U.S. Department of Veterans Affairs

March 2014

NY HARBOR HEALTHCARE SYSTEM MANHATTAN CAMPUS

Appendix C: Air Emissions Detailed Calculations and Assumptions, VAMC Manhattan

DRAFT ENVIRONMENTAL ASSESSMENT FOR

FLOOD MITIGATION MEASURES

Design and Construction of Perimeter Flood Wall

MANHATTAN, NEW YORK

Generator emissions

Generator Kilowatts		Conversion from kW to Btu/hr	Engine Btu/hr (Assume 40% efficiency converting mechanical to electrical power)	Engine MMBtu/hr
400		1364856.8	1,364,856,800	1364.86

Diesel Industrial Engine Emission Factors from AP-42, Section 3.4	NOx	CO	VOC	PM-10	SO_2	CO_2
	lb/MMBtu	lb/MMBtu	lb/MMBtu	lb/MMBtu	lb/MMBtu	lb/MMBtu
Emission Factor	3.2	0.85	0.09	0.1	1.01	165

Assume max. 1 hr/yr operation and testing per generator	NOx	CO	VOC	PM-10	SO_2	CO_2
	(lbs/yr)	(lbs/yr)	(lbs/yr)	(lbs/yr)	(lbs/yr)	(lbs/yr)
	4,367.54	1,160.13	122.84	136.49	1,378.51	225,201.37

Emissions Per Generator	NOx	CO	VOC	PM-10	SO_2	CO_2
	(tons/yr)	(tons/yr)	(tons/yr)	(tons/yr)	(tons/yr)	(tons/yr)
	2.184	**0.580**	**0.0614**	**0.0682**	**0.689**	**112.601**

Source: USEPA 1996. *AP-42. Large Stationary Diesel And All Stationary Duel-fuel Engines.* Table 3.4-1. Page 3.4-5.

Summary	Summarizes total emissions by calendar year for Construction of the Proposed Action
Combustion	Estimates emissions from non-road equipment exhaust.
Fugitive	Estimates particulate emissions from construction and demolition activities including earthmoving, vehicle traffic, and windblown dust.
Construction Commuter	Estimates emissions for construction workers commuting to the site.
Tier Report	Summarizes total emissions for the New Jersey-New York-Connecticut AQCR for 2008, to be used to compare the Proposed Action construction emissions to regional emissions.

Air Emissions for VAMC Manhattan Floodwall Construction Activities

	NO_x (ton)	VOC (ton)	CO (ton)	SO_2 (ton)	PM_{10} (ton)	$PM_{2.5}$ (ton)	CO_2 (ton)
Combustion	9.410	2.101	5.116	2.324	0.297	0.288	1,033.397
Fugitive Dust	-	-	-	-	0.904	0.090	-
Haul Truck On-Road	0.112	0.013	0.033	0.000	0.004	0.003	49.513
Commuter	0.024	0.025	0.238	0.000	0.003	0.002	39.693
TOTAL	***9.546***	***2.139***	***5.387***	***2.324***	***1.209***	***0.384***	***1,122.603***

Note: Total $PM_{10}/_{2.5}$ fugitive dust emissions are assuming USEPA 50% control efficiencies.

CO_2 emissions converted to metric tons =	***1,018.201***	***metric tons***	
State of New York's CO_2 emissions =	***172,800,000***	***metric tons***	*(U.S. DOE/EIA 2011)*
Percent of New York's CO_2 emissions =	***0.00059%***		
United States' CO_2 emissions =	***5,631,300,000***	***metric tons***	*(U.S. DOE/EIA 2011)*
Percent of USA's CO_2 emissions =	***0.000018%***		

Source: U.S. Department of Energy, Energy Information Administration (U.S. DOE/EIA). 2012. *Table 1. State Emissions by Year (Million Metric Tons of Carbon Dioxide).* Available online <http://www.eia.gov/environment/emissions/state/state_emissions.cfm>. Data released October 2011. Data accessed 19 September 2013.

Because future year budgets were not readily available, actual 2008 air emissions inventories for the counties were used as an approximation of the regional inventory. Because construction for the Proposed Action is several orders of magnitude below significance, the conclusion would be the same, regardless of whether future year budget data set were used.

New Jersey-New York-Connecticut AQCR

	Point and Area Sources Combined					
Year	NO_x (tpy)	VOC (tpy)	CO (tpy)	SO_2 (tpy)	PM_{10} (tpy)	$PM_{2.5}$ (tpy)
2008	415,090	453,929	2,212,433	70,881	100,934	43,919

Source: USEPA National Emissions Inventory (NEI) (http://neibrowser.epa.gov/eis-public-web/home.html). Site visited on 19 September 2013

Air Emissions from Proposed Construction

	Point and Area Sources Combined					
	NO_x (tpy)	VOC (tpy)	CO (tpy)	SO_2 (tpy)	PM_{10} (tpy)	$PM_{2.5}$ (tpy)
Regional Emissions	415,090	453,929	2,212,433	70,881	100,934	43,919
Emissions	9.546	2.139	5.387	2.324	1.209	0.384
% of Regional	**0.002%**	**0.000%**	**0.000%**	**0.003%**	**0.001%**	**0.001%**

Combustion Emissions

Combustion Emissions of VOC, NO_x, SO_2, CO, $PM_{2.5}$, $PM_{10,}$ and CO_2 due to Construction and Demolition

	Construction of Floodwall	**Area Disturbed**		
1.)	Demolition Activities	26,000	ft^2	Assumes demolition activities would occur for 5 weeks
2.)	Secant Wall Construction	26,000	ft^2	Assumes construction activities for the secant wall would occur for 5 weeks
3.)	Footing Excavation Activities	26,000	ft^2	Assumes footing excavation activities would occur for 5 weeks
4.)	Wall Construction	26,000	ft^2	Assumes construction activities would occur for 5 weeks
5.)	Site/Civil Activities	19,500	ft^2	Assumes site activities would occur for 4 weeks
	Total Construction Area:	26,000	ft^2	
		0.60	acres	
	Total Demolition Area:	26,000	ft^2	
		0.60	acres	
	Total Pavement Area:	19,500	ft^2	
		0.45	acres	
	Total Disturbed Area:	26,000	ft^2	Assumes activities would overlap each other
		0.60	acres	
	Construction Duration:	6	months	
	Annual Construction Activity:	120	days	Assume 4 weeks per month, 5 days per week.

Emission Factors Used for Construction Equipment

References: U.S. EPA NONROAD Emissions Model, Version 2005.0.0 and Exhaust and Crankcase Emission Factors for Nonroad Engine Modeling--Compression-Ignition (EPA420-P-04-009)
Emission factors are taken from the NONROAD model and rankcase Emission Factors for Nonroad Engine Modeling-- Compression-Ignition
Assumptions regarding the type and number of equipment are based on preliminary design of the proposed floodwall.

Floodwall Construction - emissions each day

Equipment[c]	Hours of use per day	No. Used	NO_x (lb/day)	VOC[a] (lb/day)	CO (lb/day)	SO_2[b] (lb/day)	PM_{10} (lb/day)	$PM_{2.5}$ (lb/day)	CO_2 (lb/day)
Demolition - 5 weeks									
Backhoe	10	1	37.03766	8.12514	20.06207	9.16225	1.15743	1.12270	4073.0093
Jackhammer	8	2	0.39507	0.41601	0.42329	0.08423	0.04233	0.04106	41.64934058
Pavement saw	8	2	2.56794	2.70405	2.75137	0.54753	0.27514	0.26688	270.7207
Secant Wall Construction - 5 weeks									
Low Clearance Drill Rig	10	1	105.82189	23.21468	57.32019	26.17787	3.30693	3.20773	11637.1695
Drill Rig	10	1	105.82189	23.21468	57.32019	26.17787	3.30693	3.20773	11637.1695
Skid Steer	10	2	74.07532	16.25027	40.12413	18.32451	2.31485	2.24541	8146.0186
Truck	10	2	43.21060	9.28587	22.92808	10.47115	1.32277	1.28309	4654.8678
Footing Excavation - 5 weeks									
Backhoe	10	1	37.03766	8.12514	20.06207	9.16225	1.15743	1.12270	4073.0093
Vibrating Plate	10	1	0.80248	0.84501	0.85980	0.17110	0.08598	0.08340	84.6002
Wall Construction - 5 weeks									
Concrete Pump Truck	10	1	222.22596	48.75082	120.37240	54.97352	6.94456	6.73622	24438.0559
Backhoe	10	1	37.03766	8.12514	20.06207	9.16225	1.15743	1.12270	4073.0093
Forklift	10	1	37.03766	8.12514	20.06207	9.16225	1.15743	1.12270	4073.0093
Skid Steer	10	1	37.03766	8.12514	20.06207	9.16225	1.15743	1.12270	4073.0093
Civil/Site Work - 4 weeks									
Asphalt Paving Machine	10	1	37.03766	8.12514	20.06207	9.16225	1.15743	1.12270	4073.0093
Concrete Paving Machine	10	1	37.03766	8.12514	20.06207	9.16225	1.15743	1.12270	4073.0093
Backhoe	10	1	37.03766	8.12514	20.06207	9.16225	1.15743	1.12270	4073.0093
Skid Steer	10	1	37.03766	8.12514	20.06207	9.16225	1.15743	1.12270	4073.0093

Note: Footnotes for tables are on following page

Floodwall Construction - for entire project

Equipment[c]	Days used	NO_x (lbs)	VOC[a] (lbs)	CO (lbs)	SO_2[b] (lbs)	PM_{10} (lbs)	$PM_{2.5}$[d] (lbs)	CO_2[e] (lbs)
Demolition								
Backhoe	25	925.94150	203.12842	501.55165	229.05632	28.93567	28.06760	101825.2329
Jackhammer	25	9.87671	10.40017	10.58219	2.10587	1.05822	1.02647	1041.233515
Pavement saw	25	64.19861	67.60114	68.78423	13.68815	6.87842	6.67207	6768.0178
Secant Wall Construction								
Low Clearance Drill Rig	10	1058.21886	232.14676	573.20188	261.77866	33.06934	32.07726	116371.6947
Drill Rig	15	1587.32829	348.22014	859.80282	392.66798	49.60401	48.11589	174557.5420
Skid Steer	25	1851.88300	406.25683	1003.10329	458.11265	57.87134	56.13520	203650.4657
Truck	25	1080.26508	232.14676	573.20188	261.77866	33.06934	32.07726	116371.6947
Footing Excavation								
Backhoe	25	925.94150	203.12842	501.55165	229.05632	28.93567	28.06760	101825.2329
Vibrating Plate	25	20.06207	21.12536	21.49507	4.27755	2.14951	2.08502	2115.0056
Wall Construction								
Concrete Pump Truck	25	5555.64901	1218.77050	3009.30988	1374.33794	173.61403	168.40561	610951.3972
Backhoe	25	925.94150	203.12842	501.55165	229.05632	28.93567	28.06760	101825.2329
Forklift	25	925.94150	203.12842	501.55165	229.05632	28.93567	28.06760	101825.2329
Skid Steer	25	925.94150	203.12842	501.55165	229.05632	28.93567	28.06760	101825.2329
Civil/Site Work								
Asphalt Paving Machine	20	740.75320	162.50273	401.24132	183.24506	23.14854	22.45408	81460.1863
Concrete Paving Machine	20	740.75320	162.50273	401.24132	183.24506	23.14854	22.45408	81460.1863
Backhoe	20	740.75320	162.50273	401.24132	183.24506	23.14854	22.45408	81460.1863
Skid Steer	20	740.75320	162.50273	401.24132	183.24506	23.14854	22.45408	81460.1863
Total construction emissions for		18,820.20	4,202.32	10,232.20	4,647.01	594.59	576.75	2,066,793.96

a) VOC emissions are assumed to be equal to 1.053 times the HC emissions.

b) The SO_2 emission factors assume that the average fuel burned in nonroad trucks is 1100 ppm sulfur. Trucks that would be used for the Proposed Preferred Alignment construction will all be fueled by highway grade diesel fuel which cannot exceed 500 ppm sulfur. These estimates therefore over-estimate SO2 emissions by more than a factor of two.

c) The equipment list above was based on preliminary design of the proposed floodwall .

d) $PM_{2.5}$ are estimated as 0.97 times the PM_{10} emissions

e) CO_2 emission factors are based on brake-specific fuel consumption

f) Construction equipment emission rates were calculated assuming equipment would meet Tier 2 and Tier 3 emissions standards for nonroad engines.

Sample Daily Construction Emission Calculation:
(NOx emission factor - based on equipment type and horsepower)(equipment horsepower)(hours used per day)(number used)(pound/gram conversion factor)

Sample Proposed Action Total Construction Calculation:
(Daily Construction Emissions) (Number of days used during project life)

Results: Total Project Annual Emission Rates

	NOx	VOC	CO	SO_2	PM_{10}	$PM_{2.5}$	CO_2
Total Project Emissions (lbs)	18,820.20	4,202.32	10,232.20	4,647.01	594.59	576.75	2,066,794
Total Project Emissions (tons)	9.410	2.101	5.116	2.324	0.297	0.288	1,033.397

Construction Fugitive Dust Emissions

Construction Fugitive Dust Emission Factors

	Emission Factor	Units	Source
Construction Activities	0.19	ton PM_{10}/acre-month	MRI 1996; EPA 2001; EPA 2006
$PM_{2.5}$ Emissions			
$PM_{2.5}$ Multiplier	0.10	(10% of PM_{10} emissions assumed to be $PM_{2.5}$)	EPA 2001; EPA 2006
Control Efficiency	0.50	(assume 50% control efficiency for PM_{10} and $PM_{2.5}$ emissions)	EPA 2001; EPA 2006

Project Assumptions

General Construction and Demolition Activities (0.19 ton PM_{10}/acre-month)

Duration of Project	6	months
Area	0.60	acres

	Project Emissions (tons/year)			
	PM_{10} uncontrolled	**PM_{10} controlled**	**$PM_{2.5}$ uncontrolled**	**$PM_{2.5}$ controlled**
General Construction Activities	0.680	0.340	0.068	0.034
Total	**1.809**	**0.904**	**0.181**	**0.090**

Construction Fugitive Dust Emission Factors

General Construction Activities Emission Factor

0.19 ton PM_{10}/acre-month Source: MRI 1996; EPA 2001; EPA 2006

The area-based emission factor for construction activities is based on a study completed by the Midwest Research Institute (MRI) Improvement of Specific Emission Factors (BACM Project No. 1), March 29, 1996. The MRI study evaluated seven construction projects in Nevada and California (Las Vegas, Coachella Valley, South Coast Air Basin, and the San Joaquin Valley). The study determined an average emission factor of 0.11 ton PM_{10}/acre-month for sites without large-scale cut/fill operations. A worst-case emission factor of 0.42 ton PM_{10}/acre-month was calculated for sites with active large-scale earth moving operations. The monthly emission factors are based on 168 work-hours per month (MRI 1996). A subsequent MRI Report in 1999, Estimating Particulate Matter Emissions From Construction Operations, calculated the 0.19 ton PM_{10}/acre-month emission factor by applying 25% of the large-scale earthmoving emission factor (0.42 ton PM_{10}/acre-month) and 75% of the average emission factor (0.11 ton PM_{10}/acre-month). The 0.19 ton PM_{10}/acre-month emission factor is referenced by the EPA for non-residential construction activities in recent procedures documents for the National Emission Inventory (EPA 2001; EPA 2006). The 0.19 ton PM_{10}/acre-month emission factor represents a refinement of EPA's original AP-42 area-based total suspended particulate (TSP) emission factor in Section 13.2.3 Heavy Construction Operations. In addition to the EPA, this methodology is also supported by the South Coast Air Quality Management District as well as the Western Regional Air Partnership (WRAP) which is funded by the EPA and is administered jointly by the Western Governor's Association and the National Tribal Environmental Council. The emission factor is assumed to encompass a variety of non-residential construction activities including building construction (commercial, industrial, institutional, governmental), public works, and travel on unpaved roads. The EPA National Emission Inventory documentation assumes that the emission factors are uncontrolled and recommends a control efficiency of 50% for PM_{10} and $PM_{2.5}$ in PM nonattainment areas.

New Road Construction Emission Factor

0.42 ton PM_{10}/acre-month Source: MRI 1996; EPA 2001; EPA 2006

The emission factor for new road construction is based on the worst-case conditions emission factor from the MRI 1996 study described above (0.42 tons PM_{10}/acre-month). It is assumed that road construction involves extensive earthmoving and heavy construction vehicle travel resulting in emissions that are higher than other general construction projects. The 0.42 ton PM10/acre-month emission factor for road construction is referenced in recent procedures documents for the EPA National Emission Inventory (EPA 2001; EPA 2006).

$PM_{2.5}$ Multiplier **0.10**

$PM_{2.5}$ emissions are estimated by applying a particle size multiplier of 0.10 to PM_{10} emissions. This methodology is consistent with the procedures documents for the National Emission Inventory (EPA 2006).

Control Efficiency for PM_{10} and $PM_{2.5}$ **0.50**

The EPA National Emission Inventory documentation recommends a control efficiency of 50% for PM_{10} and $PM_{2.5}$ in PM nonattainment areas (EPA 2006). Wetting controls will be applied during project construction.

References:

EPA 2001. *Procedures Document for National Emissions Inventory, Criteria Air Pollutants, 1985-1999.* EPA-454/R-01-006. Office of Air Quality Planning and Standards, United States Environmental Protection Agency. March 2001.

EPA 2006. *Documentation for the Final 2002 Nonpoint Sector (Feb 06 version) National Emission Inventory for Criteria and Hazardous Air Pollutants.* Prepared for: Emissions Inventory and Analysis Group (C339-02) Air Quality Assessment Division Office of Air Quality Planning and Standards, United States Environmental Protection Agency. July 2006.

MRI 1996. *Improvement of Specific Emission Factors (BACM Project No. 1).* Midwest Research Institute (MRI). Prepared for the California South Coast Air Quality Management District, March 29, 1996.

Haul Truck Emissions

Emissions from hauling excavation material and construction supplies are estimated in this spreadsheet.
Emission Estimation Method: United States Air Force (USAF) Institute for Environment, Safety and Occupational Health Risk Analysis (IERA) Air Emissions Inventory Guidance Document for Mobile Sources at Air Force Installations (Revised December 2013).

Assumptions:
Haul trucks carry 20 cubic yards of material per trip.
The average distance from the project site to the materials source is estimated to be 15 miles; therefore, a haul truck will travel 30 miles round trip.
Estimated number of trips required by haul trucks = total amount of material/20 cubic yards per truck

Amount of Excavation Material =	24,074	cubic yards	Assumes 25 feet of material would need to be excavated and removed
Number of trucks required =	1,203.70	heavy duty diesel haul truck trips	
Miles per trip =	30	miles	

Heavy Duty Diesel Vehicle (HDDV) Average Emission Factors (grams/mile)

	NO_x	VOC	CO	SO_2	PM_{10}	$PM_{2.5}$	CO_2
HDDV	**2.817**	**0.325**	**0.832**	**0.012**	**0.110**	**0.083**	**1243.900**

Notes:
Emission factors for all pollutants are from USAF IERA 2013.

HDDV Haul Truck Emissions

	NO_x	VOC	CO	SO_2	PM_{10}	$PM_{2.5}$	CO_2
lbs	**224.261**	**25.873**	**66.236**	**0.955**	**8.757**	**6.608**	**99026.920**
tons	**0.112**	**0.013**	**0.033**	**0.000**	**0.004**	**0.003**	**49.513**

Example Calculation: NO_x emissions (lbs) = 30 miles per trip * 369 trips * NO_x emission factor (g/mile) * lb/453.6 g

Construction Commuter Emissions

Emissions from construction workers commuting to the job site are estimated in this spreadsheet.

Emission Estimation Method: Emission factors from the South Coast Air Quality Management District (SCAQMD) EMFAC 2007 (v 2.3) Model (on-road) were used. These emission factors are available online at http://www.aqmd.gov/ceqa/handbook/onroad/onroad.html.

Assumptions:
Passenger vehicle emission factors for scenario year 2014 are used.

The average roundtrip commute for a construction worker =	30	miles
Number of construction days =	120	days
Number of construction workers (daily) =	20	people

Passenger Vehicle Emission Factors for Year 2014 (lbs/mile)

NO_x	VOC	CO	SO_2	PM_{10}	$PM_{2.5}$	CO_2
0.00065484	0.00070227	0.00660353	0.00001069	0.00009185	0.00005939	1.10257205

Source: South Coast Air Quality Management District. EMFAC 2007 (ver 2.3) On-Road Emissions Factors. Last updated April 24, 2008. Available online: <http://www.aqmd.gov/ceqa/handbook/onroad/onroad.html>. Accessed September 2013
Notes:
The SMAQMD 2007 reference lists emission factors for reactive organic gas (ROG). For purposes of this worksheet ROG = VOC.

Construction Commuter Emissions

	NO_x	VOC	CO	SO_2	PM_{10}	$PM_{2.5}$	CO_2
lbs	**47.149**	**50.564**	**475.454**	**0.770**	**6.613**	**4.276**	**79385.187**
tons	**0.024**	**0.025**	**0.238**	**0.000**	**0.003**	**0.002**	**39.693**

Example Calculation: NO_x emissions (lbs) = 60 miles/day * NO_x emission factor (lb/mile) * number of construction days * number of workers

New Jersey-New York-Connecticut AQCR

			All Emission Sources					
Row #	State	County	CO	NO_x	PM_{10}	$PM_{2.5}$	SO_2	VOC
1	CT	Fairfield	141366.60	25631.17	8079.82	3434.49	6995.62	25048.10
2	CT	Litchfield	34874.92	3764.19	3644.77	1304.43	877.80	14340.20
3	NY	Bronx	72474.37	11895.12	2815.59	1721.58	1917.69	20236.84
4	NY	Kings	124476.14	25479.52	4772.75	3078.71	4048.26	36279.75
5	NY	Nassau	195548.81	27057.32	6225.42	2820.09	3886.91	31684.39
6	NY	New York	211250.92	29692.39	7547.65	3649.52	7201.23	39224.09
7	NY	Queens	148403.56	31342.84	5663.34	3344.12	4379.50	37250.29
8	NY	Richmond	35772.64	9192.72	1687.10	883.99	936.35	8438.08
9	NY	Rockland	44352.31	6914.72	1931.37	746.82	2271.79	9383.23
10	NY	Suffolk	313609.59	44575.19	13817.17	5453.08	18563.35	54917.60
11	NY	Westchester	154973.02	20566.39	8381.70	2625.00	4411.70	27060.60
12	NJ	Bergen	141048.96	23436.88	4348.21	1569.50	1009.66	22352.76
13	NJ	Essex	78361.00	24337.16	3071.74	1388.45	2023.75	15204.50
14	NJ	Hudson	44966.41	33636.05	4885.40	3642.95	5166.59	11008.73
15	NJ	Middlesex	115081.46	24665.46	6631.41	2240.44	1275.40	23289.51
16	NJ	Monmouth	95938.38	16783.69	4466.45	1391.93	1354.81	22409.34
17	NJ	Morris	89728.95	14636.99	4067.17	1336.78	873.67	19246.56
18	NJ	Passaic	47908.01	8551.36	2147.31	631.31	438.29	11679.83
19	NJ	Somerset	54456.08	9018.82	3156.06	823.05	358.03	10852.24
20	NJ	Union	67840.88	23912.46	3593.97	1832.94	2890.14	14021.96
Grand Total			2,212,433	415,090	100,934	43,919	70,881	453,929

SOURCE:
http://neibrowser.epa.gov/eis-public-web/home.html
USEPA National Emissions Inventory (NEI)
Emissions in tons per year for 2008

TASK ORDER NO. VA101F-13-J-0159

VA PROJECT NO. 630-600

HDR PROJECT NO. 215104

500 7th Avenue 11th Floor
New York, NY 10018-4502
212.904.1212

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