I-76 & Bridge Street INTERCHANGE

Traffic Noise

Technical Report

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List of acronyms and abbreviations

BMP	Best management practice
Brighton	City of Brighton
CDOT	Colorado Department of Transportation
CFR	Code of Federal Regulations
dB	Decibel
dBA	A-weighted decibels
EA	Environmental Assessment
FHWA	Federal Highway Administration
GIS	Geographic Information Systems
Leq	Equivalent sound level
Leq(h)	Equivalent sound level per hour
LOS	Level of service
mph	Miles per hour
NAC	Noise Abatement Criteria
NEPA	National Environmental Policy Act
ROW	Right of way
TNM	Traffic Noise Model
USC	United States Code
vph	Vehicles per hour

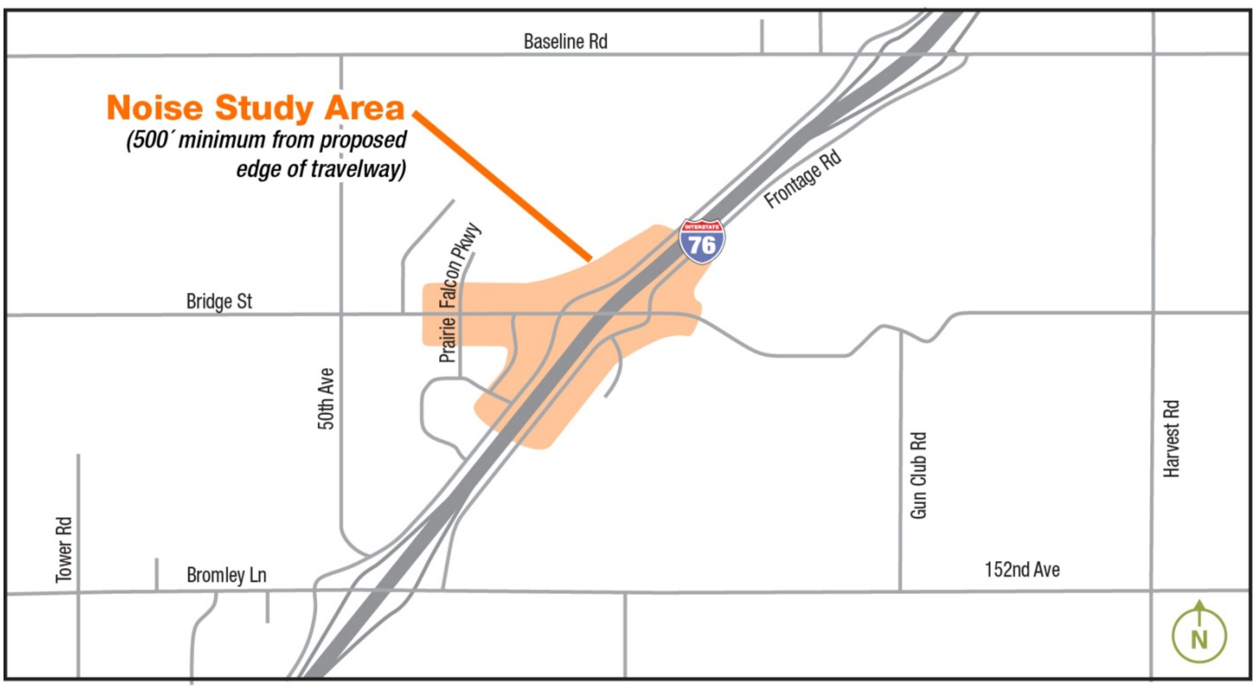
1. Introduction

The I-76 and Bridge Street Interchange Environmental Assessment (EA) is a joint effort between the City of Brighton (Brighton), the Federal Highway Administration (FHWA) and the Colorado Department of Transportation (CDOT). This EA will identify potential impacts of the proposed interchange on the human and natural environment.

1.1 Project Description

The City of Brighton proposes constructing a new interchange at I-76 and Bridge Street in eastern Brighton. The project is located in Adams County, Colorado, approximately 25 miles northeast of Denver. The noise study area is defined as the area surrounding the existing Bridge Street overpass over I-76, including the interstate, the frontage roads, and Bridge Street. The area surrounding the intersection of Bridge Street & Prairie Falcon Parkway is also included in the noise study area, where a signal is proposed as part of the project (Exhibit 1-1).

Exhibit 1-1. Noise Study Area



The purpose of the project is to increase local and regional east-west connectivity, reduce the amount of travel delay through the future design year of 2035, and improve traffic flow and access in the study area. The need for the project results from the lack of local and regional connectivity, current and projected congestion and associated travel delay, and poor current and future traffic flow on the frontage roads.

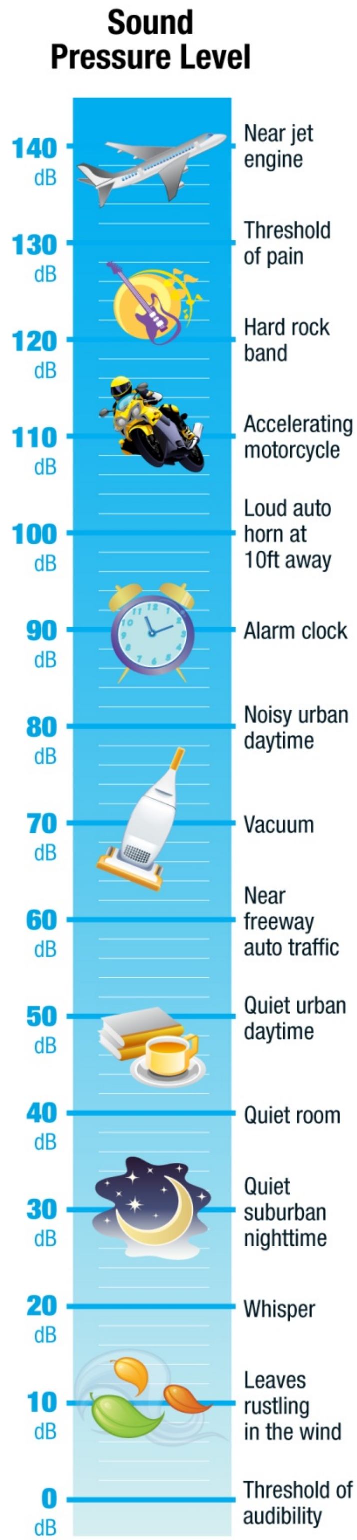
The proposed interchange provides an opportunity to increase regional east-west connectivity that will become increasingly important with future population growth and increased travel demand.

1.2 Resource Definition

Noise generally is defined as unwanted or undesirable sound. Noise typically affects humans in three different ways: noise intensity or level, noise frequency, and noise variation with time. Proposed alterations to the highway system, including the construction of a new interchange, require an assessment of project impacts on noise intensity due to traffic.

Noise intensity, or loudness, is determined by how sound pressure fluctuates and is expressed in decibels (dB). The range of noise normally encountered can be expressed by values between 0 and 120 dB on the dB scale. A 3-dB change in sound level generally represents a barely noticeable change in noise level, whereas a 10-dB change typically would be perceived as a doubling of loudness. The frequency of noise is related to the tone or pitch of the sound and is expressed in terms of cycles per second or Hertz. The human ear can detect a wide range of frequencies, from approximately 20 Hertz to 17,000 Hertz. Because human sensitivity to sound varies from person to person, the A-weighting system is commonly used when measuring noise to provide a value that represents human response. Noise levels measured using this system are called A-weighted levels, and are expressed as dBA.

Because noise fluctuates during the course of a day, it is common practice to condense all of this information into a single number, known as an equivalent sound level (Leq). Leq represents an average sound level over a specified time period (typically 60 minutes), and the value then reflects the hourly equivalent sound level, or Leq(h).



1.3 Regulatory Environment

This section discusses applicable laws, regulations, and guidance as they pertain to the analysis of traffic noise in this EA.

1.3.1 National Environmental Policy Act

The National Environmental Policy Act of 1969 (NEPA), as amended (42 United States Code (USC) §4321 et seq., Public Law 91-190, 83 Stat. 852), mandates that transportation project decisions involving federal actions consider social, economic, and environmental factors in the decision-making process. NEPA also requires that agencies making these decisions consult with other agencies, involve the public, disclose information, and prepare a detailed statement of environmental effects of a reasonable range of alternatives.

1.3.2 Procedures for Abatement of Highway Traffic Noise and Construction Noise

Title 23 CFR §772 codifies procedures for considering noise studies in NEPA and federal-aid processes and establishes requirements for transferring traffic noise information to local planning agencies to assist in their land use planning activities.

1.3.3 FHWA Measurement of Highway-Related Noise

FHWA's *Measurement of Highway-Related Noise* (1996) provides a uniform guidance reference for highway noise practitioners and researchers. The manual addresses measurement and analysis instrumentation, site selection, measurement procedures, data reduction, and analysis techniques.

1.3.4 CDOT Noise Analysis and Abatement Guidelines

CDOT's *Noise Analysis and Abatement Guidelines* (2013) serves to implement FHWA noise regulations for CDOT projects. It provides guidance on conducting traffic noise studies, analyzing abatement options, investigating construction noise levels, and coordinating noise-level information with local land use planning officials.

2. Affected Environment

2.1 Study Area

The study area is comprised of land uses typically found in suburban areas, including residential and commercial uses to the west of I-76 and industrial land uses to the east of I-76. Several residential neighborhoods are established west of I-76 along Bridge Street toward 50th Avenue. Future development is expected as new residential units are planned to the west of I-76, including the Brighton Crossing master planned community. At full build-out, the community expects to have more than 3,000 homes, townhomes, condominiums, and apartments.

2.2 Noise-Sensitive Land Uses in the Study Area

Noise-sensitive sites are defined as any location where traffic noise may be adverse to the function and outdoor enjoyment of a property. CDOT and FHWA have established noise thresholds at which noise abatement must be considered for various types of noise-sensitive sites. These noise levels are referred to as the Noise Abatement Criteria (NAC). As presented in Exhibit 2-1, NAC vary according to the land use activity category.

A traffic noise impact can occur under either of the following two separate criteria:

- Predicted traffic noise levels meet or exceed the NAC
- A substantial noise increase of 10 dBA over existing conditions is predicted

To adequately assess the noise impact of a proposed project, both criteria must be analyzed. If impacts are identified, noise abatement measures must be considered and implemented if they are determined to be both feasible and reasonable.

The noise study area is comprised mainly of NAC B (residential) areas. The NAC B receptors occur on the west side of I-76. There is an industrial building that is located east of I-76 and south of Bridge Street, which is an NAC F land use. It was not included in the model because it has no impact criteria, as shown in Exhibit 2-1.

Exhibit 2-1 CDOT Noise Abatement Criteria

Activity Category	Activity L_{eq}(h) (dbA)	Description of Land Use 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 sport 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, recreational 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 rooms, public or nonprofit institutional structures, radio studios, recording studios, schools, and television studios.
E	71 (Exterior)	Hotels, motels, offices, restaurants/bars, and other developed lands, properties or activities not included in A-D or F.
F	N/A	Agriculture, airports, bus yards, emergency services, industrial, logging, maintenance facilities, manufacturing, mining, rail yards, retail facilities, ship yards, utilities (water resources, water treatment, electrical), and warehousing.
G	N/A	Undeveloped lands that are not permitted for development.

Source: CDOT 2013

2.3 Methodology

The existing conditions noise analysis was performed in accordance with the requirements of 23 CFR §772, Procedures for Abatement of Highway Traffic Noise and Construction Noise, using methodology established by CDOT's Noise Analysis and Abatement Guidelines. Predicted noise levels were produced using the FHWA Traffic Noise Model (TNM) 2.5. All measured and predicted noise levels are expressed in dBA using A-weighting. The hourly equivalent noise levels are defined as the equivalent average sound level that, in a given hourly period, contains the same acoustic energy as the time-varying sound for the same hourly period.

Noise from traffic emanates from four primary sources: the tire/road interface, engines, aerodynamics, and exhaust stacks. Each of these is considered in the TNM 2.5 model. The dBA weighted numbers are used to determine the effect upon potential noise-sensitive sites.

2.3.1 Noise monitoring

To validate the computer noise model (see the following section), field measurements were taken within the study area following procedures documented in FHWA's *Highway Traffic Noise: Analysis and Abatement Guidance*. Field measurements were obtained using Larson Davis 812 and Larson Davis 712 Sound Level Meters. Meters, microphones, and calibrators are calibrated to factory settings at Larson Davis's Utah lab annually. Monitoring events need to last 10 or more minutes. For this project, 10 minutes was chosen as the monitoring time increment because traffic was consistent in the study area. The noise meters were calibrated using a Larson Davis sound level calibrator daily before measurements were collected. No 24-hour noise readings were conducted.

Data collection efforts focused on noise-sensitive dwelling units within the NAC B land uses in the study area. No interior readings were taken. Within the study area, there are two neighborhoods that have NAC B land use within 500 feet of I-76. One neighborhood, called Bromley Park, is located west of I-76 and south of Bridge Street, extending to 50th Avenue. The second neighborhood, called Brighton Crossing, is located west of I-76 and north of Bridge Street, extending to 50th Avenue.

Noise measurements were taken at three locations up to 500 feet from the edge of pavement of I-76, as shown in Exhibit 2-2. Noise measurements were not taken immediately adjacent to Bridge Street because I-76 is the main source of noise for the nearby dwelling units. The closest readings occurred approximately 100 feet and 150 feet from the highway edge of pavement and were used to validate the model. Additional noise measurements were taken approximately 350 feet from the same edge of pavement, which were used for general ambient noise monitoring. Field data collection and verification was used to determine additional features, such as buildings, terrain, or barriers to add into the noise model.

Exhibit 2-2 Noise Monitoring Locations

2.3.2 TNM model validation

Field validation measurements were conducted in the vicinity of noise-sensitive sites, where safe access to monitoring sites existed, where a representative sampling of free-flow traffic could be obtained, and where roadway geometry remained relatively constant.

For the model validation, two 10-minute counts were collected at each site. Traffic counts were performed with handheld counters at the time of monitoring, for traffic on I-76 and the frontage roads, which were used to validate the existing conditions model in TNM. Vehicle types were separated into three categories: cars, medium trucks, and heavy trucks. Vehicle speeds were estimated and recorded during the noise measurements to ensure proper model validation. Data collection occurred mid-afternoon when drivers on I-76 were driving at or near free-flow speeds. The CDOT *Noise Analysis and Abatement Guidelines* state that field measurements can be taken at any time, however it is best to measure when traffic is relatively free-flowing at or near the posted speed limit. Directional counts of all automobile, medium truck, and heavy truck traffic should be taken for relevant roadways adjacent to the measurement site. Traffic counts were taken for both directions of I-76 and both the east and west frontage roads.

Model validation data were collected within 350 feet of the highway edge of pavement. The noise monitoring occurred at three sites adjacent to I-76. Validation occurs when measured noise levels are within 3 dBA of the modeled value. Exhibit 2-3 summarizes the model validation counts and the additional noise readings collected within the study area. Although still within the acceptable threshold for validation, Point 2 had a 2.9 dBA difference between the field reading and the model result. The difference at this location could be a result of the noise model not being able to adequately calculate noise levels between multiple terrain lines, as Point 2 lies on the slope leading down to the existing ditch to the west of the frontage road. There were several terrain lines added in the vicinity of Point 2 to represent the ditch, but the fact that Points 1 and 3 calibrated within less than 1 dBA indicates that the model is still validated. All of the dwelling units that were included in the model are located even further beyond the ditch, so the model was considered valid. Details of the field measurements taken in September 2013 can be found in Appendix A.

Exhibit 2-3 Study Area Model Validation Counts and Noise Readings

Point	Distance from Edge of Pavement (ft)	Field Reading (dB(A))	Model Result (dB(A))	Difference (dB(A))
1	115	65.4	64.7	0.7
2	165	64.9	67.8	-2.9
3	350	62.6	62.1	0.5

2.3.3 Existing conditions worst noise hour

Based on CDOT's *Noise Analysis and Abatement Guidelines*, 66 dBA was used as the threshold noise level in the analysis of the existing conditions in the study area for the NAC B land uses (Exhibit 2-1).

Noise studies typically use the loudest noise conditions in determining the noise levels. The loudest or worst noise hour is the hour with the highest volume of traffic traveling at the fastest, congestion-free speeds. The existing noise conditions range from 45 dBA to 62 dBA. Worst-case conditions on the I-76 mainline and all other roadway segments included in the model were determined to occur during the PM peak period, and those volumes were used in the noise model. For roadway links that experience a less than optimal Level of Service (LOS) rating of LOS D, LOS E, or LOS F during the peak hours of the day, the "worst noise hour" as recommended in Exhibit 4 of the CDOT *Noise Analysis and Abatement Guidelines* can be referenced, which is summarized in the "maximum traffic volumes" column of Exhibit 2-5. Since none of the roadway segments included in the model experienced less than optimal LOS ratings, the actual traffic volumes were used, as shown in Exhibit 2-4. For the I-76 noise analysis, all of I-76 was modeled with a speed of 75 miles per hour (mph), all ramps and frontage roads were modeled with a speed of 50 mph, collector streets and arterials were modeled with a speed of 40 mph or 55 mph, depending on the location, and residential streets were modeled with a speed of 25 mph. Six-legged roundabouts were modeled with a speed of 20 mph, and four-legged roundabouts were modeled with a speed of 15 mph. Daily and hourly volumes as well as truck percentages were collected in September 2013.

Traffic volumes on local streets were not considered in the model because the low speeds of the roadways and the low traffic volumes do not contribute significantly to the overall noise level experienced by the dwelling units.

Exhibit 2-4 Traffic Volumes

Traffic Volumes by Segment							
Roadway Segment	Direction	Existing		2035 No Action Alternative		2035 Action Alternatives	
		PM Peak Hour Volume (vph)	Vehicle Distribution (Cars/Medium Trucks/Heavy Trucks) (%)	PM Peak Hour Volume (vph)	Vehicle Distribution (Cars/Medium Trucks/Heavy Trucks) (%)	PM Peak Hour Volume (vph)	Vehicle Distribution (Cars/Medium Trucks/Heavy Trucks) (%)
I-76 between Bromley and Baseline	EB	1075	85/10/5	1910	85/10/5	N/A	N/A
	WB	855		1110		N/A	N/A
I-76 south of ramps	EB	N/A	N/A	N/A	N/A	2340	88/10/2
	WB					1510	
I-76 between ramps	EB	N/A	N/A	N/A	N/A	1815	88/10/2
	WB					1060	
I-76 north of ramps	EB	N/A	N/A	N/A	N/A	1915	88/10/2
	WB					1160	
I-76 ramps	EB On	N/A	N/A	N/A	N/A	100	88/10/2
	EB Off					525	
	WB On	N/A	N/A	N/A	N/A	450	88/10/2
	WB Off					100	
Bridge Street west of Prairie Falcon Parkway	EB	260	88/10/2	400	88/10/2	490	88/10/2
	WB	275		410		500	
Bridge Street west of West Frontage Rd to Prairie Falcon Parkway	EB	260	88/10/2	255	88/10/2	460	88/10/2
	WB	200		330		550	
Bridge Street between East and West Frontage Rd	EB	110	88/10/2	125	88/10/2	185	88/10/2
	WB	110		130		590	
Bridge Street east of East Frontage Rd	EB	35	88/10/2	95	88/10/2	160	88/10/2
	WB	75		45		95	

Traffic Volumes by Segment							
Roadway Segment	Direction	Existing		2035 No Action Alternative		2035 Action Alternatives	
		PM Peak Hour Volume (vph)	Vehicle Distribution (Cars/Medium Trucks/Heavy Trucks) (%)	PM Peak Hour Volume (vph)	Vehicle Distribution (Cars/Medium Trucks/Heavy Trucks) (%)	PM Peak Hour Volume (vph)	Vehicle Distribution (Cars/Medium Trucks/Heavy Trucks) (%)
Prairie Falcon Parkway north of Bridge Street		136	94/5/1	394	94/5/1	533	94/5/1
Prairie Falcon Parkway south of Bridge Street		92	94/5/1	106	94/5/1	109	94/5/1
West Frontage Road north of Bridge Street		290	91/6/3	350	91/6/3	125	91/6/3
West Frontage Road south of Bridge Street		250	91/6/3	285	91/6/3	105	91/6/3
East Frontage Road north of Bridge Street		60	91/6/3	60	91/6/3	30	91/6/3
East Frontage Road south of Bridge Street		105	91/6/3	180	91/6/3	105	91/6/3

Exhibit 2-5 Maximum Modeled Traffic Volumes for Worst Noise Hour

Posted Speed Limit (MPH)	Maximum Traffic Volumes by Facility Type (vehicles/lane/hour)		
	Freeway	Non-Freeway Multiple Lane	Two-Lane Roadway
75 or above	1,600	N/A	N/A
70	1,700	N/A	N/A
65	1,800	1,700	1,300
60	1,900	1,800	1,300
55	2,000	1,900	1,300
50	2,100	2,000	1,400
45	2,200	2,100	1,500
40	N/A	2,200	1,600
35 or below	N/A	2,200	1,600

Source: CDOT 2013

3. Impact Analysis

Traffic-generated noise levels for the future action conditions were calculated using TNM 2.5 for the 2035 design year. Model inputs included the proposed roadway alignments, traffic volumes, vehicle speed, and truck percentages. To closely model the undulating terrain in the study area, topographic information based on one-foot contours was added to the model. Building rows were added to the model to represent the rows of houses along Bridge Street and on either side of Prairie Falcon Parkway.

Results of the noise models are discussed in Section 4.2. In general, the 2035 Leq(h) values of the receptors within the study area are expected to range from 49 dBA to 65 dB(A) for the Action Alternatives, with an average of 54.8 dBA. Based on the results of the model, noise impacts are not expected to occur at any receptor for the 2035 Action Alternatives.

3.1 Modeling Procedures

The assessment of noise effects from traffic operations is based on a comparison of existing and projected future noise exposure for noise-sensitive land use categories. The following subsections describe the procedures followed for the noise effects analysis.

3.1.1 Noise prediction model

FHWA’s TNM 2.5 was used for all traffic noise modeling. This software is required for all noise analysis per the ruling in 23 CFR §772. TNM calculates traffic noise levels based on input for the worst noise hour traffic volumes, operating speeds, and surrounding environmental characteristics. This information then is used to determine if dwelling units meet or exceed the established noise criteria.

3.1.2 Shielding

Shielding can be assigned to receptors as needed on the corridor by using building rows, barriers, or terrain lines in TNM. This determination is made based on the difference between noise readings collected during data collection and the model output. Terrain lines were added to the model to represent the berm and varying terrain south of Bridge Street and west of the Frontage Road. Building rows were added to the model to represent the rows of houses along Bridge Street and on either side of Prairie Falcon Parkway. The building percentage was calculated for each building row using the total length of all the buildings divided by the total length of the building row. The building percentages ranged from 70% to 80%.

3.1.3 Placement of receptors

The receptor location was placed in the middle of the property closest to the noise source, unless there was an apparent area of frequent outdoor human use. In locations with multiple dwelling units clustered together (such as a densely populated residential neighborhood), dwelling units were grouped to represent up to 10 dwelling units rather than modeling every property on the corridor. All receptors with NAC B land use within 500 feet of the highway edge of pavement (existing or proposed) were included in the model. A signal is proposed at the intersection of Bridge Street and Prairie Falcon Parkway as part of the project, so all receptors with the NAC B activity category within 500 feet of the edge of pavement (existing or proposed) were also included in the model. Areas of future planned development were identified on the west side of I-76, both north and south of Bridge Street. However, no building permits have been issued for any of these parcels, therefore the parcels were not included in this noise study.

All of the residential receivers that were included in the noise models are shown in Exhibit 3-1. Exhibit 3-2 shows the detailed information for the residential receivers, with the corresponding receiver numbers.

Exhibit 3-1. Noise Receivers Included in TNM

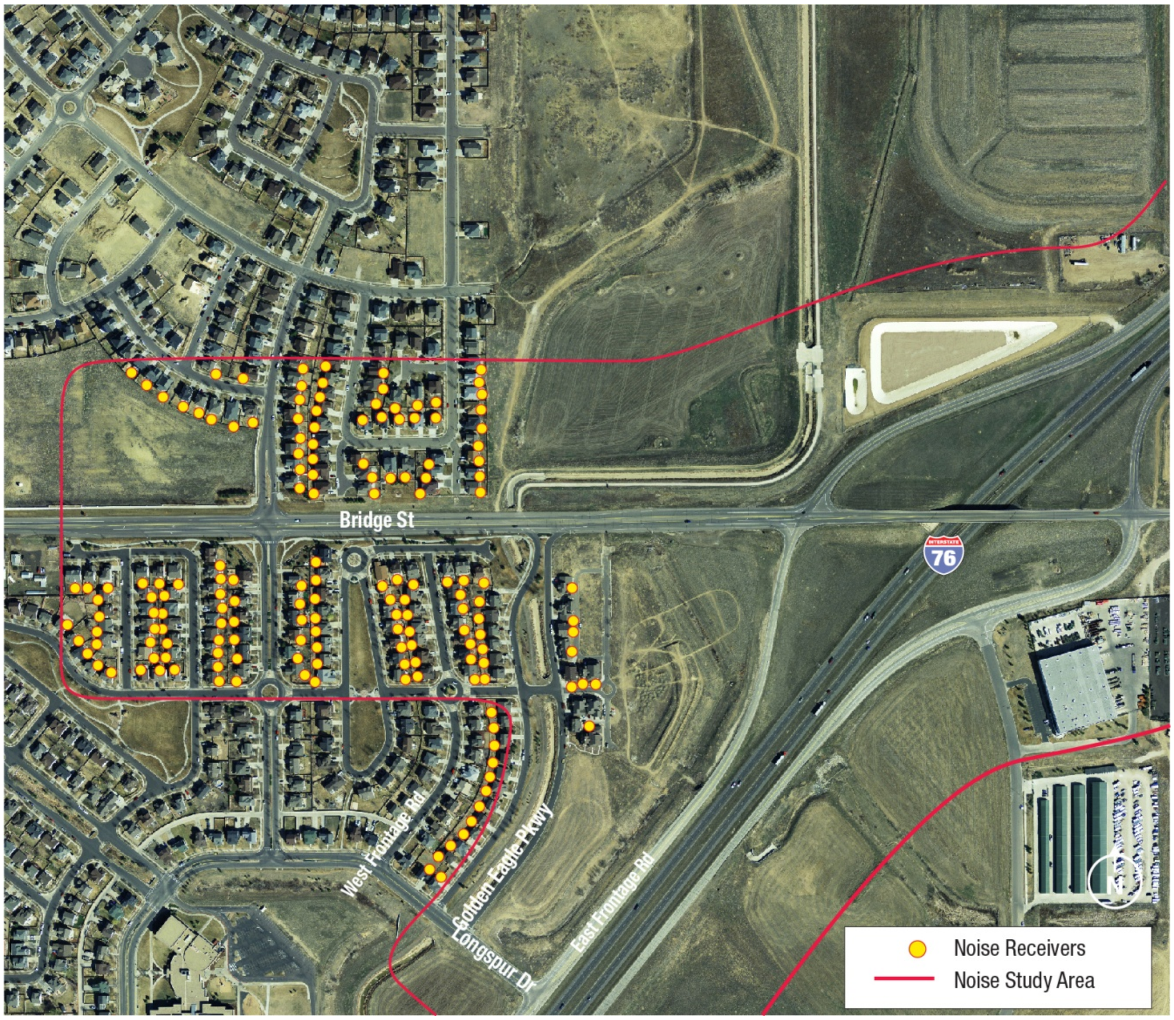
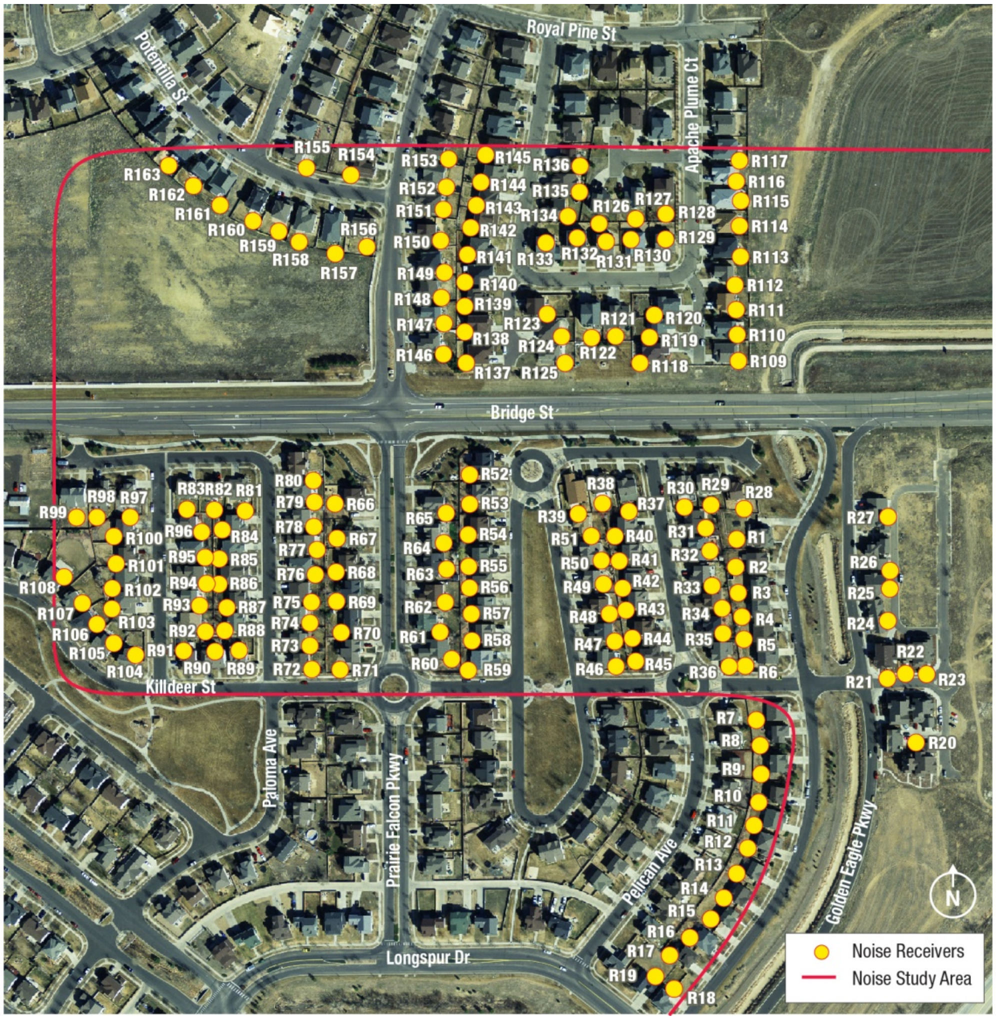


Exhibit 3-2. Detailed Noise Receiver Information



3.1.4 Traffic and speed

As discussed previously, noise monitoring was conducted during worst-case noise conditions. The same is true for modeling. Worst-case conditions on the I-76 mainline and all other roadway segments in the model were determined to occur during the PM peak period, and those volumes were used in the noise model. Exhibit 2-4 provides the volume and vehicle distribution assumptions for the traffic noise modeling. Truck percentages were determined based on values provided in the System-Level Study report which was submitted in September 2013.

3.1.5 Input data

Accurate vertical and horizontal data for roadways, receivers, existing noise walls, existing berms, and jersey barriers were needed for noise modeling. Microstation, geographic information system (GIS), and field reviews were used to provide accurate vertical/horizontal data for all features.

3.1.6 Number of lanes in TNM model

In cases where there are multiple lanes of travel, up to three lanes having the same traffic characteristics may be combined in the model as one roadway segment per direction of travel. Currently, I-76 has two lanes in each direction, so only one roadway segment was needed for each direction of I-76 in the model. Two-lane ramps, frontage roads, collector streets, and arterials were modeled as one roadway segment in TNM.

The roadway segment was modeled down the center of both lanes for a two-lane section or in the center of the lane for a one-lane section. Residential streets were modeled as one roadway segment in TNM, placed in the center between the two directions of travel, to represent both directions of travel.

3.1.7 Modeling years

Traffic-generated noise levels for the future action conditions were calculated for the 2035 future design year. The existing conditions used 2013 traffic volumes.

3.1.8 Alternatives to be modeled

The existing conditions were modeled under the current configuration, with 2013 traffic volumes, to serve as a baseline for a substantial noise increase in future years. The 2035 model was used to model the No-Action Alternative, as well as the three Action Alternatives. The three Action Alternatives are discussed in more detail in upcoming sections.

3.1.9 Interchange modeling

The 2035 model did not include an interchange at Bridge Street for the No-Action Alternative. For the three Action Alternatives, an interchange at Bridge Street was modeled using the specific design associated with each alternative.

3.1.10 Arterial streets/alternate corridors

The traffic noise model included noise-sensitive areas along Bridge Street within 500 feet of I-76 and the frontage roads, and within 500 feet of the intersection of Bridge Street and Prairie Falcon Parkway.

3.1.11 Rounding

Noise values were rounded to the nearest whole number when reporting existing and future noise volumes, per Section 4.6 of the CDOT Noise Analysis and Abatement Guidelines. For cost-benefit calculations, all values were calculated to one tenth of a decimal point, as they are reported in TNM.

3.2 No-Action Alternative

The No-Action Alternative serves as the baseline against which the Action Alternatives were compared. For the purposes of this study, the No-Action Alternative is defined as the existing and planned future facilities within the study area. Under the No-Action Alternative, no further improvements, aside from ongoing operations and maintenance, would be made to the Bridge Street overpass at I-76.

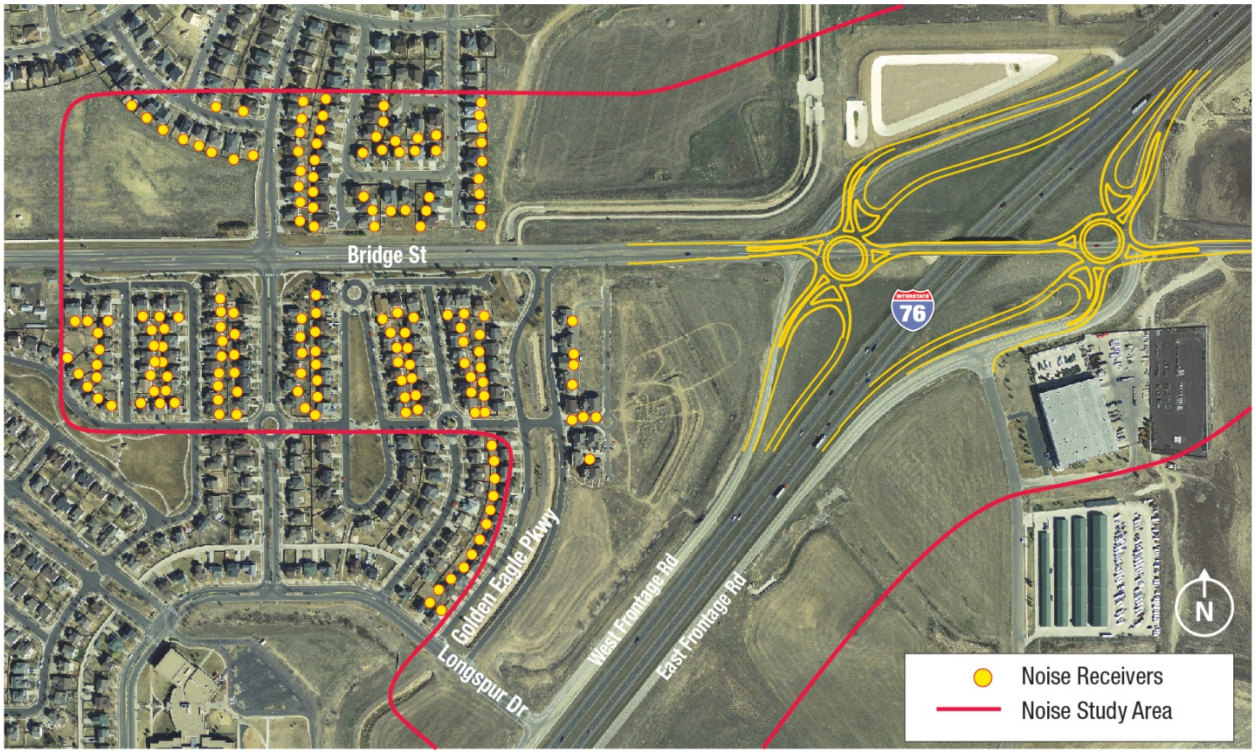
3.2.1 Direct impacts

The only change between the existing conditions and the No-Action Alternative noise models is the amount of traffic. By 2035, the increase in traffic on the existing road network would cause an increase in traffic noise for all dwelling units, but by no more than 4 dBA. Noise levels for the No-Action Alternative range between 47 dBA and 64 dBA. Since no receptors would experience an increase in noise greater than 10 dBA or a noise level greater than the NAC, there are no noise impacts under the No-Action Alternative.

3.3 Preferred Alternative: Two-Roundabout Interchange

The Preferred Alternative for this interchange is the Two-Roundabout Interchange. This alternative combines the frontage roads and ramp terminals to make one six-legged roundabout on either side of I-76. This alternative meets the documented Purpose and Need of the project. It preserves the existing bridge structure of Bridge Street over I-76, can be designed within the existing right of way (ROW), and avoids impacts to the Speer Canal to the northwest of the interchange. This alternative is expected to operate at LOS B in the year 2035. The Two-Roundabout interchange design is shown in Exhibit 3-3 below.

Exhibit 3-3. Preferred Alternative: Two-Roundabout Interchange



3.3.1 Direct impacts

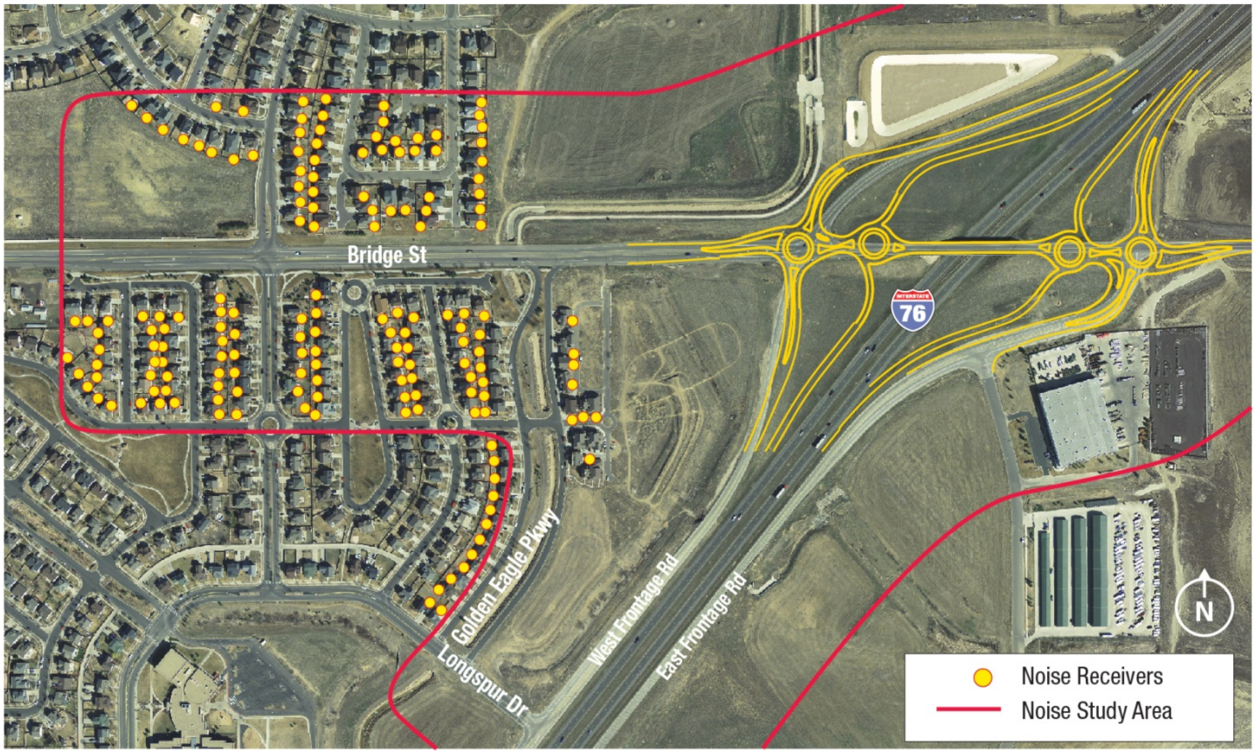
The Preferred Alternative, like all of the Action Alternatives, would draw more traffic to Bridge Street. The increase in volume would create higher noise levels in the neighborhoods surrounding the Bridge Street and Prairie Falcon Parkway intersection, which is reflected in the model results. The frontage road adjacent to I-76 is projected to carry about half the volume in this and all other Action Alternatives as compared to the No-Action Alternative. While the amount of traffic using the freeway facilities would be similar in this and all other Action Alternatives, approximately 100 vehicles in each direction would use the ramps instead of the mainline. These 200 cars would travel at a lower speed when using the ramps, resulting in less noise.

The noise levels in the Preferred Alternative range between 49 dBA and 65 dBA. No receptor experiences more than a 5 dBA increase in noise compared to existing conditions. Since no receptor would experience noise levels above the NAC threshold or a substantial increase in noise, there would be no traffic noise impacts for the Preferred Alternative. Because there are no impacted receptors for this alternative, abatement analysis and mitigation are not required.

3.4 Action Alternative 2: Four-Roundabout Interchange

Action Alternative 2 for this EA is the Four-Roundabout interchange. This alternative creates two four-legged roundabouts on either side of I-76. This alternative meets the documented Purpose and Need of the project. It preserves the existing bridge structure of Bridge Street over I-76 and has minor ROW impacts. The two four-legged roundabouts on the east and west side of I-76 allow truck traffic to be separated from residential traffic. This alternative is expected to operate at LOS B in the year 2035. The Four-Roundabout interchange design is shown in Exhibit 3-4 below.

Exhibit 3-4. Four-Roundabout Interchange



3.4.1 Direct impacts

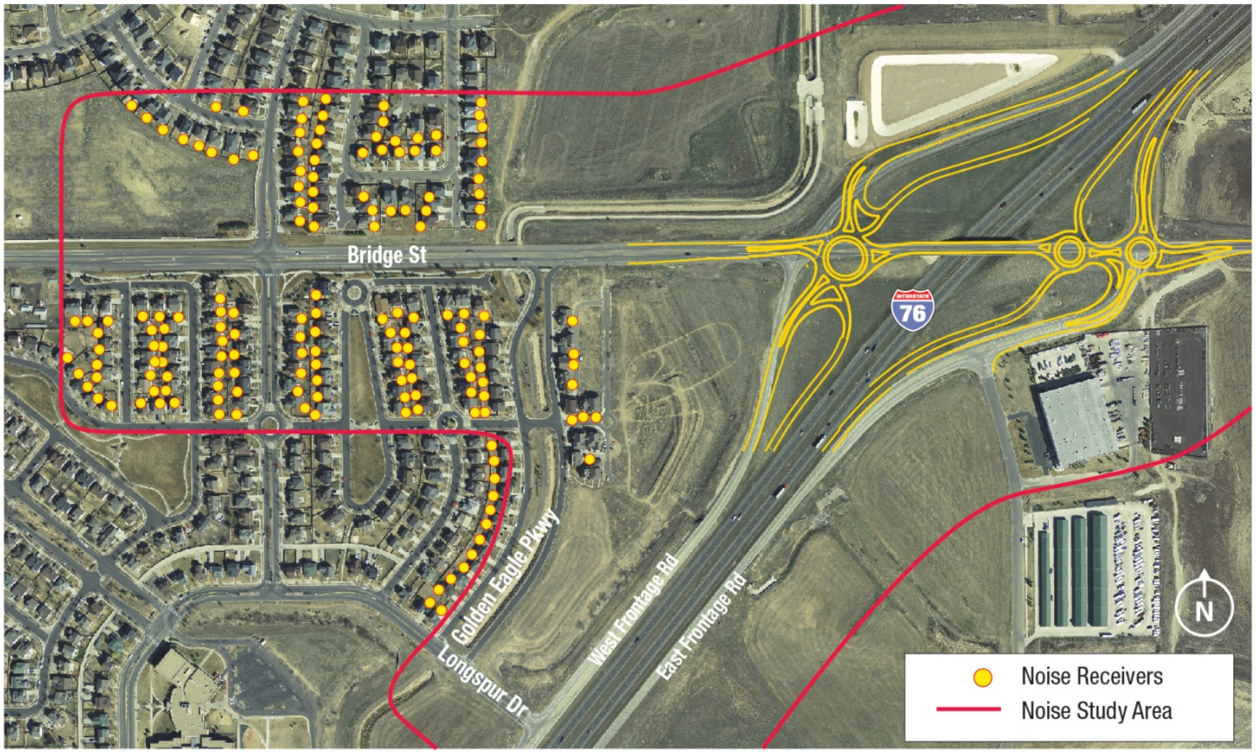
Like The Preferred Alternative, all of the receptors would experience an increase in traffic noise in Action Alternative 2 compared to the Existing Conditions.

The noise levels in Action Alternative 2 range between 49 dBA and 65 dBA. No receptor experiences more than a 5 dBA increase in noise compared to existing conditions. No receptors exceed the NAC threshold of 66 dBA or experience a substantial increase over existing conditions, so there are no noise impacts for Action Alternative 2. Because there are no impacted receptors, abatement analysis and mitigation are not required.

3.5 Action Alternative 3: Three-Roundabout Interchange

Action Alternative 3 for this EA is the Three-Roundabout interchange. This alternative consists of one large roundabout on the west side of I-76 and two smaller roundabouts on the east side of I-76. This alternative meets the documented Purpose and Need of the project. It preserves the existing bridge structure of Bridge Street over I-76 and has minor ROW impacts. The west frontage road and I-76 westbound on- and off-ramps are combined into one six-legged roundabout. The east side connects the eastbound on- and off-ramps to Bridge Street in one four-legged roundabout, and the frontage road to Bridge Street in a second four-legged roundabout. The Three-Roundabout interchange design is shown in Exhibit 3-5 below.

Exhibit 3-5. Three-Roundabout Interchange



3.5.1 Direct impacts

Similar to the Preferred Alternative and Action Alternative 2, all of the receptors would experience an increase in traffic noise compared to the existing conditions.

The noise levels in Action Alternative 3 range between 49 dBA and 65 dBA. No receptor experiences more than a 5 dBA increase in noise compared to existing conditions. No receptors exceed the NAC threshold or experience a substantial increase over existing conditions. Therefore, there are no noise impacts for Action Alternative 3. Because there are no impacted receptors, abatement analysis and mitigation are not required.

3.6 Results Summary

The results for the Existing, 2035 No-Action Alternative, and 2035 Action Alternatives are summarized in Exhibit 3-6. The detailed results are presented in Exhibit 3-7.

There are no impacts to dwelling units with the implementation of any of the alternatives, so mitigation does not need to be considered for the future action conditions.

Exhibit 3-6. Results Summary

Alternative	Predicted Noise Range Leq(h) (dBA)		Total number of Dwelling Units	Number of Dwelling Units that Exceed NAC Threshold	Number of Dwelling Units with a Substantial Noise Increase
	Min	Max			
Existing	45	62	182	0	N/A
2035 No-Action Alternative	47	64	182	0	0
2035 Preferred Alternative	49	65	182	0	0
2035 Action Alternative 2	49	65	182	0	0
2035 Action Alternative 3	49	65	182	0	0

Exhibit 3-7. Detailed Results Summary

Receptor Number	Dwelling Units	NAC Category	Existing Noise Level	2035 No Action Alternatives	2035 Preferred Alternative	2035 Action Alternative 2	2035 Action Alternative 3
1	1	B	55	57	57	58	57
2	1	B	55	56	57	57	57
3	1	B	55	56	57	57	57
4	1	B	55	57	57	57	57
5	1	B	55	57	57	57	57
6	1	B	55	57	57	57	57
7	1	B	56	58	58	58	58
8	1	B	56	58	58	58	58
9	1	B	56	58	58	58	58
10	1	B	57	59	59	59	59
11	1	B	57	59	59	59	59
12	1	B	57	59	59	59	59
13	1	B	58	60	60	60	60
14	1	B	58	60	60	60	60
15	1	B	58	60	60	60	60
16	1	B	58	60	60	60	60
17	1	B	57	59	60	60	60
18	1	B	58	60	60	60	60
19	1	B	57	59	59	60	59
20	10	B	57	59	59	59	59

Receptor Number	Dwelling Units	NAC Category	Existing Noise Level	2035 No Action Alternatives	2035 Preferred Alternative	2035 Action Alternative 2	2035 Action Alternative 3
21	3	B	56	58	58	58	58
22	1	B	56	58	58	58	58
23	4	B	59	61	60	60	60
24	3	B	56	58	58	58	58
25	2	B	56	58	58	58	58
26	2	B	56	58	58	58	58
27	2	B	57	59	59	60	59
28	1	B	57	58	60	60	60
29	1	B	55	57	58	58	58
30	1	B	55	56	57	57	57
31	1	B	55	56	57	57	57
32	1	B	54	56	57	57	57
33	1	B	54	56	56	56	56
34	1	B	54	56	57	57	57
35	1	B	55	57	57	57	57
36	1	B	55	57	57	57	57
37	1	B	52	54	56	56	56
38	1	B	54	55	57	57	57
39	1	B	53	54	56	56	56
40	1	B	51	53	54	54	54
41	1	B	50	52	53	53	53
42	1	B	50	52	53	53	53
43	1	B	50	52	53	53	53
44	1	B	51	53	54	54	54
45	1	B	53	55	55	55	55
46	1	B	53	55	55	55	55
47	1	B	52	54	54	54	54
48	1	B	51	53	53	53	53
49	1	B	51	52	53	53	53
50	1	B	51	52	54	54	54
51	1	B	51	53	55	55	55
52	1	B	60	61	64	64	64
53	1	B	57	59	61	61	61
54	1	B	52	54	57	57	57

Receptor Number	Dwelling Units	NAC Category	Existing Noise Level	2035 No Action Alternatives	2035 Preferred Alternative	2035 Action Alternative 2	2035 Action Alternative 3
55	1	B	50	51	53	53	53
56	1	B	49	50	52	52	52
57	1	B	48	50	51	51	51
58	1	B	48	50	51	51	51
59	1	B	50	52	52	52	52
60	1	B	50	51	52	52	52
61	1	B	49	51	52	52	52
62	1	B	49	51	52	52	52
63	1	B	50	52	53	53	53
64	1	B	51	53	55	55	55
65	1	B	54	56	58	58	58
66	1	B	59	61	62	62	62
67	1	B	53	55	56	56	56
68	1	B	50	52	54	54	54
69	1	B	49	50	52	52	52
70	1	B	48	50	51	51	51
71	1	B	49	50	51	51	51
72	1	B	48	50	51	51	51
73	1	B	48	50	51	51	51
74	1	B	48	50	51	51	51
75	1	B	48	50	52	52	52
76	1	B	50	52	53	53	53
77	1	B	52	54	55	55	55
78	1	B	55	57	58	58	58
79	1	B	59	61	62	62	62
80	1	B	62	64	65	65	65
81	1	B	54	56	57	57	57
82	1	B	54	56	57	57	57
83	1	B	55	56	57	57	57
84	1	B	52	54	55	55	55
85	1	B	49	51	52	52	52
86	1	B	48	49	51	51	51
87	1	B	46	48	49	49	49
88	1	B	46	48	49	49	49

Receptor Number	Dwelling Units	NAC Category	Existing Noise Level	2035 No Action Alternatives	2035 Preferred Alternative	2035 Action Alternative 2	2035 Action Alternative 3
89	1	B	47	48	49	49	49
90	1	B	47	49	50	50	50
91	1	B	47	49	50	50	50
92	1	B	47	49	50	50	50
93	1	B	47	49	50	50	50
94	1	B	48	50	51	51	51
95	1	B	49	51	52	52	52
96	1	B	52	54	55	55	55
97	1	B	54	55	56	56	56
98	1	B	54	56	57	57	57
99	1	B	56	57	58	58	58
100	1	B	52	54	55	55	55
101	1	B	51	52	53	53	53
102	1	B	49	51	52	52	52
103	1	B	49	50	51	51	51
104	1	B	48	50	50	50	50
105	1	B	48	50	50	50	50
106	1	B	48	50	51	51	51
107	1	B	49	51	52	52	52
108	1	B	51	53	54	54	54
109	1	B	59	60	62	62	62
110	1	B	56	57	59	59	59
111	1	B	54	55	57	57	57
112	1	B	52	54	55	55	55
113	1	B	51	53	54	54	54
114	1	B	51	52	53	53	53
115	1	B	50	52	52	52	52
116	1	B	50	51	52	52	52
117	1	B	49	51	51	51	51
118	1	B	58	60	62	62	62
119	1	B	54	56	58	58	58
120	1	B	52	53	55	55	55
121	1	B	56	57	60	60	60
122	1	B	56	58	60	60	60

Receptor Number	Dwelling Units	NAC Category	Existing Noise Level	2035 No Action Alternatives	2035 Preferred Alternative	2035 Action Alternative 2	2035 Action Alternative 3
123	1	B	52	54	56	56	56
124	1	B	55	57	59	59	59
125	1	B	59	60	63	63	63
126	1	B	47	49	50	50	50
127	1	B	47	49	50	50	50
128	1	B	48	50	50	50	50
129	1	B	47	49	50	50	50
130	1	B	47	49	50	50	50
131	1	B	48	49	50	50	50
132	1	B	47	49	50	50	50
133	1	B	47	49	50	50	50
134	1	B	47	49	49	49	49
135	1	B	47	49	49	49	49
136	1	B	47	49	49	49	49
137	1	B	59	61	63	63	63
138	1	B	54	56	59	59	59
139	1	B	52	54	56	56	56
140	1	B	50	52	54	54	54
141	1	B	49	51	53	53	53
142	1	B	47	50	52	52	52
143	1	B	47	49	51	51	51
144	1	B	46	48	50	50	50
145	1	B	45	47	49	49	49
146	1	B	58	60	62	62	62
147	1	B	54	56	58	58	58
148	1	B	51	54	56	56	56
149	1	B	50	52	54	54	54
150	1	B	49	52	53	53	53
151	1	B	48	50	52	52	52
152	1	B	47	49	51	51	51
153	1	B	46	48	50	50	50
154	1	B	47	50	51	51	51
155	1	B	46	48	50	50	50
156	1	B	54	58	59	59	59

Receptor Number	Dwelling Units	NAC Category	Existing Noise Level	2035 No Action Alternatives	2035 Preferred Alternative	2035 Action Alternative 2	2035 Action Alternative 3
157	1	B	52	55	57	57	57
158	1	B	51	53	55	55	55
159	1	B	51	52	54	54	54
160	1	B	50	52	53	53	53
161	1	B	49	51	52	52	52
162	1	B	48	50	51	51	51
163	1	B	47	49	50	50	50

4. Mitigation

4.1 Construction Noise

Construction noise will present the potential for short-term impacts to those receptors located along the corridor and along designated construction access routes. However, these impacts are difficult to predict. It is anticipated that a portion of the construction will occur at night to minimize traffic disruption. The primary source of construction noise is expected to be diesel-powered equipment, such as trucks and earth-moving equipment, and construction activities such as demolition hammers on trackhoes, rubble load outs, and tailgate and bucket bang.

Construction noise at off-site receptor locations will usually be dependent on the loudest one or two pieces of equipment operating at the moment. Noise levels from diesel powered equipment range from 80 to 95 dBA at a distance of 50 feet. Noise impacts are expected to occur during the day and night, but only in isolated areas along the project corridor.

This project will abide by all appropriate city codes as they pertain to construction noise. If noise levels during construction are expected to exceed the limits from the city code, the contractor must obtain the necessary ordinance variance.

According to the Building Division of the Development Services Office, the unincorporated sections of Adams County do not have a noise ordinance pertaining to construction. At Bridge Street, the City of Brighton limits are approximately one-half mile east of I-76. Unincorporated Adams County lies beyond that limit.

4.1.1 Construction mitigation

This EA document can only present mitigation recommendations, not requirements or final decisions. That step is left to final design. However, the following recommendations for mitigation measures are proposed.

Since there are only temporary noise impacts with construction of the Action Alternatives, no permanent noise mitigation is recommended. However, prior to construction, all relevant permissions will be acquired. Each construction contractor shall submit a work plan outlining work schedules and intended mitigation measures prior to initiating construction.

The following Best Management Practices (BMPs) will be recommended for the contractor as applicable:

- Use noise blankets on equipment and quiet-use generators

- Minimize construction duration in residential areas as much as possible
- Minimize night-time activities in residential areas as much as possible
- Re-route truck traffic away from residential streets where possible
- Combine noisy operations to occur in the same time period

Additional BMPs for consideration include:

- Eliminating slamming of truck beds, truck tailgates, and equipment buckets
- Idling down equipment engines when the equipment is not in immediate use
- Maintaining all equipment to meet manufacturer's specifications
- Scheduling trucks properly to minimize long queues
- Minimizing back-up distances for trucks and other equipment
- Installing localized noise shielding around compressors and other equipment when in close proximity to residences.

Contractors also will consider maintaining contact with the public through a 24-hour telephone line for questions and concerns and providing schedules of planned construction activities.

For more information on construction noise issues, see FHWA's *Highway Construction Noise Handbook* (2006).

4.2 Local Agency Coordination

Local government officials can promote compatibility between land development and highways by ensuring that NAC B,C, and E type development is restricted or limited within the areas that are projected to be impacted by traffic noise. Noise contours will be provided to local officials as a part of this project. These contours can be used to establish compatible development of currently undeveloped parcels or compatible redevelopment in areas where land use changes. NAC E sites should use this information to situate outdoor use areas associated with office buildings and commercial centers away from the roadway.

5. Summary

To determine noise impacts for the project, existing and future 2035 traffic volumes were used. Field measurements were taken in the project area to validate the existing noise model. To validate the existing noise model, results from field measurements need to be within +/- 3 dBA of the output from the model. After the existing noise model was validated, the Action and No-Action Alternatives were modeled with future 2035 traffic volumes; the Action Alternatives included an interchange at Bridge Street with three different roundabout configurations.

TNM modeling results indicate that no highway traffic noise impacts would occur under any of the No-Action or any of the Action alternatives. Therefore, no noise abatement analysis was required and no noise mitigation will be provided for the effects of this project.

6. References

Atkins, 2013. I-76 and Bridge Street: Approval Request for an Interchange at I-76 and Bridge Street, System-Level Study. Atkins North America, Inc., Denver, Colorado. September 2013.

Colorado Department of Transportation. (2013). Noise Analysis and Abatement Guidelines. Denver: Author.

Federal Highway Administration. (2010). Procedures for Abatement of Highway Traffic Noise and Construction Noise. Washington, D.C.: Author.

Federal Highway Administration. (2011). Highway Traffic Noise: Analysis and Abatement Guidance. Washington, D.C.: Author.

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Appendices

Appendix A: Details of Field Measurements

Appendix A.

Details of Field Measurements

4/25/13 Brighton Noise Readings

Start: 3:04
End: 3:14

I-76 NB

C	M	H
98	7	26

E Front

C	M	H
9		6

I-76 SB

C	M	H
73	3	17

W Front

C	M	H
23		

Sunny, Clear
75° 8-10 MPH wind

100' → 65.4 dBA
200' → 64.9 dBA

Ambient ~500' → 62.6 dBA