Chapter 11: Noise

11.1 Introduction

This chapter describes the existing noise conditions in the noise impact analysis area and the expected noise impacts of the project alternatives. Traffic noise impacts are evaluated using the noise model and methodologies approved by the Federal Highway Administration (FHWA), the Federal Transit Administration (FTA), and the Utah Department of Transportation (UDOT) (FHWA 2011; FTA 2018; UDOT 2020).

Where appropriate, noise barriers or other abatement measures are evaluated to mitigate noise impacts, and recommendations are made for noise-abatement measures consistent with UDOT Policy 08A2-01, *Noise Abatement*, revised May 28, 2020. For detailed information about the UDOT noise analysis described in this chapter, see Appendix 11A, Noise Technical Report.

What is the noise impact analysis area?

The noise impact analysis area is the land adjacent to the project alternatives that could be affected by changes in noise levels due to construction and operation of the project alternatives, as well as the two areas where mobility hubs are being proposed.

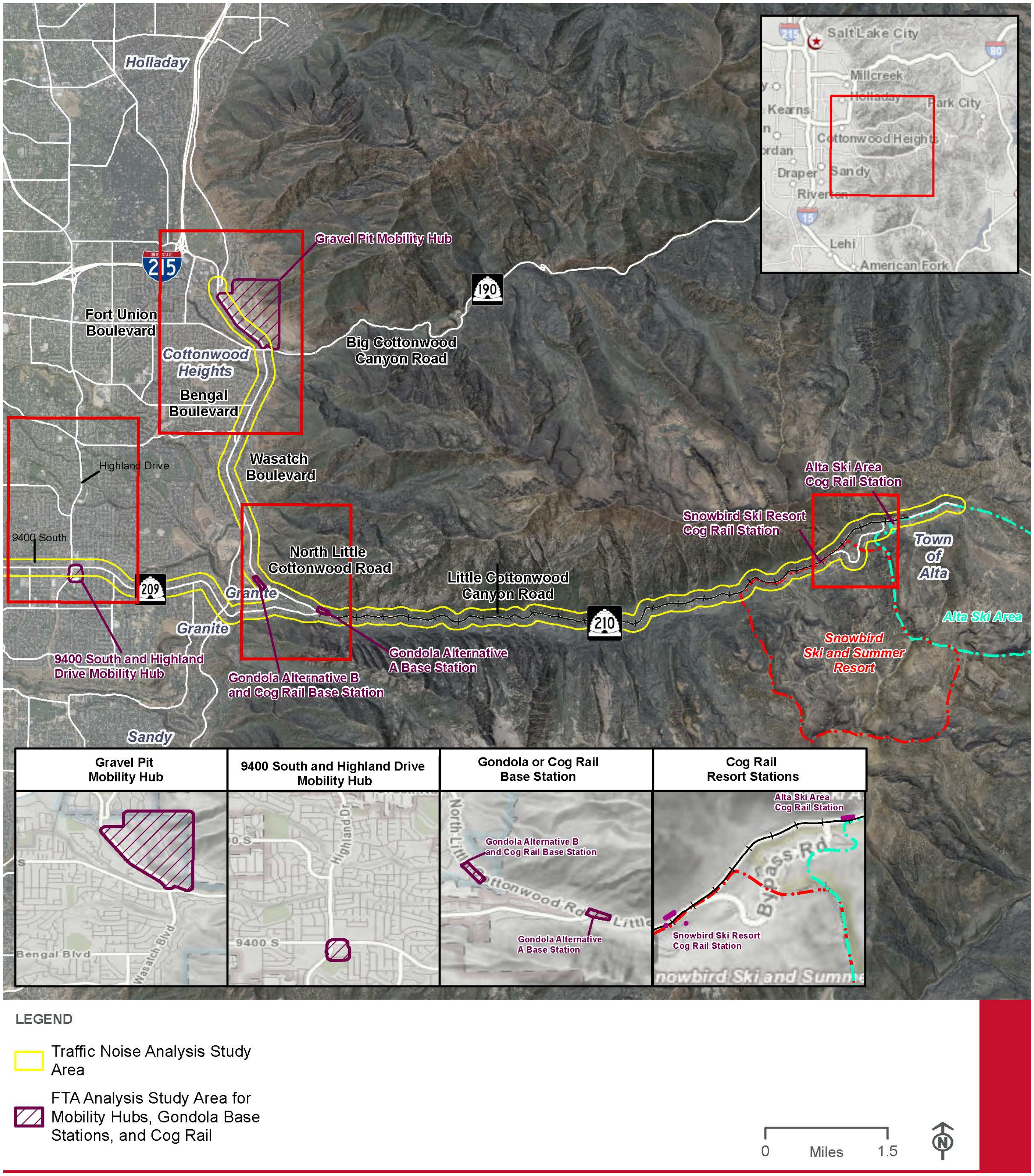
Noise Impact Analysis Area. The noise impact analysis area is the land adjacent to the project alternatives that could be affected by changes in noise levels due to construction and operation of the project alternatives. The noise impact analysis area includes the following segments of State Route (S.R.) 210 and S.R. 209:

- **Wasatch Boulevard** – S.R. 210 from 6200 South to North Little Cottonwood Road
- **North Little Cottonwood Road** – S.R. 210 from Wasatch Boulevard to the intersection with S.R. 209
- **Little Cottonwood Road** – S.R. 209 from Highland Drive (2000 East) to Little Cottonwood Canyon Road
- **Little Cottonwood Canyon Road** – S.R. 210 from the intersection of North Little Cottonwood Road and S.R. 209 through the town of Alta

The noise impact analysis area also includes the two areas where mobility hubs are being proposed: at the southeast corner of S.R. 209 and 2000 East and the gravel pit area on Wasatch Boulevard north of Big Cottonwood Canyon (see Figure 11.1-1).

Noise Policy Applicability. Under UDOT's noise-abatement policy, the S.R. 210 Project is classified as a Type I project since all of the project alternatives would add through-traffic lanes on Wasatch Boulevard. Consistent with UDOT's noise-abatement policy, if any portion of a project is a Type I project, then the entire project is considered a Type I project. For this reason, the noise impact analysis area includes S.R. 209 from Highland Drive to S.R. 210 and S.R. 210 from the mobility hub north of Big Cottonwood Canyon to the town of Alta, even though roadway widening would not occur on S.R. 209 (for all project alternatives) or on the segment of S.R. 210 between Wasatch Boulevard and the town of Alta with the Enhanced Bus Service Alternative and the gondola alternatives. Per UDOT's noise-abatement policy, UDOT considers noise abatement for all Type I projects where noise impacts are identified.

Figure 11.1-1. Noise Impact Analysis Area



Characteristics of Noise. Sound travels through the air as waves of minute air-pressure fluctuations caused by vibration. In general, sound waves travel away from the noise source as an expanding spherical surface. As a result, the energy contained in a sound wave is spread over an increasing area as it travels away from the source. This results in a decrease in loudness at greater distances from the noise source.

Sound-level meters measure the actual pressure fluctuations caused by sound waves and record separate measurements for different sound frequency ranges. The decibel (dB) scale used to describe sound is a logarithmic scale that accounts for the large range of sound pressure levels in the environment. Most sounds consist of a broad range of sound frequencies. Several frequency-weighting schemes have been used to develop composite decibel scales that approximate the way the human ear responds to sound levels. The A-weighted decibel (dBA) scale is most widely used for this purpose. Typical A-weighted noise levels for various types of sound sources are summarized in Table 11.1-1.

Table 11.1-1. Weighted Noise Levels and Human Response

Sound Source	dBA[a]	Response Descriptor
Carrier deck jet operation	140	Limit of amplified speech
	130	Painfully loud
Jet takeoff (200 feet) Auto horn (3 feet)	120	Threshold of feeling and pain
Riveting machine Jet takeoff (2,000 feet)	110	
Shout (0.5 foot) New York subway station	100	Very annoying
Heavy truck (50 feet) Pneumatic drill (50 feet)	90	Hearing damage (8-hour exposure)
Passenger train (100 feet) Helicopter (in-flight, 500 feet) Freight train (50 feet)	80	Annoying
Freeway traffic (50 feet)	70	Intrusive
Air conditioning unit (20 feet) Light auto traffic (50 feet)	60	
Normal speech (15 feet)	50	Quiet
Living room, bedroom, library	40	
Soft whisper (15 feet)	30	Very quiet
Broadcasting studio	20	
	10	Just audible
	0	Threshold of hearing

Source: CEQ 1970

[a] Typical A-weighted noise levels taken with a sound-level meter and expressed as decibels on the “A” scale. The “A” scale approximates the frequency response of the human ear.

Varying noise levels are often described in terms of the equivalent noise level (L_{eq}). Equivalent noise levels are used to develop single-value descriptions of average noise exposure over stated periods of time. The L_{eq} data used for these average noise exposure descriptors are generally based on A-weighted sound-level measurements. Most often, units of hourly L_{eq} values are used to describe traffic noise.

FTA uses the day-night noise descriptor (L_{dn}) to assess transit noise for residential land uses. The L_{dn} is used to describe a receiver's cumulative noise exposure from all events over a period of 24 hours. Events between 10 PM and 7 AM are increased by 10 dBA to account for humans' greater nighttime sensitivity to noise.

The logarithmic nature of decibel scales is such that individual decibel ratings for different noise sources cannot be added directly to give the noise level for the combined noise source. For example, two noise sources that produce equal decibel ratings at a given location will produce a combined noise level that is 3 dBA greater than either sound alone. When two noise sources differ by 10 dBA, the combined noise level will be 0.4 dBA greater than the louder source alone.

People generally perceive a 10-dBA increase in a noise source as a doubling of loudness. For example, a 70-dBA sound will be perceived by an average person as twice as loud as a 60-dBA sound. People generally cannot detect differences of 1 to 2 dBA between noise sources. Under ideal listening conditions, differences of 2 or 3 dBA can be detected by some people. A 5-dBA change would probably be perceived by most people under normal listening conditions.

When distance is the only factor considered, sound levels from isolated point sources of noise typically decrease by about 6 dBA for every doubling of distance from the noise source. When the noise source is a continuous line (for example, vehicle traffic on a highway), noise levels decrease by about 3 dBA for every doubling of distance from the source.

Noise levels at different distances can also be affected by factors other than the distance from the noise source. Topographic features and structural barriers that absorb, reflect, or scatter sound waves can increase or decrease noise levels. Atmospheric conditions (wind speed and direction, humidity levels, and temperatures) can also affect the degree to which sound is reduced over distance.

Reflections off topographical features or buildings can sometimes result in higher noise levels (lower sound attenuation rates) than would normally be expected. Temperature inversions and wind conditions can also diffract and focus a sound wave to a location at a considerable distance from the noise source. Focusing effects are usually noticeable only for very intense noise sources, such as blasting operations. As a result of these factors, the existing noise environment can be highly variable depending on local conditions.

11.2 Regulatory Setting

The Federal Noise Control Act of 1972 (Public Law 92-574) requires that all federal agencies administer their programs in a manner that promotes an environment free from noises that could jeopardize public health or welfare. The noise methodology for the S.R. 210 Project included the consideration of four distinct sources of noise: traffic noise, mobility hub noise, gondola noise, and cog rail noise. For this reason, the noise analysis was conducted in accordance with UDOT Policy 08A2-01, *Noise Abatement* (revised May 28, 2020) and FTA's *Transit Noise and Vibration Assessment Manual* (FTA 2018). There are no federal or state guidelines for evaluating noise impacts from gondola operation.

The federal regulation that FHWA uses to assess noise impacts is 23 Code of Federal Regulations (CFR) Part 772, *Procedures for Abatement of Highway Traffic Noise and Construction Noise*. This regulation was updated on July 13, 2010. The highway traffic noise prediction requirements, noise analysis, and noise-abatement criteria described in this chapter are consistent with 23 CFR Part 772 and with Utah Administrative Code Rule R930-3, *Highway Noise Abatement*.

Utah Administrative Code Rule R930-3 and UDOT's noise-abatement policy establish UDOT's noise impact and abatement policies and procedures. Since UDOT's noise-abatement policy is consistent with 23 CFR Part 772 and has been approved by FHWA, it was used by UDOT for the noise impact analysis in this EIS.

The most appropriate methodology to analyze the construction and operational noise impacts from the mobility hubs, the gondola stations, and the cog rail system is in FTA's *Transit Noise and Vibration Assessment Manual*. FTA, in conjunction with FHWA, has issued detailed regulations implementing the National Environmental Policy Act of 1969 (NEPA) for transit and highway projects. The regulations are codified in 23 CFR Part 771, *Environmental Impact and Related Procedures*. FTA's manual was updated in September 2018. The transit noise prediction requirements, noise analysis, and noise-abatement criteria described in this chapter are consistent with FTA's and UDOT's procedures and policies.

Additional details regarding the methodology used for transit noise sources are provided in Section 11.4.1.2, Methodology for Assessing Noise Impacts from Mobility Hubs and Gondola Base Stations, Section 11.4.1.3, Methodology for Assessing Noise Impacts from the Cog Rail, and Section 11.4.1.4, Combined Noise Impact Analysis for Receptors near Mobility Hubs, Gondola Base Stations, and the Cog Rail Alternative.

Noise-abatement Criteria for Traffic Noise. Noise-abatement criteria (NAC) are used to define the noise levels that are considered an impact (in hourly A-weighted sound-level decibels) for each land use activity category. If future noise levels equal or exceed the NAC, they are considered noise impacts per UDOT policy. UDOT's NAC are summarized in Table 11.2-1.

Table 11.2-1. UDOT's Noise-abatement Criteria

Activity Category	L_{eq} Noise Levels (dBA)	Description of Activity Category
A	56 (exterior)	Lands on which serenity and quiet are of extraordinary significance and serve an important public need, and where the preservation of those qualities is essential if the area is to continue to serve its intended purpose.
B	66 (exterior)	Residential.
C	66 (exterior)	Active sports areas, amphitheaters, auditoriums, campgrounds, cemeteries, day care centers, hospitals, libraries, medical facilities, parks, picnic areas, places of worship, playgrounds, public meeting rooms, public or nonprofit institutional structures, radio studios, recording studios, recreation areas, Section 4(f) sites, schools, television studios, trails and trail crossings.
D	51 (interior)	Auditoriums, day care centers, hospitals, libraries, medical facilities, places of worship, public meeting room, public or nonprofit institutional structures, radio studios, recording studios, schools, and television studios.
E	71 (exterior)	Hotels, motels, offices, restaurants/bars, and other undeveloped lands, properties, or activities not included in categories A–D or F.
F	—[a]	Agriculture, airports, bus yards, emergency services, industrial, logging, maintenance facilities, manufacturing, mining, rail yards, retail facilities, shipyards, utilities (water resources, water treatment, electrical), and warehousing.
G	—[a]	Undeveloped lands that are not permitted.

Source: UDOT 2020

[a] The F and G activity categories do not have specified noise-abatement criteria.

Section 11.4.1.1, Methodology for Assessing Noise Impacts from Traffic, describes how impacts are assessed for traffic noise.

Land Use Categories for Mobility Hubs and Gondola Base Stations. Using FTA's methodology, all receptors within FTA's recommended screening radius of 225 feet for transit centers (which would apply to the mobility hubs and gondola base stations) were categorized as one of the three land use categories listed in Table 11.2-2.

Table 11.2-2. Land Use Categories for Mobility Hub and Gondola Base Station Noise Impacts

Land Use Category	Land Use Type	Description of Land Use Category
1	High sensitivity	A land where quiet is an essential element of its intended purpose. Sample land uses include preserved land for serenity and quiet, outdoor amphitheaters and concert pavilions, and national historic landmarks with considerable outdoor use. Recording studios and concert halls are also included in this category.
2	Residential	This category is applicable to all residential land use and buildings where people normally sleep, such as hotels and hospitals.
3	Institutional	This category is applicable to institutional land uses with primarily daytime and evening use. Sample land uses include schools, libraries, theaters, and churches, where it is important to avoid interference with such activities as speech, meditation, and concentration on reading material. Places for meditation or study associated with cemeteries, monuments, museums, campgrounds, and recreational facilities are also included in this category.

Source: FTA 2018, Table 4-3

The impact thresholds are defined in FTA's *Transit Noise and Vibration Assessment Manual* based on the land use category and existing noise L_{dn}. Section 11.4.1.2, Methodology for Assessing Noise Impacts from Mobility Hubs and Gondola Base Stations, describes how impacts are assessed for receptors near mobility hubs or gondola base stations.

11.3 Affected Environment

The noise impact analysis area that was used to determine the existing noise levels is described in Section 11.1, Introduction, and shown above in Figure 11.1-1, Noise Impact Analysis Area. This noise impact analysis area contains a mix of residential developments, parks, campgrounds, commercial properties, and undeveloped land. The properties in the impact analysis area fall within activity categories B, C, D, E, F, and G under UDOT's NAC. The predominant source of noise in the impact analysis area is automobile, bus, and truck traffic on S.R. 210, S.R. 209, and other local roads that cross S.R. 210 and S.R. 209.

11.3.1 Noise Monitoring

11.3.1.1 Traffic Noise Monitoring and Noise Model Validation

11.3.1.1.1 Traffic Noise Monitoring

Existing noise levels in the noise impact analysis area for existing conditions were determined by taking short-term (15-minute) sound-level measurements at 11 locations throughout the impact analysis area with a Larson Davis model 824 sound-level meter. Noise monitoring for seven short-term monitoring locations (ML-1, ML-2, and ML-4 to ML-8) was conducted in May 2018. Noise monitoring for one short-term monitoring location (ML-3) was conducted in June 2019. Noise monitoring for additional short-term measurements (at ML-9 to ML-11) was conducted in June 2020.

Noise-measurement locations were selected to represent existing residential developments or other areas of frequent human outdoor use where people could be exposed to traffic noise for extended periods. Traffic was counted during the short-term monitoring events so that vehicle counts and vehicle classifications could be determined. Weather conditions and other parameters that could affect measured noise levels were noted. Noise measurements were conducted under the following conditions:

- Wind speeds less than 12 miles per hour
- Dry weather conditions
- Dry road conditions

Short-term noise-monitoring locations (ML) are shown in Figure 11.3-1 and listed in Table 11.3-1. The noise descriptor used in the noise monitoring is the hourly L_{eq}.

Figure 11.3-1. Noise Impact Analysis Area and Noise-monitoring Locations

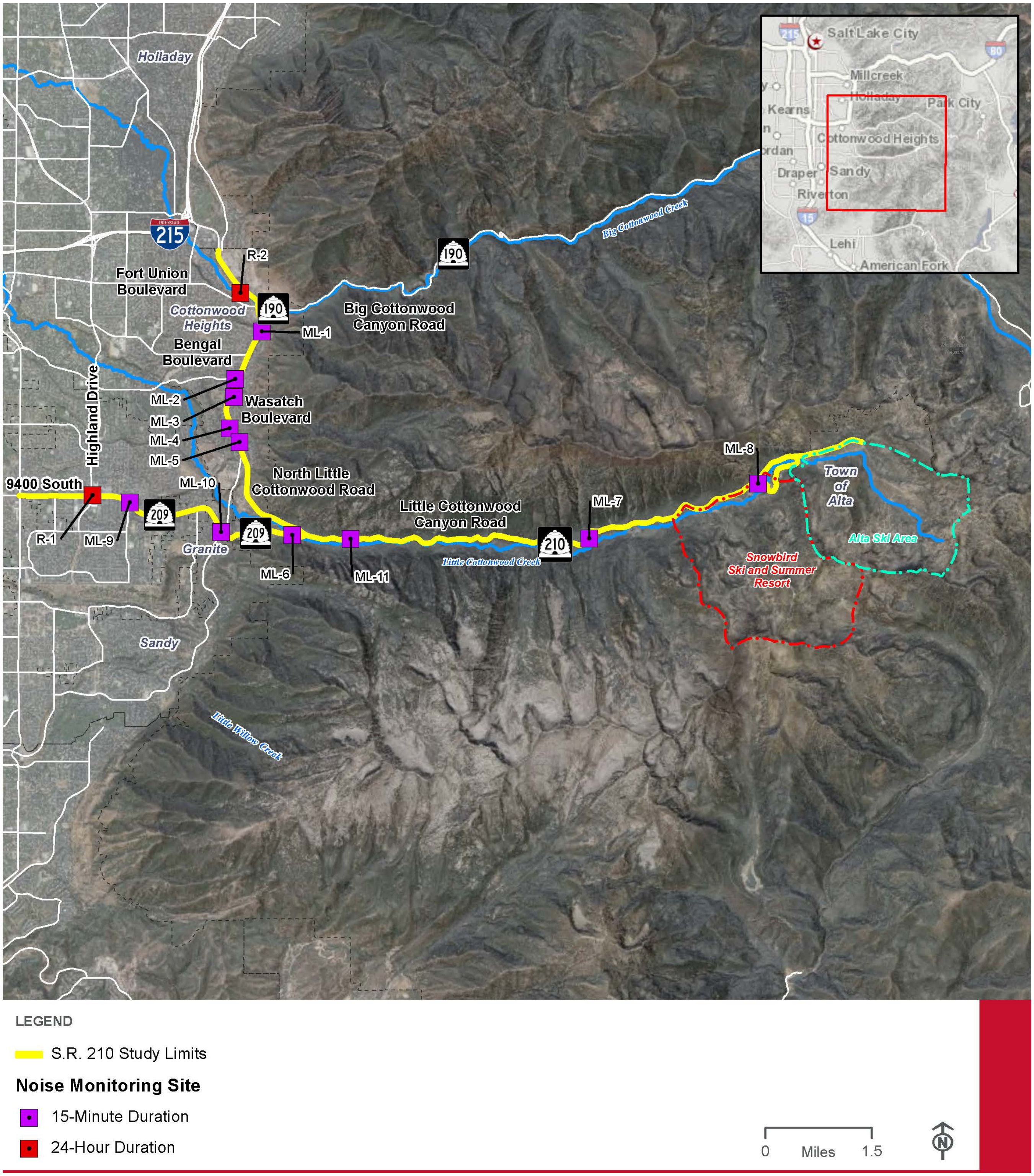


Table 11.3-1. Measured Short-term Noise Levels in the Noise Impact Analysis Area

Monitoring Location	Address	Activity Category and Noise Level (dBA L_{eq})	Land Use	Measured Noise Level (dBA L_{eq}, rounded)	Measurement Conducted
ML-1	7500 South 3835 East	B (66)	Residential	55	May 2018
ML-2	8200 South 3500 East (pathway north of the park-and-ride lot)	B (66)	Residential	56	May 2018
ML-3	Golden Hills Park, 8303 Wasatch Blvd.	B (66)	Park	54	July 2019
ML-4	8620 South, Russell Park Rd.	B (66)	Residential	54	May 2018
ML-5	Intersection of Wasatch Blvd. and Golden Hills Ave.	B (66)	Residential	57	May 2018
ML-6	9765 South, S.R. 209	B (66)	Residential	51	May 2018
ML-7	Tanners Flat Campground entrance, 7490 Little Cottonwood Canyon Rd.	C (66)	Campground	59	May 2018
ML-8	Cliff Lodge, 9320 Cliff Lodge Dr., Snowbird	E (71)	Exterior patio and pool area near hotel	54	May 2018
ML-9	Corner of S.R. 209 and Eastdell Dr.	B (66)	Residential	67	June 2020
ML-10	Corner of S.R. 209 and Wasatch Blvd.	B (66)	Residential	70	June 2020
ML-11	Little Cottonwood Trail	C (66)	Trail	56	June 2020

The measured noise levels and traffic information collected in the field were used to validate FHWA's Traffic Noise Model (TNM) version 2.5. These measured noise levels were also used to establish baseline conditions. The traffic volumes were also counted at each of the monitoring locations shown above in Table 11.3-1 and were used to determine vehicle mix (that is, the percentage of cars, medium trucks, and heavy trucks) during each measurement period as well as the directional flow of traffic on the roads.

By following this process of measuring noise and counting traffic volumes and vehicle mixes at each monitoring location, UDOT does not need to monitor noise at every receptor and can develop a noise model that can predict the noise levels at all receptors in the impact analysis area for existing and future conditions. This process of validating the noise model ensures that the measured noise levels recorded in the field agree with the traffic volumes recorded during the measurement period.

Measured noise levels in the impact analysis area were typical of suburban and rural environments and ranged from about 51 to 70 dBA, depending on the proximity of the monitoring location to the roadway and other noise sources such as local traffic on the nearby arterial streets. As a comparison, typical noise levels generally range from 35 to 50 dBA in rural and agricultural areas, from 50 to 65 dBA in suburban to urban areas, and from 65 to 75 dBA in downtown urban areas (Harris 1979).

11.3.1.1.2 Noise Model Validation

Measured noise levels that are within 3 dBA of the modeled noise are considered accurate for the purpose of validating the noise model. As shown in Table 11.3-2, the modeled noise levels were within 3 dBA of the measured noise levels, so the TNM is considered valid for use on this project.

Table 11.3-2. Model Validation

Monitoring Location	Address	Measured Noise Level (dBA L_{eq})	Modeled Noise Level (dBA L_{eq})	Difference (dBA L_{eq})
ML-1	7500 South 3835 East	54.6	57.1	+2.5
ML-2	8200 South 3500 East (pathway north of the park-and-ride lot)	55.7	57.3	+1.6
ML-3	Golden Hills Park, 8303 Wasatch Blvd.	54.4	54.3	–0.1
ML-4	8620 South, Russell Park Rd.	53.8	56.2	+2.4
ML-5	Intersection of Wasatch Blvd. and Golden Hills Ave.	57.2	59.8	+2.6
ML-6	9765 South, S.R. 209	51.2	53.2	+2.0
ML-7	Tanners Flat Campground entrance, 7490 Little Cottonwood Canyon Rd.	59.4	57.9	–1.5
ML-8	Cliff Lodge, 9320 Cliff Lodge Dr., Snowbird	54.2	53.3	–0.9
ML-9	Corner of S.R. 209 and Eastdell Dr.	66.5	65.0	–1.5
ML-10	Corner of S.R. 209 and Wasatch Blvd.	69.5	66.9	–2.6
ML-11	Little Cottonwood Trail	55.7	54.7	–1.0

11.3.1.2 Mobility Hub Noise Monitoring

Two 24-hour monitoring locations (designated as R-1 and R-2; see Table 11.3-3 for locations) were selected near each of the proposed mobility hubs. The 24-hour noise monitoring was conducted when the traffic levels reflected typical daily volumes in the area. Noise monitoring for long-term measurements at R-1 and R-2 was conducted in June 2020. The long-term (24-hour) noise-monitoring locations are shown above in Figure 11.3-1, Noise Impact Analysis Area and Noise-monitoring Locations, and the results of the 24-hour monitoring near the proposed mobility hubs are summarized in Table 11.3-3.

Table 11.3-3. Measured Long-Term Noise Levels in the Study Area

Monitoring Location	Address	Activity Category	Land Use	Measured Noise Level (dBA L_{eq}, rounded)	Measurement Conducted
R-1	9386 S. Tortellini Dr. (corner of Highland Dr. and S.R. 209)	B	Residential	41 to 59 (L_{dn} = 57)	June 2020
R-2	Big Cottonwood Trail behind 5015 E. Big Cottonwood Canyon Rd.	B	Residential	58 to 59 (L_{dn} = 64)	June 2020

11.3.2 Existing Noise Levels in the Noise Impact Analysis Area

The primary source of existing noise in the noise impact analysis area is automobile, bus, and truck traffic on S.R. 210, S.R. 209, and other local roads that cross S.R. 210 and S.R. 209.

11.3.2.1 Methodology for the Existing Traffic Noise Model

UDOT evaluated existing noise levels using noise models and methodologies approved by FHWA and UDOT (UDOT Policy 08A2-01, *Noise Abatement*, revised May 28, 2020). Areas within 500 feet from the edge of the proposed right of way of S.R. 210 and S.R. 209 were reviewed to identify UDOT land use activity categories (primarily residential, schools, and recreation sites) and to select representative receptors for the existing conditions and proposed project noise analyses. The 500-foot buffer is a large enough area to encompass all locations potentially affected by roadway widening or by introducing the enhanced bus service. More details about the methodology and data used for the noise model for the existing conditions analysis are provided in Appendix 11A, Noise Technical Report.

11.3.2.2 Methodology for the Existing Noise Conditions near the Proposed Mobility Hubs, Gondola Base Stations, and Cog Rail Base Station

The action alternatives include a combination of new mobility hubs and/or gondola or cog rail stations. The mobility hubs would function as a bus terminal and park-and-ride lot during the winter peak season. Consistent with FTA's screening criteria, land use within 225 feet of a mobility hub or gondola station could be affected by activities at the mobility hub or gondola station, including bus and vehicle traffic movements and buses idling while passengers are boarding and exiting. For the north mobility hub, the moderate and severe impact distance calculations also included the bus storage and maintenance activities in addition to the bus and vehicle traffic volumes proposed for the north mobility hub. Therefore, all receptors within the 225-foot screening radius of each mobility hub and gondola station were identified, and the existing conditions were analyzed using FTA's methodology.

Because the cog rail base station would be in the same location as the base station for Gondola Alternative B, the modeled traffic noise for the existing conditions for Gondola Alternative B also represent the existing conditions for the Cog Rail Alternative.

11.3.2.3 Summary of Existing Noise Model Results

The noise model developed for the existing conditions scenario included 2,401 receptors, including 1,745 residential receptors (land use activity category B), 56 receptors in land use activity category C, 1 receptor in land use activity category D, 18 receptors in land use activity category E, 54 receptors in land use activity category F, and 527 receptors in land use activity category G. Under the existing conditions, 173 receptors exceeded the NAC. The noise levels for the existing conditions and locations of the receptors are shown in Appendix 11A, Noise Technical Report.

Overall, noise levels with the existing conditions would range from 38 to 73 dBA, with an average of 54 dBA.

11.4 Environmental Consequences and Mitigation Measures

11.4.1 Methodology

11.4.1.1 Methodology for Assessing Noise Impacts from Traffic

According to UDOT's noise-abatement policy, a traffic noise impact occurs when either of the following conditions occurs at a sensitive land use (that is, at land uses defined in activity categories A, B, C, D, or E):

- The future-year worst-case noise level is equal to or greater than the UDOT NAC in Table 11.2-1 above, UDOT's Noise-abatement Criteria, for each corresponding land-use category, or
- The future-year worst-case noise level is equal to or greater than an increase of 10 dBA over the existing noise level (a substantial increase). This second impact criterion applies regardless of existing noise levels.

Traffic-related noise impacts with the action alternatives were estimated with TNM version 2.5 based on the roadway, mobility hub, gondola, and cog rail design for each of the action alternatives. The segments of S.R. 210 and S.R. 209 shown above in Figure 11.1-1, Noise Impact Analysis Area, and representative receptors were included in the modeling study.

The TNM estimates acoustic intensity at receptor locations based on the level of sound energy generated from a series of straight-line road segments. Where appropriate, the effects of local shielding from existing structures (for example, existing barriers and rows of homes), dense vegetation, terrain, and other adjustment factors were included in the model to provide higher levels of detail and accuracy. The noise impact analysis for the action alternatives used the same receptors that were used for the existing conditions analysis; these receptors are located within 500 feet from the edge of the proposed right of way of S.R. 210 and S.R. 209 (see Section 11.3.1.1, Traffic Noise Monitoring and Noise Model Validation). The 500-foot buffer is a large enough area to encompass all locations potentially affected by roadway widening or by introducing the enhanced bus service.

The noise models for the action alternatives used traffic volumes at a level of service (LOS) of LOS C to represent the worst-case noise conditions while traffic is operating at uncongested, free-flow speeds for the proposed project noise analyses. The TNM inputs also include traffic volume and speed for the following vehicle classifications: automobiles, medium trucks, heavy trucks, and buses. The volumes, speeds, and percentages for each of these vehicle classifications were taken from the traffic analysis for the project (Fehr & Peers 2020). More details are provided in Appendix 11A, Noise Technical Report.

What is level of service?

Level of service (LOS) is a measure of the operating conditions on a road or at an intersection. Level of service is represented by a letter "grade" ranging from A (free-flowing traffic and little delay) to F (extremely congested traffic and excessive delay).

11.4.1.2 Methodology for Assessing Noise Impacts from Mobility Hubs and Gondola Base Stations

The mobility hubs and gondola and cog rail base stations would closely resemble bus terminal or park-and-ride lots as described in the FTA manual. Therefore, the noise levels at each mobility hub and gondola base station were modeled using FTA's general noise assessment spreadsheet to evaluate project-related noise expressed as an hourly equivalent level (L_{eq}), which was then compared with UDOT's NAC later in the analysis. Figure 11.1-1 above, Noise Impact Analysis Area, shows the locations of the FTA analysis study area. Inputs to FTA's general noise assessment included the number of automobiles and buses anticipated to be entering and exiting each mobility hub throughout the day.

The general noise assessments used the L_{dn} measured nearest to each of the proposed mobility hub sites. The number of automobiles and buses was separated into daytime (7 AM to 10 PM) and nighttime (10 PM to 7 AM) categories. UDOT conservatively assumed that 25% of the parking capacity of each mobility hub would be used during the average hour and that the parking structure would have the highest usage of capacity around noon. For modeling purposes, the 9 AM hour was assumed to have the peak-hour automobile and bus volumes coming to and going from the parking structure. This peak-hour information was input into the general noise assessment spreadsheet model to determine the farthest distance at which moderate and severe noise impacts are projected to occur.

If a receptor is located within the 225-foot screening radius of a gondola station (base station or destination station), the noise generated by the gondola drive units, motor, primary reducer, and motor cooling fan were calculated based on the noise study conducted for the Far East Express gondola at Squaw Valley in Nevada (USDA Forest Service and Placer County 2015). The measured noise level for the Far East Express was 69.6 dBA at 54 feet.

The noise levels for the gondola destination stations at the Snowbird and Alta resorts were conservatively modeled using the same 225-foot screening radius assumptions for the gondola drive units, motor, primary reducer, and motor cooling fan, even though drive motors are currently proposed only at the base stations for either gondola alternative. The gondola destination stations are not proposed to have bus terminals or park-and-ride lots, so no noise from bus terminals or park-and-ride lots was included with the noise modeling for the gondola destination stations.

11.4.1.3 Methodology for Assessing Noise Impacts from the Cog Rail

Cog rail noise consists of wayside noise, locomotive noise, additional noise when the cog is in use, crossing signals, noise at crossovers, noise at embedded tracks, noise at the structure over North Little Cottonwood Road, idling diesel multiple unit (DMU) noise at cog rail stations, and noise at the operations and maintenance facility. UDOT evaluated cog rail noise using FTA's General Noise Assessment equations.

The cog rail vehicle was modeled using FTA's reference sound exposure level (SEL) for a DMU vehicle and railcars (for the diesel unit and each individual passenger car, respectively). To simulate additional noise from cog use in areas where it is projected to be used (based on the slope of the rail line), UDOT added 3 dBA to the FTA rail transit vehicle calculation results; the results were expressed as an hourly L_{eq} at 50 feet. UDOT applied noise-level adjustments for crossovers, embedded track, and the aerial structure using FTA guidelines. Idling DMU noise at cog rail stations, stationary crossing signals, the parking structure, and the operations and maintenance facility were modeled using SEL values recommended by FTA.

The crossing signal SEL as a stationary source SEL is 109 dBA at 50 feet per Table 4-13 in the FTA manual. UDOT applied adjustments based on train volumes per Table 4-14 in the FTA manual. The noise emissions from stationary idling DMUs at the cog rail base station and the Snowbird and Alta destination stations were calculated using FTA Equation 4-38 and a rail transit idling SEL of 106 dBA per Table 4-24 in the FTA manual.

UDOT calculated noise emissions for the operations and maintenance facility using Equation 4-38 and a yards and shops SEL of 118 dBA per Table 4-24 in the FTA manual. The SEL given in the FTA manual assumes 20 train movements. Therefore, UDOT corrected this SEL to 111 dBA to account for only four train movements per direction.

UDOT calculated noise emissions for the cog rail base station parking structure using Equation 4-14 and an SEL of 101 dBA per Table 4-13 in the FTA manual for a park-and-ride lot. The given SEL assumes 12 buses and 1,000 cars in the peak activity hour. Using the FTA equations and SEL values as noted, UDOT calculated park-and-ride lot noise levels for the cog rail base station based on assumed peak-hour traffic volumes of 12 buses and 1,125 automobiles (75% of the total parking structure capacity of 1,500).

UDOT performed a noise screening assessment using FTA guidance, which required adjusting the default noise-screening distances because the operational assumptions they are based on were not representative of this project. Using FTA guidance, UDOT calculated the distance to the 50-dBA L_{eq} contours for each noise source to use as modified screening distances to more accurately represent project-specific noise characteristics. For sources where noise-sensitive receptors are located within the calculated 50-dBA L_{eq} screening distance, UDOT used FTA methodology to perform a general noise assessment.

11.4.1.4 Combined Noise Impact Analysis for Receptors near Mobility Hubs, Gondola Base Stations, and the Cog Rail Alternative

All receptors inside the mobility hubs' and gondola base stations' 225-foot screening radius are located within the 500-foot radius from the S.R. 210 and S.R. 209 intersection in the noise impact analysis area. As a result, modeled noise levels from (1) roads and (2) mobility hubs or gondola base stations were combined at all receptors within the 225-foot screening radius of the mobility hubs or gondola base stations. For the Cog Rail Alternative, noise levels from roads and total cog rail noise levels were combined at receptors. These results were compared with UDOT's NAC.

Although the mobility hubs would be used seasonally, for the purpose of determining impacts and mitigation, UDOT used LOS C traffic and the posted speed in combination with the noise from the mobility hubs to simulate the worst-case noise condition generated by the traffic.

UDOT calculated the combined, or overall project-related, noise level of the vehicle traffic and the alternative-specific noise sources (stationary-source noise of the mobility hub or gondola base station, or combined fixed-guideway and stationary sources of the cog rail) using the following methodology:

1. The stationary source (mobility hub, gondola base station, parking structure, or cog rail idling DMU and crossing signal) noise level at 50 feet was calculated using Equations 4-14 and 4-38 in the FTA manual. The reference SEL of a park-and-ride lot is 101 dBA per Table 4-13 in the FTA manual; this applies to the gondola and cog rail alternatives.
2. After obtaining the stationary source noise level(s) at 50 feet, UDOT determined the distances between the proposed mobility hub, gondola base station, or idling DMU, and receptors modeled in TNM. UDOT then used this distance to calculate the stationary-source noise level (L_{eq}) at the receptor using Equation 4-18 in the FTA manual.
3. The stationary-source noise levels were logarithmically added to the traffic noise levels calculated by TNM and also to the fixed-guideway noise levels for the Cog Rail Alternative to calculate the combined noise levels at receptors near the mobility hubs, gondola base stations, or cog rail alignment.
4. The combined noise results were compared to UDOT's NAC for the respective land use category.

11.4.2 No-Action Alternative

This section describes the noise impacts of the No-Action Alternative in the Wasatch Boulevard segment of S.R. 210, in the segment of S.R. 210 from North Little Cottonwood Road to the town of Alta, at the gravel pit, and at the park-and-ride lot at 9400 South and Highland Drive.

With the No-Action Alternative, the S.R. 210 Project would not be implemented, so there would be no new project-related noise impacts. Noise levels with the No-Action Alternative would be the same as those modeled for the existing conditions.

The noise model developed for the No-Action Alternative used the existing conditions scenario that included 2,401 receptors, including 1,745 residential receptors (land use activity category B), 56 receptors in land use activity category C, 1 receptor in land use activity category D, 18 receptors in land use activity category E, 54 receptors in land use activity category F, and 527 receptors in land use activity category G. Under the No-Action Alternative, 173 receptors exceeded the NAC, and modeled noise levels ranged from 38 to 73 dBA, with an average of 54 dBA. The noise levels for the No-Action Alternative/existing conditions and locations of the receptors are provided in Appendix 11A, Noise Technical Report.

11.4.2.1 S.R. 210 – Wasatch Boulevard

With the No-Action Alternative, Wasatch Boulevard would not be widened. Noise levels with the No-Action Alternative would be the same as those modeled for the existing conditions. With the No-Action Alternative, 99 of the 856 modeled receptors along Wasatch Boulevard have noise levels that exceed UDOT's NAC. Noise levels with the No-Action Alternative in this segment were modeled to range from 38 to 73 dBA, with an average of 56 dBA.

11.4.2.2 S.R. 210 – North Little Cottonwood Road to Alta

With the No-Action Alternative, S.R. 210 would not be improved from North Little Cottonwood Road to the town of Alta. Noise levels with the No-Action Alternative would be the same as those modeled for the existing conditions.

No-Action Alternative Noise Conditions between Wasatch Boulevard and S.R. 209. With the No-Action Alternative, 9 of the 263 modeled receptors along S.R. 210 between Wasatch Boulevard and S.R. 209 would have noise levels that exceed UDOT’s NAC. Noise levels with the No-Action Alternative in this segment were modeled to range from 42 to 67 dBA, with an average of 55 dBA.

No-Action Alternative Noise Conditions between S.R. 209 and Alta. With the No-Action Alternative, none of the 728 modeled receptors along S.R. 210 between S.R. 209 and Alta would have noise levels that exceed UDOT’s NAC. Noise levels with the No-Action Alternative in this segment were modeled to range from 38 to 63 dBA, with an average of 52 dBA.

11.4.2.3 Mobility Hubs

With the No-Action Alternative, the mobility hubs would not be constructed, and there would be no additional bus traffic on S.R. 209. Noise levels with the No-Action Alternative would be the same as those modeled for the existing conditions. With the No-Action Alternative, no receptors would have noise levels that exceed UDOT’s NAC near either of the proposed mobility hub locations. With the No-Action Alternative, 65 of the 554 modeled receptors along S.R. 209 would have noise levels that exceed UDOT’s NAC. Noise levels with the No-Action Alternative in these areas were modeled to range from 39 to 70 dBA, with an average of 54 dBA.

What is a mobility hub?

A mobility hub is a location where users can transfer from their personal vehicle to a bus.

11.4.2.4 Avalanche Mitigation

With the No-Action Alternative, no snow sheds or berms would be constructed, and S.R. 210 would not be realigned. There would be no changes to the existing noise levels in these areas with the No-Action Alternative.

11.4.2.5 Trailhead Parking

With the No-Action Alternative, no trailhead parking improvements would be made. There would be no changes to the existing noise levels in these areas with the No-Action Alternative.

11.4.2.6 No Winter Parking

With the No-Action Alternative, no existing roadside parking spots would be removed near the ski resorts during the winter. There would be no changes to the existing noise levels in these areas with the No-Action Alternative.

11.4.3 Enhanced Bus Service Alternative

This section describes the noise impacts of the Enhanced Bus Service Alternative, which includes improvements to the Wasatch Boulevard segment of S.R. 210, two mobility hubs, avalanche mitigation alternatives, trailhead parking alternatives, and the No Winter Parking Alternative.

11.4.3.1 S.R. 210 – Wasatch Boulevard

This section describes the noise impacts of the Imbalanced-lane Alternative and the Five-lane Alternative, which would both widen the Wasatch Boulevard segment of S.R. 210.

11.4.3.1.1 Imbalanced-lane Alternative

Under the Imbalanced-lane Alternative with the Enhanced Bus Service Alternative, 135 residential receptors out of the 856 modeled receptors would have noise impacts.

Comparison of Impacts with the No-Action Alternative. This would be an increase of 36 impacts to residential receptors compared to the No-Action Alternative, which has 99 residential receptors that exceed UDOT's NAC. Noise levels with the Imbalanced-lane Alternative in this area were modeled to range from 40 to 72 dBA, with an average of 58 dBA. The change in noise levels at receptors with the Imbalanced-lane Alternative in this area would range from –12 dBA to +10 dBA, with an average increase of 1.6 dBA compared to the No-Action Alternative. One receptor would substantially exceed (≥ 10-dBA increase over) the No-Action Alternative noise levels. With the Imbalanced-lane Alternative, the maximum increase for any receptor would be an increase of 10 dBA compared to the No-Action Alternative. A total of 349 receptors would have a noticeable increase of 3 to 9 dBA compared to the No-Action Alternative. The maximum decrease for any receptor would be a decrease of 12 dBA compared to the No-Action Alternative. A total of 37 receptors would have a noticeable decrease of 3 to 12 dBA compared to the No-Action Alternative. Modeling results and figures showing the location of each receptor are included in Appendix 11A, Noise Technical Report.

11.4.3.1.2 Five-lane Alternative

Under the Five-lane Alternative with the Enhanced Bus Service Alternative, 151 residential receptors and 1 park receptor out of the 856 modeled receptors would have noise impacts.

Comparison of Impacts with the No-Action Alternative. This would be an increase of 52 impacts to residential receptors and 1 new impact to a park receptor compared to the No-Action Alternative, which has 99 residential receptors that exceed UDOT's NAC. Noise levels with the Five-lane Alternative in this area were modeled to range from 41 to 74 dBA, with an average of 58 dBA. The change in noise levels at receptors with the Five-lane Alternative in this area would range from –12 dBA to +9 dBA, with an average increase of 2.6 dBA compared to the No-Action Alternative. No receptors would substantially exceed (≥ 10-dBA increase over) the No-Action Alternative noise levels. With the Five-lane Alternative, the maximum increase for any receptor would be an increase of 9 dBA compared to the No-Action Alternative. A total of 492 receptors would have a noticeable increase of 3 to 9 dBA compared to the No-Action Alternative. The maximum decrease for any receptor would be a decrease of 12 dBA compared to the No-Action Alternative. A total of 28 receptors would have a noticeable decrease of 3 to 12 dBA compared to the No-Action Alternative. Modeling results and figures showing the location of each receptor are included in Appendix 11A, Noise Technical Report.

Comparison of Impacts with the Imbalanced-lane Alternative. The Five-lane Alternative would cause an average increase of about 0.9 dBA compared to the Imbalanced-lane Alternative for receptors along Wasatch Boulevard. Compared to the Imbalanced-lane Alternative, the Five-lane Alternative would have 16 more impacts to residential receptors and 1 new impact to a park receptor. With the Five-lane Alternative, the maximum increase for any receptor would be an increase of 5 dBA compared to the Imbalanced-lane Alternative. A total of 33 receptors would have a noticeable increase of 3 to 5 dBA with the Five-lane Alternative compared to the Imbalanced-lane Alternative. The maximum decrease for any receptor would be a decrease of 3 dBA with the Five-lane Alternative compared to the Imbalanced-lane Alternative. Two receptors would have a noticeable decrease of 3 dBA with the Five-lane Alternative compared to the Imbalanced-lane Alternative. Modeling results and figures showing the location of each receptor are included in Appendix 11A, Noise Technical Report.

11.4.3.2 S.R. 210 – North Little Cottonwood Road to Alta

With the Enhanced Bus Service Alternative, there would be no change to the existing S.R. 210 roadway from North Little Cottonwood Road to the town of Alta. There would be additional bus volumes on S.R. 210 in this segment. The noise impacts described below in this section would be applicable only during winter conditions when the enhanced bus service is in operation. The summer noise levels would be the same as the No-Action Alternative noise levels.

Impacts between Wasatch Boulevard and S.R. 209. With the Enhanced Bus Service Alternative, 11 residential receptors of the 263 receptors between Wasatch Boulevard and S.R. 209 would have noise impacts. This would be an increase of 2 impacts to residential receptors compared to the No-Action Alternative, which has 9 residential receptors that exceed UDOT’s NAC in this area. Noise levels with the Enhanced Bus Service Alternative in this area were modeled to range from 42 to 67 dBA, with an average of 55 dBA. The change in noise levels at receptors with the Enhanced Bus Service Alternative in this area would range from 0 dBA to +1 dBA, with an average increase of 0.2 dBA compared to the No-Action Alternative. No receptors would substantially exceed (≥ 10-dBA increase over) the No-Action Alternative noise levels. With the Enhanced Bus Service Alternative, the maximum increase for any receptor would be an increase of 1 dBA compared to the No-Action Alternative. No receptors would have a noticeable increase of 3 dBA or greater compared to the No-Action Alternative. The maximum decrease for any receptor would be a decrease of 0 dBA compared to the No-Action Alternative. No receptors would have a noticeable decrease of 3 dBA or greater compared to the No-Action Alternative. Modeling results and figures showing the location of each receptor are included in Appendix 11A, Noise Technical Report.

Impacts between S.R. 209 and Alta. With the Enhanced Bus Service Alternative, none of the 728 modeled receptors between S.R. 209 and Alta would have noise levels that exceed UDOT’s NAC. There would be no change in impacts compared to the No-Action Alternative, which also has no receptors that exceed UDOT’s NAC in this area. Noise levels with the Enhanced Bus Service Alternative in this area were modeled to range from 38 to 63 dBA, with an average of 53 dBA. The change in noise levels at receptors with the Enhanced Bus Service Alternative in this area would range from –1 dBA to +2 dBA, with an average increase of 0.4 dBA compared to the No-Action Alternative. No receptors would substantially exceed (≥ 10-dBA increase over) the No-Action Alternative noise levels. With the Enhanced Bus Service Alternative, the maximum increase for any receptor would be an increase of 2 dBA compared to the No-Action Alternative. No receptors would have a noticeable increase of 3 dBA or greater compared to the No-Action Alternative. The maximum decrease for any receptor would be a decrease of –1 dBA compared to the

No-Action Alternative. No receptors would have a noticeable decrease of 3 dBA or greater compared to the No-Action Alternative. Modeling results and figures showing the location of each receptor are included in Appendix 11A, Noise Technical Report.

11.4.3.3 Mobility Hubs Alternative

The Enhanced Bus Service Alternative includes two mobility hubs: a mobility hub at the gravel pit and a mobility hub at the park-and-ride lot at 9400 South and Highland Drive.

There would be no noise impacts from either of the proposed mobility hubs.

11.4.3.3.1 Gravel Pit

No receptors are within the 225-foot screening radius around the proposed mobility hub at the gravel pit. Therefore, no additional combined noise impact assessment is necessary for this mobility hub.

What is the gravel pit?

The gravel pit is an existing aggregate (gravel) mine located on the east side of Wasatch Boulevard between 6200 South and Fort Union Boulevard.

11.4.3.3.2 9400 South and Highland Drive

Five noise-sensitive (residential) receptors are located within the 225-foot screening radius around the proposed mobility hub at 9400 South and Highland Drive. At this location, five receptors were evaluated for combined noise impacts. The predicted combined noise levels are below the 66-dBA residential NAC per UDOT's noise-abatement policy (for more information about this analysis, see Section 6.3.1, Mobility Hub Noise Impacts, in Appendix 11A, Noise Technical Report). Thus, no noise impacts from the combined noise of the proposed mobility hub and traffic noise are predicted, and no mitigation is required per UDOT's noise-abatement policy.

Impacts on S.R. 209. With the additional bus volume on S.R. 209 with the Enhanced Bus Service Alternative, 66 residential receptors and 1 church receptor (activity category D) would have noise impacts. This would be an increase of 1 residential receptor and 1 activity category D receptor compared to the No-Action Alternative, which has 65 residential receptors that exceed UDOT's NAC. Noise levels with the Enhanced Bus Service Alternative in this area were modeled to range from 38 to 70 dBA, with an average of 54 dBA. The change in noise levels at receptors with the Enhanced Bus Service Alternative in this area would range from –2 dBA to +5 dBA, with an average increase of 0.1 dBA compared to the existing conditions. No receptors would substantially exceed (≥ 10-dBA increase over) the No-Action Alternative noise levels. With the Enhanced Bus Service Alternative, the maximum increase for any receptor would be an increase of 5 dBA compared to the No-Action Alternative. Three receptors would have a noticeable increase of 3 to 5 dBA compared to the No-Action Alternative. The maximum decrease for any receptor would be a decrease of 2 dBA compared to the No-Action Alternative. No receptors would have a noticeable decrease of 3 dBA or greater compared to the No-Action Alternative. Modeling results and figures showing the location of each receptor are included in Appendix 11A, Noise Technical Report.

11.4.3.4 Avalanche Mitigation Alternatives

The Enhanced Bus Service Alternative includes two alternatives for avalanche mitigation: the Snow Sheds with Berms Alternative and the Show Sheds with Realigned Road Alternative.

11.4.3.4.1 Snow Sheds with Berms Alternative

Traffic noise could increase in a snow shed because the noise would bounce off the walls and ceiling. This could increase noise levels at Tanners Flat Campground and the Lisa Falls and White Pine Trailheads. To model the noise levels from the snow sheds, UDOT assumed a 3.5-times increase in traffic levels to account for noise reflections off the two walls, reflection off the ceiling, and another 50% reflection off the downhill supports. Using this methodology, noise levels would increase by about 5 dBA from existing conditions (from about 51 to 56 dBA).

11.4.3.4.2 Snow Sheds with Realigned Road Alternative

The change in noise levels from the Snow Sheds with Realigned Road Alternative would be the same as from the Snow Sheds with Berms Alternative.

11.4.3.5 Trailhead Parking Alternatives

The Enhanced Bus Service Alternative includes three alternatives to address trailhead parking:

- Trailhead Improvements and No S.R. 210 Roadside Parking within ¼ Mile of Trailheads Alternative
- Trailhead Improvements and No Roadside Parking from S.R. 209/S.R. 210 Intersection to Snowbird Entry 1 Alternative
- No Trailhead Improvements and No Roadside Parking from S.R. 209/S.R. 210 Intersection to Snowbird Entry 1 Alternative

11.4.3.5.1 Trailhead Improvements and No S.R. 210 Roadside Parking within ¼ Mile of Trailheads Alternative

This alternative would not affect noise levels. Trailheads and parking lots are not an input in the noise model and would not affect the modeled noise levels.

11.4.3.5.2 Trailhead Improvements and No Roadside Parking from S.R. 209/S.R. 210 Intersection to Snowbird Entry 1 Alternative

This alternative would not affect noise levels. Trailheads and parking lots are not an input in the noise model and would not affect the modeled noise levels.

11.4.3.5.3 No Trailhead Improvements and No Roadside Parking from S.R. 209/S.R. 210 Intersection to Snowbird Entry 1 Alternative

This alternative would not affect noise levels. Trailheads and parking lots are not an input in the noise model and would not affect the modeled noise levels.

11.4.3.6 No Winter Parking Alternative

Eliminating 230 roadside parking spots during the winter near the ski resorts would not affect noise levels. Parking areas are not an input in the noise model and would not affect the modeled noise levels.

11.4.4 Enhanced Bus Service in Peak-period Shoulder Lane Alternative

This section describes the noise impacts of the Enhanced Bus Service in Peak-period Shoulder Lane Alternative, which includes improvements to the Wasatch Boulevard segment of S.R. 210, improvements to the segment of S.R. 210 from North Little Cottonwood Road to the town of Alta, two mobility hubs, avalanche mitigation alternatives, trailhead parking alternatives, and the No Winter Parking Alternative.

11.4.4.1 S.R. 210 – Wasatch Boulevard

The noise impacts from improvements to Wasatch Boulevard with the Enhanced Bus Service in Peak-period Shoulder Lane Alternative would be the same as with the Enhanced Bus Service Alternative.

11.4.4.2 S.R. 210 – North Little Cottonwood Road to Alta

The Enhanced Bus Service in Peak-period Shoulder Lane Alternative would add a peak-period shoulder lane in each direction. The peak-period shoulder lanes and additional bus volumes were modeled in the noise model for S.R. 210 from North Little Cottonwood Road to the town of Alta.

The noise modeling for the Enhanced Bus Service in Peak-period Shoulder Lane Alternative assumed LOS C traffic volumes of 350 vehicles per hour per lane for the peak-period shoulder lanes. This assumption is what is required with UDOT's noise-abatement policy. However, using the LOS C traffic volumes of 350 vehicles per hour per lane results in much louder predicted noise conditions for the Enhanced Bus Service in Peak-period Shoulder Lane Alternative since the peak-period shoulder lanes are anticipated to have a total bus volume of only 24 buses per hour per lane. Actual noise conditions with the Enhanced Bus Service in Peak-period Shoulder Lane Alternative would likely be less than what is described in this section if only the 24 buses per hour per lane are using the shoulder lanes.

Additionally, the noise impacts described below in this section would be applicable only during winter conditions when the enhanced bus service is in operation. The summer noise levels would be the same as the No-Action Alternative noise levels.

Comparison of Impacts with the No-Action Alternative between Wasatch Boulevard and S.R. 209. With this alternative, 14 residential receptors of the 263 receptors between Wasatch Boulevard and S.R. 209 would have noise impacts. This would be an increase of 5 impacts to residential receptors compared to the No-Action Alternative, which has 9 residential receptors that exceed UDOT's NAC between Wasatch Boulevard and S.R. 209. Noise levels with the Enhanced Bus Service in Peak-period Shoulder Lane Alternative in this area were modeled to range from 43 to 67 dBA, with an average of 56 dBA. The change in noise levels at receptors with this alternative in this area would range from –1 dBA to +7 dBA, with an average increase of 0.9 dBA compared to the No-Action Alternative. No receptors would substantially exceed (≥ 10-dBA increase over) the No-Action Alternative noise levels. With the Enhanced Bus Service in Peak-period Shoulder Lane Alternative, the maximum increase for any receptor would be an increase of 7 dBA compared to the No-Action Alternative. Thirteen receptors would have a noticeable increase of 3 to 7 dBA compared to the No-Action Alternative. The maximum decrease for any receptor would be a decrease of 1 dBA compared to the No-Action Alternative. No receptors would have a noticeable decrease of 3 dBA or greater compared to the No-Action Alternative. Modeling results and figures showing the location of each receptor are included in Appendix 11A, Noise Technical Report.

Comparison of Impacts with the Enhanced Bus Service Alternative between Wasatch Boulevard and S.R. 209. Compared to the Enhanced Bus Service Alternative, the Enhanced Bus Service in Peak-period Shoulder Lane Alternative would increase noise levels by an average of 0.6 dBA. The Enhanced Bus Service in Peak-period Shoulder Lane Alternative would have an increase of 3 impacts to residential receptors compared to the Enhanced Bus Service Alternative, which would have impacts to 11 residential receptors in this area. With the Enhanced Bus Service in Peak-period Shoulder Lane Alternative, the maximum increase for any receptor would be an increase of 6 dBA compared to the Enhanced Bus Service Alternative. Nine receptors would have a noticeable increase of 3 to 6 dBA with the Enhanced Bus Service in Peak-period Shoulder Lane Alternative compared to the Enhanced Bus Service Alternative. The maximum decrease for any receptor would be a decrease of 1 dBA with the Enhanced Bus Service in Peak-period Shoulder Lane Alternative compared to the Enhanced Bus Service Alternative. No receptors would have a noticeable decrease of 3 dBA or greater with the Enhanced Bus Service in Peak-period Shoulder Lane Alternative compared to the Enhanced Bus Service Alternative. Modeling results and figures showing the location of each receptor are included in Appendix 11A, Noise Technical Report.

Comparison of Impacts with the No-Action Alternative between S.R. 209 and Alta. With the Enhanced Bus Service in Peak-period Shoulder Lane Alternative, none of the 728 modeled receptors between S.R. 209 and Alta would have noise levels that exceed UDOT's NAC. This would be no change in noise impacts compared to the No-Action Alternative, which also has no receptors that exceed UDOT's NAC in this area. Noise levels with the Enhanced Bus Service in Peak-period Shoulder Lane Alternative in this area were modeled to range from 39 to 64 dBA, with an average of 54 dBA. The change in noise levels at receptors with the Enhanced Bus Service in Peak-period Shoulder Lane Alternative in this area would range from –2 dBA to +8 dBA, with an average increase of 2.3 dBA compared to the No-Action Alternative. No receptors would substantially exceed (≥ 10-dBA increase over) the No-Action Alternative noise levels. With the Enhanced Bus Service in Peak-period Shoulder Lane Alternative, the maximum increase for any receptor would be an increase of 8 dBA compared to the No-Action Alternative. A total of 321 receptors would have a noticeable increase of 3 to 8 dBA compared to the No-Action Alternative. The maximum decrease for any receptor would be a decrease of 2 dBA compared to the No-Action Alternative. No receptors would have a noticeable decrease of 3 dBA or greater compared to the No-Action Alternative. Modeling results and figures showing the location of each receptor are included in Appendix 11A, Noise Technical Report.

Comparison of Impacts with the Enhanced Bus Service Alternative between S.R. 209 and Alta. Compared to the Enhanced Bus Service Alternative, the Enhanced Bus Service in Peak-period Shoulder Lane Alternative would increase noise levels by an average of 1.9 dBA. There would be no change to the number of impacted receptors compared to the Enhanced Bus Service Alternative, which would also have no impacts to receptors in this area. With the Enhanced Bus Service in Peak-period Shoulder Lane Alternative, the maximum increase for any receptor would be an increase of 7 dBA compared to the Enhanced Bus Service Alternative. A total of 257 receptors would have a noticeable increase of 3 to 7 dBA with the Enhanced Bus Service in Peak-period Shoulder Lane Alternative compared to the Enhanced Bus Service Alternative. The maximum decrease for any receptor would be a decrease of 3 dBA with the Enhanced Bus Service in Peak-period Shoulder Lane Alternative compared to the Enhanced Bus Service

Alternative. One receptor would have a noticeable decrease of 3 dBA with the Enhanced Bus Service in Peak-period Shoulder Lane Alternative compared to the Enhanced Bus Service Alternative. Modeling results and figures showing the location of each receptor are included in Appendix 11A, Noise Technical Report.

11.4.4.3 Mobility Hubs Alternative

The noise impacts from the mobility hubs with the Enhanced Bus Service in Peak-period Shoulder Lane Alternative would be the same as with the Enhanced Bus Service Alternative.

11.4.4.4 Avalanche Mitigation Alternatives

The noise impacts from the avalanche mitigation measures with the Enhanced Bus Service in Peak-period Shoulder Lane Alternative would be the same as with the Enhanced Bus Service Alternative.

11.4.4.5 Trailhead Parking Alternatives

The noise impacts from the trailhead parking alternatives with the Enhanced Bus Service in Peak-period Shoulder Lane Alternative would be the same as with the Enhanced Bus Service Alternative.

11.4.4.6 No Winter Parking Alternative

The noise impacts from the No Winter Parking Alternative with the Enhanced Bus Service in Peak-period Shoulder Lane Alternative would be the same as with the Enhanced Bus Service Alternative.

11.4.5 Gondola Alternative A (Starting at Canyon Entrance)

This section describes the noise impacts of Gondola Alternative A, which includes a gondola alignment from the entrance to Little Cottonwood Canyon to the Snowbird and Alta ski resorts, improvements to the Wasatch Boulevard segment of S.R. 210, two mobility hubs, avalanche mitigation alternatives, trailhead parking alternatives, and the No Winter Parking Alternative.

What are base, angle, and terminal stations?

As used in this chapter, the term *terminal station* refers to the first and last stations on a passenger's gondola trip. Passengers board and disembark the gondola cabins at the terminal stations.

The *base station* is the terminal station at the bottom of the canyon, and a *destination station* is a terminal station at the top of the canyon.

The gondola alternatives also include *angle stations*, which are needed to adjust the horizontal direction of the cabin; passengers remain in the cabin as it passes through an angle station.

A *tower* supports the gondola cable.

11.4.5.1 S.R. 210 – Wasatch Boulevard

With Gondola Alternative A, the noise impacts from the improvements to Wasatch Boulevard would be the same as with the Enhanced Bus Service Alternative.

11.4.5.2 S.R. 210 – North Little Cottonwood Road to Alta

With Gondola Alternative A, there would be no improvements to S.R. 210 from North Little Cottonwood Road to the town of Alta. However, the proposed gondola towers, the gondola stations, and the easement underneath the gondola cables would parallel S.R. 210.

There would be additional bus volumes on S.R. 210 to the gondola base station at the entrance to Little Cottonwood Canyon.

Impacts between Wasatch Boulevard and S.R. 209. With Gondola Alternative A, noise levels would range from 42 to 67 dBA, with an average of 55 dBA, and 11 residential receptors would have noise impacts between Wasatch Boulevard and S.R. 209. This would be an increase of 2 impacts to residential receptors compared to the No-Action Alternative, which has 9 residential receptors that exceed UDOT's NAC between Wasatch Boulevard and S.R. 209. The change in noise to receptors with Gondola Alternative A in this area would range from 0 dBA to +1 dBA, with an average increase of 0.2 dBA compared to the No-Action Alternative between Wasatch Boulevard and S.R. 209. Gondola Alternative A would cause the same increases in noise levels as the Enhanced Bus Service Alternative between Wasatch Boulevard and S.R. 209. Gondola Alternative A would impact the same 11 residential receptors as the Enhanced Bus Service Alternative.

Impacts between S.R. 209 and Alta. With Gondola Alternative A, there would be no improvements to S.R. 210 between S.R. 209 and Alta, and the noise levels would be the same as the No-Action Alternative noise levels. With the No-Action Alternative, none of the 728 modeled receptors between S.R. 209 and Alta would have noise levels that exceed UDOT's NAC. Noise levels with the No-Action Alternative in this segment were modeled to range from 38 to 63 dBA, with an average of 52 dBA between S.R. 209 and Alta. Modeling results and figures showing the location of each receptor are included in Appendix 11A, Noise Technical Report.

Base Station Noise. Gondola Alternative A would include a modified parking lot for buses and other vehicles at the gondola base station, to be located at the existing park-and-ride lot on S.R. 210 near the intersection with S.R. 209. For this gondola base station, the nearest façade of the occupied portion of the nearest noise-sensitive land use is farther than the unobstructed 225-foot screening radius. The noise level at a 225-foot distance for the gondola base station during operations is predicted to be 57 dBA. The highest predicted traffic noise level at the closest residential receptor near the Gondola Alternative A base station would be 64 dBA. This residential receptor is more than 225 feet from the Gondola Alternative A base station. The combined noise level with the Gondola Alternative A base station noise and the roadway noise would be 65 dBA, which is below UDOT's impact criterion of 66 dBA for land use activity category B. Therefore, no combined noise impacts are expected from the gondola base station with Gondola Alternative A.

Operation Noise. The noise levels associated with the operation of the gondola system after a gondola cabin leaves the base station would be minor because there would be no drive motors or loading and unloading activities at the towers and angle stations. The existing noise levels around S.R. 210 in Little Cottonwood Canyon range from 38 to 63 dBA, with an average of 52 dBA. To better estimate gondola noise levels, UDOT conducted noise monitoring at Snowbird Tram tower 1. The monitoring showed that the average noise level below the tower was about 50 dBA (HDR 2020). Therefore, UDOT expects that the gondola noise would average about 50 dBA, or within the existing noise conditions created by the S.R. 210 roadway, and thus would not cause an adverse noise impact to recreational users.

Destination Station Noise. With Gondola Alternative A, the destination stations at Snowbird and Alta would be at least 225 feet from the nearest sensitive receptors. The noise level at a 225-foot distance for the gondola destination stations during operation is predicted to be 57 dBA. The highest predicted traffic noise level is 62 dBA at Snowbird and 63 dBA at Alta. The highest combined noise level of the gondola destination station and traffic would be 63 dBA at Snowbird and 64 dBA at Alta, which would be influenced primarily by traffic noise. The noise from the gondola destination stations at Snowbird or Alta is predicted to add no more than 1 dBA of noise to any receptors. The combined noise level for all receptors near the gondola destination stations at Snowbird and Alta would be below UDOT's NAC of 66 dBA for activity categories B and C.

11.4.5.3 Mobility Hubs Alternative

The noise impacts from the mobility hubs with Gondola Alternative A would be the same as with the Enhanced Bus Service Alternative.

11.4.5.4 Avalanche Mitigation Alternatives

The noise impacts from the avalanche mitigation measures with Gondola Alternative A would be the same as with the Enhanced Bus Service Alternative.

11.4.5.5 Trailhead Parking Alternatives

The noise impacts from the trailhead parking alternatives with Gondola Alternative A would be the same as with the Enhanced Bus Service Alternative.

11.4.5.6 No Winter Parking Alternative

The noise impacts from the No Winter Parking Alternative with Gondola Alternative A would be the same as with the Enhanced Bus Service Alternative.

11.4.6 Gondola Alternative B (Starting at La Caille)

This section describes the noise impacts of Gondola Alternative B, which includes a gondola alignment from La Caille to the Snowbird and Alta ski resorts, improvements to the Wasatch Boulevard segment of S.R. 210, two mobility hubs, avalanche mitigation alternatives, trailhead parking alternatives, and the No Winter Parking Alternative.

11.4.6.1 S.R. 210 – Wasatch Boulevard

With Gondola Alternative B, the noise impacts from the improvements to Wasatch Boulevard would be the same as with the Enhanced Bus Service Alternative.

11.4.6.2 S.R. 210 – North Little Cottonwood Road to Alta

With Gondola Alternative B, there would be no improvements to S.R. 210 from North Little Cottonwood Road to the town of Alta except for adding the auxiliary lane on North Little Cottonwood Road from Wasatch Boulevard to the base station. The proposed gondola towers, the gondola stations, and the easement underneath the gondola cables would parallel S.R. 210.

There would be additional bus volumes on S.R. 210 to the gondola base station at La Caille.

Impacts between Wasatch Boulevard and S.R. 209. With Gondola Alternative B, noise levels would range from 42 to 67 dBA, with an average of 55 dBA, and 11 residential receptors would have noise impacts between Wasatch Boulevard and S.R. 209. This would be an increase of 2 impacts to residential receptors compared to the No-Action Alternative, which has 9 residential receptors that exceed UDOT's NAC between Wasatch Boulevard and S.R. 209. The change in noise levels at receptors with Gondola Alternative B in this area would range from 0 dBA to +1 dBA, with an average increase of 0.2 dBA compared to the No-Action Alternative between Wasatch Boulevard and S.R. 209. Gondola Alternative B would cause the same increases in noise levels as the Enhanced Bus Service Alternative and Gondola Alternative A between Wasatch Boulevard and S.R. 209. Gondola Alternative B would impact the same 11 residential receptors as the Enhanced Bus Service Alternative and Gondola Alternative A.

Impacts between S.R. 209 and Alta. With Gondola Alternative B, there would be no improvements to S.R. 210 between S.R. 209 and Alta, and the noise levels would be the same as the No-Action Alternative noise levels. With the No-Action Alternative, none of the 728 modeled receptors between S.R. 209 and Alta would have noise levels that exceed UDOT's NAC. Noise levels with the No-Action Alternative in this segment were modeled to range from 38 to 63 dBA, with an average of 52 dBA between S.R. 209 and Alta. Modeling results and figures showing the location of each receptor are included in Appendix 11A, Noise Technical Report.

Base Station Noise. Gondola Alternative B would include a modified parking lot for buses and other vehicles at the gondola base station, to be located about 0.75 mile from the intersection of S.R. 210 and S.R. 209. Six noise-sensitive (residential) receptors are located within the 225-foot screening radius around the proposed gondola base station with Gondola Alternative B. The noise level at a 225-foot distance for the gondola base station during operations is predicted to be 57 dBA. At each of the six receptors evaluated for combined noise impacts, the predicted combined noise levels are below the 66-dBA residential NAC per UDOT's noise-abatement policy (for more information about this analysis, see Section 6.3.2, Gondola Alternatives A and B Base Stations, in Appendix 11A, Noise Technical Report). Thus, no noise impacts from the combined noise of the proposed gondola base station with Gondola Alternative B and traffic noise are predicted, and no mitigation is required per UDOT's noise-abatement policy.

Operation Noise. The noise levels associated with the operation of the gondola system after a gondola cabin leaves the base station would be minor because there would be no drive motors or loading and unloading activities at the towers and angle stations. The existing noise levels around S.R. 210 in Little Cottonwood Canyon range from 38 to 63 dBA, with an average of 52 dBA. To better estimate gondola noise levels, UDOT conducted noise monitoring at Snowbird Tram tower 1. The monitoring showed that the average noise level below the tower was about 50 dBA (HDR 2020). Therefore, UDOT expects that the gondola noise would average about 50 dBA, or within the existing noise conditions created by the S.R. 210 roadway, and thus would not cause an adverse noise impact to recreational users.

Destination Station Noise. With Gondola Alternative B, the destination stations at Snowbird and Alta would be at least 225 feet from the nearest sensitive receptors. The noise level at a 225-foot distance for the gondola destination stations during operation is predicted to be 57 dBA. The highest predicted traffic noise level is 62 dBA at Snowbird and 63 dBA at Alta. The highest combined noise level of the gondola destination station and traffic would be 63 dBA at Snowbird and 64 dBA at Alta, which would be influenced primarily by traffic noise. The noise from the gondola destination stations at Snowbird or Alta is predicted to add no more than 1 dBA of noise to any receptors. The combined noise level for all receptors near the gondola destination stations at Snowbird and Alta would be below UDOT's NAC of 66 dBA for activity categories B and C.

11.4.6.3 Mobility Hubs Alternative

The noise impacts from the mobility hubs with Gondola Alternative B would be the same as with the Enhanced Bus Service Alternative.

11.4.6.4 Avalanche Mitigation Alternatives

The noise impacts from the avalanche mitigation measures with Gondola Alternative B would be the same as with the Enhanced Bus Service Alternative.

11.4.6.5 Trailhead Parking Alternatives

The noise impacts from the trailhead parking alternatives with Gondola Alternative B would be the same as with the Enhanced Bus Service Alternative.

11.4.6.6 No Winter Parking Alternative

The noise impacts from the No Winter Parking Alternative with Gondola Alternative B would be the same as with the Enhanced Bus Service Alternative.

11.4.7 Cog Rail Alternative

This section describes the noise impacts of the Cog Rail Alternative, which includes a new cog rail alignment from La Caille to the Snowbird and Alta ski resorts, improvements to the Wasatch Boulevard segment of S.R. 210, improvements to the segment of S.R. 210 on North Little Cottonwood Road, two mobility hubs, avalanche mitigation alternatives, trailhead parking alternatives, and the No Winter Parking Alternative.

What are cog rail base and terminal stations?

As used in this chapter, the term *terminal station* refers to the first and last stations on a passenger's cog rail trip. Passengers board and disembark the cog rail vehicles at the terminal stations.

The *base station* is the terminal station at the bottom of the canyon, and a *destination station* is a terminal station at the top of the canyon.

11.4.7.1 S.R. 210 – Wasatch Boulevard

With the Cog Rail Alternative, the noise impacts from the improvements to Wasatch Boulevard would be the same as with the Enhanced Bus Service Alternative.

11.4.7.2 S.R. 210 – North Little Cottonwood Road to Alta

With the Cog Rail Alternative, there would be no improvements to S.R. 210 from North Little Cottonwood Road to the town of Alta except for adding the auxiliary lane on North Little Cottonwood Road from Wasatch Boulevard to the base station. The cog rail alignment would parallel S.R. 210.

Impacts between Wasatch Boulevard and S.R. 209. With the Cog Rail Alternative, more buses would travel on S.R. 210 to the cog rail base station at La Caille than with the No-Action Alternative. Noise levels would range from 42 to 67 dBA, with an average of 55 dBA, and 11 residential receptors would have noise impacts between Wasatch Boulevard and S.R. 209. This would be 2 more impacted residential receptors compared to the No-Action Alternative, under which 9 residential receptors exceed UDOT's NAC.

The change in noise levels at receptors with the Cog Rail Alternative in this area would range from 0 dBA to +1 dBA, with an average increase of 0.2 dBA compared to the No-Action Alternative. The Cog Rail Alternative would cause the same increases in noise levels as the Enhanced Bus Service Alternative and the gondola alternatives. Noise impacts at the two additional residential receptors would be due to traffic noise; the addition of the cog rail noise sources would not increase the noise level at these residential receptors. No receptors would substantially exceed (≥ 10-dBA increase over) the No-Action Alternative noise levels.

With the Cog Rail Alternative, the maximum increase for any receptor would be an increase of 1 dBA compared to the No-Action Alternative. No receptors would have a noticeable increase of 3 dBA or greater compared to the No-Action Alternative. The maximum decrease for any receptor would be a decrease of 0 dBA compared to the No-Action Alternative. No receptors would have a noticeable decrease of 3 dBA or greater compared to the No-Action Alternative. The Cog Rail Alternative would impact the same 11 residential receptors as the Enhanced Bus Service Alternative and the gondola alternatives.

For more information about this analysis, see Section 6.3.3, Cog Rail Alternative, in Appendix 11A, Noise Technical Report. Modeling results and figures showing the location of each receptor are included in Appendix 11A, Noise Technical Report.

Impacts between S.R. 209 and Alta. With the Cog Rail Alternative, there would be no improvements to S.R. 210 between S.R. 209 and Alta. Noise levels with the Cog Rail Alternative would equal or exceed UDOT's NAC at distances of up to 105 feet from the cog rail tracks. There are no noise-sensitive receptors between S.R. 209 and Alta.

Destination Station Noise. UDOT determined that there are no noise-sensitive receptors within the 50-dBA contours (305 feet) for the noise source of idling DMUs at the Snowbird and Alta destination stations. Therefore, idling DMUs at the destination stations do not require additional assessment and would not cause impacts as defined by UDOT's NAC.

Operations and Maintenance Facility and Base Station Parking Structure Noise. UDOT determined that there are no noise-sensitive land uses within 332 feet of the cog rail operations and maintenance facility or within 54 feet of the cog rail base station parking structure. These are the distances to the NAC noise impact contours for the operations and maintenance facility and base station parking structure, respectively, as determined by FTA methodologies. Therefore, the cog rail operations and maintenance facility and the base station parking structure are not projected to cause noise impacts as defined by UDOT's NAC.

Trail Noise. UDOT also evaluated overall cog rail–related noise levels at trails in Little Cottonwood Canyon (land use activity category C). UDOT determined that segments of trails approaching and leaving trailhead areas are not considered noise-sensitive due to their proximity to the existing S.R. 210 and trailhead parking lots. Trail users are not stationary and do not have consistent exposure to noise. UDOT assumes that trail users expect to experience transportation noise in trail areas close to S.R. 210 and parking lots. In these areas, cog rail–related noise levels would equal or exceed UDOT's NAC at distances of up to 105 feet from the cog rail tracks. Beyond that distance, overall cog rail–related noise levels are projected to be below UDOT's NAC. When the cog rail is not in operation, noise levels are projected to be the same as the noise levels with the No-Action Alternative.

11.4.7.3 Mobility Hubs Alternative

The noise impacts from the mobility hubs with the Cog Rail Alternative would be the same as with the Enhanced Bus Service Alternative.

11.4.7.4 Avalanche Mitigation Alternatives

The noise impacts from the avalanche mitigation measures with the Cog Rail Alternative would be the same as with the Enhanced Bus Service Alternative.

11.4.7.5 Trailhead Parking Alternatives

The noise impacts from the trailhead parking alternatives with the Cog Rail Alternative would be the same as with the Enhanced Bus Service Alternative.

11.4.7.6 No Winter Parking Alternative

The noise impacts from the No Winter Parking Alternative with the Cog Rail Alternative would be the same as with the Enhanced Bus Service Alternative.

11.4.8 Summary of Noise Impacts

The traffic noise analysis included 2,401 receptors, including 1,745 residential receptors (land use activity category B), 56 receptors in land use activity category C, 1 receptor in land use activity category D, 18 receptors in land use activity category E, 54 receptors in land use activity category F, and 527 receptors in land use activity category G. More details about the receptors modeled for the project alternatives are provided in Appendix 11A, Noise Technical Report.

Table 11.4-1 summarizes the noise impacts of the action alternatives. As listed in the table, the action alternatives would cause noise impacts to 213 to 233 total receptors, depending on the alternative. The Enhanced Bus Service in Peak-period Shoulder Lane Alternative with the Five-lane Alternative on Wasatch Boulevard would have the most total noise impacts (233) and the most residential noise impacts (231), and the Enhanced Bus Service Alternative or either of the gondola alternatives with the Imbalanced-lane Alternative on Wasatch Boulevard would have the fewest total noise impacts (213) and residential noise impacts (212). A detailed summary table including the existing noise level and noise level for each receptor with each action alternative is provided in Appendix 11A, Noise Technical Report.

Table 11.4-1. Traffic Noise Impacts for the Action Alternatives

Receptors with Modeled Noise Greater than UDOT NAC with Existing Conditions and No-Action Alternative	Wasatch Boulevard Alternative	Total Noise Impacts (and Residential Noise Impacts)[a]				
		Enhanced Bus Service Alternative	Enhanced Bus Service in Peak-period Shoulder Lane Alternative	Gondola Alternative A	Gondola Alternative B	Cog Rail Alternative
173	Imbalanced-lane Alternative	213 (212)	216 (215)	213 (212)	213 (212)	213 (212)
	Five-lane Alternative	230 (228)	233 (231)	230 (228)	230 (228)	230 (228)

[a] Impacts to land use activity category B (residential properties) are listed in parentheses.

The action alternatives would cause a net increase of 40 to 60 noise impacts compared to the existing conditions/No-Action Alternative, with 173 receptors that exceed UDOT's NAC levels.

Widening Wasatch Boulevard is proposed under all five action alternatives. In all cases, the alternatives would cause 17 fewer noise impacts with the Imbalanced-lane Alternative on Wasatch Boulevard compared to the Five-lane Alternative on Wasatch Boulevard.

The proposed widening of Little Cottonwood Canyon Road with the Enhanced Bus Service in Peak-period Shoulder Lane Alternative would impact an additional three residential receptors compared to any of the other action alternatives.

In undeveloped areas around S.R. 210 (land use activity category G), future noise levels would range from 38 to 74 dBA. Increases in noise levels in any areas that would not be permitted for development prior to the signing of the project's Record of Decision were not considered noise impacts and were not evaluated for noise mitigation.

Mobility Hub Noise Impacts, Gondola Station Noise Impacts, and Combined Traffic and Mobility Hub or Gondola Station Noise Impacts. No noise impacts are anticipated at receptors near the mobility hubs proposed with any of the action alternatives, the gondola stations proposed with Gondola Alternative A or B, or the cog rail stations proposed with the Cog Rail Alternative.

11.4.9 Mitigation Measures

This section discusses UDOT's methodology for evaluating noise-abatement mitigation measures for the traffic noise impacts identified in Section 11.4.3, Enhanced Bus Service Alternative, through Section 11.4.7, Cog Rail Alternative. As stated in Section 11.4.1, Methodology, noise mitigation typically consists of installing a noise wall or other physical barrier that blocks the line of sight from the roadway noise source to nearby receptors.

According to UDOT's noise-abatement policy (UDOT Policy 08A2-01, *Noise Abatement*, revised May 28, 2020), noise abatement will be considered for new highway construction where noise impacts are identified. The goal of noise abatement is to substantially reduce noise, which might or might not result in noise levels below the NAC.

The two primary criteria to consider when evaluating noise-abatement measures are feasibility and reasonableness. Noise abatement will be provided by UDOT only if UDOT determines that noise-abatement measures are *both* feasible and reasonable.

11.4.9.1 Feasibility Factors

The feasibility of noise-abatement measures deals primarily with construction and engineering considerations such as safety, presence of cross streets, sight distance, and access to adjacent properties, among other considerations, including the following.

What is a front-row receptor?

A front-row receptor is a residence in the first row of homes adjacent to a project alternative.

- **Acoustic Feasibility.** Noise abatement must be considered acoustically feasible. This is defined as achieving at least a 5-dBA noise reduction for at least 50% of front-row receptors. A 5-dBA change in noise would be perceptible by most people under normal listening conditions. If a noise-abatement measure is determined by UDOT to be acoustically feasible, then the abatement measure will be evaluated to determine whether its construction is reasonable. If a noise-abatement measure is determined by UDOT to be not feasible, it will not be considered any further.
- **Safety on Urban Non-access-controlled Roads.** UDOT's noise-abatement policy states that, "[t]o avoid a damaged wall from becoming a safety hazard, in the event of a failure, wall height shall be no greater than the distance from the back of curb to the face of [the] proposed wall."

11.4.9.2 Reasonableness Factors

Under UDOT's noise-abatement policy, reasonableness factors must be collectively achieved in order for a noise-abatement measure to be considered "reasonable." If any of the three reasonableness factors (noise-abatement design goal, cost-effectiveness, and viewpoints of property owners and residents) specified in the policy are not achieved, the noise-abatement measure will be considered not reasonable and therefore not included in the project.

- **Noise-abatement Design Goal.** UDOT defines the minimum noise reduction (design goal) from proposed abatement measures to be 7 dBA or greater for at least 35% of front-row receptors. As a result, no abatement measure will be considered reasonable if the noise-abatement design goal cannot be achieved.
- **Cost-effectiveness.** The cost of a noise-abatement measure must be considered reasonable for it to be included in the project. Noise-abatement costs are determined by multiplying a fixed unit cost per square foot by the height and length of the barrier.

  For residential receptors (activity category B in Table 11.2-1 above, UDOT's Noise-abatement Criteria), cost-effectiveness is based on the cost of the abatement measure (for example, a noise wall) divided by the number benefited receptors (dwelling units at which noise is reduced by a minimum of 5 dBA as a result of the abatement measure). Currently, the maximum cost used to determine the reasonableness of a noise-abatement measure is $30,000 per benefiting residence based on a unit barrier cost of $20 per square foot of barrier, and $360 per lineal foot for activity categories A, C, D, or E.

- **Viewpoints of Property Owners and Residents.** If a noise-abatement measure is both feasible and cost-effective, UDOT will also consider the viewpoints of property owners and residents (non-owners) to determine whether the noise-abatement measure is desired. Balloting will be conducted for those noise-abatement measures that both meet the noise-abatement design goal and are cost-effective consistent with the procedures described in UDOT's noise-abatement policy.

11.4.9.3 Noise-abatement Evaluation for the Proposed Alternatives

UDOT evaluated 18 noise walls at locations where noise impacts would occur with the action alternatives. Of the 18 modeled noise barriers for the five action alternatives, 14 met UDOT's feasibility and reasonableness acoustic and cost criteria for all five action alternatives with the Imbalanced-lane Alternative on Wasatch Boulevard, and 13 met UDOT's feasibility and reasonableness acoustic and cost criteria for all five action alternatives with the Five-lane Alternative on Wasatch Boulevard. Maps showing the locations of the noise walls evaluated for the action alternatives and more detailed information is available for each barrier in Appendix 11A, Noise Technical Report.

Table 11.4-2 summarizes the analyzed noise barriers. The locations of the noise barriers are shown in Figure 11.4-1 and Figure 11.4-2 beginning on page 11-35.

Noise-abatement Consideration during Final Design. The final decision to build a noise barrier will be made on completion of the project design, completion of the public involvement process, and concurrence with UDOT's noise-abatement policy. A barrier identified as recommended for balloting is a barrier that has been shown to be both feasible and reasonable. However, that finding is not a commitment to build a barrier.

11.4.10 Construction Noise

Noise during construction is discussed in Section 19.2.2.7, Noise Impacts from Construction, in Chapter 19, Construction Impacts.

Table 11.4-2. Barrier Analysis Summary

Proposed Barrier	Alternative(s)	Wasatch Boulevard Alternative	Is Barrier Feasible, Reasonable, and Recommended for Balloting?	Recommended Barrier Height
1	All action alternatives	Imbalanced-lane Alternative	No	NA
	All action alternatives	Five-lane Alternative	No	NA
2	All action alternatives	Imbalanced-lane Alternative	No	NA
	All action alternatives	Five-lane Alternative	No	NA
3	All action alternatives	Imbalanced-lane Alternative	Yes	17 feet
	All action alternatives	Five-lane Alternative	No	NA
4	All action alternatives	Imbalanced-lane Alternative	Yes	7 feet
	All action alternatives	Five-lane Alternative	Yes	7 feet
5	All action alternatives	Imbalanced-lane Alternative	Yes	11 feet
	All action alternatives	Five-lane Alternative	Yes	10 feet
6	All action alternatives	Imbalanced-lane Alternative	Yes	8 feet
	All action alternatives	Five-lane Alternative	Yes	9 feet
7	All action alternatives	Imbalanced-lane Alternative	No	NA
	All action alternatives	Five-lane Alternative	No	NA
8	All action alternatives	Imbalanced-lane Alternative	Yes	7 feet
	All action alternatives	Five-lane Alternative	Yes	6 feet
9	All action alternatives	Imbalanced-lane Alternative	Yes	7 feet
	All action alternatives	Five-lane Alternative	Yes	6 feet
10	All action alternatives	Imbalanced-lane Alternative	Yes	7 feet
	All action alternatives	Five-lane Alternative	Yes	7 feet
11	All action alternatives	Imbalanced-lane Alternative	Yes	9 feet
	All action alternatives	Five-lane Alternative	Yes	8 feet
12	All action alternatives	Imbalanced-lane Alternative	Yes	8 feet
	All action alternatives	Five-lane Alternative	Yes	7 feet
13	All action alternatives	Imbalanced-lane Alternative	No	NA
	All action alternatives	Five-lane Alternative	No	NA
14	Enhanced Bus Service and Cog Rail Alternatives	NA	Yes	8 feet
	Enhanced Bus Service in Peak-period Shoulder Lane Alternative	NA	Yes	8 feet
	Gondola Alternative A	NA	Yes	8 feet
15	Enhanced Bus Service, Gondola Alternative A, Gondola Alternative B, and Cog Rail Alternative	NA	Yes	8 feet
	Enhanced Bus Service in Peak-period Shoulder Lane	NA	Yes	8 feet
16	All action alternatives	NA	Yes	6 feet
17	All action alternatives	NA	Yes	7 feet
18	All action alternatives	NA	Yes	8 feet

NA = not applicable

Figure 11.4-1. Noise Barriers Overview (1 of 2)

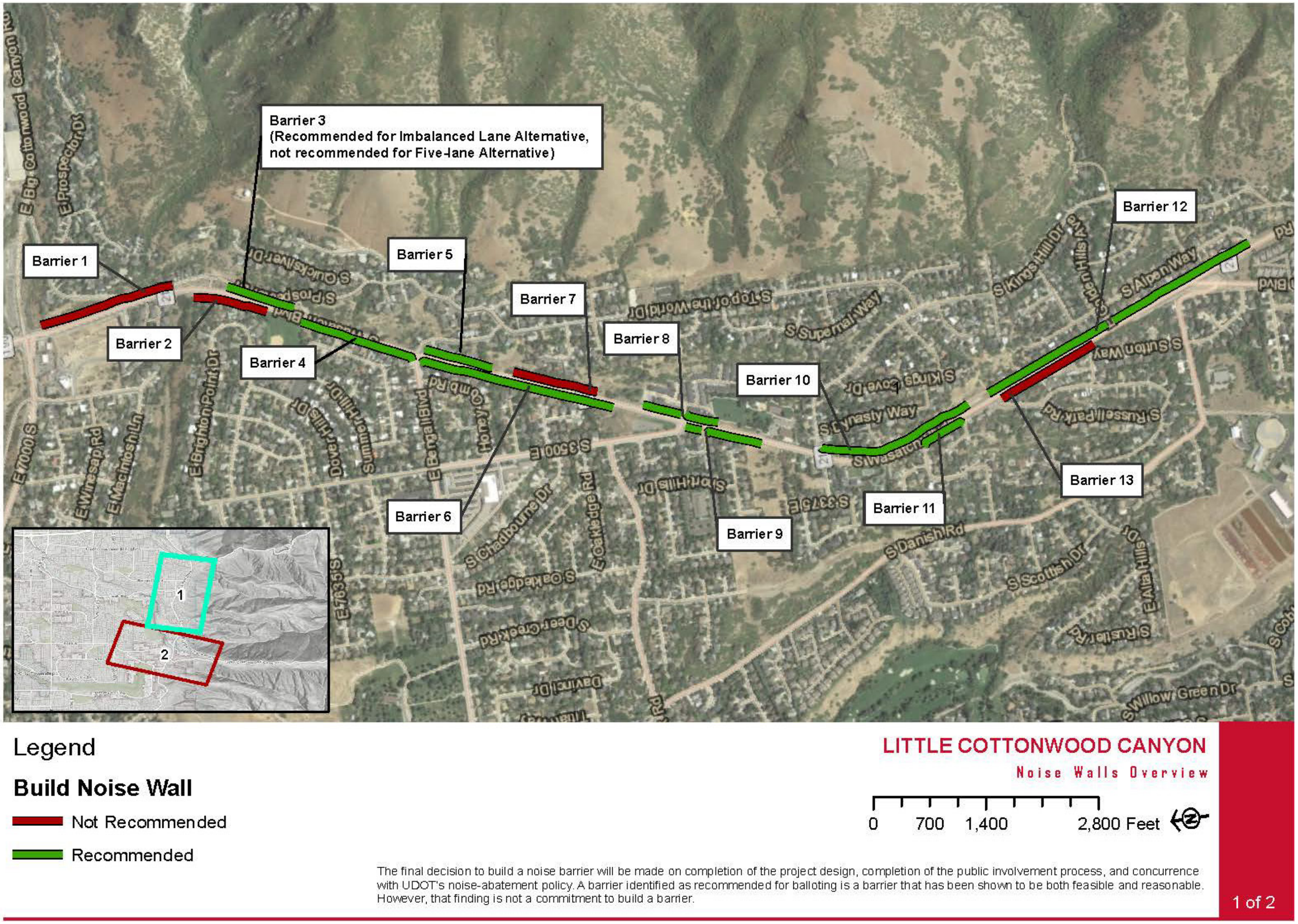


Figure 11.4-2. Noise Barriers Overview (2 of 2)

Legend

Build Noise Wall

Not Recommended

Recommended

LITTLE COTTONWOOD CANYON

Noise Walls Overview

0 750 1,500 3,000 Feet

The final decision to build a noise barrier will be made on completion of the project design, completion of the public involvement process, and concurrence with UDOT's noise-abatement policy. A barrier identified as recommended for balloting is a barrier that has been shown to be both feasible and reasonable. However, that finding is not a commitment to build a barrier.

2 of 2

11.5 References

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