APPENDIX E.2
VEHICLE MICROSCALE
CO CONCENTRATION MODELING

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The CO microscale air quality analysis is based on procedures outlined in the following documents:

- Guideline for Modeling CO From Roadway Intersections (USEPA 1992); and
- Mobile 6.2 User's Guide (USEPA 2003).

Carbon monoxide concentrations are determined in two steps: 1) vehicle exhaust emission factors are calculated using the USEPA Mobile 6.2 computer model; and 2) these emission factors are subsequently used as input for the USEPA CAL3QHC dispersion model. The models used are described as follows:

- Mobile 6.2 generates vehicular emission factors based on locality-specific vehicle fleet characteristics including vehicle age, operating mode of vehicles (hot/cold starts), and percentage of oxygenated fuel used. Input files containing the latest planning assumptions for Fairfax County were provided by the Metropolitan Washington Council of Governments (MWCOG) (MWCOG 2005).
- CAL3QHC predicts the level of CO or other pollutant concentrations from motor vehicles traveling near roadway intersections. The model incorporates inputs such as roadway geometry, traffic volumes, vehicular emission rates, and meteorological conditions.

The intersection location determinations and CO estimations were made through the following process:

1. Traffic, operating conditions, roadway configurations and geometry information was gathered for roadways and intersections of interest.
2. Potential worst-case roadways were identified based on the level of service and traffic flow.
3. Worst-case receptor locations were identified as the location of maximum CO concentration.
4. Mobile 6.2 and CAL3QHC were used to calculate CO concentrations due to vehicle traffic at identified "worst-case" roadway and receptor locations. Assumptions outlined in the 1985 Caltrans Report, Development of Worst Case Meteorology Criteria (Nokes and Benson 1985) were used for the analysis.
5. Persistence factor of 0.7 was used to estimate the 8-Hour concentration from the 1-Hour concentration.
6. Background concentrations at the intersection were determined using local monitoring data obtained from the VDEQ and added to modeled concentrations.

Data Inputs and results tabulated below (Table E.2-1).

Table E.2-1
Peak hour CO levels for all alternative and intersections analyzed

Intersection Location		1-hour [CO]	8-hour [CO]
Fairfax County Parkway./ John J Kingman Rd.	Existing	6.6	4.6
Fairfax County Parkway./ John J Kingman Rd.	No-Action	6.7	4.7
Fairfax County Parkway./ John J Kingman Rd.	Preferred	6.8	4.8
Fairfax County Parkway./ John J Kingman Rd.	Town Center	7.0	4.9
Fairfax County Parkway./ John J Kingman Rd.	City Center	6.7	4.7
Fairfax County Parkway./ John J Kingman Rd.	Satellite	7.0	4.9
Franconia Springfield Parkway EB Ramp./ Backlick Rd.	Existing	7.6	5.3
Franconia Springfield Parkway EB Ramp./ Backlick Rd.	No-Action	7.6	5.3
Franconia Springfield Parkway EB Ramp./ Backlick Rd.	Preferred	7.6	5.3
Franconia Springfield Parkway EB Ramp./ Backlick Rd.	City Center	7.6	5.3
Franconia Springfield Parkway./ Beulah St.	Existing	6.7	4.7
Franconia Springfield Parkway./ Beulah St.	No-Action	7.0	4.9
Franconia Springfield Parkway./ Beulah St.	Preferred	6.8	4.8
Franconia Springfield Parkway./ Beulah St.	Town Center	6.8	4.8
Franconia Springfield Parkway./ Beulah St.	City Center	6.8	4.8
Franconia Springfield Parkway./ Beulah St.	Satellite	6.8	4.8
Franconia Springfield Parkway/ Spring Village Dr.	Existing	6.2	4.3
Franconia Springfield Parkway/ Spring Village Dr.	No-Action	6.7	4.7
Franconia Springfield Parkway/ Spring Village Dr.	Preferred	7.3	5.1
Franconia Springfield Parkway/ Spring Village Dr.	City Center	7.3	5.1
Route 1./ Backlick Rd. - Pohick Rd.	Existing	5.2	3.6
Route 1/ Backlick Rd. - Pohick Rd.	No-Action	5.6	3.9
Route 1/ Backlick Rd. - Pohick Rd.	Preferred	6.0	4.2
Route 1/ Backlick Rd. - Pohick Rd.	Town Center	6.3	4.4
Route 1/ Backlick Rd. - Pohick Rd.	City Center	5.7	4.0
Route 1/ Backlick Rd. - Pohick Rd.	Satellite	6.1	4.3
Route 1./ Belvoir Rd.	Existing	5.0	3.5
Route 1./ Belvoir Rd.	No-Action	5.0	3.5
Route 1./ Belvoir Rd.	Preferred	5.7	4.0
Route 1./ Belvoir Rd.	Town Center	5.4	3.8
Route 1/Fairfax County Parkway.	Existing	5.8	4.1
Route 1/ Fairfax County Parkway.	No Action	5.9	4.1
Route 1/ Fairfax County Parkway.	Preferred	6.2	4.3
Route ./ Fairfax County Parkway.	Town Center	6.6	4.6
Route 1/ Fairfax County Parkway.	City Center	6.1	4.3
Route 1/ Fairfax County Parkway.	Satellite	6.4	4.5
Route 1./ Telegraph Rd. - Old Colchester Rd.	Existing	6.2	4.3
Route 1./ Telegraph Rd. - Old Colchester Rd.	No-Action	6.6	4.6
Route 1./ Telegraph Rd. - Old Colchester Rd.	Preferred	6.9	4.8
Route 1./ Telegraph Rd. - Old Colchester Rd.	Town Center	6.8	4.8
Route 1./ Telegraph Rd. - Old Colchester Rd.	City Center	6.8	4.8
Route 1./ Telegraph Rd. - Old Colchester Rd.	Satellite	6.8	4.8

INTERSECTION DESCRIPTION - Fairfax County Parkway./ John J Kingman Rd.

IDLE EMISSION FACTOR [GRAMS/HOUR]	53.715
MOVING EMISSION FACTOR	4.972
LANE WIDTH (FEET)	12
SOURCE HEIGHT (FEET)	0
SIGNAL LENGTH (S)	208
CLEARANCE LOST TIME (S)	2

Existing Conditions

	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
START X1 (FEET)	-96	-96		108	108	108	18	36	54	-24	-48	-66
START YI (FEET)	-6	-18		6	18	30	-72	-72	-60	84	84	-60
END X2 (FEET)	-500	-500		500	500	500	18	36	54	-24	-48	-66
END Y2 (FEET)	-6	-18		6	18	108	-500	-500	-500	500	500	500
TRAFFIC VOLUME [VPH]	15	60	20	20	20	130	30	940	395	1095	910	60
EMISSION FACTOR	53.715	53.715		53.715	53.715	53.715	53.715	53.715	53.715	53.715	53.715	53.715
SOURCE HEIGHT	0	0		0	0	0	0	0	0	0	0	0
MIXING ZONE WIDTH	12	12		12	12	12	12	24	12	24	24	12
NUMBER OF LANES IN QUEUE	1	1		1	1	1	1	2	1	2	2	1
TOTAL SIGNAL LENGTH	208	208		208	208	208	208	208	208	208	208	208
AVERAGE RED	176	176		161	161	84	186	156	156	131	101	101
CLEARANCE LOST TIME	2	2		2	2	2	2	2	2	2	2	2
SATURATION FLOW RATE (per lane)	1770	1792		1681	1770	1583	1770	1769.5	1583	1716.5	1769.5	1583
AVERAGE GREEN	32	32		47	47	124	22	52	52	77	107	107
SATURATION FLOW RATE	1770	1792		1681	1770	1583	1770	3539	1583	3433	3539	1583
	EBA	**EBD**		**WBA**	**WBD**		**NBA**	**NBD**		**SBA**	**SBD**	
START X1 (FEET)	0	0		0	0		36	36		-48	-48	
START YI (FEET)	-18	-18		18	18		0	0		0	0	
END X2 (FEET)	-500	500		500	-500		36	36		-48	-48	
END Y2 (FEET)	-18	-18		18	18		-500	500		500	-500	
TRAFFIC VOLUME [VPH]	95	1550		170	110		2430	1085		2065	950	
EMISSION FACTOR	4.972	4.972		4.972	4.972		4.972	4.972		4.972	4.972	
SOURCE HEIGHT	0	0		0	0		0	0		0	0	
MIXING ZONE WIDTH	34	34		46	22		46	34		70	34	
NUMBER OF LANES IN QUEUE	2	2		3	1		3	2		5	2	

No-Action Alternative

	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
TRAFFIC VOLUME [VPH]	50	30	70	490	20	1130	40	970	60	200	820	10
TOTAL SIGNAL LENGTH	208	208		208	208	208	208	208	208	208	208	208
AVERAGE RED	196	196		87	87	73	196	149	149	194	147	147
AVERAGE GREEN	12	12		121	121	135	12	59	59	14	61	61
	EBA	**EBD**		**WBA**	**WBD**		**NBA**	**NBD**		**SBA**	**SBD**	
TRAFFIC VOLUME [VPH]	150	290		1640	70		1230	2150		1030	1380	

Preferred Alternative

	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
TRAFFIC VOLUME [VPH]	50	40	60	450	20	1140	40	1280	70	250	1080	20
TOTAL SIGNAL LENGTH	208	208		208	208	208	208	208	208	208	208	208
AVERAGE RED	196	196		101	101	85	196	137	137	192	133	133
AVERAGE GREEN	12	12		107	107	123	12	71	71	16	75	75
	EBA	**EBD**		**WBA**	**WBD**		**NBA**	**NBD**		**SBA**	**SBD**	
TRAFFIC VOLUME [VPH]	150	360		1610	80		1600	2470		1350	1590	

Town Center Alternative

	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
TRAFFIC VOLUME [VPH]	20	90	20	70	20	340	40	1930	900	1810	1840	50
TOTAL SIGNAL LENGTH	208	208		208	208	208	208	208	208	208	208	208
AVERAGE RED	194	194		196	196	111	195	111	111	123	39	39
AVERAGE GREEN	14	14		12	12	97	13	97	97	85	169	169
	EBA	**EBD**		**WBA**	**WBD**		**NBA**	**NBD**		**SBA**	**SBD**	
TRAFFIC VOLUME [VPH]	130	2800		430	110		4640	2290		3700	1930	

City Center Alternative

	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
TRAFFIC VOLUME [VPH]	50	30	70	560	20	1080	40	1230	80	240	1090	10
TOTAL SIGNAL LENGTH	208	208		208	208	208	208	208	208	208	208	208
AVERAGE RED	196	196		102	102	85	196	137	137	191	132	132
AVERAGE GREEN	12	12		106	106	123	12	71	71	17	76	76
	EBA	**EBD**		**WBA**	**WBD**		**NBA**	**NBD**		**SBA**	**SBD**	
TRAFFIC VOLUME [VPH]	150	350		1660	70		1550	2360		1340	1720	

Satellite Campus Alternative

	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
TRAFFIC VOLUME [VPH]	430	30	230	690	20	1360	60	1400	150	340	1020	20
TOTAL SIGNAL LENGTH	208	208		208	208	208	208	208	208	208	208	208
AVERAGE RED	174	174		121	121	103	196	141	141	190	135	135
AVERAGE GREEN	34	34	34	87	87	105	12	67	67	18	73	73
	EBA	**EBD**		**WBA**	**WBD**		**NBA**	**NBD**		**SBA**	**SBD**	
TRAFFIC VOLUME [VPH]	690	520		2070	100		1890	3190		1380	1940	

INTERSECTION DESCRIPTION - FSP and Backlick

IDLE EMISSION FACTOR [GRAMS/HOUR]	53.715
MOVING EMISSION FACTOR	4.972
LANE WIDTH (FEET)	12
SOURCE HEIGHT (FEET)	0
SIGNAL LENGTH (S)	150
CLEARANCE LOST TIME (S)	2

Existing Conditions

	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR		
START X1 (FEET)	-48		-48				6	60			-6	-18		
START YI (FEET)	-12		-30				-48	-48			48	48		
END X2 (FEET)	-500		500				6	24			-6	-18		
END Y2 (FEET)	-12		-30				-500	-500			500	500		
TRAFFIC VOLUME [VPH]	1375		250				170	1380			565	85		
EMISSION FACTOR	53.715		53.715				53.715	53.715			53.715	53.715		
SOURCE HEIGHT	0		0				0	0			0	0		
MIXING ZONE WIDTH	12		12				12	24			24	12		
NUMBER OF LANES IN QUEUE	1		1				1	2			2	1		
TOTAL SIGNAL LENGTH	150		150				150	150			150	150		
AVERAGE RED	101		59				101	101			131			
CLEARANCE LOST TIME	2		2				2	2			2	2		
SATURATION FLOW RATE (per lane)	1681		1583				1770	1769.5			1769.5	1583		
AVERAGE GREEN	49		91				49	49			19	19		
SATURATION FLOW RATE	1681		1583				1770	3539			3539	1583		
	EBA				**WBD**		**NBA**	**NBD**		**SBA**	**SBD**	**FSP WB**	**FSP EB**	**I95**
START X1 (FEET)	0				0		60	60		-6	-6	144	144	264
START YI (FEET)	-18				24		0	0		0	0	0	-120	1000
END X2 (FEET)	-500				-500		60	60		-6	-6	0	0	264
END Y2 (FEET)	-18				24		-500	500		500	-500	-114	-222	-1000
TRAFFIC VOLUME [VPH]	1625				255		1380	2755		650	815	1270	2120	22800
EMISSION FACTOR	4.972				4.972		4.972	4.972		4.972	4.972	4.972	4.972	4.972
SOURCE HEIGHT	0				0		0	0		0	0	0	0	0
MIXING ZONE WIDTH	46				34		46	34		46	34	46	82	178
NUMBER OF LANES IN QUEUE	3				2		3	2		3	2	3	6	14

No-Action Alternative

	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR		
TRAFFIC VOLUME [VPH]	1500	10	220	10	10	10	170	1410	10	10	620	110		
TOTAL SIGNAL LENGTH	150		150				150	150			150	150		
AVERAGE RED	81		51				51	81			111	111		
AVERAGE GREEN	69		99				99	69			39	39		
	EBA			**WBA**	**WBD**		**NBA**	**NBD**		**SBA**	**SBD**			
TRAFFIC VOLUME [VPH]	1730			30	290		1430	2920		740	850			

Preferred Alternative

	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR		
TRAFFIC VOLUME [VPH]	1510	0	140	10	10	10	140	1420	10	10	780	190		
TOTAL SIGNAL LENGTH	150		150				150	150			150	150		
AVERAGE RED	81		51				51	81			111	111		
AVERAGE GREEN	69		99				99	69			39	39		
	EBA			**WBA**	**WBD**		**NBA**	**NBD**		**SBA**	**SBD**			
TRAFFIC VOLUME [VPH]	1650			30	340		1440	2940		980	930			

City Center Alternative

	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR		
TRAFFIC VOLUME [VPH]	1510	0	140	10	10	10	140	1420	10	10	780	190		
TOTAL SIGNAL LENGTH	150		150				150	150			150	150		
AVERAGE RED	81		51				51	81			111	111		
AVERAGE GREEN	69		99				99	69			39	39		
	EBA			**WBA**	**WBD**		**NBA**	**NBD**		**SBA**	**SBD**			
TRAFFIC VOLUME [VPH]	1650			30	340		1440	2940		980	930			

INTERSECTION DESCRIPTION - Franconia Springfield Parkway./ Beulah St. 13

IDLE EMISSION FACTOR [GRAMS/HOUR]	53.715
MOVING EMISSION FACTOR	4.972
LANE WIDTH (FEET)	12
SOURCE HEIGHT (FEET)	0
SIGNAL LENGTH (S)	180
CLEARANCE LOST TIME (S)	2

Existing Conditions

	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
START X1 (FEET)	-60	-60		60	60		0	24		-6	-24	
START YI (FEET)	-6	-24		-6	12		-60	-60		48	48	
END X2 (FEET)	-500	-500		500	500		0	24		-6	-24	
END Y2 (FEET)	-6	-24		-6	12		-500	-500		500	500	
TRAFFIC VOLUME [VPH]	410	2120	860	205	1270	165	780	515	235	220	445	365
EMISSION FACTOR	53.715	53.715		53.715	53.715	53.715	53.715	53.715		53.715	53.715	
SOURCE HEIGHT	0	0		0	0		0	0		0	0	
MIXING ZONE WIDTH	12	24		12	24		24	24		12	24	
NUMBER OF LANES IN QUEUE	1	2		1	2		2	2		1	2	
TOTAL SIGNAL LENGTH	180	180		180	180		180	180		180	180	
AVERAGE RED	91	91		80	106		146	146		149	149	
CLEARANCE LOST TIME	2	2		2	2		2	2		2	2	
SATURATION FLOW RATE (per lane)	1641	1769.5		1770	1769.5		1716.5	1769.5		1770	1769.5	
AVERAGE GREEN	89	89		100	74		34	34		31	31	
SATURATION FLOW RATE	1641	3539		1770	3539		3433	3539		1770	3539	
	EBA	**EBD**		**WBA**	**WBD**		**NBA**	**NBD**		**SBA**	**SBD**	
START X1 (FEET)	0	0		0	0		24	24		-24	-24	
START YI (FEET)	-24	-24		12	12		0	0		0	0	
END X2 (FEET)	-500	500		500	-500		24	24		-24	-24	
END Y2 (FEET)	-24	-24		12	12		-500	500		500	-500	
TRAFFIC VOLUME [VPH]	3390	2575		1640	2415		970	1090		1030	1510	
EMISSION FACTOR	4.972	4.972		4.972	4.972		4.972	4.972		4.972	4.972	
SOURCE HEIGHT	0	0		0	0		0	0		0	0	
MIXING ZONE WIDTH	58	46		58	46		58	46		58	46	
NUMBER OF LANES IN QUEUE	4	3		4	3		4	3		4	3	

No-Action Alternative

	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
TRAFFIC VOLUME [VPH]	480	2260	810	230	1400	220	760	680	260	290	570	430
TOTAL SIGNAL LENGTH	180	180		180	180		180	180		180	180	
AVERAGE RED	44	84		88	106		145	140		154	149	
AVERAGE GREEN	136	96		92	74		35	40		26	31	
	EBA	**EBD**		**WBA**	**WBD**		**NBA**	**NBD**		**SBA**	**SBD**	
TRAFFIC VOLUME [VPH]	3550	2810		1850	2590		1230	1380		1290	1610	

Preferred Alternative

	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
TRAFFIC VOLUME [VPH]	540	2320	860	220	1340	230	720	680	240	290	580	440
TOTAL SIGNAL	180	180		180	180		180	180		180	180	

LENGTH												
AVERAGE RED	36	80		90	107		148	143		154	149	
AVERAGE GREEN	144	100		90	73		32	37		26	31	
	EBA	**EBD**		**WBA**	**WBD**		**NBA**	**NBD**		**SBA**	**SBD**	
TRAFFIC VOLUME [VPH]	3720	2850		1790	2500		1210	1450		1310	1660	

Town Center Alternative

	EBL	**EBT**	**EBR**	**WBL**	**WBT**	**WBR**	**NBL**	**NBT**	**NBR**	**SBL**	**SBT**	**SBR**
TRAFFIC VOLUME [VPH]	540	2320	860	220	1340	230	720	680	240	290	580	440
TOTAL SIGNAL LENGTH	180	180		180	180		180	180		180	180	
AVERAGE RED	36	80		90	107		148	143		154	149	
AVERAGE GREEN	144	100		90	73		32	37		26	31	
	EBA	**EBD**		**WBA**	**WBD**		**NBA**	**NBD**		**SBA**	**SBD**	
TRAFFIC VOLUME [VPH]	3720	2850		1790	2500		1210	1450		1310	1660	

City Center Alternative

	EBL	**EBT**	**EBR**	**WBL**	**WBT**	**WBR**	**NBL**	**NBT**	**NBR**	**SBL**	**SBT**	**SBR**
TRAFFIC VOLUME [VPH]	510	2300	870	230	1320	230	730	670	250	290	590	420
TOTAL SIGNAL LENGTH	180	180		180	180		180	180		180	180	
AVERAGE RED	41	83		89	107		147	141		154	148	
AVERAGE GREEN	139	97		91	73		33	39		26	32	
	EBA	**EBD**		**WBA**	**WBD**		**NBA**	**NBD**		**SBA**	**SBD**	
TRAFFIC VOLUME [VPH]	3680	2840		1780	2470		1210	1410		1300	1690	

Satellite Campus Alternative

	EBL	**EBT**	**EBR**	**WBL**	**WBT**	**WBR**	**NBL**	**NBT**	**NBR**	**SBL**	**SBT**	**SBR**
TRAFFIC VOLUME [VPH]	420	2330	790	220	1410	200	840	740	290	280	580	410
TOTAL SIGNAL LENGTH	180	180		180	180		180	180		180	180	
AVERAGE RED	51	84		83	100		144	138		155	149	
AVERAGE GREEN	129	96		97	80		36	42		25	31	
	EBA	**EBD**		**WBA**	**WBD**		**NBA**	**NBD**		**SBA**	**SBD**	
TRAFFIC VOLUME [VPH]	3540	2900		1830	2660		1310	1360		1270	1590	

INTERSECTION DESCRIPTION - Franconia Springfield Parkway/ Spring Village Dr.

IDLE EMISSION FACTOR [GRAMS/HOUR]	53.715
MOVING EMISSION FACTOR	4.972
LANE WIDTH (FEET)	12
SOURCE HEIGHT (FEET)	0
SIGNAL LENGTH (S)	180
CLEARANCE LOST TIME (S)	2

Existing Conditions

	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
START X1 (FEET)	-48	-48	-48	48	48	48	-6	6	18	6	-6	-18
START YI (FEET)	-6	-30	-42	-6	18	42	-72	-72	-72	72	72	72
END X2 (FEET)	-500	-500	-500	500	500	500	-6	6	18	6	-6	-18
END Y2 (FEET)	-6	-30	-42	-6	18	42	-500	-500	-500	500	500	500
TRAFFIC VOLUME [VPH]	70	1905	95	250	4130	100	45	5	150	90	10	50
EMISSION FACTOR	53.715	53.715	53.715	53.715	53.715	53.715	53.715	53.715	53.715	53.715	53.715	53.715
SOURCE HEIGHT	0	0	0	0	0	0	0	0	0	0	0	0
MIXING ZONE WIDTH	12	36	12	12	36	12	12	12	12	12	12	12
NUMBER OF LANES IN QUEUE	1	3	1	1	3	1	1	1	1	1	1	1
TOTAL SIGNAL LENGTH	180	180	180	180	180	180	180	180	180	180	180	180
AVERAGE RED	53	53	53	45	45	45	152	152	152	152	152	152
CLEARANCE LOST TIME	2	2	2	2	2	2	2	2	2	2	2	2
SATURATION FLOW RATE (per lane)	60	1695	1583	1770	1695	1583	1770	1863	1583	1711	1863	1583
SATURATION FLOW RATE	60	5085	1583	1770	5085	1583	1770	1863	1583	1711	1863	1583
	EBA	**EBD**		**WBA**	**WBD**		**NBA**	**NBD**		**SBA**	**SBD**	
START X1 (FEET)	0	0		0	0		6	6		-6	-6	
START YI (FEET)	-30	-30		18	18		0	0		0	0	
END X2 (FEET)	-500	500		500	-500		6	6		-6	-6	
END Y2 (FEET)	-30	-30		18	18		-500	500		500	-500	
TRAFFIC VOLUME [VPH]	2070	2145		4480	4225		245	175		150	355	
EMISSION FACTOR	4.972	4.972		4.972	4.972		4.972	4.972		4.972	4.972	
SOURCE HEIGHT	0	0		0	0		0	0		0	0	
MIXING ZONE WIDTH	46	46		46	46		34	34		34	34	
NUMBER OF LANES IN QUEUE	3	3		3	3		2	2		2	2	

No-Action Alternative

	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
TRAFFIC VOLUME [VPH]	100	1900	110	270	4130	130	50	10	160	110	20	70
TOTAL SIGNAL LENGTH	180	180	180	180	180	180	180	180	180	180	180	180
AVERAGE RED	76	88	88	16	58	58	134	134	134	134	134	134
AVERAGE GREEN	104	92	92	164	122	122	46	46	46	46	46	46
	EBA	**EBD**		**WBA**	**WBD**		**NBA**	**NBD**		**SBA**	**SBD**	
TRAFFIC VOLUME [VPH]	2110	2170		4530	4250		280	240		200	400	

Preferred Alternative

	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
TRAFFIC VOLUME [VPH]	60	3820	250	670	1570	80	170	20	470	60	60	30
TOTAL SIGNAL LENGTH	276	276	276	276	276	276	276	276	276	276	276	276
AVERAGE RED	108	120	120	58	58	58	230	230	230	230	230	230
AVERAGE GREEN	168	156	156	218	218	218	46	46	46	46	46	46
	EBA	**EBD**		**WBA**	**WBD**		**NBA**	**NBD**		**SBA**	**SBD**	
TRAFFIC VOLUME [VPH]	4130	4350		2320	1770		550	160		150	980	

City Center Alternative

	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
TRAFFIC VOLUME [VPH]	60	3800	270	680	1600	80	180	30	480	60	60	30
TOTAL SIGNAL LENGTH	276	276	276	276	276	276	276	276	276	276	276	276
AVERAGE RED	108	120	120	58	58	58	230	230	230	230	230	230
AVERAGE GREEN	168	156	156	218	218	218	46	46	46	46	46	46
	EBA	**EBD**		**WBA**	**WBD**		**NBA**	**NBD**		**SBA**	**SBD**	
TRAFFIC VOLUME [VPH]	4130	4340		2360	1810		570	170		150	1010	

INTERSECTION DESCRIPTION - Route 1/ Backlick Rd. - Pohick Rd.

IDLE EMISSION FACTOR [GRAMS/HOUR]	53.715
MOVING EMISSION FACTOR	4.972
LANE WIDTH (FEET)	12
SOURCE HEIGHT (FEET)	0
SIGNAL LENGTH (S)	180
CLEARANCE LOST TIME (S)	2

Existing Conditions

	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
START X1 (FEET)	-60	-60	-60	48	48		-6	6		-30	-18	-6
START YI (FEET)	6	-12	-30	-6	12		-60	-60		60	60	-72
END X2 (FEET)	-500	-500	500	500	500		-6	6		-30	-18	-6
END Y2 (FEET)	6	-12	-30	-6	12		-500	-500		500	500	500
TRAFFIC VOLUME [VPH]	5	1220	140	10	1430	90	110	70	25	185	15	10
EMISSION FACTOR	53.715	53.715	53.715	53.715	53.715		53.715	53.715		53.715	53.715	53.715
SOURCE HEIGHT	0	0	0	0	0		0	0		0	0	0
MIXING ZONE WIDTH	12	24	12	12	24		12	12		12	12	12
NUMBER OF LANES IN QUEUE	1	2	1	1	2		1	1		1	1	1
TOTAL SIGNAL LENGTH	180	180	180	180	180		180	180		180	180	180
AVERAGE RED	74	90.5	90.5	74	90.5		130	130		156	156	156
CLEARANCE LOST TIME	2	2	2	2	2		2	2		2	2	2
SATURATION FLOW RATE (per lane)	1770	1769.5	1583	1770	1753.5		1681	1689		1593	1676	1478
AVERAGE GREEN	106	89.5	89.5	106	89.5		50	50		24	24	24
SATURATION FLOW RATE	1770	3539	1583	1770	3507		1681	1689		1593	1676	1478

	EBA	EBD		WBA	WBD		NBA	NBD		SBA	SBD	
START X1 (FEET)	0	0		0	0		6	6		-18	-18	
START YI (FEET)	-12	-12		12	12		0	0		0	0	
END X2 (FEET)	-500	500		500	-500		6	6		-18	-18	
END Y2 (FEET)	-12	-12		12	12		-500	500		500	-500	
TRAFFIC VOLUME [VPH]	1365	1430		1530	1550		280	165		210	165	
EMISSION FACTOR	4.972	4.972		4.972	4.972		4.972	4.972		4.972	4.972	
SOURCE HEIGHT	0	0		0	0		0	0		0	0	
MIXING ZONE WIDTH	58	34		58	34		34	22		46	22	
NUMBER OF LANES IN QUEUE	4	2		4	2		2	1		3	1	

No-Action Alternative

	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
TRAFFIC VOLUME [VPH]	10	1280	140	20	1490	60	1180	110	40	190	20	10
TOTAL SIGNAL LENGTH	180	180	180	180	180		180	180		180	180	180
AVERAGE RED	96	107.5	107.5	96	107.5		121	121		143	143	143
AVERAGE GREEN	84	72.5	72.5	84	72.5		59	59		37	37	37
	EBA	**EBD**		**WBA**	**WBD**		**NBA**	**NBD**		**SBA**	**SBD**	
TRAFFIC VOLUME [VPH]	1430	1510		1570	2680		340	180		220	180	

Preferred Alternative

	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
TRAFFIC VOLUME [VPH]	10	1680	180	80	1850	110	890	350	110	170	90	10
TOTAL SIGNAL LENGTH	180	180	180	180	180		180	180		180	180	180
AVERAGE RED	89	100.5	100.5	89	100.5		128	128		143	143	143
AVERAGE GREEN	91	79.5	79.5	91	79.5		52	52		37	37	37
	EBA	**EBD**		**WBA**	**WBD**		**NBA**	**NBD**		**SBA**	**SBD**	
TRAFFIC VOLUME [VPH]	1870	1960		2040	2750		630	470		270	350	

Town Center Alternative

	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
TRAFFIC VOLUME [VPH]	10	1500	270	120	1670	100	1210	430	150	150	110	10
TOTAL SIGNAL LENGTH	180	180	180	180	180		180	180		180	180	180
AVERAGE RED	98	109.5	109.5	98	109.5		119	119		143	143	143
AVERAGE GREEN	82	70.5	70.5	82	70.5		61	61		37	37	37
	EBA	**EBD**		**WBA**	**WBD**		**NBA**	**NBD**		**SBA**	**SBD**	
TRAFFIC VOLUME [VPH]	1780	1800		1890	2890		730	540		270	500	

City Center Alternative

	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
TRAFFIC VOLUME [VPH]	10	1530	200	10	1570	90	1060	200	70	210	50	10
TOTAL SIGNAL LENGTH	180	180	180	180	180		180	180		180	180	180
AVERAGE RED	94	105.5	105.5	94	105.5		123	123		123	123	123
AVERAGE GREEN	86	74.5	74.5	86	74.5		57	57		57	57	57
	EBA	**EBD**		**WBA**	**WBD**		**NBA**	**NBD**		**SBA**	**SBD**	
TRAFFIC VOLUME [VPH]	1740	1810		1670	2640		480	300		270	260	

Satellite Campus Alternative

	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
TRAFFIC VOLUME [VPH]	10	1570	260	80	1640	80	110	390	100	140	120	10
TOTAL SIGNAL LENGTH	180	180	180	180	180		180	180		180	180	180
AVERAGE RED	96	107.5	107.5	96	107.5		121	121		143	143	143
AVERAGE GREEN	84	72.5	72.5	84	72.5		59	59		37	37	37
	EBA	**EBD**		**WBA**	**WBD**		**NBA**	**NBD**		**SBA**	**SBD**	
TRAFFIC VOLUME [VPH]	1840	1810		1800	1760		630	480		270	460	

INTERSECTION DESCRIPTION - Route 1/ Belvoir

IDLE EMISSION FACTOR [GRAMS/HOUR]	53.715
MOVING EMISSION FACTOR	4.972
LANE WIDTH (FEET)	12
SOURCE HEIGHT (FEET)	0
SIGNAL LENGTH (S)	180
CLEARANCE LOST TIME (S)	2

Existing Conditions

	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
START X1 (FEET)		-36	-36	36	36		6		18			
START YI (FEET)		-12	-18	6	24		-48		-48			
END X2 (FEET)		-500	500	500	500		6		18			
END Y2 (FEET)		-12	-18	6	24		-500		-500			
TRAFFIC VOLUME [VPH]		1720	295	270	1590		155		85			
EMISSION FACTOR		53.715	53.715	53.715	53.715		53.715		53.715			
SOURCE HEIGHT		0	0	0	0		0		0			
MIXING ZONE WIDTH		24	12	12	24		12		12			
NUMBER OF LANES IN QUEUE		2	1	1	2		1		1			
TOTAL SIGNAL LENGTH		180	180	180	180		180		180			
AVERAGE RED		65	65	138.5	23.5		156.5		156.5			
CLEARANCE LOST TIME		2	2	2	2		2		2			
SATURATION FLOW RATE (per lane)		1769.5	1583	1770	1769.5		1770		1583			
AVERAGE GREEN		115	115	41.5	156.5		23.5		23.5			
SATURATION FLOW RATE		3539	1583	1770	3539		1770		1583			
	EBA	**EBD**		**WBA**	**WBD**		**NBA**				**SBD**	
START X1 (FEET)	0	0		0	0		0				0	
START YI (FEET)	-12	-12		24	24		0				0	
END X2 (FEET)	-500	500		500	-500		0				0	
END Y2 (FEET)	-12	-12		24	24		-500				0	
TRAFFIC VOLUME [VPH]	2015	1805		1860	1745		85				565	
EMISSION FACTOR	4.972	4.972		4.972	4.972		4.972				4.972	
SOURCE HEIGHT	0	0		0	0		0				0	
MIXING ZONE WIDTH	34	34		46	34		34				34	
NUMBER OF LANES IN QUEUE	2	2		3	2		2				2	

No-Action Alternative

	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
TRAFFIC VOLUME [VPH]		1760	210	310	1590		120		110			
TOTAL SIGNAL LENGTH		180	180	180	180		180		180			
AVERAGE RED		66	66	23	23		137		157			
AVERAGE GREEN		114	114	157	157		43		23			
	EBA	**EBD**		**WBA**	**WBD**		**NBA**				**SBD**	
TRAFFIC VOLUME [VPH]	1970	1870		1900	1710		110				520	

Preferred Alternative

	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
TRAFFIC VOLUME [VPH]		2050	320	410	1600		430		390			
TOTAL SIGNAL LENGTH		180	180	180	180		180		180			
AVERAGE RED		80	80	143	43		137		137			
AVERAGE GREEN		100	100	37	137		43		43			
	EBA	**EBD**		**WBA**	**WBD**		**NBA**				**SBD**	
TRAFFIC VOLUME [VPH]	2370	2440		2010	2030		390				730	

Town Center Alternative

	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
TRAFFIC VOLUME [VPH]		1780	130	650	1790		220		630			
TOTAL SIGNAL LENGTH		180	180	180	180		180		180			
AVERAGE RED		92	92	32	32		148		148			
AVERAGE GREEN		88	88	148	148		32		32			
	EBA	**EBD**		**WBA**	**WBD**		**NBA**				**SBD**	
TRAFFIC VOLUME [VPH]	1910	2410		2440	2010		630				780	

INTERSECTION DESCRIPTION - Route 1/ Fairfax County Parkway

IDLE EMISSION FACTOR [GRAMS/HOUR]	53.715
MOVING EMISSION FACTOR	4.972
LANE WIDTH (FEET)	12
SOURCE HEIGHT (FEET)	0
SIGNAL LENGTH (S)	180
CLEARANCE LOST TIME (S)	2

Existing Conditions

	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
START X1 (FEET)	-60	-60			60					-24		-42
START YI (FEET)	-12	-36			12					60		48
END X2 (FEET)	-500	-500			500					-24		-42
END Y2 (FEET)	-12	-36			12					500		500
TRAFFIC VOLUME [VPH]	340	2085			650	920				840		20
EMISSION FACTOR	53.715	53.715			53.715					53.715		53.715
SOURCE HEIGHT	0	0			0					0		0
MIXING ZONE WIDTH	24	24			24					24		12
NUMBER OF LANES IN QUEUE	2	2			2					2		1
TOTAL SIGNAL LENGTH	180	180			180					180		180
AVERAGE RED	150	57.5			87.5					122.5		150
CLEARANCE LOST TIME	2	2			2					2		2
SATURATION FLOW RATE (per lane)	1716.5	1769.5			1769.5					1716.5		1583
AVERAGE GREEN	30	122.5			92.5					57.5		30
SATURATION FLOW RATE	3433	3539			3539					3433		1583
	EBA	**EBD**		**WBA**	**WBD**		**NBA**	**NBD**		**SBA**		
START X1 (FEET)	0	0		0	0		0	0		0		
START YI (FEET)	-36	-36		12	12		0	0		0		
END X2 (FEET)	-500	500		500	-500		0	0		0		
END Y2 (FEET)	-36	-36		12	12		-500	500		500		
TRAFFIC VOLUME [VPH]	2425	2925		1570	670		840	1260		860		
EMISSION FACTOR	4.972	4.972		4.972	4.972		4.972	4.972		4.972		
SOURCE HEIGHT	0	0		0	0		0	0		0		
MIXING ZONE WIDTH	58	34		46	34		46	34		46		
NUMBER OF LANES IN QUEUE	4	2		3	2		3	2		3		

No-Action Alternative

	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
TRAFFIC VOLUME [VPH]	390	2050			660	1000				930		30
TOTAL SIGNAL LENGTH	180	180			180					180		180
AVERAGE RED	147	59			92					121		88
AVERAGE GREEN	33	121			88					59		92
	EBA	**EBD**		**WBA**	**WBD**		**NBA**	**NBD**		**SBA**	**SBD**	
TRAFFIC VOLUME [VPH]	2440	2980		1660	690		930	1390		960	0	

Preferred Alternative

	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
TRAFFIC VOLUME [VPH]	710	1860			1070	1240				1260		90
TOTAL SIGNAL LENGTH	180	180			180					180		180
AVERAGE RED	150	57.5			87.5					122.5		92.5
AVERAGE GREEN	30	122.5			92.5					57.5		87.5
	EBA	**EBD**		**WBA**	**WBD**		**NBA**	**NBD**		**SBA**	**SBD**	
TRAFFIC VOLUME [VPH]	2570	3120		2310	1160		1260	1950		1350	0	

Town Center Alternative

	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
TRAFFIC VOLUME [VPH]	1090	1730			1070	1420				1560		160
TOTAL SIGNAL LENGTH	180	180			180					180		180
AVERAGE RED	128	74			126					106		54
AVERAGE GREEN	52	106			54					74		126
	EBA	**EBD**		**WBA**	**WBD**		**NBA**	**NBD**		**SBA**	**SBD**	
TRAFFIC VOLUME [VPH]	2820	3290		2490	1230		1560	2510		1720	0	

City Center Alternative

	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
TRAFFIC VOLUME [VPH]	580	1910			980	1090				1120		70
TOTAL SIGNAL LENGTH	180	180			180					180		180
AVERAGE RED	150	57.5			87.5					122.5		92.5
AVERAGE GREEN	30	122.5			92.5					57.5		87.5
	EBA	**EBD**		**WBA**	**WBD**		**NBA**	**NBD**		**SBA**	**SBD**	
TRAFFIC VOLUME [VPH]	2490	3030		2070	1050		1120	1670		1190	0	

Satellite Campus Alternative

	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
TRAFFIC VOLUME [VPH]	940	1620			980	1420				1550		140
TOTAL SIGNAL LENGTH	180	180			180					180		180
AVERAGE RED	131	78			127					102		53
AVERAGE GREEN	49	102			53					78		127
	EBA	**EBD**		**WBA**	**WBD**		**NBA**	**NBD**		**SBA**	**SBD**	
TRAFFIC VOLUME [VPH]	2560	3170		2400	1120		1550	2360		1690	0	

INTERSECTION DESCRIPTION - Route 1/ Telegraph

IDLE EMISSION FACTOR [GRAMS/HOUR]	53.715
MOVING EMISSION FACTOR	4.972
LANE WIDTH (FEET)	12
SOURCE HEIGHT (FEET)	0
SIGNAL LENGTH (S)	180
CLEARANCE LOST TIME (S)	2

Existing Conditions

	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
START X1 (FEET)	-72	-72		84	84	84	-6	6	18	0	-18	-42
START YI (FEET)	-12	-42		-6	12	42	-84	-84	-84	60	60	60
END X2 (FEET)	-500	-500		-500	500	-500	-6	6	18	0	-18	-42
END Y2 (FEET)	-12	-42		-6	12	42	500	500	500	500	500	500
TRAFFIC VOLUME [VPH]	220	715	55	150	1960	35	5	25	30	70	175	800
EMISSION FACTOR	53.715	53.715		53.715	53.715	53.715	53.715	53.715	53.715	53.715	53.715	53.715
SOURCE HEIGHT	0	0		0	0	0	0	0	0	0	0	0
MIXING ZONE WIDTH	24	36		12	48	12	12	12	12	24	12	36
NUMBER OF LANES IN QUEUE	2	3		1	4	1	1	1	1	2	1	3
TOTAL SIGNAL LENGTH	180	180		180	180	180	180	180	180	180	180	180
AVERAGE RED	154.5	84		162.5	92	92	158	158	158	135.5	135.5	135.5
CLEARANCE LOST TIME	2	2		2	2	2	2	2	2	2	2	2
SATURATION FLOW RATE (per lane)	1716.5	1695		1770	1602	1583	1770	1863	1583	1716.5	1860	1203.333
AVERAGE GREEN	25.5	96		17.5	88	88	22	22	22	44.5	44.5	44.5
SATURATION FLOW RATE	3433	5085		1770	6408	1583	1770	1863	1583	3433	1860	3610
	EBA	**EBD**		**WBA**	**WBD**		**NBA**	**NBD**		**SBA**	**SBD**	
START X1 (FEET)	0	0		0	0		-84	-84		60	60	
START YI (FEET)	-42	-42		12	12		0	0		0	0	
END X2 (FEET)	-500	500		500	-500		-84	-84		60	60	
END Y2 (FEET)	-42	-42		12	12		-500	500		500	-500	
TRAFFIC VOLUME [VPH]	990	815		2145	2765		125	280		1045	380	
EMISSION FACTOR	4.972	4.972		4.972	4.972		4.972	4.972		4.972	4.972	
SOURCE HEIGHT	0	0		0	0		0	0		0	0	
MIXING ZONE WIDTH	70	46		82	58		46	34		82	22	
NUMBER OF LANES IN QUEUE	5	3		6	4		3	2		6	1	

No-Action Alternative

	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
TRAFFIC VOLUME [VPH]	280	700	50	150	1990	60	10	30	30	100	190	950
TOTAL SIGNAL LENGTH	180	180	180	180	180	180	180	180	180	180	180	180
AVERAGE RED	158	129		158	122	122	130	130	130	130	130	130
AVERAGE GREEN	22	51		22	58	58	50	50	50	50	50	50
	EBA	**EBD**		**WBA**	**WBD**		**NBA**	**NBD**		**SBA**	**SBD**	
TRAFFIC VOLUME [VPH]	1030	830		2200	2950		160	370		1240	390	

Preferred Alternative

	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
TRAFFIC VOLUME [VPH]	260	1040	40	210	2000	80	10	30	40	200	140	860
TOTAL SIGNAL LENGTH	180	180	180	180	180	180	180	180	180	180	180	180
AVERAGE RED	158	128		149	119	72	130	130	130	133	133	133
AVERAGE GREEN	22	52		31	61	108	50	50	50	47	47	47
	EBA	**EBD**		**WBA**	**WBD**		**NBA**	**NBD**		**SBA**	**SBD**	
TRAFFIC VOLUME [VPH]	1340	1280		2290	2870		270	370		1200	390	

Town Center Alternative

	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
TRAFFIC VOLUME [VPH]	240	910	40	200	2340	90	10	30	40	190	150	840
TOTAL SIGNAL LENGTH	180	180	180	180	180	180	180	180	180	180	180	180
AVERAGE RED	158	127		144	113	72	130	130	130	139	139	139
AVERAGE GREEN	22	53		36	67	108	50	50	50	41	41	41
	EBA	**EBD**		**WBA**	**WBD**		**NBA**	**NBD**		**SBA**	**SBD**	
TRAFFIC VOLUME [VPH]	1190	1140		2630	3190		260	360		1180	390	

City Center Alternative

	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
TRAFFIC VOLUME [VPH]	270	980	50	180	2030	130	10	30	40	170	170	870
TOTAL SIGNAL LENGTH	180	180	180	180	180	180	180	180	180	180	180	180
AVERAGE RED	158	124		153	119	130	130	130	130	133	133	133
AVERAGE GREEN	22	56		27	61	50	50	50	50	47	47	47
	EBA	**EBD**		**WBA**	**WBD**		**NBA**	**NBD**		**SBA**	**SBD**	
TRAFFIC VOLUME [VPH]	1300	1190		2340	2910		240	430		1210	400	

Satellite Campus Alternative

	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
TRAFFIC VOLUME [VPH]	230	930	30	160	2170	90	10	30	40	240	200	990
TOTAL SIGNAL LENGTH	180	180	180	180	180	180	180	180	180	180	180	180
AVERAGE RED	158	127		149	118	72	130	130	130	134	134	134
AVERAGE GREEN	22	53		31	62	108	50	50	50	46	46	46
	EBA	**EBD**		**WBA**	**WBD**		**NBA**	**NBD**		**SBA**	**SBD**	
TRAFFIC VOLUME [VPH]	1190	1210		2420	3170		310	350		1430	390	

APPENDIX E.3
CRITERIA AIR POLLUTANTS—SOURCES AND IMPACTS

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Criteria Pollutants—Sources and Impacts

Pollutants and Their Sources	Health and Environmental Impacts
Ozone (O_3): a gas composed of three oxygen atoms. It is not usually emitted directly into the air, but at ground level is created by a chemical reaction between oxides of NO_x and VOC in the presence of heat and sunlight. Ozone has the same chemical structure whether it occurs miles above the earth or at ground level and can be "good" or "bad," depending on its location in the atmosphere. "Good" ozone occurs naturally in the stratosphere approximately 10 to 30 miles above the earth's surface and forms a layer that protects life on earth from the sun's harmful rays. In the earth's lower atmosphere, ground-level ozone is considered "bad." **a) VOC + NOx + Heat + Sunlight = Ozone** Motor vehicle exhaust and industrial emissions, gasoline vapors, and chemical solvents are some of the major sources of NO_x and VOC, that help to form ozone. Sunlight and hot weather cause ground-level ozone to form in harmful concentrations in the air. As a result, it is known as a summertime air pollutant. Many urban areas tend to have high levels of "bad" ozone, but even rural areas are also subject to increased ozone levels because wind carries ozone and pollutants that form it hundreds of miles away from their original sources.	**Health Problems**: Ozone can irritate lung airways and cause inflammation much like a sunburn. Other symptoms include wheezing, coughing, pain when taking a deep breath, and breathing difficulties during exercise or outdoor activities. People with respiratory problems are most vulnerable, but even healthy people that are active outdoors can be affected when ozone levels are high. Repeated exposure to ozone pollution for several months may cause permanent lung damage. Anyone who spends time outdoors in the summer is at risk, particularly children, and other people who are active outdoors. Even at very low levels, ground-level ozone triggers a variety of health problems including aggravated asthma, reduced lung capacity, and increased susceptibility to respiratory illnesses like pneumonia and bronchitis. **Plant and Ecosystem Damage**: Ground-level ozone interferes with the ability of plants to produce and store food, which makes them more susceptible to disease, insects, other pollutants, and harsh weather. Ozone damages the leaves of trees and other plants, ruining the appearance of cities, national parks, and recreation areas. Ozone reduces crop and forest yields and increases plant vulnerability to disease, pests, and harsh weather.
Carbon Monoxide (CO): a colorless, odorless gas that is formed when carbon in fuel is not burned completely. It is a component of motor vehicle exhaust, which contributes about 56 percent of all CO emissions nationwide. Other non-road engines and vehicles (such as construction equipment and boats) contribute about 22 percent of all CO emissions nationwide. Higher levels of CO generally occur in areas with heavy traffic congestion. In cities, 85 to 95 percent of all CO emissions may come from motor vehicle exhaust. Other sources of CO emissions include industrial processes (such as metals processing and chemical manufacturing), residential wood burning, and natural sources such as forest fires. Woodstoves, gas stoves, cigarette smoke, and unvented gas and kerosene space heaters are sources of CO indoors. The highest levels of CO in the outside air typically occur during the colder months of the year when inversion conditions are more frequent. The air pollution becomes trapped near the ground beneath a layer of warm air.	**Health Problems** CO can cause harmful health effects by reducing oxygen delivery to the body's organs (like the heart and brain) and tissues. **Cardiovascular Effects.** The health threat from lower levels of CO is most serious for those who suffer from heart disease, like angina, clogged arteries, or congestive heart failure. For a person with heart disease, a single exposure to CO at low levels may cause chest pain and reduce that person's ability to exercise; repeated exposures may contribute to other cardiovascular effects. **Central Nervous System Effects.** Even healthy people can be affected by high levels of CO. People who breathe high levels of CO can develop vision problems, reduced ability to work or learn, reduced manual dexterity, and difficulty performing complex tasks. At extremely high levels, CO is poisonous and can cause death. **Smog.** CO contributes to the formation of smog and ground level O_3, which can trigger serious respiratory problems.
Sulfur Dioxide (SO_2): SO_2 belongs to the family of sulfur oxide gases (SO_x). Sulfur is prevalent in all raw materials, including crude oil, coal, and ore that contains common metals like aluminum, copper, zinc, lead, and iron. SO_x gases are formed when fuel containing sulfur, such as coal and oil, is burned, and when gasoline is extracted from oil, or metals are extracted from ore. SO_2 dissolves in water vapor to form acid, and interacts with other gases and particles in the air to form sulfates and other products that can be harmful to people and their environment.	SO_2 causes a wide variety of health and environmental impacts because of the way it reacts with other substances in the air. Particularly sensitive groups include people with asthma who are active outdoors and children, the elderly, and people with heart or lung disease. **Health Problems**: **Respiratory Effects from Gaseous SO_2** Peak levels of SO_2 in the air can cause temporary breathing difficulty for people with asthma who are active outdoors. Longer-term exposures to high levels of SO_2 gas and particles cause respiratory illness and aggravate existing heart disease.

Over 65% of SO_2 released to the air, or more than 13 million tons per year, comes from electric utilities, especially those that burn coal. Other sources of SO_2 are industrial facilities that derive their products from raw materials like metallic ore, coal, and crude oil, or that burn coal or oil to produce process heat. Examples are petroleum refineries, cement manufacturing, and metal processing facilities. Also, locomotives, large ships, and some non-road diesel equipment currently burn high sulfur fuel and release SO_2 emissions to the air in large quantities.	**Respiratory Effects from Sulfate Particles** SO_2 reacts with other chemicals in the air to form tiny sulfate particles. When these are breathed, they gather in the lungs and are associated with increased respiratory symptoms and disease, difficulty in breathing, and premature death. **Visibility Impairment** Haze occurs when light is scattered or absorbed by particles and gases in the air. Sulfate particles are the major cause of reduced visibility in many parts of the U.S., including our national parks. **Plant and Ecosystem Damage**: **Acid Rain** SO_2 and nitrogen oxides react with other substances in the air to form acids, which fall to earth as rain, fog, snow, or dry particles. Some may be carried by the wind for hundreds of miles. **Plant and Water Damage** Acid rain damages forests and crops, changes the makeup of soil, and makes lakes and streams acidic and unsuitable for fish. Continued exposure over a long time changes the natural variety of plants and animals in an ecosystem. **Aesthetic Damage** SO_2 accelerates the decay of building materials and paints, including irreplaceable monuments, statues, and sculptures that are part of our nation's cultural heritage.
Nitrogen Dioxide (NO_2): the generic term for a group of highly reactive gases, all of which contain nitrogen and oxygen in varying amounts. Many of the nitrogen oxides are colorless and odorless. However, one common pollutant, NO_2, along with particles in the air can often be seen as a reddish-brown layer over many urban areas. Nitrogen oxides form when fuel is burned at high temperatures, as in a combustion process. The primary sources of NO_x are motor vehicles, electric utilities, and other industrial, commercial, and residential sources that burn fuels.	NO_x causes a wide variety of health and environmental impacts because of various compounds and derivatives in the family of nitrogen oxides, including nitrogen dioxide, nitric acid, nitrous oxide, nitrates, and nitric oxide. **Health Problems**: Ground-level ozone (smog) is formed when NOx and volatile organic compounds (VOCs) react in the presence of heat and sunlight. Children, people with lung diseases such as asthma, and people who work or exercise outside are susceptible to adverse effects such as damage to lung tissue and reduction in lung function. Ozone can be transported by wind currents and cause health impacts far from original sources. Millions of Americans live in areas that do not meet the health standards for ozone. **Particles** NO_x reacts with ammonia, moisture, and other compounds to form nitric acid and related particles. Human health concerns include effects on breathing and the respiratory system, damage to lung tissue, and premature death. Small particles penetrate deeply into sensitive parts of the lungs and can cause or worsen respiratory disease such as emphysema and bronchitis, and aggravate existing heart disease. **Toxic Chemicals** In the air, NOx reacts readily with common organic chemicals and even ozone, to form a wide variety of toxic products, some of which may cause biological mutations. Examples of these chemicals include the nitrate radical, nitroarenes, and nitrosamines.

	Visibility Impairment Nitrate particles and nitrogen dioxide can block the transmission of light, reducing visibility in urban areas and on a regional scale in our national parks. **Plant and Ecosystem Damage**: Direct impacts from ozone include damaged vegetation and reduced crop yields. **Acid Rain** NOx and sulfur dioxide react with other substances in the air to form acids, which fall to earth as rain, fog, snow, or dry particles. Some may be carried by wind for hundreds of miles. Acid rain damages; causes deterioration of cars, buildings and historical monuments; and causes lakes and streams to become acidic and unsuitable for many fish. **Water Quality Deterioration** Increased nitrogen loading in water bodies, particularly coastal estuaries, upsets the chemical balance of nutrients used by aquatic plants and animals. Additional nitrogen accelerates "eutrophication," which leads to oxygen depletion and reduces fish and shellfish populations. NOx emissions in the air are one of the largest sources of nitrogen pollution in the Chesapeake Bay. **Global Warming** One member of the NOx family, nitrous oxide, is a greenhouse gas. It accumulates in the atmosphere with other greenhouse gasses causing a gradual rise in the earth's temperature. This will lead to increased risks to human health, a rise in the sea level, and other adverse changes to plant and animal habitat.
Particulates (PM_{10} and $PM_{2.5}$): Particulate matter (PM) is the term for particles found in the air, including dust, dirt, soot, smoke, and liquid droplets. Particles can be suspended in the air for long periods of time. Some particles are large or dark enough to be seen as soot or smoke. Others are so small that individually they can only be detected with an electron microscope. Some particles are directly emitted into the air. They come from a variety of sources such as cars, trucks, buses, factories, construction sites, tilled fields, unpaved roads, stone crushing, and burning of wood. Other particles may be formed in the air from the chemical change of gases. They are indirectly formed when gases from burning fuels react with sunlight and water vapor. These can result from fuel combustion in motor vehicles, at power plants, and in other industrial processes.	**Health Problems**: Many scientific studies have linked breathing PM to a series of health problems, including: • aggravated asthma • increases in respiratory symptoms like coughing and difficult or painful breathing • chronic bronchitis • decreased lung function • premature death **Visibility Impairment** PM is the major cause of reduced visibility (haze) in parts of the United States, including many of our national parks. **Plant and Ecosystem Damage**: **Atmospheric deposition** Particles can be carried over long distances by wind and then settle on ground or water. The effects of this settling include: • making lakes and streams acidic • changing the nutrient balance in coastal waters and

	large river basins • depleting the nutrients in soil • damaging sensitive forests and farm crops • affecting the diversity of ecosystems **Aesthetic damage** Soot, a type of PM, stains and damages stone and other materials, including culturally important objects such as monuments and statues.
Lead (Pb): a metal found naturally in the environment as well as in manufactured products. The major sources of lead emissions have historically been motor vehicles (such as cars and trucks) and industrial sources. Due to the phase out of leaded gasoline, metals processing is the major source of lead emissions to the air today. The highest levels of lead in air are generally found near lead smelters. Other stationary sources are waste incinerators, utilities, and lead-acid battery manufacturers.	People, animals, and fish are mainly exposed to lead by breathing and ingesting it in food, water, soil, or dust. Lead accumulates in the blood, bones, muscles, and fat. Infants and young children are especially sensitive to even low levels of lead. **Health Problems**: **Damages organs** - Lead causes damage to the kidneys, liver, brain and nerves, and other organs. Exposure to lead may also lead to osteoporosis (brittle bone disease) and reproductive disorders. **Affects the brain and nerves** - Excessive exposure to lead causes seizures, mental retardation, behavioral disorders, memory problems, and mood changes. Low levels of lead damage the brain and nerves in fetuses and young children, resulting in learning deficits and lowered IQ. **Affects the heart and blood** - Lead exposure causes high blood pressure and increases heart disease, especially in men. Lead exposure may also lead to anemia, or weak blood. **Plant and Ecosystem Damage**: **Affects animals and plants** - Wild and domestic animals can ingest lead while grazing. They experience the same kind of effects as people who are exposed to lead. Low concentrations of lead can slow down vegetation growth near industrial facilities. Lead can enter water systems through runoff and from sewage and industrial waste streams. Elevated levels of lead in the water can cause reproductive damage in some aquatic life and cause blood and neurological changes in fish and other animals that live there.

Source: (USEPA 2006a)

APPENDIX E.4
PERMITTED SOURCES OF AIR EMISSIONS—
POTENTIAL-TO-EMIT CALCULATIONS

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ARMY CORP OF ENGINEERS - PROPOSED NGA OPERATIONS AT FORT BELVIOR
POTENTIAL EMISSION ESTIMATES FOR FACILITY BOILERS

ANNUAL EMISSIONS CALCULATIONS BASED UPON AP-42 EMISSION FACTORS AND EXPECTED PERFORMANCE LEVELS

FUEL USAGE	Natural Gas Fired	365 days/year	8,760 hr/yr, or
	No. 2 Fuel Oil Fired	365 days/year	8,760 hr/yr
NATURAL GAS	Heat Input =	24.49 mmBtu/hr	214.6 mmCF/yr (max. one boiler)
	Firing Rate =	0.024 mmCF/hr or	858.3 mmCF/yr (max. four boilers)
	Heat Capacity =	1,000 Btu/CF	
NO. 2 FUEL OIL	Heat Input =	24.49 mmBtu/hr	1511.0 mgal/yr (max. one boiler)
	Firing Rate =	0.172 mgal/hr or	6,044.2 mgal/yr (max.four boilers)
	Heat Capacity =	142,000 Btu/gal	
	Sulfur In Fuel Oil =	0.2 % by weight	

Pollutant Emissions	Emission Factors (lb/mmCF or lb/mgal)		Ind. Boiler Emission Rates (lb/hr)		Facility Boilers Potential Emissions (tons/year)
	Natural Gas	2FO	Natural Gas	2FO	
VOC	5.5	0.34	0.13	0.06	2.4
NO_x	35	36	0.86	6.12	107.3
CO	84	27	2.06	4.58	80.2
SO_2	0.6	28.4	0.01	4.90	85.8
PM/PM_{10}	10	6.36	0.24	1.10	19.2
Lead	0.0005	0.00034	0.10	0.53	1.0E-03

Notes:

*1 Emission factors for natural gas and fuel oil combustion (except those specified in *2 below) based upon values presente in the USEPA reference document AP-42 Section 1.4 and 1.3, respectively.

*2 Emissions factors for NOx, CO for fuel oil firing and PM from natural gas firing based upon manufacturer's expected performance levels.

*3 Maximum annual fuel usage presented above is based upon maximum usage of a particular fuel for the entire year.

*4 Emissions rates calculated based upon the following equation:

Emission Rate (lb/hr) = Emission factor (lb/mmCF or lb/mgal) * Fuel Input (mmCF/hr or mgal/hr)

*5 Potential emissions for both facility boilers based upon worst-case operating scenario (i.e. natural gas or fuel oil) based upon the following equations:

For VOC:
Annual Emissions (TPY) = [Gas Usage (mmCF/yr for four boilers) * Emission Factor (lb/mmCF)]* 1 Ton/2,000 lb

For NO_x, CO, SO_2, PM/PM_{10} and Pb:
Annual Emissions (TPY)=[(Oil Usage (mgal/yr for four boilers)*Emission Factor (lb/mgal)]*1Ton/2,000 lb

ARMY CORP OF ENGINEERS - PROPOSED WHS OPERATIONS AT FORT BELVIOR
POTENTIAL EMISSION ESTIMATES FOR FACILITY BOILERS

ANNUAL EMISSIONS CALCULATIONS BASED UPON AP-42 EMISSION FACTORS AND EXPECTED PERFORMANCE LEVELS

FUEL USAGE	Natural Gas Fired	365 days/year	8,760 hr/yr, or
	No. 2 Fuel Oil Fired	365 days/year	8,760 hr/yr
NATURAL GAS	Heat Input =	28.58 mmBtu/hr	250.3 mmCF/yr (max. one boiler)
	Firing Rate =	0.029 mmCF/hr or	751.0 mmCF/yr (max. three boilers)
	Heat Capacity =	1,000 Btu/CF	
NO. 2 FUEL OIL	Heat Input =	28.98 mmBtu/hr	1787.9 mgal/yr (max. one boiler)
	Firing Rate =	0.204 mgal/hr or	5,363.7 mgal/yr (max.three boilers)
	Heat Capacity =	142,000 Btu/gal	
	Sulfur In Fuel Oil =	0.2 % by weight	

Pollutant Emissions	Emission Factors (lb/mmCF or lb/mgal)		Ind. Boiler Emission Rates (lb/hr)		Facility Boilers Potential Emissions (tons/year)
	Natural Gas	2FO	Natural Gas	2FO	
VOC	5.5	0.34	0.16	0.07	2.1
NO_x	35	36	1.00	7.25	95.2
CO	84	27	2.40	5.42	71.2
SO_2	0.6	28.4	0.02	5.80	76.2
PM/PM_{10}	10	6.36	0.29	1.30	17.1
Lead	0.0005	0.00034	0.10	0.53	9.1E-04

Notes:

*1 Emission factors for natural gas and fuel oil combustion (except those specified in *2 below) based upon values presente in the USEPA reference document AP-42 Section 1.4 and 1.3, respectively.

*2 Emissions factors for NOx, CO for fuel oil firing and PM from natural gas firing based upon manufacturer's expected performance levels.

*3 Maximum annual fuel usage presented above is based upon maximum usage of a particular fuel for the entire year.

*4 Emissions rates calculated based upon the following equation:

Emission Rate (lb/hr) = Emission factor (lb/mmCF or lb/mgal) * Fuel Input (mmCF/hr or mgal/hr)

*5 Potential emissions for both facility boilers based upon worst-case operating scenario (i.e. natural gas or fuel oil) based upon the following equations:

For VOC:
Annual Emissions (TPY) = [Gas Usage (mmCF/yr for four boilers) * Emission Factor (lb/mmCF)]* 1 Ton/2,000 lb

For NO_x, CO, SO_2, PM/PM_{10} and Pb:
Annual Emissions (TPY)=[(Oil Usage (mgal/yr for four boilers)*Emission Factor (lb/mgal)]*1Ton/2,000 lb

ARMY CORP OF ENGINEERS - PROPOSED NGA OPERATIONS AT FORT BELVIOR
ANTICIPATED ACTUAL EMISSION ESTIMATES FOR FACILITY BOILERS

ANNUAL EMISSIONS CALCULATIONS BASED UPON AP-42 EMISSION FACTORS AND EXPECTED PERFORMANCE LEVELS

BOILER DISPATCH 66% of maximum capacity of each boiler
1000 hours per year each boiler on oil

NATURAL GAS	Heat Input =	24.49 mmBtu/hr	566.5 mmCF/yr (both boilers no oil)
	Firing Rate =	0.024 mmCF/hr or	468.5 mmCF/yr (four boilers w/ oil)
	Heat Capacity =	1,000 Btu/CF	
NO. 2 FUEL OIL	Heat Input =	24.49 mmBtu/hr	690.0 mgal/yr (four boilers)
	Firing Rate =	172.5 gal/hr or	
	Heat Capacity =	142,000 Btu/gal	
	Sulfur In Fuel Oil =	0.2 % by weight	

Pollutant Emissions	Emission Factors (lb/mmCF or lb/mgal)		Ind. Boiler Emission Rates (lb/hr)		Facility Boilers Actual Emissions (tons/year)
	Natural Gas	2FO	Natural Gas	2FO	
VOC	5.5	0.34	0.13	0.06	1.56
NO_x	35	36	0.86	6.12	8.20
CO	84	27	2.06	4.58	19.68
SO_2	0.6	28.4	0.01	4.90	0.14
PM/PM_{10}	10.0	6.36	0.24	1.10	2.34
Lead	0.0005	0.00034	1.2E-05	5.8E-05	1.2E-04

Notes:

*1 Emission factors for natural gas and fuel oil combustion (except those specified in *2 below) based upon values presente in the USEPA reference document AP-42 Section 1.4 and 1.3, respectively.

*2 Emissions factors for NOx, CO for fuel oil firing and PM from natural gas firing based upon manufacturer's expected performance levels.

*3 Emissions rates calculated based upon the following equation:

Emission Rate (lb/hr) = Emission factor (lb/mmCF or lb/mgal) * Fuel Input (mmCF/hr or mgal/hr)

*4 Actual emissions for both facility boilers based upon worst-case actual operating scenario (i.e. natural gas or fuel oil) for anticipated actual boiler utilization using the following equations:

For VOC and CO:
Annual Emissions (TPY) = [Gas Usage (mmCF/yr) * Emission Factor (lb/mmCF)]* 1 Ton/2,000 lb

For NO_x, SO_2, PM/PM_{10} and Pb:
Annual Emissions (TPY) = [(Gas Usage (mmCF/yr)*Emission Factor (lb/mmCF))+(Oil Usage (mgal/yr)*Emission Factor (lb/mgal))]

ARMY CORP OF ENGINEERS - PROPOSED WHS OPERATIONS AT FORT BELVIOR
ANTICIPATED ACTUAL EMISSION ESTIMATES FOR FACILITY BOILERS

ANNUAL EMISSIONS CALCULATIONS BASED UPON AP-42 EMISSION FACTORS AND EXPECTED PERFORMANCE LEVELS

BOILER DISPATCH 66% of maximum capacity of each boiler
1000 hours per year each boiler on oil

NATURAL GAS	Heat Input =	28.58 mmBtu/hr	495.6 mmCF/yr (three boilers no oil)
	Firing Rate =	0.029 mmCF/hr or	409.9 mmCF/yr (three boilers w/ oil)
	Heat Capacity =	1,000 Btu/CF	
NO. 2 FUEL OIL	Heat Input =	28.98 mmBtu/hr	0.6 mgal/yr (three boilers)
	Firing Rate =	0.204 gal/hr or	
	Heat Capacity =	142,000 Btu/gal	
	Sulfur In Fuel Oil =	0.2 % by weight	

Pollutant Emissions	Emission Factors (lb/mmCF or lb/mgal)		Ind. Boiler Emission Rates (lb/hr)		Facility Boilers Actual Emissions (tons/year)
	Natural Gas	2FO	Natural Gas	2FO	
VOC	5.5	0.34	0.16	0.00	1.36
NO_x	35	36	1.00	0.01	7.17
CO	84	27	2.40	0.01	17.22
SO_2	0.6	28.4	0.02	0.01	0.12
PM/PM_{10}	10.0	6.36	0.29	0.00	2.05
Lead	0.0005	0.00034	1.4E-05	6.9E-08	1.0E-04

Notes:

*1 Emission factors for natural gas and fuel oil combustion (except those specified in *2 below) based upon values presente in the USEPA reference document AP-42 Section 1.4 and 1.3, respectively.

*2 Emissions factors for NOx, CO for fuel oil firing and PM from natural gas firing based upon manufacturer's expected performance levels.

*3 Emissions rates calculated based upon the following equation:

Emission Rate (lb/hr) = Emission factor (lb/mmCF or lb/mgal) * Fuel Input (mmCF/hr or mgal/hr)

*4 Actual emissions for both facility boilers based upon worst-case actual operating scenario (i.e. natural gas or fuel oil) for anticipated actual boiler utilization using the following equations:

For VOC and CO:
Annual Emissions (TPY) = [Gas Usage (mmCF/yr) * Emission Factor (lb/mmCF)]* 1 Ton/2,000 lb

For NO_x, SO_2, PM/PM_{10} and Pb:
Annual Emissions (TPY) = [(Gas Usage (mmCF/yr)*Emission Factor (lb/mmCF))+(Oil Usage (mgal/yr)*Emission Factor (lb/mgal))]

ARMY CORP OF ENGINEERS - PROPOSED NGA OPERATIONS AT FORT BELVIOR
POTENTIAL EMISSION ESTIMATES FOR 20 MW EMERGENCY GENERATORS

ANNUAL EMISSIONS CALCULATIONS BASED UPON AP-42 EMISSION FACTORS

FUEL USAGE No. 2 Fuel Oil Fired 500 hr/yr

Heat Input =	24.61 mmBtu/hr	3515.514286	hp-hr
Firing Rate =	0.173 mgal/hr or	12,304	mmBtu/yr
Heat Capacity =	142,000 Btu/CF	86.7	mgal/yr
Fuel Oil Sulfur Content =	0.2 % by weight		

Pollutant Emissions	Emission Factors (lb/mmBtu)	Emission Factors (g/hp-hr)	Emission Rates (lb/hr)	Potential Emissions (tons/year)
VOC		0.1	0.78	1.6
NO_x		5.05	39.14	78.3
CO		0.41	3.18	6.4
SO_2	0.29		7.14	14.3
PM/PM_{10}	0.31		7.63	15.3

Notes:

*1 VOC, NOx and CO emission factors for diesel fired emergency generators are based upon values provided by the engine vendor.

*2 SO2 and PM/PM10 emission factors for diesel fired emergency generators are based upon values presented in the USEPA reference document AP-42 Section 3.4.

*3 Emissions rates calculated based upon the following equation:

Emission Rate (lb/hr) = Emission factor (lb/mmBtu) * Fuel Input (mmBtu/hr)

*4 Annual emissions based upon the following equation.

Annual Emissions (TPY) = Fuel Input (mmBtu/hr)*Emission Factor (lb/mmBtu)*500 hr/yr*1Ton/2,000 lb

ARMY CORP OF ENGINEERS - PROPOSED WHS OPERATIONS AT FORT BELVIOR
POTENTIAL EMISSION ESTIMATES FOR EMERGENCY GENERATORS

ANNUAL EMISSIONS CALCULATIONS BASED UPON AP-42 EMISSION FACTORS

FUEL USAGE No. 2 Fuel Oil Fired 500 hr/yr

Heat Input =	17.71	mmBtu/hr	2639 hp-hr
Firing Rate =	0.125	mgal/hr or	8,854 mmBtu/yr
Heat Capacity =	142,000	Btu/CF	62.4 mgal/yr
Fuel Oil Sulfur Content =	0.05	% by weight	

Pollutant Emissions	Emission Factors (lb/mmBtu)	Emission Factors (g/hp-hr)	Emission Rates (lb/hr)	Potential Emissions (tons/year)
VOC		0.1	0.58	0.7
NO_x		5.05	29.38	36.7
CO		0.41	2.39	3.0
SO_2	0.29		5.14	6.4
PM/PM_{10}	0.31		5.49	6.9

Notes:

*1 VOC, NOx and CO emission factors for diesel fired emergency generators are based upon values provided by the engine vendor.

*2 SO2 and PM/PM10 emission factors for diesel fired emergency generators are based upon values presented in the USEPA reference document AP-42 Section 3.4.

*3 Emissions rates calculated based upon the following equation:

Emission Rate (lb/hr) = Emission factor (lb/mmBtu) * Fuel Input (mmBtu/hr)

*4 Annual emissions based upon the following equation.

Annual Emissions (TPY) = Fuel Input (mmBtu/hr)*Emission Factor (lb/mmBtu)*500 hr/yr*1Ton/2,000 lb

ARMY CORP OF ENGINEERS - PROPOSED NGA OPERATIONS AT FORT BELVIOR
ANTICIPATED ACTUAL EMISSION ESTIMATES FOR 20 MW EMERGENCY GENERATORS

ANNUAL EMISSIONS CALCULATIONS BASED UPON AP-42 EMISSION FACTORS

FUEL USAGE No. 2 Fuel Oil Fired 250 hr/yr

Heat Input =	24.61 mmBtu/hr	3515.5 hp-hr
Firing Rate =	0.173 mgal/hr or	6,152 mmBtu/yr
Heat Capacity =	142,000 Btu/CF	43.3 mgal/yr
Fuel Oil Sulfur Content =	0.2 % by weight	

Pollutant Emissions	Emission Factors (lb/mmBtu)	Emission Factors (g/hp-hr)	Emission Rates (lb/hr)	Actual Emissions (tons/year)
VOC		0.1	0.78	0.8
NO_x		5.05	39.14	39.1
CO		0.41	3.18	3.2
SO_2	0.29		7.14	7.1
PM/PM_{10}	0.31		7.63	7.6

Notes:

*1 VOC, NOx and CO emission factors for diesel fired emergency generators are based upon values provided by the engine vendor.

*2 SO2 and PM/PM10 emission factors for diesel fired emergency generators are based upon values presented in the USEPA reference document AP-42 Section 3.4.

*3 Emissions rates calculated based upon the following equation:

Emission Rate (lb/hr) = Emission factor (lb/mmBtu) * Fuel Input (mmBtu/hr)

*4 Annual emissions based upon the following equation.

Annual Emissions (TPY) = Fuel Input (mmBtu/hr)*Emission Factor (lb/mmBtu)*250 hr/yr*1Ton/2,000 lb

ARMY CORP OF ENGINEERS - PROPOSED WHS OPERATIONS AT FORT BELVIOR
ANTICIPATED ACTUAL EMISSION ESTIMATES FOR 20 MW EMERGENCY GENERATORS

ANNUAL EMISSIONS CALCULATIONS BASED UPON AP-42 EMISSION FACTORS

FUEL USAGE No. 2 Fuel Oil Fired 250 hr/yr

Heat Input =	17.71 mmBtu/hr	2639 hp-hr
Firing Rate =	0.125 mgal/hr or	4,427 mmBtu/yr
Heat Capacity =	142,000 Btu/CF	31.2 mgal/yr
Fuel Oil Sulfur Content =	0.2 % by weight	

Pollutant Emissions	Emission Factors (lb/mmBtu)	Emission Factors (g/hp-hr)	Emission Rates (lb/hr)	Actual Emissions (tons/year)
VOC		0.1	0.58	0.4
NO_x		5.05	29.38	18.4
CO		0.41	2.39	1.5
SO_2	0.29		5.14	3.2
PM/PM_{10}	0.31		5.49	3.4

Notes:

*1 VOC, NOx and CO emission factors for diesel fired emergency generators are based upon values provided by the engine vendor.

*2 SO2 and PM/PM10 emission factors for diesel fired emergency generators are based upon values presented in the USEPA reference document AP-42 Section 3.4.

*3 Emissions rates calculated based upon the following equation:

Emission Rate (lb/hr) = Emission factor (lb/mmBtu) * Fuel Input (mmBtu/hr)

*4 Annual emissions based upon the following equation.

Annual Emissions (TPY) = Fuel Input (mmBtu/hr)*Emission Factor (lb/mmBtu)*250 hr/yr*1Ton/2,000 lb

ARMY CORP OF ENGINEERS - PROPOSED NGA AND WHS OPERATIONS AT FORT BELVIOR
SUMMARY OF ANTICIPATED WORST-CASE ACTUAL EMISSIONS FOR 20MW GENERATOR SCENARIO

CONTAMINANT	NGA Boilers	NGA 20 MW Emergency Generators	WHS Boilers	WHS Emergency Generators	Facility Total Emissions	Major Source Threshold
VOC	1.56	0.78	1.36	0.36	**4.1**	**50**
NO_x	8.20	39.14	7.17	18.36	**72.9**	**100**
CO	19.68	3.18	17.22	1.49	**41.6**	**100**
SO_2	0.14	7.14	0.12	3.21	**10.6**	**100**
PM/PM_{10}	2.34	7.63	2.05	3.43	**15.5**	**100**
HAPs						**25**
Lead	1.17E-04		1.02E-04		**2.2E-04**	10

NOTES:
*1 - Please refer to individual spreadsheets for detailed emissions calculations for each unit
*2 - Worst-Case Anticipated Actual Emissionscalculated based upon asumptions presented for each unit.
*3 - PSD threshold based upon the definition of "najor stationary source" presented in Section 808 of the Virginia DEQ regulations for facility with boilers with a total heat input of greater than 250 mmBtu/hr.
*4 - NA-NSR threshold based upon status of Fairfax County as Ozone Transport Region.

Preferred Alternative– Stationary Source Emissions

Project Name	Heated Area	CO [tons]	NOx [tons]	PM [tons]	SO_2 [tons]	VOC [tons]
EPG Infrastructure (EPG) (2008), Operations	25000	0.10	0.12	0.01	0.00	0.01
Child Dev Center – 244 (EPG), Operations	19590	0.08	0.09	0.01	0.00	0.01
Child Development Center (EPG), Operations	24036	0.10	0.12	0.01	0.00	0.01
Emergency Services Center (EPG), Operations	14700	0.06	0.07	0.01	0.00	0.00
Secure Admin Facility (EPG) (WHS) (2008), Operations	2219000	17.22	7.17	2.05	0.12	1.36
NGA Admin (EPG), Operations	2419000	16.98	8.2	2.34	0.14	1.56
EPG Total	4721326	34.53	15.77	4.42	0.26	2.94

Project Name	Number of Generators	Size of Generators	Hours of Operation	CO [tons]	NOx [tons]	PM [tons]	SO_2 [tons]	VOC [tons]
Secure Admin Facility (EPG) (WHS) (2008), Operations	5	2000	250	1.49	18.36	3.43	3.21	0.36
NGA Admin (EPG), Operations	8	2500	250	3.18	39.14	7.63	7.14	0.78
			EPG Total	4.67	57.5	11.06	10.35	1.14

Project Name	Heated Area	CO [tons]	NOx [tons]	PM [tons]	SO_2 [tons]	VOC [tons]
Access Road/Control Point, Operations	280	0.00	0.00	0.00	0.00	0.0001
MDA (2007), Operations	104000	0.13	0.15	0.01	0.00	0.0084
NARMC HQ Building, Operations	9000	0.04	0.04	0.00	0.00	0.0024
NARMC HQ Building, Operations	39825	0.16	0.19	0.01	0.00	0.0105
Network Enterprise Communications Facility (AKO), Operations	73500	0.11	0.13	0.01	0.00	0.007
Network Enterprise Communications Facility (AKO), Operations	73500	0.11	0.13	0.01	0.00	0.007
Dental Clinic, Operations	16000	0.06	0.08	0.01	0.00	0.0042
Family Travel Camp, Operations	16658	0.07	0.08	0.01	0.00	0.0044
Medical Guest House, Operations	100000	0.12	0.15	0.01	0.00	0.008
Admin Bldg, MEDCOM, Operation	9000	0.04	0.04	0.00	0.00	0.0024
Administrative Facility (Bldgs 211, 215, 219, 220), Operations	133600	0.16	0.20	0.01	0.00	0.0107
Hospital (2008), Operations	868800	1.17	1.39	0.11	0.01	0.0767
USANCA Support Facility, Operations	20000	0.08	0.10	0.01	0.00	0.0053

Preferred Alternative– Stationary Source Emissions

Network Operations Center (part of PEO EIS), Operations	5000	0.02	0.02	0.00	0.00	0.0013
Main Post Total	1469163	2.26	2.69	0.20	0.02	0.1484

Sources: AP-42 Section 1.4 and DOE 1999

Project Name	Number of Generators	Size of Generators	Hours of Operation	CO [tons]	NOx [tons]	PM [tons]	SO_2 [tons]	VOC [tons]
Hospital (2008), Operations	6	1500	500	0.00	33.21	0.20	0.66	1.53
USANCA Support Facility, Operations	1	125	500	0.28	1.29	0.09	0.09	0.29
Emergency Services Center (EPG), Operations	1	45	500	0.10	0.46	0.03	0.03	0.1
Network Operations Center (part of PEO EIS), Operations	1	30	500	0.07	0.31	0.02	0.02	0.07
Total			Main Post Total	0.45	35.27	0.34	0.80	1.99

Sources: AP-42 and Manufacturers Specification

Roll-up	CO [tons]	NOx [tons]	PM [tons]	SO2 [tons]	VOC [tons]
Main Post	3	38	1	1	2
EPG	39	73	15	11	4

Town Center and Satellite Campuses Alternative– Stationary Source Emissions

Project Name	Heated Area	CO [tons]	NOx [tons]	PM [tons]	SO_2 [tons]	VOC [tons]
Access Road/Control Point, Operations	280	0.00	0.00	0.00	0.00	0.00
EPG Infrastructure (EPG) (2008), Operations	25000	0.10	0.12	0.01	0.00	0.01
MDA (2007), Operations	104000	0.13	0.15	0.01	0.00	0.01
NARMC HQ Building, Operations	9000	0.04	0.04	0.00	0.00	0.00
NARMC HQ Building, Operations	39825	0.16	0.19	0.01	0.00	0.01
Network Enterprise Communications Facility (AKO), Operations	73500	0.11	0.13	0.01	0.00	0.01
Network Enterprise Communications Facility (AKO), Operations	73500	0.11	0.13	0.01	0.00	0.01
Dental Clinic, Operations	16000	0.06	0.08	0.01	0.00	0.00
Family Travel Camp, Operations	16658	0.07	0.08	0.01	0.00	0.00
Medical Guest House, Operations	100000	0.12	0.15	0.01	0.00	0.01
Admin Bldg, MEDCOM, Operation	9000	0.04	0.04	0.00	0.00	0.00
Administrative Facility (Bldgs 211, 215, 219, 220), Operations	133600	0.16	0.20	0.01	0.00	0.01
Child Dev Center – 244 (EPG), Operations	19590	0.08	0.09	0.01	0.00	0.01
Child Development Center (EPG), Operations	24036	0.10	0.12	0.01	0.00	0.01
Hospital (2008), Operations	868800	1.17	1.39	0.11	0.01	0.08
USANCA Support Facility, Operations	20000	0.08	0.10	0.01	0.00	0.01
Emergency Services Center (EPG), Operations	14700	0.06	0.07	0.01	0.00	0.00
Network Operations Center (part of PEO EIS), Operations	5000	0.02	0.02	0.00	0.00	0.00
Secure Admin Facility (EPG) (WHS) (2008), Operations	2219000	17.22	7.17	2.05	0.12	1.36
NGA Admin (EPG), Operations	2419000	16.98	8.20	2.34	0.14	1.56
Main Post Total	6495489	36.80	18.46	4.63	0.28	3.09

Sources: AP-42 Section 1.4 and DOE 1999

Town Center and Satellite Campuses Alternative– Stationary Source Emissions

Project Name	Number of Generators	Size of Generators	Hours of Operation	CO [tons]	NOx [tons]	PM [tons]	SO_2 [tons]	VOC [tons]
Hospital (2008), Operations	6	1500	500	0.00	33.21	0.20	0.66	1.53
USANCA Support Facility, Operations	1	125	500	0.28	1.29	0.09	0.09	0.29
Emergency Services Center (EPG), Operations	1	45	500	0.10	0.46	0.03	0.03	0.10
Network Operations Center (part of PEO EIS), Operations	1	30	500	0.07	0.31	0.02	0.02	0.07
Secure Admin Facility (EPG) (WHS) (2008), Operations	5	2000	250	2.98	18.36	3.43	3.21	0.36
NGA Admin (EPG), Operations	8	2500	250	3.18	39.14	7.63	7.14	0.78
Main Post Total				6.61	92.77	11.40	11.15	3.13

Source: AP-42 and manufacturer specifications

Roll-up	CO [tons]	NOx [tons]	PM [tons]	SO_2 [tons]	VOC [tons]
Main Post	43	111	16	11	6
EPG	0	0	0	0	0

City Center Alternative – Stationary Source Emissions

Project Name (EPG)	Heated Area	CO [tons]	NOx [tons]	PM [tons]	SO_2 [tons]	VOC [tons]
EPG Infrastructure (EPG) (2008), Operations	25000	0.10	0.12	0.01	0.00	0.01
MDA (2007), Operations	104000	0.13	0.15	0.01	0.00	0.01
NARMC HQ Building, Operations	9000	0.04	0.04	0.00	0.00	0.00
NARMC HQ Building, Operations	39825	0.16	0.19	0.01	0.00	0.01
Network Enterprise Communications Facility (AKO), Operations	73500	0.11	0.13	0.01	0.00	0.01
Family Travel Camp, Operations	16658	0.07	0.08	0.01	0.00	0.00
Medical Guest House, Operations	100000	0.12	0.15	0.01	0.00	0.01
Child Dev Center – 244 (EPG), Operations	19590	0.08	0.09	0.01	0.00	0.01
Child Development Center (EPG), Operations	24036	0.10	0.12	0.01	0.00	0.01
Hospital (2008), Operations	868800	1.17	1.39	0.11	0.01	0.08
Emergency Services Center (EPG), Operations	14700	0.06	0.07	0.01	0.00	0.00
Network Operations Center (part of PEO EIS), Operations	5000	0.02	0.02	0.00	0.00	0.00
Secure Admin Facility (EPG) (WHS) (2008), Operations	2219000	17.22	7.17	2.05	0.12	1.36
NGA Admin (EPG), Operations	2419000	16.98	8.20	2.34	0.14	1.56
EPG Total		36.35	17.92	4.58	0.28	3.06

Project Name (EPG)	Number of Generators	Size of Generators	Hours of Operation	CO [tons]	NOx [tons]	PM [tons]	SO_2 [tons]	VOC [tons]
Hospital (2008), Operations	6	1500	500	0.00	33.21	0.20	0.66	1.53
Emergency Services Center (EPG), Operations	1	45	500	0.10	0.46	0.03	0.03	0.1
Network Operations Center (part of PEO EIS), Operations	1	30	500	0.07	0.31	0.02	0.02	0.07
Secure Admin Facility (EPG) (WHS) (2008), Operations	5	2000	500	2.98	18.36	3.43	3.21	0.36
NGA Admin (EPG), Operations	8	2500	500	3.18	39.14	7.63	7.14	0.78
EPG Total				6.33	91.48	11.31	11.06	2.84

City Center Alternative – Stationary Source Emissions

Project Name (Main Post)	Heated Area	CO [tons]	NOx [tons]	PM [tons]	SO_2 [tons]	VOC [tons]
Access Road/Control Point, Operations	280	0.00	0.00	0.00	0.00	0.00
Network Enterprise Communications Facility (AKO), Operations	73500	0.11	0.13	0.01	0.00	0.01
Dental Clinic, Operations	16000	0.06	0.08	0.01	0.00	0.00
Admin Bldg, MEDCOM, Operation	9000	0.04	0.04	0.00	0.00	0.00
Administrative Facility (Bldgs 211, 215, 219, 220), Operations	133600	0.16	0.20	0.01	0.00	0.01
USANCA Support Facility, Operations	20000	0.08	0.10	0.01	0.00	0.01
Main Post Total	6495489	0.45	0.54	0.04	0.00	0.03

Project Name(Main Post)	Number of Generators	Size of Generators	Hours of Operation	CO [tons]	NOx [tons]	PM [tons]	SO_2 [tons]	VOC [tons]
USANCA Support Facility, Operations	1	125	500	0.28	1.29	0.09	0.09	0.29
Main Post Total				0.28	1.29	0.09	0.09	0.29

Roll-up	CO [tons]	NOx [tons]	PM [tons]	SO_2 [tons]	VOC [tons]
Main Post	1	2	0	0	0
EPG	43	109	16	11	6

Notes: Only actual equipment for the NGA and WHS facilities has been chosen at this time. Detailed methodologies for emissions calculations for boilers can be located in the Appendix E.1. Potential to emit estimation for emergency generators were based on a 250 hours of operations federally enforceable permit limitation for NGA and WHS facilities, and 500 hours for all the other facilities.

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