7.13 VIBRATION

7.13.1 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. 61st Street Shaft Site to result in vibration impacts. The methodology used to prepare this Section is described in Section 3.12, "Vibration," in Chapter 3, "Impact Methodologies."

In addition to the Shaft Site itself, this alternative would include construction of a water main extension that would travel from the Shaft Site to the potential First Avenue route, Sutton Place route, or E. 59th Street/E. 61st Street route. Potential vibration impacts associated with this extension would be similar to those described for construction of the water mains in Section 5.13, "Vibration," of Chapter 5, "Water Main Connections." 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.

7.13.2 Existing Conditions

As discussed in Section 4.13, "Vibration," in Chapter 4, "Preferred Shaft Site," an ambient vibration survey was conducted to establish the baseline vibration levels from traffic traveling over the Queensboro Bridge to determine whether there would be cumulative vibration effects with the shaft construction activities. The results of the vibration monitoring show that existing vibration levels near the Bridge are negligible and would not affect the impact criteria for structural damage or procedures for the shaft construction activities. The levels would be higher at the two E. 59th Street Shaft Sites than at the E. 61st Street Shaft Site, which is further from the Bridge.

7.13.3 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. 61st Street Shaft Site.

7.13.4 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 the 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 the Shaft Site. Additional protection measures will be put in place to protect fragile, sensitive, and historic structures. The Queensboro Bridge exit ramp overpass is the only known or potential historic resource within 100 feet of this E. 61st Street Shaft 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 the 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 and form the distribution chamber at the top of the shaft. Blasting would not occur at the ground surface since

the bedrock at the site is more than 18 feet below the ground surface. As described in Section 7.1, depending on the construction schedule for the project at this site, different construction techniques (either the raise bore method or the surface excavation method) would need to be utilized for shaft construction. Like the preferred Shaft Site, blasting would be expected to occur for roughly eight months using the raise bore method. Under the surface excavation method, blasting would occur over a 24-month period (18 months for the shaft and 6 months for the distribution chamber). 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 and two per day for the distribution chamber work (as with the raise bore method).

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. These same procedures would be put in place at the E. 61st Street Shaft Site

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. As discussed in that Section, although the rotary drilling equipment used for raised boring 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 7.13-1. 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 are dependent on construction procedures, soil and geological conditions, and the structural characteristics of the receptor (e.g., foundation, construction type).

Table 7.13-1
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 this site are the early learning childhood center and a church-related building abutting this site, residences located across E. 61st Street and the Queensboro Bridge exit ramp overpass. At the childhood center and residences across E. 61st Street, which are are approximately 70 feet from the edge of the shaft chamber, and the church-related building, which is approximately 38 feet from the shaft chamber, peak particle velocity (PPV) levels 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 this 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. 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.

With regard to the Queensboro Bridge (exit ramp overpass is at a distance of 27.5 feet from the edge of this shaft chamber), measures based on actual site conditions will be put in place to ensure that there are no adverse vibration impacts to the Queensboro Bridge, a critical transportation structure. For a discussion of these measures, see Section 4.13.

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 8 months for the raise bore method and 24 months for the surface excavation method. 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 at E. 61st Street.

Operation

None of the activities associated with the activation or operation of this 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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