Appendix D – Air Quality Emission Calculations

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Table 1
Estimated Carbon Monoxide Emissions from Proposed Parking Garage

Tennessee Valley Authority
Knoxville, Tennessee

Carbon Monoxide (CO)

Technical Data[1]						Weekdays								
						Idle Emissions				Travel Emissions				
Spaces	Lengh	Width	Garage Area/Level	Levels	Garage Fullness	8-hr Period with Largest Avg # Veh Departing[3]	Emission Factor[4]	Avg Idle Time per Veh During 8-hr[5]	Idle Emissions Rate per 8-hr period[6]	8-hr Period with Largest Avg # Veh Moving[7]	Emission Factor[8]	Mean Travel Distance[9]	Travel Emission Rate per 8-hr period[10]	**Total Emission Rate over 8-hr period[11]**
#	feet	feet	sqft	#	percent	veh/hr	gm/hr/veh	min/veh	gm/sec	veh/hr	gm/veh-mi	feet	gm/sec	gm/sec
1000	290	140	40,600	6	90	169	94.823	1	0.074	225	25.369	922	0.277	0.351

Technical Data[1]						Evening and Weekends								
						Idle Emissions				Travel Emissions				
Spaces	Lengh	Width	Garage Area/Level	Levels	Garage Fullness[2]	16-hr Period with Largest Avg # Veh Departing[3]	Emission Factor[4]	Avg Idle Time per Veh During 16-hr[5]	Idle Emissions over 16-hr period[6]	16-hr Period with Largest Avg # Veh Moving[7]	Emission Factor[8]	Mean Travel Distance[9]	Travel Emission Rate per 16-hr period[10]	**Total Emission Rate over 16-hr period[11]**
#	feet	feet	sqft	#	percent	min/veh	gm/hr/veh	min/veh	gm/sec	veh/hr	gm/veh-mi	feet	gm/s	gm/sec
1000	140	290	40,600	6	30	19	94.823	1	0.008	38	25.369	922	0.0013	0.0095

Weekday							Weekend Days				
Emission Rate per 8-hr Period	Emissions per 8-hr Period[12]	Emission Rate per 16-hr Period	Emissions per 16-hr Period[12]	Weekday Emissions	Weekend Days per Year	Total Weekday Emissions	Emission rate per 24-hr Period	Emissions per 24-hr Period[12]	Weekend Days per Year	Total Weekend Day Emissions	**Total Annual Emissions**
gm/sec	tons/8-hr	gm/sec	tons/16-hr	tons/day	days/year	tons/year	gm/sec	tons/day	days/year	tons/year	tons/year
0.351	0.01114	0.0095	0.00060	0.0117	260	3.053	0.014	0.0014	104	0.141	3.19

[1] Technical data from client
[2] Garage fullness 30% (MTA, 2009a)
[3] # Parking spaces x 90% full / 8 (or 16) hours
[4] Idle emission factor = emission factor in gm/mile from MOBILE6.2 x 2.5 miles/hr (USEPA,1993)
[5] Factors specified in (NYC, 2012) and (NNMC, 2007)
[6] Idle emissions = # Vehicles moving during 8-hour (or 16-hr) peroiod x Emission factor x avg idle time per vehicle during 8-hour period (NCDENR, 2007)
[7] # Parking spaces x 30% full x 2 vehicles in and out / 8 (or 16) hours
[8] Travel emission factor from MOBILE6.2 at 5 mph (NNMC, 2007; NYC, 2012)
[9] Travel distance = 2/3 length of garage + 1/2 width of garage x # Levels (NCDENR, 2007; MTA, 2009b)
10 Travel emission rate = (# Vehicles moving during 8-hr or 16-hr period x Emission factor x Mean Travel Distance) / (5280 feet/mile x 3600 sec/hr) (NCDENR, 2007; MTA, 2009b)
[11] Total emissions = Idle emissions x Travel emissions
[12] Emissions per period = (Emission rate per period in gm/sec x 3600 sec/hr x 0.002204 lb/gm*8 hrs/day)/2000 lb/ton

Table 2
Estimated Nitrogen Oxide Emissions from Proposed Parking Garage

Tennessee Valley Authority
Knoxville, Tennessee

Nitrogen Oxides (NO_x)

Technical Data[1]						Weekdays								
						Idle Emissions				Travel Emissions				
Spaces	Lengh	Width	Garage Area/Level	Levels	Garage Fullness	8-hr Period with Largest Avg # Veh Departing[3]	Emission Factor[4]	Avg Idle Time per Veh During 8-hr[5]	Idle Emissions Rate per 8-hr period[6]	8-hr Period with Largest Avg # Veh Moving[7]	Emission Factor[8]	Mean Travel Distance[9]	Travel Emission Rate per 8-hr period[10]	**Total Emission Rate over 8-hr period[11]**
#	feet	feet	sqft	#	percent	veh/hr	gm/hr/veh	min/veh	gm/sec	veh/hr	gm/veh-mi	feet	gm/sec	gm/sec
1000	290	140	40,600	6	90	169	3.950	1	0.003	225	1.410	922	0.015	0.018

Technical Data[1]						Evening and Weekends								
						Idle Emissions				Travel Emissions				
Spaces	Lengh	Width	Garage Area/Level	Levels	Garage Fullness[2]	16-hr Period with Largest Avg # Veh Departing[3]	Emission Factor[4]	Avg Idle Time per Veh During 16-hr[5]	Idle Emissions over 16-hr period[6]	16-hr Period with Largest Avg # Veh Moving[7]	Emission Factor[8]	Mean Travel Distance[9]	Travel Emission Rate per 16-hr period[10]	**Total Emission Rate over 16-hr period[11]**
#	feet	feet	sqft	#	percent	min/veh	gm/hr/veh	min/veh	gm/sec	veh/hr	gm/veh-mi	feet	gm/s	gm/sec
1000	140	290	40,600	6	30	19	3.950	1	3.43E-04	38	1.410	922	3.92E-06	3.47E-04

Weekday							Weekend days				**Total Annual Emissions**
Emission Rate per 8-hr Period	Emissions per 8-hr Period[12]	Emission Rate per 16-hr Period	Emissions per 16-hr Period[12]	Weekday Emissions	Weekend Days per Year	Total Weekday Emissions	Emission rate per 24-hr Period	Emissions per 24-hr Period[12]	Weekend Days per Year	Total Weekend Day Emissions	
gm/sec	tons/8-hr	gm/sec	tons/16-hr	tons/day	days/year	tons/year	gm/sec	tons/day	days/year	tons/year	tons/year
0.018	0.00059	3.47E-04	2.20E-05	6.08E-04	260	0.158	5.20E-04	4.95E-05	104	5.15E-03	1.63E-01

[1] Technical data from client
[2] Garage fullness 30% (MTA, 2009a)
[3] # Parking spaces x 90% full / 8 (or 16) hours
[4] Idle emission factor = emission factor in gm/mile from MOBILE6.2 x 2.5 miles/hr (USEPA,1993)
[5] Factors specified in (NYC, 2012) and (NNMC, 2007)
[6] Idle emissions = # Vehicles moving during 8-hour (or 16-hr) peroiod x Emission factor x avg idle time per vehicle during 8-hour period (NCDENR, 2007)
[7] # Parking spaces x 30% full x 2 vehicles in and out / 8 (or 16) hours
[8] Travel emission factor from MOBILE6.2 at 5 mph (NNMC, 2007; NYC, 2012)
[9] Travel distance = 2/3 length of garage + 1/2 width of garage x # Levels (NCDENR, 2007; MTA, 2009b)
10 Travel emission rate = (# Vehicles moving during 8-hr or 16-hr period x Emission factor x Mean Travel Distance) / (5280 feet/mile x 3600 sec/hr) (NCDENR, 2007; MTA, 2009b)
[11] Total emissions = Idle emissions x Travel emissions
[12] Emissions per period = (Emission rate per period in gm/sec x 3600 sec/hr x 0.002204 lb/gm*8 hrs/day)/2000 lb/ton

Table 3
Estimated Particulate Matter Emissions from Proposed Parking Garage

Tennessee Valley Authority
Knoxville, Tennessee

Particulate Matter ($PM_{2.5}$)

Technical Data[1]						Weekdays								
						Idle Emissions				Travel Emissions				
Spaces	Lengh	Width	Garage Area/Level	Levels	Garage Fullness	8-hr Period with Largest Avg # Veh Departing[3]	Emission Factor[4]	Avg Idle Time per Veh During 8-hr[5]	Idle Emissions Rate per 8-hr period[6]	8-hr Period with Largest Avg # Veh Moving[7]	Emission Factor[8]	Mean Travel Distance[9]	Travel Emission Rate per 8-hr period[10]	**Total Emission Rate over 8-hr period[11]**
#	feet	feet	sqft	#	percent	veh/hr	gm/hr/veh	min/veh	gm/sec	veh/hr	gm/veh-mi	feet	gm/sec	gm/sec
1000	290	140	40,600	6	90	169	0.0485	1	3.79E-05	225	0.0194	922	2.12E-04	2.50E-04

Technical Data[1]						Evening and Weekends								
						Idle Emissions				Travel Emissions				
Spaces	Lengh	Width	Garage Area/Level	Levels	Garage Fullness[2]	16-hr Period with Largest Avg # Veh Departing[3]	Emission Factor[4]	Avg Idle Time per Veh During 16-hr[5]	Idle Emissions over 16-hr period[6]	16-hr Period with Largest Avg # Veh Moving[7]	Emission Factor[8]	Mean Travel Distance[9]	Travel Emission Rate per 16-hr period[10]	**Total Emission Rate over 16-hr period[11]**
#	feet	feet	sqft	#	percent	min/veh	gm/hr/veh	min/veh	gm/sec	veh/hr	gm/veh-mi	feet	gm/s	gm/sec
1000	140	290	40,600	6	30	19	0.0485	1	4.21E-06	38	0.0194	922	7.43E-10	4.21E-06

Weekdays							Weekend Days				**Total Annual Emissions**
Emission Rate per 8 hr Period	Emissions per 8-hr Period[12]	Emission Rate per 16-hr Period	Emissions per 16-hr Period[12]	Weekday Emissions	Weekend Days per Year	Total Weekday Emissions	Emission rate per 24-hr Period	Emissions per 24-hr Period[12]	Weekend Days per Year	Total Weekend Day Emissions	
gm/sec	tons/8-hr	gm/sec	tons/16-hr	tons/day	days/year	tons/year	gm/sec	tons/day	days/year	tons/year	tons/year
2.496E-04	0.00001	4.21E-06	2.67E-07	8.19E-06	260	2.129E-03	6.32E-06	6.01E-07	104	6.25E-05	2.19E-03

[1] Technical data from client
[2] Garage fullness 30% (MTA, 2009a)
[3] # Parking spaces x 90% full / 8 (or 16) hours
[4] Idle emission factor = emission factor in gm/mile from MOBILE6.2 x 2.5 miles/hr (USEPA,1993)
[5] Factors specified in (NYC, 2012) and (NNMC, 2007)
[6] Idle emissions = # Vehicles moving during 8-hour (or 16-hr) peroiod x Emission factor x avg idle time per vehicle during 8-hour period (NCDENR, 2007)
[7] # Parking spaces x 30% full x 2 vehicles in and out / 8 (or 16) hours
[8] Travel emission factor from MOBILE6.2 at 5 mph (NNMC, 2007; NYC, 2012)
[9] Travel distance = 2/3 length of garage + 1/2 width of garage x # Levels (NCDENR, 2007; MTA, 2009b)
10 Travel emission rate = (# Vehicles moving during 8-hr or 16-hr period x Emission factor x Mean Travel Distance) / (5280 feet/mile x 3600 sec/hr) (NCDENR, 2007; MTA, 2009b)
[11] Total emissions = Idle emissions x Travel emissions
[12] Emissions per period = (Emission rate per period in gm/sec x 3600 sec/hr x 0.002204 lb/gm*8 hrs/day)/2000 lb/ton

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