Appendix B

Air Quality Emissions Calculations

Projected Emissions for CY 2013
All Sources
Concrete Casing in the Hudson Yards

Emission Source	CY 2013 Emissions (tons per year)							CY 2013 (metric tons per year)
	CO	NOx	VOC	PM_{10}	$PM_{2.5}$	SO_2	CO_2	CO_2
Construction Equipment Operation	9.77	20.72	2.52	1.86	1.86	1.34	1,663.87	1,509.44
Site Prepapration - Fugitive Emissions	--	--	--	4.00E-02	4.00E-02	--	--	--
Soil Transport - Fugutuve Emissions	--	--	--	1.15	0.120	--	--	--
Total	9.77	20.72	2.52	3.05	2.02	1.34	1,663.87	1,509.44

Projected Emissions for CY 2014
All Sources
Concrete Casing in the Hudson Yards

Emission Source	CY 2014 Emissions (tons per year)							CY 2014 (metric tons per year)
	CO	NOx	VOC	PM_{10}	$PM_{2.5}$	SO_2	CO_2	CO_2
Construction Equipment Operation	9.64	20.10	2.47	1.81	1.81	1.30	1,640.58	1,488.31
Site Prepapration - Fugitive Emissions	--	--	--	0	0	--	--	--
Soil Transport - Fugutuve Emissions	--	--	--	1.15	0.12	--	--	--
Total	9.64	20.10	2.47	2.96	1.93	1.30	1,640.58	1,488.31

1. Assume $PM=PM_{10}=PM_{2.5}$
2. Assume rock/soil transport occurs over a year, equally divided between CY 2013 and CY 2014.

Construction Equipment Projected Hours of Operation
Concrete Casing in the Hudson Yards

Diesel Equipment		Average Rated HP[1]	No. of Units	CY 2013 Hours	CY 2014 Hours
Manlift	Forklifts	51	1	360	360
855 Liebherr Crane	Cranes	604	1	540	540
Atlas ROC D3 Drill Rig	Bore/Drill Rigs	156	3	720	720
KR-803-1 Rock Anchor Drill	Bore/Drill Rigs	140	1	270	270
Dump Truck	Dumpers/Tenders	400	8	650	650
Generator	Emergency Generator (AP-42)	75	1	720	0
Mobile Crane	Cranes	300	1	180	180
Pay Loader	Emergency Generator (AP-42)	60	1	1080	1080
Hydraulic Drill Rig BG 28	Bore/Drill Rigs	475	1	810	810
Concrete Mixer Truck	Cement Mixers	470	3	810	810
Excavator 322C CAT	Excavators	470	1	810	810
Excavator 318E CAT	Excavators	114	2	810	810
Air Compressor	Emergency Generator (AP-42)	80	1	2160	2160
Hoe Ram	Emergency Generator (AP-42)	60	1	540	540
Alimak Scando 450	CY 2014 Emissions (tons per year)	60	1	1080	1080
Pickup Truck	Off-Highway Trucks	489	2	1080	1080

Construction is projected to start in May 2013 and be completed by December 2014 as a worst case scenario.
Typical workday will include 12 hours of construction (7:00 am to 7:00 pm)
Estimated hours of operation are based on projected run months provided by Parsons Brinkerhoff and approved by Amtrak.
Depending on the type of equipment, hours of operation are estimated to be 4, 6, 8 or 12 per day.
With the exception of emergency generator, projected hours of operation were split between CY 2013 and CY 2014.

Dump Truck Hours estimated as follows:

Cubic yards transported =	83,000	
Cy/truck/trip hauled =	16	
Total trips =	5187.5	
Average run per trip =	2	
Total hours operated =	10400	say 5200 hrs
Total hours/truck =	1300	or 650 hrs/year

Construction Equipment Air Quality Emission Factors
Concrete Casing in the Hudson Yards

Diesel Equipment		Average Rated HP[1]	Loading Factors[2]	Emission Factors (grams/HP-hr)[2]						Emission Factors (lbs/hr)[3]					
				CO	NOx	VOC	PM[4]	SOx	CO2	CO	NOx	VOC	PM[4]	SOx	CO2
Manlift	Forklifts	51	59%	3.31	5.31	0.56	0.55	0.4	569	0.22	0.35	0.04	0.04	0.03	37.75
855 Liebherr Crane	Cranes	604	43%	1.37	5.47	0.38	0.29	0.37	533	0.78	3.13	0.22	0.17	0.21	305.19
Atlas ROC D3 Drill Rig	Bore/Drill Rigs	156	43%	2.49	6.97	0.60	0.48	0.38	539	0.37	1.03	0.09	0.07	0.06	79.71
KR-803-1 Rock Anchor Drill	Bore/Drill Rigs	140	43%	2.49	6.97	0.60	0.48	0.38	539	0.33	0.93	0.08	0.06	0.05	71.54
Dump Truck	Dumpers/Tenders	400	21%	8.50	7.45	2.27	1.41	0.47	680	1.57	1.38	0.42	0.26	0.09	125.93
Generator[5]	Emergency Generator (AP-42)	75	75%	6.68E-03	0.031	2.515E-03	2.20E-03	2.05E-03	1.15	0.38	1.74	0.14	0.12	0.12	64.69
Mobile Crane	Cranes	300	43%	1.37	5.47	0.380	0.29	0.37	533	0.39	1.56	0.11	0.08	0.11	151.58
Pay Loader[5]	Emergency Generator (AP-42)	60	75%	6.68E-03	0.031	2.515E-03	2.20E-03	2.05E-03	1.15	0.30	1.40	0.11	0.10	0.09	5.18E+01
Hydraulic Drill Rig BG 28	Bore/Drill Rigs	475	43%	2.49	6.97	0.60	0.48	0.38	539	1.12	3.14	0.27	0.22	0.17	242.71
Concrete Mixer Truck	Cement Mixers	470	43%	3.25	7.16	0.82	0.61	0.39	563	1.45	3.19	0.37	0.27	0.17	250.85
Excavator 322C CAT	Excavators	470	59%	1.70	4.55	0.34	0.32	0.38	541	1.04	2.78	0.21	0.20	0.23	330.74
Excavator 318E CAT	Excavators	114	59%	1.70	4.55	0.34	0.32	0.38	541	0.25	0.67	0.05	0.05	0.06	80.22
Air Compressor[5]	Emergency Generator (AP-42)	80	75%	6.68E-03	0.031	2.515E-03	2.20E-03	2.05E-03	1.15	0.40	1.86	0.15	0.13	0.12	6.90E+01
Hoe Ram[5]	Emergency Generator (AP-42)	60	75%	6.68E-03	0.031	2.515E-03	2.20E-03	2.05E-03	1.15	0.30	1.40	0.11	0.10	0.09	5.18E+01
Alimak Scando 450[5]	CY 2014 Emissions (tons per y	60	75%	6.68E-03	0.031	2.515E-03	2.20E-03	2.05E-03	1.15	0.30	1.40	0.11	0.10	0.09	5.18E+01
Pickup Truck	Off-Highway Trucks	489	59%	1.66	5.11	0.29	0.26	0.37	536	1.06	3.25	0.18	0.17	0.24	340.93

1. Average horsepower ratings were obtained from a review of various manufacturers' specifications
2. Loading factors and emission factors from USAF IERA Air Emissions Inventory Guidance Document For Mobile Sources at Air Force Installations, May 1999, Revised December 2009, Section 3.
3. Emission Factors (lbs/hr) = Average Rated HP X Loading Factors X Emission Factors (grams/HP-hr) X Conversion Factor (grams to lbs)
4. $PM=PM_{10}=PM_{2.5}$
5. Emission Factors lbs/hp-hr from Chapter 3.3, Gasoline and Diesel Industrial Engines, AP-42.

Projected Emissions for CY 2013
Construction Equipment
Concrete Casing in the Hudson Yards

Construction Equipment	Usage (hrs)	Emissions (lbs)					
		CO	NOx	VOC	PM_{10}	SO_2	CO_2
Manlift	360	79.05	126.81	13.37	13.13	9.55	13,588.49
855 Liebherr Crane	540	423.60	1,691.30	117.49	89.67	114.40	164,801.32
Atlas ROC D3 Drill Rig	720	795.39	2,226.45	191.66	153.33	121.38	172,174.93
KR-803-1 Rock Anchor Drill	270	89.23	249.76	21.50	17.20	13.62	19,314.49
Dump Truck	650	8,185.32	7,174.20	2,185.96	1,357.80	452.60	654,825.94
Generator	720	270.54	1,255.50	101.85	89.10	83.03	46,575.00
Mobile Crane	180	70.13	280.02	19.45	14.85	18.94	27,284.99
Pay Loader	1080	324.65	1,506.60	122.21	106.92	99.63	55,890.00
Hydraulic Drill Rig BG 28	810	908.20	2,542.23	218.84	175.07	138.60	196,593.97
Concrete Mixer Truck	810	3,518.77	7,752.11	887.81	660.45	422.25	609,558.39
Excavator 322C CAT	810	841.82	2,253.10	168.36	158.46	188.17	267,896.16
Excavator 318E CAT	810	408.37	1,092.99	81.67	76.87	91.28	129,958.14
Air Compressor	2160	865.73	4,017.60	325.91	285.12	265.68	149,040.00
Hoe Ram	540	162.32	753.30	61.11	53.46	49.82	27,945.00
Alimak Scando 450	1080	324.65	1,506.60	122.21	106.92	99.63	55,890.00
Pickup Truck	1080	2,280.64	7,020.53	398.43	357.21	508.34	736,399.94
Total Emissions	**(lb/yr):**	**19,548.4**	**41,449.1**	**5,037.8**	**3,715.6**	**2,676.9**	**3,327,736.8**
Total Emissions	**(tpy)**	**9.77**	**20.72**	**2.52**	**1.86**	**1.34**	**1,663.87**
Total Emissions	**(Metric Tons/yr)**						**1,509.44**

Projected Emissions for CY 2014
Construction Equipment
Concrete Casing in the Hudson Yards

Construction Equipment	Usage (hrs)	Emissions (lbs)					
		CO	NOx	VOC	PM_{10}	SO_2	CO_2
Manlift	360	79.05	126.81	13.37	13.13	9.55	13,588.49
855 Liebherr Crane	540	423.60	1,691.30	117.49	89.67	114.40	164,801.32
Atlas ROC D3 Drill Rig	720	795.39	2,226.45	191.66	153.33	121.38	172,174.93
KR-803-1 Rock Anchor Drill	270	89.23	249.76	21.50	17.20	13.62	19,314.49
Dump Truck	650	8,185.32	7,174.20	2,185.96	1,357.80	452.60	654,825.94
Generator	0	0.00	0.00	0.00	0.00	0.00	0.00
Mobile Crane	180	70.13	280.02	19.45	14.85	18.94	27,284.99
Pay Loader	1080	324.65	1,506.60	122.21	106.92	99.63	55,890.00
Hydraulic Drill Rig BG 28	810	908.20	2,542.23	218.84	175.07	138.60	196,593.97
Concrete Mixer Truck	810	3,518.77	7,752.11	887.81	660.45	422.25	609,558.39
Excavator 322C CAT	810	841.82	2,253.10	168.36	158.46	188.17	267,896.16
Excavator 318E CAT	810	408.37	1,092.99	81.67	76.87	91.28	129,958.14
Air Compressor	2160	865.73	4,017.60	325.91	285.12	265.68	149,040.00
Hoe Ram	540	162.32	753.30	61.11	53.46	49.82	27,945.00
Alimak Scando 450	1080	324.65	1,506.60	122.21	106.92	99.63	55,890.00
Pickup Truck	1080	2,280.64	7,020.53	398.43	357.21	508.34	736,399.94
Total Emissions	**(lb/yr):**	**19,277.9**	**40,193.6**	**4,936.0**	**3,626.5**	**2,593.9**	**3,281,161.8**
Total Emissions	**(tpy)**	**9.64**	**20.10**	**2.47**	**1.81**	**1.30**	**1,640.58**
Total Emissions	**(Metric Tons/yr)**						**1,488.31**

Assumptions:
Source: Emission factors and methodology from USAF IERA Air Emissions Inventory Guidance Document For Mobile Sources at Air Force Installations (Sections 3 and 4, revised December 2009).
Note: Assume PM= PM_{10}=$PM_{2.5}$

Fugitive Dust Emissions (Site Preparation)
Concrete Casing in the Hudson Yards

Description:[1]	
Square feet:	43,560
Total acres of land disturbed:	1.000
Assumed number of 12-hr days:	60
Assumed equivalent acres/day:	0.017

Equation for Fugitive Dust Emissions (PM_{10})
E_{TSP} (lb/yr) = 80 * No. of 8-hr days * Acres/day

Calculation

E_{TSP} (lb/yr) = 80 * 60 days * 0.017 acres/day

E_{TSP} = 80.00 lb/yr

4.00E-02 tpy

Assumptions: CY 2014 Emissions (tons per year)

[1] The construction site is an existing building and the surrounding area. The area of disturbance is conservatively assumed to be 50 percent of the area.
[2] It is assumed that construction activity related to site preparation will be completed in CY 2013.

Source of Equation

USAF IERA Air Emissions Inventory Guidance Document For Stationary Sources at Air Force Installations (Section 16, revised December 2009).
Note: Assume PM= PM_{10}=$PM_{2.5}$

Fugitive Dust Emissions (Rock/Soil Transport)
Concrete Casing in the Hudson Yards

Input Parameters:

Soil moved during excavation =	83,000	cy	
Soil moved during excavation =	134,460	tons	(1.62 tons/cy)
Mean wind speed =	9	mph	(New York, NY)
Material silt content =	11		(Mean, Table 13.2.2-1, Page 13.2.2-3)
Material moisture content =	12.0		(Mean, Table 13.2.4, Page 13.2.4-2)

Emissions from loading/unloading excavated rock/soil into dump trucks (USEPA AP-42, Eq. 1, Section 13.2.4, January 1995)

EF = k (0.0032) [U/5)1.3 / (M/2)1.4]

0.0004	**lbs/ton**	**PM**
0.0002	**lbs/ton**	**PM10**
0.0000	**lbs/ton**	**PM2.5**

where:

EF = emission factor, lbs/ton

k = particle size multiplier = 0.74 for PM, 0.35 for PM10, and 0.053 for PM2.5

U = mean wind speed, miles/hr (mph)

M = material moisture content (%)

CY 2014 Emissions (tons per year)

Therefore, total emissions from loading/unloading excavated rock/soil from dump trucks =

EF * tons/yr of rock/soil loading/unloading

56.45	lbs/yr	**0.028**	**tons/yr**	**PM**	**E1**
26.7	lbs/yr	**0.013**	**tons/yr**	**PM10**	**E1**
4.04	lbs/yr	**0.002**	**tons/yr**	**PM2.5**	**E1**

Emissions from driving dump trucks on unpaved roads (USEPA AP-42, Eqs. 1a and 2, Section 13.2.2, November 2006

EF = [k(s/12)a (W/3)b][(365-p)/365]

6.52	**lbs/VMT/truck**	**PM**
1.76	**lbs/VMT/truck**	**PM10**
0.18	**lbs/VMT/truck**	**PM2.5**

where:

k = particle size multiplier = 4.9 lb/VMT (PM), 1.5 lb/VMT (PM10) and 0.15 lb/VMT (PM2.5)

s = material silt content (%)

W = Weight of the vehicle (tons) = 40 tons

p = Number of days when precipitation was greater than 0.01 inches = 130 (Figure 13.2.2-1)

a = 0.7 for PM, 0.90 for PM10 and 0.9 for PM2.5 (Table 13.2.2-2, Page 13.2.2-5)

b = 0.45 for PM, PM10 and PM2.5 (Table 13.2.2-2, Page 13.2.2-5)

VMT = vehicle miles travelled by loaded & unloaded trucks on unpaved roads

VMT = (83,000 cy/year of excavated soil)/(truck load)*(average distance travelled each way)

VMT = ((83,000 cy/yr) / (16 cy/truck))*5 miles/round trip

VMT = 25,937.5 VMT/yr

Therefore, total emissions from driving dump trucks on unpaved roads =

EF *VMT

169,052	lbs/yr	**84.53**	**tons/yr**	**PM**
45,650	lbs/yr	**22.83**	**tons/yr**	**PM10**
4,669	lbs/yr	**2.33**	**tons/yr**	**PM2.5**

Fugitive Dust Emissions (Continued)
Concrete Casing in the Hudson Yards

Assume fugitive dust from unpaved roads is controlled using water sprays.

Assume 90% control efficiency from water spray.

Therefore, actual controlled emissions from driving dump trucks on unpaved roads =

uncontrolled emissions * 0.1

8.45	**tons/yr**	**PM**	**E2**
2.28	**tons/yr**	**PM10**	**E2**
0.233	**tons/yr**	**PM2.5**	**E2**

Total annual fugitive emissions from soil removal (tons/yr) =

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8.481	**tons/yr**	**PM**
2.296	**tons/yr**	**PM10**
0.235	**tons/yr**	**PM2.5**