California High-Speed Rail Authority

Burbank to Los Angeles Project Section

Final Environmental Impact Report/ Environmental Impact Statement

Appendix 3.4-A: Noise and Vibration Mitigation Guidelines

September 2021

CALIFORNIA High-Speed Rail Authority

The environmental review, consultation, and other actions required by applicable Federal environmental laws for this project are being or have been carried out by the State of California pursuant to 23 U.S.C. 327 and a Memorandum of Understanding dated July 23, 2019, and executed by the Federal Railroad Administration and the State of California.

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APPENDIX 3.4-A: NOISE AND VIBRATION MITIGATION GUIDELINES

INTRODUCTION

This appendix describes the noise mitigation that must be considered when noise impacts are identified.

NOISE MITIGATION GUIDELINES

In general, noise mitigation must be considered when impacts are identified. Mitigation guidelines for the three impact categories identified by Federal Railroad Administration (FRA) are as follows:

- No Impact: No mitigation required.
- Moderate Impact: Mitigation may be considered at the discretion of the California High-Speed Rail Authority (Authority), and implementation would be subject to reasonable project-specific factors related to effectiveness, cost, density, and proximity of sensitive receivers.
- Severe Impact: Consideration of mitigation is required if impacts cannot be avoided. The Authority would take steps to reduce noise substantially through mitigation measures that are reasonable, physically feasible, practical, and cost effective.

MITIGATION OF SEVERE NOISE IMPACTS

The Authority will examine alternatives to avoid, minimize, or mitigate severe noise impacts. If severe noise impacts cannot be avoided, then the Authority would take steps to reduce severe noise substantially through mitigation measures that are reasonable, physically feasible, practical, and cost effective. The following criteria will be used for evaluating the reasonableness of noise barriers as mitigation for severe noise impacts:

- Calculations and computations for barrier geometry as stated in the FRA's *High-Speed Ground Transportation Noise and Vibration Impact Assessment* (FRA 2012), Table 5-3
- Increase over existing noise levels
- Number of noise-sensitive sites affected
- The minimum number of affected sites should be at least 10, and the length of a noise barrier should be at least 800 feet.
- Barrier heights up to a maximum of 14 feet will be considered. Mitigation options for areas that require barriers over 14 feet will be studied on a case-by-case basis.
- The cost limit for a noise barrier would be set at $95,000 (2018 dollars) per benefited residence.
- The community should approve of implementation of the recommended noise barriers (75 percent of all affected parties).

Section 4(f) and Section 106 properties with severe or moderate noise impacts will require mitigation, will not be subject to these guidelines, and will be evaluated on a case-by-case basis.

Substantial Noise Reduction

A minimum outdoor noise reduction of 5 decibels (dB) using the applicable criterion for the property is considered substantial.

Reasonable

Reasonableness implies that good judgment and common sense have been applied during the decisionmaking process. Reasonableness is determined on the basis of several factors regarding the individual circumstances and the specific needs of affected receivers.

Physically Feasible

Noise mitigation measure must be designed, constructed, installed, or implemented in compliance with structural requirements related to ground conditions, wind loading, seismic risk, safety considerations, accessibility, material maintainability and longevity, and applicable engineering design practices and technology. Noise mitigation measures must not result in an adverse environmental impact, such as significant visual intrusions, blocked views, or adverse effects on a historical site.

Sound barriers are the most common noise mitigation measure. The maximum sound barrier height would be 14 feet for at-grade sections; however, all sound barriers should be designed to be as low as possible to achieve a substantial noise reduction. Berm and berm/wall combinations are the preferred types of sound barriers where space and other environmental constraints permit.

On aerial structures, the maximum sound barrier height would also be 14 feet, but barrier material would be limited by engineering weight restrictions for barriers on the structure. Sound barriers on the aerial structure should still be designed to be as low as possible to achieve a substantial noise reduction.

Visual Effects

Noise mitigation measures must be designed, constructed, installed, and implemented in a manner that does not result in adverse impacts on the visual resources in the area. Sound barriers would consist of a solid barrier no more than 6 feet in height. Above 6 feet, the sound barrier would be made of transparent materials. For example, a 13-foot-high sound barrier would consist of 6 feet of solid material on the bottom topped by 7 feet of transparent material.

Cost Effectiveness

The cost for constructing a noise barrier along the at-grade portion of the alignment is estimated to be $70 per square foot, and the cost to construct a noise barrier along the elevated portion of the alignment is $65 per square foot. The total cost of mitigation cannot exceed $95,000 per benefitted receiver. This cost is determined by dividing the total cost of the mitigation measure by the number of noise-sensitive buildings that receive a substantial (i.e., 5 A-weighted decibels [dBA] or greater) outdoor noise reduction. This calculation will generally limit the use of mitigation in rural areas that have few or isolated residential buildings. If the density of residential dwellings is insufficient to make the measure cost effective, then other noise abatement measures, such as sound insulation, would be considered on a case-by-case basis. If sound insulation is identified as an alternative mitigation measure, the treatment must provide a substantial increase in noise reduction (i.e., 5 dBA or greater) between the outside and inside noise levels for interior habitable rooms.

Mitigation Parameters

Prior to operation of the high-speed rail, the Authority would install sound barriers where they can achieve between 5 and 15 dB of noise reduction, depending on their height and location relative to the tracks. The primary requirements for an effective sound barrier are that the barrier must (1) be high enough and long enough to break the line of sight between the sound source and the receiver, (2) be of an impervious material with a minimum surface density of 4 pounds per square foot, and (3) not have any gaps or holes between the panels or at the bottom. Because many materials meet these requirements, aesthetics, durability, cost, and maintenance considerations usually determine the selection of materials for sound barriers. Depending on the situation, sound barriers can become visually intrusive. Typically, the sound barrier style is selected with input from the local jurisdiction to reduce the visual effect of barriers on adjacent lands uses. For example, sound barriers could be solid or transparent, and made of various colors, materials, and surface treatments.

- The Authority would work with the communities to identify how the use and height of sound barriers would be determined using jointly developed performance criteria. Other solutions may

result in higher numbers of residual impacts than reported herein. Options may be to reduce the height of sound barriers and combine barriers with sound insulation or to accept higher noise thresholds than the FRA's current noise thresholds.

- If sound walls are not proposed or do not reduce sound levels to below a severe impact level, building sound insulation can be installed. Sound insulation of residences and institutional buildings to improve the outdoor-to-indoor noise reduction is a mitigation measure that can be provided when the use of sound barriers is not feasible in providing a reasonable level (5 to 7 dB) of noise reduction. Although this approach has no effect on noise in exterior areas, it may be the best choice for sites where sound barriers are not feasible or desirable and for buildings where indoor sensitivity is of most concern. Substantial improvements in building sound insulation (on the order of 5 to 10 dB) can often be achieved by adding an extra layer of glazing to windows, sealing holes in exterior surfaces that act as sound leaks, and providing forced ventilation and air conditioning so that windows do not need to be opened. Performance criteria would be established to balance existing noise events and ambient roadway noise conditions as factors for determining mitigation measures.
- If sound walls or sound installation is not effective, the Authority can acquire easements on properties severely affected by noise. Another option for mitigating noise impacts is for the authority to acquire easements on residences likely to be affected by high-speed rail operations in which the homeowners would accept the future noise conditions. This approach is usually taken only in isolated cases where other mitigation options are infeasible, impractical, or too costly.
- The decision to include mitigation assessments may depend on factors such as the number of noise-sensitive sites affected, the relative increase in noise levels, the sensitivity at affected land uses, the effectiveness of mitigation measures, community views, costs versus benefits, design limitations, whether sensitive use is solely indoors, and safety. For example, where land-use activity is solely indoors, an interior day-night sound level, dBA, criterion of 45 dBA from project sources is recommended to determine whether building sound insulation improvements should be considered for mitigation.

FEDERAL TRANSIT ADMINISTRATION/FEDERAL RAILROAD ADMINISTRATION CONSTRUCTION NOISE MITIGATION

1. Design considerations and project layout:
    - Construct noise barriers, such as temporary walls or piles of excavated material, between noisy activities and noise-sensitive receivers.
    - Route truck traffic away from residential streets, if possible. Select streets with the fewest homes, if no alternatives are available.
    - Site equipment on the construction lot as far away from noise-sensitive sites as possible.
    - Construct walled enclosures around especially noisy activities or around clusters of noisy equipment. For example, shields can be used around pavement breakers and loaded vinyl curtains can be draped under elevated structures.
2. Sequence of operations:
    - Combine noisy operations so they occur in the same time period. The total noise level produced would not be substantially greater than the level produced if the operations were performed separately.
    - Avoid nighttime activities. Sensitivity to noise increases during the nighttime hours in residential neighborhoods.
3. Alternative construction methods:

- Avoid impact pile driving where possible in noise-sensitive areas. Drilled piles or the use of a sonic or vibratory pile driver are quieter alternatives where the geological conditions permit their use.
- Use specially quieted equipment, such as quieted and enclosed air compressors, and mufflers on all engines.
- Select quieter demolition methods, where possible. For example, sawing bridge decks into sections that can be loaded onto trucks results in lower cumulative noise levels than impact demolition by pavement breakers.
- The environmental assessment should include a description of one or more mitigation approach for each affected location.

FEDERAL TRANSIT ADMINISTRATION/FEDERAL RAILROAD ADMINISTRATION CONSTRUCTION VIBRATION MITIGATION

1. Design considerations and project layout:
   - Route heavily loaded trucks away from residential streets, if possible. Select streets with fewest homes, if no alternatives are available.
   - Operate earthmoving equipment on the construction lot as far away from vibration-sensitive sites as possible.
2. Sequence of operations:
   - Phase demolition, earthmoving, and ground-impacting operations so as not to occur in the same time period. Unlike noise, the total vibration level produced could be substantially less when each vibration source operates separately.
   - Avoid nighttime activities. People are more aware of vibration in their homes during the nighttime hours.
3. Alternative construction methods:
   - Avoid impact pile driving where possible in vibration-sensitive areas. Drilled piles or the use of a sonic or vibratory pile driver causes lower vibration levels where the geological conditions permit their use.
   - Select demolition methods not involving impact, where possible. For example, sawing bridge decks into sections that can be loaded onto trucks results in lower vibration levels than impact demolition by pavement breakers, and milling generates lower vibration levels than excavation using clam shell or chisel drops.
   - Avoid vibratory rollers and packers near sensitive areas.

CONSTRUCTION NOISE MITIGATION GUIDELINES

All construction activities in this report were analyzed in terms of their noise impacts in regard to FRA-recommended guidelines. Local jurisdictions provide construction noise exempt times where the FRA guidelines are followed. A majority of construction would be conducted during these construction noise exempt times, but when construction is conducted outside of the construction noise exempt times, construction noise must abide by local noise standards. Proper mitigation may be necessary in order to avoid noise impacts at nearby noise-sensitive receivers.

Pile driving would be the loudest noise-generating activity during construction of the high-speed rail corridor. Therefore, piles that are required along the high-speed rail corridor and that would be located within 500 feet of a noise-sensitive receiver should be installed using the drilling and casing method. Another method to mitigate noise related to pile driving is the use of an augur to install the piles instead of a pile driver, which would reduce noise levels substantially. If pile driving is necessary, limit the time of day the activity can occur.

The most effective way to minimize the impact of construction noise during the development of the project is to enforce the time restrictions for the hours of construction as listed in local noise ordinances. It is important for the design engineer to plan the order of operations during construction so that the noise levels resulting from construction operations would not exceed local noise ordinances or those recommended by the FRA. To avoid unnecessary annoyance from construction noise, the following best practices for construction noise control should also be considered for inclusion in construction contract documents:

- All noise-producing project equipment and vehicles using internal combustion engines would be equipped with mufflers and air-inlet silencers, where appropriate, in good operating condition that meet or exceed original factory specifications. Mobile or fixed "package" equipment (e.g., arc-welders, air compressors) would be equipped with shrouds and noise control features that are readily available for that type of equipment.
- All mobile or fixed noise-producing equipment used on the project, which is regulated for noise output by a local, state, or federal agency, would comply with such regulation while in the course of project activity.
- Material stockpiles and mobile equipment staging, parking, and maintenance areas would be located as far as practicable from noise-sensitive receivers.
- Material stockpiles should be used to block line of sight to nearby noise-sensitive receivers when possible.
- Locate fixed noise-generating equipment as far from noise-sensitive land uses as is practical.
- Limit the loudest construction activities, such as concrete breaking and jack hammering, to the middle of the day when the sensitivity to such noises would be minimal. Noise-producing signals, including horns, whistles, alarms, and bells would be used for safety warning purposes only.
- No project-related public address or music system would be audible at any adjacent receiver.
- If complaints arise, the contractor would initiate a construction noise monitoring plan to ensure the construction noise levels at the nearest noise-sensitive land uses are within the limits of the noise ordinance.
- Avoid nighttime construction in residential neighborhoods.
- During nighttime work, use smart back-up alarms, which automatically adjust the alarm level based on the background level, or switch off back-up alarms and replace with spotters.
- Re-route construction-related truck traffic along roadways that would cause the least disturbance to residents.
- Implement noise-deadening measures for truck loading and operations.
- Minimize the use of generators to power equipment.
- Grade surface irregularities on construction sites.
- Use of temporary noise barriers would be considered where project activities and equipment are unavoidably close to noise-sensitive receivers.
- Use on-site trailers and containers as temporary barriers between any fixed construction noise source and nearby sensitive receivers.
- All workers involved with the construction of this project must be protected from excessive noise exposure as mandated by the Occupational Safety and Health Administration, which has regulated worker noise exposure to a time-weighted-average of 90 dBA over an 8-hour work shift. Areas where levels exceed 85 dBA must be designated and labeled as high noise-level areas where hearing protection is required.

CONSTRUCTION VIBRATION MITIGATION GUIDELINES

After locating potential vibration impacts from to construction, mitigation may be necessary to ensure that there would be no vibration impacts at sensitive receivers. Changes in the design and project layout, changes in the sequence of operations, and use of alternative construction methods are all available vibration mitigation options.

When the engineers design the project and the layout of the project, heavily loaded trucks can be re-routed away from residential streets and onto streets with fewer homes. Earthmoving equipment on the construction lot should also be operated as far as possible from sensitive receivers. Changes in the sequence of operations can also mitigate vibration impacts at sensitive receivers. Construction activities that cause high levels of vibration should be staggered so that multiple sources of vibration are not occurring at once. Nighttime construction activities should also be avoided. Alternative construction methods are also an acceptable vibration mitigation option. If pile driving does occur, impact pile driving should be avoided near vibration-sensitive areas. A sonic or vibratory pile driver would generate lower vibration levels at sensitive receivers.

Demolition methods not involving impacts should be used when possible. The utilization of vibratory rollers and packers should be avoided near vibration-sensitive receivers.

References

Federal Railroad Administration (FRA). 2012. *High-Speed Ground Transportation Noise and Vibration Impact Assessment*. Washington, DC: September 2012.