Table A1
Maximum Daily Construction Emissions
Loomis-SPMUD Sewer Diversion Pipeline Project

Maximum Daily Construction Emissions in 2018 (lbs/day)										
Emission Source	**NOx**	**CO**	**ROG**	**SOx**	**PM_{10}**	**$PM_{2.5}$**	**CO_2**	**CH_4**	**N_2O**	**CO_2e**
Onsite										
Mobile Equipment Engine Exhaust	12	6.1	1.08	0.024	0.61	0.59	2472	0.10	0.020	2480
Fugitive Dust from Mobile Equipment	-	-	-	-	4.08	0.73	-	-	-	-
Subtotal Onsite in 2018:	12	6.1	1.08	0.024	4.7	1.32	2,472	0.10	0.020	2,480
Offsite										
Worker Travel	0.26	2.0	0.078	0.0054	0.072	0.030	540	0.018	0.0044	542
Fugitive Dust from Worker Travel					4.8	1.17				
Construction Materials Deliveries	0.67	0.052	0.010	0.0016	0.015	0.0089	167	0.00060	0.0014	167
Fugitive Dust from Materials Delivery Trucks					0.92	0.23				
Subtotal Offsite in 2018:	0.93	2.07	0.09	0.0070	5.8	1.43	707	0.019	0.0057	709
Total Daily Construction Emissions in 2018 (rounded)	**12.9**	**8.2**	**1.2**	**0.031**	**10.5**	**2.8**	**3,178**	**0.12**	**0.026**	**3,189**

Table A2
2018 Construction Onsite Equipment Hours, Emission Factors, and Emissions
Loomis/SPMUD Sewer Pipeline Project

Equipment	HP	Load Factor (1) ( )	Off-Road or On-Road?	Tier	BSFC(2) (lb/hp-hr)	Annual Use (hrs/yr)	Daily Use(4) (hrs/day)	On-Site Average Speed(4) (mph)	Daily Distance Traveled (mi)	Annual Distance Traveled (mi)
Pickup trucks, three	300 (8)		On	-	-	173.3	2	5	10.0	867
Haul/Delivery trucks	400 (1)		On	-	-	21.7 (16)	0.5	5	2.5	108
Water truck	400 (1)	0.38 (1)	On	-	-	693.3	8	5	40.0	3467
Excavator	163 (1)	0.38 (1)	Off	3	0.367	347 (16)	8	-	-	-
Boring machine	206 (1)	0.50 (1)	Off	3	0.367	347 (16)	8	-	-	-
Backhoe	98 (1)	0.37 (1)	Off	3B	0.367	173.3 (16)	4	-	-	-
Compactor	81 (1)	0.38 (1)	Off	3B	0.367	35	4	1.5	6.0	52
Wheeled Loader	98 (1)	0.37 (1)	Off	3	0.367	346.7 (16)	8	-	-	-
Welder	46 (1)	0.45 (1)	Off	4A	0.408	173.3 (16)	4	-	-	-
Total	-	-	-	-	-	2,310	-	-	-	-

Equipment	ARB Off-Road or EPA Nonroad(3) Emission Factors (g/bhp-hr)									
	NOx(2)	CO(2)	VOC(2)	SOx(5)	PM_{10} (2)	$PM_{2.5}$ (6)	CO_2 (7)	CH_4 (8,9)	N_2O(8,10)	CO_2e(11,12)
Pickup trucks, three	-	-	-	-	-	-	-	-	-	-
Haul/Delivery trucks	-	-	-	-	-	-	-	-	-	-
Water truck	-	-	-	-	-	-	-	-	-	-
Excavator	2.5	0.8667	0.1836	0.0050	0.22	0.21	531	0.022	0.0043	533
Boring machine	2.15 (1)	1.073 (1)	0.1545 (1)	0.0048 (1)	0.0608 (1)	0.056 (1)	484.5605 (1)	0.1509 (1)	0.0039	490
Backhoe	3.0	2.3655	0.1836	0.0050	0.20	0.19	531	0.022	0.0043	533
Compactor	3.0	2.3655	0.1836	0.0050	0.20	0.19	531	0.022	0.0043	533
Wheeled Loader	2.45	0.843	0.10	0.0050	0.11	0.11	531	0.022	0.0043	533
Welder	4.607 (1)	5.092 (1)	1.21 (1)	0.007 (1)	0.311 (1)	0.311 (1)	568.299 (1)	0.109 (1)	##########	572 (21,22)
Total	-	-	-	-	-	-	-	-	-	-

Equipment	Onroad Emission Factors (lbs/VMT)(3)									
	NOx	CO	ROG	SOx	PM_{10}	$PM_{2.5}$	CO_2	CH_4 (8,9)	N_2O(8,10)	CO_2e(11,12)
Pickup trucks, three	7.81E-04	6.85E-03	6.31E-03	3.72E-05	2.35E-05	2.16E-05	3.71E+00	0.000189	0.000030	3.73
Haul/Delivery trucks	5.09E-02	1.01E-02	3.69E-03	6.95E-05	2.92E-04	2.80E-04	7.28E+00	0.07779	0.000059	9.24
Water truck	2.40E-02	5.63E-03	3.21E-03	4.72E-05	4.32E-04	4.13E-04	4.95E+00	0.00015	0.000040	4.97
Excavator	-	-	-	-	-	-	-	-	-	-
Boring machine	-	-	-	-	-	-	-	-	-	-
Backhoe	-	-	-	-	-	-	-	-	-	-
Compactor	-	-	-	-	-	-	-	-	-	-
Wheeled Loader	-	-	-	-	-	-	-	-	-	-
Welder	-	-	-	-	-	-	-	-	-	-
Total	-	-	-	-	-	-	-	-	-	-

Equipment	Daily Offroad Equipment Emissions (lbs/day)									
	NOx	CO	VOC	SOx	PM_{10}	$PM_{2.5}$	CO_2	CH_4 (8,9)	N_2O(8,10)	CO_2e(11,12)
Pickup trucks, three	7.81E-03	6.85E-02	6.31E-02	3.72E-04	2.35E-04	2.16E-04	3.71E+01	0.0015 (18,19)	0.00030 (18,20)	37 (21,22)
Haul/Delivery trucks	1.27E-01	2.53E-02	9.23E-03	1.74E-04	7.30E-04	6.99E-04	1.82E+01	0.0007 (18,19)	0.00015 (18,20)	18 (21,22)
Water truck	9.59E-01	2.25E-01	1.28E-01	1.89E-03	1.73E-02	1.65E-02	1.98E+02	0.0080 (18,19)	0.0016 (18,20)	199 (21,22)
Excavator	2.73E+00	9.47E-01	2.01E-01	5.46E-03	2.40E-01	2.33E-01	5.80E+02	0.024 (18,19)	0.0047 (18,20)	582 (21,22)
Boring machine	3.91E+00	1.95E+00	2.81E-01	8.72E-03	1.10E-01	1.02E-01	8.80E+02	0.0357 (18,19)	0.00714 (18,20)	883 (21,22)
Backhoe	9.59E-01	7.56E-01	5.87E-02	1.60E-03	6.40E-02	6.20E-02	1.70E+02	0.0069 (18,19)	0.0014 (18,20)	170 (21,22)
Compactor	8.14E-01	6.42E-01	4.98E-02	1.36E-03	5.43E-02	5.27E-02	1.44E+02	0.0059 (18,19)	0.0012 (18,20)	145 (21,22)
Wheeled Loader	1.57E+00	5.39E-01	6.40E-02	3.19E-03	7.04E-02	6.82E-02	3.40E+02	0.0138 (18,19)	0.0028 (18,20)	341 (21,22)
Welder	8.41E-01	9.30E-01	2.21E-01	1.28E-03	5.68E-02	5.68E-02	1.04E+02	0.004 (18,19)	0.0008 (18,20)	104 (21,22)
Total	11.9	6.1	1.08	0.024	0.61	0.59	2,472	0.10	0.020	2,480

Equipment	Annual Offroad Equipment Emissions (tpy)										Weight (tons)	Notes
	NOx	CO	VOC	SOx	PM_{10}	$PM_{2.5}$	CO_2	CH_4 (8,9)	N_2O(8,10)	CO_2e(11,12)		
Pickup trucks, three	3.38E-04	2.97E-03	2.73E-03	1.61E-05	1.02E-05	9.37E-06	1.61E+00	0.00007	0.000013	1.61		
Haul/Delivery trucks	2.76E-03	5.48E-04	2.00E-04	3.76E-06	1.58E-05	1.51E-05	3.94E-01	0.00002	0.000003	0.40		
Water truck	4.16E-02	9.77E-03	5.57E-03	8.19E-05	7.48E-04	7.16E-04	8.58E+00	0.00035	0.00007	8.6		(15)
Excavator	5.92E-02	2.05E-02	4.35E-03	1.18E-04	5.21E-03	5.05E-03	1.26E+01	0.0005	0.00010	12.6	######	
Boring machine	8.48E-02	4.22E-02	6.08E-03	1.89E-04	2.39E-03	2.20E-03	1.91E+01	0.00077	0.000155	19.14		
Backhoe	2.08E-02	1.64E-02	1.27E-03	3.46E-05	1.39E-03	1.34E-03	3.68E+00	0.00015	0.00003	3.7	1.2	
Compactor	3.53E-03	2.78E-03	2.16E-04	5.87E-06	2.35E-04	2.28E-04	6.25E-01	0.00003	0.00001	0.6		
Wheeled Loader	3.40E-02	1.17E-02	1.39E-03	6.92E-05	1.52E-03	1.48E-03	7.36E+00	0.00030	0.00006	7.4	14.2	
Welder	1.82E-02	2.01E-02	4.79E-03	2.77E-05	1.23E-03	1.23E-03	2.25E+00	0.00009	0.00002	2.26		
Total	0.27	0.13	0.027	0.00055	0.013	0.012	56	0.0023	0.00046	56		

1) CalEEMod (Version 2013.2.2) Appendix D Tables 3.3 and 33.4 default values.
2) EPA, *Exhaust and Crankcase Emission Factors for Nonroad Engine Modeling – Compression-Ignition*, ReportNR-009d, EPA-420-R-10-018, Table A4, July 2010
3) EMFAC2014 for part of Placer County in the Sacramento Valley Air Basin in 2017 at an annual average temperature of 60 F and relative humidity of 50%.
4) Estimated
5) Calculated from BSFC assuming 15 ppmw sulfur in Diesel fuel.
6) $PM_{2.5}/PM_{10}$ ratio (Footnote 2) = 0.97
7) Density of Distillate Fuel No. 2 (metric tons fuel/bbl fuel) = 0.1346 (CFR Part 98, Subpart MM, Table MM-1)
CO_2 emission factor for Distillate Fuel No. 2 (metric tons CO_2/bbl fuel) = 0.4296 (CFR Part 98, Subpart MM, Table MM-1)
CO_2 emission factor for gasoline (metric tons CO_2/bbl fuel) = 0.3686 (CFR Part 98, Subpart MM, Table MM-1)
8) Diesel fuel CO_2 emission factor (kg CO_2/MMBtu) = 73.96 (EPA. 2013 Revisions to the Greenhouse Gas Reporting Rule and Final Confidentiality Determinations for New or Substantitally Revised Data Elements; Final Rule, Federal Register, Volume 78, Number 230, Table C-1 to Subpart C, p. 71951, November 29, 2013.)
9) Diesel fuel CH_4 emission factor (kg CH_4/MMBtu) = 0.003 (EPA. 2013 Revisions to the Greenhouse Gas Reporting Rule and Final Confidentiality Determinations for New or Substantitally Revised Data Elements; Final Rule, Federal Register, Volume 78, Number 230, Table C-2 to Subpart C, p. 71952, November 29, 2013.)
10) Diesel fuel N_2O emission factor (kg N_2O/MMBtu) = 0.0006 (EPA. 2013 Revisions to the Greenhouse Gas Reporting Rule and Final Confidentiality Determinations for New or Substantitally Revised Data Elements; Final Rule, Federal Register, Volume 78, Number 230, Table C-2 to Subpart C, p. 71952, November 29, 2013.)
11) CH_4 Global Warming Potential (-) = 25 (EPA. 2013 Revisions to the Greenhouse Gas Reporting Rule and Final Confidentiality Determinations for New or Substantitally Revised Data Elements; Final Rule, Federal Register, Volume 78, Number 230, Table 2, p. 71909, November 29, 2013.)
12) N_2O Global Warming Potential (-) = 298 (EPA. 2013 Revisions to the Greenhouse Gas Reporting Rule and Final Confidentiality Determinations for New or Substantitally Revised Data Elements; Final Rule, Federal Register, Volume 78, Number 230, Table 2, p. 71909, November 29, 2013.)
13) Caterpillar, *Cat Resource Center* , http://www.catresourcecenter.com/construction-excavators.asp?utm_campaign=catbc1630
14)
15) Assumed same as off-highway trucks in CalEEMod Appendix D Table 3.3.
16) Equipment used for half the period of Phase 3 because other activities occupy the other half (e.g., mobilization/demobilization/maintenance/weather delay).

Table A3
Construction Fugitive Dust Emission Summary
Loomis-SPMUD Sewer Diversion Pipeline Project

Daily Construction Fugitive Dust Emissions

$PM_{2.5}$ (lb/day)		
	Daily Fugitive Dust Emission by Construction Phase	
Equipment / Project Year:	2017	2018
Pickup trucks, three	0.031	0.031
Haul/Delivery trucks	0.020	0.020
Water truck	0.27	0.27
Dump truck	0.16	0
Excavator	0.11	0.11
Paving(2017)/Boring(2018) Machine	0.014	0.11
Backhoe	0.053	0.053
Compactor	0.073	0.036
Wheeled Loader	0.11	0.11
$PM_{2.5}$ Subtotal (lbs/day) =	0.83	0.73

PM_{10} (lb/day)		
	Daily Fugitive Dust Emission by Construction Phase	
Equipment / Project Year:	2017	2018
Pickup trucks, three	0.31	0.31
Haul/Delivery trucks	0.20	0.20
Water truck	2.65	2.65
Dump truck	1.59	
Excavator	0.19	0.19
Paving(2017)/Boring(2018) Machine	0.048	0.19
Backhoe	0.10	0.10
Compactor	0.48	0.24
Wheeled Loader	0.19	0.19
PM_{10} Subtotal (lbs/day) =	5.77	4.08

$PM_{2.5}$ (lb/day)		
	Daily Fugitive Dust Emission by Construction Phase	
Source / Project Year:	2017	2018
Windblown Dust (active construction	0.00022	0.00022
$PM_{2.5}$ Subtotal (lbs/day) =	0.00022	0.00022
$PM_{2.5}$ Total (lbs/day) =	0.83	0.73

PM_{10} (lb/day)		
	Daily Fugitive Dust Emission by Construction Phase	
Source / Project Year:	2017	2018
Windblown Dust (active construction	0.00056	0.00056
PM_{10} Subtotal (lbs/day) =	0.00056	0.00056
PM_{10} Total (lbs/day) =	5.8	4.1

Annual Construction Fugitive Dust Emissions

$PM_{2.5}$ (tpy)		
	Annual Fugitive Dust Emission by Construction Phase	
Equipment / Project Year:	2017	2018
Pickup trucks, three	0.0037	0.0014
Haul/Delivery trucks	0.0024	0.00043
Water truck	0.032	0.011
Dump truck	0.019	0
Excavator	0.013	0.0023
Paving(2017)/Boring(2018) Machine	0.00016	0.0023
Backhoe	0.0063	0.0012
Compactor	0.00058	0.00010
Wheeled Loader	0.013	0.0023
$PM_{2.5}$ Subtotal (tpy) =	0.09	0.021

PM_{10} (tpy)		
	Annual Fugitive Dust Emission by Construction Phase	
Equipment / Project Year:	2017	2018
Pickup trucks, three	0.0375	0.0014
Haul/Delivery trucks	0.0237	0.00043
Water truck	0.316	0.011
Dump truck	0.189	0
Excavator	0.023	0.0023
Paving(2017)/Boring(2018) Machine	0.00162	0.0023
Backhoe	0.0115	0.0012
Compactor	0.00577	0.00010
Wheeled Loader	0.023	0.0023
PM_{10} Subtotal (tpy) =	0.63	0.021

$PM_{2.5}$ (tpy)		
	Annual Fugitive Dust Emission by Construction Phase	
Source / Project Year:	2017	2018
Windblown Dust (active construction	0.000027	0.000010
$PM_{2.5}$ Subtotal (tpy) =	0.000027	0.000010
$PM_{2.5}$ Total (tpy) =	0.089	0.021

PM_{10} (tpy)		
	Annual Fugitive Dust Emission by Construction Phase	
Source / Project Year:	2017	2018
Windblown Dust (active construction	0.000067	0.000024
PM_{10} Subtotal (tpy) =	0.000067	0.000024
PM_{10} Total (tpy) =	0.63	0.021

Table A4
Construction Offsite On-Road Vehicle Emissions
Loomis-SPMUD Sewer Diversion Pipeline Project

Construction Offsite On-Road Vehicle Emissions in 2018

Materials DeliveryTruck Emissions in 2018

Materials Delivery Truck Peak Daily Emissions in 2018																					
Maximum Number of Deliveries per Day	Average Round-Trip Haul Distance (miles)	Vehicle-Miles Traveled per Day	Emission Factors (lbs/VMT)									Daily Emissions (lbs/day)									
			NOx	CO	VOC	SOx	PM_{10}	$PM_{2.5}$	CO_2	CH_4 (2,3)	N_2O (2,4)	NOx	CO	VOC	SOx	PM_{10}	$PM_{2.5}$	CO_2	CH_4	N_2O	CO_2e (5,6)
1	46	46	0.0121	0.00077	0.00015	0.000031	0.00033	0.00019	3.29	0.0000088	0.000027	0.67	0.052	0.010	0.0016	0.015	0.0089	167	0.00060	0.0014	167
Paved-Road Fugitive Dust							0.020	0.0049								0.92	0.23				

Materials Delivery Truck Annual Emissions in 2018																					
Number of Deliveries per Year	Average Round-Trip Haul Distance (miles)	Annual Vehicle-Miles Traveled	Emission Factors (lbs/VMT)									Annual Emissions (tons/yr)									
			NOx	CO	VOC	SOx	PM_{10}	$PM_{2.5}$	CO_2	CH_4	N_2O	NOx	CO	VOC	SOx	PM_{10}	$PM_{2.5}$	CO_2	CH_4	N_2O	CO_2e (5,6)
18	46	828	0.0121	0.00077	0.00015	0.000031	0.00033	0.00019	3.29	0.0000088	0.000027	0.0061	0.00047	0.00010	0.000014	0.00014	0.000080	1.50	0.0000054	0.000012	1.50
Paved-Road Fugitive Dust							0.019	0.0046								0.0078	0.0019				

2) Diesel fuel CO_2 emission factor (kg CO_2/MMBtu) = 73.96 (EPA. 2013 Revisions to the Greenhouse Gas Reporting Rule and Final Confidentiality Determinations for New or Substantitally Revised Data Elements; Final Rule, Federal Register, Volume 78, Number 230, Table C-1 to Subpart C, p. 71951, November 29, 2013.)

3) Diesel fuel CH_4 emission factor (kg CH_4/MMBtu) = 0.0030 (EPA. 2013 Revisions to the Greenhouse Gas Reporting Rule and Final Confidentiality Determinations for New or Substantitally Revised Data Elements; Final Rule, Federal Register, Volume 78, Number 230, Table C-2 to Subpart C, p. 71952, November 29, 2013.)

4) Diesel fuel N_2O emission factor (kg N_2O/MMBtu) = 0.0006 Ibid

5) CH_4 Global Warming Potential (-) = 25 (EPA. 2013 Revisions to the Greenhouse Gas Reporting Rule and Final Confidentiality Determinations for New or Substantitally Revised Data Elements; Final Rule, Federal Register, Volume 78, Number 230, Table 2, p. 71909, November 29, 2013.)

6) N_2O Global Warming Potential (-) = 298 Ibid

Table A4
Construction Offsite On-Road Vehicle Emissions
Loomis-SPMUD Sewer Diversion Pipeline Project

Construction Worker Vehicle Emissions in 2018

Worker Travel Daily Emissions in 2018 (Maximum)																							
Maximum Number of Workers per Day	Average Number of Worker Round Trips Per Day	Total Number of Worker Round Trips per Day	Average Worker Round Trip Distance (Miles)	Carpool Factor (No. People per Vehicle)	Worker Vehicle Distance Traveled per Day (miles)	Emission Factors (lbs/vmt)									Daily Emissions (lbs/day)									
						NOx	CO	VOC	SOx	PM_{10}	$PM_{2.5}$	CO_2	CH_4[2,3]	N_2O[2,4]	NOx	CO	VOC	SOx	PM_{10}	$PM_{2.5}$	CO_2	CH_4	N_2O	CO_2e[5,6]
15	1	15	46	1	690	0.00036	0.0028	0.000094	0.0000078	0.00010	0.000044	0.78	0.000025	0.0000063	0.26	2.0	0.078	0.0054	0.0718	0.0305	539.9	0.0179	0.00438	542
Paved-Road Fugitive Dust										0.0069	0.0017								4.75	1.17				

Worker Travel Annual Emissions in 2018																								
Annual Average (Weighted) Number of Workers Per Day	Average Number of Worker Round Trips Per Day	Total Number of Worker Round Trips per Day	Average Worker Round Trip Distance (Miles)	Carpool Factor (No. People per Vehicle)	Number of Construction Days	Vehicle Miles Traveled Per Year	Emission Factors (lbs/vmt)									Annual Emissions (tons/yr)								
							NOx	CO	VOC	SOx	PM_{10}	$PM_{2.5}$	CO_2	CH_4	N_2O	NOx	CO	VOC	SOx	PM_{10}	$PM_{2.5}$	CO_2	CH_4	N_2O	CO_2e[5,6]
15.0	1	15.0	46	1	87	59,800	0.00036	0.0028	0.000094	0.0000078	0.00010	0.000044	0.78	0.000025	0.0000063	0.011	0.087	0.010	0.00023	0.0031	0.0013	23.4	0.00083	0.00019	23.5
Paved-Road Fugitive Dust											0.0065	0.0016								0.19	0.047				

Table A5
Assumptions for Construction Emission Analysis
Loomis-SPMUD Sewer Diversion Pipeline Project

Assumption	Units	Value	Reference
Number of construction days per week	days/week	5	Project Description, page 14
Construction period, CY 2017	days/year	238	48 weeks for Phases 1 and 2
Construction period, CY 2018	days/year	87	17 weeks for Phase 3
Construction schedule, daily	hrs/day	8	Estimated
Number of construction workers commuting to job site	number	15	Estimated
Number of daily round-trips by each construction worker	trips/day	1	Assumes no travel home for lunch
Construction worker average one-way commute distance	miles	23	Distance to center of Sacramento
Number of construction materials deliveries in CY 2017	number	48	Assumes weekly
Number of construction materials deliveries in CY 2018	number	17	Assumes weekly
Construction materials average one-way delivery distance	miles	23	Distance to center of Sacramento
Number of paving days, 2017	days/year	24	Assumed to be 10% construction days.
Number of paving days, 2018	days/year	9	Assumed to be 10% construction days.
Total project area disturbed	acres	6.7	Project Description, page 1, March 15
Area disturbed, 2017	acres	4.9	Assumed proportional to number of construction days
Area disturbed, 2018	acres	1.8	Assumed proportional to number of construction days
Onsite speed of water and dump trucks	mph	5	Estimated
Maximum water capacity of water trucks	gallons	4,000	Standard capacity

Note: Values are conservative maxima to assure no underestimation of construction emissions.

Table A6
Construction Equipment Speed
Loomis-SPMUD Sewer Diversion Project

Construction Equipment Speeds

Equipment	Average Vehicle Speed[1] (mph)
PICKUP 3/4 TON 4X4 CREW CAB	5
TRUCK DUMP TANDEM AXLE 13-15 CY D	5
TRUCK WATER 3600-4000GAL F-R SPRAY BARS / MONITOR 2AXLE D	5
EXCAVATOR	0.5
BACKHOE	0.5
COMPACTOR VIB SMOOTH 66" 7.7T 75HP D	1.5
WHEELED LOADER	2.0
PAVING MACHINE	0.5

1) Estimated