2015 Total, MTCO2e/Yr =	118.55
2016	EPBM Flower WB	50.81
	EPBM Flower EB	50.81
	Open Face/Shield on Flower	169.35
	SEM on Flower	16.94
	2016 Total, MTCO2e/Yr =	287.90
2017	EPBM Flower EB	84.67
	SEM on Flower	203.22
	Cut & Cover Along Flower Street	16.93
	2017 Total, MTCO2e/Yr =	304.82

Table 2-10: Daily and Annual GHG Emissions (Haul Trucks) - Alternative B

Alternative 4

Phase	Description	Truck Trips	Daily VMT	Start Month	End Month	Total	Duration (months)			
							2014	2015	2016	2017
1	EPBM Flower	20	400	Jun-15	Feb-17	21	--	7	12	2
2	Grouting on Flower	0	0	Feb-15	Oct-15	9	--	9	--	--
3	SEM on Flower	20	400	Apr-16	May-17	14	--	--	9	5
4	Cut & Cover Along Flower Street	20	400	May-17	Jul-17	3	--	--	--	3
5	SEM on Flower	20	400	Dec-16	Dec-17	13	--	--	1	12
6	Cut & Cover Along Flower Street	20	400	Dec-17	Feb-18	3	--	--	--	1

Daily vehicle miles traveled (round-trip) 20 (estimated value) Default value from URBEMIS

Daily Emissions

Phase	Description	Year	Emissions (lb/day)	
			CO2	CH4
1	EPBM Flower	2015	1696.86	0.03
1	EPBM Flower	2016	1696.86	0.03
1	EPBM Flower	2017	1696.86	0.02
2	Grouting on Flower	2015	0.00	0.00
3	SEM on Flower	2016	1696.86	0.03
3	SEM on Flower	2017	1696.86	0.02
4	Cut & Cover Along Flower Street	2017	1696.86	0.02
5	SEM on Flower	2016	1696.86	0.03
5	SEM on Flower	2017	1696.86	0.02
6	Cut & Cover Along Flower Street	2017	1696.86	0.02

Annual Emissions

Phase	Description	Year	Emissions (tons per year)		CO2e Emissions (tons per year)			MTCO2e/Yr
			CO2	CH4	CO2	CH4:CO2	CO2e	
1	EPBM Flower	2015	130.66	2.24E-03	130.66	0.05	130.70	118.55
1	EPBM Flower	2016	223.98	3.49E-03	223.98	0.07	224.06	203.22
1	EPBM Flower	2017	37.33	5.43E-04	37.33	0.01	37.34	33.87
2	Grouting on Flower	2015	0.00	0.00E+00	0.00	0.00	0.00	0.00
3	SEM on Flower	2016	167.99	2.62E-03	167.99	0.06	168.04	152.42
3	SEM on Flower	2017	93.33	1.36E-03	93.33	0.03	93.36	84.67
4	Cut & Cover Along Flower Street	2017	56.00	8.15E-04	56.00	0.02	56.01	50.80
5	SEM on Flower	2016	167.99	2.62E-03	167.99	0.06	168.04	152.42
5	SEM on Flower	2017	93.33	1.36E-03	93.33	0.03	93.36	84.67
6	Cut & Cover Along Flower Street	2017	56.00	8.15E-04	56.00	0.02	56.01	50.80

Note: Construction assumed to occur 22 days per month (i.e., 5 days per week).

Comments:

INDEX formula used to look-up emission factor from "EMFAC\_Construction.xlsx" spreadsheet.

MATCH formula used to identify row number and column number for each year-pollutant combination.

21 GWP of CH4:CO2  
0.907 tons/MT

Annual GHG Emissions Summary - Haul Trucks

Year	Description	MTCO2e
2014	No Activity	0.00
	2014 Total, MTCO2e/Yr =	0.00
2015	EPBM Flower	118.55
	Grouting on Flower	0.00
	2015 Total, MTCO2e/Yr =	118.55
2016	EPBM Flower	203.22
	SEM on Flower	152.42
	SEM on Flower	152.42
	2016 Total, MTCO2e/Yr =	508.05
2017	EPBM Flower	33.87
	SEM on Flower	84.67
	Cut & Cover Along Flower Street	50.80
	SEM on Flower	84.67
	Cut & Cover Along Flower Street	50.80
	2017 Total, MTCO2e/Yr	304.82

**Table 2-11: Daily and Annual GHG Emissions Summary (Worker Commute) - Locally Preferred Alternative**

**Locally Preferred Alternative/Baseline**

Phase	Description	No. of Crew	Daily VMT	Start Month	End Month	Total	Duration (months)			
							2014	2015	2016	2017
1	EPBM Flower	20	600	May-15	Nov-16	19	--	8	11	--
2	Cut & Cover Along Flower Street	30	900	Sep-14	Sep-17	37	4	12	12	9

Daily vehicle miles traveled (round-trip) 30 (estimated value)

**Daily Emissions**

Phase	Description	Year	Emissions (lb/day)	
			CO2	CH4
1	EPBM Flower	2015	509.81	0.02
1	EPBM Flower	2016	509.18	0.02
2	Cut & Cover Along Flower Street	2014	765.81	0.04
2	Cut & Cover Along Flower Street	2015	764.71	0.04
2	Cut & Cover Along Flower Street	2016	763.77	0.03
2	Cut & Cover Along Flower Street	2017	762.89	0.03

**Annual Emissions**

Phase	Description	Year	Emissions (tons per year)		CO2e Emissions (tons per year)			MTCO2e/Yr
			CO2	CH4	CO2	CH4:CO2	CO2e	
1	EPBM Flower	2015	4.49E+01	2.10E-03	44.86	0.04	44.91	40.73
1	EPBM Flower	2016	6.16E+01	2.64E-03	61.61	0.06	61.67	55.93
2	Cut & Cover Along Flower Street	2014	3.37E+01	1.75E-03	33.70	0.04	33.73	30.60
2	Cut & Cover Along Flower Street	2015	1.01E+02	4.71E-03	100.94	0.10	101.04	91.64
2	Cut & Cover Along Flower Street	2016	1.01E+02	4.32E-03	100.82	0.09	100.91	91.52
2	Cut & Cover Along Flower Street	2017	7.55E+01	3.04E-03	75.53	0.06	75.59	68.56

Note: Construction assumed to occur 22 days per month (i.e., 5 days per week).

**Comments:**

INDEX formula used to look-up emission factor from "EMFAC\_Construction.xlsx" spreadsheet.  
MATCH formula used to identify row number and column number for each year-pollutant combination.

21 GWP of CH4:CO2  
0.907 tons/MT

**Annual GHG Emissions Summary - Worker Commute**

Year	Description	MTCO2e
2014	Cut & Cover Along Flower Street	30.60
	2014 Total, MTCO2e/Yr =	30.60
2015	EPBM Flower	40.73
	Cut & Cover Along Flower Street	91.64
	2015 Total, MTCO2e/Yr =	132.37
2016	EPBM Flower	55.93
	Cut & Cover Along Flower Street	91.52
	2016 Total, MTCO2e/Yr =	147.46
2017	Cut & Cover Along Flower Street	68.56
	2017 Total, MTCO2e/Yr =	68.56

**Table 2-14: Daily and Annual GHG Emissions Summary (Worker Commute) - Alternative A**

**Alternative A**

Phase	Description	No. of Crew	Daily VMT	Start Month	End Month	Total	Duration (months)			
							2014	2015	2016	2017
1	EPBM Flower WB	20	600	Jun-15	Mar-16	10	--	7	3	--
2	EPBM Flower EB	20	600	Oct-16	May-17	8	--	--	3	5
3	Grouting on Flower	40	1,200	Nov-14	Nov-15	13	2	11	--	--
4	Open Face/Shield on Flower	20	600	Mar-16	Dec-16	10	--	--	10	--
5	SEM on Flower	20	600	Dec-16	Dec-17	13	--	--	1	12
6	Cut & Cover Along Flower Street	30	900	Dec-17	Feb-18	3	--	--	--	1

Daily vehicle miles traveled (round-trip) 30 (estimated value)

**Daily Emissions**

Phase	Description	Year	Emissions (lb/day)	
			CO2	CH4
1	EPBM Flower WB	2015	509.81	0.02
1	EPBM Flower WB	2016	509.18	0.02
2	EPBM Flower EB	2016	509.18	0.02
2	EPBM Flower EB	2017	508.59	0.02
3	Grouting on Flower	2014	1021.08	0.05
3	Grouting on Flower	2015	1019.61	0.05
4	Open Face/Shield on Flower	2016	509.18	0.02
5	SEM on Flower	2016	509.18	0.02
5	SEM on Flower	2017	508.59	0.02
6	Cut & Cover Along Flower Street	2017	762.89	0.03

**Annual Emissions**

Phase	Description	Year	Emissions (tons per year)		CO2e Emissions (tons per year)			MTCO2e/Yr
			CO2	CH4	CO2	CH4:CO2	CO2e	
1	EPBM Flower WB	2015	3.93E+01	1.83E-03	3.93E+01	3.85E-02	3.93E+01	3.56E+01
1	EPBM Flower WB	2016	1.68E+01	7.20E-04	1.68E+01	1.51E-02	1.68E+01	1.53E+01
2	EPBM Flower EB	2016	1.68E+01	7.20E-04	1.68E+01	1.51E-02	1.68E+01	1.53E+01
2	EPBM Flower EB	2017	2.80E+01	1.13E-03	2.80E+01	2.37E-02	2.80E+01	2.54E+01
3	Grouting on Flower	2014	2.25E+01	1.16E-03	2.25E+01	2.44E-02	2.25E+01	2.04E+01
3	Grouting on Flower	2015	1.23E+02	5.76E-03	1.23E+02	1.21E-01	1.23E+02	1.12E+02
4	Open Face/Shield on Flower	2016	5.60E+01	2.40E-03	5.60E+01	5.04E-02	5.61E+01	5.08E+01
5	SEM on Flower	2016	5.60E+00	2.40E-04	5.60E+00	5.04E-03	5.61E+00	5.08E+00
5	SEM on Flower	2017	6.71E+01	2.71E-03	6.71E+01	5.68E-02	6.72E+01	6.09E+01
6	Cut & Cover Along Flower Street	2017	8.39E+00	3.38E-04	8.39E+00	7.10E-03	8.40E+00	7.62E+00

Note: Construction assumed to occur 22 days per month (i.e., 5 days per week).

**Comments:**

INDEX formula used to look-up emission factor from "EMFAC\_Construction.xlsx" spreadsheet.

MATCH formula used to identify row number and column number for each year-pollutant combination.

21 GWP of CH4:CO2  
0.907 tons/MT

**Annual GHG Emissions Summary - Worker Commute**

Year	Description	MTCO2e
2014	Grouting on Flower	20.40
	2014 Total, MTCO2e/Yr =	20.40
2015	EPBM Flower WB	35.64
	Grouting on Flower	112.01
	2015 Total, MTCO2e/Yr =	147.65
2016	EPBM Flower WB	15.25
	EPBM Flower EB	15.25
	Open Face/Shield on Flower	50.85
	SEM on Flower	5.08
	2016 Total, MTCO2e/Yr =	86.44
2017	EPBM Flower EB	25.39
	SEM on Flower	60.94
	Cut & Cover Along Flower Street	7.62
	2017 Total, MTCO2e/Yr =	93.95



**Table 2-15: Daily and Annual GHG Emissions Summary (Worker Commute) - Alternative B**

**Alternative B**

Phase	Description	No. of Crew	Daily VMT	Start Month	End Month	Total	Duration (months)			
							2014	2015	2016	2017
1	EPBM Flower	20	600	Jun-15	Feb-17	21	--	7	12	2
2	Grouting on Flower	20	600	Feb-15	Oct-15	9	--	9	--	--
3	SEM on Flower	20	600	Apr-16	May-17	14	--	--	9	5
4	Cut & Cover Along Flower Street	30	900	May-17	Jul-17	3	--	--	--	3
5	SEM on Flower	20	600	Dec-16	Dec-17	13	--	--	1	12
6	Cut & Cover Along Flower Street	20	600	Dec-17	Feb-18	3	--	--	--	1

Daily vehicle miles traveled (round-trip) 30 (estimated value)

**Daily Emissions**

Phase	Description	Year	Emissions (lb/day)	
			CO2	CH4
1	EPBM Flower	2015	509.81	0.02
1	EPBM Flower	2016	509.18	0.02
1	EPBM Flower	2017	508.59	0.02
2	Grouting on Flower	2015	509.81	0.02
3	SEM on Flower	2016	509.18	0.02
3	SEM on Flower	2017	508.59	0.02
4	Cut & Cover Along Flower Street	2017	762.89	0.03
5	SEM on Flower	2016	2545.28	0.04
5	SEM on Flower	2017	2545.28	0.04
6	Cut & Cover Along Flower Street	2017	2545.28	0.04

**Annual Emissions**

Phase	Description	Year	Emissions (tons per year)		CO2e Emissions (tons per year)			MTCO2e/Yr
			CO2	CH4	CO2	CH4:CO2	CO2e	
1	EPBM Flower	2015	39.26	0.00	39.26	0.04	39.29	35.64
1	EPBM Flower	2016	67.21	0.00	67.21	0.06	67.27	61.02
1	EPBM Flower	2017	11.19	0.00	11.19	0.01	11.20	10.16
2	Grouting on Flower	2015	50.47	0.00	50.47	0.05	50.52	45.82
3	SEM on Flower	2016	50.41	0.00	50.41	0.05	50.45	45.76
3	SEM on Flower	2017	27.97	0.00	27.97	0.02	28.00	25.39
4	Cut & Cover Along Flower Street	2017	25.18	0.00	25.18	0.02	25.20	22.85
5	SEM on Flower	2016	251.98	0.00	251.98	0.08	252.07	228.62
5	SEM on Flower	2017	139.99	0.00	139.99	0.04	140.03	127.01
6	Cut & Cover Along Flower Street	2017	83.99	0.00	83.99	0.03	84.02	76.21

Note: Construction assumed to occur 22 days per month (i.e., 5 days per week).

**Comments:**

INDEX formula used to look-up emission factor from "EMFAC\_Construction.xlsx" spreadsheet.

MATCH formula used to identify row number and column number for each year-pollutant combination.

21 GWP of CH4:CO2  
0.907 tons/MT

**Annual GHG Emissions Summary - Worker Commute**

Year	Description	MTCO2e
2014	No Activity	0.00
	2014 Total, MTCO2e/Yr =	0.00
2015	EPBM Flower	35.64
	Grouting on Flower	45.82
	2015 Total, MTCO2e/Yr =	81.46
2016	EPBM Flower	61.02
	SEM on Flower	45.76
	SEM on Flower	228.62
	2016 Total, MTCO2e/Yr =	335.40
2017	EPBM Flower	10.16
	SEM on Flower	25.39
	Cut & Cover Along Flower Street	22.85
	SEM on Flower	127.01
	Cut & Cover Along Flower Street	76.21
2017 Total, MTCO2e/Yr =	261.62	