APPENDIX G: Noise and Vibration Technical Report

G.1 Introduction

This section presents the applicable noise and vibration standards and criteria, ascertains the existing baseline noise levels at representative locations in the proposed project corridor, and projects the specific noise and vibration effects of the project.

Noise

Environmental noise is defined as the sound in a community emanating from man-made sources such as automobiles, trucks, buses, aircraft, trains, and fixed industrial sources, or from natural sources such as animals and wind. Sound levels are measured in logarithmic units called decibels (dB). An overall measurement of sound results in a single decibel value that describes the sound environment, taking all frequencies (pitches) into account. The human ear, however, does not sense all frequencies in the same manner. The "A"-weighted scale (expressed in dBA units) was developed to closely approximate the human sensory response from highway-related noise.

Since an instantaneous noise measurement (measured in dBA) describes noise levels at just one moment of time, and since very few noises in a community area are constant, other descriptors are used to represent varying sound levels over extended periods of time. The equivalent continuous level, L_{eq}, is the logarithmic average of the varying sound levels during a defined period of time, normally one hour. For areas where nighttime noise is a concern, such as places where people sleep, a second descriptor is used, the day-night sound level, L_{dn}. L_{dn} applies a 10 dBA penalty to nighttime sound levels between the hours of 10:00 PM and 7:00 AM to account for the increased noise-sensitivity of people during nighttime hours, then logarithmically averages the sound levels over a 24-hour period. The effect of this penalty is that one train pass-by during the nighttime hours is equivalent to 10 pass-bys during the daytime hours. L_{eq} and L_{dn} are widely used as descriptors of environmental noise because they correlate well with the human response to noise.

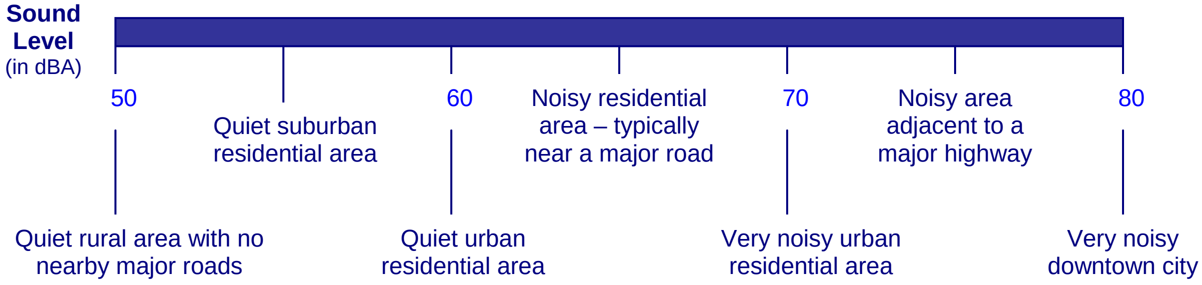
The ability of an average individual to perceive changes in noise levels is well documented. Generally, an increase of less than 3 dBA is barely perceptible to most listeners, a 5 dBA increase is readily noticeable, and a 10 dBA increase normally is perceived as a doubling of noise. A list of typical community sound levels is shown in Figure G.1.

Noise radiated to the community from the operation of a commuter rail system would vary due to a number of factors including the number of locomotive and cars, their speeds, the frequency of train pass-bys and time of day, train and track configuration and condition, the intervening terrain and buildings, and the distance between the sensitive land use and the track.

Vibration

Ground-borne vibration is the noticeable movement of building floors, rattling windows, shaking of items on shelves or hanging on walls, and rumbling sounds. Building damage is typically not a factor for normal transportation projects.

Figure G.1: Typical Community Sound Levels

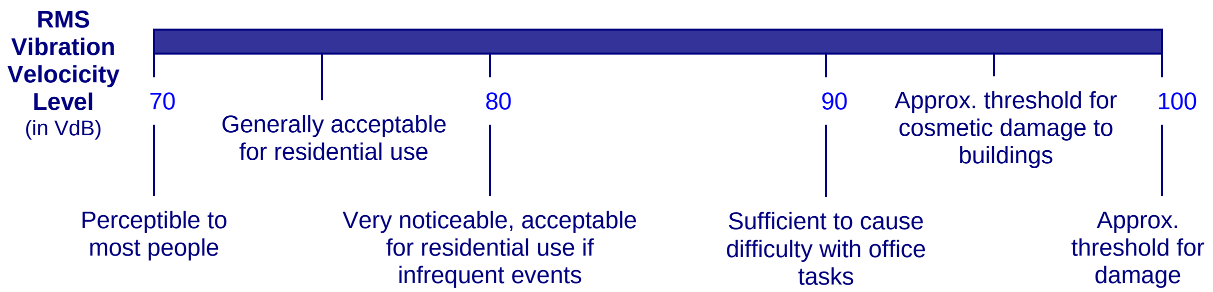


Source: FTA, May 2006

Vibration caused by trains is the result of wheels rolling on the rails. This energy is then transmitted through the track support system into the transit structure, through the ground, to the foundations of nearby buildings, and finally throughout the remainder of the building structure. The level of vibration received at the building is a function of the type of trains, their speeds, track system, structure, support and condition, distance from the tracks, geological conditions, and the receiving structure. Ground-borne vibration does not typically annoy people who are outdoors.

The motion due to ground-borne vibration is described in vibration velocity levels, measured in decibels referenced to 1 micro-inch per second. To avoid confusion with the decibel used to describe sound levels, the abbreviation VdB is used. Typical ground-borne vibration levels are shown in Figure G.2.

Figure G.2: Typical Ground-borne Vibration Levels



Source: FTA, May 2006

G.2 <u>Methodology</u>

The FTA has published the most recent guidance manual for the assessment of noise and vibration impacts in transportation projects, *Transit Noise and Vibration Impact Assessment*, May 2006. The impact criteria for transit projects are expressed for the three following land use categories:

Category 1: Tracts of land where quiet is an essential element for their intended purpose. This category includes tracts of land set aside for serenity and quiet and such land uses as outdoor concert pavilions, as well as National Historical Landmarks with significant outdoor use.

Category 2: Residential – This category covers all residential land uses and any buildings where people sleep, such as hotels and hospitals.

Category 3: Institutional – This category includes schools, parks, libraries, cemeteries, and churches where it is important to avoid interference with such activities as speech, meditation and concentration on reading.

Noise

To determine the noise impacts from the project the predicted project sound levels are compared to existing sound levels at noise sensitive locations throughout the corridor. For land uses involving primarily daytime activities, Category 1 and 3 uses, the descriptor L_{eq} is used, and for land uses where nighttime sensitivity is a factor, Category 2 uses, L_{dn} is used. These criteria do not apply to industrial or commercial areas since they are generally compatible with higher noise levels. Table G.1 shows the range of project related sound levels that would cause an impact or severe impact in relation to the existing sound level.

The classifications of No Impact, Impact, and Severe Impact are defined as follows:

- *No Impact* – The project would result in an insignificant increase in the number of people "highly annoyed" by the new noise.
- *Impact* – The change in cumulative noise is noticeable to most people, but may not be sufficient enough to cause significant, adverse community reactions. The need for mitigation for impacted areas depends upon project-specific factors, such as the predicted level of increase over existing noise levels, the type and number of sensitive land uses affected, and the cost effectiveness of the mitigation.
- *Severe Impact* – A significant percentage of people would be highly annoyed by the noise levels. This would be a significant impact under NEPA, and would typically require mitigation.

Maps, aerial photography, and field review were used to identify sensitive land uses. Representative land uses were chosen for noise monitoring to determine existing ambient sound levels. Long-term, continuous 24-hour measurements were taken at four residences, and short-term, one-hour measurements were taken at seven institutional uses. A Metrosonics db-3080 was used for data collection. The device was equipped with a windscreen to eliminate noise associated with wind blowing across the microphone. The monitor was calibrated with an acoustical calibrator before and after each measurement. Weather conditions were also considered to ensure an accurate reading. For areas not monitored, existing sound levels were estimated based upon similar conditions to sites that were monitored.

Distances defining the impact and severe impact areas were estimated using the FTA detailed assessment guidelines and the FTA spreadsheet model. Project details including the number of trains during the day and night, number of cars per train, speed, and topographic shielding were input into the model and compared to existing sound levels to determine the distances within which sensitive receptors would be impacted. Noise impact contours were developed for each corridor to identify the number of sensitive receptors within the impact and severe impact range.

Table G.1: FTA Noise Impact Criteria (dBA)

Existing Noise Exposure*	Sound Level of Project Noise That Would Cause Impact/Severe Impact			
	Category 1 (in L_{eq}) or Category 2 (in L_{dn}) Sites		Category 3 Sites	
	Impact	Severe Impact	Impact	Severe Impact
47-48	53-59	>59	58-64	>64
49-50	54-59	>59	59-64	>64
51	54-60	>60	59-65	>65
52-53	55-60	>60	60-65	>65
54	55-61	>61	60-66	>66
55	56-61	>61	61-66	>66
56	56-62	>62	61-67	>67
57-58	57-62	>62	62-67	>67
59-60	58-63	>63	63-68	>68
61-62	59-64	>64	64-69	>69
63	60-65	>65	65-70	>70
64	61-65	>65	66-70	>70
65	61-66	>66	66-71	>71
66	62-67	>67	67-72	>72
67	63-67	>67	68-72	>72
68	63-68	>68	68-73	>73
69	64-69	>69	69-74	>74
70	65-69	>69	70-74	>74

* L_{eq} is used as the descriptor for Category 1 and 3 sites, and L_{dn} is used for Category 2 sites, where nighttime sensitivity is a factor.

Source: FTA's Transit Noise and Vibration Impact Assessment (May 2006).

Vibration

For areas with infrequent existing rail traffic, less than three trains per day, existing vibration measurements are not required. Impacts are determined by estimating future ground-borne vibration levels and comparing those levels to the criteria shown in Table G.2.

Table G.2: Ground-Borne Vibration and Noise Impact Criteria

Land Use Category	Ground-Borne Vibration Impact Levels (VdB re 1 micro in/sec)	
	Frequent Events (1)	Infrequent Events (2)
Category 1: Buildings where low ambient vibration is essential for interior operations.	65 VdB	65 VdB
Category 2: Residences and buildings where people normally sleep.	72 VdB	80 VdB
Category 3: Institutional land uses with primarily daytime use.	75 VdB	83 VdB

(1) "Frequent Events" is defined as more than 70 vibration events per day. Most rapid transit projects fall into this category.
(2) "Infrequent Events" is defined as fewer than 70 vibration events per day. This category includes most commuter rail systems.
This criterion limit is based on levels that are acceptable for most moderately sensitive equipment such as optical microscopes. Vibration-sensitive equipment is not sensitive to ground-borne vibration noise.

Source: FTA's *Transit Noise and Vibration Impact Assessment* (May 2006).

Since there is infrequent to no service along the corridors, a general assessment was performed for the vibration analysis. The project related vibration was estimated using the generalized ground surface vibration curves from the FTA Guidance Manual. The curve is then adjusted to account for project specific factors including track support system, speed, and local geology. Vibration sensitive receptors within this contour were identified and specific vibration levels were estimated based upon the building type and construction.

As this project would have approximately 16 vibration events per day west of Andover, and 37 vibration events per day east of Andover, this assessment uses the criteria for infrequent events.

G.3 Existing Conditions

Noise

The western portion of the alignment currently experiences regular train traffic. Infrequent freight service runs between Slateford Junction and Scranton. In addition, infrequent excursions from the Steamtown National Historic Site run through Scranton. To account for the varying track usages, existing sound levels, and the service that would occur on the alignment, the corridor was divided into four segments: the Western Pennsylvania section – between Scranton and Pocono Mountain; the Eastern Pennsylvania section – between Pocono Mountain and the Delaware River; the western New Jersey section – between the Delaware River and Andover; and the eastern New Jersey section – between Andover and Port Morris.

To document the varying sound levels throughout the corridor, long-term (24-hour) measurements were taken at each type of corridor usage (passenger, freight, and none). Four locations were chosen for long-term measurements. To document existing train noise one location was measured at East Stroudsburg and one was measured in Scranton. Train pass-bys were recorded at both of the sites. To document the sound levels in areas where there currently is no train traffic, one measurement was made in Greendell, in Sussex County. Finally, to measure the existing sound levels along a heavily used roadway, one measurement was made in Analomink (refer to Table G.3).

Table G.3: Existing Sound Levels at Category 2 Locations (Residences)

Location	Section	Existing Sound Levels (dBA, L_{dn})	Distance from Tracks or Roadway (feet)
Mahon Court, Scranton, PA	Western Pennsylvania	65	20
PA 447, Analomink, PA	Eastern Pennsylvania	64	30
King Street, East Stroudsburg, PA	Eastern Pennsylvania	59	60
Green Farms Road, Greendell, NJ	Western New Jersey	50	N/A

Source: Edwards and Kelcey, 2005.

To represent the worst-case scenario, the long-term measurements were conducted at the residential sites closest to the rail line. For Analomink the residential site chosen was the closest one to the roadway.

In addition, several short-term measurements were made at Category 3 locations, such as parks and schools, which use the average 1-hour sound level as their basis for existing conditions. For these locations, measurements were taken for one hour during the time of day when the facilities would be used. Existing measurements were taken at seven of the closest Category 3 locations (Refer to Table G.4).

Table G.4: Existing Sound Levels at Category 3 Locations (Parks and Schools)

Location	Section	Existing Sound Levels (L_{eq})	Distance from Tracks (feet)
University of Scranton Fields, PA*	Western Pennsylvania	58	70
Nay Aug Park, Scranton, PA*	Western Pennsylvania	58	70
South Main Street Playground, Elmhurst, PA	Western Pennsylvania	47	100
Gouldsboro State Park/Tobyhanna State Park, Gouldsboro/Tobyhanna, PA**	Western Pennsylvania	47	100
Unnamed local park, South Kistler Street, E. Stroudsburg, PA	Eastern Pennsylvania	59	80
Notre Dame Elementary School, Ridgeway Street, E. Stroudsburg, PA	Eastern Pennsylvania	54	250
Smithfield Township Park, PA Route 45067, Delaware Water Gap, PA	Eastern Pennsylvania	57	60
Delaware Water Gap National Recreation Area, Slateford/Delaware Water Gap, PA**	Eastern Pennsylvania	53	100
Knowlton Park, NJ Route 94, Columbia, NJ	Western, New Jersey	47	100
Undeveloped Johnsonburg Swamp, Ramsey Road/Dark Moon Road, Frelinghuysen Twp., NJ**	Western, New Jersey	53	100
Andover Borough Park, County Route 517, Andover, NJ	Western, New Jersey	53	140
Carol O. Johnson Municipal Park, Roseville Road, Byram, NJ**	Eastern New Jersey	53	120
Undeveloped/unnamed municipal park, near Brookwood Road, Byram, NJ**	Eastern New Jersey	53	100

Existing sound levels from the 24-hour measurement performed at Mahon Ct. in Scranton were used for these locations due to its proximity to the two parks and the similar background sound levels. To be conservative the quietest hour between 7am and 6pm (typical hours of use) was used as the existing sound level.
** Existing sound levels from parks with similar locations and settings were used to approximate existing sound levels.

Source: Edwards and Kelcey, 2006.

Vibration

The major existing source of vibration in the corridor is truck and bus traffic on local roads, and the existing infrequent freight rail operations on portions of the corridor in Pennsylvania. As described in Section G.2, existing vibration measurements are not used to determine the potential impact of the project.

G.4 Impacts

Noise

Wayside and Whistle Noise

Distances defining the impact and severe impact areas were estimated using the FTA detailed assessment guidelines and the FTA spreadsheet model. Project details including number of trains during the day and night, number of cars per train, speed, and topographic shielding were input into the model and compared to existing sound levels to determine the distances within which sensitive receptors would be impacted. It was assumed that there would be eight cars on each train, with an average speed of 40 mph.

The Western Pennsylvania section would experience 11 train passbys during the day, and 5 at night. The Eastern Pennsylvania section would experience 12 train passbys during the day, and 4 at night. The Western New Jersey section would experience 13 train passbys during the day, and 3 at night, and the Eastern New Jersey section would experience 26 train passbys during the day, and 11 at night. Within the New Jersey sections several portions of the track are depressed or raised significantly compared with the neighboring sensitive receptors. This natural buffering blocks much of the wayside noise, thereby reducing the sound levels at the neighboring receptors. Table G.5 shows the distances within which sensitive receptors in each section would be impacted.

Table G.5: Impact Distances for Wayside and Whistle Noise for Residences

Section	Project Impact Distance (ft)			Project Severe Impact Distance (ft)		
	Wayside Alone	Near Station	Near Grade Crossing	Wayside Alone	Near Station	Near Grade Crossing
Western Pennsylvania	90	140	270	25	40	70
Eastern Pennsylvania	110	160	320	25	40	70
Western New Jersey (without natural buffering)	160	280	460	60	110	180
Western New Jersey (with natural buffering)	50	80	130	20	30	50
Eastern New Jersey (without natural buffering)	350	500	900	130	190	380
Eastern New Jersey (with natural buffering)	100	150	270	45	60	100

Source: Edwards and Kelcey, 2006.

Using the distances identified in Table G.5, aerials, topographic maps, and field visits were examined to determine which residences would be located within the calculated impact distances (refer to Tables G.6 and G.7).

The analysis shows that without mitigation, approximately 448 residences would be impacted by the wayside and whistle noise associated with the project, and 38 residences would be severely impacted. The warning whistles are responsible for a large number (234) of the impacts and all 38 severe impacts.

Institutional facilities were analyzed in a similar manner. The distance between the facility and the right-of-way was used to determine if the facility would be impacted or severely impacted by the project. Table G.8 shows the distances within which institutional facilities would be impacted.

As shown in the table, the only institutional facility that would be impacted by the project is the Smithfield Township Park in Delaware Water Gap, Pennsylvania. The impact to this park, which is adjacent to the station, would be caused by the warning whistle.

Table G.6: Location of Residences within the Impact Distances for Wayside and Whistle Noise

Milepost	Location	Wayside	Whistle	Total
Western Pennsylvania				
132.3 to 133.3	Harrison Ave., Bogart Pl., Scranton, PA	65	0	65
131	Joseph Ave., Myrtle St., Scranton, PA	18	0	18
130.5	Lake St., Dunmore, PA	6	0	6
120.5	Market St., Moscow, PA	4	0	4
112.8	Main St. (SR 507), Lehigh, PA	0	11	11
107.4	Church St., Tobyhanna, PA	2	12	14
Eastern Pennsylvania				
102.3	Summit Ave. (SR 940), Tobyhanna, PA	0	24	24
101.2	Hrath Ln., Mt. Pocono, PA	8	0	8
98.4	Route 940, Paradise, PA	1	0	1
97.4	Devils Hole Rd., Paradise, PA	0	1	1
94.8	Hardytown Rd., Barrett, PA	4	0	4
94.5	Routes 191/390, Barrett, PA	3	0	3
90.2	Browns Hill Rd., Paradise, PA	3	4	7
86	Cherry Lane Rd., Stroud, PA	3	0	3
84.5 to 85.5	Route 191, Stroud	4	0	4
83	Stokes Avenue, East Stroudsburg, PA	11	5 (6 severe)	16 (6 severe)
82.5	North Cortland St., East Stroudsburg, PA	9	7 (9 severe)	16 (9 severe)
81 to 82	Analomink St., East Broad St., Burson St., East Stroudsburg, PA	31	103 (14 severe)	134 (14 severe)
73.5	Slateford Rd., Slateford Junction, PA	9	0	9
Western New Jersey				
72.5	Victoria Crossing, Knowlton, NJ	1	0	1
69.5	Vail Road, Knowlton, NJ	3	0	3
57.6	Wolfs Corner Rd., Green, NJ	4	10 (4 severe)	14 (4 severe)
Eastern New Jersey				
52.9	Andover Station, Roseville Rd, Andover, NJ	7	0	0
47.8	Brooklyn Rd., Stanhope, NJ	18	57 (5 severe)	75 (5 severe)
TOTAL		**214**	**234 (38 severe)**	**448 (38 severe)**

Source: Edwards and Kelcey, 2006.

Table G.7: Summary of Residences within the Impact and Severe Impact Distances for Wayside and Whistle Noise

Segment/Location	Number of Residences within Impact Distance	Number of Residences within Severe Impact Distance
Western Pennsylvania		
Wayside	95	0
Warning Whistles: *Church St., Main St. (Route 507)*	23	0
Eastern Pennsylvania		
Wayside	86	0
Warning Whistles: *River Rd., Analomink St., Broad St., Burson St., N. Courtland St., Stokes Ave., Browns Hill Rd., Routes 191/390, Devils Hole Rd., Summit Ave.*	144	29
Western New Jersey		
Wayside	8	0
Warning Whistles: *Wolfs Corner Rd.*	15	4
Eastern New Jersey		
Wayside	25	0
Warning Whistles: *Brooklyn Rd.*	57	5
Total	**448**	**38**
* Impact and Severe Impact are defined by FTA, the number of properties in the Impacted category does not include the properties in the Severely Impacted category.		

Source: Edwards and Kelcey, 2006.

Table G.8: Impact Distances for Wayside and Whistle Noise for Institutional Facilities

Location	Section	Project Impact Distance (in feet)		Distance from Tracks (feet)	Impact/ Severe Impact?
		Impact	Severe		
University of Scranton Field, Scranton, PA	Western Pennsylvania	14	6	70	No
Nay Aug Park, Scranton, PA	Western Pennsylvania	14	6	70	No
South Main Street Playground, Elmhurst, PA	Western Pennsylvania	25	8	100	No
Gouldsboro State Park/Tobyhanna State Park, Gouldsboro/Tobyhanna, PA	Western Pennsylvania	30	10	100	No
Unnamed local park, South Kistler Street, E. Stroudsburg, PA	Eastern Pennsylvania	60	24	80	No
Notre Dame Elementary School, Ridgeway Street, E. Stroudsburg, PA	Eastern Pennsylvania	90	30	250	No
Smithfield Township Park, PA Route 45067, Delaware Water Gap, PA	Eastern Pennsylvania	70	25	60	Impact
Delaware Water Gap National Recreation Area, Slateford/Delaware Water Gap, PA	Eastern Pennsylvania	20	8	100	No
Knowlton Park, NJ Route 94, Columbia, NJ	Western New Jersey	30	10	100	No
Undeveloped Johnsonburg Swamp, Ramsey Road/Dark Moon Road, Frelinghuysen Twp., NJ	Western, New Jersey	20	8	100	No
Andover Borough Park, County Route 517, Andover, NJ	Western New Jersey	20	8	140	No
Carol O. Johnson Municipal Park, Roseville Road, Byram, NJ	Eastern New Jersey	20	8	120	No
Undeveloped/unnamed municipal park, near Brookwood Road, Byram, NJ	Eastern New Jersey	20	8	100	No

Source: Edwards and Kelcey, 2006.

<u>Access Road Impacts</u>

A worst-case analysis was performed at the largest station, Pocono Mountain, which will have a maximum parking capacity of 1,000 vehicles, using the FTA detailed assessment guidelines, Table G-1, and FTA spreadsheet model. With the addition of this traffic, residences within 35 feet of the access roadways would be impacted, and within 18 feet of the access roadways would be severely impacted; while for parks and schools, the impact distance would be 17 feet and the severe impact distance would be 6 feet. Topographic maps and field visits did not show any receptors within the above noted distances of the access roadways for any of the stations.

<u>Station Area Impacts</u>

Similarly, a worst-case analysis was performed at Pocono Mountain for the noise associated with parking. Residences within 35 feet of the station would be impacted, and within 22 feet would be severely impacted; while for parks and schools, the impact distance would be 20 feet and the severe impact distance would be 12 feet. Topographic maps and field visits did not show any receptors within the above noted distances of any of the stations.

<u>Yard Facility Impacts</u>

A similar analysis was performed to determine if there would be any impacted sites associated with the operation of the yard in Scranton. For this area, using the FTA detailed assessment guidelines, Table G-1, and the FTA spreadsheet model, it was estimated that residences within 190 feet of the center of the yard would be impacted, and within 90 feet of the center of the yard would be severely impacted. A review of aerial mapping and field visits showed that 12 residences would be impacted by operation of the yard, but no residences would be severely impacted.

Construction Impacts

Construction would be required at the stations, yard, and areas requiring new track, especially through Sussex and Warren Counties in New Jersey. Noise due to construction could create temporary adverse impacts. However, the construction would not be focused in any one area for a significant length of time. Impacts could be minimized by imposing reasonable time of day restrictions on construction activities and requiring the use of properly maintained equipment in accordance with industry standards.

Vibration

A general vibration assessment was performed according to the procedures identified in FTA's Noise and Vibration Assessment guidelines. Project related vibration was estimated using the generalized ground surface vibration curves from the FTA Guidance Manual. The curve was then adjusted to account for project specific factors. It was assumed that the entire corridor would use continuous welded rail, with a train speed of 40 mph. The FTA impact threshold applicable to residences is 80 decibels (VdB), since there would be less than 70 train events per day. For institutional and commercial land uses, the threshold is 83 VdB. Based upon these assumptions, the impact distance for residences would be 40 feet from the center of the tracks and for institutional and commercial buildings would be 25 feet from the center of the tracks. Using aerial photography and topographic maps, it was determined that no buildings were within the distances designated above. Therefore, the projected vibration from the project is below the impact threshold. Vibration impacts are therefore not anticipated with this project.

G.5 Mitigation Measures

Noise

The analysis shows that without mitigation, a total of approximately 448 residences would be impacted by the project, and 38 residences would be severely impacted by the project. As discussed earlier in the document, mitigation is only required for severely impacted sites, but implementation depends upon several factors including sound level increases, number of impacted properties, and cost effectiveness. Impacted sites as defined under the FTA guidelines are not considered to be significant impacts as defined by NEPA.

Options for mitigation of noise effects from rail projects involve treatments of three fundamental components of the noise problem: 1) at the noise source, 2) along the source-to-receiver propagation path, or 3) at the receiver. Generally, a transit agency has the authority to treat the source and some elements of the propagation path, but may have little or no authority to implement modifications at the receiver location.

Since the Severe Impacts are caused by the warning whistles, one possible mitigation measure would be to establish "Quiet Zones" at grade crossings in the vicinity of residential areas. As required by the Federal Railroad Administration (FRA), the municipalities would be required to petition the FRA for Quiet Zone designations, in accordance with FRA's Interim Final Rule on the Use of Locomotive Horns at Highway-Rail Grade Crossings (49 CFR Part 222 and 229). However, once approved, the project would pay for the design and installation of the Quiet Zones.

The implementation of Quiet Zones at the following seven intersections would eliminate all of the severe impacts and 182 impacts:

- Stokes Avenue (Gravel Place) in East Stroudsburg, PA
- North Cortland Street in East Stroudsburg, PA
- Burson Street in East Stroudsburg, PA
- East Broad Street in East Stroudsburg, PA
- Analomink Street in East Stroudsburg, PA
- Wolf's Corner Road in Green Township, NJ
- Brooklyn Road in Stanhope

Additional locations where Quiet Zones would reduce the impacts include the following six grade crossings:

- Main Street (SR 507) in Lehigh Township, PA
- Church Street (SR 423) in Coolbaugh, PA
- Summit Avenue (SR 940) in Tobyhanna, PA
- Devils Hole in Paradise, PA
- Route 191/390 in Barrett, PA
- Browns Hill Road in Paradise, PA

Other measures that would significantly reduce the wayside noise include installation of noise barriers, vehicle skirts and/or undercar absorption. A list of practical noise mitigation procedures and their expected attenuation values is summarized in the FTA manual *Transit Noise and Vibration Impact Assessment* (May 2006) and shown in Table G.9. Consideration of mitigation measures would be done in consultation with the affected residents and municipalities during final design of the project.

Table G. 9: FTA Transit Noise Mitigation Measures

Mitigation Measure	Effectiveness
Vehicle Skirts	6-10 dB
Undercar Absorption	5 dB
Acquisition of Buffer Zones	Varied
Ballast on At-Grade Guideway	3 dB
Construction of Sound Barriers	5-10 dB
Building Noise Insulation	5-20 dB

Source: FTA's Transit Noise and Vibration Assessment (May 2006).

The establishment of Quiet Zones at the grade crossings in East Stroudsburg, Green Township and Stanhope would eliminate the severe impacts. Therefore, the noise associated with the project would not cause any significant impacts.

Vibration

No vibration impacts are predicted as a result of this project. However, to prevent future impacts, it is necessary to maintain the train wheels and rails, keeping the wheels and rails as smooth as possible. In addition, to minimize the vibration, recommended measures include rail grinding, wheel truing, wheel flat detector systems, and vehicle reconditioning programs.