8.13 VIBRATION

8.13.1 Introduction

Construction activities have the potential to produce vibration levels that may be annoying or disturbing to humans and may cause damage to structures. Architectural and even structural damage to existing structures surrounding a site could occur if appropriate precautions are not taken.

The effects of ground-borne vibration include discernable movement of building floors, rattling of windows, shaking of items on shelves or hanging on walls, and rumbling sounds. The vibration from the construction-related activity "excites" the adjacent ground, creating vibration waves that propagate through the various soil and rock strata to the foundations of nearby buildings. As the vibration propagates from the foundation through the remaining building structure, certain resonant, or natural, frequencies of various components of the building may be excited. In extreme cases, vibration can cause damage to buildings.

This Section discusses existing vibration conditions in the vicinity of the shaft site and assesses the potential for construction at the E. 54th Street/Second Avenue Shaft Site to result in vibration impacts. The methodology used to prepare this Section is described in Section 3.13, "Vibration," in Chapter 3, "Impact Methodologies."

In addition to the Shaft Site itself, this alternative would include construction of a water main connection that would travel from the Shaft Site along Second Avenue to the potential First Avenue or Sutton Place route discussed in Chapter 5, "Water Main Connections." Potential vibration impacts associated with this extension would be similar to those described for construction of the water mains in Section 5.13, "Vibration." These activities would be short-term and temporary in nature. Therefore, no potential significant adverse vibration impacts would be anticipated to occur from water main construction.

8.13.2 Existing Conditions

There are no existing major sources of vibration near this project site. Vibration levels are expected to be typical of those found in Midtown Manhattan.

8.13.3 Future Conditions Without the Project

None of the projects identified for development between 2006 and 2012 would be expected to introduce significant vibration levels in the Study Area. Therefore, vibration levels would be expected to be comparable to those currently existing in the vicinity of the E. 54th Street/Second Avenue Shaft Site.

8.13.4 Future Conditions With the Project

Construction

Overview

Controlled blasting, pavement breaking (including jack hammers), rock drilling, soil compaction, and pile installation would produce the highest vibration levels during construction of this Shaft Site. Blasting is discussed first, followed by a discussion of other construction activities at the site.

Protective measures will be implemented to avoid potential construction-related vibration impacts at this Shaft Site. Additional protection measures will be put in place to protect fragile, sensitive, and historic structures. At the E. 54th Street/Second Avenue Shaft Site, there are no known or potential historic resources within 100 feet of this Site.

A detailed vibration control plan that will include the measures discussed below will be developed by the construction contractor prior to construction. The plan will include a vibration monitoring program to be implemented during construction. The detailed vibration plan will account for specific geological conditions, foundation assessment of structures near vibration-causing construction activities, and the appropriateness of the vibration thresholds to affected buildings. Finally, the detailed plan will include specific measures and best management practices to avoid potential vibration impacts.

In advance of certain activities that are likely to result in high vibration levels such as blasting, NYCDEP and its contractors would conduct extensive outreach to those in the vicinity of this Shaft Site that could be affected. This would include providing the nearby community with the expected start date for blasting operations, the general time pattern during the ensuing months, and the timing and significance of the warning whistles.

Finally, NYCDEP would not permit construction activities to occur between 11:00 p.m. and 7:00 a.m. with the exception of the 3 months of 24 hours per day, 7 days per week raise boring activities. Blasting operations would be expected to occur during daytime hours (see Section 4.13, "Vibration," in Chapter 4, "Preferred Shaft Site").

Blasting

Of the construction activities proposed, blasting would result in the highest potential vibration levels. Blasting would be necessary at this Shaft Site to enlarge the shaft. Section 4.13, "Vibration," in Chapter 4, "Preferred Shaft Site," discusses blasting procedures, including protective measures that will be implemented to avoid potential construction-related vibration impacts from blasting at the preferred Shaft Site. There is also a discussion of special protection measures that will be put in place to protect fragile, sensitive, and historic structures. Similar procedures would be put in place at the E. 54th Street/Second Avenue Shaft Site, with one exception. Due to the very close proximity of the residences and restaurant to the site, as close as 11 feet from the edge of the shaft chamber, and because the bedrock is only 3 feet from the surface, blasting would likely not occur until a substantial distance below the top of bedrock was

reached. To excavate to this distance, alternative techniques including hydraulic splitting, which does not emit high vibration levels, would be employed to minimize the potential for any inadvertent damage to nearby structures. This would likely be necessary to achieve the 0.5 ips threshold established by NYCDEP to protect more fragile structures, or against cosmetic/ architectural damage. These measures would add several months to the construction schedule at this Shaft Site.

As described in Section 8.1, depending on the construction schedule for the project at this site, different construction techniques (either the raise bore or method or the surface excavation method) would need to be utilized for shaft construction. Blasting would be expected to occur for roughly six months using the raise bore method. Under the surface excavation method, blasting would occur over a 15 month period. While the time period is longer for the surface excavation method, there would be one, rather than two, blasts per day for the shaft work for most of the blasting period.

Other Construction Activities

Other construction activities would result in varying degrees of ground-borne vibration, depending on the stage of construction, the equipment and construction methods employed, the distance from the construction to vibration-sensitive receptors and geotechnical and soil conditions. The following activities and equipment could induce the highest vibration levels:

- Raise boring from the tunnel upwards with rotary drilling equipment.
- Pile installation with a pile drill rig.
- Soil compaction with a compactor.
- Rock drilling with crawlers or pneumatic hammers.
- Pavement breaking with jackhammers.
- Delivery and cement trucks.

The use and potential vibration effects of this equipment are discussed in Section 4.13, "Vibration," in Chapter 4, "Preferred Shaft Site." As discussed in that Section, although the rotary drilling equipment used for raise bore operations produce high levels of vibration, much of this activity would occur many feet below ground entirely within bedrock. Vibration sources in rock tend to result in low amplitudes of vibration levels.

Typical vibration levels for other construction equipment, similar to that being proposed for use at the Shaft Site, are shown in Table 8.13-1. Values provided for caisson drilling are representative of those for the proposed pile drill rig and soil compactor. Levels shown for jackhammers are similar to or greater than those that can be expected for rock drilling and pneumatic hammering. The values provided in the table are based on the literature. Actual vibration levels are dependent on construction procedures, soil and geological conditions, and the structural characteristics of the receptor (e.g., foundation, construction type).

Table 8.13-1
Typical Levels of Vibration for Construction Equipment Similar to that Proposed for Shaft Site Construction

Construction Activity	PPV at 75 feet (ips)	PPV at 50 feet (ips)	PPV at 25 feet (ips)
Caison Drilling/Large Bulldozer	0.0	0.03	0.089
Loaded Trucks	0.0	0.027	0.076
Jack Hammer	0.0	0.015	0.035

Sources: Federal Transit Administration (FTA), *Transit Noise and Vibration Impact Assessment*, April 1995.

Notes: PPV at 25 feet are based on FTA 1995. To calculate PPV at other distances, the following equation (FTA 1995) was used:
PPV at Distance D = PPV (at 25 ft) * [(25/D)^1.5]

The closest sensitive structures to the site are residences and the restaurant (Lenny's) located adjacent to the site. At this Shaft Site, the enclosed seating area at Lenny's would be removed, and the distance from the adjacent buildings to the shaft chamber would be approximately 11 feet. Peak particle velocity (PPV) levels for this equipment are expected to be well below the 2.0 inches per second (ips) threshold to avoid structural damage and below the 0.5 ips threshold to protect more fragile structures or against cosmetic/architectural damage. This would be expected to be the case even with more than one piece of machinery operating. The contractor will be required to have a vibration control plan and monitoring program in place during all construction activities. Some of the construction for the water main would overlap with construction of the shaft. Since the water main work does not involve blasting, the combined effects of more than one piece of machinery operating would not change the results of this assessment.

There is the potential that, at times, vibration effects would reach levels that would be annoying to residents in nearby buildings. Many of these buildings contain ground floor commercial uses and vibration levels are likely to be lower on the second floor and above, where the residences are located, depending on the building construction. Much of the vibrating equipment, such as rock drills, the raise bore, and pile drilling rig would be used below the ground surface where additional distance and ground attenuation would reduce vibration levels. Lastly, much of the vibration-causing construction equipment would be used on an intermittent basis during the construction period.

Conclusions

With implementation of the measures discussed above, vibration levels during construction would be limited to levels that would not cause structural damage. However, at times, vibration levels would still occur at levels that would be likely to cause annoyance to residents and other sensitive receptors in the immediate vicinity of the site. Blasting, which would cause the most intrusive vibration effects, would occur over a period of six months for the raise bore method and 15 months for the surface excavation method. Hydraulic splitting, rather than blasting, would be used at this Shaft Site until a substantial distance below bedrock was reached to minimize potential vibration effects. Other vibration-causing construction equipment would be used on an

intermittent basis during the construction period or would be used primarily below the surface. These potential impacts are considered short-term and temporary in nature. The contractor will be required to have a vibration control plan and monitoring program in place during all construction activities. Therefore, no potential significant adverse vibration impacts would be anticipated to occur from construction of the shaft and its water main connections at E. 54th Street and Second Avenue.

Operation

None of the activities associated with the activation or operation of the Shaft would cause potential vibration impacts, as there would be no significant vibration-causing machinery associated with these activities. Therefore, no potential significant adverse impacts are anticipated to occur.

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