APPENDIX L

MITIGATION

POTENTIAL NOISE MITIGATION MEASURES

A menu of possible noise mitigation measures that would be applicable to the Proposed Action's construction activities in mitigating increased noise levels at the sensitive receptor locations identified in Chapter 21, "Construction" is provided below. While the measures identified are specific to the Proposed Action, they may also be relevant to construction activities expected to be undertaken by other Lower Manhattan Recovery projects. The further development and implementation of the noise mitigation measures for the Proposed Action would be coordinated with noise mitigation measures proposed by other Lower Manhattan Recovery projects to optimize their combined benefits for lowering noise levels.

Noise mitigation measures for the Proposed Action focus on reducing noise levels at the noise source, rather than at a specific receptor site, thus providing greater benefit to several receptor locations. Notwithstanding the range of noise source reduction measures considered, the desired reduction in noise levels may not be achieved at certain receptor locations. In consideration of this, the range of noise mitigation measures also includes measures that reduce noise at the receptor location. This provides for additional noise attenuation on a receptor-specific basis. The possible noise mitigation measures are listed below along with their potential extent of noise reduction.

SOURCE REDUCTION MEASURES

1. **Employment of modern, state-of-art construction equipment with lowest noise emission**. The use of the modern construction equipment, rather than older equipment would result in lower noise levels. For example, modern jackhammers with mufflers integrated into their design would result in noise levels ranging between 70-80 dBA at 50 feet. This would represents a substantial reduction (5-15 dBA assuming L_{eq}) over the use of older equipment.

2. **Use of acoustic barriers and walled enclosures around certain construction activities.** Noise tents or sheds could be used around workers using jackhammers to reduce noise levels by 10 dBA or more. Where practicable, a temporary noise barrier of 20-feet in height could be installed along the fence line/property line (at least partially) of the work zone(s) to reduce the noise levels. For example, temporary noise barriers (e.g. wood panels on top of Jersey barriers) could be positioned adjacent to slurry wall and other construction operations and moved along with these construction operations.

3. **Installation of silencers on equipment.** Jackhammers, air compressors, generators, light plants and cranes could be equipped with silencers to reduce noise levels by

approximately 5-10 dBA. These types of equipment are expected to be used extensively throughout the construction period.

4. **Use of electrically operated equipment**. Where possible and practical, the use of electrically powered equipment instead of combustion powered equipment could reduce noise emissions. Reduction of approximately 10 dBA could be achieved for receptors in close proximity to equipment such as generators. Employment of electrical equipment could be applied throughout all work zones shown in Chapter 21, "Construction."

5. **Employment of noise dampening activities.** Noise dampening activities would include lining of trucks with soil inside aluminum carrying cases. This could reduce the impact noise from the loading and unloading of rocks into trucks by 5-10 dBA at receptor sites.

6. **Placement of most loading/unloading inside the excavated areas.** The siting of construction loading/unloading zones within the below grade areas of the WTC Site or the Southern Site rather than at street level, could reduce noise from construction loading/unloading by 5 dBA.

7. **Use of drive-through street-level truck enclosures.** Use of a "drive-through garage" for loading and unloading of concrete trucks and other trucks could reduce noise levels by 5-10 dBA. Such enclosures could be particularly effective where relocation of loading/unloading zones away from sensitive receptors is not practicable.

8. **Alternative methods to backup alarms.** Backup alarms and alarms on the back of construction vehicles audible when equipment is in reverse gear tend to create high-pitched noise and noise levels with the project vicinity. Replacement of such alarms with alarms that adjust based upon ambient noise levels would reduce high-pitched noise and noise levels with the project vicinity.

9. **Use of alternative, quieter construction techniques.** Use of alternative techniques or equipment such as pulverizers and cutters instead of impact tools such as hoe rams could reduce noise levels by 10 dBA. Expansion grouting or concrete saws could also avoid or reduce the need for pavement breakers to cut pavement in cut-and cover operations.

10. **Noise insulating windows.** Noise-insulating window treatments at the receptor location, rather than treating the noise source, could provide effective noise reduction. Noise insulating windows, where appropriate, could provide 40-50 dBA noise reduction for interior spaces in combination with other sound-proofing measures at the noise source.

Table 1
Emission Factors for Construction Equipment (with Mitigation)

Equipment Type	Power Output (hp)	NONROAD Emission Factor (g/hp-hr)			Adjusted NONROAD Emission Factor * (g/hp-hr)		
		NO_X	PM_{10}	$PM_{2.5}$	NO_X	PM_{10}	$PM_{2.5}$
Air Compressor	185	2.394	0.134	0.123	2.394	0.030	0.028
Air Compressor	310, 360, 460	2.780	0.172	0.159	2.780	0.039	0.036
Air Compressor	80	2.528	0.267	0.246	2.528	0.060	0.055
Asphalt Compactor	70	3.137	0.404	0.372	3.137	0.091	0.084
Asphalt Paving Machine or Paving Box	153, 158	3.271	0.250	0.230	3.271	0.056	0.052
Backhoe	90	1.503	0.290	0.267	1.503	0.065	0.060
Concrete Pump	300	2.941	0.265	0.244	2.941	0.060	0.055
Crawler Crane	273	2.714	0.187	0.172	2.714	0.042	0.039
Diesel Generator	100	2.971	0.389	0.358	2.971	0.087	0.080
Diesel Generator	500	3.166	0.358	0.329	3.166	0.080	0.074
Diesel Generator	750	3.160	0.360	0.331	3.160	0.081	0.074
Dozer	100	3.038	0.371	0.341	3.038	0.083	0.077
Dozer	150	2.869	0.214	0.197	2.869	0.048	0.044
Drill	204	3.129	0.222	0.204	3.129	0.050	0.046
Gas Generator	10	2.068	0.078	0.072	2.068	0.078	0.072
Gas Pump for Dewatering	16	1.935	0.077	0.070	1.935	0.077	0.070
Grader	185	2.701	0.186	0.171	2.701	0.042	0.039
Hi-Lift (Forklift)	120	3.166	0.242	0.222	3.166	0.054	0.050
Hydraulic All Terrain Crane	165	2.357	0.137	0.126	2.357	0.031	0.028
Hydraulic Drill Rig	150	3.220	0.232	0.213	3.220	0.052	0.048
Hydraulic Excavator	300	2.615	0.180	0.166	2.615	0.040	0.037
Hydraulic Excavator	320, 321, 428	2.922	0.167	0.154	2.922	0.038	0.035
Pump	150	3.022	0.274	0.252	3.022	0.062	0.057
Pump	350	3.120	0.336	0.310	3.120	0.076	0.070
Roadheader for tunneling or excavator	120, 143	2.781	0.208	0.191	2.781	0.047	0.043
Rubber tire backhoe/loader	88	3.138	0.405	0.372	3.138	0.091	0.084
Rubber tire loader	196	2.862	0.199	0.183	2.862	0.045	0.041
Slurry mixing or desanding plant or Grout Plant	50	3.680	0.383	0.352	3.680	0.329	0.303

Table 1 (cont'd)
Emission Factors for Construction Equipment (with Mitigation)

Equipment Type	Power Output (hp)	NONROAD Emission Factor (g/hp-hr)			Adjusted NONROAD Emission Factor * (g/hp-hr)		
		NO_X	PM_{10}	$PM_{2.5}$	NO_X	PM_{10}	$PM_{2.5}$
Tower Crane	273	2.235	0.119	0.109	2.235	0.027	0.025
Track Dozer or Crawler Crane	338, 340, 350, 450	3.111	0.187	0.172	3.111	0.042	0.039
Track Loader	160	1.584	0.176	0.162	1.584	0.040	0.036
Track Loader or Wheel Loader	229, 260	1.526	0.165	0.152	1.526	0.037	0.034
Vibratory Roller	150	3.011	0.225	0.207	3.011	0.051	0.047
Welding Machine	33, 35	1.402	0.315	0.290	1.402	0.071	0.065

Notes: * 14% reduction for ULSD on all engines and 80% reduction for USLD and DPFs on engines > 60 hp.
Sources: NONROAD2002a Model, New York

Table 2
Area Source Emission Factors (with Mitigation)

Zone	Area [m^2]	Emission Factor [g/s-m^2]				
		NOx	PM2.5		PM10	
		Annual Average	Peak Day Average	Annual Average	Peak Day Average	Annual Average
LMDC						
Tunneling Under 1/9 Line	4,482	4.85E-05	2.46E-06	7.23E-07	2.71E-06	8.25E-07
Northwest Quadrant Subgrade Retail	11,620	5.71E-05	1.30E-06	7.71E-07	1.51E-06	8.65E-07
Memorial, Open Space, Cultural Space (Zones 1 & 2)	30,512	2.06E-06	0.00E+00	2.96E-08	0.00E+00	3.40E-08
Southeast Quadrant Subgrade - Towers 3 & 4 (Zone 4)	11,988	6.39E-05	1.23E-06	9.07E-07	1.83E-06	1.03E-06
Northeast Quadrant Subgrade - Tower 2 (Zone 5)	8,622	8.88E-05	1.71E-06	1.26E-06	2.19E-06	1.39E-06
East Bathtub Above Grade Fitout	28,963	1.90E-06	0.00E+00	3.02E-08	0.00E+00	5.08E-08
Freedom Tower	5,128	2.46E-04	5.74E-06	3.46E-06	6.88E-06	3.85E-06
Southern Expansion	12,070	1.07E-04	1.85E-06	1.52E-06	2.50E-06	1.79E-06
PATH						
Platform/Mezzanine Conversion	8,366	1.42E-04	2.14E-06	1.96E-06	3.10E-06	2.29E-06
1/9 Tunnel	2,707	1.13E-04	7.75E-06	1.81E-06	8.57E-06	1.99E-06
Church St Tunnel	400	9.10E-04	5.24E-05	1.47E-05	5.75E-05	1.61E-05
Demolition Temporary PATH Concourse	8,210	4.81E-05	0.00E+00	6.99E-07	0.00E+00	9.57E-07
Pedestrian Concourse	954	1.44E-04	2.62E-05	2.44E-06	3.28E-05	2.93E-06
ROUTE 9A						
Annual: SB Bypass / Peak: NONROAD engines	4385 / 977	2.00E-04	1.49E-05	3.66E-06	1.62E-05	6.45E-06
Annual: NB Bypass / Peak: Truck engines+dust	4794 / 4385	4.93E-05	1.63E-06	8.49E-07	1.02E-05	1.60E-06
Annual: NA / Peak: Handling dust	NA / 977	---	0.00E+00	---	0.00E+00	---
FULTON TRANSIT						
Dey Street	396	3.39E-04	0.00E+00	4.74E-06	0.00E+00	5.53E-06
Transit Center	3,660	2.36E-04	9.61E-06	3.63E-06	1.07E-05	4.15E-06
Transit Center - Temporary Support Façade	750	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
A/C Mezzanine	967	8.82E-04	7.38E-05	1.60E-05	9.32E-05	1.77E-05
4/5 Underpasses	150	1.65E-03	1.70E-04	2.43E-05	1.86E-04	2.66E-05
Station Rehabilitation - 4/5 Fulton	780	5.07E-04	8.72E-06	6.23E-06	9.69E-06	6.91E-06

Notes: All factors are applied to 10 hours per day, except Route 9A, which are applied to 20 hours per day.

Figure 1
Peak Total PM_{10} Emissions by Month (with Mitigation)