US 36 CORRIDOR

Final Environmental Impact Statement/
Final Section 4(f) Evaluation

Highway Noise Analysis Technical Report (Addendum)

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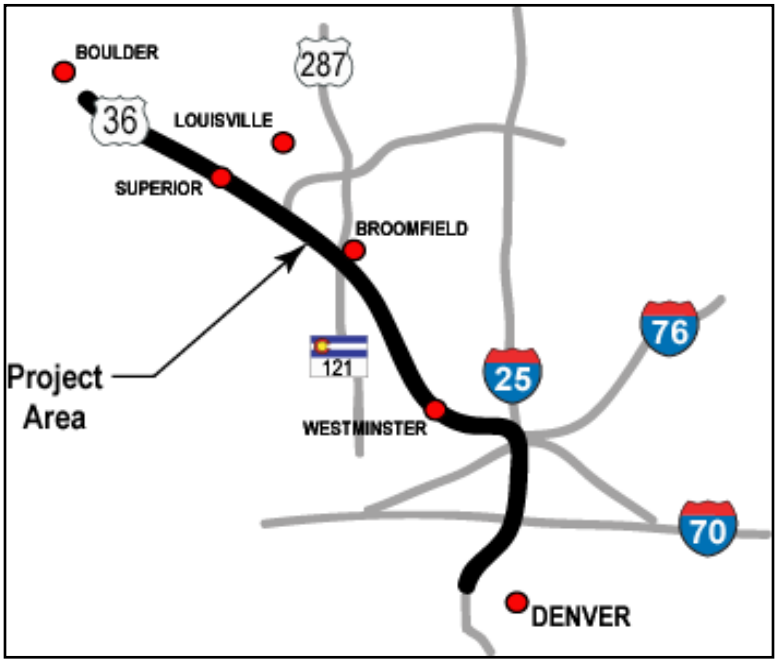
BRT	bus rapid transit
CDOT	Colorado Department of Transportation
dB	decibel
dBA	decibel (A-weighted scale)
FHWA	Federal Highway Administration
FTA	Federal Transit Administration
HOV	high-occupancy vehicle
Hz	hertz
I-#	Interstate #
Leq	equivalent sound level
LOS	level of service
mph	mile per hour
NAC	Noise Abatement Criteria
ROW	right-of-way
URS	URS Corporation
US 36	United States Highway 36

This report describes the results of a traffic noise study conducted for the Combined Alternative Package (Preferred Alternative) and Package 1: No Action (2035) for the United States Highway 36 (US 36) Corridor Improvements Project. The noise study area extends for approximately 25 miles between Denver and Boulder along US 36 and Interstate 25 (I-25), as shown in Figure 1-1, Project Location/Highway Noise Study Area. The limits of construction for this project are from about Table Mesa Drive in Boulder to the I-25 interchange. Traffic noise impacts and mitigation from Package 2 and Package 4, and Package 1 (2025) were documented previously in the report entitled *Highway Noise Analysis Report, US 36 Corridor Draft EIS* (Hankard Environmental et al. 2007) and are not repeated here. Only highway and bus noise impacts are described herein. Noise and vibration impacts from the proposed commuter rail operations on the existing BNSF Railway tracks are described in a separate report.

Figure 1-1: Project Location/Highway Noise Study Area



Source: US 36 Mobility Partnership, 2009.

The analysis of highway noise impacts and mitigation was conducted according to Colorado Department of Transportation (CDOT) guidelines. Existing noise levels were measured and used to validate a computer highway noise model (measurements and model validation are described in the Package 2 and Package 4 *Highway Noise Analysis Report, US 36 Corridor Draft EIS* [Hankard Environmental, et al. 2007]). The model was used to predict loudest hour noise levels for Package 1 conditions in 2035 and for the Combined Alternative Package (Preferred Alternative) in 2035. The predicted noise levels were compared to CDOT's Noise Abatement Criteria (NAC), and the feasibility and reasonableness of noise mitigation was analyzed at all locations where the criteria were exceeded. Section 2, Methodology, describes the standards used to assess noise impacts and the methodologies used to measure and predict noise levels. Section 3, Noise Impact Assessment, describes the predicted noise levels and the results of the noise impact assessment. Noise mitigation is described in Section 4, Noise Mitigation, and construction noise is addressed in Section 5, Construction Noise. Appendices A, B, and C

contain the following data, respectively: relevant noise terminology, noise model input data, and detailed maps.

2.1 NOISE ANALYSIS STANDARDS

The noise analysis was conducted according to CDOT noise guidelines, which are set forth in the document entitled *CDOT Noise Analysis and Abatement Guidelines* (CDOT 2002). The CDOT noise guidelines are consistent with those of the Federal Highway Administration (FHWA) (23 Code of Federal Regulations 772) and have been approved by the FHWA for use on Federal-aid projects in Colorado.

CDOT's guidelines establish NAC and design and cost requirements for noise mitigation. The guidelines state that noise mitigation must be considered for any receptor or group of receptors where predicted traffic noise levels, using future traffic volumes and roadway conditions, equal or exceed CDOT's NAC shown in Table 2-1, CDOT Noise Abatement Criteria. The guidelines also state that noise mitigation must be considered for any receptors where predicted noise levels for future conditions are greater than existing noise levels by 10 decibels (A-weighted scale) (dBA) or more.

Table 2-1: CDOT Noise Abatement Criteria

Activity Category	Leq[1] (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)	Picnic areas, recreation areas, playgrounds, active sports areas, parks, residences, motels, hotels, schools, churches, libraries, and hospitals.
C	71 (exterior)	Developed lands, properties, or activities not included in Categories A or B above.
D	--	Undeveloped lands.
E	51 (interior)	Residences, motels, hotels, public meeting rooms, schools, churches, libraries, hospitals, and auditoriums.

Source: US 36 Mobility Partnership, 2009.

Notes:

[1] Hourly A-weighted equivalent level for the "noisiest hour" of the day in the design year.

-- = not applicable

CDOT = Colorado Department of Transportation

dBA = decibel (A-weighted scale)

Leq = equivalent sound level

Wherever the NAC or increase criterion are met or exceeded, CDOT guidelines require that a mitigation analysis be conducted. This analysis entails first determining if proposed mitigation meets the following "feasibility" criteria:

- Absolute minimum noise reduction of at least 5 dBA at one front-row receiver, and a "desired" substantial reduction of 10 dBA at front row receptors
- No "fatal flaw" maintenance or safety issues
- For barriers – continuous construction (limited breaks)

Mitigation measures that are considered feasible are then reviewed using the "reasonableness" criteria listed below. Each criterion is given a rating ranging from "unreasonable" to "very reasonable" based on the information provided in CDOT's guidelines. The decision of whether

or not to include each proposed mitigation measure in the project is made by reviewing the ratings.

- Cost benefit ratio
- Overall design-year noise levels
- Impacted persons' desires
- Development type
- Development existence
- Increase in noise levels

2.2 NOISE LEVEL MEASUREMENTS

See the *Highway Noise Analysis Report, US 36 Corridor Draft EIS* (Hankard Environmental et al. 2007).

2.3 NOISE LEVEL PREDICTION METHODOLOGY

The STAMINA 2.0 software model was used to predict future noise levels and the effects of potential mitigation measures. The STAMINA model calculates the hourly, A-weighted equivalent sound level (Leq) at a receptor location given the noise emission level of automobiles, medium, and heavy trucks; the volume and speed of each of these vehicle types on each roadway of interest; the relative location of all roadways, receptors, and terrain features (i.e., natural and man-made barriers); and the type of terrain that exists between each receptor and each roadway. Roadway and terrain data were obtained from computer-aided drafting files. The location and land use of receptors was obtained by conducting a field survey. Traffic data were obtained from URS Corporation (URS) and corresponds to level of service (LOS) "C" conditions. Appendix B, Noise Model Input Data, provides a more detailed description of the modeling procedures and input data used to predict noise levels on this project.

2.4 VALIDATION OF NOISE PREDICTION PROCEDURES

See the *Highway Noise Analysis Report, US 36 Corridor Draft EIS* (Hankard Environmental et al. 2007).

3.1 NOISE ABATEMENT CRITERION B NOISE IMPACTS

For CDOT Category B receptors (residences, parks, schools, etc.), noise impact was assessed by predicting existing and future noise levels at a total of 108 locations. This process was conducted for the Package 1 and the Combined Alternative Package (Preferred Alternative). A receptor is considered impacted if its design-year (2035) noise level equals or exceeds 66 dBA, or if design-year noise levels are predicted to exceed existing levels by 10 dBA or more. The predicted noise levels and the results of the noise impact assessment for each alternative are shown in Table 3-1, Predicted Loudest Hour Noise Levels for Noise Abatement Criterion B Receptors for the Combined Alternative Package (Preferred Alternative). Noise impacts along I-25 and within the Denver Segment where no physical construction will occur were determined on a more qualitative basis, which was based on measured noise levels and expected traffic volume increases.

Table 3-1: Predicted Loudest Hour Noise Levels for Noise Abatement Criterion B Receptors for the Combined Alternative Package (Preferred Alternative)

Receptor Number	Description	Existing (2003) (dBA)	Package 1: No Action (2035) (dBA)	Combined Alternative Package (Preferred Alternative) (2035) (dBA)	Combined Alternative Package (Preferred Alternative) Impact? (dBA)
R1 – R16	Denver Segment	NA	NA	NA	NA
R17	SF Homes off Greenwood Boulevard	66	61	62	NA
R18	SF Homes off Broadway Off-Ramp	70	70	71	Yes
R19	SF Homes off Greenwood Boulevard	64	57	58	NA
R21	SF Homes - Broadway to Pecos Street	57	(1)	(1)	NA
R22	SF Homes - Broadway to Pecos Street	60	(1)	(1)	NA
R23	SF Homes - Broadway to Pecos Street	53	(1)	(1)	NA
R24	SF Homes - Broadway to Pecos Street	60	(1)	(1)	NA
R25	SF Homes - Broadway to Pecos Street	56	(1)	(1)	NA
R26	SF Homes - Broadway to Pecos Street	62	(1)	(1)	NA
R27	SF Homes - Pecos Street to Federal Boulevard	60	(1)	(1)	NA
R28	SF Homes - Pecos Street to Federal Boulevard	63	(1)	(1)	NA
R29	SF Homes - Pecos Street to Federal Boulevard	60	(1)	(1)	NA
R30	SF Homes - Pecos Street to Federal Boulevard	56	(1)	(1)	NA
R31	SF Homes - Pecos Street to Federal Boulevard	61	(1)	(1)	NA
R32	SF Homes - Pecos Street to Federal Boulevard	61	(1)	(1)	NA
R33	SF Homes - Pecos Street to Federal Boulevard	62	(1)	(1)	NA
R34	SF Homes - Pecos Street to Federal Boulevard	61	(1)	(1)	NA
R35	SF Homes - Pecos Street to Federal Boulevard	57	(1)	(1)	NA
R36	SF Homes - Pecos Street to Federal Boulevard	63	(1)	(1)	NA
R37	SF Homes - Pecos Street to Federal Boulevard	62	(1)	(1)	NA
R38	SF Homes - Pecos Street to Federal Boulevard	57	(1)	(1)	NA
R39	Waddell Park	63	63	63	NA
R40	CRC and Westminster Park	65	65	66	Yes
R41	SF Homes - Federal Boulevard to 80th Avenue	62	(1)	(1)	NA
R42	SF Homes - Federal Boulevard to 80th Avenue	57	(1)	(1)	NA
R43	SF Homes - Federal Boulevard to 80th Avenue	64	(1)	(1)	NA
R44	SF Homes - Federal Boulevard to 80th Avenue	58	(1)	(1)	NA

Table 3-1: Predicted Loudest Hour Noise Levels for Noise Abatement Criterion B Receptors for the Combined Alternative Package (Preferred Alternative)

Receptor Number	Description	Existing (2003) (dBA)	Package 1: No Action (2035) (dBA)	Combined Alternative Package (Preferred Alternative) (2035) (dBA)	Combined Alternative Package (Preferred Alternative) Impact? (dBA)
R45	SF Homes - Federal Boulevard to 80th Avenue	63	(1)	(1)	NA
R46	SF Homes - Federal Boulevard to 80th Avenue	58	(1)	(1)	NA
R47	SF Homes - Federal Boulevard to 80th Avenue	61	(1)	(1)	NA
R48	SF Homes - Federal Boulevard to 80th Avenue	61	(1)	(1)	NA
R49	SF Homes - Federal Boulevard to 80th Avenue	54	(1)	(1)	NA
R50	SF Homes - Federal Boulevard to 80th Avenue	59	(1)	(1)	NA
R51	SF Homes - 80th Avenue to Sheridan Boulevard	60	(1)	(1)	NA
R52	Westminster Hills Elementary School	62	(1)	(1)	NA
R53	SF Homes - 80th Avenue to Sheridan Boulevard	60	(1)	(1)	NA
R54	SF Homes - 80th Avenue to Sheridan Boulevard	60	(1)	(1)	NA
R55	Park along Oakwood Drive	61	(1)	(1)	NA
R56	SF Homes - 80th Avenue to Sheridan Boulevard	59	(1)	(1)	NA
R57	SF Homes - 80th Avenue to Sheridan Boulevard	57	(1)	(1)	NA
R58	Rotary Park	58	(1)	(1)	NA
R59	SF Homes - 80th Avenue to Sheridan Boulevard	64	(1)	(1)	NA
R60	SF Homes - 80th Avenue to Sheridan Boulevard	63	(1)	(1)	NA
R61	SF Homes - 80th Avenue to Sheridan Boulevard	56	(1)	(1)	NA
R62	SF Homes - 80th Avenue to Sheridan Boulevard	59	(1)	(1)	NA
R63	Madison Hill Townhomes	73	70	73	(2)
R64	Madison Hill Townhomes	66	65	66	Yes
R65	Tuscany Trails - SF Homes	62	70	71	Yes
R66	Open Space	71	67	68	Yes
R67	Open Space	72	69	70	Yes
R68	Westcliff Apartments	59	62	62	NA
R69	SF Homes - off North Westcliff Parkway	62	64	64	NA
R70	Open Space	68	70	70	Yes
R71	Lower Church Park	68	65	69	Yes
R72	SF Homes - off Old Wadsworth Boulevard	62	62	63	(2)
R73	SF Homes - off Old Wadsworth Boulevard	69	69	71	Yes
R74	SF Homes - off new 120th Avenue	58	56	60	NA
R75	SF Home - off existing 120th Avenue	65	64	66	Yes
R76	SF Home - off existing 120th Avenue	65	63	72	(2)
R77	SF Home - off existing 120th Avenue	58	57	60	NA
R77a	Arista Townhomes	59	57	60	NA
R77b	Arista Townhomes	58	57	60	NA
R78	East Interlocken Park	69	71	70	Yes
R79	Interlocken Golf Course	65	68	68	Yes
R80	Interlocken West Trail	60	65	66	Yes
R81	Rock Creek Apartments	62	65	66	Yes
R82	Rock Creek Apartments	53	57	57	NA
R83	SF Homes - west of 88th Street	59	61	62	NA
R84	SF Homes - west of 88th Street	55	56	57	NA
R85	SF Homes - west of 88th Street	58	58	59	NA

Table 3-1: Predicted Loudest Hour Noise Levels for Noise Abatement Criterion B Receptors for the Combined Alternative Package (Preferred Alternative)

Receptor Number	Description	Existing (2003) (dBA)	Package 1: No Action (2035) (dBA)	Combined Alternative Package (Preferred Alternative) (2035) (dBA)	Combined Alternative Package (Preferred Alternative) Impact? (dBA)
R86	Coal Creek Golf Course	70	71	72	Yes
R87	SF Homes - behind Coal Creek Golf Course	59	60	61	NA
R88	Hotels - off McCaslin Boulevard	63	64	64	NA
R89	SF Homes - off Dyer Road	60	60	60	NA
R90	SF Homes - off Dyer Road	68	68	68	Yes
R91	SF Homes - off Dyer Road	68	68	67	Yes
R92	SF Homes - off Dyer Road	65	64	63	NA
R93	SF Homes - off Marshall Drive	65	65	64	NA
R94	SF Homes - off Marshall Drive	65	68	66	Yes
R95	SF Homes - off Marshall Drive	60	59	58	NA
R96	SF Home - north of US 36	57	57	56	NA
R97	SF Home - off Cherryvale Road	62	62	61	NA
R98	SF Home - off Cherryvale Road	62	62	61	NA
R99	Apartments - off South Boulder Road	64	64	64	NA
R100	Townhomes - off Table Mesa Drive	65	63	63	NA
R101	Townhomes - off Apache Road	60	61	61	NA
R102	Townhomes - off Apache Road	66	67	67	Yes
R103	Apartments - off Moorhead Avenue	73	71	72	(2)
R104	SF Homes - off Moorehead Avenue	62	63	64	NA
R105	SF Homes - off Moorehead Avenue	73	71	72	Yes
R106	SF Homes - off Apache Road	67	68	68	Yes
R107	SF Homes - off Apache Road	55	56	57	NA
R108	SF Homes - off Moorehead Avenue	53	54	54	NA
R109	SF Homes - off Apache Road	66	68	67	Yes
R110	SF Homes - off Apache Road	58	57	57	NA
R111	SF Homes - off Moorehead Avenue	73	71	71	Yes
R112	SF Homes - off Moorehead Avenue	63	64	64	NA
R113	SF Homes - off Apache Road	55	59	59	NA
R114	Open Space	68	69	69	Yes
R115	University of Colorado Dorms	63	64	64	NA
R116	SF Homes - off Moorehead Avenue	54	55	56	NA
R117	SF Homes - off Moorehead Avenue	63	64	64	NA
R118	SF Homes - off Moorehead Avenue	72	70	70	Yes
R119	SF Homes - off Moorehead Avenue	73	70	70	Yes
R120	Apartments - off Moorhead Avenue	62	61	61	NA

Source: US 36 Mobility Partnership, 2009.

Notes:

(1) Not impacted due to existing noise wall which will be replaced if removed.

(2) Property acquired under this Alternative.

NA = indicates no noise predictions conducted for Denver Segment

SF = single family

The locations where noise levels are considered impacted are shown in Figure 3-1, Noise Abatement Criterion B Noise Impact Locations. All of the impacts are the result of exceeding the 66 dBA NAC. Noise levels are not predicted to increase by 10 dBA or more at any of the receptor locations.

Under the Combined Alternative Package (Preferred Alternative), some of the properties from R21 to R62 would be acquired to make room for the expanded roadway, and some of the existing noise walls would be removed and rebuilt along the edge of the expanded road. The list of properties that would be acquired and the list of which existing noise barriers would be removed will be finalized during final design. The existing properties behind the existing noise walls are not currently impacted by noise, and would not be in the future provided that any noise walls that are removed are replaced with a barrier that meets all of CDOT's feasibility and reasonableness criteria.

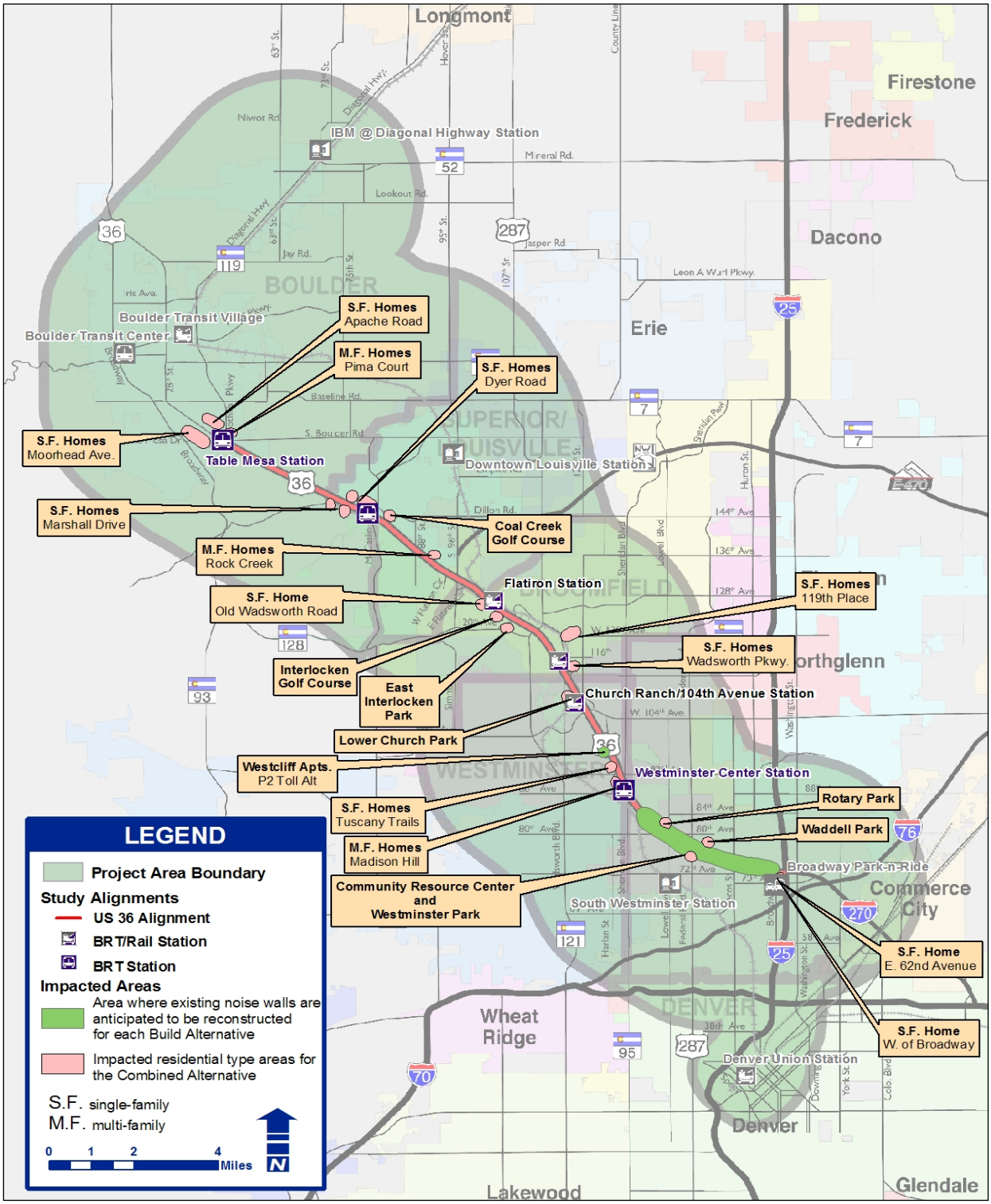
3.2 NOISE ABATEMENT CRITERION C NOISE IMPACTS

Noise impact at commercial (NAC C) properties was assessed by predicting the location of the 71 dBA noise level contour along both sides of the highway, and identifying the commercial properties located between the highway and the contours. There are three restaurants with outdoor seating near Pecos Street (Great Scott, Brewski's, and Famous Doors), but outdoor noise levels at these locations are predicted to be less than 71 dBA in 2035. There are a number of businesses along US 36 near Sheridan Boulevard that are relatively close to the highway, but none have any outdoor use that would substantially benefit from noise mitigation. Finally, the Dark Horse Saloon on Baseline Road in Boulder has outdoor seating along US 36, but predicted levels there do not exceed 71 dBA. In summary, none of the commercial land uses along US 36 that have predicted noise levels equal to or greater than 71 dBA have any outdoor use to warrant noise mitigation.

3.3 BUS RAPID TRANSIT AT TABLE MESA DRIVE

In the previous analysis (Package 2 and Package 4) there were two options for the bus rapid transit (BRT) accessing the Table Mesa Station. Under the Combined Alternative Package (Preferred Alternative), there is only one (at-grade), which was included in the analysis discussed above.

Figure 3-1: Noise Abatement Criterion B Noise Impact Locations



Source: US 36 Mobility Partnership, 2009.
Note: The 116th Avenue Rail Station is not a part of the 2004 FasTracks Program. Additional stations were added in the early planning stages of the US 36 Environmental Impact Statement. Exact rail station locations and additional stations may be reconsidered in the U.S. Army Corps of Engineers/Regional Transportation District Northwest Rail Environmental Assessment/Environmental Evaluation.

3.4 TRANSIT STATION NOISE IMPACTS

A Federal Transit Administration (FTA) noise screening analysis was conducted for the three transit stations that would be expanded under the build alternatives (FTA 2006). This includes the Westminster Center Station at Sheridan Boulevard, 116th Avenue Station, and the McCaslin Station. For the Westminster Center Station, the nearest residence is approximately 1,300 feet away surrounded by a mall, commercial properties, and US 36. Per the screening analysis, buses and automobiles accessing the Westminster Center Station are not predicted to create a noise impact. For the 116th Avenue Station, there are commercial properties to the north, open lands to the east, US 36 to the west, and one unobstructed single-family home approximately 100 feet to the south. This single-family home is within the 225 feet screening distance for a noise impact. As part of final design, further analysis is recommended to determine if noise mitigation would be warranted. For the McCaslin Station, the nearest residence is about 1,500 feet to the west and is blocked by at least one large building. The nearest hotel is approximately 400 feet to the east and on the other side of McCaslin Boulevard. Directly surrounding this station is a movie theater, other commercial properties, McCaslin Boulevard, and US 36. In conclusion, with the exception of the one home near the proposed 116th Avenue Station, no noise impacts are predicted. Mitigation for the one home near the 116th Avenue Station will be investigated during final design.

3.5 DROP-RAMP IMPACTS

There are no drop-ramps being proposed under the Combined Alternative Package (Preferred Alternative).

3.6 INDIRECT IMPACTS

The proposed project has the potential to indirectly affect residents living along roads that feed traffic onto US 36 and to BRT/rail stations. Also, increased bus and automobile traffic at BRT/rail stations within downtown Boulder and Denver are expected to occur due to this project. The following describes the indirect impacts along I-25 south of US 36, within downtown Denver, and within downtown Boulder.

There are a number of residential neighborhoods located along I-25 between 20th Street and I-70. However, due to either distance from the highway or shielding from existing sound walls or buildings, predicted noise levels at these locations are less than 66 dBA. Less than 1 dBA change in loudest hour noise levels would be expected at these residences as a result of implementing the Combined Alternative Package (Preferred Alternative), as the project would not add any capacity to I-25. It would add some bus traffic in the managed lanes, but the number of added buses is minor compared to existing traffic volumes. A slightly larger increase (less than 2 dBA) is possible at the high-rise condominiums located along the 20th Street high-occupancy vehicle (HOV)/express ramp, because the number of added buses is slightly more compared to the overall volume of traffic on the ramp.

Downtown Boulder has a broad mix of uses including retail, employment, and residential. The area around the downtown Boulder Station is commercial. Transit ridership is expected to increase by 140 and 170 boardings per day at the downtown Boulder Station in Package 2 and Package 4, respectively. The peak hour would see about 60 percent of these boardings, or about

85 to 105 between the two packages. Because the station is in the downtown area, less than half of the peak hour patrons would arrive by automobile at the rate of about 1 minute per new vehicle. A barely perceptible impact from additional noise generated by automobiles would be expected. Ten more buses would be added during the peak hours to the downtown station, resulting in a bus every 3 to 3.5 minutes. In the Combined Alternative Package (Preferred Alternative), there would be an additional three buses along Broadway over Package 1, resulting in a bus every 5 minutes. These volumes would be accommodated in the downtown street network with no additional noise or vibration impact expected. The Regional Transportation District will continue to work with the City of Boulder and others through the FasTracks local organization process to accommodate the additional bus traffic in downtown Boulder.

The Boulder Transit Village is currently in the planning stages as a mixed-use, transit, and pedestrian-oriented development at 30th Street and Pearl Street. Residential uses as well as employment and retail commercial uses are planned. Immediately to the north, residential areas exist, including the Steel Yard redevelopment project with a combination of live-work units. The bus-oriented transit facilities would be located off Pearl Street on the southern portion of the site. The commuter rail station in Package 1 would be located on the north portion of the area. In all package, the added BRT service would draw riders from the commuter rail service for no change in ridership on a daily basis. The number of new bus trips to provide the BRT service would increase by 20 in the peak hours for a rate of a bus every 2.5 minutes in Package 2 and Package 4, and would increase by 14 in the Combined Alternative Package (Preferred Alternative) for a rate of a bus every 3 to 3.5 minutes. Noticeable noise and vibration increases from the bus operations would not be expected.

4.0 NOISE MITIGATION

A noise mitigation review was conducted for each of the areas considered impacted by the Combined Alternative Package (Preferred Alternative). The analysis was conducted in accordance with *Noise Analysis and Abatement Guidelines* (CDOT 2002), as previously described. The range of noise mitigation options includes shifting the highway away from residences, depressing the highway into the ground, reducing the design speed, installing low noise pavement, and constructing barriers along the highway. The feasibility and reasonableness of applying each of these measures to this project are as follows.

4.1 SHIFT HIGHWAY

Shifting US 36 to reduce impacts is not applicable to this project because extensive development exists along both sides of the highway.

4.2 DEPRESS HIGHWAY

Depressing the highway into the ground such that it is not visible from adjacent residences is not applicable to this project because of the complexity and cost of the retaining walls that would be required.

4.3 REDUCE DESIGN SPEED

Each 5 mile per hour (mph) reduction in speed results in approximately 1 dBA of noise reduction. However, a reduction in speed means less traffic flow, which does not meet the Purpose and Need for this project. In addition, speed reductions are difficult to enforce.

4.4 INSTALL LOW NOISE PAVEMENT

Particular types of pavement have been demonstrated to be as much as 3 to 5 dBA quieter than others. The ability of these pavements to retain their noise-reducing qualities over time (years) is currently being studied by CDOT, FHWA, as well as states other than Colorado. It should be noted that noise is only one issue involved in the pavement selection process; others include life cycle cost, durability, and safety.

4.5 CONSTRUCT NOISE BERMS

Earthen berms require a substantial amount of undeveloped land between the highway and homes, which does not exist at any of the impacted sites along the corridor.

4.6 CONSTRUCT NOISE WALLS

As is often the case in developed areas, sound walls are the most viable noise mitigation measure for this project. CDOT policy requires that sound walls (a) achieve between 5 and 10 dBA of noise reduction, and (b) must be cost-effective (See Section 2.1, Noise Analysis Standards). The noise reduction that would be provided by walls was predicted using STAMINA. Walls were placed in the model along the highway right-of-way (ROW) in front of the impacted residences.

A unit cost of $30 per square foot was used to compute the cost of each wall under study. Note that the mitigation recommendations contained herein are preliminary and will be refined during the future phases of the project.

Table 4-1, Summary of Noise Mitigation Analysis Results, describes the results of the mitigation review for each impacted property. The review was qualitative for those sites where it can be reasonably assumed that noise mitigation would not be feasible and/or reasonable. Note that the mitigation recommendations contained herein are preliminary and will be refined during future phases of the project. The paragraphs following the table describe the locations where a more quantitative noise wall analysis was conducted. Refer to the site plans in Appendix C, Combined Alternative Package (Preferred Alternative) Noise Analysis Site Plans, for a map of each site.

Table 4-1: Summary of Noise Mitigation Analysis Results

Receptor Number	Location Description	Mitigation Analysis Overview	Mitigation Recommended?
R16	SF Homes off 62nd Avenue	A noise wall along I-25 may be feasible but is not reasonable due to excessive cost.	No
R18	SF Home - off Broadway Off-Ramp	Isolated home. Mitigation not reasonable due to excessive cost.	No
R40	CRC and Westminster Park	(1)	(1)
R63	Madison Hill Townhomes	Analyzed in conjunction with R65 (see R65).	Yes
R65	Tuscany Trails - SF Homes	A noise wall was analyzed for the Madison Hill and Tuscany Trails areas and was found to be feasible and reasonable.	Yes
R66	Open Space	(1)	(1)
R67	Open Space	(1)	(1)
R70	Open Space	(1)	(1)
R71	Lower Church Park	(1)	(1)
R73	SF Homes - off Wadsworth Boulevard	A noise wall along US 36 was analyzed and found to be feasible, but not reasonable due to excessive cost.	No
R74	SF Homes - off new 120th Avenue	Mitigation for noise impacts for homes off the new 120th Avenue analyzed per separate project.	No
R75	SF Home - off existing 120th Avenue	Isolated home. Mitigation not reasonable due to excessive cost.	No
R78	East Interlocken Park	(1)	(1)
R79	Interlocken Golf Course	(1)	(1)
R81	Rock Creek Apartments	A noise wall along US 36 is considered both feasible and reasonable.	Yes
R86	Coal Creek Golf Course	(1)	(1)
R90	SF Homes - off Dyer Road	A noise wall along US 36 was analyzed and found to be feasible, but not reasonable due to excessive cost.	No
R91	SF Homes - off Dyer Road	A noise wall along US 36 was analyzed and found to be feasible, but not reasonable due to excessive cost.	No
R94	SF Homes - off Marshall Drive	Isolated home. Mitigation not reasonable due to excessive cost.	No
R102	Townhomes - off Apache Road	R102, R106, and R109 were analyzed together (see R109).	Yes
R105	SF Homes - off Moorehead Avenue	R105 and R111 were analyzed together (see R111).	Yes
R106	SF Homes - off Apache Road	R102, R106, and R109 were analyzed together (see R109).	Yes

Table 4-1: Summary of Noise Mitigation Analysis Results

Receptor Number	Location Description	Mitigation Analysis Overview	Mitigation Recommended?
R109	SF Homes - off Apache Road	A noise wall along US 36 was analyzed and found to be both feasible and reasonable.	Yes
R111	SF Homes - off Moorehead Avenue	A noise wall along US 36 was analyzed and found to be both feasible and reasonable.	Yes
R114	Open Space	(1)	(1)

Source: US 36 Mobility Partnership, 2009.

Notes:

(1) The decision of whether or not to provide noise mitigation for impacted parks needs to be assessed by the municipality where the park is located, in consultation with Colorado Department of Transportation and Federal Highway Administration. Priority should be given to parks where there is regular outdoor use and where noise mitigation measures would provide a clear benefit. Typically noise mitigation is not provided for golf courses as while there is active outdoor use, this use is for a short duration of time.

I-25 = Interstate 25

SF = single family

US 36 = United States Highway 36

4.7 62ND AVENUE SINGLE-FAMILY HOMES

A 500 foot long, 10 foot tall sound wall would be required to provide at least 5 dBA of noise reduction at these residences. This equates to a cost benefit of $6,000 per decibel (dB) per receptor, which exceeds CDOT's $4,000 standard. Also, this wall lies outside of the area where physical construction will take place, as no improvements are proposed for I-25 as part of this project. Therefore, this wall is considered feasible but not reasonable and is not recommended.

4.8 REPLACEMENT NOISE MITIGATION FROM BROADWAY TO SHERIDAN BOULEVARD

There are several locations where existing noise walls will need to be removed for construction of the new highway. Per *CDOT Noise Guidelines*, these noise walls will need to be replaced with a new barrier that is predicted to provide at least 5 dBA (and preferably 10 dBA) of noise reduction at the residences located directly behind it. More precise locations where existing walls will need to be removed and replaced will be identified during future phases of the project. The existing walls are typically 15 feet tall, and it is expected that these will be replaced with a barrier of a similar height.

4.9 REPLACEMENT NOISE MITIGATION FOR WESTCLIFF APARTMENTS

For Package 2 and the Combined Alternative Package (Preferred Alternative), the existing noise wall in front of the Westcliff Apartments will need to be removed and replaced. The existing wall is approximately 10 feet tall, and it is expected that the replacement wall will need to be of a similar height. Additional analysis of this wall should be conducted during future phases of the project.

4.10 MADISON HILLS AND TUSCANY TRAILS RESIDENCES

A 2,400 foot long, 15 foot tall sound wall at this location would reduce noise levels by an average of over 9 dBA and protect 100 residences at a cost benefit of less than $1,200. The wall is considered both feasible and reasonable and is recommended.

4.11 WADSWORTH BOULEVARD SINGLE-FAMILY HOMES

An 890 foot long wall of heights up to 15 feet tall was analyzed for this location. While an average of 5 to 9 dBA of noise reduction was achieved for the four homes, the cost benefit is excessive at over $13,000. Due to this excessive cost, the noise wall is not considered to be reasonable and is not recommended.

4.12 ROCK CREEK APARTMENTS

A 611 foot long, 15 foot tall wall at this location would reduce noise levels by an average of 5 dBA and would protect at least 18 residences. This would result in a cost benefit of a little less than $3,800. The wall is considered feasible and reasonable and is recommended.

4.13 DYER ROAD SINGLE-FAMILY HOMES

A 1,600 foot long, 15 foot tall wall at this location would reduce noise levels by about 5 dBA and protect five homes. This would result in a cost benefit of more than $37,000. Due to this excessive cost, a noise wall is not considered reasonable and is not recommended.

4.14 APACHE ROAD SINGLE-FAMILY HOMES AND PIMA COURT MULTI-FAMILY HOMES

A 3,800 foot long, 15 foot tall noise wall is predicted to provide over 6 dBA of noise reduction at approximately 80 residences at a cost benefit of less than $2,600. The wall is considered feasible and reasonable and is recommended.

4.15 MOORHEAD AVENUE SINGLE-FAMILY HOMES

A 15 foot tall sound wall or wall/berm combination is warranted in this area. The wall should start just north of Table Mesa Drive and continue to the Bear Creek Trail underpass. This 4,100 foot long wall is predicted to achieve over 5 dBA of noise reduction at approximately 100 residences at a cost benefit of less than $3,600. It is considered feasible and reasonable and is recommended.

5.0 CONSTRUCTION NOISE

During construction, noise would be generated from diesel-powered earth-moving equipment, such as dump trucks and bulldozers, back-up alarms on certain equipment, compressors, and pile drivers (near bridge abutments and retaining walls, if necessary). Construction noise at off-site receptor locations would be dependent on the number and type of equipment in use, and the proximity of that equipment. Noise levels from a single piece of diesel-powered equipment range from 80 to 95 dBA at a distance of 50 feet. Impact equipment such as rock drills and pile drivers can generate louder instantaneous noise levels.

Construction noise impacts on large corridor projects such as this can often last for years. Construction noise will typically not be present continuously at any given residence throughout the entire duration of construction, but instead intermittently as certain phases of construction proceed up the corridor. Construction noise, particularly at night, is often subject to local regulations, unlike operation of the highway. Construction noise impacts can be minimized by limiting work to daylight hours (to the extent possible), requiring the use of well-maintained equipment (particularly with respect to mufflers), the construction of temporary noise walls, the construction of permanent walls toward the start of the project, and specific equipment treatments.

Colorado Department of Transportation (CDOT). 1995. *Reference Energy Mean Emission Levels Used in STAMINA 2.0 for Highway Noise Prediction in the State of Colorado.* February.

Colorado Department of Transportation (CDOT). 2002. *Noise Analysis and Abatement Guidelines*. December.

Federal Transit Administration (FTA). 2006. *Transit Noise, and Vibration Impact Assessment, Report No. FTA-VA-90-1003-06.* May.

Hankard Environmental, CH2M Hill, and URS Corporation. 2007. *Highway Noise Analysis Report, US 36 Corridor Draft EIS*. April.

US 36 Mobility Partnership. 2009.

Appendix A
Relevant Noise Terminology

A-Weighted Sound (dBA) – A-weighting network was developed and is applied to either measured or predicted noise levels to mimic the ear's varying sensitivity to frequency. Resulting noise levels are expressed in dBA. Table A-1, Typical Noise Levels, shows the A-weighted noise levels of some common noise sources.

Table A-1: Typical Noise Levels

Noise Source	Noise Level (dBA)
Amplified Rock Band	115–120
Commercial Jet Takeoff at 200 Feet	105–115
Community Warning Siren at 100 Feet	95–105
Busy Urban Street	85–95
Construction Equipment at 50 Feet	75–85
Freeway Traffic at 50 Feet	65–75
Normal Conversation at 6 Feet	55–65
Typical Office Interior	45–55
Soft Radio Music	35–45
Typical Residential Interior	25–35
Typical Whisper at 6 Feet	15–25
Human Breathing	5–15
Threshold of Hearing	0–5

Source: US 36 Mobility Partnership, 2009.
Note:
dBA = decibel (A-weighted scale)

Decibel (dB) – A decibel is 0.1 of a Bel. For sound pressure levels, it is a measure on a logarithmic scale, which indicates the squared ratio of sound pressure to a reference sound pressure.

Equivalent Sound Level (Leq) – The equivalent steady state sound level, which in a stated period of time would contain the same acoustical energy as the time-varying sound level during the same period. The time period used for highway noise analysis is 1 hour. All noise levels described in this report are hourly, A-weighted Leq(s).

Frequency (f) – The number of oscillations per second of a periodic wave sound expressed in units of hertz (Hz). The value is the reciprocal (1/x) of the period of oscillations in seconds. The human ear is, in general, capable of detecting frequencies between 20 to 20,000 Hz. The human ear is more sensitive to high frequency sounds than to low frequency sounds.

Noise – Unwanted sound, usually loud or unexpected.

Noise Receptors – Areas in which people are typically located, which include places such as residences, hotels, commercial buildings, parks, etc. Usually, one noise receptor location is used to analyze an area unless the area is quite large and covers various distances from the roadway. The noise receptor is typically located on the façade of a structure that faces the noise source or roadway.

Pascal (Pa) – A unit of pressure (in acoustics, normally root mean square [RMS] sound pressure) equal to one Newton per square meter (N/m^2). A reference pressure for a sound pressure level of 0 dB is 20 micro Pascal (μPa).

Sound – Caused by pressure fluctuations in the air. The range of sound pressures, which the human ear is capable of detecting, is very large (0.00002 to 200 Pascals). To facilitate easier discussion, sound pressures are described on a decibel (dB) scale.

Sound Absorption – This typically occurs when sound is converted to heat or another form of energy. A common sound absorptive material is fiberglass insulation.

Sound Pressure Level (SPL) – Sound pressure level in dB is equal to $10Log_{10}(p^2/p_o^2)$ where p is the instantaneous sound pressure and p_o is the reference sound pressure of 0.00002 Pa. This results in a scale of 0 dB (threshold of audibility) to 120 dB (threshold of pain).

Sound Reflection – The reflection of sound occurs when an object is able to significantly increase the impedance when compared to the surrounding air. This would require an object to be non-porous and to have enough density, stiffness, and thickness.

Sound Transmission Loss (STL or TL) – The conversion of sound energy to another form of energy (usually heat) from one side of a barrier to the other.

Appendix B
Noise Model Input Data

VEHICLE EMISSION LEVELS

Vehicle emission levels refer to the noise level of vehicles measured at a reference distance and a reference speed. STAMINA requires separate emission levels for automobiles, medium trucks (generally, trucks with two axles, six tires, and a gross vehicle weight greater than 9,900 pounds and less than 26,400 pounds), and heavy trucks (generally, trucks with three or more axles and a gross vehicle weight greater than 26,400 pounds). The Colorado-specific Reference Energy Mean Emission Levels were used for all vehicle types in all of the predictions. These emission levels were developed by CDOT, approved by FHWA, and are published in the document entitled *Reference Energy Mean Emission Levels Used in STAMINA 2.0 for Highway Noise Prediction in the State of Colorado* (CDOT 1995).

TRAFFIC VOLUMES AND SPEEDS

Traffic volumes used for Package 1: No Action (2035) and the Combined Alternative Package (Preferred Alternative) are provided in the tables below. Note: traffic volumes and speed used for the validation, existing (2003), and Package 2 and Package 4 are provided in the *Highway Noise Analysis Report, US 36 Corridor Draft EIS* (Hankard Environmental et al. 2007). The traffic volumes were provided by URS Corporation. In order to model loudest-hour conditions, all of the volumes represent maximum LOS C conditions or better. That is, where traffic projections indicated that the LOS would be A, B, or C, all of which represent free-flowing conditions, the projected volumes were used directly. When traffic projections indicated that the LOS would be D, E, or F, which represents some degree of congestion and therefore lower speeds, the volumes were reduced to replicate LOS C conditions. Free flow speeds were used in all of the predictions, which range from 30 mph for loop-ramps, 35 to 40 mph for side roads, and 55 mph to 65 mph along US 36. For a majority of the analysis, 3 percent medium trucks and 1 percent heavy trucks were used. See Tables B-1 through B-3 for additional information.

Table B-1: Combined Alternative Package (Preferred Alternative) – US 36 Loudest-Hour Mainline Traffic Volumes

Segment	Vehicle	Westbound	Eastbound	Speed
104th Avenue to 92nd Avenue	Automobiles	5,765	5,802	55
	Medium Trucks	119	120	55
	Heavy Trucks	59	60	55
92nd Avenue to Federal Boulevard	Automobiles	5,914	5,792	55
	Medium Trucks	122	119	55
	Heavy Trucks	61	60	55
Baseline Road to Table Mesa Drive	Automobiles	2,745	2,939	65
	Medium Trucks	57	61	65
	Heavy Trucks	28	30	65
Broadway to I-25	Automobiles	6,066	6,063	55
	Medium Trucks	125	125	55
	Heavy Trucks	63	63	55
Federal Boulevard to Pecos Street	Automobiles	5,816	5,547	55
	Medium Trucks	120	114	55
	Heavy Trucks	60	57	55

Table B-1: Combined Alternative Package (Preferred Alternative) – US 36 Loudest-Hour Mainline Traffic Volumes

Segment	Vehicle	Westbound	Eastbound	Speed
Flatiron to Wadsworth	Automobiles	5,154	5,866	55
	Medium Trucks	106	121	55
	Heavy Trucks	53	60	55
McCaslin Boulevard to Flatiron	Automobiles	5,956	NA	55
	Medium Trucks	123	NA	55
	Heavy Trucks	61	NA	55
Pecos Street to Broadway	Automobiles	6,066	6,100	55
	Medium Trucks	125	126	55
	Heavy Trucks	63	63	55
Table Mesa Drive to McCaslin Boulevard East	Automobiles	4,835	5,017	55
	Medium Trucks	100	103	55
	Heavy Trucks	50	52	55
Table Mesa Drive to McCaslin Boulevard West	Automobiles	4,773	2,696	65
	Medium Trucks	98	56	65
	Heavy Trucks	49	28	65
Wadsworth to 104th Avenue	Automobiles	5,516	5,772	55
	Medium Trucks	114	119	55
	Heavy Trucks	57	60	55

Source: US 36 Mobility Partnership, 2009.
Notes:
I-25 = Interstate 25
NA = not applicable

Table B-2: Combined Alternative Package (Preferred Alternative) – US 36 Loudest Hour Ramp Traffic Volumes

Segment	Vehicle	Westbound	Eastbound	Speed
104th Avenue Off-Ramp	Automobiles	824	796	35
	Medium Trucks	17	16	35
	Heavy Trucks	9	8	35
104th Avenue On-Ramp	Automobiles	1,212	1,135	35
	Medium Trucks	25	23	35
	Heavy Trucks	13	12	35
92nd Avenue On-Ramp	Automobiles	1,164	NA	35
	Medium Trucks	24	NA	35
	Heavy Trucks	12	NA	35
92nd Avenue Off-Ramp	Automobiles	NA	1,475	35
	Medium Trucks	NA	30	35
	Heavy Trucks	NA	15	35
96th Street Off-Ramp	Automobiles	1,144	960	35
	Medium Trucks	24	20	35
	Heavy Trucks	12	10	35
96th Street On-Ramp	Automobiles	766	1,639	35
	Medium Trucks	16	34	35
	Heavy Trucks	8	17	35

Table B-2: Combined Alternative Package (Preferred Alternative) – US 36 Loudest Hour Ramp Traffic Volumes

Segment	Vehicle	Westbound	Eastbound	Speed
Broadway On-Ramp	Automobiles	330	NA	35
	Medium Trucks	7	NA	35
	Heavy Trucks	3	NA	35
Broadway Off-Ramp	Automobiles	NA	475	35
	Medium Trucks	NA	10	35
	Heavy Trucks	NA	5	35
Federal Boulevard Off-Ramp	Automobiles	1,697	1,465	35
	Medium Trucks	35	30	35
	Heavy Trucks	18	15	35
Federal Boulevard Off-Ramp Northbound	Automobiles	1,649	174	35
	Medium Trucks	34	4	35
	Heavy Trucks	17	2	35
Federal Boulevard Off-Ramp Southbound	Automobiles	233	1,290	35
	Medium Trucks	5	27	35
	Heavy Trucks	2	13	35
Federal Boulevard On-Ramp	Automobiles	921	1096	35
	Medium Trucks	19	23	35
	Heavy Trucks	10	11	35
Flatiron On-Ramp	Automobiles	NA	1164	35
	Medium Trucks	NA	24	35
	Heavy Trucks	NA	12	35
I-25 Off-Ramp	Automobiles	1697	1697	35
	Medium Trucks	35	35	35
	Heavy Trucks	18	18	35
McCaslin Boulevard Off-Ramp	Automobiles	2,328	2,687	35
	Medium Trucks	48	55	35
	Heavy Trucks	24	28	35
McCaslin Boulevard On-Ramp	Automobiles	902	776	35
	Medium Trucks	19	16	35
	Heavy Trucks	9	8	35
Pecos Street Off-Ramp	Automobiles	1,241	950	35
	Medium Trucks	26	20	35
	Heavy Trucks	13	10	35
Pecos Street On-Ramp	Automobiles	1,106	921	35
	Medium Trucks	23	19	35
	Heavy Trucks	11	10	35
Table Off-Ramp	Automobiles	912	553	35
	Medium Trucks	19	11	35
	Heavy Trucks	9	6	35
Table On-Ramp	Automobiles	485	553	35
	Medium Trucks	10	11	35
	Heavy Trucks	5	6	35
Wadsworth Off-Ramp	Automobiles	1,106	NA	35
	Medium Trucks	23	NA	35
	Heavy Trucks	11	NA	35

Table B-2: Combined Alternative Package (Preferred Alternative) – US 36 Loudest Hour Ramp Traffic Volumes

Segment	Vehicle	Westbound	Eastbound	Speed
Wadsworth On-Ramp	Automobiles	1,203	NA	35
	Medium Trucks	25	NA	35
	Heavy Trucks	12	NA	35
Foothills Parkway Off-Ramp	Automobiles	514	475	35
	Medium Trucks	11	10	35
	Heavy Trucks	5	5	35
Foothills Parkway On-Ramp	Automobiles	291	NA	35
	Medium Trucks	6	NA	35
	Heavy Trucks	3	NA	35

Source: US 36 Mobility Partnership, 2009.
Notes:
I-25 = Interstate 25
NA = not applicable

Table B-3: Combined Alternative Package (Preferred Alternative) – US 36 Loudest Hour Cross-Road Traffic Volumes

Segment	Vehicle	Westbound	Eastbound	Speed
92nd Avenue	Automobiles	3,686	3,375	35
	Medium Trucks	76	70	35
	Heavy Trucks	38	35	35
Segment	Vehicle	Northbound	Southbound	Speed
Broadway	Automobiles	2,114	1,523	35
	Medium Trucks	44	31	35
	Heavy Trucks	22	16	35
Federal Boulevard North	Automobiles	5,917	5,636	35
	Medium Trucks	122	116	35
	Heavy Trucks	61	58	35
McCaslin Boulevard	Automobiles	4,787	6,300	35
	Medium Trucks	99	130	35
	Heavy Trucks	49	65	35
Wadsworth Parkway	Automobiles	5,286	6,557	35
	Medium Trucks	109	135	35
	Heavy Trucks	55	68	35
Pecos Street	Automobiles	4,025	4,316	35
	Medium Trucks	83	89	35
	Heavy Trucks	42	45	35

Table B-3: Combined Alternative Package (Preferred Alternative) – US 36 Loudest Hour Cross-Road Traffic Volumes

Segment	Vehicle	Northbound	Southbound	Speed
Moorhead	Automobiles	640	35	NA
	Medium Trucks	13	35	NA
	Heavy Trucks	7	35	NA
South Boulder Road	Automobiles	2308	35	NA
	Medium Trucks	48	35	NA
	Heavy Trucks	24	35	NA
Table Mesa Drive	Automobiles	3395	35	NA
	Medium Trucks	70	35	NA
	Heavy Trucks	35	35	NA
Table Mesa Drive	Automobiles	3191	35	NA
	Medium Trucks	66	35	NA
	Heavy Trucks	33	35	NA
West 104th Avenue	Automobiles	5684	35	NA
	Medium Trucks	117	35	NA
	Heavy Trucks	59	35	NA
Church Ranch Boulevard	Automobiles	3502	35	NA
	Medium Trucks	72	35	NA
	Heavy Trucks	36	35	NA
East Flatiron Circle	Automobiles	2658	35	NA
	Medium Trucks	55	35	NA
	Heavy Trucks	27	35	NA

Source: US 36 Mobility Partnership, 2009.
Note:
NA = not applicable

LOCATION OF ROADWAYS

The locations of all roadways were determined using computer-aided drafting topographical maps. This information was provided in electronic form by URS Corporation and/or CH2M Hill.

LOCATION OF RECEPTORS

Noise levels were predicted at the 120 locations shown in Appendix C, Combined Alternative Package (Preferred Alternative) Noise Analysis Site Plans. These locations are considered representative of all of the noise activity Category B receptors located along the corridor (residences, schools, hotels, etc.). The coordinates of these locations were determined from topographical plans.

LOCATION OF TERRAIN FEATURES AND STRUCTURES

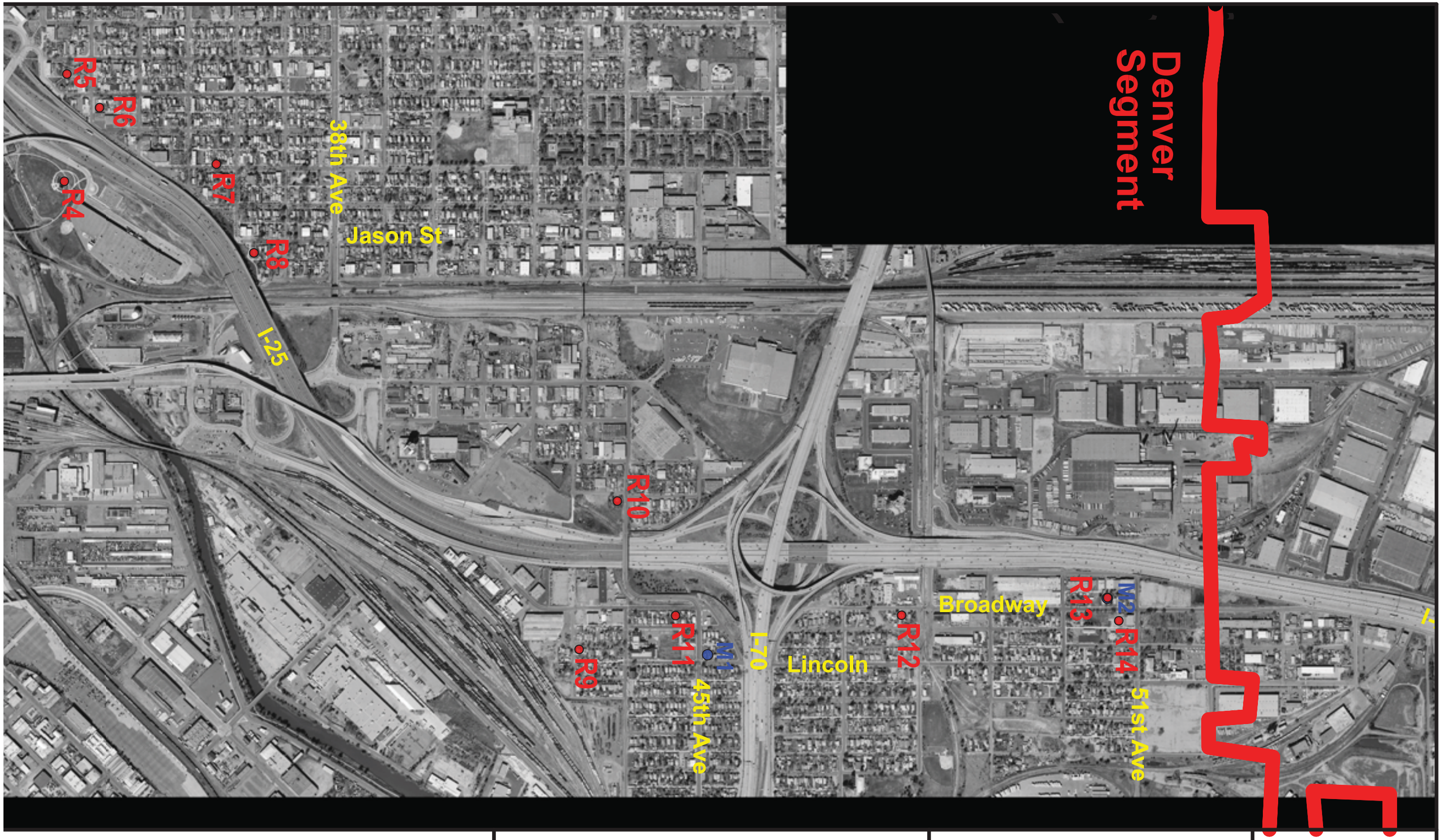
Existing terrain features such as embankments, existing noise walls, the edge of the roadway itself, and structures can act as barriers that reduce noise propagation. The effects of these features were modeled when it was determined that they break the line-of-sight between the adjacent roadway and receptors and were of substantial mass.

TERRAIN TYPE

STAMINA allows the user to select one of two types of ground for each receiver-roadway pair: hard or soft. This selection is made using the alpha factor input variable. An alpha factor of zero represents hard ground such as pavement and water, as well as the case where either the source or the receptor are significantly elevated above the ground. An alpha factor of 0.5 represents acoustically soft terrain, which is representative of vegetated ground with both source and receiver located close to the ground.

Appendix C

Combined Alternative Package (Preferred Alternative) Noise Analysis Site Plans



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Alternative P4 Max
Noise Analysis Site Plan

Figure C-1

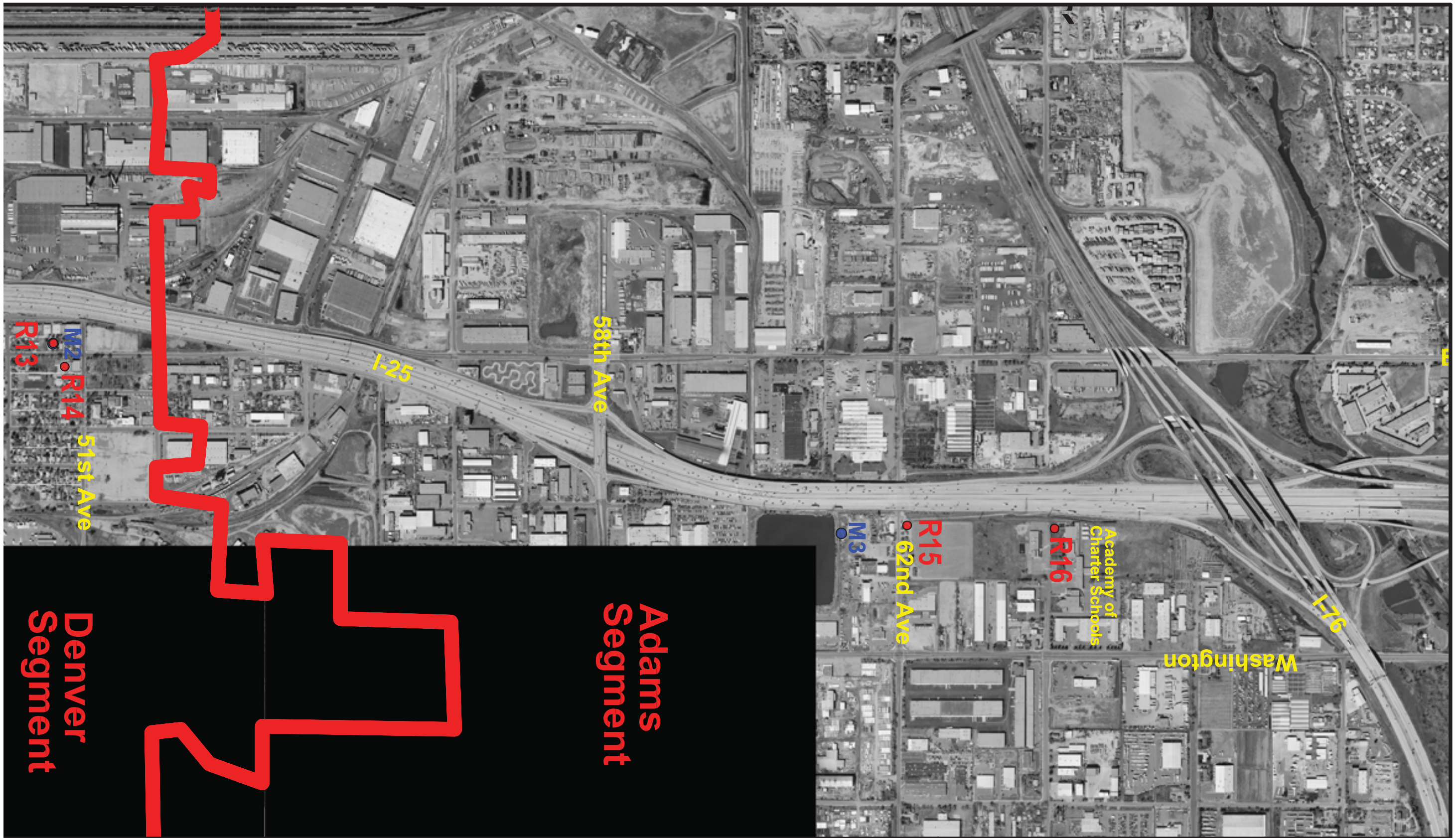

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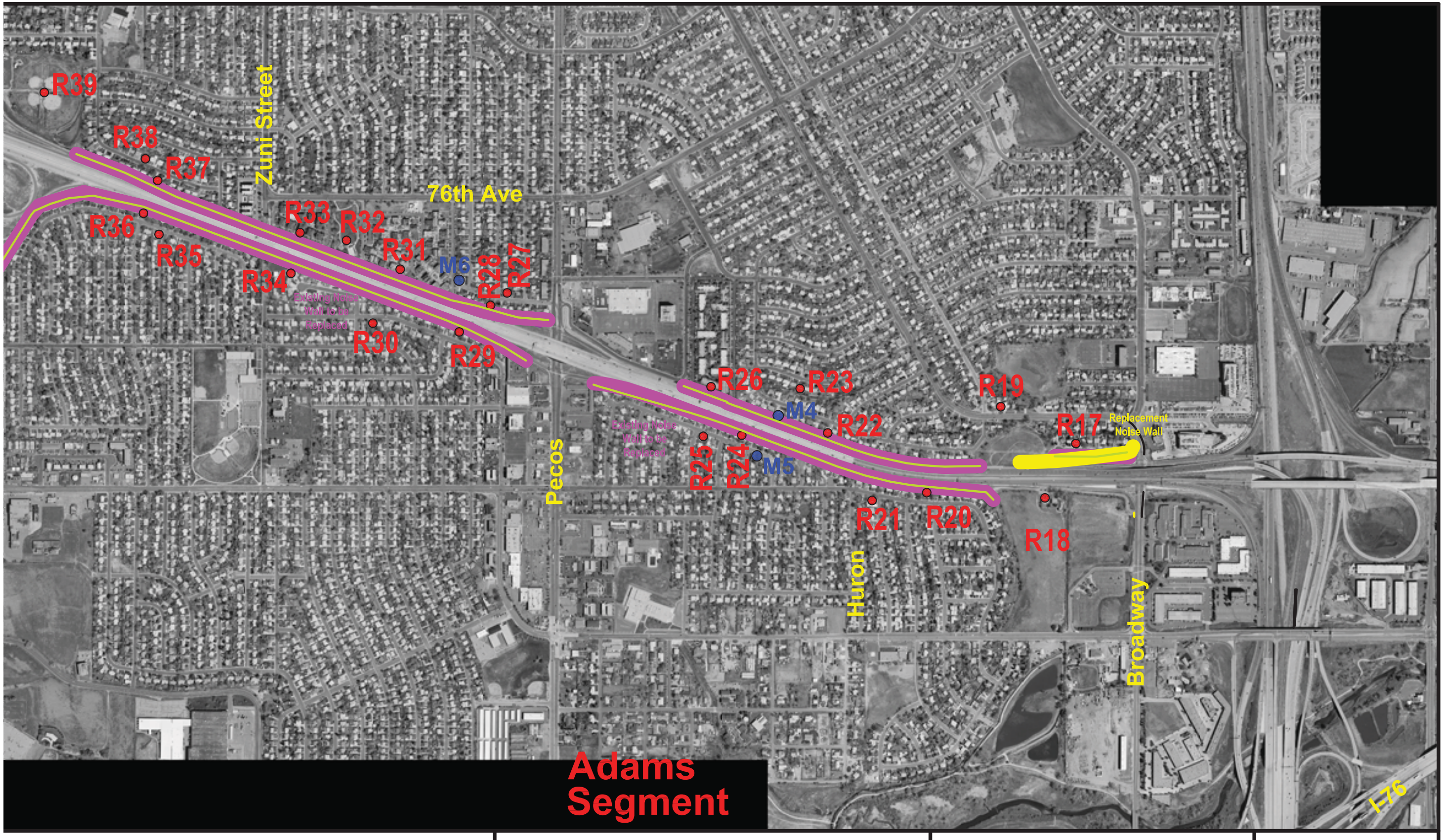
Figure C-2



NORTH

0 500'

- Noise Receptor Locations
- Noise Measurement Locations
- New/Replacement Noise Mitigation
- Existing Barrier

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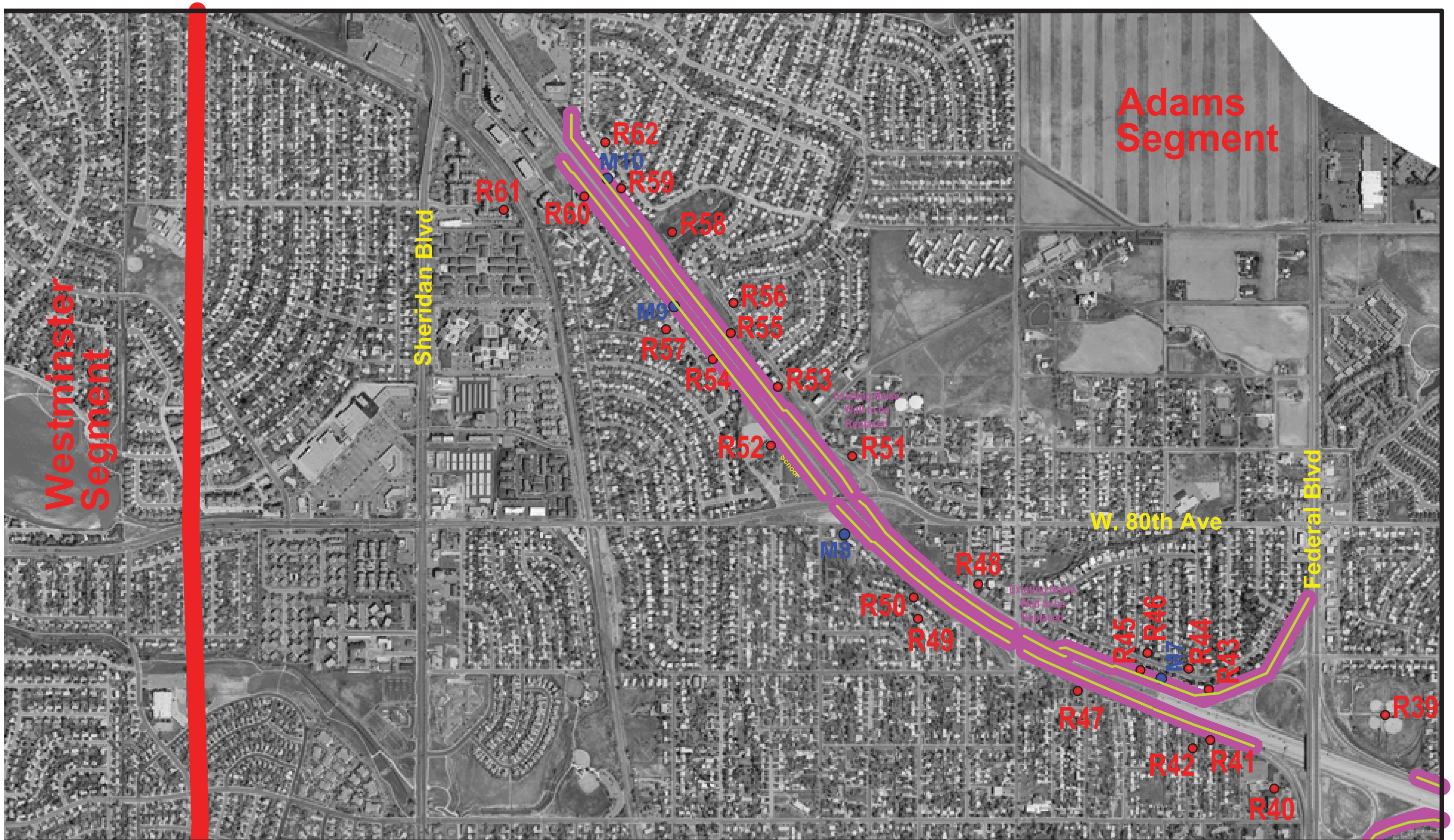
Figure C-3


Westminster Segment
Sheridan Blvd
Adams Segment
Federal Blvd
W. 80th Ave
R62
M10
R59
R61
R60
R58
R56
M9
R55
R57
R54
R53
Existing Noise Wall to be Replaced
R52
R51
M8
R48
R50
R49
Existing Noise Barrier to be Replaced
R45
R46
M7
R44
R43
R47
R39
R42
R41
R40
NORTH
0
500'
- Noise Receptor Locations
- Noise Measurement Locations
- New/Replacement Noise Mitigation
- Existing Barrier
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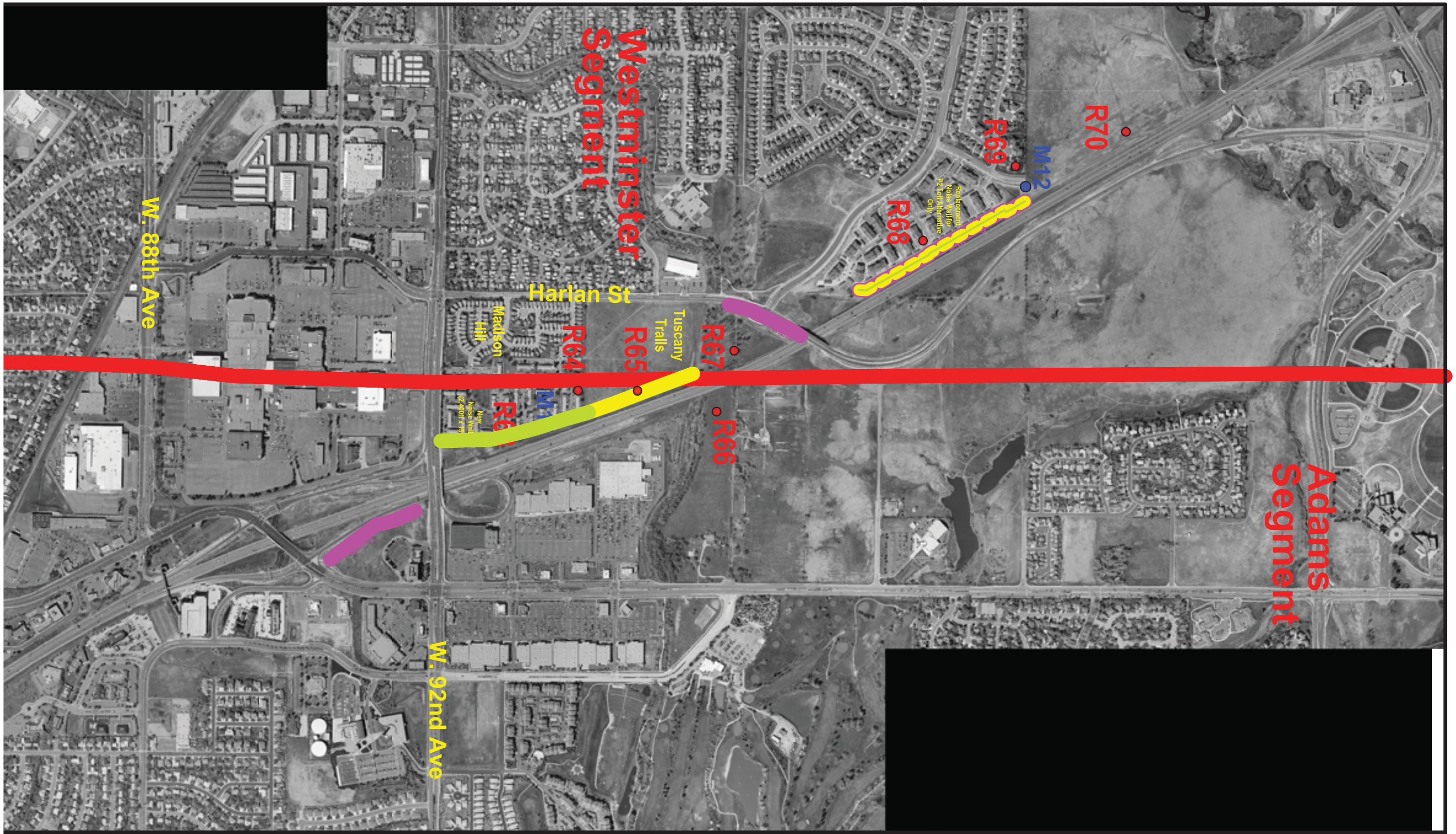
Alternative P4 Max
Noise Analysis Site Plan
Figure
C-4



NORTH

0 500'

- Noise Receptor Locations
- Noise Measurement Locations
- New/Replacement Noise Mitigation
- Existing Barrier

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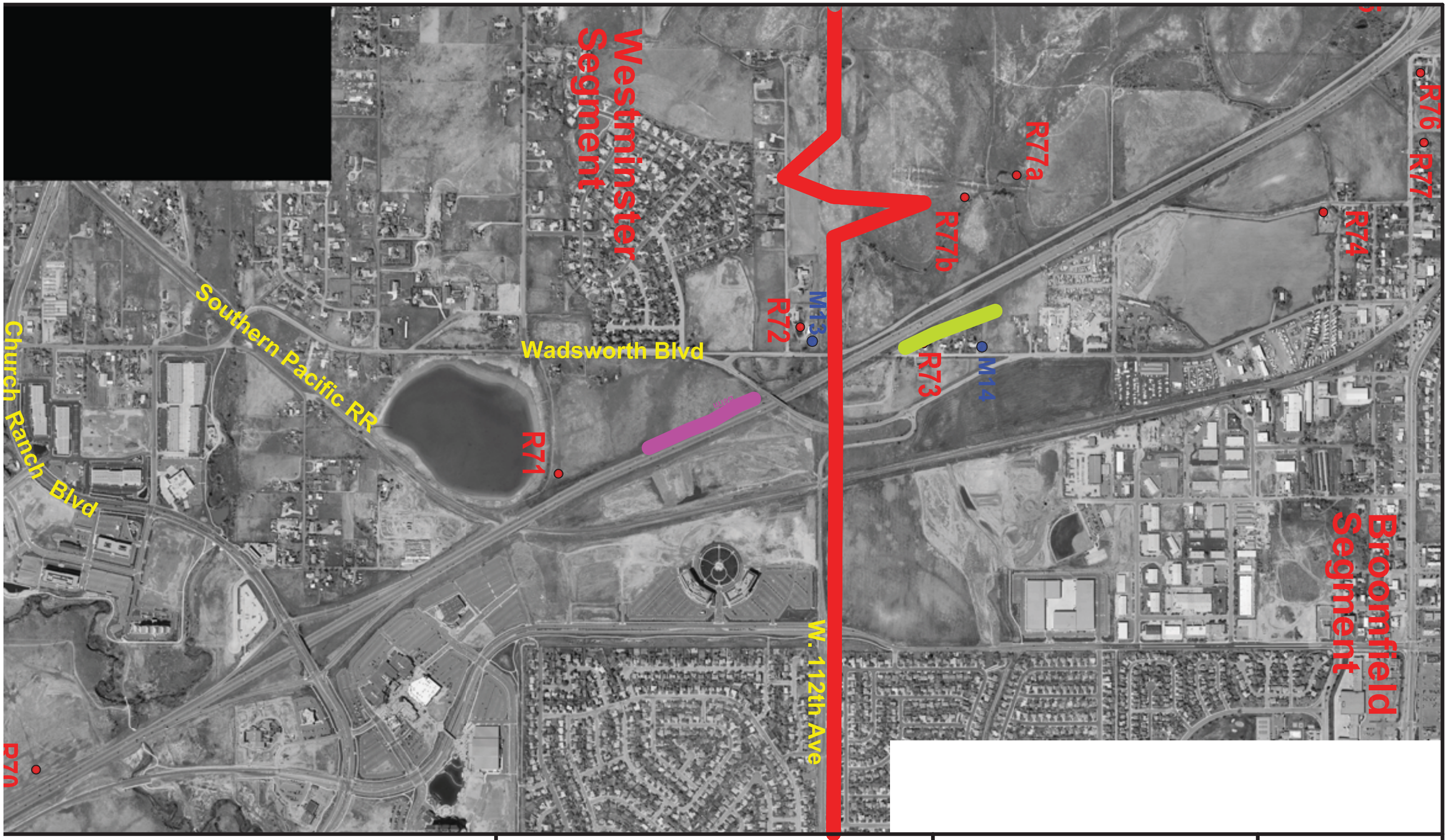
Figure C-5



NORTH

0 500'

- Noise Receptor Locations
- Noise Measurement Locations
- New/Replacement Noise Mitigation
- Existing Barrier

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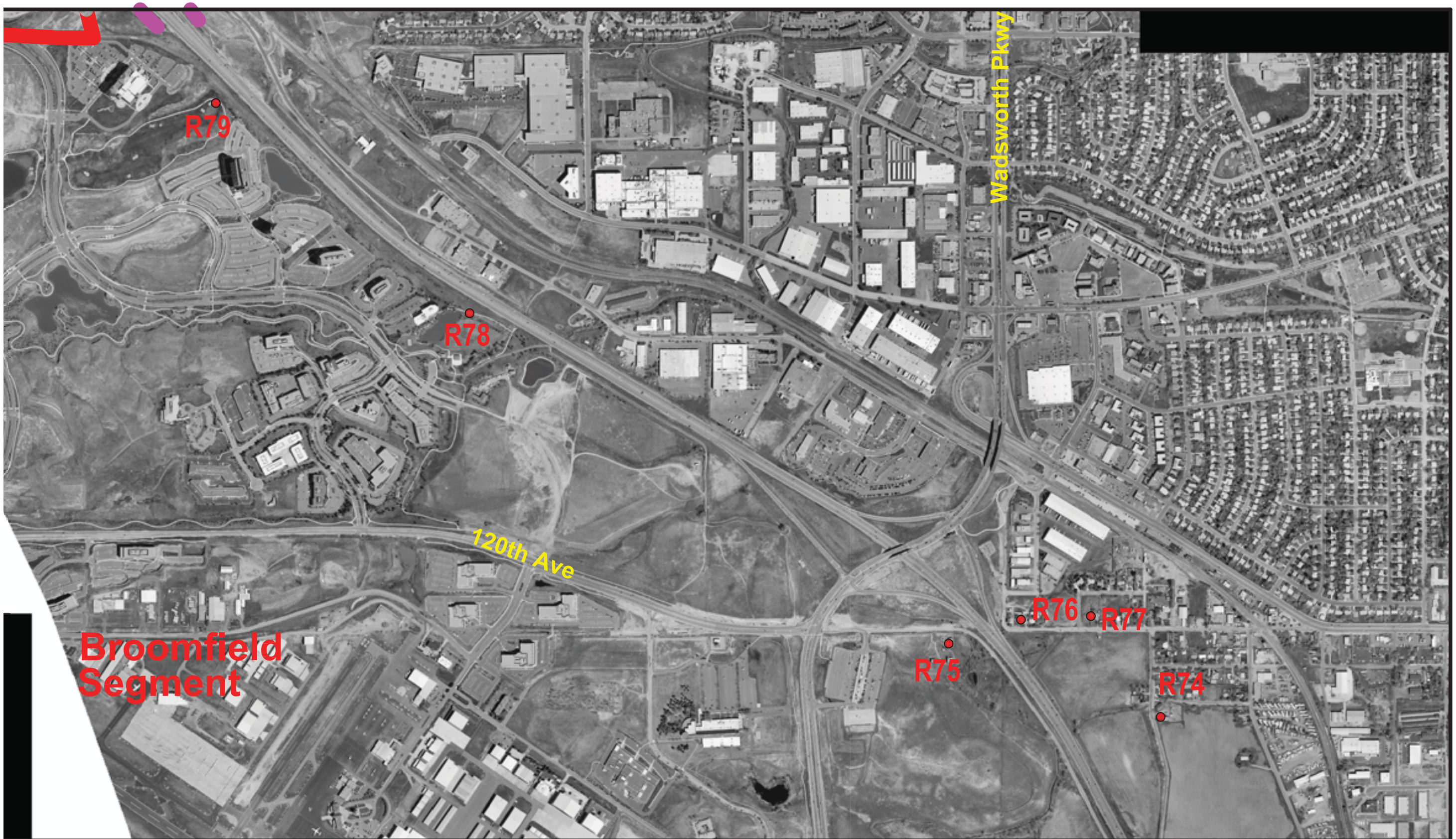
Noise Analysis Site Plan

Figure C-6



NORTH

0 500'

- Noise Receptor Locations
- Noise Measurement Locations
- New/Replacement Noise Mitigation
- Existing Barrier

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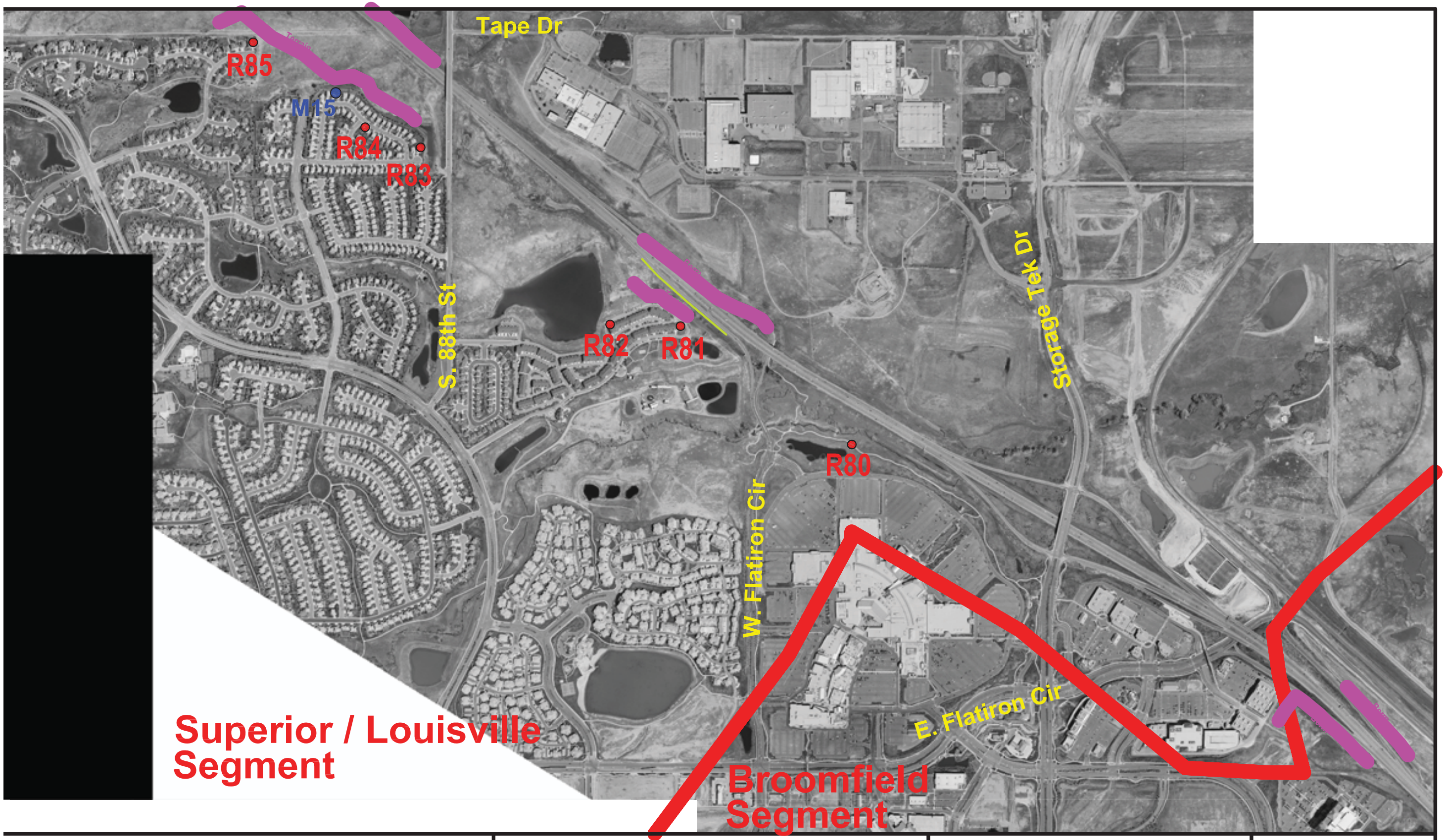
Alternative P4 Max
Noise Analysis Site Plan

Figure C-7



NORTH

0 500'

- Noise Receptor Locations
- Noise Measurement Locations
- New/Replacement Noise Mitigation
- Existing Barrier

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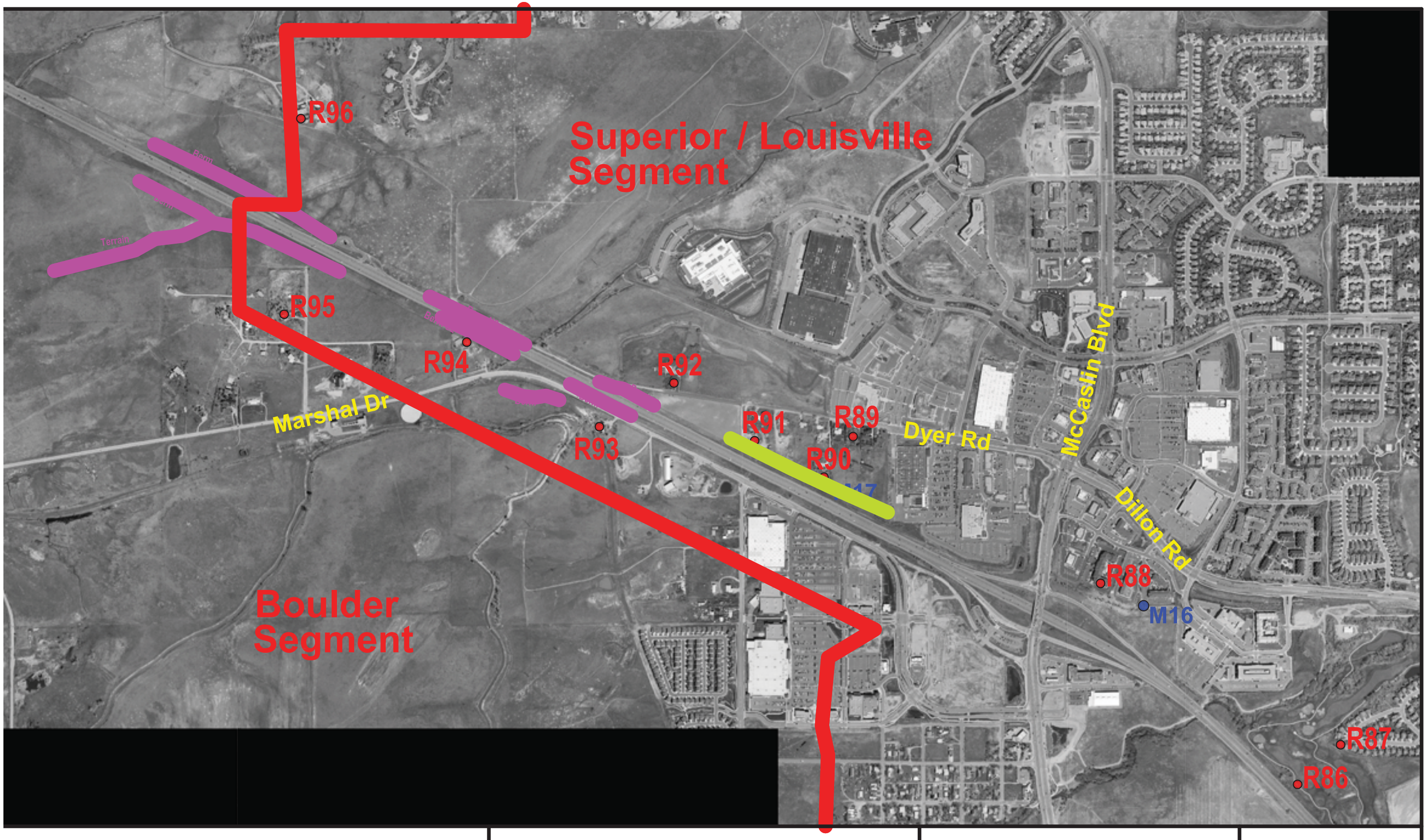
Noise Analysis Site Plan

Figure C-8



NORTH

0 500'

- Noise Receptor Locations
- Noise Measurement Locations
- New/Replacement Noise Mitigation
- Existing Barrier

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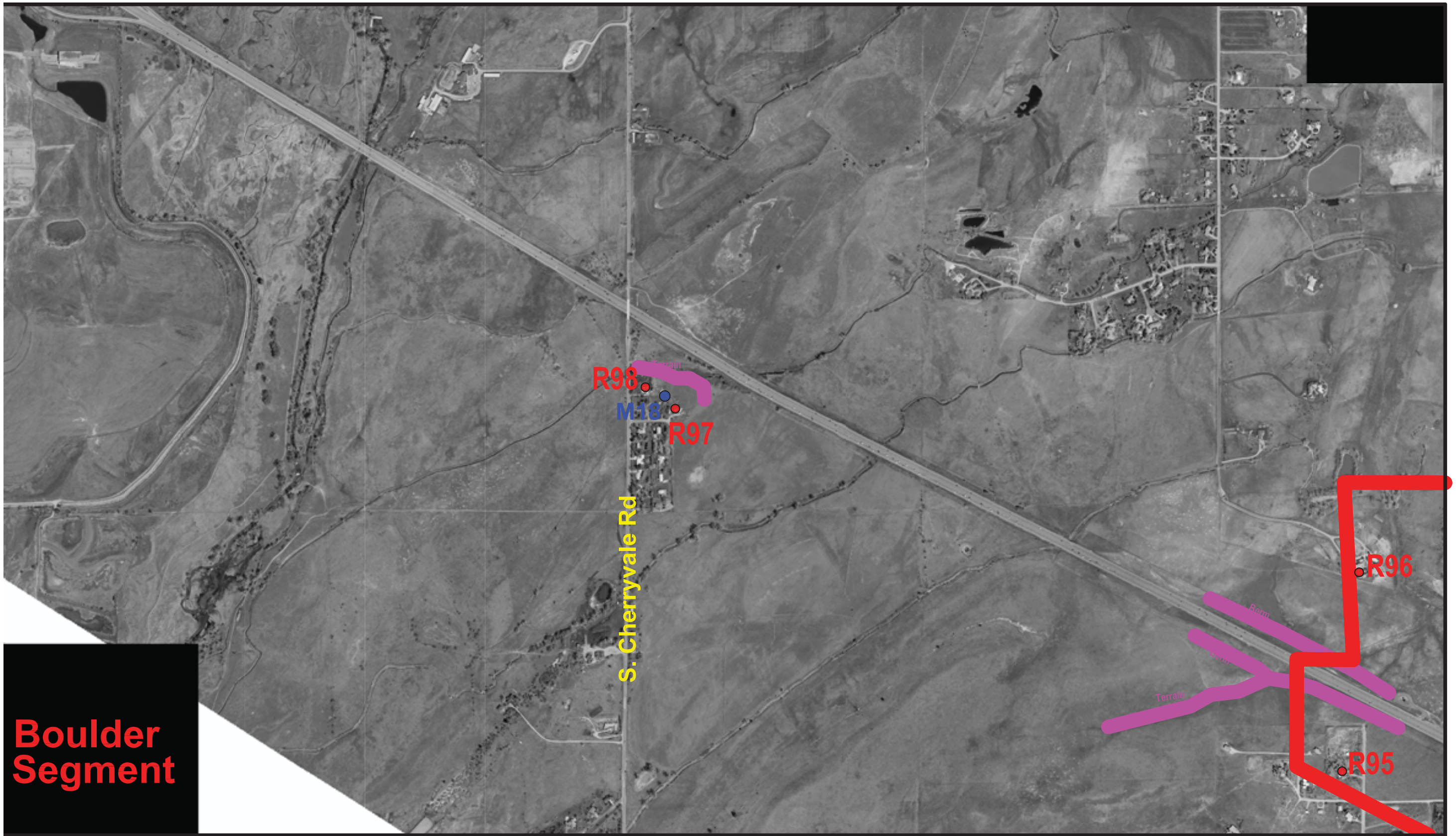
Alternative P4 Max
Noise Analysis Site Plan

Figure C-9



NORTH

0 500'

- Noise Receptor Locations
- Noise Measurement Locations
- New/Replacement Noise Mitigation
- Existing Barrier

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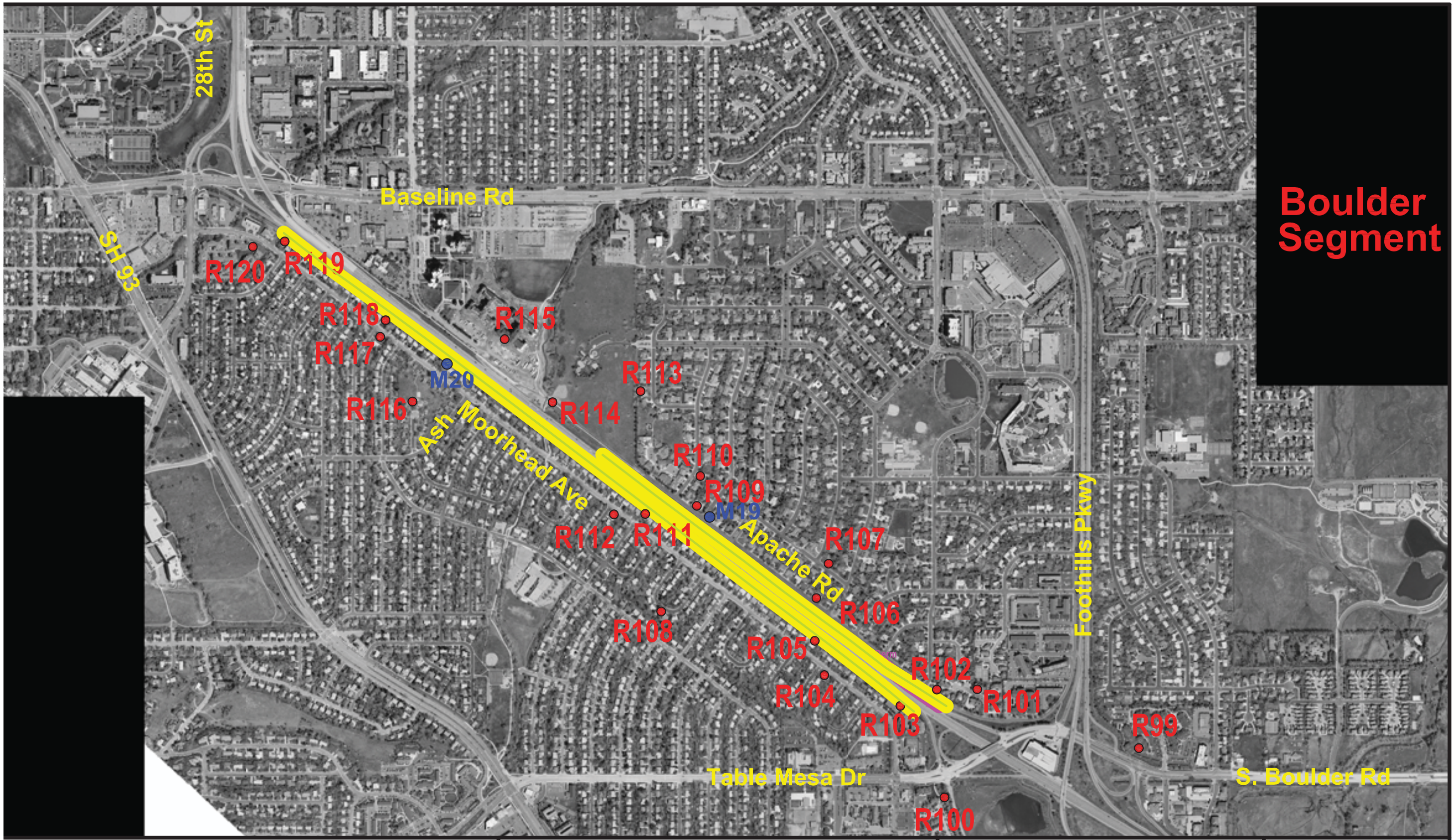
Alternative P4 Max
Noise Analysis Site Plan

Figure C-10



NORTH

0 500'

- Noise Receptor Locations
- Noise Measurement Locations
- New/Replacement Noise Mitigation
- Existing Barrier

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US 36 Corridor Project Area

Alternative P4 Max
Noise Analysis Site Plan

Figure C-11