

3.13 VIBRATION

3.13.1 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 describes the methodology used to determine the potential vibration impacts from the Shaft 33B project and associated water mains. None of the activities associated with the activation or operation of Shaft 33B or water mains would cause potential vibration impacts as there would be no significant vibration-causing machinery associated with these activities. Therefore, the assessment addresses potential vibration impacts from construction activities associated with the shaft and water mains only.

Controlled blasting, pavement breaking (with the use of jack hammers), rock drilling, soil compaction, and pile installation activities would produce the highest vibration levels during construction of the Shaft. None of these activities, except pavement breaking and soil compaction would occur during water main construction. The methodology used to assess potential vibration impacts as a result of construction of the shaft and water mains is described below.

Types of Vibration Impacts

Measurements of vibration used in this evaluation are expressed in terms of the peak particle velocity (PPV) in the unit of inches per second (ips). The PPV, a quantity commonly used for vibration measurements, is the maximum velocity experienced by any point in a structure during a vibration event. It is an indication of the magnitude of energy transmitted through vibration. PPV is an indicator often used in determining potential damage to buildings from stress associated with blasting and other construction activities.

NYCDEP requires that the impacts of all construction activities be limited by specific vibration restrictions. One of the more frequently used thresholds for vibration, established by the United States Bureau of Mines, is a PPV of 2.0 ips at the closest structure to prevent structural damage. This level is a typical nominal structural damage criterion employed by construction projects. However, where the most stringent protection is required as in blasting, NYCDEP specifies a

PPV limit of 0.5 ips, which is 10 times more restrictive than 2.0 ips (on the logarithmic scale). A PPV limit of 0.5 ips is associated with protection of surrounding historic structures that are susceptible to cosmetic cracks in fragile plaster. This limit could be lowered to protect fragile and/or historic structures based on a detailed vibration assessment to be conducted by the construction contractor prior to construction, monitoring during structural conditions in the vicinity of the Shaft Site, and as modified by the New York City Landmarks Preservation Commission (NYCLPC).

The Queensboro Bridge (Bridge), due to its close proximity to several of the potential Shaft Sites, critical transportation importance, and historic nature, would be evaluated by the construction contractor prior to construction to determine an appropriate protective level. Special protection measures for the Bridge and other historic structures are outlined in the evaluation of those Shaft Sites that are in close proximity to the Bridge.

In addition, certain uses are highly sensitive for vibration, such as hospitals, eye clinics, audio recording studios, and laboratories with sensitive equipment. Thresholds for these uses with sensitive equipment or procedures are even lower. While none of these uses have been found to date within the vicinity of the potential project sites, a more detailed identification program would be conducted by the construction contractor. The 0.5 ips threshold discussed above could be lowered if these uses are found in the area of potential effect. A third type of vibration impact is human annoyance. Human annoyance is highly dependent on frequency of occurrence and generally occurs when inside buildings. Although ground-borne vibration impacts may be somewhat perceptible to people who are outdoors, it is almost never annoying. This is because without the shaking of a building or items within a building or the rumble noise that can only occur indoors, vibration does not cause a strong adverse human reaction. (FTA 1995) The effects of vibration on human annoyance are discussed qualitatively.

3.13.2 Existing Conditions Methodology

Although typical background vibration levels are low in residential areas throughout the City and are not considered in construction analyses, the Queensboro Bridge was thought to be a potential source of vibration that could affect a number of the potential shaft Study Areas. As vehicles pass over the Bridge, vibration is generated in the Bridge structure and may propagate to other structures surrounding the Bridge piers. The level of vibration is a function of the weights and speeds of the passing vehicles, as well as the volume of vehicular traffic and pavement condition of the Bridge roadways.

Vibration measurements of the Bridge were taken to determine whether the vibration levels from construction, combined with the vibration levels from the Bridge would not exceed the impact criteria discussed above. An ambient vibration survey was conducted to determine the existing vibration levels caused by the vehicular traffic crossing the Bridge. The survey was performed with geophones and seismographs, which measure the vibration levels in PPV, at various locations at the Bridge and near surrounding buildings. These results and locations are provided in Section 4.13, "Vibration," in Chapter 4, "Preferred Shaft Site."

3.13.3 Future Conditions Without the Project Methodology

This Section of the assessment presents whether there are any foreseeable changes in vibration levels in close proximity to the potential Shaft Sites and water main routes.

3.13.4 Future Conditions With the Project Methodology

Blasting

Vibration levels associated with blasting are site-specific and are dependent on the amount of explosive used, soil conditions between the blast site and the receptor, and the elevation where blasting would take place (specifically, the below surface elevation where bedrock would be encountered). Blasting below the surface would produce lower vibration levels at a receptor due to additional attenuation provided by distance and transmission through soil and rock. Under the project, blasting procedures would be dictated by site-specific conditions as determined by the construction contractor prior to construction, through monitoring during construction, and by New York City Fire Department (FDNY) regulations. Therefore, a quantitative assessment of potential vibration impacts from blasting is not provided. Rather, the blasting is discussed in the context of protective measures that will be put in place to minimize or avoid adverse vibration effects.

Other Construction Activities

To determine potential impacts of the project's other construction activities, estimates of vibration levels induced by the construction equipment at various distances are presented. For purposes of this assessment, construction equipment is assumed to be at the edge of the shaft chamber, which is representative of a typical on-site location. At times, equipment would be closer to or farther away than this location. In the next step of the assessment, structures (e.g., residences, schools, and other uses) within the vicinity of the Shaft Sites and water main routes are identified to determine whether any structures are located within distances that could be affected by the Shaft 33B project.

Typical vibration levels induced by construction equipment similar to that proposed for use for construction of the shaft at 25, 50, and 75 feet are shown in Table 3.13-1. The values provided for caisson drilling/large bulldozer 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. Typical vibration levels induced by construction equipment similar to that proposed for use for construction of the water main at 10, 15, and 25 feet are shown in Table 3.13-2. Distances differ for the two types of activities because, other than for the E. 54th Street/Second Avenue Shaft Site, the water main work would be conducted closer to residential and other sensitive receptors. Table 3.13-2 is used for the assessment of the E. 54th Street/Second Avenue Shaft Site. Soil excavation equipment, such as backhoes and other construction equipment, would have negligible vibration effects and are not presented.

**Table 3.13-1
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)
Caisson 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
Source:	Federal Transit Administration (FTA), <i>Transit Noise and Vibration Impact Assessment</i> , April 1995.		
Note:	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 values provided in the tables 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 and construction type).

**Table 3.13-2
Typical Levels of Vibration for Construction Equipment
Similar to that Proposed for Water Main Construction**

Construction Activity	PPV at 25 feet (ips)	PPV at 15 feet (ips)	PPV at 10 feet (ips)
Large Bulldozer	0.089	0.19	0.35
Loaded Trucks	0.076	0.16	0.30
Jack Hammer	0.035	0.08	0.14
Source:	Federal Transit Administration (FTA), <i>Transit Noise and Vibration Impact Assessment</i> , April 1995.		
Note:	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}]		

