APPENDIX L

EQUIPMENT-INDUCED VIBRATION MEMO

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HDR memo

To File

From Tim Casey

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RE Equipment-induced Vibration

In environmental review projects (NEPA/SEPA/CEQRA), vibration analyses are typically performed when the proposed action is likely to have the potential to create vibrations that will affect people or vibration-sensitive facilities or resources. This memo demonstrates that the proposed Converted MTSs are unlikely to have such potential.

Vibration is quantified using one of three measures: displacement, velocity, or acceleration. Displacement is the distance that a point on a vibrating surface moves away from its static position. Velocity represents the instantaneous speed of the movement, and acceleration is the rate of change of the speed. Displacement is rarely used for describing ground-borne vibration because most transducers used for measuring ground-borne vibration use either velocity or acceleration and, more important, because the response of humans, buildings, and equipment to vibration is more accurately described using velocity or acceleration. Human response to vibration is typically quantified using the root mean square (rms) vibration velocity, which represents average vibration level. Building response to vibration is typically quantified using peak particle velocity (PPV).

To simplify vibration velocity estimates, the range of commonly occurring vibration velocities from low velocity, characteristic of the threshold of human perception, to high velocity that may cause building damage, is compressed into a logarithmic scale or metric using the vibration decibel. The Federal Transit Administration (FTA) advocates use of such a logarithmic unit of measure and it is expressed as vibration decibel. VdB is defined as:

$$20 \times \log_{10} (v/v_{ref})$$

Where v is the velocity measured and v_{ref} is the reference velocity of 1×10^{-6} inches/second.

Equipment-Induced Vibration at the proposed Converted MTSs

Mechanical equipment that will be used at the proposed Converted MTSs includes a variety of mobile and fixed (stationary) material handling equipment. Vibration generated by mechanical equipment originates from many sources within the equipment. The magnitude of generated vibration velocity can be reduced by including the following measures in the design or operation of the equipment.

- The rotating crankshaft of reciprocating engines. Vibrations beyond the design tolerance will cause failures in common engines and motors. Also, vehicles and mobile equipment with reciprocating engines typically include vibration isolating engine mounts and other suspension systems that reduce vibration transmission into the ground. Rubber tires also reduce the transmission of reciprocating engine vibration, and their mobility limits the amount of vibrations transmitted into the ground at any one location.

- DSNY collection vehicles and commercial waste hauling vehicles. According to the Federal Highway Administration (FHWA), Engineering Guidelines for the Analysis of Traffic-Induced Vibration (FHWA-RD-78-766, February 1978), parameters governing traffic-induced vibration include:

    - Gross vehicle weight and speed. Ground vibration levels increase approximately 3 dBfor each doubling of gross vehicle weight. Increasing vehicle speed increases the vibration levels approximately 3 to 6 dB (per FHWA dB which refers to vibration acceleration level (dB, relative to 1 g (rms) = 9.8 m/s2)) per doubling of speed. These are concerns at highway speeds. Vehicle speeds at the proposed Converted MTSs will be significantly below highway speeds, therefore weight and speed-induced vibrations are not a concern.

    - Pavement/subgrade parameters. Pavement surface roughness variations of approximately 0.25 inches appear to be able to cause perceptible ground vibration at the edge of the pavement at highway speeds. Speeds at the proposed Converted MTSs will be significantly below highway speeds. Therefore, pavement/subgrade-induced vibrations are not expected to be a concern.

    - Potholes and other discrete bumps. As stated, pavement roughness variations of approximately 0.25 inches appear to be able to cause perceptible ground vibration at the edge of the pavement at highway speeds. Speeds at proposed Converted MTSs will be significantly below highway speeds and limited to traveling on new, well maintained, access/egress ramps and within the process building. Therefore, pothole and other discrete bump-induced vibrations are not expected to be a concern.

- Imperfections at the wheel-rail points of contact on the gantry cranes. Gantry cranes are overhead cranes that are rigidly supported on two or more legs running on fixed rails. Imperfections in the wheels or the rails cause vibrations, a common phenomenon in

railroads. In well-designed and maintained cranes such imperfections increase vibration levels.

The weight of a fully loaded DSNY gantry crane may approach the weight of a light rail rapid transit car; However gantry cranes are not considered to be a significant source of ground-borne vibration because:

- Typical gantry crane travel speeds are very slow. Typical large gantry cranes move at speeds less than 3.5 miles per hour (approximately 300 feet per minute).
- There are no curves on the tracks of the rail-supported gantry cranes at the proposed Converted MTSs to cause the wheel flange to contact the rail, and the rails will be welded seamless, so there are no bumps or discontinuities. The absence of high-speed braking reduces the creation of imperfections in wheels and rails – which minimizes vibrations.
- The gantry cranes are located on the waterfront side of proposed Converted MTS facilities, which is typically the farthest point from vibration-sensitive receptors.

The table below provides estimates of the vibration levels associated with the equipment that will be included in the proposed Converted MTSs, as well as the thresholds for human response to vibration. All data is based on the Federal Transit Administration (FTA) Transit Noise and Vibration Impact Assessment guidance document (April 1995).

Vibration Source or Human Response to Vibration	**Typical RMS Vibration Velocity Levels (VdB) @ 50 Feet From the Source** [1]
Residential Annoyance from >70 rapid train passages per day	72
Threshold of Human Perception	65
DSNY Collection Vehicles	62
Wheel loaders [2]	62
Sweepers [2]	62
Typical Background Vibration	52
Gantry Cranes	NA
Tug Boats	NA

Notes:
NA = not available
(1) FTA Transit Noise and Vibration Impact Assessment, April 1995

(2) Assumed to be representative of other rubber-tired vehicles, such as heavy trucks.

The table shows that typical equipment-induced ground-vibration levels at the proposed Converted MTSs are below the threshold of human perception at distances of 50 feet and beyond based on vibration levels published by FTA. At distances closer than 50 feet, equipment-induced ground-vibration levels may be higher than levels shown in the table above. Since foundation and soil conditions differ at each site, meaningful calculation of resulting vibration levels cannot be performed without rigorous analyses. However, where proposed Converted MTS facility property lines are within 50 feet of an area where a vibration source may operate (such as a highway, which is the case at the East 91st Street and Hamilton Avenue Converted MTSs), background vibration levels are likely to be high due to roadway traffic and other non-MTS activities. In these areas, non-project-related background vibration will likely mask any potential Converted MTS equipment- induced vibrations. At the Southwest Brooklyn and North Shore Converted MTSs, there are no vibration sensitive receptors within 50 feet of a vibration source.

Therefore, equipment-induced vibrations at the proposed Converted MTSs are not expected to be perceived as annoyance by nearby residents or to affect other vibration-sensitive facilities or resources that may exist near a proposed Converted MTS site.