Traffic Noise Technical Report

North Houston Highway Improvement Project:
From US 59/I-69 at Spur 527 to I-45 at Beltway 8 North

Harris County

CSJ: 0912-00-146

June 2020

The environmental review, consultation, and other actions required by applicable Federal environmental laws for this project are being, or have been, carried-out by TxDOT pursuant to 23 U.S.C. 327 and a Memorandum of Understanding dated December 9, 2019, and executed by FHWA and TxDOT.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF ATTACHMENTS

LIST OF EXHIBITS

LIST OF APPENDICES

1.0 INTRODUCTION

The Texas Department of Transportation (TxDOT) proposes to construct improvements to Interstate Highway 45 (I-45) in the northern portion of the City of Houston. The proposed project, referred to as the North Houston Highway Improvement Project (NHHIP), begins at the interchange of I-45 and Beltway 8 North and continues south along I-45 to Downtown Houston where it terminates at the interchange of U.S. Highway (US) 59/I-69 and Spur 527 south of Downtown Houston. The project area also includes portions of I-10 and US 59/I-69 near Downtown Houston. The project area is composed of three study segments, Segments 1 through 3 (**Exhibit 1**).

This noise technical report supports the Final Environmental Impact Statement (Final EIS) that evaluates the social, economic, and environmental impacts potentially resulting from the Preferred Alternative for the proposed project. This report presents mitigation for noise impacts in the form of barriers.

Additional walls may be built for the proposed project for Environmental Justice mitigation. The documentation and location of those walls can be found in the Community Impacts Assessment Technical Report.

2.0 PROJECT DESCRIPTION

2.1 Existing Facility

Segment 1: I-45 from Beltway 8 North to north of I-610 (North Loop)

I-45 within this segment consists of eight general purpose lanes (i.e., mainlanes; four lanes in each direction), four to six frontage road lanes (two to three lanes in each direction), and a reversible high occupancy vehicle (HOV) lane in the middle, all within a variable right-of-way (ROW) width of 250 to 300 feet. The existing posted speed limit along the general-purpose lanes and reversible HOV lane is 60 miles per hour (mph). The existing posted speed limit for the frontage roads is 45 mph. The length of Segment 1 is approximately 8.8 miles, and the area of the existing ROW is approximately 349 acres.

Segment 2: I-45 from north of I-610 (North Loop) to I-10 (including the interchange with I-610)

I-45 within this segment primarily consists of eight at-grade general purpose lanes (four lanes in each direction), four to six frontage road lanes (two to three lanes in each direction), and a reversible HOV lane in the middle, all within a variable ROW width of 300 to 325 feet. Segment 2 also includes a depressed section that consists of eight general purpose lanes (four lanes in each direction) and a reversible HOV lane in the middle, all below grade, within a 245-foot ROW. The frontage road lanes associated with the depressed section are located at-grade. The existing posted speed limit is 60 mph along the general-purpose lanes, 55 mph along the reversible HOV lane, and 40 mph along the frontage road lanes. The I-45 and I-610 frontage roads are discontinuous at the I-45/I-610 interchange. The length of Segment 2 is approximately 4.5 miles, and the area of the existing ROW is approximately 220 acres.

Segment 3: Downtown Loop System (I-45, US 59/I-69, and I-10)

The Downtown Loop System consists of three interstate highways that create a loop around Downtown Houston. I-45 forms the western and southern boundaries of the loop and is known locally as the Pierce Elevated because it partially follows the alignment of Pierce Street. I-10 forms the northern boundary of the loop, and US 59/I-69 forms the eastern boundary of the loop. The loop includes three major interchanges: I-45 and I-10, I-10 and US 59/I-69, and US 59/I-69 and I-45. The interchange of US 59/I-69 and Spur 527 is located southwest of Downtown Houston.

I-45 along the western and southern sides of Downtown consists of six elevated general-purpose lanes (three lanes in each direction) within a variable ROW that is typically 205 feet to 320 feet wide. I-10 north of Downtown, between I-45 and US 59/I-69, consists of six general purpose lanes (three lanes in each direction) within an existing ROW width of 420 feet. US 59/I-69 along the east side of Downtown consists of six general purpose lanes (three lanes in each direction) within an existing ROW width of 225 feet. US 59/I-69 south of Downtown from I-45 to Spur 527 has eight general purpose lanes (four in each direction). Generally, local streets serve as one-way frontage roads within Segment 3, except near the I-10 and US 59/I-69 interchange, where the frontage roads are discontinuous. The length of Segment 3, which includes the Downtown Loop System, is approximately 13.1 miles, and the existing ROW is approximately 638 acres.

2.2 Proposed Facility

The Preferred Alternative for the proposed project is described below, by study segment. The Preferred Alternative includes changes to the Recommended Alternative (for each segment) presented and evaluated in the Draft Environmental Impact Statement. Section 2.0 of the Final EIS discusses the design changes, including the proposed locations of storm water detention areas.

Segment 1: I-45 from Beltway 8 North to north of I-610 (North Loop)

The Preferred Alternative would widen the existing I-45 primarily on the west side of the roadway to accommodate four managed express (MaX) lanes. The proposed typical section would include eight to ten general purpose lanes (four to five lanes in each direction), four MaX lanes (two lanes in each direction), and four to six frontage road lanes (two to three lanes in each direction). The general-purpose lanes and MaX lanes would be at-grade except at major cross streets, where they would be elevated over the intersecting streets. Approximately 200 to 225 feet of new ROW would be required for the roadway widening, mostly to the west of the existing I-45. New ROW would also be required on the west side of I-45 for proposed storm water detention areas. New ROW would be required to the east of the existing I-45 ROW at intersections with major streets and between Crosstimbers Street and I-610. Approximately 246 acres of new ROW would be required in Segment 1.

Segment 2: I-45 from north of I-610 (North Loop) to I-10 (including the interchange with I-610)

The Preferred Alternative would widen the existing I-45 to accommodate four MaX lanes. The proposed typical section would include ten general purpose lanes (five lanes in each direction), four MaX lanes (two lanes in each direction), and four to six frontage road lanes (two to three lanes in each direction). From north of Cottage Street to Norma Street, the general-purpose lanes and the Max lanes would be depressed, while the frontage road lanes would be at-grade. The proposed I-45 and I-610 frontage roads would be continuous through the I-45/I-610 interchange. New ROW would be required from both the east and west sides of the existing I-45. The new ROW would include proposed storm water detention areas on the east side of I-45, south of Patton Street. Approximately 44 acres of new ROW would be required in Segment 2.

The Preferred Alternative provides a structural “cap” over a portion of the depressed lanes of I-45 from north of Cottage Street to south of N. Main Street. Future use of the structural cap area for another purpose would require additional development and funding by entities other than TxDOT.

Segment 3: Downtown Loop System (I-45, US 59/I-69, and I-10)

The Preferred Alternative would reconstruct all the existing interchanges in the Downtown Loop System and reroute I-45 to be parallel to I-10 on the north side of Downtown and parallel to US 59/I-69 on the east side of Downtown. Access to the west side of Downtown would be provided via “Downtown Connectors” that would consist of entrance and exit ramps for various Downtown streets. A section of the Downtown Connectors would be below-grade (depressed) between approximately W. Dallas Street to Andrews Street. The existing elevated I-45 roadway along the west and south sides of Downtown would be removed. The portion of I-45 (Pierce Elevated) between Brazos Street and US 59/I-69 could be left in place for future use and redevelopment by others; however, an alternative use for the structure is not proposed by TxDOT and is not evaluated in this Final EIS.

To improve safety and traffic flow in the north and east portions of Segment 3, portions of both I-10 and US 59/I-69 would be realigned (straightened) to eliminate the current roadway curvature. I-45 and US 59/I-69 would be depressed along a portion of the alignment east of Downtown. South of the George R. Brown Convention Center, the rerouted I-45 would begin to elevate to tie to existing I-45 southeast of Downtown, while US 59/I-69 would remain depressed as it continues southwest toward Spur 527. US 59/I-69 would be widened from eight to twelve general purpose lanes between I-45 and SH 288, and would be reconstructed to ten general purpose lanes from SH 288 to Spur 527.

The four proposed I-45 MaX lanes in Segments 1 and 2 would terminate/begin in Segment 3 at Milam Street/Travis Street, respectively. I-10 express lanes (two lanes in each direction) would be located generally in the center of the general-purpose lanes within the proposed parallel alignment of I-10 and I-45 on the north side of Downtown. The I-10 express lanes would vary between being elevated and at-grade.

New ROW to the east of the existing US 59/I-69 along the east side of Downtown would be required to accommodate the proposed realigned I-45. A new continuous southbound access road would be provided adjacent to US 59/I-69 and would tie to existing Hamilton Street on the south side of the Convention Center. The existing St. Emanuel Street would serve as a northbound access road. The project ROW would include areas to be developed as storm water detention. Approximately 160 acres of new ROW would be required, the majority of which would be for the I-10 and US 59/I-69 realignments (straightening) and to construct the proposed I-45 lanes adjacent to US 59/I-69 along the east side of Downtown.

The Preferred Alternative provides a structural “cap” over the proposed depressed lanes of I-45 and US 59/I-69 from approximately Commerce Street to Lamar Street. There would also be a structural cap over the depressed lanes of US 59/I-69 between approximately Main Street and Fannin Street, and in the area of the Caroline Street/Wheeler Street intersection. Future use of the structural cap areas for another purpose would require additional development and funding by entities other than TxDOT.

3.0 ROADWAY NOISE IMPACT ANALYSIS

This analysis was accomplished in accordance with TxDOT’s (FHWA approved) Guidelines for Analysis and Abatement of Roadway Traffic Noise (2011) and *Reasonable Cost Proposal for 2018 Noise Policy* (FHWA 2017).

3.1 Characteristics of Noise

Sound from highway traffic is generated primarily from a vehicle's tires, engine and exhaust. It is commonly measured in decibels and is expressed as "dB."

Sound occurs over a wide range of frequencies. However, not all frequencies are detectable by the human ear; therefore, an adjustment is made to the high and low frequencies to approximate the way an average person hears traffic sounds. This adjustment is called A-weighting and is expressed as "dB(A)."

Also, because traffic sound levels are never constant due to the changing number, type and speed of vehicles, a single value is used to represent the average or equivalent sound level and is expressed as "Leq."

The traffic noise analysis typically includes the following elements:

- Identification of land use activity areas that might be impacted by traffic noise.
- Determination of existing noise levels.
- Prediction of future noise levels.
- Identification of possible noise impacts.
- Consideration and evaluation of measures to reduce noise impacts.

As shown in **Table 3.1**, the FHWA has established the following Noise Abatement Criteria (NAC) for various land use activity areas that is used as one of two means to determine when a traffic noise impact would occur.

Table 3.1: FHWA Noise Abatement Criteria (NAC)

Activity Category	FHWA (dB(A) Leq)	Description of Land Use Activity Areas
A	57 (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	67 (exterior)	Residential
C	67 (exterior)	Active sport areas, amphitheatres, auditoriums, campgrounds, cemeteries, day care centers, hospitals, libraries, medical facilities, parks, picnic areas, places of worship, playgrounds, public meeting rooms, public or non-profit

Table 3.1: FHWA Noise Abatement Criteria (NAC)

Activity Category	FHWA (dB(A) Leq)	Description of Land Use Activity Areas
		institutional structures, radio studios, recording studios, recreation areas, Section 4(f) sites, schools, television studios, trails, and trail crossings.
D	52 (interior)	Auditoriums, day care centers, hospitals, libraries, medical facilities, places of worship, public meeting rooms, public or non-profit institutional structures, radio studios, recording studios, schools, and television studios.
E	72 (exterior)	Hotels, motels, offices, restaurants/bars, and other developed lands, properties, or activities not included in A-D or F
F	--	Agricultural, airports, bus yards, emergency services, industrial, logging, maintenance facilities, manufacturing, mining, rail yards, retail facilities, shipyards, utilities (water resources, water treatment, electrical), and warehousing.
G	--	Undeveloped lands that are not permitted.

Source: TxDOT 2011

A noise impact occurs when either the absolute or relative criterion is met:

Absolute criterion - The predicted noise level at a receiver approaches, equals or exceeds the NAC. "Approach" is defined as one dB(A) below the NAC. For example: a noise impact would occur at a Category B residence if the noise level is predicted to be 66 dB(A) or above.

Relative criterion - The predicted noise level substantially exceeds the existing noise level at a receiver even though the predicted noise level does not approach, equal or exceed the NAC. “Substantially exceeds” is defined as more than 10 dB(A). For example: a noise impact would occur at a Category B residence if the existing level is 54 dB(A) and the predicted level is 65 dB(A).

When a traffic noise impact occurs, noise abatement measures must be considered. A noise abatement measure is any positive action taken to reduce the impact of traffic noise on an activity area.

3.2 Traffic Noise Model Validation

A validation is used to demonstrate that a noise model is an accurate representation of the real-world noise levels within the limitations of the noise model algorithm. In accordance with FHWA (23 CFR 772.11 (d) (2), field measured traffic noise levels must be compared to the predicted results from the Traffic Noise Model (TNM) model. Data collected from the field should reflect existing parameters (traffic speed, traffic counts, pavement conditions, obstructions, geometry, meteorology, reflections, background noise, etc.) so they can be used in comparison to those conditions modelled in the TNM model. TNM predicts traffic noise levels for a period of 1 hour; therefore, if field samples are collected for periods of less than one hour, the results must be converted so they reflect an hourly condition. We were successful in validating the TNM model for the NHHIP analysis. See Appendix A to review the Noise Model Validation Report.

3.3 Existing and Predicted Noise Levels

The FHWA Traffic Noise Model (TNM) 2.5 software was used to calculate existing and predicted traffic noise levels. The model primarily considers the number, type and speed of vehicles; highway alignment and grade; cuts, fills and natural berms; surrounding terrain features; and the locations of activity areas likely to be impacted by the associated traffic noise.

Existing and predicted traffic noise levels were modelled at receiver locations (Table 3.2 and Exhibit 2) that represent the land use activity areas adjacent to the proposed project that might be impacted by traffic noise and potentially benefit from feasible and reasonable noise abatement.

Table 3.2: Traffic Noise Levels db(A) Leq

Representative Receiver		NAC Category	NAC Level	Existing	Predicted 2040	Change* (+/-)	Noise Impact	Exhibit 2 Page #
Segment 1								
R1	Restaurant	E	72	67	71	+4	Yes	2
R2	Restaurant	E	72	75	73	-2	Yes	3
R3	School Interior	D	52	48	48	0	No	3
R4	School	C	67	65	68	+3	Yes	3
R5	Restaurant	E	72	68	74	+6	Yes	3
R6	Church Interior	D	52	46	47	+1	No	3
R7	Church Interior	D	52	56	53	-3	Yes	4
R9	Restaurant	E	72	67	72	+5	Yes	4
R10	Residential	B	67	75	72	-3	Yes	7,8
R11	Residential	B	67	77	72	-5	Yes	7,8
R12	Residential	B	67	76	72	-4	Yes	7,8
R13	Residential	B	67	75	72	-3	Yes	8
R15	Residential	B	67	69	75	+6	Yes	8
R16	Residential	B	67	67	73	+6	Yes	8
R17	Residential	B	67	76	76	0	Yes	8
R18	Residential	B	67	76	76	0	Yes	8

Table 3.2: Traffic Noise Levels db(A) Leq

Representative Receiver		NAC Category	NAC Level	Existing	Predicted 2040	Change* (+/-)	Noise Impact	Exhibit 2 Page #
R19	Residential	B	67	69	76	+7	Yes	8
R20	Residential	B	67	69	76	+7	Yes	8
R21	Residential	B	67	77	76	-1	Yes	8
R22	Residential	B	67	69	76	+7	Yes	8
R23	Residential	B	67	69	76	+7	Yes	8
R24	Residential	B	67	76	75	-1	Yes	8
R25	Residential	B	67	76	75	-1	Yes	8
R26	Residential	B	67	69	77	+8	Yes	8
R27	Residential	B	67	69	77	+8	Yes	8
R28	Residential	B	67	69	76	+7	Yes	8
R29	Residential	B	67	69	76	+7	Yes	8
R30	Residential	B	67	69	75	+6	Yes	8
R31	Residential	B	67	69	74	+5	Yes	8
R32	Residential	B	67	68	75	+7	Yes	8
R32A	Residential	B	67	69	76	+7	Yes	8
R33	Apartments	B	67	60	64	+4	No	9
R34	Residential	B	67	69	75	+6	Yes	9
R35	Funeral Home Interior	D	52	56	55	-1	Yes	9
R36	Residential	B	67	68	74	+6	Yes	9
R37	Residential	B	67	69	76	+7	Yes	9
R38	Residential	B	67	68	75	+7	Yes	9,10
R39	Residential	B	67	68	75	+7	Yes	9,10
R40	Restaurant	E	72	74	70	-4	No	10
R41	Restaurant	E	72	73	72	-1	Yes	10,11
R42	Residential	B	67	72	72	0	Yes	11
R43	Residential	B	67	73	71	-2	Yes	11
R44	Residential	B	67	69	69	0	Yes	11
R45	Residential	B	67	68	71	+3	Yes	11
R46	Residential	B	67	66	70	+4	Yes	11
R47	Residential	B	67	65	67	+2	Yes	11
R47A	Residential	B	67	65	67	+2	Yes	11
Segment 2								
R1	Residential	B	67	69	68	-1	Yes	11
R2	Residential	B	67	67	69	+2	Yes	11,12
R3	Residential	B	67	66	68	+2	Yes	11,12
R4	Residential	B	67	70	68	-2	Yes	11,12
R5	Residential	B	67	71	69	-2	Yes	11,12,14
R6	Residential	B	67	67	69	+2	Yes	11,12,14
R7	Residential	B	67	68	69	+1	Yes	13,14

Table 3.2: Traffic Noise Levels db(A) Leq

Representative Receiver		NAC Category	NAC Level	Existing	Predicted 2040	Change* (+/-)	Noise Impact	Exhibit 2 Page #
R8	Residential	B	67	68	70	+2	Yes	13,14
R9	Residential	B	67	69	70	+1	Yes	13,14
R10	Residential	B	67	62	65	+3	No	12
R11	Residential	B	67	74	74	0	Yes	12
R12	Residential	B	67	71	72	+1	Yes	12
R13	Residential	B	67	74	76	+2	Yes	12
R14	Residential	B	67	67	69	+2	Yes	12
R15	Residential	B	67	72	75	+3	Yes	12
R16	Residential	B	67	75	74	-1	Yes	12
R17	Residential	B	67	70	74	+4	Yes	12
R18	Residential	B	67	69	73	+4	Yes	12
R19	Residential	B	67	71	74	+3	Yes	11,12
R20	Residential	B	67	71	75	+4	Yes	11,12,14
R21	Cemetery	C	67	72	76	+4	Yes	12
R21A	Residential	B	67	73	72	-1	Yes	12
R22	Residential	B	67	75	76	+1	Yes	13
R23	Residential	B	67	76	76	0	Yes	13
R24	Residential	B	67	70	69	-1	Yes	13
R25	Residential	B	67	61	61	0	No	13
R26	Residential	B	67	61	62	+1	No	13
R27	Residential	B	67	61	62	+1	No	13
R28	Residential	B	67	61	62	+1	No	13
R29	Residential	B	67	66	65	-1	No	13
R30	Residential	B	67	63	70	+7	Yes	13
R31	Residential	B	67	66	70	+4	Yes	13,14
R32	Residential	B	67	68	69	+1	Yes	12,14
R33	Residential	B	67	68	69	+1	Yes	13,14
R34	Music Association Hall Interior	D	52	50	48	-2	No	12,13,14
R35	Residential	B	67	69	67	-2	Yes	13,14
R36	Residential	B	67	72	71	-1	Yes	13,14
R37	Residential	B	67	72	68	-4	Yes	13,14
R38	Residential	B	67	72	68	-4	Yes	14
R39	Residential	B	67	72	68	-4	Yes	14
R40	Residential	B	67	70	72	+2	Yes	14
R41	Hotel Pool	E	72	63	65	+2	No	14,15
R42	Church Interior	D	52	43	47	+4	No	14,15
R43	Residential	B	67	66	68	+2	Yes	15
R44	Residential	B	67	69	69	0	Yes	15

Table 3.2: Traffic Noise Levels db(A) Leq

Representative Receiver		NAC Category	NAC Level	Existing	Predicted 2040	Change* (+/-)	Noise Impact	Exhibit 2 Page #
R45	Residential	B	67	69	70	+1	Yes	15
R46	Residential	B	67	69	70	+1	Yes	15
R47	Residential	B	67	72	70	-2	Yes	15
R48	Residential	B	67	75	72	-3	Yes	15
R49	Residential	B	67	72	74	+2	Yes	15
R50	Residential	B	67	75	74	-1	Yes	15
R51	Residential	B	67	57	57	0	No	15
R52	Residential	B	67	63	64	+1	No	15
R53	Residential	B	67	68	68	0	Yes	15,16
R54	Apartments	B	67	70	68	-2	Yes	15,16
R55	Residential	B	67	69	68	-1	Yes	15,16
R56	Cemetery	C	67	64	64	0	No	16
R57	Residential	B	67	71	72	+1	Yes	16
R58	Residential	B	67	67	69	+2	Yes	16
R59	Residential	B	67	74	76	+2	Yes	16
R60	Residential	B	67	73	75	+2	Yes	16
R61	Residential	B	67	73	69	-4	Yes	16
R62	Residential	B	67	71	63	-8	No	16
R63	Residential	B	67	75	74	-1	Yes	16
R64	Residential	B	67	73	72	-1	Yes	16
R65	Residential	B	67	76	72	-4	Yes	16
R66	Residential	B	67	76	70	-6	Yes	16
R67	Woodland Park Ball Field	C	67	70	69	-1	Yes	16
R68	Woodland Park Trail	C	67	75	73	-2	Yes	16
R69	Residential	B	67	74	73	-1	Yes	16
R70	Residential	B	67	72	71	-1	Yes	16
R71	Residential	B	67	74	72	-2	Yes	16
R72	Apartments	B	67	69	69	0	Yes	16,18
Segment 3—I10								
R1	Residential	B	67	77	79	+2	Yes	18
R2	Park	C	67	66	68	+2	Yes	18
R3	Church Interior	D	52	52	54	+2	Yes	18
R4	Residential	B	67	77	78	+1	Yes	18
R5	Residential	B	67	74	75	+1	Yes	18
R6	Park	C	67	68	69	+1	Yes	16,17,18
R7	Community Center	C	67	68	65	-3	No	17,18
R8	Park	C	67	71	60	-11	No	17,18
R9	Medical	C	67	64	62	-2	No	17,18

Table 3.2: Traffic Noise Levels db(A) Leq

Representative Receiver		NAC Category	NAC Level	Existing	Predicted 2040	Change* (+/-)	Noise Impact	Exhibit 2 Page #
R10	Residential	B	67	75	69	-6	Yes	17,18
R11	Residential	B	67	73	71	-2	Yes	17,18
R12	Residential	B	67	74	76	+2	Yes	17,18
R13	Residential	B	67	71	72	+1	Yes	17,18
R14	Park	C	67	76	72	-4	Yes	17,18,19
R15	Residential	B	67	71	67	-4	Yes	17,18,19
R16	Church Interior	D	52	49	43	-6	No	17,19
R17	University Interior	D	52	42	36	-6	No	19
R18	University Interior	D	52	37	47	+10	No	19
R18A	Residential	B	67	55	63	+8	No	19
R19	Residential	B	67	72	70	-2	Yes	19,22
R20	Park	C	67	64	72	+8	Yes	22
R20-1	Restaurant	E	72	69	74	+5	Yes	22
R22	Apartments	B	67	49	45	-4	No	25
R23	Park	C	67	58	62	+4	No	25
R24	School	C	67	69	64	-5	No	24
R25	Church	C	67	71	63	-8	No	24
R26	Funeral Home Interior	D	52	53	44	-9	No	24
R27	Residential	B	67	66	60	-6	No	24
R28	Residential	B	67	71	65	-6	No	24
R29	Residential	B	67	72	72	0	Yes	22,23,24
R30	Church Interior	D	52	51	50	-1	No	22,23,24
R31	Church Interior	D	52	47	49	+2	No	22,24
R32	Apartments	B	67	69	66	-3	Yes	22,23,24
R33	Townhomes	B	67	74	73	-1	Yes	22,24
R34	School Interior	D	52	49	50	+1	No	22,24
R35	Townhomes	B	67	70	67	-3	Yes	22,24
R36	Residential	B	67	70	66	-4	Yes	22,24
R37	Apartments	B	67	68	66	-2	Yes	22,24
R38	Residential	B	67	72	67	-5	Yes	22,23
R39	Park	C	67	69	70	+1	Yes	22,23
R40	Residential	B	67	69	67	-2	Yes	23
R41	Residential	B	67	69	70	+1	Yes	23
R42	Townhomes	B	67	68	68	0	Yes	23
R43	Residential	B	67	69	68	-1	Yes	23
R44	Residential	B	67	63	63	0	No	23
R45	Residential	B	67	68	72	+4	Yes	23
R46	Residential	B	67	70	74	+4	Yes	23
R47	Senior Center	C	67	66	69	+3	Yes	23

Table 3.2: Traffic Noise Levels db(A) Leq

Representative Receiver		NAC Category	NAC Level	Existing	Predicted 2040	Change* (+/-)	Noise Impact	Exhibit 2 Page #
R48	Library	C	67	71	74	+3	Yes	23
R49	Residential	B	67	71	77	+6	Yes	23
R50	Residential	B	67	72	74	+2	Yes	23
R51	Residential	B	67	76	77	+1	Yes	23
R52	Church Interior	D	52	50	50	0	No	23
R52A	Residential	B	67	74	76	+2	Yes	23
R53	Church Interior	D	52	46	49	+3	No	23
Segment 3—I45								
R1	Residential	B	67	75	62	-13	No	17,20
R2	Aquarium	C	67	73	60	-13	No	20
R3	Apartments	B	67	64	62	-2	No	20
R4	Park	C	67	70	62	-8	No	20
R5	Hobby Center for Performing Arts Interior	D	52	44	39	-5	No	20
R6	City Hall Annex	E	72	62	60	-2	No	20,21
R7	Park	C	67	59	55	-4	No	20
R8	Park	C	67	63	60	-3	No	20,21
R9	Park	C	67	64	61	-3	No	20,21
R10	Restaurant	E	72	68	63	-5	No	20,21
R11	Apartments	B	67	74	67	-7	Yes	20,21
R12	Apartments	B	67	76	70	-6	Yes	20,21
R13	Townhomes	B	67	73	67	-6	Yes	20,21
R14	Apartments	B	67	71	63	-8	No	21
R15	Hotel Pool	E	72	69	65	-4	No	21
R16	Apartments	B	67	69	65	-4	No	21
R17	Restaurant	E	72	71	61	-10	No	21
R18	Restaurant	E	72	73	54	-19	No	21
R19	Park	C	67	65	51	-14	No	21
Segment 3—I69								
R1	Apartments	B	67	35	41	+6	No	25
R2	Apartments	B	67	40	40	0	No	26
R3	Townhomes	B	67	65	74	+9	Yes	26
R4	Townhomes	B	67	64	74	+10	Yes	26,27
R5	Apartments	B	67	73	75	+2	Yes	26,28
R6	Residential	B	67	68	75	+7	Yes	27
R6A	Townhomes	B	67	70	75	+5	Yes	27
R7	Townhomes	B	67	64	68	+4	Yes	27
R8	Residential	B	67	67	69	+2	Yes	27
R9	Residential	B	67	67	73	+6	Yes	27,28

Table 3.2: Traffic Noise Levels db(A) Leq

Representative Receiver		NAC Category	NAC Level	Existing	Predicted 2040	Change* (+/-)	Noise Impact	Exhibit 2 Page #
R10	Townhomes	B	67	75	75	0	Yes	28
R11	Church Interior	D	52	46	51	+5	Yes	27,28
R12	Residential	B	67	66	70	+4	Yes	27,28
R13	Church Interior	D	52	49	48	-1	No	28
R14	Townhomes	B	67	76	76	0	Yes	28
R15	Townhomes	B	67	71	72	+1	Yes	28
R16	Townhomes	B	67	78	80	+2	Yes	28
R17	Townhomes	B	67	68	68	0	Yes	28
R18	Townhomes	B	67	78	80	+2	Yes	28
R19	Townhomes	B	67	73	72	-1	Yes	28
R20	Residential	B	67	69	68	-1	Yes	28
R21	Apartments	B	67	77	77	0	Yes	28
R22	Residential	B	67	73	71	-2	Yes	28
R23	Townhomes	B	67	76	76	0	Yes	28
R24	Townhomes	B	67	76	77	+1	Yes	28,29
R25	Apartments	B	67	76	76	0	Yes	28
R26	Residential	B	67	73	73	0	Yes	28,29
R28	School	C	67	64	66	+2	Yes	28,29
R29	Residential	B	67	69	73	+4	Yes	28,29
R31	Playground	C	67	73	74	+1	Yes	28,29
R32	Residential	B	67	71	74	+3	Yes	28,29
R33	Apartments	B	67	71	73	+2	Yes	28,29
R34	Townhomes	B	67	71	74	+3	Yes	28,29
R35	Apartments	B	67	75	79	+4	Yes	28,29,31
R36	Church Interior	D	52	51	52	+1	Yes	28,29,31
R37	Townhomes	B	67	68	68	0	Yes	30
R38	Townhomes	B	67	78	81	+3	Yes	30
R39	School	C	67	75	78	+3	Yes	30
R40	Apartments	B	67	69	74	+5	Yes	30
R41	Residential	B	67	69	66	-3	Yes	30
R42	Residential	B	67	68	66	-2	Yes	30
R43	Apartments	B	67	52	50	-2	No	30
R44	Townhomes	B	67	67	64	-3	No	30
R45	Townhomes	B	67	65	62	-3	No	30
R46	Residential	B	67	61	64	+3	No	30
R47	Residential	B	67	76	78	+2	Yes	30
R48	School	C	67	71	69	-2	Yes	30
R49	Residential	B	67	69	69	0	Yes	30
R50	Residential	B	67	75	77	+2	Yes	29,30

Table 3.2: Traffic Noise Levels db(A) Leq

Representative Receiver		NAC Category	NAC Level	Existing	Predicted 2040	Change* (+/-)	Noise Impact	Exhibit 2 Page #
R51	Residential	B	67	75	70	-5	Yes	29
R52	Residential	B	67	76	72	-4	Yes	29
R53	Residential	B	67	75	73	-2	Yes	29
R54	Residential	B	67	75	71	-4	Yes	29
R55	Residential	B	67	75	70	-5	Yes	29
R57	Church	C	67	73	79	+6	Yes	29,31
R58	Community Center	C	67	72	76	+4	Yes	29,31
R59	Residential	B	67	70	73	+3	Yes	29,31
R60	Residential	B	67	68	73	+5	Yes	29,31
R61	Residential	B	67	68	73	+5	Yes	29,31
R62	Residential	B	67	67	73	+6	Yes	29,31
R63	Residential	B	67	66	72	+6	Yes	29,31
R64	Residential	B	67	67	69	+2	Yes	29,31
R65	Residential	B	67	69	72	+3	Yes	29,31
R65-1	Residential	B	67	68	70	+2	Yes	29,31
R66	Townhomes	B	67	77	75	-2	Yes	29,31
R67	Church Interior	D	52	49	49	0	No	29,31
R68	Residential	B	67	70	71	+1	Yes	31
R69	Residential	B	67	69	69	0	Yes	31
R70	Residential	B	67	68	69	+1	Yes	31
R71	Residential	B	67	68	69	+1	Yes	31
R72	Residential	B	67	68	70	+2	Yes	31
R73	Residential	B	67	69	70	+1	Yes	31
R74	Residential	B	67	68	70	+2	Yes	31
R75	Residential	B	67	71	73	+2	Yes	31
R76	Residential	B	67	69	72	+3	Yes	31
R77	Residential	B	67	72	74	+2	Yes	31
R78	Townhomes	B	67	64	66	+2	Yes	31
R79	Residential	B	67	70	74	+4	Yes	31
R80	Residential	B	67	74	76	+2	Yes	31
R81	Residential	B	67	75	76	+1	Yes	31
R82	Residential	B	67	71	75	+4	Yes	31,32
R83	Medical Interior	D	52	53	55	+2	Yes	32
R84	Residential	B	67	73	76	+3	Yes	32
R85	Residential	B	67	74	76	+2	Yes	32
R86	Residential	B	67	72	75	+3	Yes	32
R87	Townhomes	B	67	72	74	+2	Yes	32
R88	Residential	B	67	74	77	+3	Yes	32
R89	Residential	B	67	74	77	+3	Yes	32

Table 3.2: Traffic Noise Levels db(A) Leq

Representative Receiver		NAC Category	NAC Level	Existing	Predicted 2040	Change* (+/-)	Noise Impact	Exhibit 2 Page #
R90	Townhomes	B	67	78	79	+1	Yes	32

Source: NHHIP Project Team 2018
Note: 1) Predicted noise levels may decrease or increase in some locations due to the location of the proposed project and traffic distribution. This does not include predicted potential noise reduction from use of longitudinally-tined pavement.
2) Representative receivers and their NAC category are selected based on the land use descriptions detailed in Table 3.1: FHWA Noise Abatement Criteria (NAC).

As indicated in Table 3.2, the proposed project would result in a traffic noise impact and the following noise abatement measures were considered: traffic management, alteration of horizontal and/or vertical alignments, acquisition of undeveloped property to act as a buffer zone and the construction of noise barriers.

Before any abatement measure can be proposed for incorporation into the project, it must be both feasible and reasonable. In order to be "feasible," the abatement measure must be able to reduce the noise level at greater than 50% of impacted, first row receivers by at least five dB(A); and to be "reasonable," it must not exceed the cost-effectiveness criterion of $52,500 (FHWA 2017) for each receiver that would benefit by a reduction of at least five dB(A) and the abatement measure must be able to reduce the noise level at least one impacted, first row receiver by at least seven dB(A).

The cost-effectiveness criteria can be met through evaluation of individual noise walls or through corridor-wide cost averaging of acoustically feasible noise walls. Cost averaging provides a strategy that may be employed when there are numerous traffic noise impacts throughout a corridor where many impacts can be abated with traffic noise barriers that meet the cost-effectiveness criterion of $52,500 for each benefited receiver and other impacts can only be abated with barriers that exceed the cost-effectiveness criterion. By averaging the cost of the abatement measures together, the cost per benefitted receiver criterion may, in some cases, be met. Cost averaging requires that no single traffic noise abatement measure exceed two times the cost effectiveness criterion (or $105,000 per benefitted receiver) and that collectively all traffic noise abatement measures being averaged do not exceed $52,500 per benefitted receiver. This noise analysis was conducted using the corridor-wide cost averaging strategy. The cost averaging strategy was applied by Segment and the Cost Averaging Table is found in Attachment 1.

Traffic management - Control devices could be used to reduce the speed of the traffic; however, the minor benefit of one dB(A) per five mph reduction in speed does not outweigh the associated increase in congestion and air pollution. Other measures such as time or use restrictions for certain vehicles are prohibited on state highways.

Alteration of horizontal and/or vertical alignments - Any alteration of the existing alignment would displace existing businesses and residences, require additional right-of-way (ROW) and not be cost effective/reasonable.

Buffer zone - The acquisition of undeveloped property to act as a buffer zone is designed to avoid rather than abate traffic noise impacts and, therefore, is not feasible.

Noise barriers - This is the most commonly used noise abatement measure. Noise barriers were evaluated for each of the impacted receiver locations with the following results:

3.3.1 Outcome of Noise Abatement Analysis

The existing and future noise environments for this project involved analyzing existing noise barrier walls within the project area for both. The preferred alternative alignment would result in the acquisition of new right of way. The analysis focused on noise sensitive representative receivers in NAC locations adjacent to the preferred alternative's existing and proposed right of way. The noise analysis conducted for the proposed project included 283 representative receivers; 61 of the 283 representative receivers did not have noise impacts. A noise barrier analysis was conducted for the remaining 222 impacted representative receivers.

3.3.1.1 Noise Abatement Not Proposed:

Noise barriers would not be feasible and reasonable for any of the impacted receivers described below and, therefore, are not proposed for incorporation into the proposed project.

Segment 1:

R1: This receiver represents a single commercial property, a restaurant. A split noise barrier with one gap was modeled along the ROW 20 feet high and 267 feet in total length, would not be sufficient to achieve the minimum feasible reduction of 5 dB(A) or the noise reduction design goal of 7 dB(A).

R2: This receiver represents a single commercial property, a restaurant. A split noise barrier with one gap was modeled along the ROW 20 feet high and 224 feet in total length, would be sufficient to achieve the minimum feasible reduction of 5 dB(A), but not the noise reduction design goal of 7 dB(A).

R4: This receiver represents a school property football stadium and recreational area. Based on a residential lot size of approximately 0.14 acres, estimated from nearby homes on Wellman Ln., the approximately 5.88 acres of impacted area is equivalent to 42 residential receivers. A split noise barrier with one gap was modeled along the ROW 20 feet high and 1,290 feet in total length, would be sufficient to achieve the minimum feasible reduction of 5 dB(A) and the noise reduction design goal of 7 dB(A) at first row receivers in the parking lot. This would not provide a benefit to the athletic fields located past the first row and therefore is not recommended.

R5: This receiver represents a single commercial property, a restaurant. A continuous noise barrier was modeled along the ROW 20 feet high and 213 feet in length, would not be sufficient to achieve the minimum feasible reduction of 5 dB(A) or the noise reduction design goal of 7 dB(A).

R7: This receiver represents a single church property with a driveway facing the roadway. A split noise barrier with one gap was modeled along the ROW 20 feet high and 124 feet in total length, would be sufficient to achieve the minimum feasible reduction of 5 dB(A), but not the noise reduction design goal of 7 dB(A).

R9: This receiver represents a single commercial property, a restaurant, with a driveway facing the roadway. A split noise barrier with one gap was modeled along the ROW 20 feet high and 152 feet in total length, would be sufficient to achieve the minimum feasible reduction of 5 dB(A), but not the noise reduction design goal of 7 dB(A).

R35: This receiver represents one commercial property, a funeral home. A continuous noise barrier along the ROW 14 feet high and 348 feet in length, would achieve the minimum feasible reduction of 5 dB(A) (with at least a 7 dB(A) design goal at one receiver) for one benefited receiver at a total cost of $170,520 or $170,520 for each benefited receiver, would exceed the reasonable, cost-effectiveness criterion of $52,500. Cost-averaging was not considered because the estimated cost per benefitted receiver is greater than two times the cost effectiveness criterion.

R41: This receiver represents a single commercial property, a restaurant. A continuous noise barrier was modeled along the ROW 20 feet high and 221 feet in length, would be sufficient to achieve the minimum feasible reduction of 5 dB(A) but not the noise reduction design goal of 7 dB(A).

R42 to R47, R47A: These receivers represent fourteen residences. Based on preliminary calculations, a split noise barrier with five gaps 1,163 ft in total length and 14 ft in height would reduce noise levels by at least 5 dB(A) or more and achieve a 7 dB(A) reduction at one or more receivers for eight benefited receivers at a total cost of $569,870, or $71,233 for each benefited receiver, would exceed the reasonable, cost-effectiveness criterion of $52,500 and would exceed the allowable cost averaging cumulative cost for Segment 1.

Segment 2:

R1 to R3, and R6: These receivers represent 24 residences, which are located adjacent to Little Whiteoak Bayou. A noise barrier along the ROW line would encroach on the zoned floodway. Due to drainage considerations, noise mitigation is not constructible at this location.

R11: This receiver represents two residences. Based on preliminary calculations, a split noise barrier with one gap 400 ft in total length and 16 ft in height would reduce noise levels by at least 5 dB(A) or more and achieve a 7 dB(A) reduction at one or more receivers for two benefited receivers at a total cost of $224,000, or $112,000 for each benefited receiver. Cost-averaging was not considered because the estimated cost per benefitted receiver is greater than two times the cost effectiveness criterion.

R12: This receiver represents four residences. A split noise barrier with one gap was modeled along the ROW 20 ft in height and 126 ft in total length, would not be sufficient to achieve the minimum feasible reduction of 5 dB(A), or the noise reduction design goal of 7 dB(A).

R14: This receiver represents seven residences. A split noise barrier with three gaps was modeled along the ROW 20 feet high and 175 feet in total length, would not be sufficient to achieve the minimum feasible reduction of 5 dB(A), or the noise reduction design goal of 7 dB(A).

R15: This receiver represents three residences. A split noise barrier with two gaps was modeled along the ROW 20 feet high and 74 feet in total length, would not be sufficient to achieve the minimum feasible reduction of 5 dB(A), or the noise reduction design goal of 7 dB(A).

R16: This receiver represents one residence. A continuous noise barrier was modeled along the ROW 20 feet high and 34 feet in length, would not be sufficient to achieve the minimum feasible reduction of 5 dB(A), or the noise reduction design goal of 7 dB(A).

R17: This receiver represents four residences. A split noise barrier with three gaps was modeled along the ROW 18 feet high and 170 feet in total length, would achieve the minimum feasible reduction of 5 dB(A) (with at least a 7 dB(A) design goal at one receiver) for one benefited receiver at a total cost of $107,100 or $107,100 for each benefited receiver, would exceed the reasonable, cost-effectiveness criterion of $52,500. Cost averaging was not considered because the estimated cost per benefited receiver is greater than two times the cost effectiveness criterion.

R21: This receiver represents a cemetery. Based on a residential lot size of approximately 0.15 acres, estimated adjacent homes on Eastman St., the approximately 0.58 acres of impacted area is equivalent to four residential receivers. A split noise barrier with one gap was modeled along the ROW 20 feet high and 344 feet in total length, would be sufficient to achieve the minimum feasible reduction of 5 dB(A), but not the noise reduction design goal of 7 dB(A).

R21A: This receiver represents two residences. Based on preliminary calculations, a split noise barrier with one gap 203 ft in total length and 16 ft in height would reduce noise levels by at least 5 dB(A) or more and achieve a 7 dB(A) reduction at one or more receivers for one benefited receiver at a total cost of $113,680, or $113,680 for each benefited receiver. The cost of the barrier exceeds the reasonable, individual cost-effectiveness criterion of $52,500 per benefited receiver. Cost-averaging was not considered because the estimated cost per benefitted receiver is greater than two times the cost effectiveness criterion.

R32: This receiver represents one residence, which is located adjacent to Little Whiteoak Bayou. A noise barrier along the ROW line would encroach on the zoned floodway. Due to drainage considerations, noise mitigation is not constructible at this location.

R42 to R47: These receivers represent 9 residences and one church, which are located adjacent to Little Whiteoak Bayou. A noise barrier along the ROW line would encroach on the zoned floodway. Due to drainage considerations, noise mitigation is not constructible at this location.

R49: This receiver represents one residence. A continuous noise barrier was modeled along the ROW 20 feet high and 34 feet in length, would not be sufficient to achieve the minimum feasible reduction of 5 dB(A), or the noise reduction design goal of 7 dB(A).

R50: This receiver represents two residences. A split noise barrier with one gap was modeled along the ROW 20 feet high and 96 feet in total length, would not be sufficient to achieve the minimum feasible reduction of 5 dB(A), or the noise reduction design goal of 7 dB(A).

R53: This receiver represents two residences. A split noise barrier with one gap was modeled along the ROW 20 feet high and 164 feet in total length, would not be sufficient to achieve the minimum feasible reduction of 5 dB(A), or the noise reduction design goal of 7 dB(A).

R54: This receiver represents an apartment complex. A continuous noise barrier was modeled along the ROW 20 feet high and 68 feet in length, would not be sufficient to achieve the minimum feasible reduction of 5 dB(A), or the noise reduction design goal of 7 dB(A).

R57: This receiver represents one residence. A continuous noise barrier was modeled along the ROW 20 feet high and 66 feet in length, would not be sufficient to achieve the minimum feasible reduction of 5 dB(A), or the noise reduction design goal of 7 dB(A).

R58: This receiver represents one residence. A continuous noise barrier was modeled along the ROW 20 feet high and 16 feet in length, would not be sufficient to achieve the minimum feasible reduction of 5 dB(A), or the noise reduction design goal of 7 dB(A).

R71: This receiver represents four residences. A split noise barrier with two gaps was modeled along the ROW 20 feet high and 247 feet in total length, would be sufficient to achieve the minimum feasible reduction of 5 dB(A), but not the noise reduction design goal of 7 dB(A).

Segment 3; I-10:

R2 and R6: These receivers represent the White Oak Park, and a portion of the White Oak Bayou Greenway Trail. Based on a residential lot size of approximately 0.11 acres, estimated from nearby homes on Wrightwood St., the approximately 4.07 acres of impacted area is equivalent to 37 residential receivers. A split noise barrier with one gap was modeled along the ROW 20 feet high and 1,851 feet in total length, would achieve the minimum feasible reduction of 5 dB(A) (with at least a 7 dB(A) design goal at one receiver) for ten benefited receivers at a total cost of $1,295,570 or $129,570 for each benefited receiver, would exceed the reasonable, cost-effectiveness criterion of $52,500. Cost-averaging was not considered because the estimated cost per benefitted receiver is greater than two times the cost effectiveness criterion.

R10 to R12 and R13: These receivers represent six residences. Based on preliminary calculations, a split noise barrier with one gap 906 ft in total length and 16 ft in height would reduce noise levels by at least 5 dB(A) or more and achieve a 7 dB(A) reduction at one or more receivers for two benefited receivers at a total cost of $507,360, or $253,680 for each benefited receiver. The cost of the barrier exceeds the reasonable, individual cost-effectiveness criterion of $52,500 per benefited receiver. Cost-averaging was not considered because the estimated cost per benefitted receiver is greater than two times the cost effectiveness criterion.

R14 and R15: This receiver represents the American Statesmanship Park and seven residences. The park is equivalent to one receiver. This location is a monument designed to be observed from the I-45, a continuous noise barrier would restrict visual access to this park. Additionally, a continuous noise barrier along the ROW 20 feet high and 693 feet in length, would achieve the minimum feasible reduction of 5 dB(A) (with at least a 7 dB(A) design goal at one receiver) for two benefited receivers at a total cost of $485,100 or $242,550 for each benefited receiver, would exceed the reasonable, cost-effectiveness criterion of $52,500. Cost-averaging was not considered because the estimated cost per benefitted receiver is greater than two times the cost effectiveness criterion.

R19: This receiver represents two residences. A split noise barrier with one gap was modeled along the ROW 20 feet high and 94 feet in total length, would not be sufficient to achieve the minimum feasible reduction of 5 dB(A), or the noise reduction design goal of 7 dB(A).

R33: This receiver represents two residences. A continuous noise barrier modeled along the ROW 20 feet high and 72 feet in length, would not be sufficient to achieve the minimum feasible reduction of 5 dB(A), or the noise reduction design goal of 7 dB(A).

R41: This receiver represents two residences. A continuous noise barrier modeled along the ROW 20 feet high and 166 feet in length, would be sufficient to achieve the minimum feasible reduction of 5 dB(A), but not the noise reduction design goal of 7 dB(A).

R44 and R46: These receivers represent four residences. Based on preliminary calculations, a split noise barrier with four gaps 746 ft in total length and 16 ft in height would reduce noise levels by at least 5 dB(A) or more and achieve a 7 dB(A) reduction at one or more receivers for three benefited receivers at a total cost of $417,760, or $139,253 for each benefited receiver, would exceed the reasonable, cost-effectiveness criterion of $52,500. Cost-averaging was not considered because the estimated cost per benefitted receiver is greater than two times the cost effectiveness criterion.

R45: This receiver represents two residences. Based on preliminary calculations, a continuous noise barrier 447 ft in length and 16 ft in height would reduce noise levels by at least 5 dB(A) or more and achieve a 7 dB(A) reduction at one or more receivers for two benefited receivers at a total cost of $250,320, or $125,160 for each benefited receiver, would exceed the reasonable, cost-effectiveness criterion of $52,500. Cost-averaging was not considered because the estimated cost per benefitted receiver is greater than two times the cost effectiveness criterion.

R47: This receiver represents one Senior Center. A continuous noise barrier modeled along the ROW 20 feet high and 122 feet in length, would not be sufficient to achieve the minimum feasible reduction of 5 dB(A), or the noise reduction design goal of 7 dB(A).

R50 to R51, and R52A: These receivers represent seven residences. Based on preliminary calculations, a split noise barrier with one gap 1,803 ft in total length and 16 ft in height would reduce noise levels by at least 5 dB(A) or more and achieve a 7 dB(A) reduction at one or more receivers for seven benefited receivers at a total cost of $1,009,680, or $144,240 for each benefited receiver, would exceed the reasonable, cost-effectiveness criterion of $52,500. Cost-averaging was not considered because the estimated cost per benefitted receiver is greater than two times the cost effectiveness criterion.

Segment 3; I-45:

R11 and R12: These receivers represent 38 residences. A split noise barrier with one gap was modeled along the ROW 20 feet high and 395 feet in total length, would not be sufficient to achieve the minimum feasible reduction of 5 dB(A), or the noise reduction design goal of 7 dB(A).

Segment 3; I-69:

R3: This receiver represents seven residences. A continuous noise barrier modeled along the ROW 20 feet high and 254 feet in length, would not be sufficient to achieve the minimum feasible reduction of 5 dB(A), or the noise reduction design goal of 7 dB(A).

R4: Although this receiver is impacted, the adjacent ROW aerial easement is for the elevated direct connector proposed for the project. TxDOT is not proposing mitigation in this area as they do not own the ROW at this location. Any proposed mitigation in this area would be the responsibility of the City of Houston.

R5: This receiver represents an apartment complex. A continuous noise barrier modeled along the ROW 20 feet high and 241 feet in total length, would not be sufficient to achieve the minimum feasible reduction of 5 dB(A), or the noise reduction design goal of 7 dB(A).

R6: This receiver represents three residences. A split noise barrier with one gap modeled along the ROW 20 feet high and 106 feet in total length, would not be sufficient to achieve the minimum feasible reduction of 5 dB(A), or the noise reduction design goal of 7 dB(A).

R9: This receiver represents one residence. A continuous noise barrier modeled along the ROW 20 feet high and 155 feet in length, would not be sufficient to achieve the minimum feasible reduction of 5 dB(A), or the noise reduction design goal of 7 dB(A).

R33: This receiver represents a condominium. Based on preliminary calculations, a continuous noise barrier 288 ft in length and 16 ft in height would reduce noise levels by at least 5 dB(A) or more and achieve a 7 dB(A) reduction at one receivers for a total cost of $161,280. Cost-averaging was not considered because the estimated cost per benefitted receiver is greater than two times the cost effectiveness criterion.

R35: This receiver represents an apartment complex. Based on preliminary calculations, a continuous noise barrier 715 ft in length and 20 ft in height would reduce noise levels by at least 5 dB(A) or more and achieve a 7 dB(A) reduction at one receivers for a total cost of $500,500 Cost-averaging was not considered because the estimated cost per benefitted receiver is greater than two times the cost effectiveness criterion.

R37, R41 and R42: These receivers represent a total of four residences. They are located behind an existing retaining wall for I-69. The construction of a noise barrier at this location would jeopardize the structural integrity of the existing retaining wall. Therefore, noise mitigation is not proposed at this location.

R38 and R39: These receivers represent eight residences and a school activity area. They are located behind an existing retaining wall for I-69. The construction of a noise barrier at this location would jeopardize the structural integrity of the existing retaining wall. Therefore, noise mitigation is not proposed at this location.

R40: This receiver represents an apartment complex with 18 first and second floor residences. It is located behind an existing retaining wall for I-69 that will be replaced as part of the proposed project. The retaining wall elevation will be determined at the time of the design-build process. As such, it is not possible to determine if mitigation is warranted or reasonable or feasible.

R50: This receiver represents one residence. A continuous noise barrier modeled along the ROW 20 feet high and 183 feet in length, would not be sufficient to achieve the minimum feasible reduction of 5 dB(A), or the noise reduction design goal of 7 dB(A).

R51: This receiver represents one residence. A continuous noise barrier modeled along the ROW 20 feet high and 190 feet in length, would not be sufficient to achieve the minimum feasible reduction of 5 dB(A), or the noise reduction design goal of 7 dB(A).

R52: This receiver represents two residences. A continuous noise barrier modeled along the ROW 20 feet high and 173 feet in length, would not be sufficient to achieve the minimum feasible reduction of 5 dB(A), or the noise reduction design goal of 7 dB(A).

R53 to R54: These receivers represent four residences. A continuous noise barrier modeled along the ROW 20 feet high and 167 feet in length, would be sufficient to achieve the minimum feasible reduction of 5 dB(A), but not the noise reduction design goal of 7 dB(A).

R55: This receiver represents three residences. A continuous noise barrier modeled along the ROW 20 feet high and 227 feet in length, would not be sufficient to achieve the minimum feasible reduction of 5 dB(A), or the noise reduction design goal of 7 dB(A).

R57: This receiver represents a church. A continuous noise barrier modeled along the ROW 20 feet high and 172 feet in length, would not be sufficient to achieve the minimum feasible reduction of 5 dB(A), or the noise reduction design goal of 7 dB(A).

R83: This receiver represents a medical clinic. A continuous noise barrier modeled along the ROW 20 feet high and 90 feet in length, would not be sufficient to achieve the minimum feasible reduction of 5 dB(A), or the noise reduction design goal of 7 dB(A).

3.3.1.2 Noise Abatement Proposed:

Noise barriers would be feasible and reasonable for the following impacted receivers and, therefore, are proposed for incorporation into the proposed project (refer to **Table 3.3**). Refer to **Exhibit 2** for the proposed locations of noise abatement barriers.

Segment 1

R10 to R13: These receivers represent five residences. Based on preliminary calculations, a split noise barrier with three gaps 536 ft in total length and 14 ft in height would reduce noise levels by at least 5 dB(A) or more and achieve a 7 dB(A) reduction at one or more receivers for five benefited receivers at a total cost of $262,150, or $52,430 for each benefited receiver.

R15 to R16, R19, R20, R22, R23, and R26 to R31: These receivers represent 16 residences. Based on preliminary calculations, a split noise barrier with four gaps 1,458 ft in total length and 14 ft in height would reduce noise levels by at least 5 dB(A) or more and achieve a 7 dB(A) reduction at one or more receivers for 14 benefited receivers at a total cost of $714,420, or $51,030 for each benefited receiver.

R17 to R18: These receivers represent two residences with driveways facing the roadway. Based on preliminary calculations, a continuous noise barrier 245 ft in length and 14 ft in height would reduce noise levels by at least 5 dB(A) or more and achieve a 7 dB(A) reduction at one or more receivers for two benefited receivers at a total cost of $120,050, or $60,025 for each benefited receiver. The cost of the barrier exceeds the reasonable, individual cost-effectiveness criterion of $52,500 per benefited receiver, but is less than the cost averaging criterion of $105,000 per benefited receiver. The cumulative estimated build cost (see Attachment) for this barrier is cost-effective and therefore, this barrier is proposed for incorporation into the project.

R21: This receiver represents one residence. Based on preliminary calculations, a continuous noise barrier 127 ft in length and 14 ft in height would reduce noise levels by at least 5 dB(A) or more and achieve a 7 dB(A) reduction at one benefited receiver at a total cost of $62,230. The cost of the barrier exceeds the reasonable, individual cost-effectiveness criterion of $52,500 per benefited receiver, but is less than the cost averaging criterion of $105,000 per benefited receiver. The cumulative estimated build cost (see Attachment) for this barrier is cost-effective and therefore, this barrier is proposed for incorporation into the project.

R24 to R25: These receivers represent two residences. Based on preliminary calculations, a continuous noise barrier 263 ft in length and 14 ft in height would reduce noise levels by at least 5 dB(A) or more and achieve a 7 dB(A) reduction at one or more receivers for two benefited receivers at a total cost of $128,870 or $64,435 for each benefited receiver. The cost of the barrier exceeds the reasonable, individual cost-effectiveness criterion of $52,500 per benefited receiver, but is less than the cost averaging criterion of $105,000 per benefited receiver. The cumulative estimated build cost (see Attachment) for this barrier is cost-effective and therefore, this barrier is proposed for incorporation into the project.

R32 and R32A: These receivers represent nine residences. Based on preliminary calculations, a split noise barrier with one gap 719 ft in total length and 14 ft in height would reduce noise levels by at least 5 dB(A) or more and achieve a 7 dB(A) reduction at nine benefited receivers at a total cost of $352,310 or $39,145 for each benefitted reliever.

R34, and R36 to R39: These receivers represent nine residences. Based on preliminary calculations, a split noise barrier with three gaps 740 ft in total length and 14 ft in height would reduce noise levels by at least 5 dB(A) or more and achieve a 7 dB(A) reduction at one or more receivers for seven benefited receivers at a total cost of $362,600, or $51,800 for each benefited receiver.

Segment 2:

R4, R5, and R7 to R9: This receiver represents 22 residences. Based on preliminary calculations, a split noise barrier with five gaps 1,238 ft in total length and 16 ft in height would reduce noise levels by at least 5 dB(A) or more and achieve a 7 dB(A) reduction at one or more receivers for 15 benefited receivers at a total cost of $693,280, or $46,219 for each benefited receiver.

R13: This receiver represents four residences and one resident of a multifamily unit. Based on preliminary calculations, a continuous noise barrier 224 ft in length and 16 ft in height would reduce noise levels by at least 5 dB(A) or more and achieve a 7 dB(A) reduction at one or more receivers for four benefited receivers at a total cost of $125,440, or $31,360 for each benefited receiver.

R18 to R20: These receivers represent nine residences. Based on preliminary calculations, a split noise barrier with one gap 770 ft in total length and 16 ft in height would reduce noise levels by at least 5 dB(A) or more and achieve a 7 dB(A) reduction at one or more receivers for nine benefited receivers at a total cost of $431,200, or $47,911 for each benefited receiver.

R22 to R23: These receivers represent seven residences. Based on preliminary calculations, a split noise barrier with two gaps 411 ft in total length and 16 ft in height would reduce noise levels by at least 5 dB(A) or more and achieve a 7 dB(A) reduction at one or more receivers for four benefited receivers at a total cost of $230,160, or $57,540 for each benefited receiver. The cost of the barrier exceeds the reasonable, individual cost-effectiveness criterion of $52,500 per benefited receiver, but is less than the cost averaging criterion of $105,000 per benefited receiver. The cumulative estimated build cost (see Attachment) for this barrier is cost-effective and therefore, this barrier is proposed for incorporation into the project.

R24: This receiver represents one residence. Based on preliminary calculations, a continuous noise barrier 77 ft in length and 16 ft in height would reduce noise levels by at least 5 dB(A) or more and achieve a 7 dB(A) reduction for one benefited receiver at a total cost of $43,120. This proposed noise barrier is an extension of an existing 16 ft noise barrier. The proposed barrier extension would block an existing gate (with no legal driveway access) that faces the frontage road.

R30, R31, and R33: These receivers represent 19 residences. Residences along IH 610 currently have an existing 16 ft noise barrier. However, due to the proposed project the existing noise barrier and some residential homes will be displaced. Based on preliminary calculations, a split noise replacement barrier with two gaps 1,235 ft in total length and 16 ft in height would reduce noise levels by at least 5 dB(A) or more and achieve a 7 dB(A) reduction at one or more receivers for 14 benefited receivers at a total cost of $691,600, or $49,400 for each benefited receiver.

R34, R35, and R37 to R40: These receivers represent 10 residences and one music association hall. Based on preliminary calculations, a split noise barrier with three gaps 918 ft in total length and 16 ft in height would reduce noise levels by at least 5 dB(A) or more and achieve a 7 dB(A) reduction at one or more receivers for nine benefited receivers at a total cost of $514,080, or $57,120 for each benefited receiver. The cost of the barrier exceeds the reasonable, individual cost-effectiveness criterion of $52,500 per benefited receiver, but is less than the cost averaging criterion of $105,000 per benefited receiver. The cumulative estimated build cost (see Attachment) for this barrier is cost-effective and therefore, this barrier is proposed for incorporation into the project.

R36: This receiver represents six residences. Based on preliminary calculations, a continuous noise barrier 372 ft in length and 16 ft in height would reduce noise levels by at least 5 dB(A) or more and achieve a 7 dB(A) reduction at one or more receivers for six benefited receivers at a total cost of $208,320, or $34,720 for each benefited receiver.

R48: This receiver represents two residences. Based on preliminary calculations, a continuous noise barrier 202 ft in length and 16 ft in height would reduce noise levels by at least 5 dB(A) or more and achieve a 7 dB(A) reduction at one or more receivers for two benefited receivers at a total cost of $113,120, or $56,560 for each benefited receiver. The cost of the barrier exceeds the reasonable, individual cost-effectiveness criterion of $52,500 per benefited receiver, but is less than the cost averaging criterion of $105,000 per benefited receiver. The cumulative estimated build cost (see Attachment) for this barrier is cost-effective and therefore, this barrier is proposed for incorporation into the project.

R55: This receiver represents four residences. Based on preliminary calculations, a continuous noise barrier 178 ft in length and 16 ft in height would reduce noise levels by at least 5 dB(A) or more and achieve a 7 dB(A) reduction at one or more receivers for four benefited receivers at a total cost of $99,680, or $24,920 for each benefited receiver.

R59, R60, R63 to R70, and R72: These receivers represent 21 residences an apartment pool area and a park. Based on a residential lot size of approximately 0.11 acres, estimated from adjacent homes on Parkview St., the approximately 3.63 acres of impacted area is equivalent to 18 residential receivers for the park adjacent area. A split noise barrier was modelled inside TxDOT ROW with three gaps 2,901 ft in total length and 16 ft in height would reduce noise levels by at least 5 dB(A) or more and achieve a 7 dB(A) reduction at one or more receivers for 33 benefited receivers at a total cost of $1,624,560, or $49,229 for each benefited receiver.

R61 to R62: These receivers represent four residences. Based on preliminary calculations, a continuous noise barrier 354 ft in length and 16 ft in height would reduce noise levels by at least 5 dB(A) or more and achieve a 7 dB(A) reduction at one or more receivers for three benefited receivers at a total cost of $198,240, or $66,080 for each benefited receiver. The cost of the barrier exceeds the reasonable, individual cost-effectiveness criterion of $52,500 per benefited receiver, but is less than the cost averaging criterion of $105,000 per benefited receiver. The cumulative estimated build cost (see Attachment) for this barrier is cost-effective and therefore, this barrier is proposed for incorporation into the project.

Segment 3; I-10:

R1, R3, and R4 to R5: These receivers represent eight residences and a church. Based on preliminary calculations, a split noise barrier with two gaps 1,125 ft in total length and 16 ft in height would reduce noise levels by at least 5 dB(A) or more and achieve a 7 dB(A) reduction at one or more receivers for nine benefited receivers at a total cost of $630,000, or $70,000 for each benefited receiver. The cost of the barrier exceeds the reasonable, individual cost-effectiveness criterion of $52,500 per benefited receiver, but is less than the cost averaging criterion of $105,000 per benefited receiver. The cumulative estimated build cost (see Attachment) for this barrier is cost-effective and therefore, this barrier is proposed for incorporation into the project.

R20: This receiver represents the Hennessey Park. Based on a residential lot size of approximately 0.11 acres, estimated from nearby homes on Charles St., the approximately 0.88 acres of impacted area is equivalent to 8 residential receivers. A continuous noise barrier 200 ft in length and 16 ft in height would reduce noise levels by at least 5 dB(A) or more and achieve a 7 dB(A) reduction at one or more receivers for four benefited receivers at a total cost of $112,000, or $28,000 for each benefited receiver.

R20-1: This receiver represents the St. Arnold Beer Garden. Based on preliminary calculations, a continuous noise barrier 171 ft in length and 16 ft in height would reduce noise levels by at least 5 dB(A) or more and achieve a 7 dB(A) reduction at one receiver for a total cost of $95,760. The cost of the barrier exceeds the reasonable, individual cost-effectiveness criterion of $52,500 per benefited receiver, but is less than the cost averaging criterion of $105,000 per benefited receiver. The cumulative estimated build cost (see Attachment) for this barrier is cost-effective and therefore, this barrier is proposed for incorporation into the project.

R29: This receiver represents an outdoor area associated with a four-unit apartment building. Based on preliminary calculations, a continuous noise barrier 100 ft in length and 16 ft in height would reduce noise levels by at least 5 dB(A) or more and achieve a 7 dB(A) reduction for one benefited receiver at a total cost of $56,000. The cost of the barrier exceeds the reasonable, individual cost-effectiveness criterion of $52,500 per benefited receiver, but is less than the cost averaging criterion of $105,000 per benefited receiver. The cumulative estimated build cost (see Attachment) for this barrier is cost-effective and therefore, this barrier is proposed for incorporation into the project.

R32, R37, and R39: These receivers represent the Kelly Village Apartment Complex and park. Based on a residential lot size of approximately 0.11 acres, estimated from nearby homes on Gregg St., the approximately 2.75 acres of impacted area is equivalent to 25 residential receivers. A continuous noise barrier 1,633 ft in length and 16 ft in height would reduce noise levels by at least 5 dB(A) or more and achieve a 7 dB(A) reduction at one or more receivers for 21 benefited receivers at a total cost of $914,480, or $43,547 for each benefited receiver.

R35: This receiver represents both the green space area in front of seven residences and the outdoor use areas for the seven residences within the fence line. Based on preliminary calculations, a continuous noise barrier 226 ft in length and 16 ft in height would reduce noise levels by at least 5 dB(A) or more and achieve a 7 dB(A) reduction at one or more receivers for seven benefited receivers at a total cost of $126,560, or $18,080 for each benefited receiver.

R36: This receiver represents ten residences. Based on preliminary calculations, a continuous noise barrier 296 ft in length and 16 ft in height would reduce noise levels by at least 5 dB(A) or more and achieve a 7 dB(A) reduction at one or more receivers for eight benefited receivers at a total cost of $165,760, or $20,720 for each benefited receiver.

R38: This receiver represents ten residences. Based on preliminary calculations, a split noise barrier with two gaps 749 ft in total length and 16 ft in height would reduce noise levels by at least 5 dB(A) or more and achieve a 7 dB(A) reduction at one or more receivers for 9 benefited receivers at a total cost of $419,440, or $46,604 for each benefited receiver.

R40: This receiver represents three residences. Based on preliminary calculations, a split noise barrier with three gaps 178 ft in total length and 16 ft in height would reduce noise levels by at least 5 dB(A) or more and achieve a 7 dB(A) reduction at one or more receivers for three benefited receivers at a total cost of $99,680, or $33,227 for each benefited receiver.

R42 to R43: These receivers represent eight residences. Based on preliminary calculations, a continuous noise barrier 262 ft in length and 16 ft in height would reduce noise levels by at least 5 dB(A) or more and achieve a 7 dB(A) reduction at one or more receivers for four benefited receivers at a total cost of $146,720, or $36,680 for each benefited receiver.

R48: This receiver represents one Library. Based on preliminary calculations, a continuous noise barrier 159 ft in total length and 16 ft in height would reduce noise levels by at least 5 dB(A) or more and achieve a 7 dB(A) reduction at one benefited receiver at a total cost of $89,040, or $89,040 for each benefited receiver. The cost of the barrier exceeds the reasonable, individual cost-effectiveness criterion of $52,500 per benefited receiver, but is less than the cost averaging criterion of $105,000 per benefited receiver. The cumulative estimated build cost (see Attachment) for this barrier is cost-effective and therefore, this barrier is proposed for incorporation into the project.

R49: This receiver represents two residences. Based on preliminary calculations, a continuous noise barrier 264 ft in length and 16 ft in height would reduce noise levels by at least 5 dB(A) or more and achieve a 7 dB(A) reduction at one or more receivers for two benefited receivers at a total cost of $147,840, or $73,920 for each benefited receiver. The cost of the barrier exceeds the reasonable, individual cost-effectiveness criterion of $52,500 per benefited receiver, but is less than the cost averaging criterion of $105,000 per benefited receiver. The cumulative estimated build cost (see Attachment) for this barrier is cost-effective and therefore, this barrier is proposed for incorporation into the project.

Segment 3; I-45:

R13: This receiver represents eight residences. Based on preliminary calculations, a split noise barrier with gaps for pedestrian entry 175 ft in total length and 16 ft in height would reduce noise levels by at least 5 dB(A) or more and achieve a 7 dB(A) reduction at one or more receivers for six benefited receivers at a total cost of $98,000, or $16,333 for each benefited receiver.

Segment 3; I-69:

R6A: This receiver represents six residences. Based on preliminary calculations a split noise barrier with gaps for pedestrian entry 161 ft in total length and 16 ft in height would reduce noise levels by at least 5 dB(A) or more and achieve a 7 dB(A) reduction at one or more receivers for six benefited receivers at a total cost of $90,160, or $15,027 for each benefited receiver.

R7: This receiver represents five residences. Although there is an existing masonry wall, based on preliminary calculations, a continuous noise barrier 210 ft in length and 16 ft in height would reduce noise levels by at least 5 dB(A) or more and achieve a 7 dB(A) reduction at one or more receivers for three benefited receivers at a total cost of $117,600, or $39,200 for each benefited receiver.

R8: This receiver represents 16 residences. Based on preliminary calculations, a split noise barrier with two gaps 950 ft in total length and 16 ft in height would reduce noise levels by at least 5 dB(A) or more and achieve a 7 dB(A) reduction at one or more receivers for 12 benefited receivers at a total cost of $532,000, or $44,333 for each benefited receiver.

R10: This receiver represents four residences. Based on preliminary calculations, a continuous noise barrier 227 ft in length and 16 ft in height would reduce noise levels by at least 5 dB(A) or more and achieve a 7 dB(A) reduction at one or more receivers for four benefited receivers at a total cost of $127,120, or $31,780 for each benefited receiver.

R11, R12 and R15: These receivers represent 15 residences and one church. Based on preliminary calculations, a split noise barrier with two gaps 1,013 ft in total length and 16 ft in height would reduce noise levels by at least 5 dB(A) or more and achieve a 7 dB(A) reduction at one or more receivers for 15 benefited receivers at a total cost of $567,280, or $37,819 for each benefited receiver.

R14: This receiver represents a single residence. Based on preliminary calculations, a continuous noise barrier 54 ft in length and 16 ft in height would reduce noise levels by at least 5 dB(A) or more and achieve a 7 dB(A) reduction at one receiver for a total cost of $30,240.

R16 and R18: These receivers represent 12 residences. Based on preliminary calculations, a continuous noise barrier 250 ft in length and 16 ft in height would reduce noise levels by at least 5 dB(A) or more and achieve a 7 dB(A) reduction at one or more receivers for 12 benefited receivers at a total cost of $140,000, or $11,667 for each benefited receiver.

R17: This receiver represents three residences. Although there is an existing masonry wall, based on preliminary calculations, a continuous noise barrier 200 ft in length and 16 ft in height would reduce noise levels by at least 5 dB(A) or more and achieve a 7 dB(A) reduction at one or more receivers for three benefited receivers at a total cost of $112,000, or $37,333 for each benefited receiver.

R19: This receiver represents three residences and a gym with an outdoor area. Based on preliminary calculations, a continuous noise barrier 200 ft in length and 16 ft in height would reduce noise levels by at least 5 dB(A) or more and achieve a 7 dB(A) reduction at one or more receivers for three benefited receivers at a total cost of $112,000, or $37,333 for each benefited receiver.

R20: This receiver represents two residences. Based on preliminary calculations, a continuous noise barrier 100 ft in length and 16 ft in height would reduce noise levels by at least 5 dB(A) or more and achieve a 7 dB(A) reduction at one or more receivers for two benefited receivers at a total cost of $56,000, or $28,000 for each benefited receiver.

R21: This receiver represents eight residences in an apartment complex. Based on preliminary calculations, a split noise barrier with seven gaps for pedestrian and garage entry 201 ft in total length and 16 ft in height would reduce noise levels by at least 5 dB(A) or more and achieve a 7 dB(A) reduction at one or more receivers for eight benefited receivers at a total cost of $112,560, or $14,070 for each benefited receiver.

R22: This receiver represents seven residences. Based on preliminary calculations, a continuous noise barrier 271 ft in length and 16 ft in height would reduce noise levels by at least 5 dB(A) or more and achieve a 7 dB(A) reduction at one or more receivers for six benefited receivers at a total cost of $151,760, or $25,293 for each benefited receiver.

R23: This receiver represents three residences. Based on preliminary calculations, a split noise barrier with gaps for pedestrian entry 198 ft in total length and 16 ft in height would reduce noise levels by at least 5 dB(A) or more and achieve a 7 dB(A) reduction at one or more receivers for three benefited receivers at a total cost of $110,880, or $36,960 for each benefited receiver.

R24 and R26: These receivers represent 11 residences. Based on preliminary calculations, a continuous noise barrier 479 ft in length and 16 ft in height would reduce noise levels by at least 5 dB(A) or more and achieve a 7 dB(A) reduction at one or more receivers for nine benefited receivers at a total cost of $268,240, or $29,804 for each benefited receiver.

R25: This receiver represents two apartments and a residence. Based on preliminary calculations, a split noise barrier with one gap 116 ft in total length and 16 ft in height would reduce noise levels by at least 5 dB(A) or more and achieve a 7 dB(A) reduction at one or more receivers for three benefited receivers at a total cost of $64,960, or $21,653 for each benefited receiver.

R28: This receiver represents a school basketball court. Based on preliminary calculations, a continuous noise barrier 165 ft in length and 16 ft in height would reduce noise levels by at least 5 dB(A) or more and achieve a 7 dB(A) reduction at one receiver for a total cost of $92,400. Barrier proposed based on cost averaging. The cost of the barrier exceeds the reasonable, individual cost-effectiveness criterion of $52,500 per benefited receiver, but is less than the cost averaging criterion of $105,000 per benefited receiver. The cumulative estimated build cost (see Attachment) for this barrier is cost-effective and therefore, this barrier is proposed for incorporation into the project.

R29, R32 and R34: These receivers represent 11 residences. Based on preliminary calculations, a continuous noise barrier 741 ft in length and 16 ft in height would reduce noise levels by at least 5 dB(A) or more and achieve a 7 dB(A) reduction at one or more receivers for 11 benefited receivers at a total cost of $414,960, or $37,723 for each benefited receiver.

R31: This receiver represents a park. Based on a residential lot size of approximately 0.11 acres, estimated from adjacent homes on Chenevert St., the approximately 1.32 acres of impacted area is equivalent to 12 residential receivers for the park. A continuous barrier 203 ft in length and 16 ft in height would reduce noise levels by at least 5 dB(A) or more and achieve a 7 dB(A) reduction at one or more receivers for seven benefited receivers at a total cost of $113,680, or $16,240 for each benefited receiver.

R36, R61, R63 and R65: These receivers represent 15 residences and one church. Based on preliminary calculations, a split noise barrier with one gap 1,654 ft in total length and 16 ft in height would reduce noise levels by at least 5 dB(A) or more and achieve a 7 dB(A) reduction at one or more receivers for 13 benefited receivers at a total cost of $926,240, or $71,249 for each benefited receiver. The cost of the barrier exceeds the reasonable, individual cost-effectiveness criterion of $52,500 per benefited receiver, but is less than the cost averaging criterion of $105,000 per benefited receiver. The cumulative estimated build cost (see Attachment) for this barrier is cost-effective and therefore, this barrier is proposed for incorporation into the project.

R47: This receiver represents three residences. Based on preliminary calculations, a continuous noise barrier 16 ft in height and 176 ft in length would reduce noise levels by at least 5 dB(A) or more and achieve a 7 dB(A) reduction at one or more receivers for one benefited receiver at a total cost of $98,560 or $98,560 for each benefited receiver. The cost of the barrier exceeds the reasonable, individual cost-effectiveness criterion of $52,500 per benefited receiver, but is less than the cost averaging criterion of $105,000 per benefited receiver. The cumulative estimated build cost (see Attachment) for this barrier is cost-effective and therefore, this barrier is proposed for incorporation into the project.

R48 and R49: These receivers represent seven residences and one school. Based on preliminary calculations, a continuous noise barrier 16 ft in height and 632 ft in length would reduce noise levels by at least 5 dB(A) or more and achieve a 7 dB(A) reduction at one or more receivers for seven benefited receivers at a total cost of $353,920 or $50,560 for each benefited receiver.

R58 to R60: These receivers represent three residences and a community center. Based on preliminary calculations, a continuous noise barrier 16 ft in height and 384 ft in length would reduce noise levels by at least 5 dB(A) or more and achieve a 7 dB(A) reduction at one or more receivers for four benefited receivers at a total cost of $215,040 or $53,760 for each benefited receiver. The cost of the barrier exceeds the reasonable, individual cost-effectiveness criterion of $52,500 per benefited receiver, but is less than the cost averaging criterion of $105,000 per benefited receiver. The cumulative estimated build cost (see Attachment) for this barrier is cost-effective and therefore, this barrier is proposed for incorporation into the project.

R62 and R64: These receivers represent six residences. Based on preliminary calculations, a continuous noise barrier 440 ft in length and 16 ft in height would reduce noise levels by at least 5 dB(A) or more and achieve a 7 dB(A) reduction at one or more receivers for four benefited receivers at a total cost of $246,400, or $61,600 for each benefited receiver. Barrier proposed based on cost averaging. The cost of the barrier exceeds the reasonable, individual cost-effectiveness criterion of $52,500 per benefited receiver, but is less than the cost averaging criterion of $105,000 per benefited receiver. The cumulative estimated build cost (see Attachment) for this barrier is cost-effective and therefore, this barrier is proposed for incorporation into the project

R65-1: This receiver represents a senior housing complex with an outdoor area and four first floor apartments facing the roadway. Based on preliminary calculations, a continuous noise barrier 404 ft in length and 16 ft in height would reduce noise levels by at least 5 dB(A) or more and achieve a 7 dB(A) reduction at one or more receivers for four benefited receivers at a total cost of $226,240, or $56,560 for each benefited receiver. Barrier proposed based on cost averaging. The cost of the barrier exceeds the reasonable, individual cost-effectiveness criterion of $52,500 per benefited receiver, but is less than the cost averaging criterion of $105,000 per benefited receiver. The cumulative estimated build cost (see Attachment) for this barrier is cost-effective and therefore, this barrier is proposed for incorporation into the project.

R66: This receiver represents five townhomes and two multi-family structures. Based on preliminary calculations, a continuous noise barrier 481 ft in length and 16 ft in height would reduce noise levels by at least 5 dB(A) or more and achieve a 7 dB(A) reduction at one or more receivers for five benefited receivers at a total cost of $269,360, or $53,872 for each benefited receiver. Barrier proposed based on cost averaging. The cost of the barrier exceeds the reasonable, individual cost-effectiveness criterion of $52,500 per benefited receiver, but is less than the cost averaging criterion of $105,000 per benefited receiver. The cumulative estimated build cost (see Attachment) for this barrier is cost-effective and therefore, this barrier is proposed for incorporation into the project.

R68: This receiver represents five residences. Based on preliminary calculations, a split noise barrier with four gaps 400 ft in total length and 16 ft in height would reduce noise levels by at least 5 dB(A) or more and achieve a 7 dB(A) reduction at one or more receivers for five benefited receivers at a total cost of $224,000, or $44,800 for each benefited receiver.

R69: This receiver represents two residences. Based on preliminary calculations, a continuous noise barrier 16 ft in height and 210 ft in length would reduce noise levels by at least 5 dB(A) or more and achieve a 7 dB(A) reduction at one or more receivers for two benefited receivers at a total cost of $117,600 or $58,800 for each benefited receiver. The cost of the barrier exceeds the reasonable, individual cost-effectiveness criterion of $52,500 per benefited receiver, but is less than the cost averaging criterion of $105,000 per benefited receiver. The cumulative estimated build cost (see Attachment) for this barrier is cost-effective and therefore, this barrier is proposed for incorporation into the project.

R70: This receiver represents two residences. Based on preliminary calculations, a continuous noise barrier 16 ft in height and 216 ft in length would reduce noise levels by at least 5 dB(A) or more and achieve a 7 dB(A) reduction at one or more receivers for two benefited receivers at a total cost of $120,960 or $60,480 for each benefited receiver. Barrier proposed based on cost averaging. The cost of the barrier exceeds the reasonable, individual cost-effectiveness criterion of $52,500 per benefited receiver, but is less than the cost averaging criterion of $105,000 per benefited receiver. The cumulative estimated build cost (see Attachment) for this barrier is cost-effective and therefore, this barrier is proposed for incorporation into the project.

R71: This receiver represents two residences. Based on preliminary calculations, a continuous noise barrier 16 ft in height and 210 ft in length would reduce noise levels by at least 5 dB(A) or more and achieve a 7 dB(A) reduction at one or more receivers for two benefited receivers at a total cost of $117,600 or $58,800 for each benefited receiver. The cost of the barrier exceeds the reasonable, individual cost-effectiveness criterion of $52,500 per benefited receiver, but is less than the cost averaging criterion of $105,000 per benefited receiver. The cumulative estimated build cost (see Attachment) for this barrier is cost-effective and therefore, this barrier is proposed for incorporation into the project.

R72: This receiver represents three residences. Based on preliminary calculations, a split noise barrier with two gaps 203 ft in total length and 16 ft in height would reduce noise levels by at least 5 dB(A) or more and achieve a 7 dB(A) reduction at one or more receivers for three benefited receivers at a total cost of $113,680, or $37,893 for each benefited receiver.

R73: This receiver represents two residences. Based on preliminary calculations, a continuous noise barrier 16 ft in height and 256 ft in length would reduce noise levels by at least 5 dB(A) or more and achieve a 7 dB(A) reduction at one or more receivers for two benefited receivers at a total cost of $143,360 or $71,680 for each benefited receiver. Barrier proposed based on cost averaging. The cost of the barrier exceeds the reasonable, individual cost-effectiveness criterion of $52,500 per benefited receiver, but is less than the cost averaging criterion of $105,000 per benefited receiver. The cumulative estimated build cost (see Attachment) for this barrier is cost-effective and therefore, this barrier is proposed for incorporation into the project

R74: This receiver represents two residences. Based on preliminary calculations, a split noise barrier with one gap 201 ft in total length and 16 ft in height would reduce noise levels by at least 5 dB(A) or more and achieve a 7 dB(A) reduction at one or more receivers for two benefited receivers at a total cost of $112,560, or $56,280 for each benefited receiver. The cost of the barrier exceeds the reasonable, individual cost-effectiveness criterion of $52,500 per benefited receiver, but is less than the cost averaging criterion of $105,000 per benefited receiver. The cumulative estimated build cost (see Attachment) for this barrier is cost-effective and therefore, this barrier is proposed for incorporation into the project.

R75: This receiver represents two residences. Based on preliminary calculations, a continuous noise barrier 16 ft in height and 238 ft in length would reduce noise levels by at least 5 dB(A) or more and achieve a 7 dB(A) reduction at one or more receivers for two benefited receivers at a total cost of $133,280, or $66,640 for each benefited receiver. The cost of the barrier exceeds the reasonable, individual cost-effectiveness criterion of $52,500 per benefited receiver, but is less than the cost averaging criterion of $105,000 per benefited receiver. The cumulative estimated build cost (see Attachment) for this barrier is cost-effective and therefore, this barrier is proposed for incorporation into the project.

R76: This receiver represents two residences. Based on preliminary calculations, a split noise barrier with one gap 158 ft in total length and 16 ft in height would reduce noise levels by at least 5 dB(A) or more and achieve a 7 dB(A) reduction at one or more receivers for two benefited receivers at a total cost of $88,480, or $44,240 for each benefited receiver.

R77 and R78: These receivers represent four residences. Three of these residences (**R78**) have an existing masonry wall. Based on preliminary calculations, a continuous noise barrier 16 ft in height and 285 ft in length would reduce noise levels by at least 5 dB(A) or more and achieve a 7 dB(A) reduction at one or more receivers for four benefited receivers at a total cost of $159,600, or $39,900 for each benefited receiver.

R79: This receiver represents two residences. Based on preliminary calculations, a split noise barrier with one gap 249 ft in total length and 16 ft in height would reduce noise levels by at least 5 dB(A) or more and achieve a 7 dB(A) reduction at one or more receivers for two benefited receivers at a total cost of $139,440, or $69,720 for each benefited receiver. The cost of the barrier exceeds the reasonable, individual cost-effectiveness criterion of $52,500 per benefited receiver, but is less than the cost averaging criterion of $105,000 per benefited receiver. The cumulative estimated build cost (see Attachment) for this barrier is cost-effective and therefore, this barrier is proposed for incorporation into the project.

R80 and R81: This receiver represents three residences. Based on preliminary calculations, a split noise barrier with one gap 16 ft in height and 414 ft in total length would reduce noise levels by at least 5 dB(A) or more and achieve a 7 dB(A) reduction at one or more receivers for three benefited receivers at a total cost of $231,840, or $77,280 for each benefited receiver. The cost of the barrier exceeds the reasonable, individual cost-effectiveness criterion of $52,500 per benefited receiver, but is less than the cost averaging criterion of $105,000 per benefited receiver. The cumulative estimated build cost (see Attachment) for this barrier is cost-effective and therefore, this barrier is proposed for incorporation into the project.

R82: This receiver represents four residences. Based on preliminary calculations, a split noise barrier with one gap 659 ft in total length and 16 ft in height would reduce noise levels by at least 5 dB(A) or more and achieve a 7 dB(A) reduction at one or more receivers for four benefited receivers at a total cost of $369,040, or $92,260 for each benefited receiver. Barrier proposed based on cost averaging. The cost of the barrier exceeds the reasonable, individual cost-effectiveness criterion of $52,500 per benefited receiver, but is less than the cost averaging criterion of $105,000 per benefited receiver. The cumulative estimated build cost (see Attachment) for this barrier is cost-effective and therefore, this barrier is proposed for incorporation into the project.

R84: This receiver represents one residence. Based on preliminary calculations, a continuous noise barrier 97 ft in length and 16 ft in height would reduce noise levels by at least 5 dB(A) or more and achieve a 7 dB(A) reduction at one receiver for a total cost of $54,320. The cost of the barrier exceeds the reasonable, individual cost-effectiveness criterion of $52,500 per benefited receiver, but is less than the cost averaging criterion of $105,000 per benefited receiver. The cumulative estimated build cost (see Attachment) for this barrier is cost-effective and therefore, this barrier is proposed for incorporation into the project.

R85: This receiver represents two residences. Based on preliminary calculations, a continuous noise barrier 16 ft in height and 268 ft in length would reduce noise levels by at least 5 dB(A) or more and achieve a 7 dB(A) reduction at one or more receivers for two benefited receivers at a total cost of $150,080, or $75,040 for each benefited receiver. The cost of the barrier exceeds the reasonable, individual cost-effectiveness criterion of $52,500 per benefited receiver, but is less than the cost averaging criterion of $105,000 per benefited receiver. The cumulative estimated build cost (see Attachment) for this barrier is cost-effective and therefore, this barrier is proposed for incorporation into the project.

R86 and R87: This receiver represents five residences. Based on preliminary calculations, a split noise barrier with one gap 16 ft in height and 364 ft in total length would reduce noise levels by at least 5 dB(A) or more and achieve a 7 dB(A) reduction at one or more receivers for four benefited receivers at a total cost of $203,840, or $50,960 for each benefited receiver.

R88: This receiver represents three residences. Based on preliminary calculations, a split noise barrier with one gap 16 ft in height and 348 ft in total length would reduce noise levels by at least 5 dB(A) or more and achieve a 7 dB(A) reduction at one or more receivers for three benefited receivers at a total cost of $194,880, or $64,960 for each benefited receiver. The cost of the barrier exceeds the reasonable, individual cost-effectiveness criterion of $52,500 per benefited receiver, but is less than the cost averaging criterion of $105,000 per benefited receiver. The cumulative estimated build cost (see Attachment) for this barrier is cost-effective and therefore, this barrier is proposed for incorporation into the project.

R89: This receiver represents one residence. Based on preliminary calculations, a continuous noise barrier 118 ft in length and 16 ft in height would reduce noise levels by at least 5 dB(A) or more and achieve a 7 dB(A) reduction at one receiver for a total cost of $66,080. The cost of the barrier exceeds the reasonable, individual cost-effectiveness criterion of $52,500 per benefited receiver, but is less than the cost averaging criterion of $105,000 per benefited receiver. The cumulative estimated build cost (see Attachment) for this barrier is cost-effective and therefore, this barrier is proposed for incorporation into the project.

R90: This receiver represents two residences. Based on preliminary calculations, a continuous noise barrier 12 ft in height and 232 ft in length would reduce noise levels by at least 5 dB(A) or more and achieve a 7 dB(A) reduction at one or more receivers for one benefited receiver at a total cost of $97,440 or $97,440 for each benefited receiver. Barrier proposed based on cost averaging. The cost of the barrier exceeds the reasonable, individual cost-effectiveness criterion of $52,500 per benefited receiver, but is less than the cost averaging criterion of $105,000 per benefited receiver. The cumulative estimated build cost (see Attachment) for this barrier is cost-effective and therefore, this barrier is proposed for incorporation into the project.

Table 3.3: Noise Barrier Proposal (Preliminary)

Barrier	Representative Receivers	Total No. Benefited Receivers	Length (feet)	Height (feet)	Total Cost	Cost/ Benefited Receiver	Cost Averaging Result
Segment 1							
1	R10 to R13	5	536	14	$262,150	$52,430	Cost-effective Stand Alone
2	R15 to R16, R19, R20, R22, R23, R26 to R31	14	1,458	14	$714,420	$51,030	Cost-effective Stand Alone
3	R17 to R18	2	245	14	$120,050	$60,025	Cost-effective Cumulative
4	R21	1	127	14	$62,230	$62,230	Cost-effective Cumulative
5	R24-R25	2	263	14	$128,870	$64,435	Cost-effective Cumulative
6	R32-R32A	9	719	14	$352,310	$39,145	Cost-effective Stand Alone
7	R34, R36-R39	7	740	14	$362,600	$51,800	Cost-effective Stand Alone
Segment 2							
8	R4, R5, and R7 to R9	15	1,238	16	$693,280	$46,219	Cost-effective Stand Alone
9	R13	4	224	16	$125,440	$31,360	Cost-effective Stand Alone
10	R18 to R20	9	770	16	$431,200	$47,911	Cost-effective Stand Alone
11	R22 to R23	4	411	16	$230,160	$57,540	Cost-effective Cumulative
12	R24	1	77	16	$43,120	$43,120	Cost-effective Stand Alone
13	R30, R31, and R33	14	1,235	16	$691,600	$49,400	Cost-effective Stand Alone
14	R34, R35, and R37 to R40	9	918	16	$514,080	$57,120	Cost-effective Cumulative
15	R36	6	372	16	$208,320	$34,720	Cost-effective Stand Alone
16	R48	2	202	16	$113,120	$56,560	Cost-effective Cumulative
17	R55	4	178	16	$99,680	$24,920	Cost-effective Stand Alone
18	R59, R60, R63 to R70, and R72	33	2,901	16	$1,624,560	$49,229	Cost-effective Stand Alone

Table 3.3: Noise Barrier Proposal (Preliminary)

Barrier	Representative Receivers	Total No. Benefited Receivers	Length (feet)	Height (feet)	Total Cost	Cost/ Benefited Receiver	Cost Averaging Result
19	R61 to R62	3	354	16	$198,240	$66,080	Cost-effective Cumulative
Segment 3: I-10							
20	R1, R3, and R4 to R5	9	1,125	16	$630,000	$70,000	Cost-effective Cumulative
21	R20	4	200	16	$112,000	$28,000	Cost-effective Stand Alone
22	R20-1	1	171	16	$95,760	$95,760	Cost-effective Cumulative
23	R29	1	100	16	$56,000	$56,000	Cost-effective Cumulative
24	R32, R37, and R39	21	1,633	16	$914,480	$43,547	Cost-effective Stand Alone
25	R35	7	226	16	$126,560	$18,080	Cost-effective Stand Alone
26	R36	8	296	16	$165,760	$20,720	Cost-effective Stand Alone
27	R38	9	749	16	$419,440	$46,604	Cost-effective Stand Alone
28	R40	3	178	16	$99,680	$33,227	Cost-effective Stand Alone
29	R42 to R43	4	262	16	$146,720	$36,680	Cost-effective Stand Alone
30	R48	1	159	16	$89,040	$89,040	Cost-effective Cumulative
31	R49	2	264	16	$147,840	$73,920	Cost-effective Cumulative
Segment 3: I-45							
32	R13	6	175	16	$98,000	$16,333	Cost-effective Stand Alone
Segment 3: I-69							
33	R6A	6	161	16	$90,160	$15,027	Cost-effective Stand Alone
34	R7	3	210	16	$117,600	$39,200	Cost-effective Stand Alone
35	R8	12	950	16	$532,000	$44,333	Cost-effective Stand Alone
36	R10	4	227	16	$127,120	$31,780	Cost-effective Stand Alone
37	R11, R12 and R15	15	1,013	16	$567,280	$37,819	Cost-effective Stand Alone
38	R14	1	54	16	$30,240	$30,240	Cost-effective Stand Alone
39	R16 and R18	12	250	16	$140,000	$11,667	Cost-effective Stand Alone
40	R17	3	200	16	$112,000	$37,333	Cost-effective Stand Alone

Table 3.3: Noise Barrier Proposal (Preliminary)

Barrier	Representative Receivers	Total No. Benefited Receivers	Length (feet)	Height (feet)	Total Cost	Cost/ Benefited Receiver	Cost Averaging Result
41	R19	3	200	16	$112,000	$37,333	Cost-effective Stand Alone
42	R20	2	100	16	$56,000	$28,000	Cost-effective Stand Alone
43	R21	8	201	16	$112,560	$14,070	Cost-effective Stand Alone
44	R22	6	271	16	$151,760	$25,293	Cost-effective Stand Alone
45	R23	3	198	16	$110,880	$36,960	Cost-effective Stand Alone
46	R24, R26	9	479	16	$268,240	$29,804	Cost-effective Stand Alone
47	R25	3	116	16	$64,960	$21,653	Cost-effective Stand Alone
48	R28	1	165	16	$92,400	$92,400	Cost-effective Cumulative
49	R29, R32 and R34	11	741	16	$414,960	$37,723	Cost-effective Stand Alone
50	R31	7	203	16	$113,680	$16,240	Cost-effective Stand Alone
51	R36, R61, R63 and R65	13	1,654	16	$926,240	$71,249	Cost-effective Cumulative
52	R47	1	176	16	$98,560	$98,560	Cost-effective Cumulative
53	R48 and R49	7	632	16	$353,920	$50,560	Cost-effective Stand Alone
54	R58 to R60	4	384	16	$215,040	$53,760	Cost-effective Cumulative
55	R62 and R64	4	440	16	$246,400	$61,600	Cost-effective Cumulative
56	R65-1	4	404	16	$226,240	$56,560	Cost-effective Cumulative
57	R66	5	481	16	$269,360	$53,872	Cost-effective Cumulative
58	R68	5	400	16	$224,000	$44,800	Cost-effective Stand Alone
59	R69	2	210	16	$117,600	$58,800	Cost-effective Cumulative
60	R70	2	216	16	$120,960	$60,480	Cost-effective Cumulative
61	R71	2	210	16	$117,600	$58,800	Cost-effective Cumulative
62	R72	3	203	16	$113,680	$37,893	Cost-effective Stand Alone
63	R73	2	256	16	$143,360	$71,680	Cost-effective Cumulative
64	R74	2	201	16	$112,560	$56,280	Cost-effective Cumulative

Table 3.3: Noise Barrier Proposal (Preliminary)

Barrier	Representative Receivers	Total No. Benefited Receivers	Length (feet)	Height (feet)	Total Cost	Cost/ Benefited Receiver	Cost Averaging Result
65	R75	2	238	16	$133,280	$66,640	Cost-effective Cumulative
66	R76	2	158	16	$88,480	$44,240	Cost-effective Stand Alone
67	R77 to R78	4	285	16	$159,600	$39,900	Cost-effective Stand Alone
68	R79	2	249	16	$139,440	$69,720	Cost-effective Cumulative
69	R80 to R81	3	414	16	$231,840	$77,280	Cost-effective Cumulative
70	R82	4	659	16	$369,040	$92,260	Cost-effective Cumulative
71	R84	1	97	16	$54,320	$54,320	Cost-effective Cumulative
72	R85	2	268	16	$150,080	$75,040	Cost-effective Cumulative
73	R86 to R87	4	364	16	$203,840	$50,960	Cost-effective Stand Alone
74	R88	3	348	16	$194,880	$64,960	Cost-effective Cumulative
75	R89	1	118	16	$66,080	$66,080	Cost-effective Cumulative
76	R90	1	232	12	$97,440	$97,440	Cost-effective Cumulative

Source: NHHIP Project Team 2018

Any subsequent proposed project design changes may require a re-evaluation of this preliminary noise barrier proposal. Adjustments to noise barrier locations may occur during final design. The final decision to construct the proposed noise barrier will not be made until completion of the proposed project design, utility evaluation, and polling of adjacent property owners.

3.3.2 Noise Impact Contour Analysis

To avoid noise impacts that may result from future development of properties adjacent to the project, local officials responsible for land use control programs must ensure, to the maximum extent possible, no new activities are planned or constructed along or within the following predicted (2040) noise impact contours.

Table 3.4: Traffic Noise Impact Contours

Land Use	Contour Area	Impact Contour	Distance from Right-of-Way (feet)
Segment 1			
NAC category B & C	I-45: Beltway 8 N. to Fallbrook Dr.	66 dB(A)	525
NAC category E	I-45: Beltway 8 N. to Fallbrook Dr.	71 dB(A)	175
NAC category B & C	I-45: to Fallbrook Dr. to West Rd.	66 dB(A)	410
NAC category E	I-45: Fallbrook Dr. to West Rd.	71 dB(A)	80
NAC category B & C	I-45: West Rd. to Blue Bell Rd.	66 dB(A)	420
NAC category E	I-45: West Rd. to Blue Bell Rd.	71 dB(A)	140
NAC category B & C	I-45: Blue Bell Rd. to W. Mt. Houston Rd	66 dB(A)	400
NAC category E	I-45: Blue Bell Rd. to W. Mt. Houston Rd.	71 dB(A)	75
NAC category B & C	I-45: W. Mt. Houston Rd. to Gulf Bank Rd.	66 dB(A)	435
NAC category E	I-45: W. Mt. Houston Rd. to Gulf Bank Rd.	71 dB(A)	110
NAC category B & C	I-45: Gulf Bank Rd. to Shepherd Rd.	66 dB(A)	550
NAC category E	I-45: Gulf Bank Rd. to Shepherd Rd.	71 dB(A)	225
NAC category B & C	I-45: Little York Rd. to W Parker Rd.	66 dB(A)	525
NAC category E	I-45: Little York Rd. to W Parker Rd.	71 dB(A)	15
NAC category B & C	I-45: Tidwell Rd. to Airline Dr.	66 dB(A)	505
NAC category E	I-45: Tidwell Rd. to Airline Dr.	71 dB(A)	105
Segment 2			
NAC category B & C	I-610: I-45 to Helmers St.	66 dB(A)	340
NAC category E	I-610: I-45 to Helmers St.	71 dB(A)	30
NAC category B & C	I-45: Cavalcade St. to Main St.	66 dB(A)	245
NAC category E	I-45: Cavalcade St. to Main St.	71 dB(A)	40
NAC category B & C	I-45: Main St. to White Oak Dr.	66 dB(A)	240
NAC category E	I-45: Main St. to White Oak Dr.	71 dB(A)	Inside ROW
Segment 3			
NAC category B & C	I-10: N. Milam St. to Jensen Dr.	66 dB(A)	365
NAC category E	I-10: N. Milam St. to Jensen Dr.	71 dB(A)	85
NAC category B & C	I-10: Gregg St. to Waco St.	66 dB(A)	390
NAC category E	I-10: Gregg St. to Waco St.	71 dB(A)	165
NAC category B & C	I-69: I-10 to Capitol St.	66 dB(A)	300
NAC category E	I-69: I-10 to Capitol St.	71 dB(A)	85
NAC category B & C	I-69: Capitol St. to Gray St.	66 dB(A)	470
NAC category E	I-69: Capitol St. to Gray St.	71 dB(A)	125
NAC category B & C	I-45: SH 288 to Scott St.	66 dB(A)	90
NAC category E	I-45: SH 288 to Scott St.	71 dB(A)	Inside ROW

Table 3.4: Traffic Noise Impact Contours

Land Use	Contour Area	Impact Contour	Distance from Right-of-Way (feet)
NAC category B & C	I-69: I-45 to SH 288	66 dB(A)	365
NAC category E	I-69: I-45 to SH 288	71 dB(A)	65
NAC category B & C	I-69: SH 288 to Montrose Blvd.	66 dB(A)	585
NAC category E	I-69: SH 288 to Montrose Blvd.	71 dB(A)	340
NAC category B & C	SH 288: Alabama St. to Wentworth Ave.	66 dB(A)	245
NAC category E	SH 288: Alabama St. to Wentworth Ave.	71 dB(A)	Inside ROW

Source: NHHIP Project Team 2018

3.4 Other Best Management Practices for Noise Mitigation

Best Management Practices will be utilized for the complete project. The noise analysis presented in the report was modelled using the FHWA-mandated average pavement type. In addition to noise mitigation by way of noise barriers, Best Management Practices (BMPs) that will be implemented to reduce noise levels of the project include the use of tined pavement. Potential noise reductions from the use of longitudinally-tined pavement, which is quieter than traditional concrete pavement, have not been quantified for this project.

As part of the environmental analysis for the project, a Community Impact Analysis was prepared to ensure compliance with Executive Order 12898: Federal Actions to Address Environmental Justice (EJ) in Minority Populations and Low-Income (1994). This order directs TxDOT to identify and address the disproportionately high and adverse human health or environmental effects caused by project actions on minority and low-income populations, to the greatest extent practicable and as permitted by law.

EJ aesthetic walls will be constructed in certain areas on the project to provide a visual barrier between the project and EJ neighborhoods. These walls will also provide noise mitigation. For additional information, please refer to the Community Impacts Technical Report for this project.

3.5 Noise from Construction

Noise associated with the construction of the project is difficult to predict. Heavy machinery, the major source of noise in construction, is constantly moving in unpredictable patterns. However, construction normally occurs during daylight hours when occasional loud noises are more tolerable. None of the receivers are expected to be exposed to construction noise for a long duration; therefore, any extended disruption of normal activities is not expected. Provisions will be included in the plans and specifications throughtout the project, that require the contractor to make every reasonable effort to minimize construction noise through abatement measures such as work-hour controls and proper maintenance of muffler systems.

4.0 SUMMARY

The proposed project has been determined to result in noise impacts. A total 283 representative receivers would be expected to have a noise increase at or above the criteria for absolute or relative impacts; therefore, noise barriers were considered for the proposed project. Noise barriers were found to meet the reasonable and feasible criteria for 205 of these impacted receivers and would potentially benefit approximately 414 individual receivers.

A copy of this traffic noise analysis will be available to local officials. On the date of approval of this document (Date of Public Knowledge), FHWA and TxDOT are no longer responsible for providing noise abatement for new development adjacent to the project.

5.0 REFERENCES

Federal Highway Administration. 2017. Reasonable Cost Proposal for 2018 Noise Policy. Letter from Michael T. Leary FHWA to Carlos Swonke TxDOT. December 19, 2017

Federal Highway Administration Environmental Justice Reference Guide, April 1, 2015 (FHWA-HEP-15-035)

Texas Department of Transportation 2011. *Guidelines for Analysis and Abatement of Roadway Traffic Noise*. Website: http://ftp.dot.state.tx.us/pub/txdot-info/library/pubs/bus/env/traffic_noise.pdf. Accessed April 2016.

__. 2014. *Examples of Recommended Text for Documenting Traffic Noise Analyses.* April 2014.

Attachments

Attachment 1: Cost Averaging Table

Summary of Noise Barrier Cost Averaging Analysis

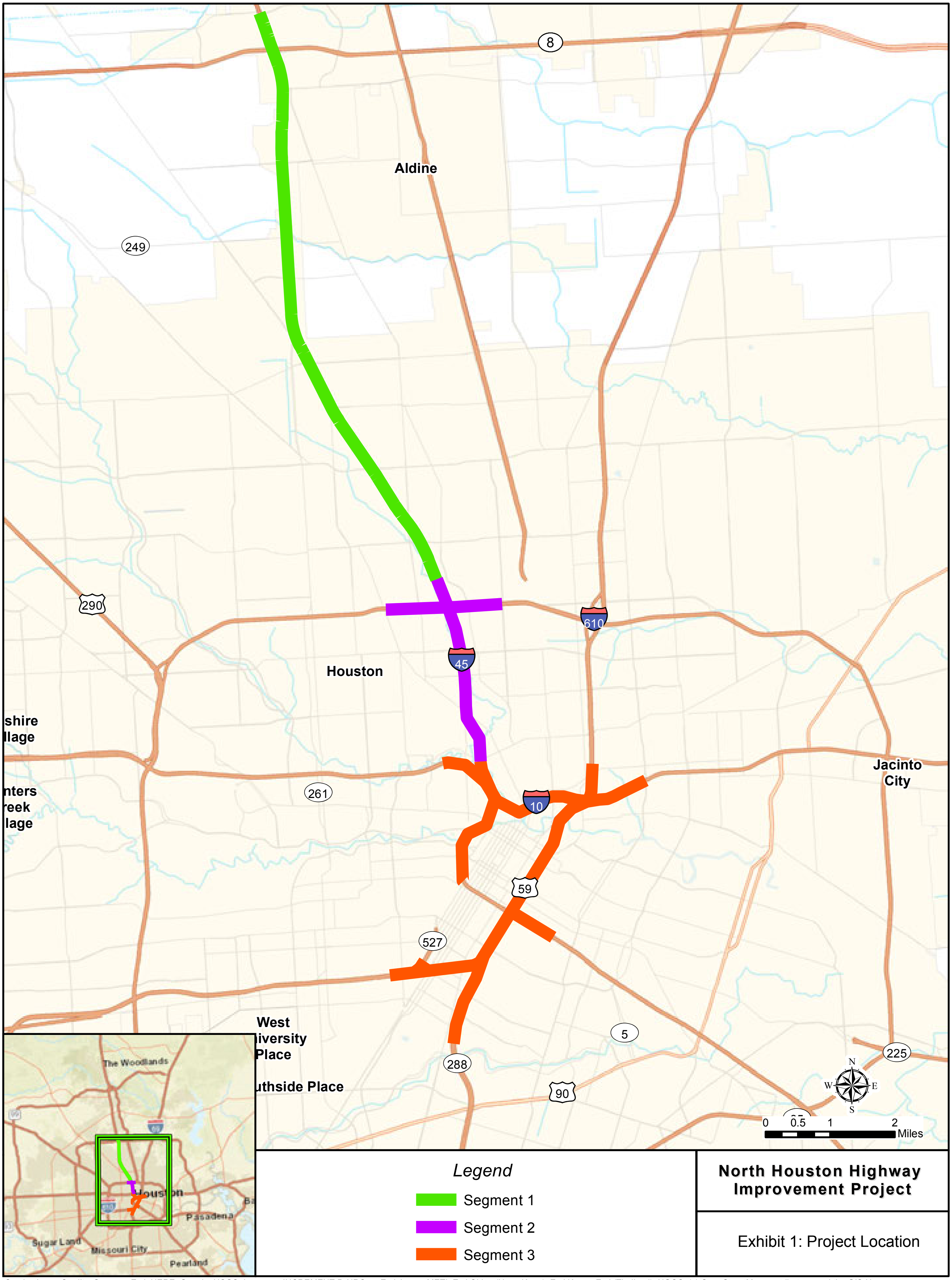
Barrier #	Receivers	Representative Receivers	Total Benefitted	Height (feet)	Total Length (feet)	Estimated Barrier Cost	Estimated Barrier Cost per Benefitted Reciever	Ratio of Build Cost to Reasonable Cost	Cumulative Estimated Cost per Benefitted Receiver	Result of Determination
Segment 1										
6	R32 and R32A	9	9	14	719	$ 352,310	$ 39,146	0.75	$ 39,146	Cost-effective Stand Alone
2	R15 to R16, R19, R20, R22, R23, R26 to R31	16	14	14	1458	$ 714,420	$ 51,030	0.97	$ 46,380	Cost-effective Stand Alone
7	R34, R36 to R39	9	7	14	740	$ 362,600	$ 51,800	0.99	$ 47,644	Cost-effective Stand Alone
1	R10 to R13	5	5	14	535	$ 262,150	$ 52,430	1.00	$ 48,328	Cost-effective Stand Alone
3	R17 to R18	2	2	14	245	$ 120,050	$ 60,025	1.14	$ 48,960	Cost-effective Cumulative
4	R21	1	1	14	127	$ 62,230	$ 62,230	1.19	$ 49,309	Cost-effective Cumulative
5	R24 to R25	2	2	14	263	$ 128,870	$ 64,435	1.23	$ 50,066	Cost-effective Cumulative
	R42 to R47, R47A	14	8	14	1163	$ 569,870	$ 71,234	1.36	$ 53,594	Not Cost Effective Cumulative
	R35	1	1	14	348	$ 170,520	$ 170,520	3.25	N/A*	Not Cost Effective Cumulative
Segment 2										
17	R55	1	4	16	178	$ 99,680	$ 24,920	0.47	$ 24,920	Cost-effective Stand Alone
9	R13	1	4	16	224	$ 125,440	$ 31,360	0.60	$ 28,140	Cost-effective Stand Alone
15	R36	1	6	16	372	$ 208,320	$ 34,720	0.66	$ 30,960	Cost-effective Stand Alone
12	R24	1	1	16	77	$ 43,120	$ 43,120	0.82	$ 31,771	Cost-effective Stand Alone
8	R4, R5, and R7 to R9	22	15	16	1238	$ 693,280	$ 46,219	0.88	$ 38,995	Cost-effective Stand Alone
10	R18 to R20	9	9	16	770	$ 431,200	$ 47,911	0.91	$ 41,052	Cost-effective Stand Alone
18	R59, R60, R63 to R70, and R72	11	33	16	2901	$ 1,624,560	$ 49,229	0.94	$ 44,800	Cost-effective Stand Alone
13	R30, R31, and R33	3	14	16	1235	$ 691,600	$ 49,400	0.94	$ 45,549	Cost-effective Stand Alone
16	R48	1	2	16	202	$ 113,120	$ 56,560	1.08	$ 45,799	Cost-effective Cumulative
14	R34, R35, and R37 to R40	6	9	16	918	$ 514,080	$ 57,120	1.09	$ 46,849	Cost-effective Cumulative
11	R22 to R23	7	4	16	411	$ 230,160	$ 57,540	1.10	$ 47,273	Cost-effective Cumulative
19	R61 to R62	2	3	16	354	$ 198,240	$ 66,080	1.26	$ 47,815	Cost-effective Cumulative
	R17	4	1	18	170	$ 107,100	$ 107,100	2.04	N/A*	Not Cost Effective Cumulative
	R11	2	2	16	400	$ 224,000	$ 112,000	2.13	N/A*	Not Cost Effective Cumulative
	R21A	2	1	16	203	$ 113,680	$ 113,680	2.17	N/A*	Not Cost Effective Cumulative
Segment 3: I-10										
25	R35	7	7	16	226	$ 126,560	$ 18,080	0.34	$ 18,080	Cost-effective Stand Alone
26	R36	1	8	16	296	$ 165,760	$ 20,720	0.39	$ 19,488	Cost-effective Stand Alone
21	R20	1	4	16	200	$ 112,000	$ 28,000	0.53	$ 21,280	Cost-effective Stand Alone
22	R20-1	1	1	16	171	$ 95,760	$ 95,760	1.82	$ 28,732	Cost-effective Cumulative
28	R40	1	3	16	178	$ 99,680	$ 33,227	0.63	$ 26,077	Cost-effective Stand Alone
29	R42 to R43	2	4	16	262	$ 146,720	$ 36,680	0.70	$ 27,647	Cost-effective Stand Alone
24	R32, R37, and R39	3	21	16	1633	$ 914,480	$ 43,547	0.83	$ 34,603	Cost-effective Stand Alone
27	R38	1	9	16	749	$ 419,440	$ 46,604	0.89	$ 36,498	Cost-effective Stand Alone
23	R29	1	1	16	100	$ 56,000	$ 56,000	1.07	$ 36,834	Cost-effective Cumulative

Summary of Noise Barrier Cost Averaging Analysis										
Barrier #	Receivers	Representative Receivers	Total Benefitted	Height (feet)	Total Length (feet)	Estimated Barrier Cost	Estimated Barrier Cost per Benefitted Reciever	Ratio of Build Cost to Reasonable Cost	Cumulative Estimated Cost per Benefitted Receiver	Result of Determination
20	R1, R3, and R4 to R5	10	10	16	1240	$ 694,400	$ 69,440	1.32	$ 41,629	Cost-effective Cumulative
31	R49	1	2	16	264	$ 147,840	$ 73,920	1.41	$ 42,552	Cost-effective Cumulative
30	R48	1	1	16	159	$ 89,040	$ 89,040	1.70	$ 43,207	Cost-effective Cumulative
	R45	2	2	16	447	$ 250,320	$ 125,160	2.38	N/A*	Not Cost Effective Cumulative
	R2 and R6	37	10	20	1851	$ 1,295,700	$ 129,570	2.47	N/A*	Not Cost Effective Cumulative
	R44 and R46	4	3	16	746	$ 417,760	$ 139,253	2.65	N/A*	Not Cost Effective Cumulative
	R50 to R51, and R52A	7	7	16	1803	$ 1,009,680	$ 144,240	2.75	N/A*	Not Cost Effective Cumulative
	R14 and R15	8	2	20	693	$ 485,100	$ 242,550	4.62	N/A*	Not Cost Effective Cumulative
	R10 to R12 and R13	6	2	16	906	$ 507,360	$ 253,680	4.83	N/A*	Not Cost Effective Cumulative
Segment 3:I-45										
32	R13	1	6	16	175	$ 98,000	$ 16,333	0.31	$ 16,333	Cost-effective Stand Alone
Segment 3:I-69										
39	R16 and R18	2	12	16	250	$ 140,000	$ 11,667	0.22	$ 11,667	Cost-effective Stand Alone
43	R21	1	8	16	201	$ 112,560	$ 14,070	0.27	$ 12,628	Cost-effective Stand Alone
33	R6A	1	6	16	161	$ 90,160	$ 15,027	0.29	$ 13,182	Cost-effective Stand Alone
50	R31	1	7	16	203	$ 113,680	$ 16,240	0.31	$ 13,830	Cost-effective Stand Alone
47	R25	1	3	16	116	$ 64,960	$ 21,653	0.41	$ 14,482	Cost-effective Stand Alone
44	R22	1	6	16	271	$ 151,760	$ 25,293	0.48	$ 16,027	Cost-effective Stand Alone
42	R20	1	2	16	100	$ 56,000	$ 28,000	0.53	$ 16,571	Cost-effective Stand Alone
46	R24, R26	2	9	16	479	$ 268,240	$ 29,804	0.57	$ 18,818	Cost-effective Stand Alone
38	R14	1	1	16	54	$ 30,240	$ 30,240	0.58	$ 19,030	Cost-effective Stand Alone
36	R10	1	4	16	227	$ 127,120	$ 31,780	0.61	$ 19,909	Cost-effective Stand Alone
45	R23	1	3	16	198	$ 110,880	$ 36,960	0.70	$ 20,748	Cost-effective Stand Alone
40	R17	1	3	16	200	$ 112,000	$ 37,333	0.71	$ 21,525	Cost-effective Stand Alone
41	R19	1	3	16	200	$ 112,000	$ 37,333	0.71	$ 22,233	Cost-effective Stand Alone
37	R11, R12 and R15	3	15	16	1013	$ 567,280	$ 37,819	0.72	$ 25,084	Cost-effective Stand Alone
62	R72	1	3	16	203	$ 113,680	$ 37,893	0.72	$ 25,536	Cost-effective Stand Alone
49	R29, R32 and R34	3	11	16	741	$ 414,960	$ 37,724	0.72	$ 26,933	Cost-effective Stand Alone
33	R7	1	3	16	210	$ 117,600	$ 39,200	0.75	$ 27,304	Cost-effective Stand Alone
67	R77 to R78	2	4	16	285	$ 159,600	$ 39,900	0.76	$ 27,793	Cost-effective Stand Alone
35	R8	1	12	16	950	$ 532,000	$ 44,333	0.84	$ 29,519	Cost-effective Stand Alone
66	R76	1	2	16	158	$ 88,480	$ 44,240	0.84	$ 29,771	Cost-effective Stand Alone
58	R68	1	5	16	400	$ 224,000	$ 44,800	0.85	$ 30,387	Cost-effective Stand Alone
53	R48 and R49	2	7	16	632	$ 353,920	$ 50,560	0.96	$ 31,482	Cost-effective Stand Alone
73	R86 to R87	2	4	16	364	$ 203,840	$ 50,960	0.97	$ 32,067	Cost-effective Stand Alone
54	R58 to R60	3	4	16	384	$ 215,040	$ 53,760	1.02	$ 32,701	Cost-effective Cumulative

Summary of Noise Barrier Cost Averaging Analysis										
Barrier #	Receivers	Representative Receivers	Total Benefitted	Height (feet)	Total Length (feet)	Estimated Barrier Cost	Estimated Barrier Cost per Benefitted Reciever	Ratio of Build Cost to Reasonable Cost	Cumulative Estimated Cost per Benefitted Receiver	Result of Determination
71	R84	1	1	16	97	$ 54,320	$ 54,320	1.03	$ 32,857	Cost-effective Cumulative
57	R66	1	5	16	481	$ 269,360	$ 53,872	1.03	$ 33,592	Cost-effective Cumulative
64	R74	1	2	16	201	$ 112,560	$ 56,280	1.07	$ 33,905	Cost-effective Cumulative
56	R65-1	4	4	16	404	$ 226,240	$ 56,560	1.08	$ 34,513	Cost-effective Cumulative
59	R69	1	2	16	210	$ 117,600	$ 58,800	1.12	$ 34,835	Cost-effective Cumulative
61	R71	1	2	16	210	$ 117,600	$ 58,800	1.12	$ 35,148	Cost-effective Cumulative
60	R70	1	2	16	216	$ 120,960	$ 60,480	1.15	$ 35,475	Cost-effective Cumulative
55	R62 and R64	2	4	16	440	$ 246,400	$ 61,600	1.17	$ 36,132	Cost-effective Cumulative
74	R88	3	3	16	348	$ 194,880	$ 64,960	1.24	$ 36,666	Cost-effective Cumulative
75	R89	1	1	16	118	$ 66,080	$ 66,080	1.26	$ 36,847	Cost-effective Cumulative
65	R75	1	2	16	238	$ 133,280	$ 66,640	1.27	$ 37,208	Cost-effective Cumulative
68	R79	2	2	16	249	$ 139,440	$ 69,720	1.33	$ 37,597	Cost-effective Cumulative
51	R36, R61, R63 and R65	4	13	16	1654	$ 926,240	$ 71,249	1.36	$ 40,028	Cost-effective Cumulative
63	R73	1	2	16	256	$ 143,360	$ 71,680	1.37	$ 40,375	Cost-effective Cumulative
72	R85	2	2	16	268	$ 150,080	$ 75,040	1.43	$ 40,752	Cost-effective Cumulative
69	R80 and R81	3	3	16	414	$ 231,840	$ 77,280	1.47	$ 41,338	Cost-effective Cumulative
48	R28	1	1	16	165	$ 92,400	$ 92,400	1.76	$ 41,610	Cost-effective Cumulative
70	R82	1	4	16	659	$ 369,040	$ 92,260	1.76	$ 42,665	Cost-effective Cumulative
76	R90	1	1	12	232	$ 97,440	$ 97,440	1.86	$ 42,949	Cost-effective Cumulative
52	R47	3	1	16	176	$ 98,560	$ 98,560	1.88	$ 43,235	Cost-effective Cumulative
	R33	1	1	16	288	$ 161,280	$ 161,280	3.07	N/A*	Not Cost Effective Cumulative
	R35	1	1	20	715	$ 500,500	$ 500,500	9.53	N/A*	Not Cost Effective Cumulative

N/A* - Not part of the evaluation as estimated cot is more than two times the allowable cost.

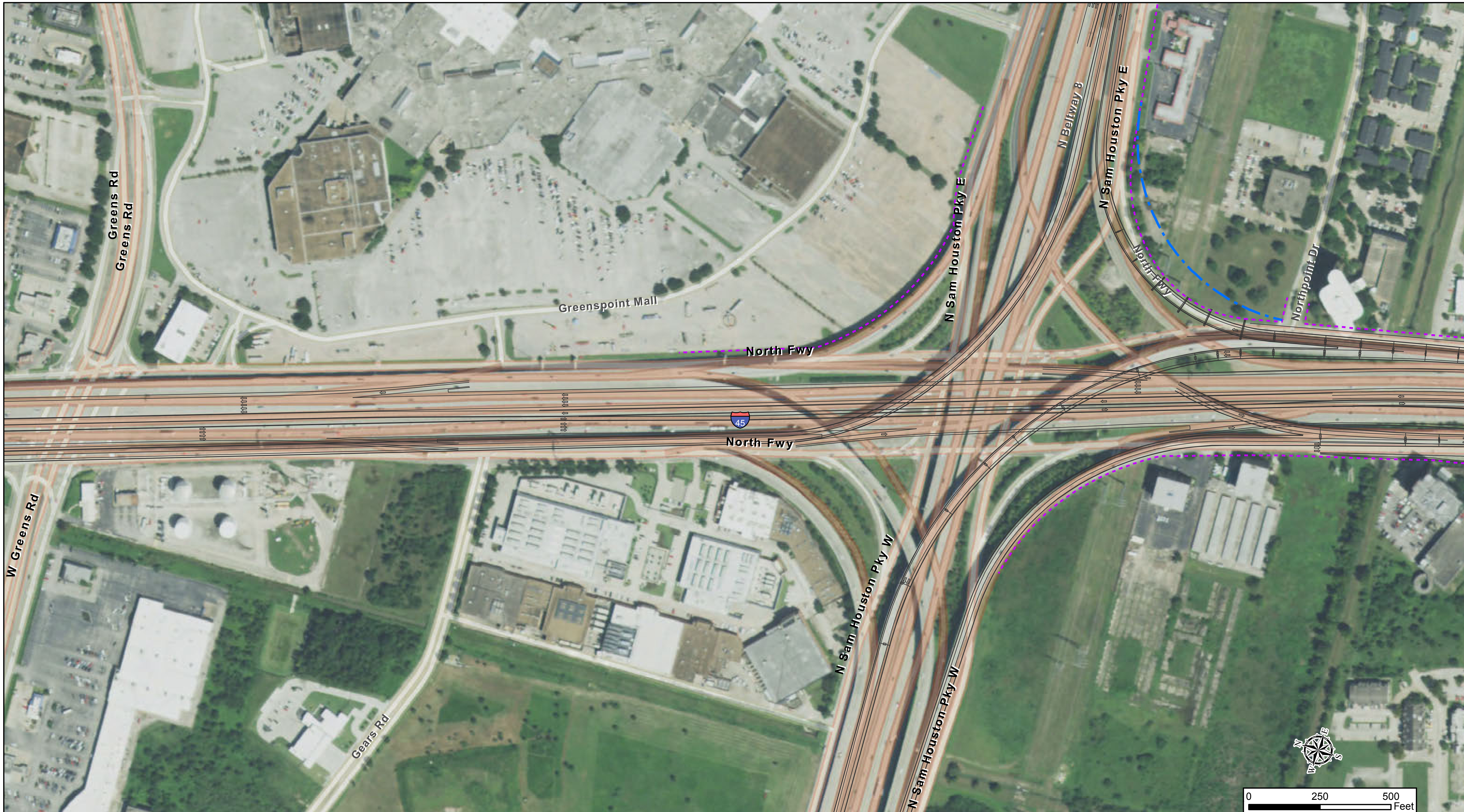
Exhibits

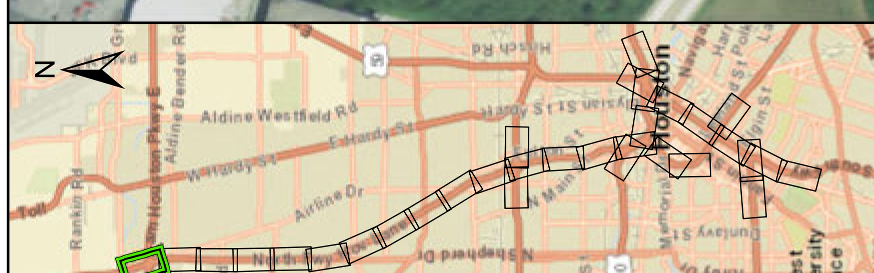


North Houston Highway Improvement Project

Exhibit 1: Project Location

Service Layer Credits: Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User





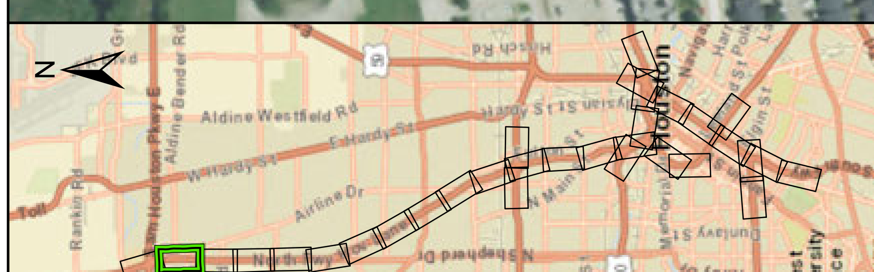
Legend

Benefited	Proposed Barriers	Proposed Right of Way
Impacted	Existing Barrier	Proposed Design
Non Impacted	Existing Right of Way	

North Houston Highway Improvement Project

Exhibit 2: Noise Receivers and Proposed Barriers Map

Sources: TNRIS (2016)



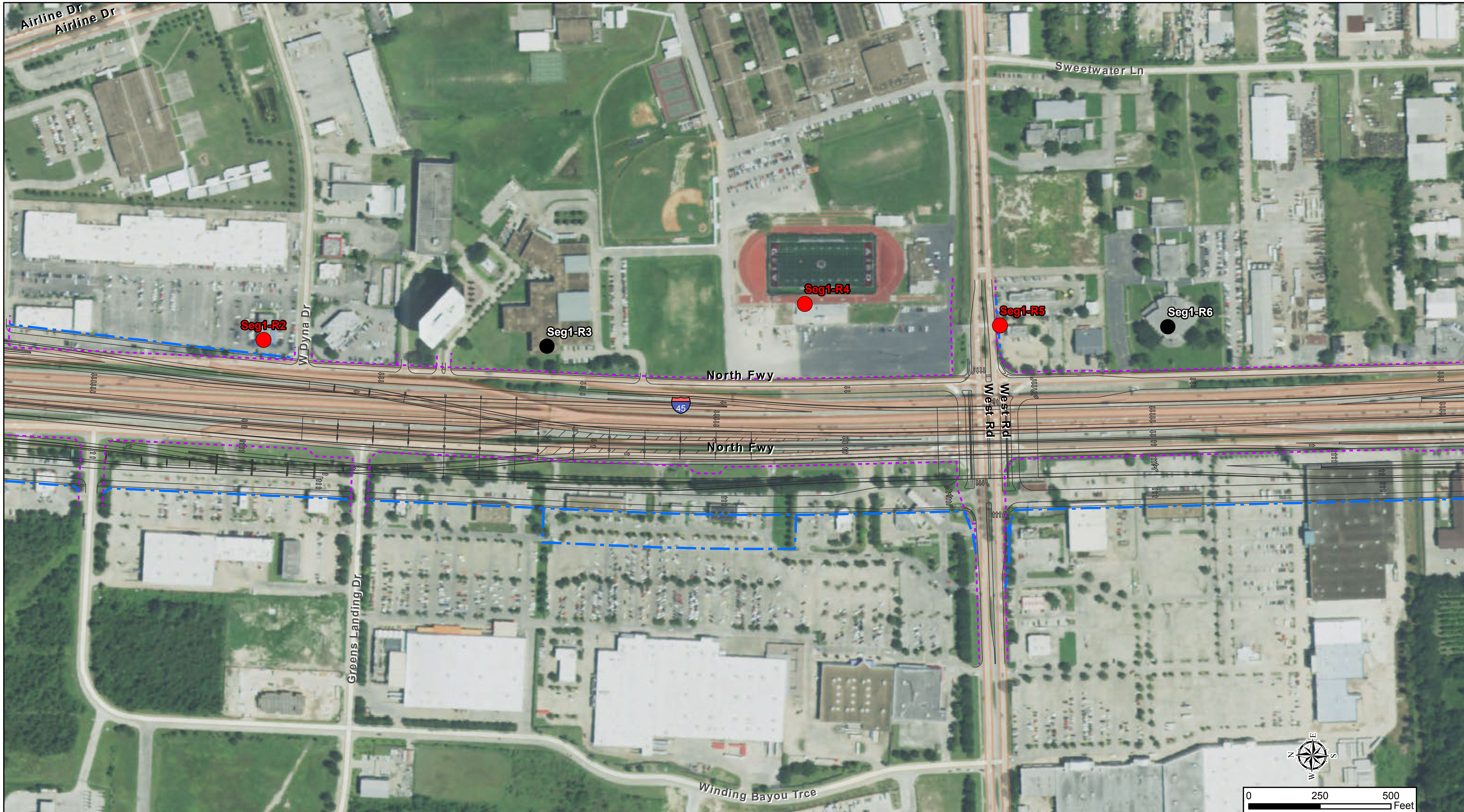
Legend

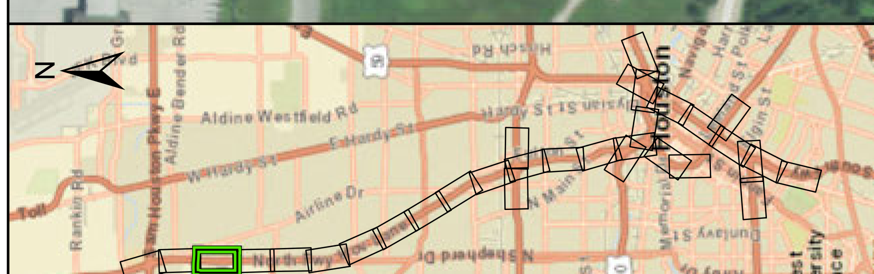
- Benefited
- Impacted
- Non Impacted
- Proposed Barriers
- Existing Barrier
- Existing Right of Way
- Proposed Right of Way
- Proposed Design

North Houston Highway Improvement Project

Exhibit 2: Noise Receivers and Proposed Barriers Map

Sources: TNRIS (2016)





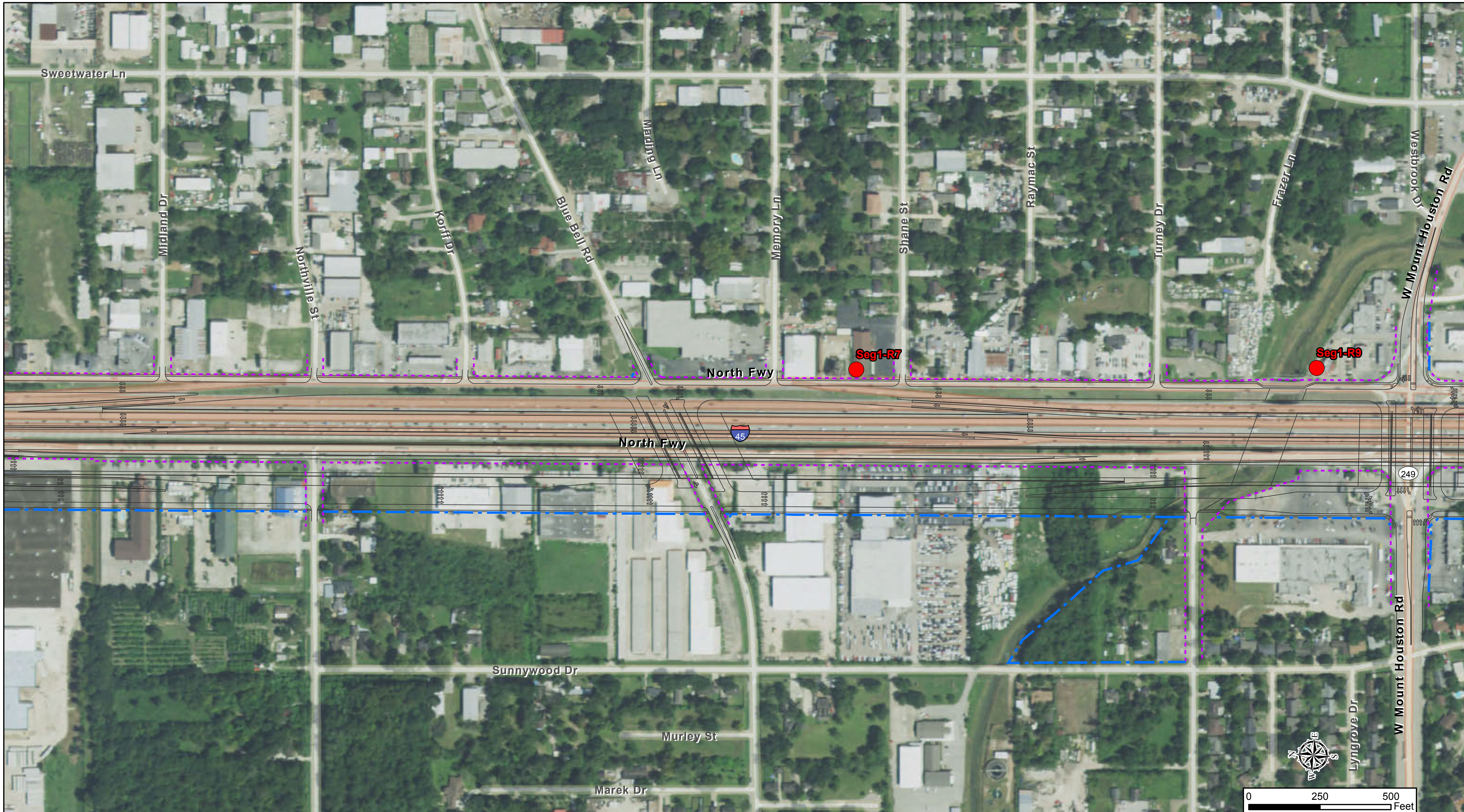
Legend

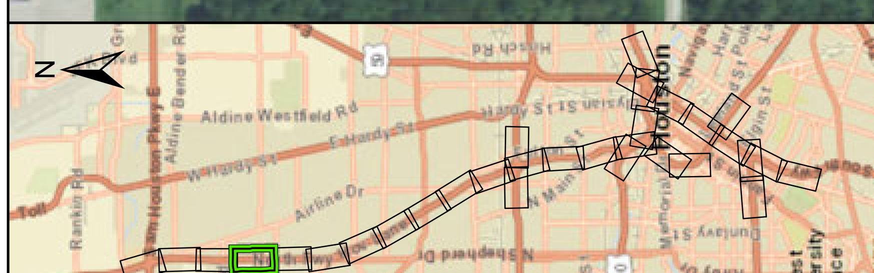
- Benefited
- Impacted
- Non Impacted
- Proposed Barriers
- Existing Barrier
- Existing Right of Way
- Proposed Right of Way
- Proposed Design

North Houston Highway Improvement Project

Exhibit 2: Noise Receivers and Proposed Barriers Map

Sources: TNRIS (2016)





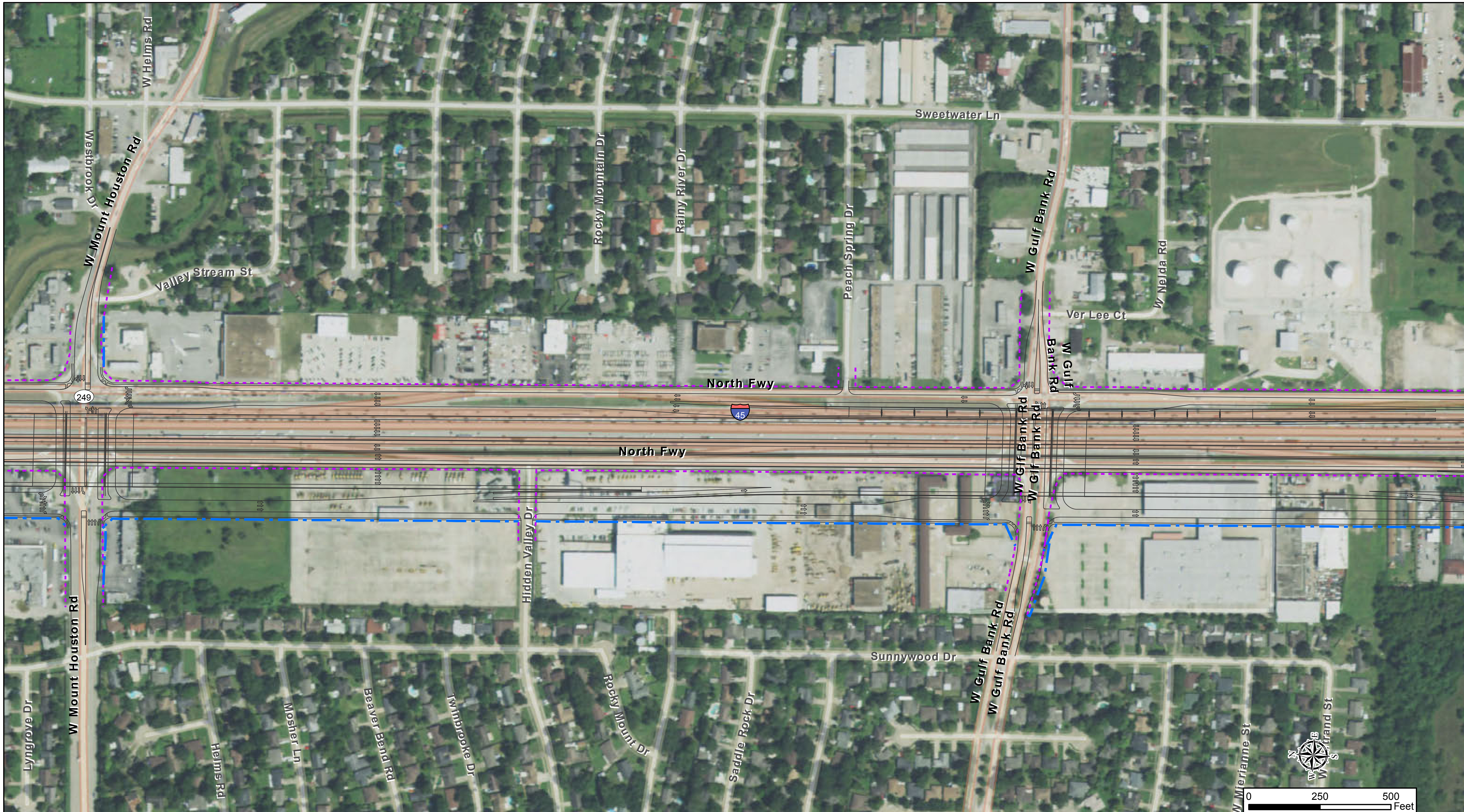
Legend

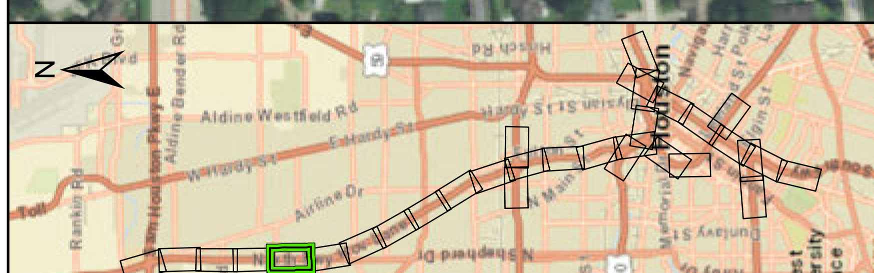
Benefited	Proposed Barriers	Proposed Right of Way
Impacted	Existing Barrier	Proposed Design
Non Impacted	Existing Right of Way	

North Houston Highway Improvement Project

Exhibit 2: Noise Receivers and Proposed Barriers Map

Sources: TNRIS (2016)





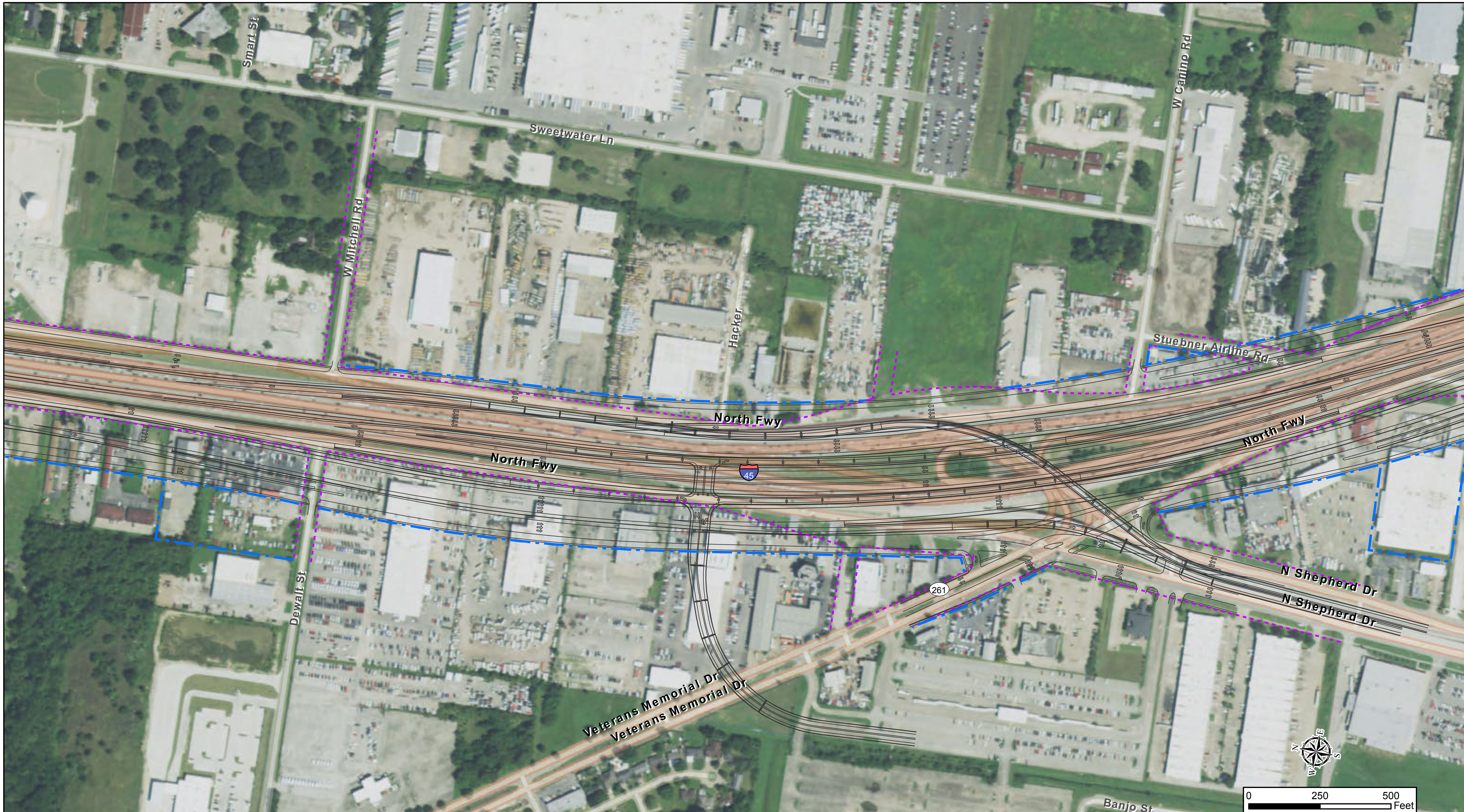
Legend

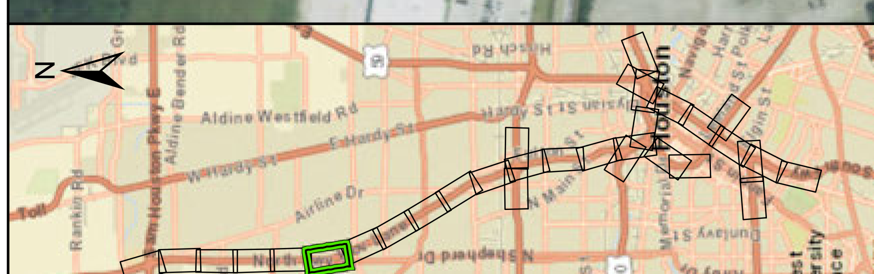
Benefited	Proposed Barriers	Proposed Right of Way
Impacted	Existing Barrier	Proposed Design
Non Impacted	Existing Right of Way	

North Houston Highway Improvement Project

Exhibit 2: Noise Receivers and Proposed Barriers Map

Sources: TNRIS (2016)





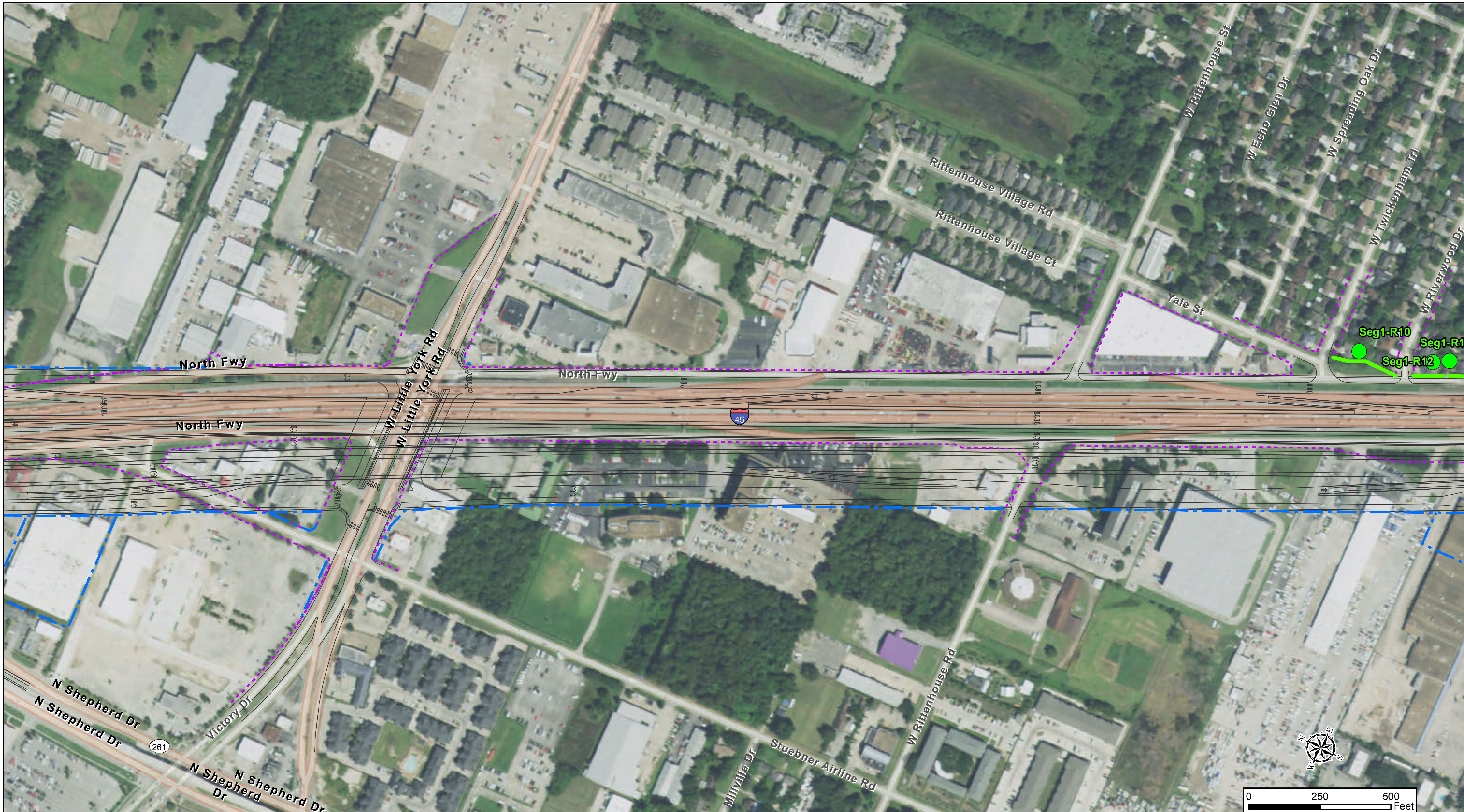
Legend

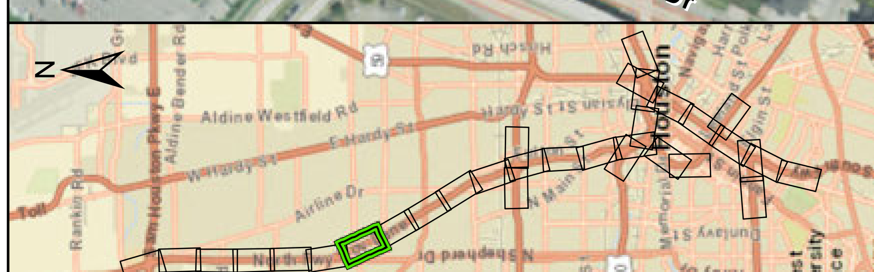
Benefited	Proposed Barriers	Proposed Right of Way
Impacted	Existing Barrier	Proposed Design
Non Impacted	Existing Right of Way	

North Houston Highway Improvement Project

Exhibit 2: Noise Receivers and Proposed Barriers Map

Sources: TNRIS (2016)





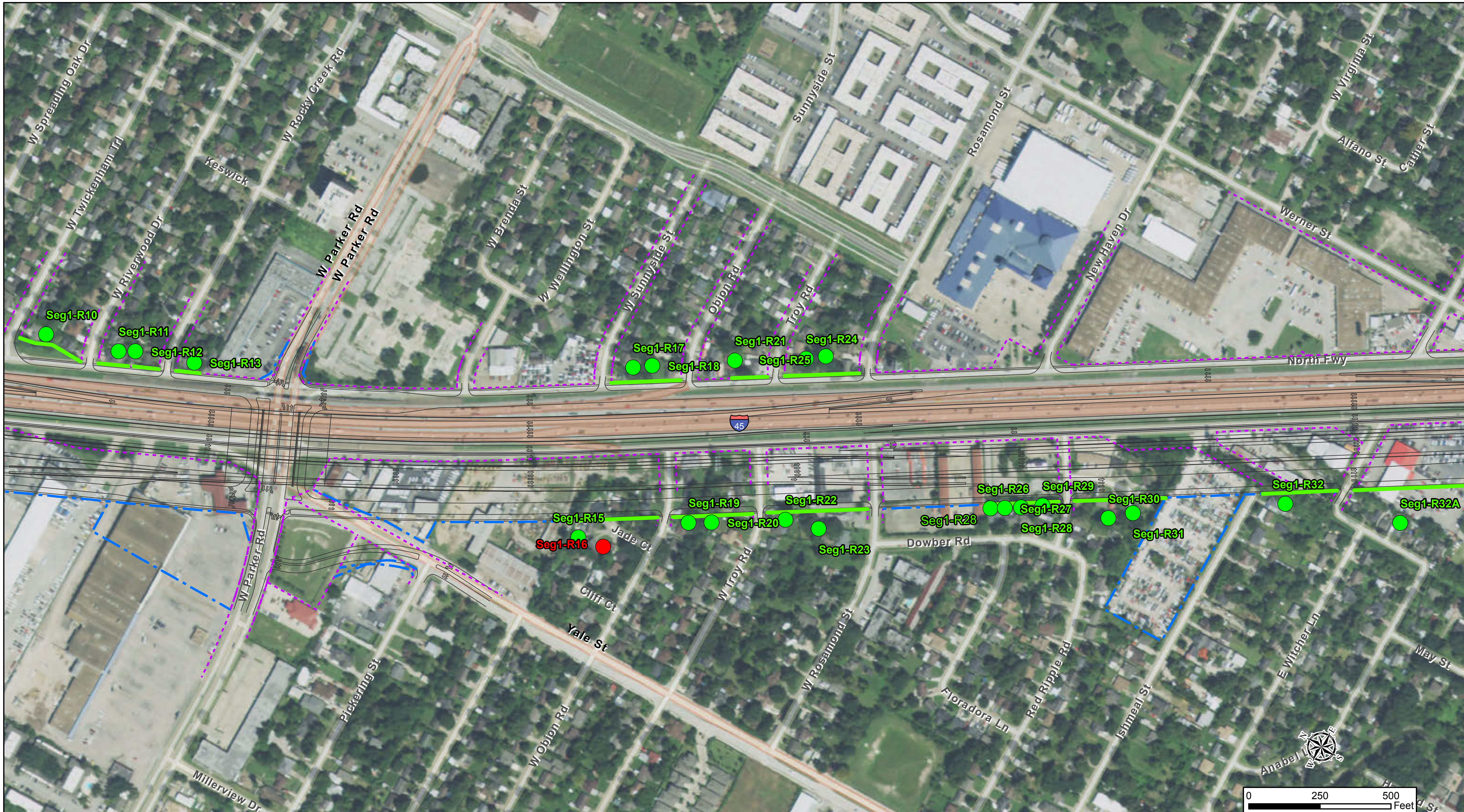
Legend

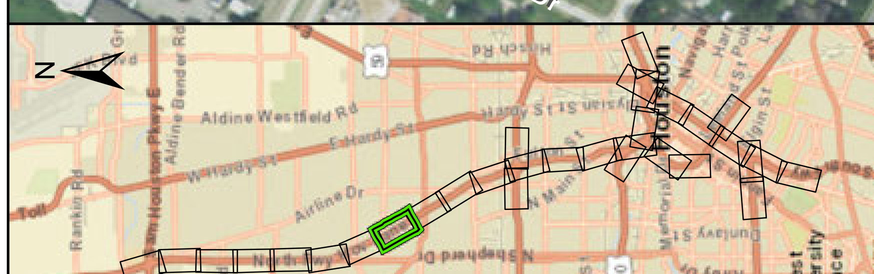
Benefited	Proposed Barriers	Proposed Right of Way
Impacted	Existing Barrier	Proposed Design
Non Impacted	Existing Right of Way	

North Houston Highway Improvement Project

Exhibit 2: Noise Receivers and Proposed Barriers Map

Sources: TNRIS (2016)





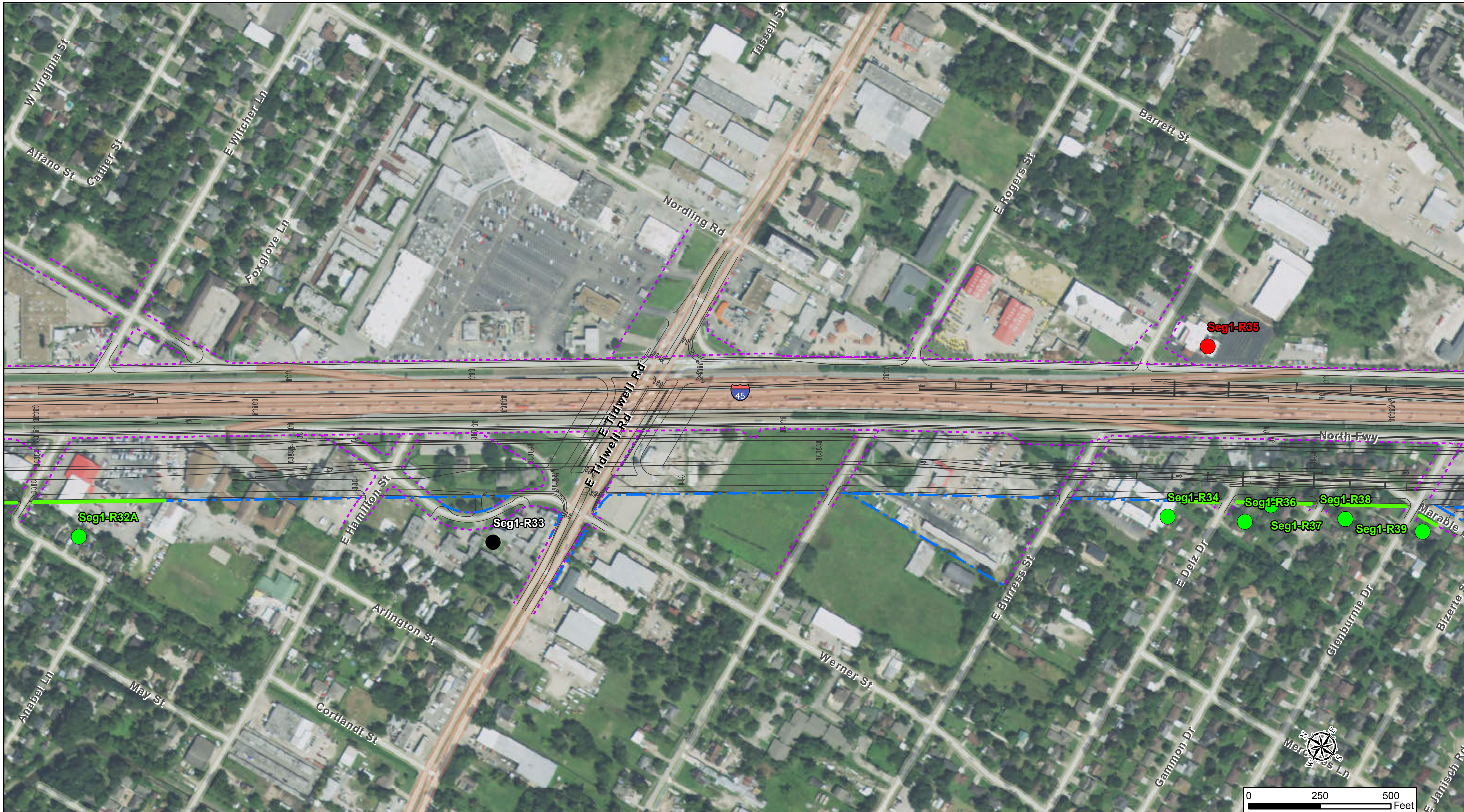
Legend

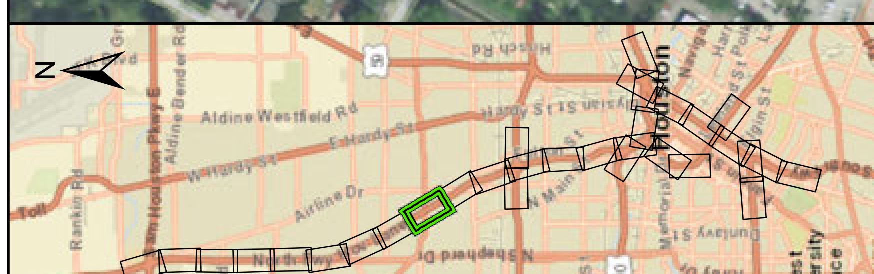
Benefited	Proposed Barriers	Proposed Right of Way
Impacted	Existing Barrier	Proposed Design
Non Impacted	Existing Right of Way	

North Houston Highway Improvement Project

Exhibit 2: Noise Receivers and Proposed Barriers Map

Sources: TNRIS (2016)





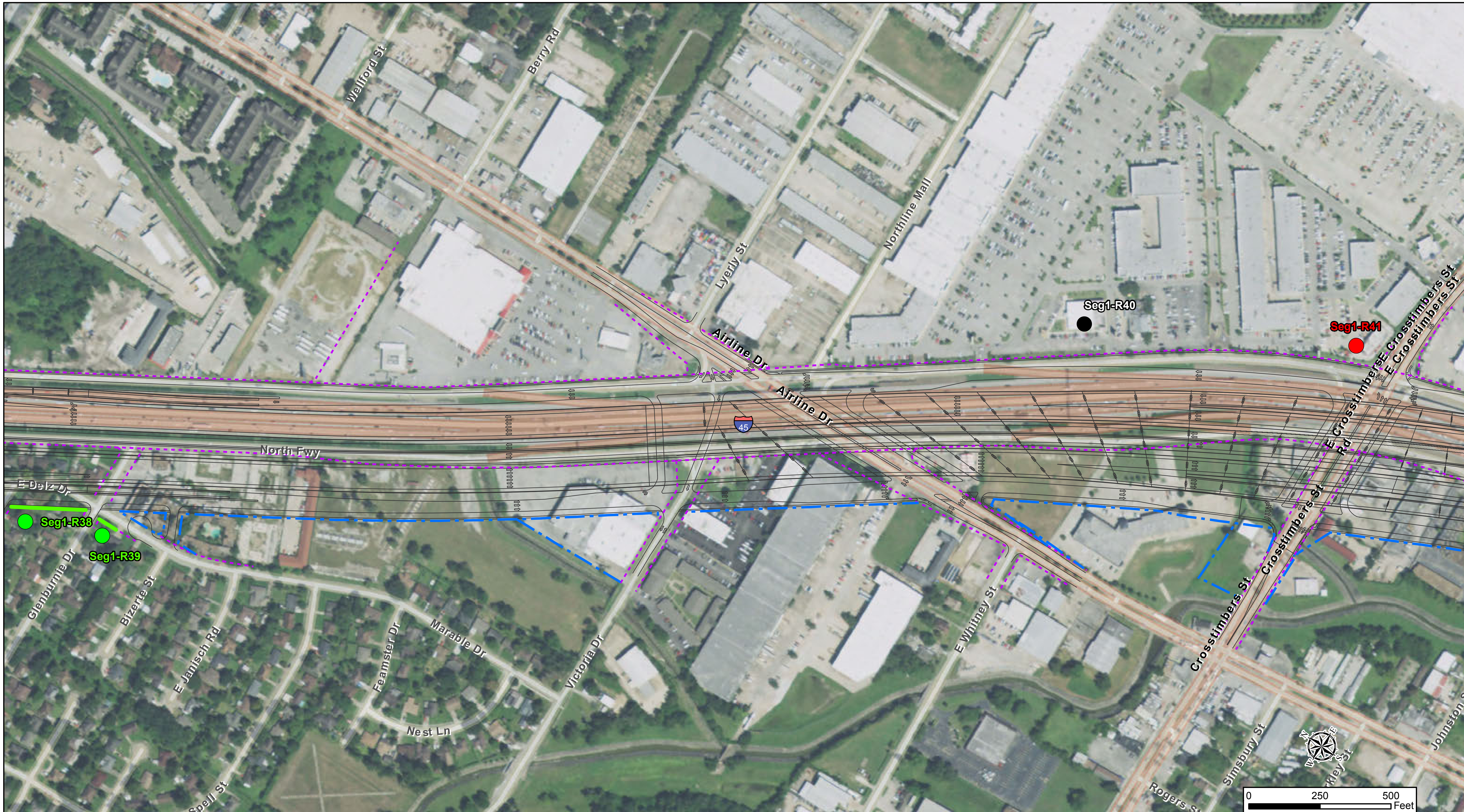
Legend

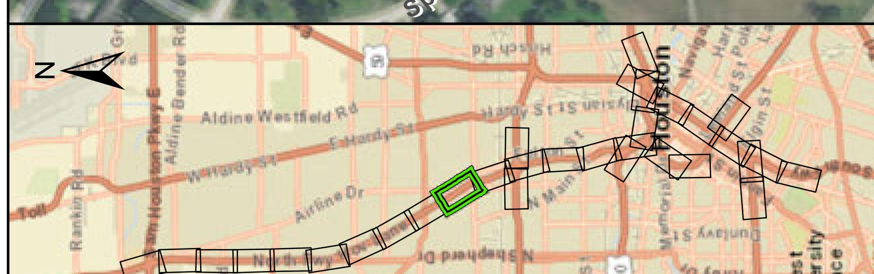
Benefited	Proposed Barriers	Proposed Right of Way
Impacted	Existing Barrier	Proposed Design
Non Impacted	Existing Right of Way	

North Houston Highway Improvement Project

Exhibit 2: Noise Receivers and Proposed Barriers Map

Sources: TNRIS (2016)





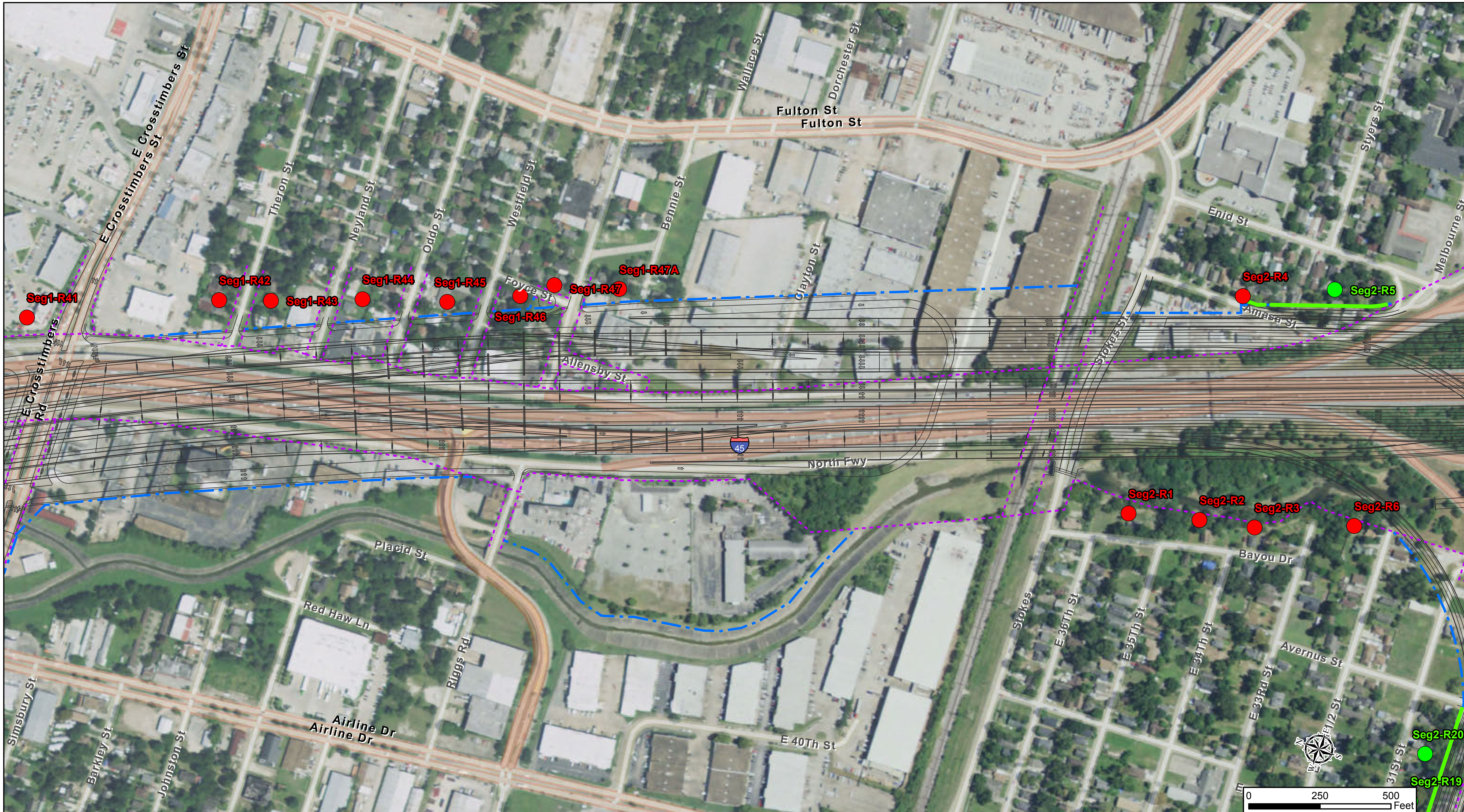
Legend

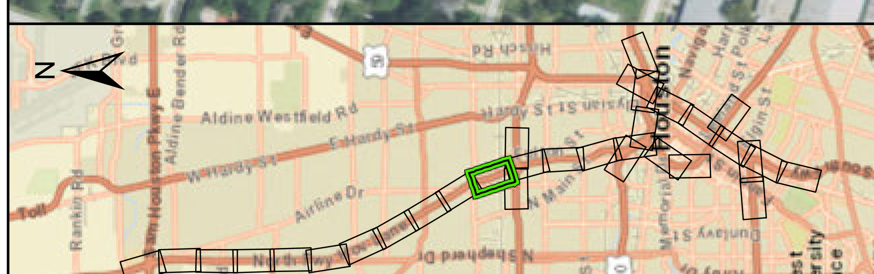
- Benefited
- Impacted
- Non Impacted
- Proposed Barriers
- Existing Barrier
- Existing Right of Way
- Proposed Right of Way
- Proposed Design

North Houston Highway Improvement Project

Exhibit 2: Noise Receivers and Proposed Barriers Map

Sources: TNRIS (2016)





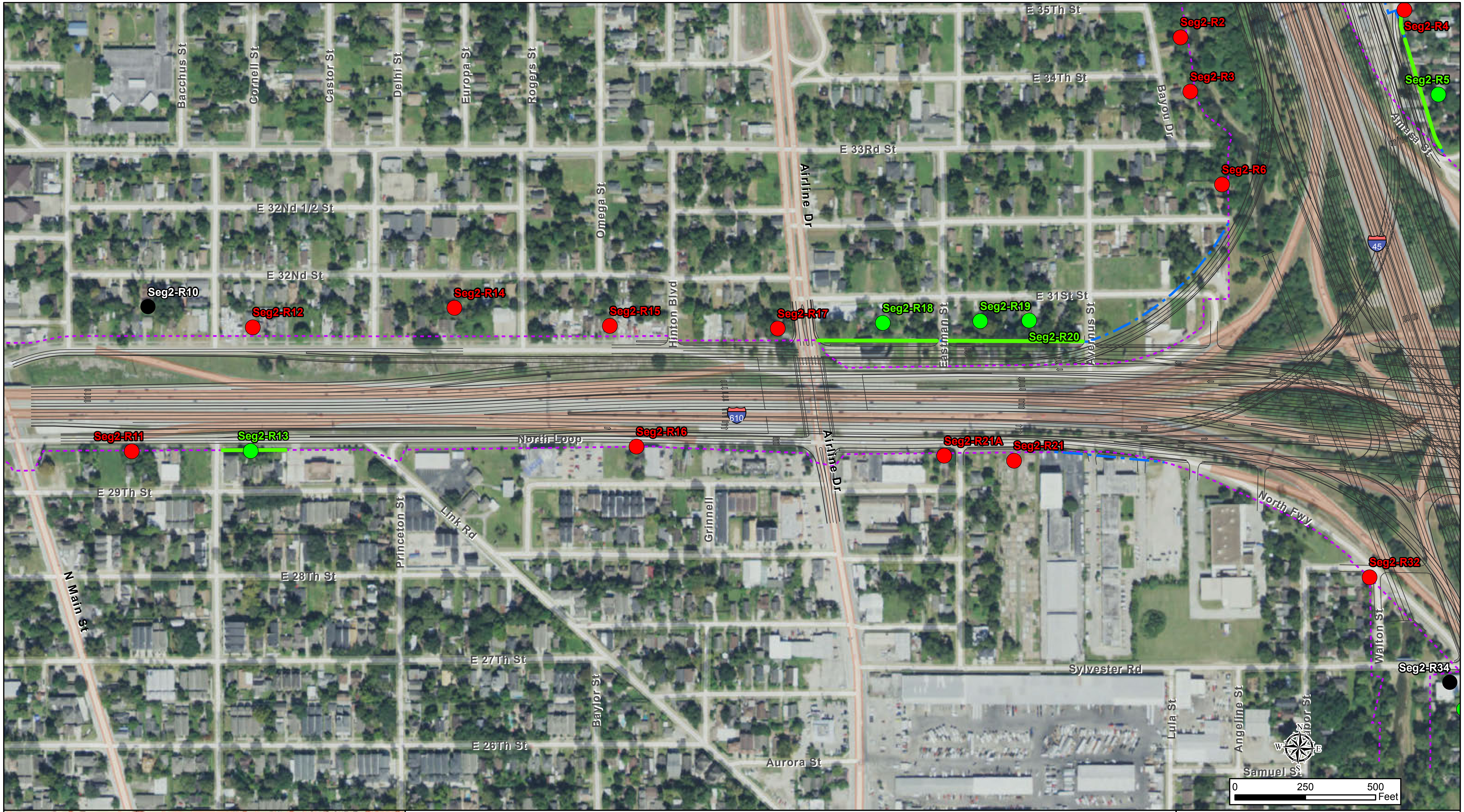
Legend

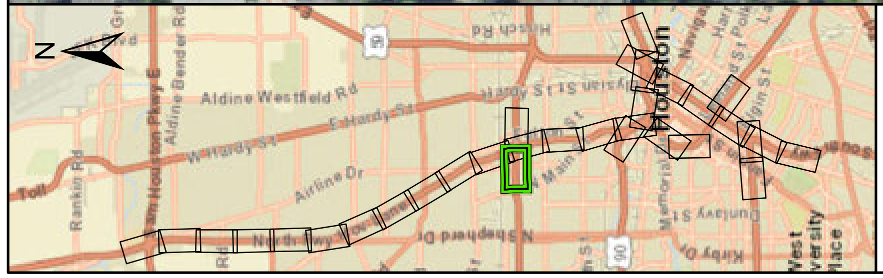
- Benefited
- Impacted
- Non Impacted
- Proposed Barriers
- Existing Barrier
- Existing Right of Way
- Proposed Right of Way
- Proposed Design

North Houston Highway Improvement Project

Exhibit 2: Noise Receivers and Proposed Barriers Map

Sources: TNRIS (2016)





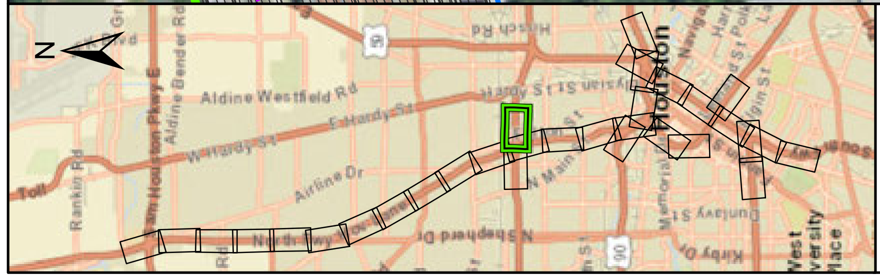
Legend

Benefited	Proposed Barriers	Proposed Right of Way
Impacted	Existing Barrier	Proposed Design
Non Impacted	Existing Right of Way	

North Houston Highway Improvement Project

Exhibit 2: Noise Receivers and Proposed Barriers Map

Sources: TNRIS (2016)



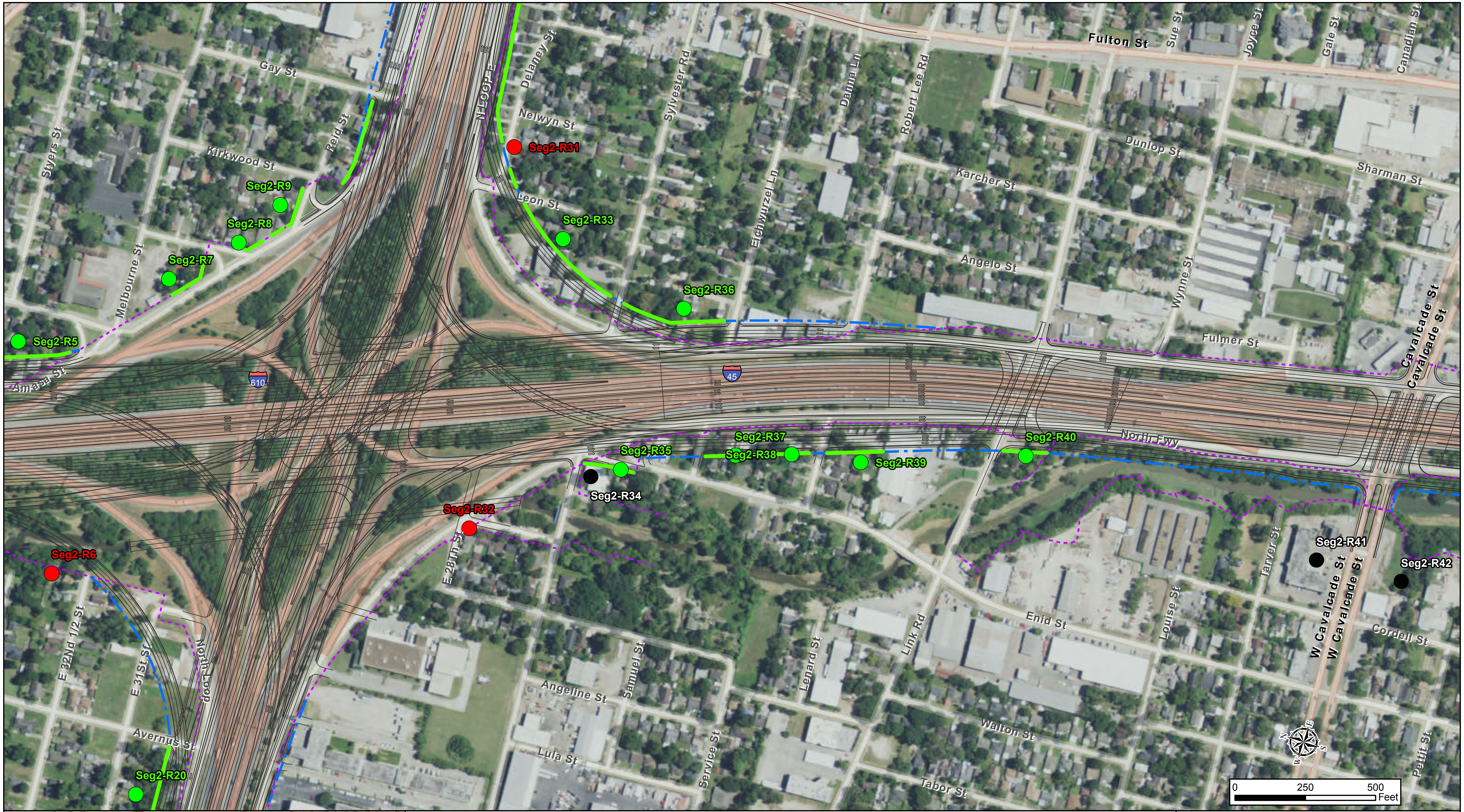
Legend

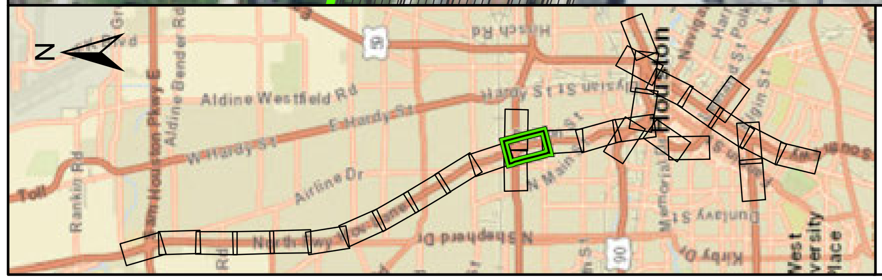
- Benefited
- Impacted
- Non Impacted
- Proposed Barriers
- Existing Barrier
- Existing Right of Way
- Proposed Right of Way
- Proposed Design

North Houston Highway Improvement Project

Exhibit 2: Noise Receivers and Proposed Barriers Map

Sources: TNRIS (2016)





Legend

- Benefited
- Impacted
- Non Impacted
- Proposed Barriers
- Existing Barrier
- Existing Right of Way
- Proposed Right of Way
- Proposed Design

North Houston Highway Improvement Project

Exhibit 2: Noise Receivers and Proposed Barriers Map

Sources: TNRIS (2016)

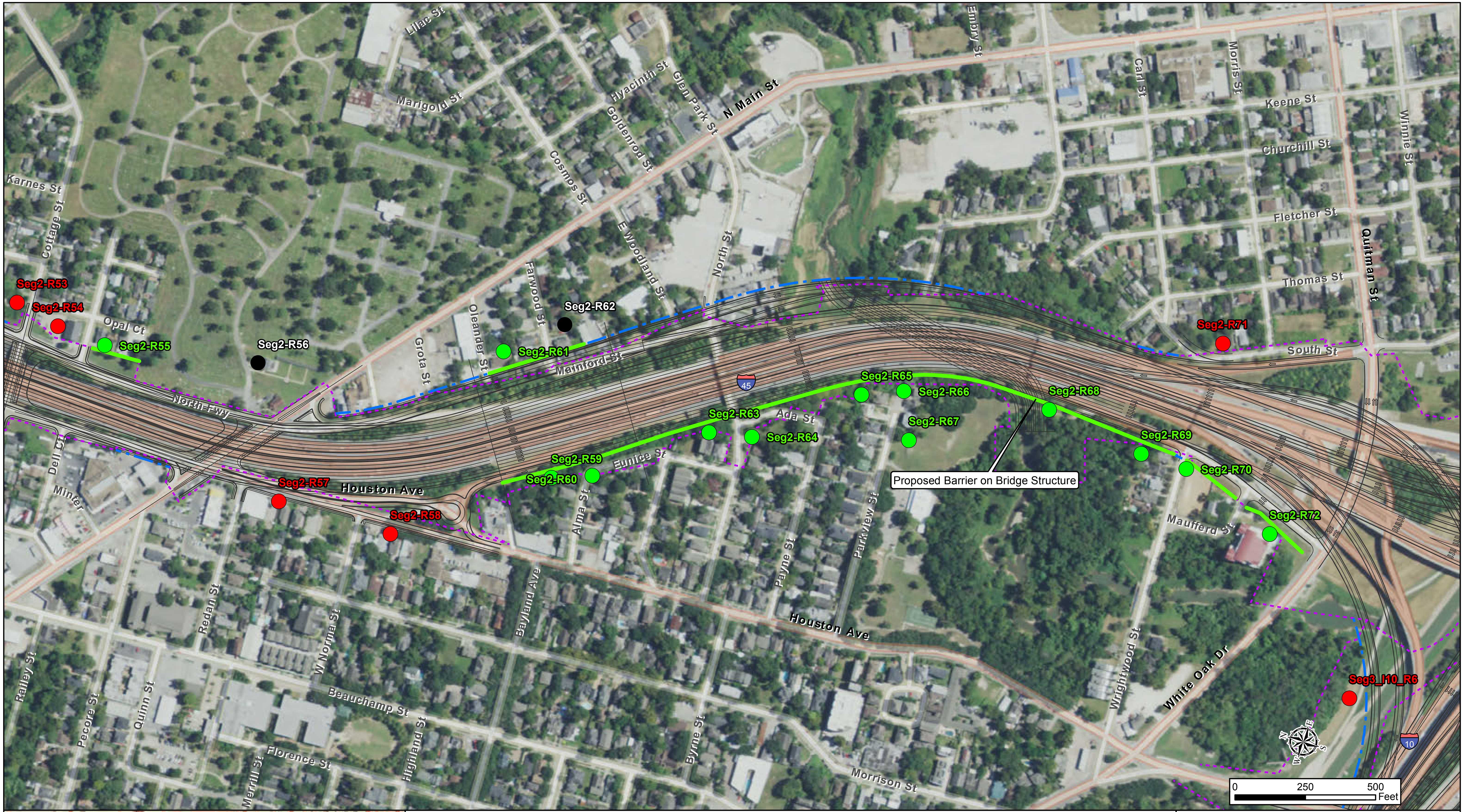
Legend

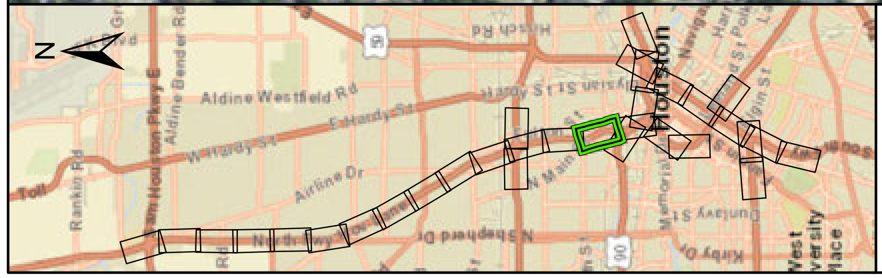
- Benefited
- Impacted
- Non Impacted
- Proposed Barriers
- Existing Barrier
- Existing Right of Way
- Proposed Right of Way
- Proposed Design

North Houston Highway Improvement Project

Exhibit 2: Noise Receivers and Proposed Barriers Map

Sources: TNRIS (2016)





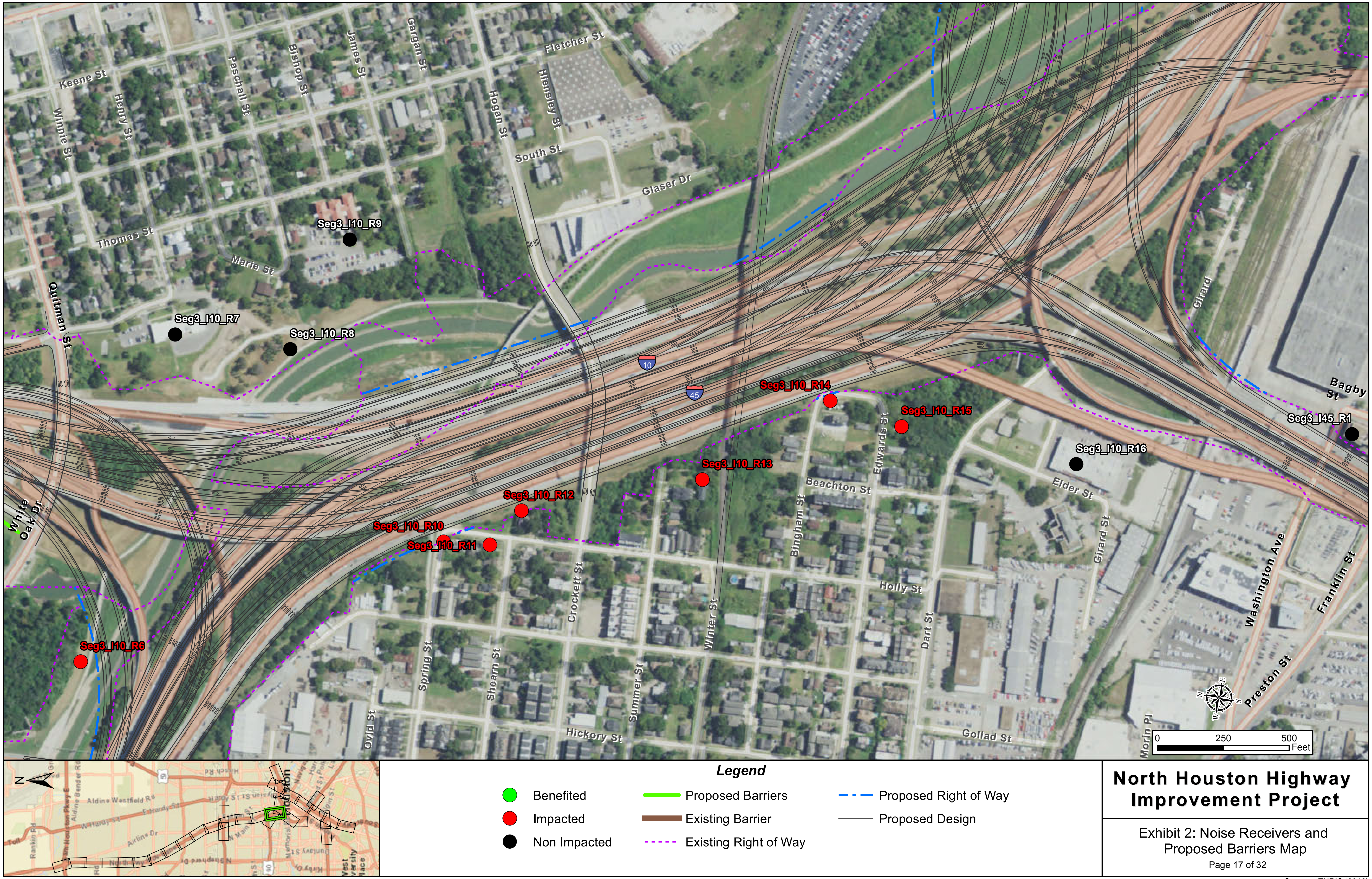
Legend

Benefited	Proposed Barriers
Impacted	Existing Barrier
Non Impacted	Existing Right of Way
Proposed Right of Way	Proposed Design

North Houston Highway Improvement Project

Exhibit 2: Noise Receivers and Proposed Barriers Map

Sources: TNRIS (2016)



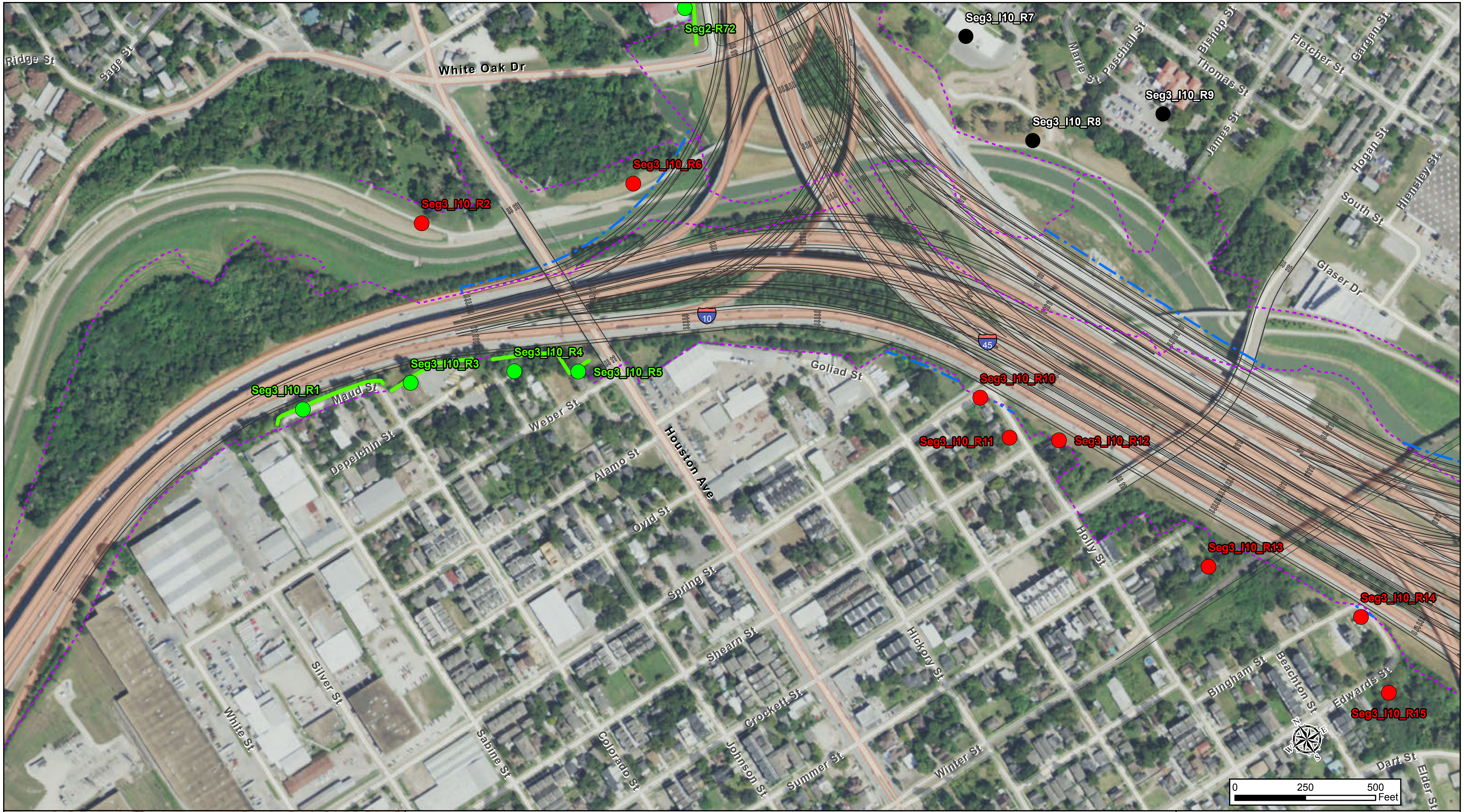
Legend

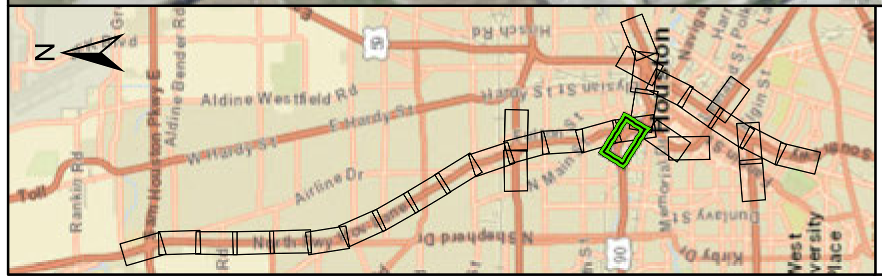
- Benefited
- Impacted
- Non Impacted
- Proposed Barriers
- Existing Barrier
- Existing Right of Way
- Proposed Right of Way
- Proposed Design

North Houston Highway Improvement Project

Exhibit 2: Noise Receivers and Proposed Barriers Map

Sources: TNRIS (2016)





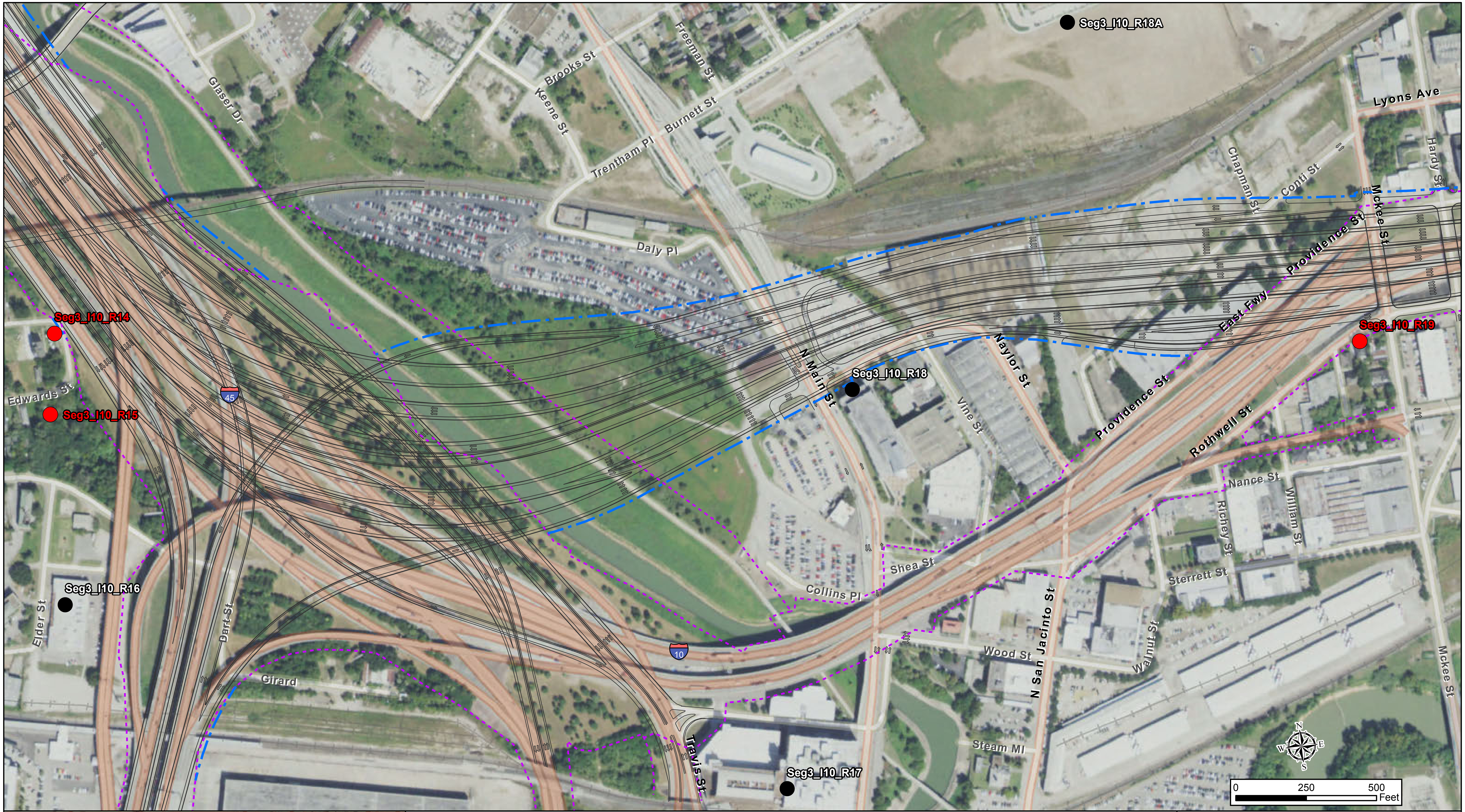
Legend

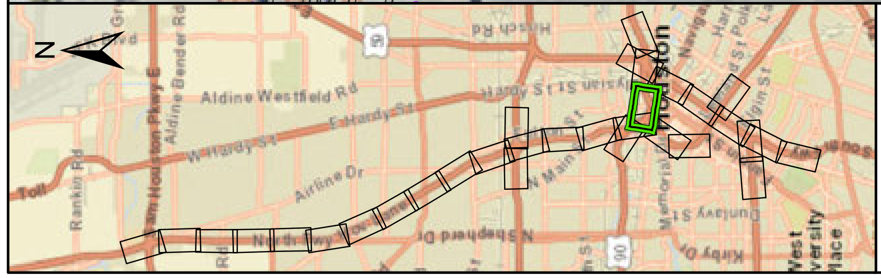
Benefited	Proposed Barriers	Proposed Right of Way
Impacted	Existing Barrier	Proposed Design
Non Impacted	Existing Right of Way	

North Houston Highway Improvement Project

Exhibit 2: Noise Receivers and Proposed Barriers Map

Sources: TNRIS (2016)





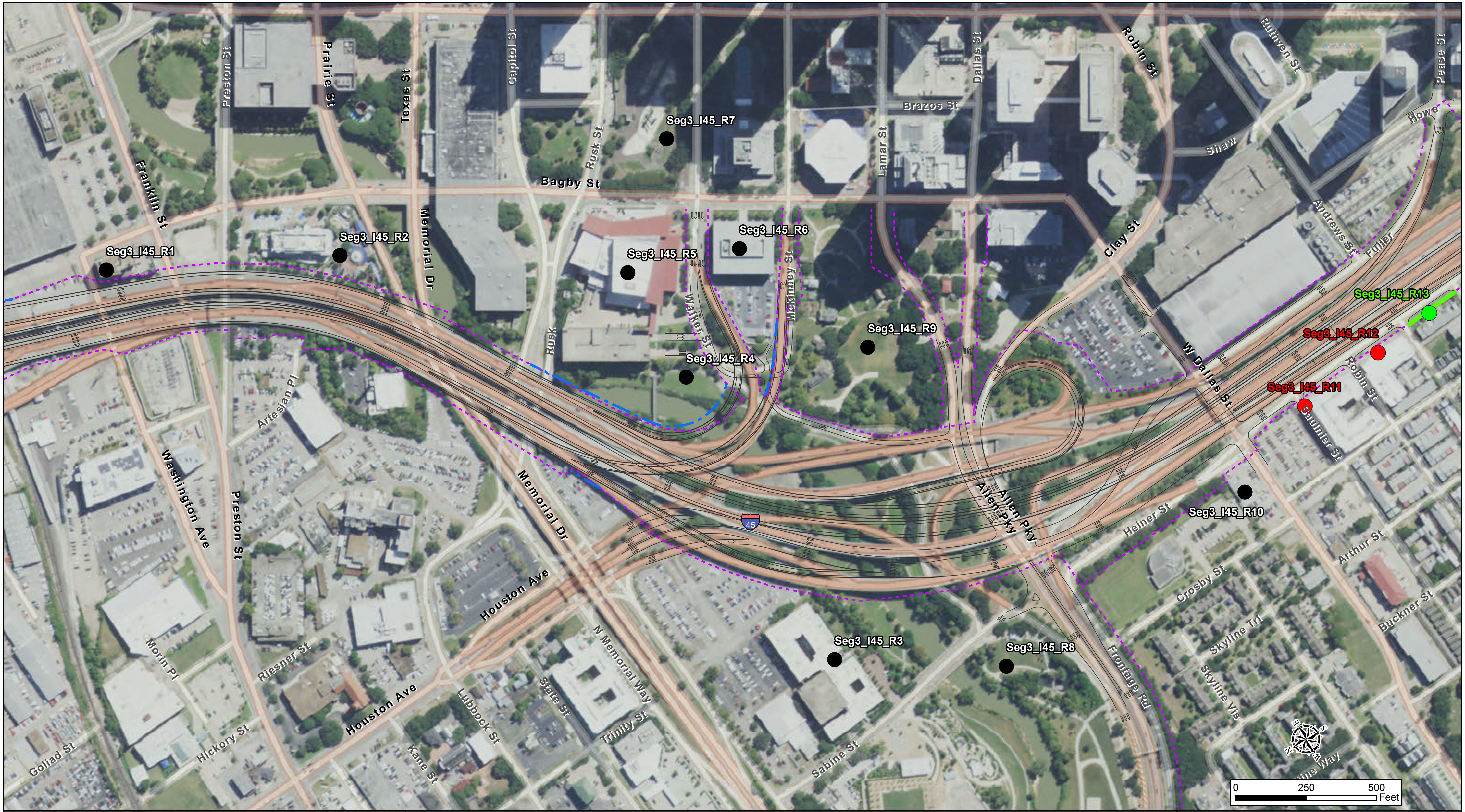
Legend

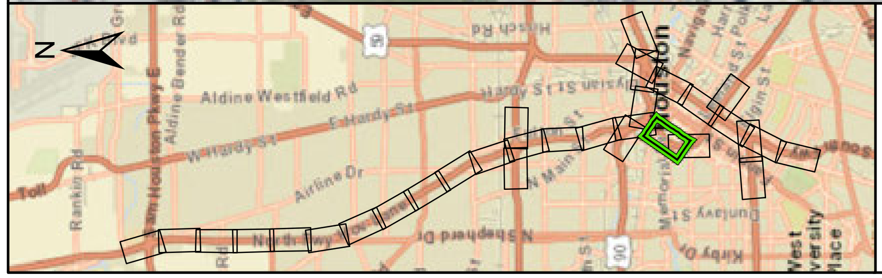
Benefited	Proposed Barriers	Proposed Right of Way
Impacted	Existing Barrier	Proposed Design
Non Impacted	Existing Right of Way	

North Houston Highway Improvement Project

Exhibit 2: Noise Receivers and Proposed Barriers Map

Sources: TNRIS (2016)





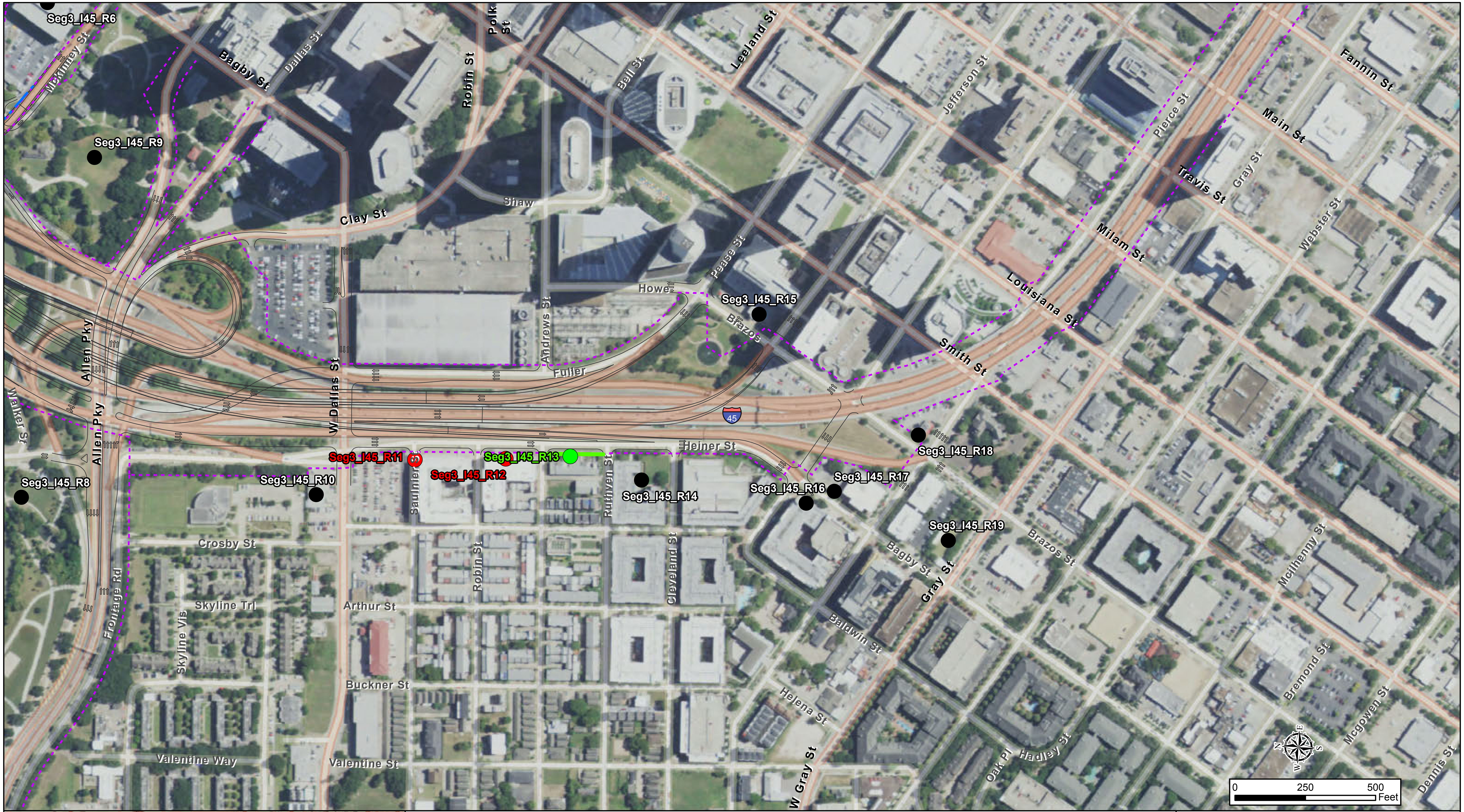
Legend

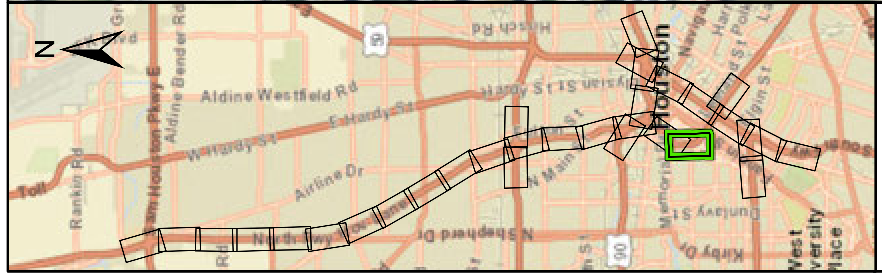
- Benefited
- Impacted
- Non Impacted
- Proposed Barriers
- Existing Barrier
- Existing Right of Way
- Proposed Right of Way
- Proposed Design

North Houston Highway Improvement Project

Exhibit 2: Noise Receivers and Proposed Barriers Map

Sources: TNRIS (2016)





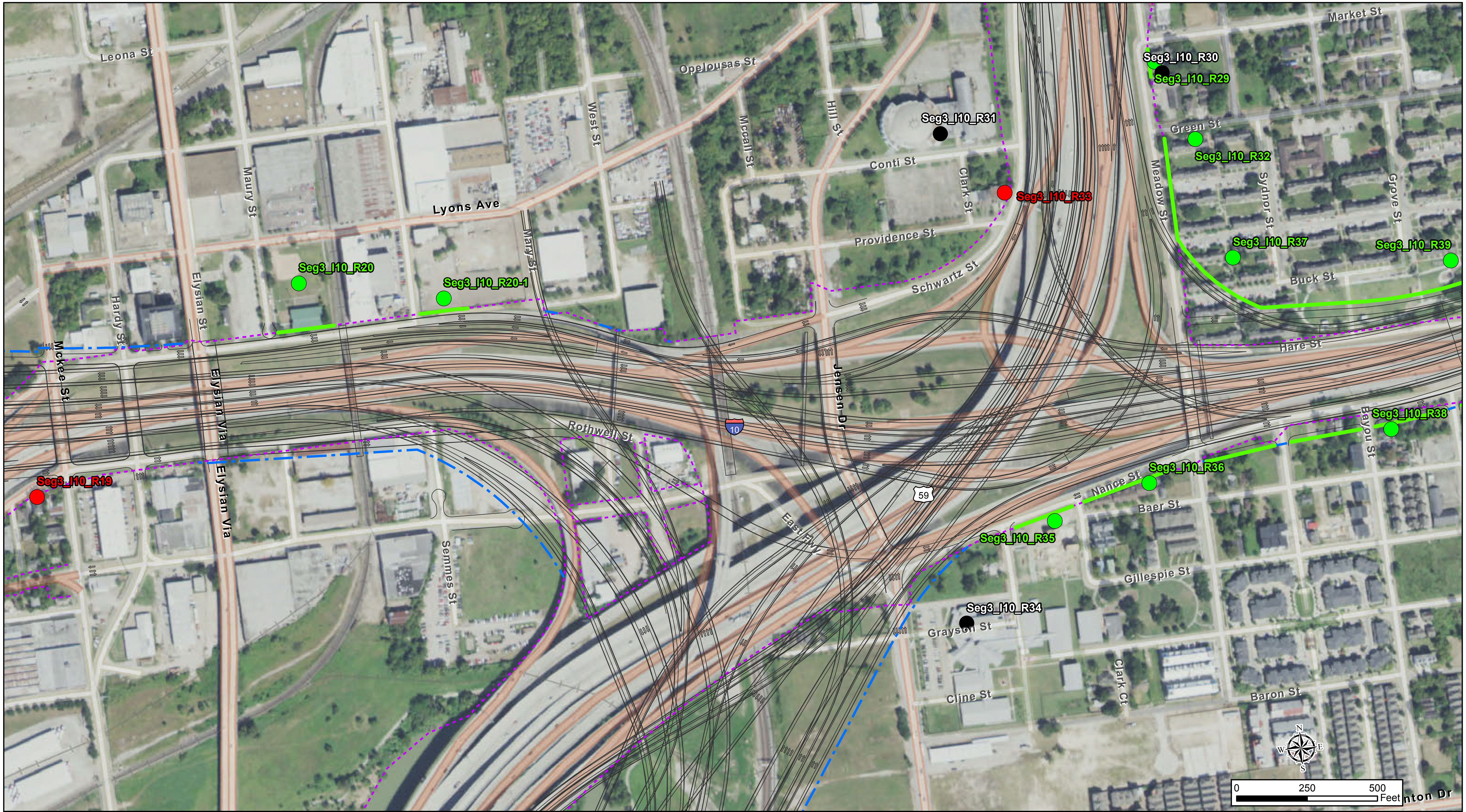
Legend

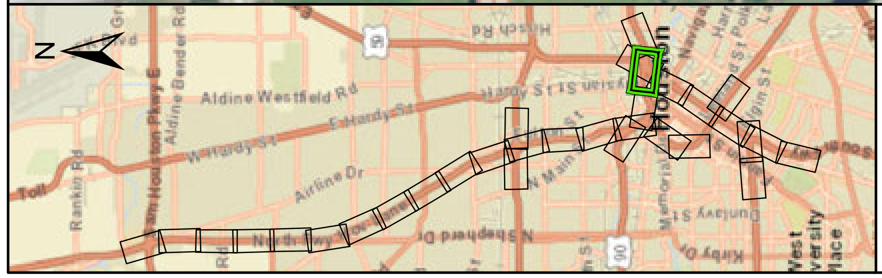
Benefited	Proposed Barriers	Proposed Right of Way
Impacted	Existing Barrier	Proposed Design
Non Impacted	Existing Right of Way	

North Houston Highway Improvement Project

Exhibit 2: Noise Receivers and Proposed Barriers Map

Sources: TNRIS (2016)





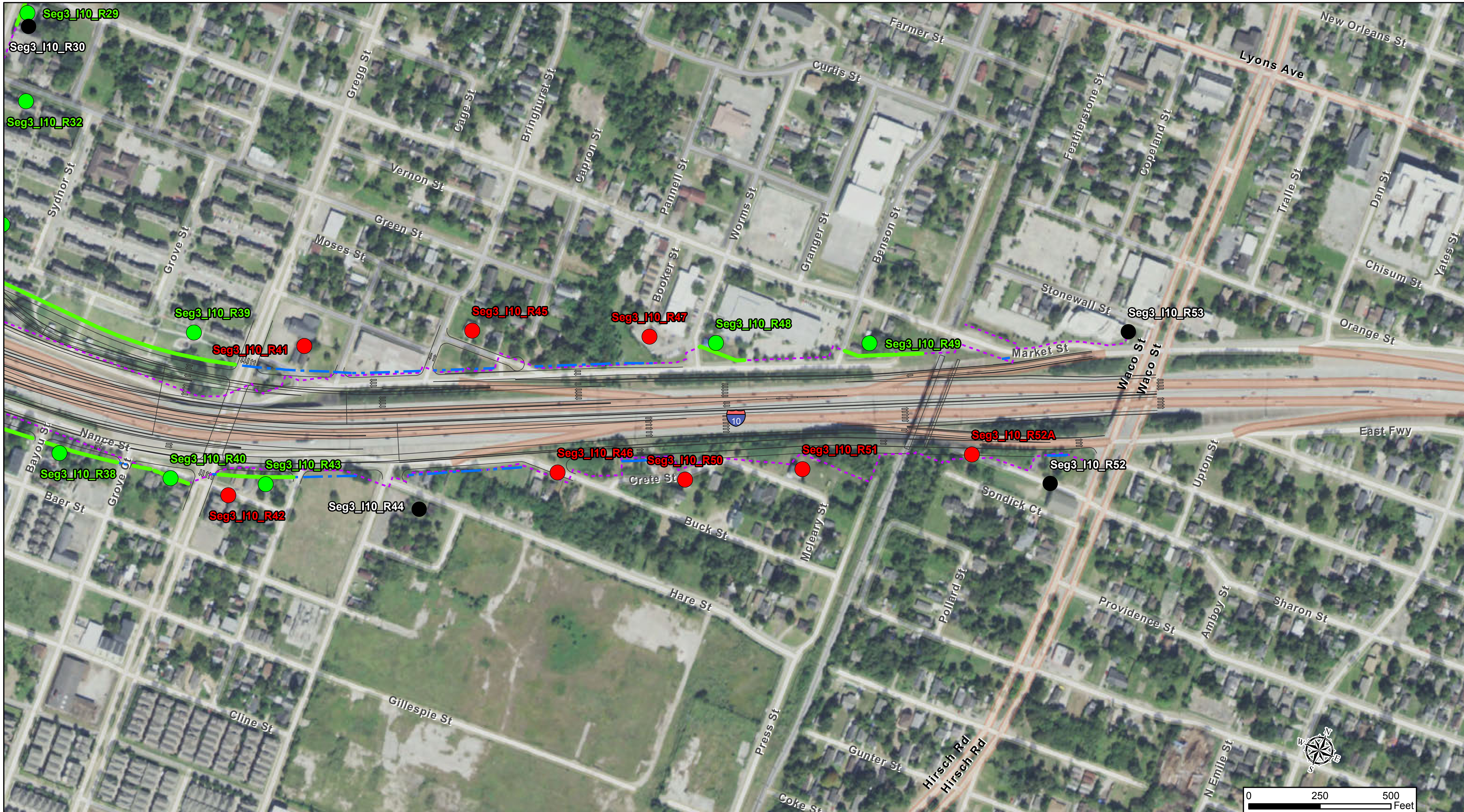
Legend

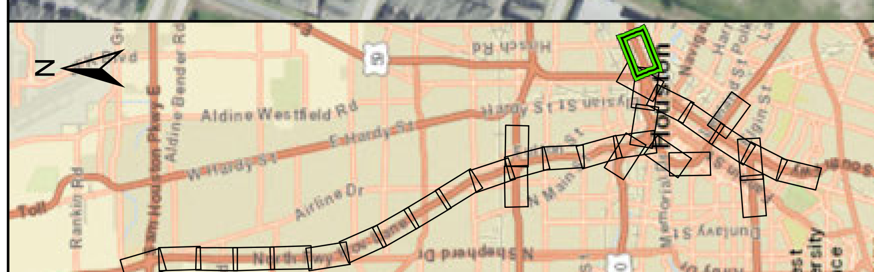
- Benefited
- Impacted
- Non Impacted
- Proposed Barriers
- Existing Barrier
- Existing Right of Way
- Proposed Right of Way
- Proposed Design

North Houston Highway Improvement Project

Exhibit 2: Noise Receivers and Proposed Barriers Map

Sources: TNRIS (2016)





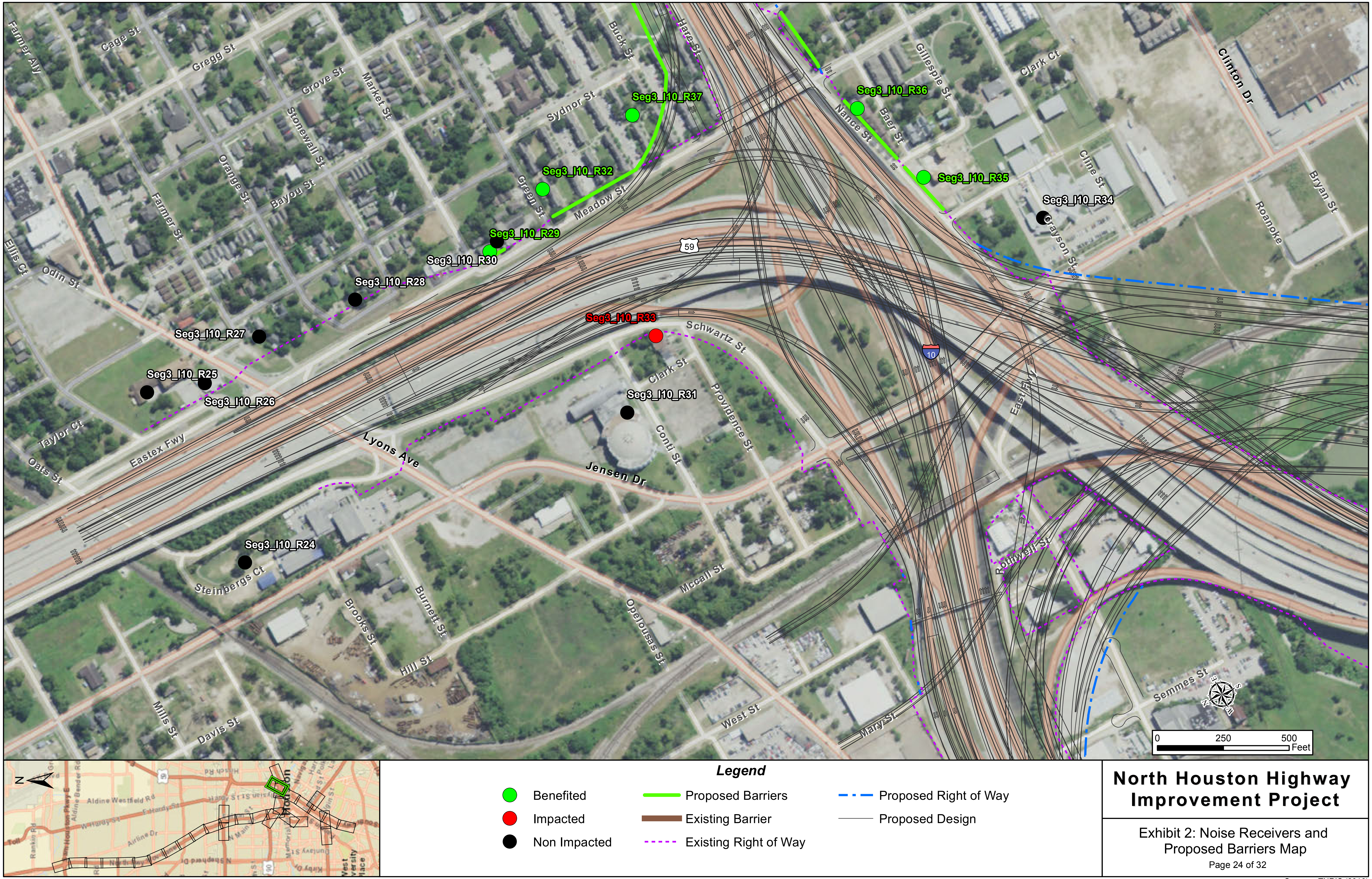
Legend

- Benefited
- Impacted
- Non Impacted
- Proposed Barriers
- Existing Barrier
- Existing Right of Way
- Proposed Right of Way
- Proposed Design

North Houston Highway Improvement Project

Exhibit 2: Noise Receivers and Proposed Barriers Map

Sources: TNRIS (2016)



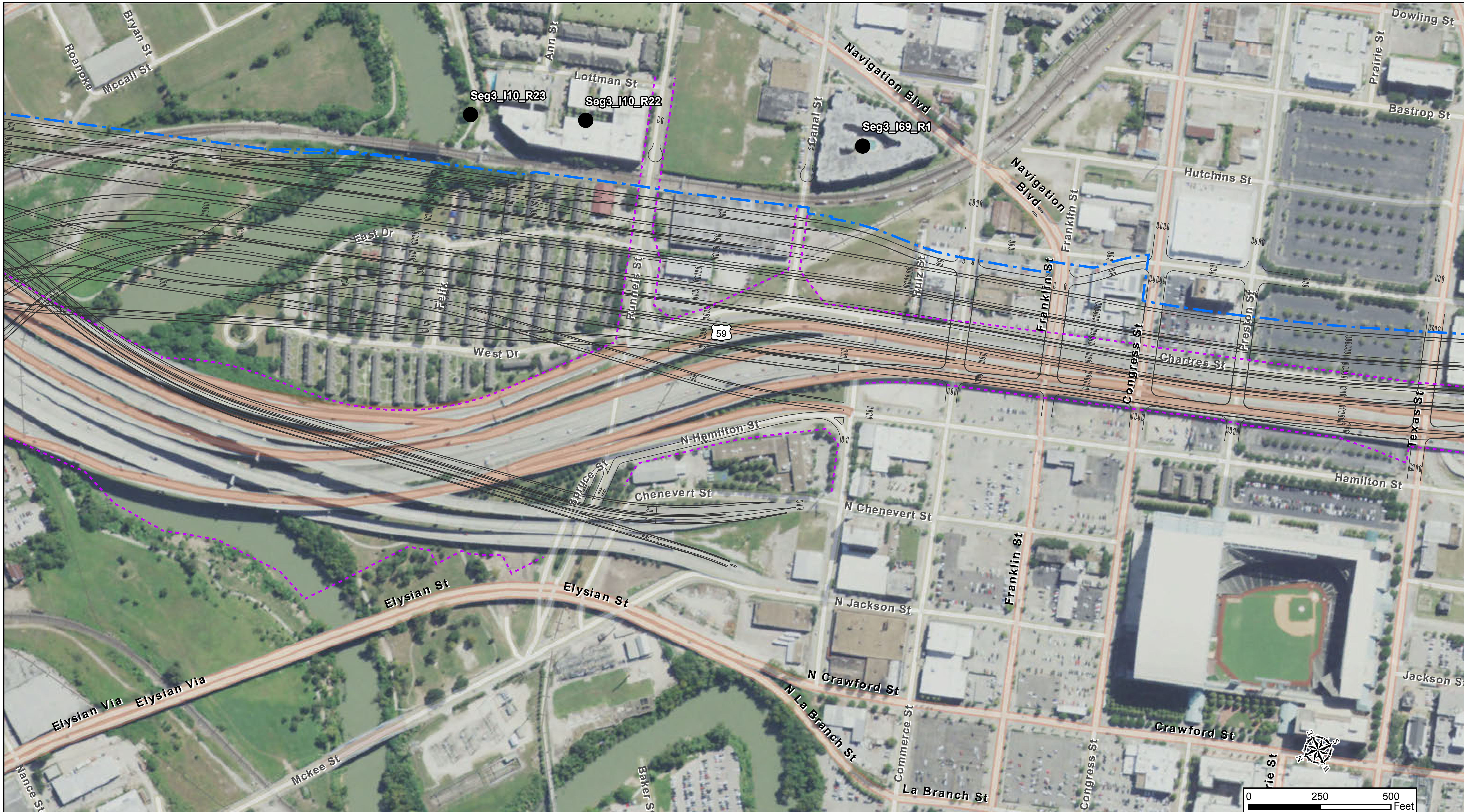
Legend

- Benefited
- Impacted
- Non Impacted
- Proposed Barriers
- Existing Barrier
- Existing Right of Way
- Proposed Right of Way
- Proposed Design

North Houston Highway Improvement Project

Exhibit 2: Noise Receivers and Proposed Barriers Map

Sources: TNRIS (2016)



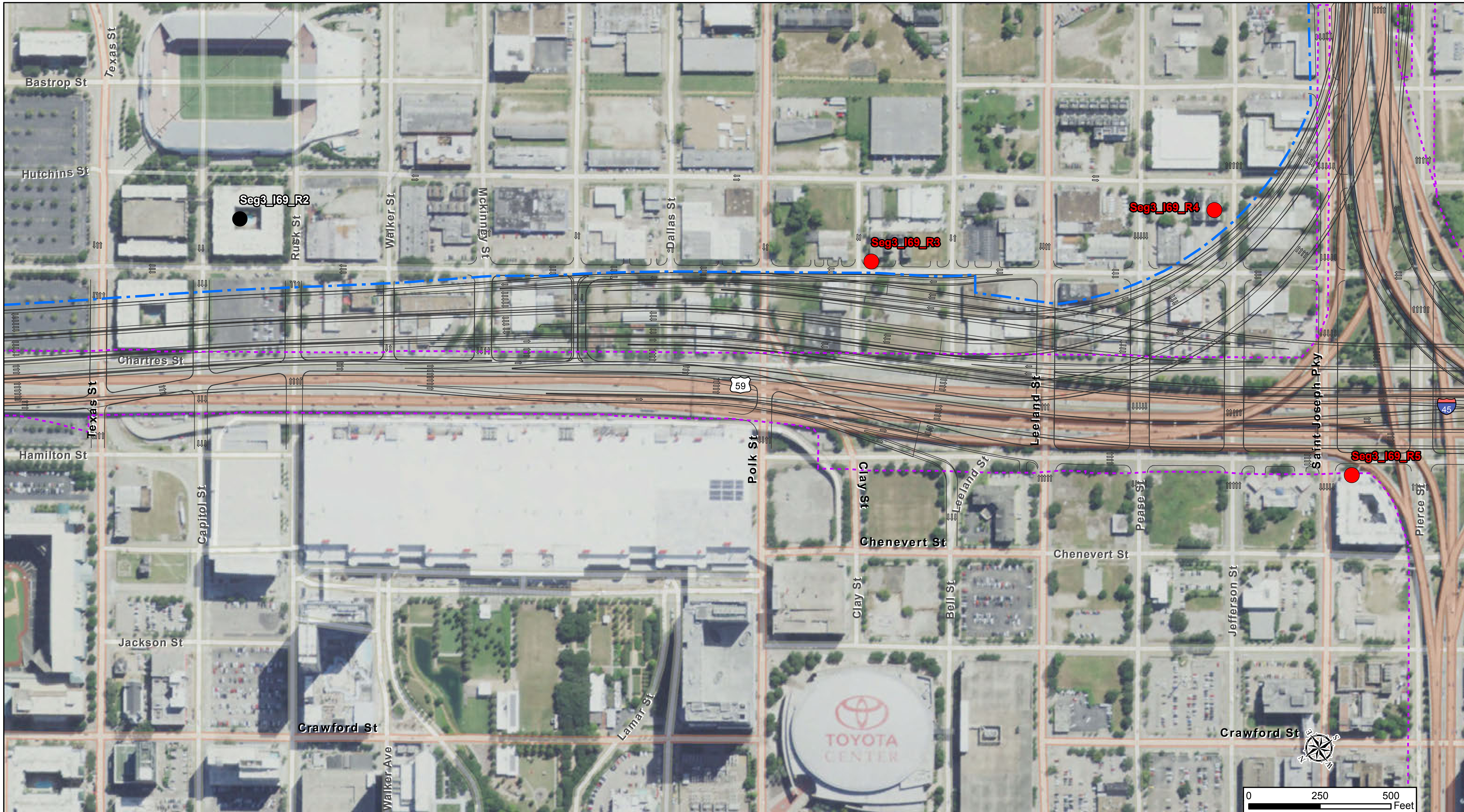
Legend

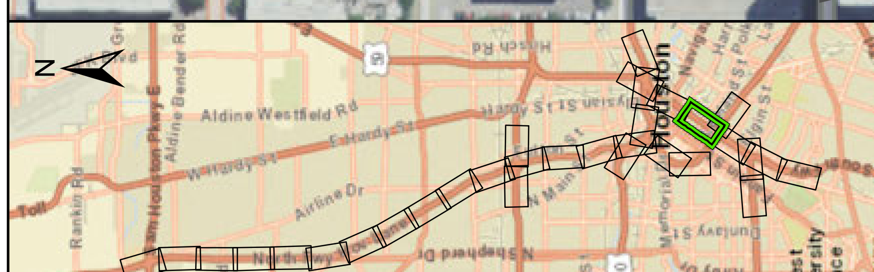
- Benefited
- Impacted
- Non Impacted
- Proposed Barriers
- Existing Barrier
- Existing Right of Way
- Proposed Right of Way
- Proposed Design

North Houston Highway Improvement Project

Exhibit 2: Noise Receivers and Proposed Barriers Map

Sources: TNRIS (2016)





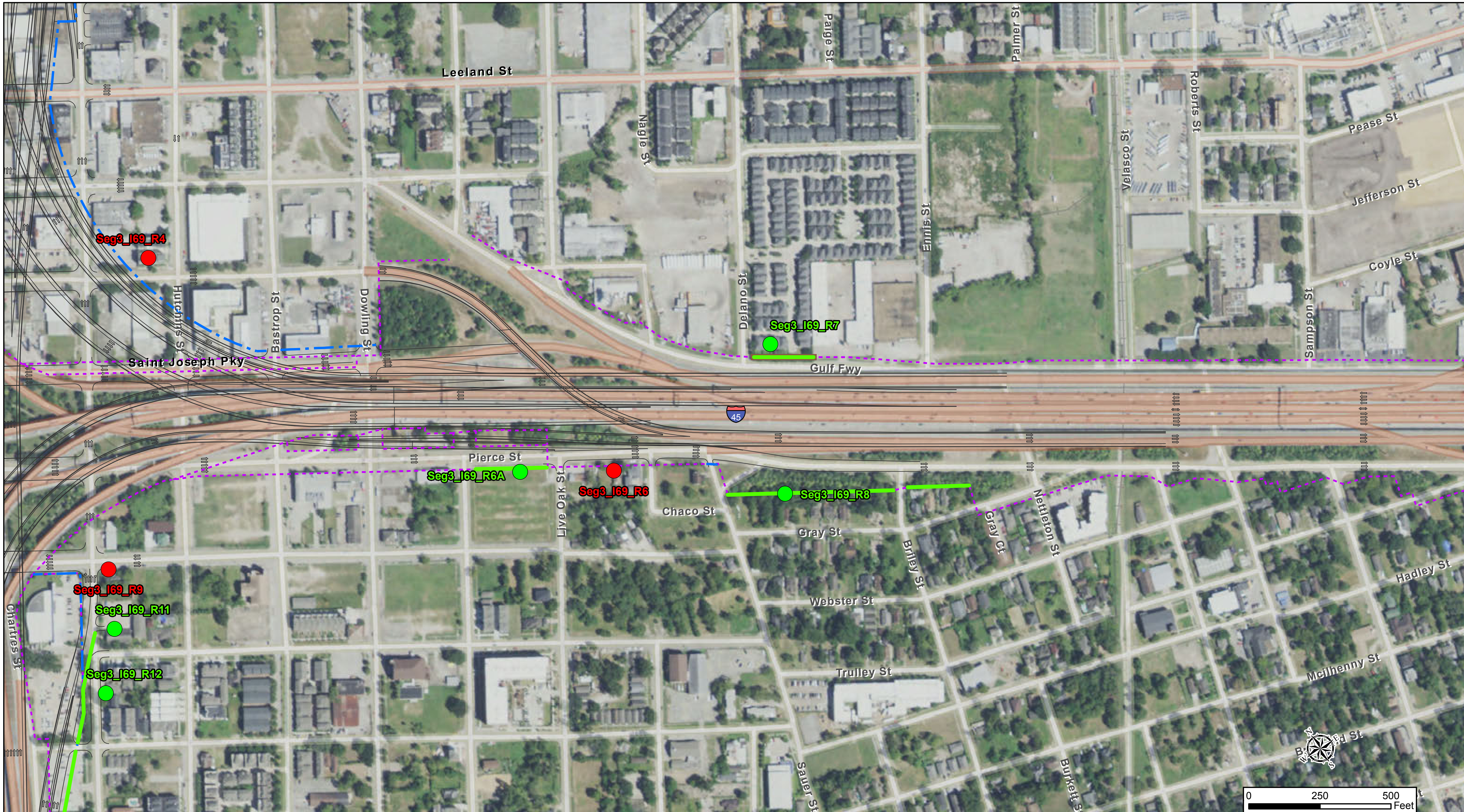
Legend

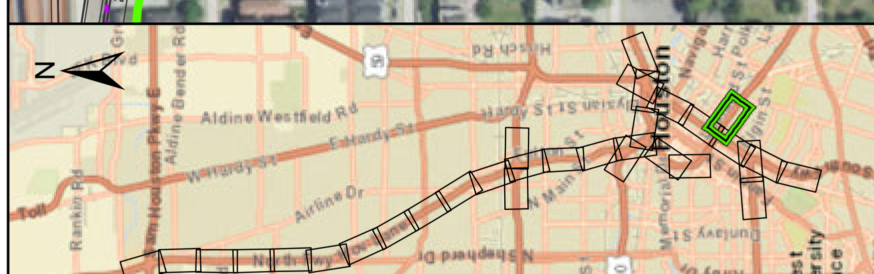
- Benefited
- Impacted
- Non Impacted
- Proposed Barriers
- Existing Barrier
- Existing Right of Way
- Proposed Right of Way
- Proposed Design

North Houston Highway Improvement Project

Exhibit 2: Noise Receivers and Proposed Barriers Map

Sources: TNRIS (2016)





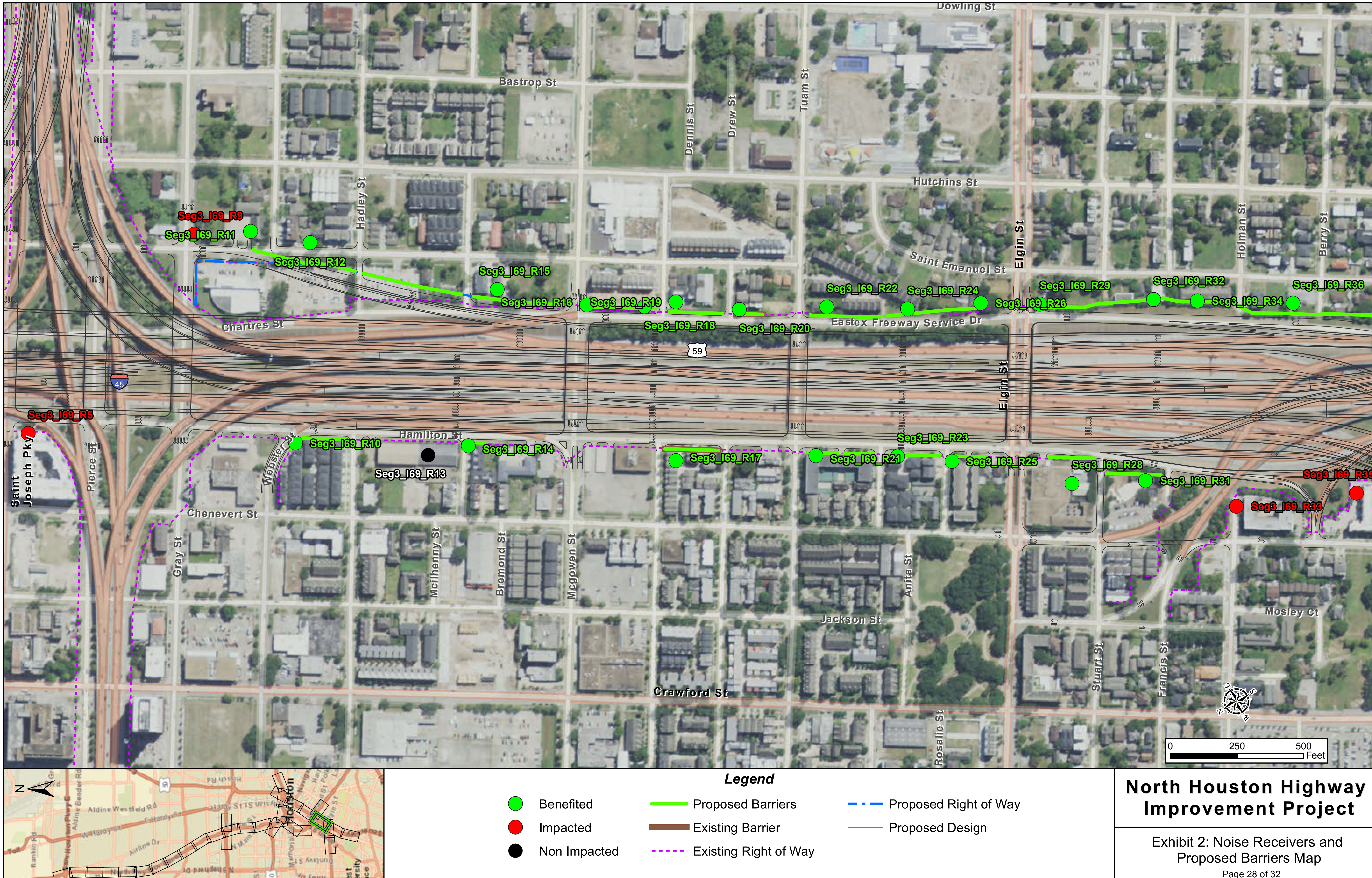
Legend

- Benefited
- Impacted
- Non Impacted
- Proposed Barriers
- Existing Barrier
- Existing Right of Way
- Proposed Right of Way
- Proposed Design

North Houston Highway Improvement Project

Exhibit 2: Noise Receivers and Proposed Barriers Map

Sources: TNRIS (2016)



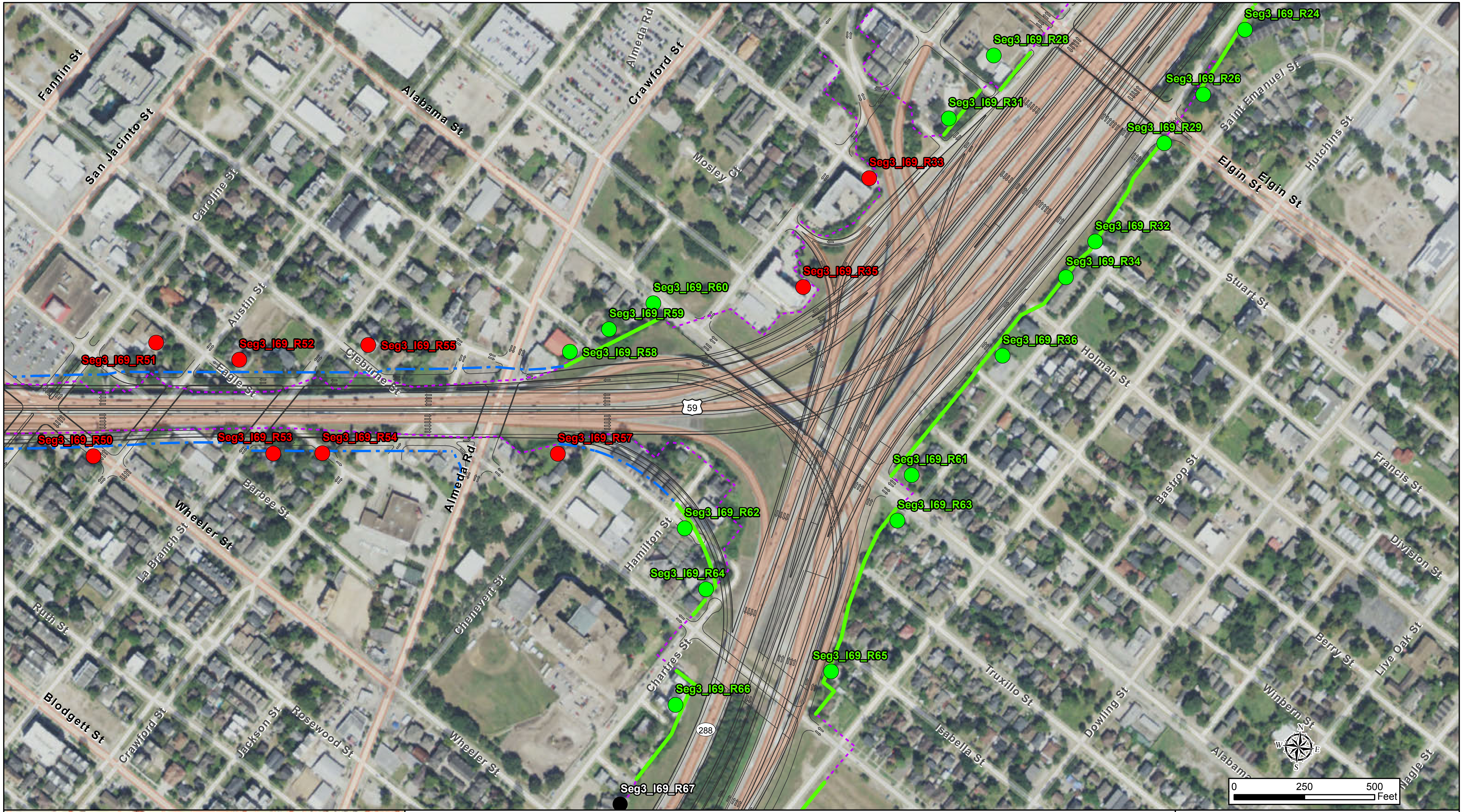
Legend

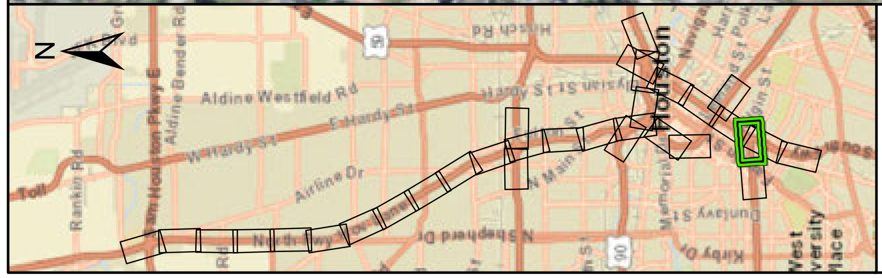
- Benefited
- Impacted
- Non Impacted
- Proposed Barriers
- Existing Barrier
- Existing Right of Way
- Proposed Right of Way
- Proposed Design

North Houston Highway Improvement Project

Exhibit 2: Noise Receivers and Proposed Barriers Map

Sources: TNRIS (2016)





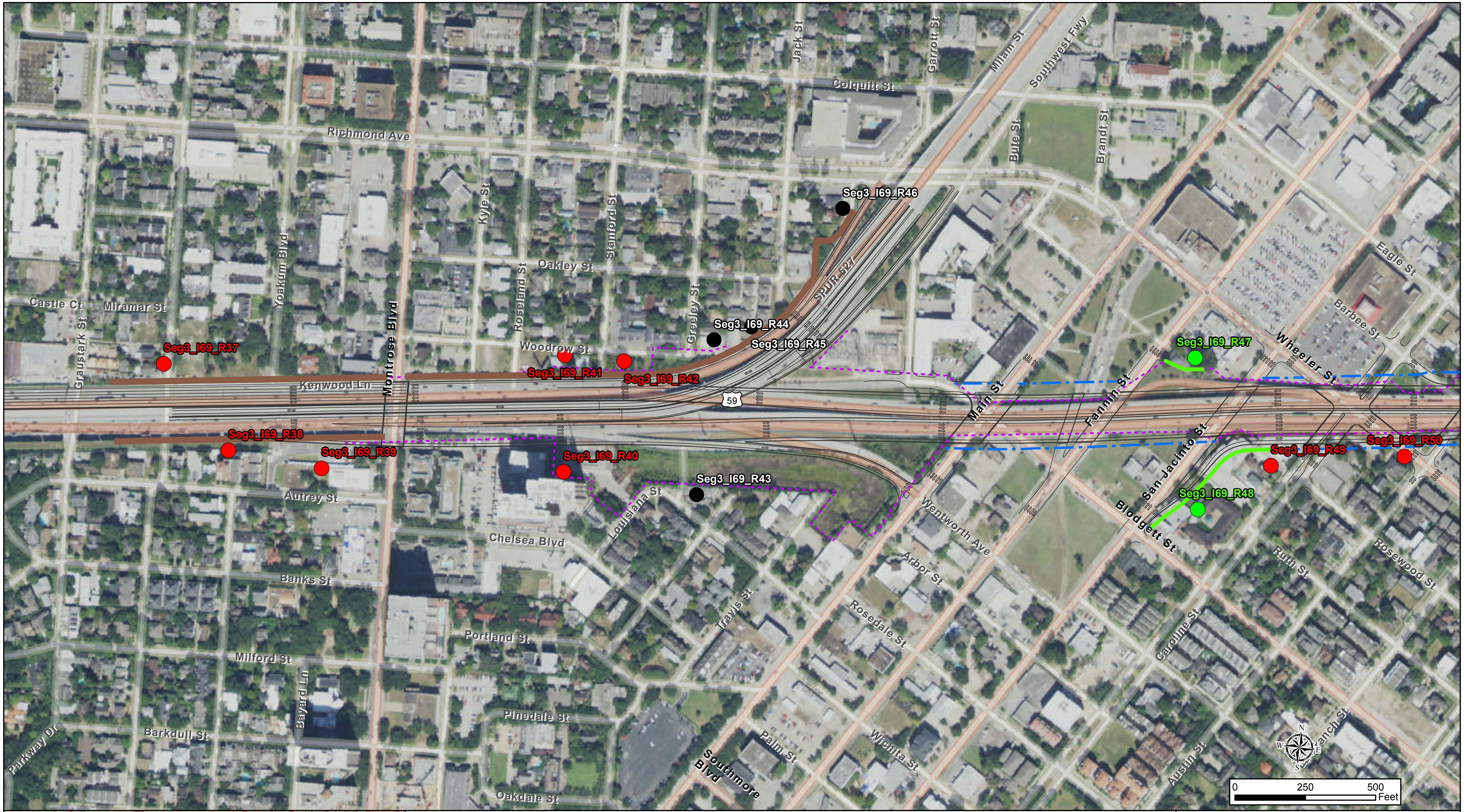
Legend

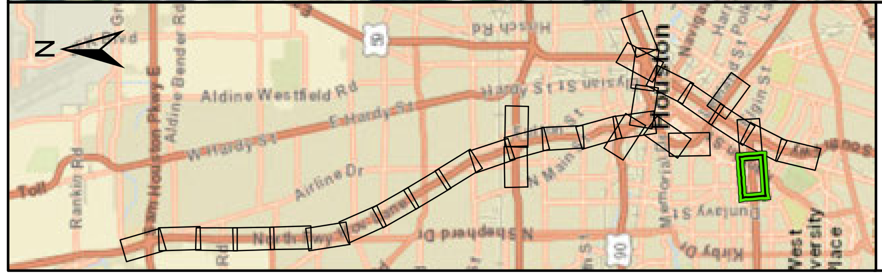
- Benefited
- Impacted
- Non Impacted
- Proposed Barriers
- Existing Barrier
- Existing Right of Way
- Proposed Right of Way
- Proposed Design

North Houston Highway Improvement Project

Exhibit 2: Noise Receivers and Proposed Barriers Map

Sources: TNRIS (2016)





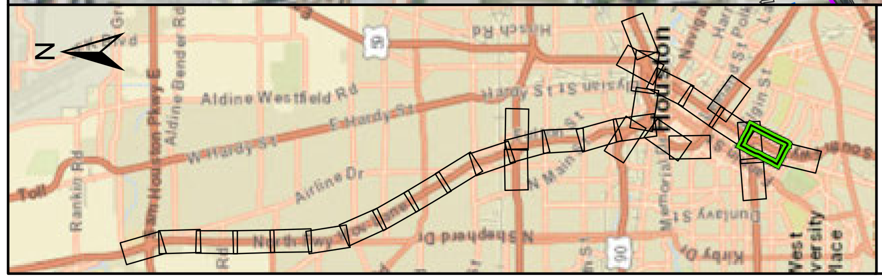
Legend

- Benefited
- Impacted
- Non Impacted
- Proposed Barriers
- Existing Barrier
- Existing Right of Way
- Proposed Right of Way
- Proposed Design

North Houston Highway Improvement Project

Exhibit 2: Noise Receivers and Proposed Barriers Map

Sources: TNRIS (2016)



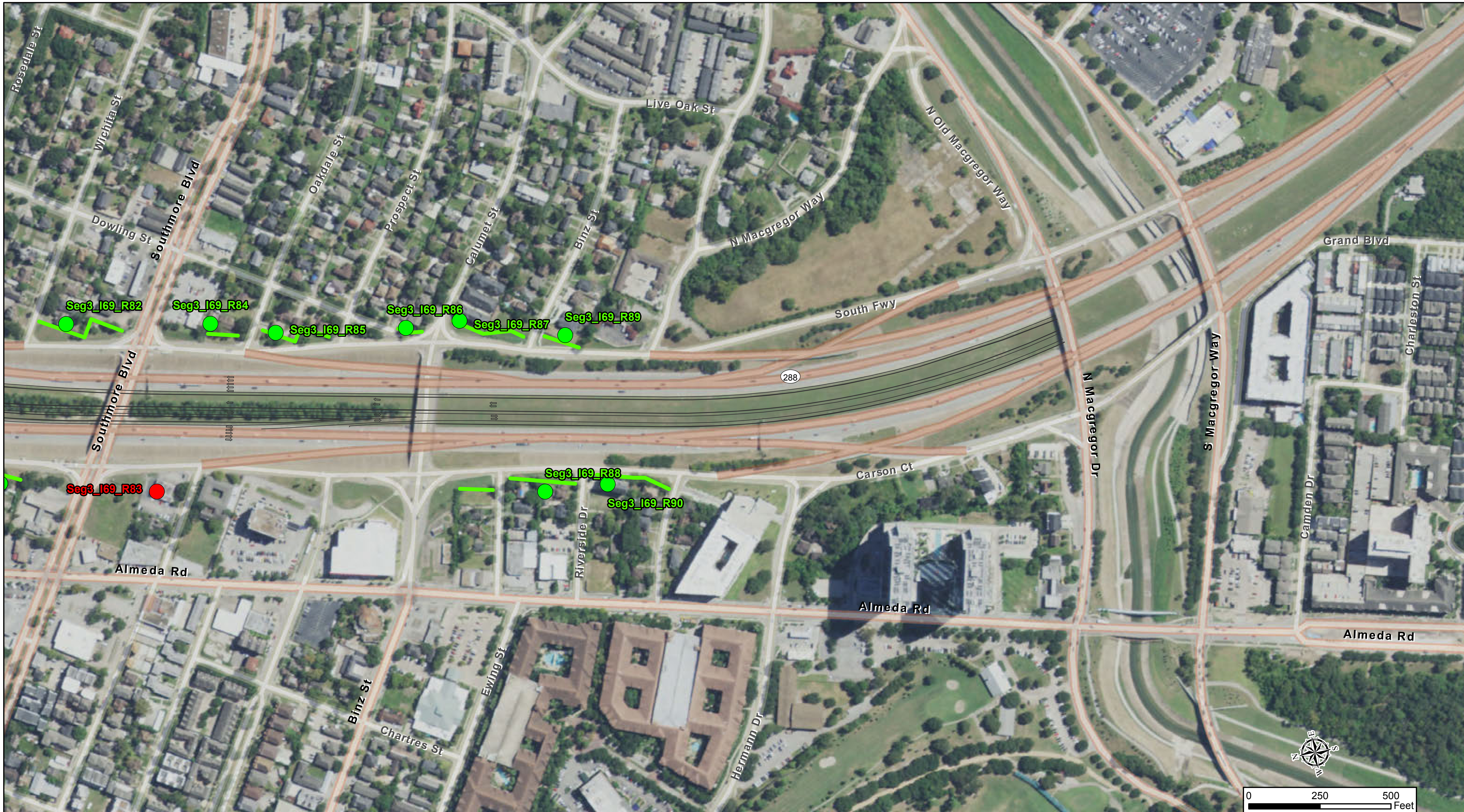
Legend

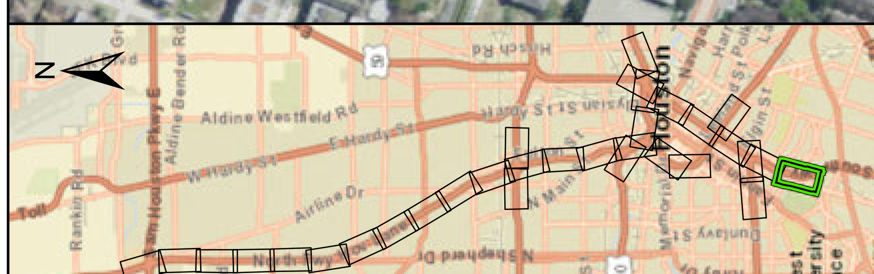
Benefited	Proposed Barriers	Proposed Right of Way
Impacted	Existing Barrier	Proposed Design
Non Impacted	Existing Right of Way	

North Houston Highway Improvement Project

Exhibit 2: Noise Receivers and Proposed Barriers Map

Sources: TNRIS (2016)





Legend

Benefited	Proposed Barriers	Proposed Right of Way
Impacted	Existing Barrier	Proposed Design
Non Impacted	Existing Right of Way	

North Houston Highway Improvement Project

Exhibit 2: Noise Receivers and Proposed Barriers Map

Sources: TNRIS (2016)

Appendices

Appendix A: Traffic Noise Validation Technical Report

Traffic Noise Validation Technical Report

North Houston Highway Improvement Project:
From US 59/I-69 at Spur 527 to I-45 at Beltway 8 North

Harris County

CSJ: 0912-00-146

June 2018

The environmental review, consultation, and other actions required by applicable Federal environmental laws for this project are being, or have been, carried-out by TxDOT pursuant to 23 U.S.C. 327 and a Memorandum of Understanding dated December 16, 2014, and executed by FHWA and TxDOT.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF EXHIBITS

LIST OF APPENDICES

1.0 INTRODUCTION

The Texas Department of Transportation (TxDOT) proposes to construct improvements to Interstate Highway 45 (I-45) in the northern portion of the City of Houston. The proposed project, referred to as the North Houston Highway Improvement Project (NHHIP), begins at the interchange of I-45 and Beltway 8 North and continues south along I-45 to Downtown Houston where it terminates at the interchange of U.S. Highway (US) 59/I-69 and Spur 527 south of Downtown Houston. The project area also includes portions of I-10 and US 59/I-69 near Downtown Houston. The project area is composed of three study segments, Segments 1 through 3 (**Exhibit 1**).

This validation report supports the noise technical report and the Final Environmental Impact Statement (Final EIS) that evaluates the social, economic, and environmental impacts potentially resulting from the Preferred Alternative for the proposed project.

2.0 NORTH HOUSTON IMPROVEMENT PROJECT (NHHIP) NOISE MODEL VALIDATION

2.1 Noise Model Validation

A validation is used to demonstrate that a noise model is an accurate representation of the real world noise levels within the limitations of the noise model algorithm. In accordance with FHWA (23 CFR 772.11 (d)) (2), field measured traffic noise levels must be compared to the predicted results from the Traffic Noise Model (TNM) model. Data collected from the field should reflect existing parameters (traffic speed, traffic counts, pavement conditions, obstructions, geometry, meteorology, reflections, background noise, etc.) so they can be used in comparison to those conditions modeled in the TNM model. TNM predicts traffic noise levels for a period of one hour; therefore, if field samples are collected for periods of less than one hour, the results must be converted so they reflect an hourly condition.

2.2 Model Validation Set Up

The North Houston Highway Improvement project is a complex urban project with an active involved public. The project begins at the I-45/BW 8 N interchange south along I-45 to downtown Houston, terminating at the US 59/I-69 and SP 527 interchange. The project includes portions of I-10 and US 59/I-69 near downtown Houston.

The Jacobs project team worked with the TxDOT Environmental Affairs Division (ENV) Noise Technical Expert and the TxDOT Houston District Environmental Project Manager to determine the parameters and methodology for the validation, based on recommendations from the project team’s experience conducting noise validations for other State Departments of Transportation (DOTs), including the

Florida DOT. Currently TxDOT does not have approved standards for noise validation and is in the process of developing this guidance. In the meantime, to the project team based the analysis on the Florida DOT's guidance "Traffic Noise Modelling and Analysis Practitioners Handbook" (January 1, 2016). Using the agreed-upon methods, the TNM results were validated at four representative validation locations. The four sites were chosen because each was representative of the existing conditions and proposed designs, as well as these sites were considered optimal due to the ability to conduct the measurements safely, minimum intersections, minimum obstructions, level elevations and/or grading and line of sight.

To accurately capture the existing conditions, traffic number counts, traffic speed, and traffic noise volume were recorded at each site.

For each site, the TNM model used the existing conditions schematics and included travel lanes, shoulders, medians, concrete traffic barriers, as well as the measured traffic counts and traffic speeds. This information was compared to determine if the noise measurements taken in the field were within three (3) A-weighted decibels (dBA) of the existing noise model.

2.3 Field Measurements and Model Validation

Field visits were conducted for the four validation sites between May 29 and June 7, 2017. As part of the preparation to go in the field, safety meetings were held prior to each site visit to discuss location situations, to ensure that Safety Action Plan were in place, to verify that the project team was appropriately attired for the field with personal protection equipment (PPE) and had the appropriate equipment to take measurements and field recordings. An item of note was that the project team coordinated with the Houston Police Department (HPD) at one of the sites regarding staff safety. HPD provided additional site area safety by advising the project team to work quickly and made a number of circuits while the team worked.

Prior to going to each site, weather conditions were gathered from the National Oceanic and Atmospheric Administration (NOAA) website for the closest zip code. Fresh batteries were put into the equipment; all equipment was fully charged and then calibrated to meet all criteria for testing. Noise measurements were conducted using a Quest 2900 Type I sound level meter that met the American National Standards Institute standards. Meters were calibrated and placed at five feet above the ground surface, as this is the average height of the human ear.

At each site, we set up based on previous planning discussions, but made adjustments if needed, such as for vegetation blocking the camera views. Cameras were used to capture each direction of traffic, and a Stalker Pro radar gun was used to capture lane traffic speeds. Due to the radar being taken at an angle, a degree of error was present. The degree between the car direction and radar direction was measured and later adjusted through calculations to provide a more accurate result.

The noise meter was set up at the location of the representative receiver. Noise readings were collected for 10 minutes three times at each location. Traffic counts were collected by vehicle type simultaneously with the noise measurements. Operating speeds and existing geometry were also collected.

The project team also made note of any exceptions that would impact the noise measurements, such as heavy truck jack-brakes, police and fire sirens, cars honking and a funeral procession.

Once the project team was back in the office, all of the data that was collected was recorded and saved. Accurate traffic counts were made by reviewing the camera video and counting the vehicle mix lane by lane. The video could be played in a slow motion format to ensure that all of the traffic counts were captured accurately.

Two of the sites required adjustments in the field. For Site 1: Due to dense vegetation between the frontage road and main lanes on the southbound side of IH 45, it was impossible to count the vehicles from the one camera view. Therefore, the vehicle count for the southbound traffic was done using the video recording from the northbound side.

For Site 4: The vehicle counts for all of the main lanes (both I-45 and US 59/I-69) was determined using the video recording from the camera on Tuam Street due to the difficulty of obtaining an accurate count from the camera on McGowan Street.

The Federal Highway Administration (FHWA) approved TNM 2.5 software was used for validation and Analysis. Table 1 summarizes the field-recorded and the TNM-predicted noise levels.

Table 2.1: Field-recorded and TNM-predicted Noise Levels

Meter No	Location	Sequence No	Field-recorded Noise Levels L(eq)	TNM-predicted Noise Levels L(eq)	Difference (+/-)
Site 1	I-45 (by Tidwell)	1	77.3	76.7	**-0.6**
		2	76.9	76.7	**-0.2**
		3	77.1	77.1	**0.0**
Site 2	I-45 & Fugate St	1	69.6	68.8	**-0.8**
		2	67.3	68.8	**+1.5**
		3	67.7	68.5	**+0.8**
Site 3	I-10 & US 59/I-69	1	71.5	72.3	**+0.8**
		2	71.6	72.0	**+0.4**
		3	70.6	71.9	**+1.3**
Site 4	US 59/I-69 & SH 288	1	66.9	69.8	**+2.9**
		2	66.1	68.2	**+2.1**
		3	66.4	68.6	**+2.2**

Source: NHHIP Project Team, 2017
L(eq) = Equivalent Continuous Sound Level

The difference between the field recordings and the average noise levels predicted by the model was less than three (3) dBA, which is considered validated, per TxDOT Technical Expert. Therefore, the model was considered an accurate representation of the existing conditions.

The project team was successful in conducting the validation for NHHIP; with a maximum average difference of 2.9 – within the 3 dBA goal. The real-time validation confirmed the accuracy of the TNM analysis performed for this highly complex project.

3.0 REFERENCES

Federal Highway Administration 2011. Analysis and Abatement Guidance. Website: https://www.fhwa.dot.gov/Environment/noise/regulations_and_guidance/analysis_and_abatement_guidance/polguide02.cfm. Accessed January 2018.

Florida Department of Transportation. 2016. *Traffic Noise Modelling and Analysis Practioner's Handbook.* Environmental Management Office. January 1, 2016. http://www.fdot.gov/environment/pubs/Traffic%20Noise%20Modeling%20and%20Analysis%20Practitioners%20Handbook%20-%20January%202016%20Version.pdf

Texas Department of Transportation 2011. *Guidelines for Analysis and Abatement of Roadway Traffic Noise*. Website: http://ftp.dot.state.tx.us/pub/txdot-info/library/pubs/bus/env/traffic_noise.pdf. Accessed April 2016.

____. 2014. *Examples of Recommended Text for Documenting Traffic Noise Analyses.* April 2014.

Exhibits

Exhibit 1: Project Area Map (North Houston Highway Improvement Project)

Exhibit 2: Proposed Noise Validation Site Overview Map

Exhibit 1: Project Area Map

(North Houston Highway Improvement Project)

PROJECT AREA MAP

North Houston Highway Improvement Project

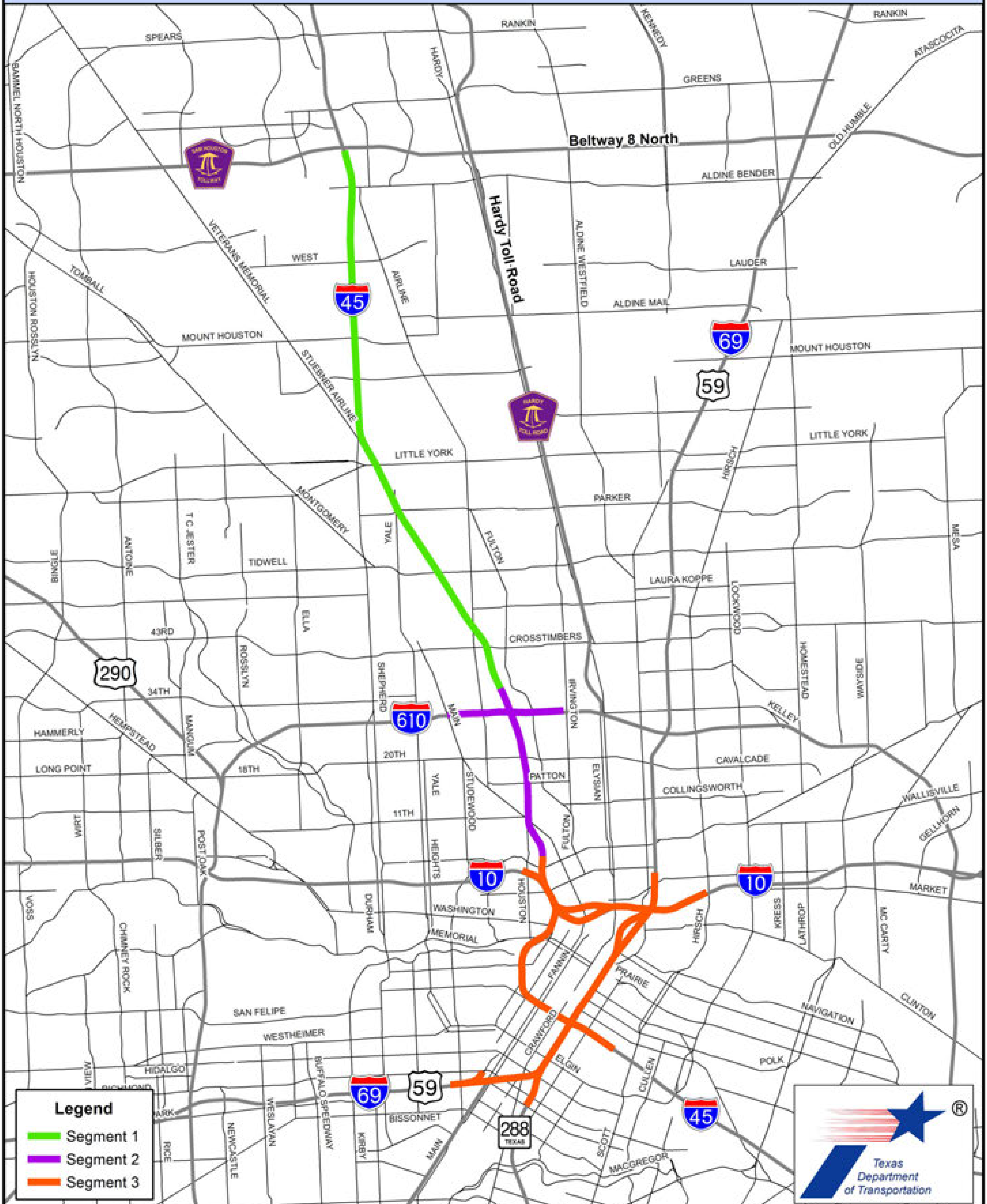
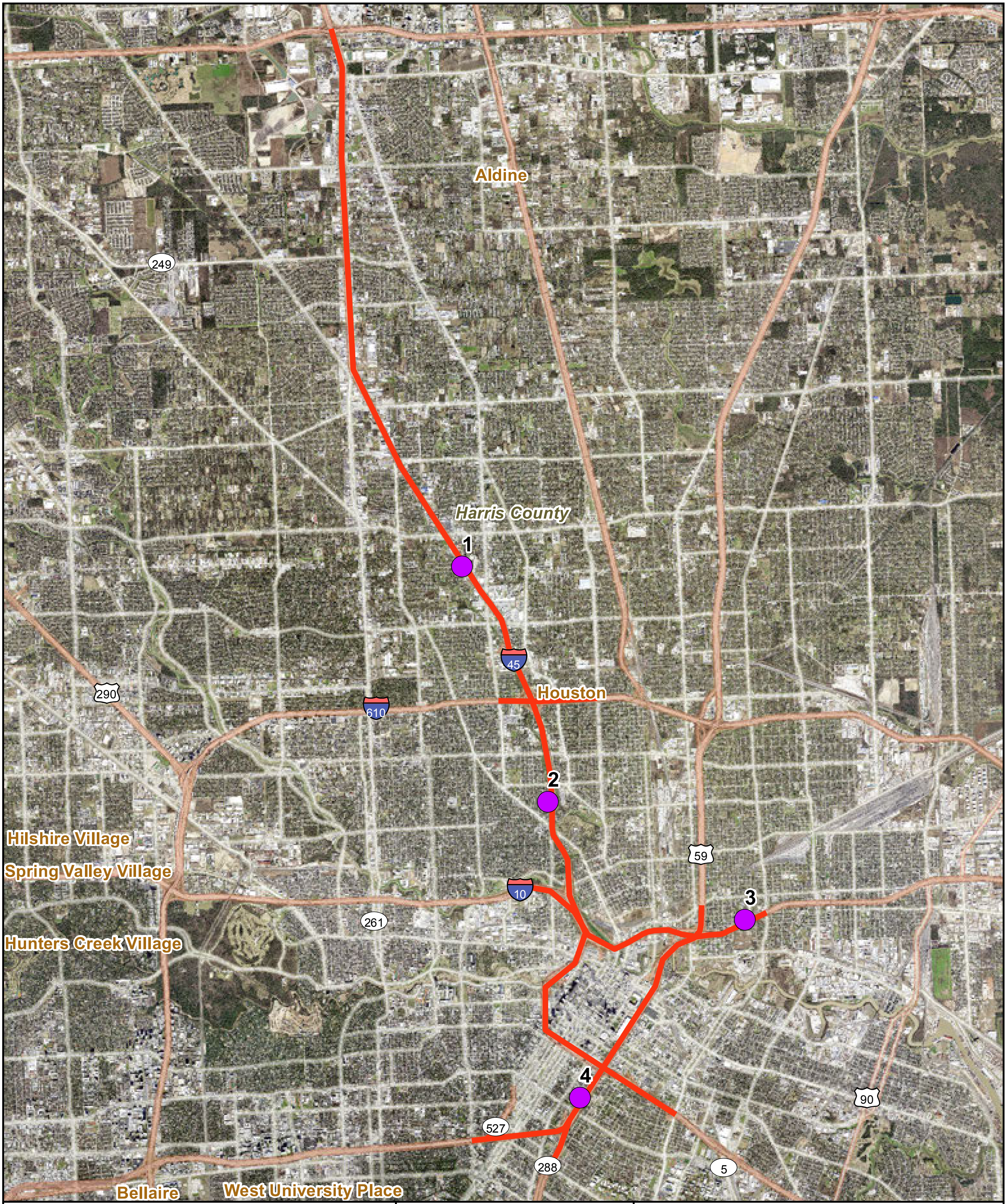


Exhibit 2: Proposed Noise Validation Site Overview Map

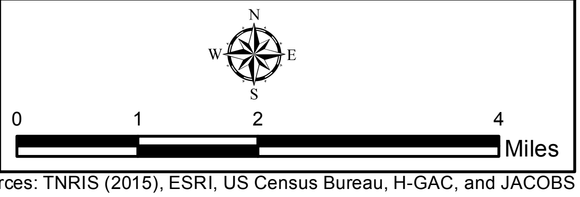


Proposed Noise Validation Site Overview Map

Legend

Validation Receivers

Proposed Alignment



Sources: TNRIS (2015), ESRI, US Census Bureau, H-GAC, and JACOBS

APPENDICES

Appendix A.1: Site 1 Validation Site Data

- Proposed Noise Validation Sites – Site 1
- Noise Measurement Data Sheet
- Screenshot of camera views
- Traffic Count and speeds data

Appendix A.2: Site 2 Validation Site Data

- Proposed Noise Validation Sites – Site 2
- Noise Measurement Data Sheet
- Screenshot of camera views
- Traffic Count and speeds data

Appendix A.3: Site 3 Validation Site Data

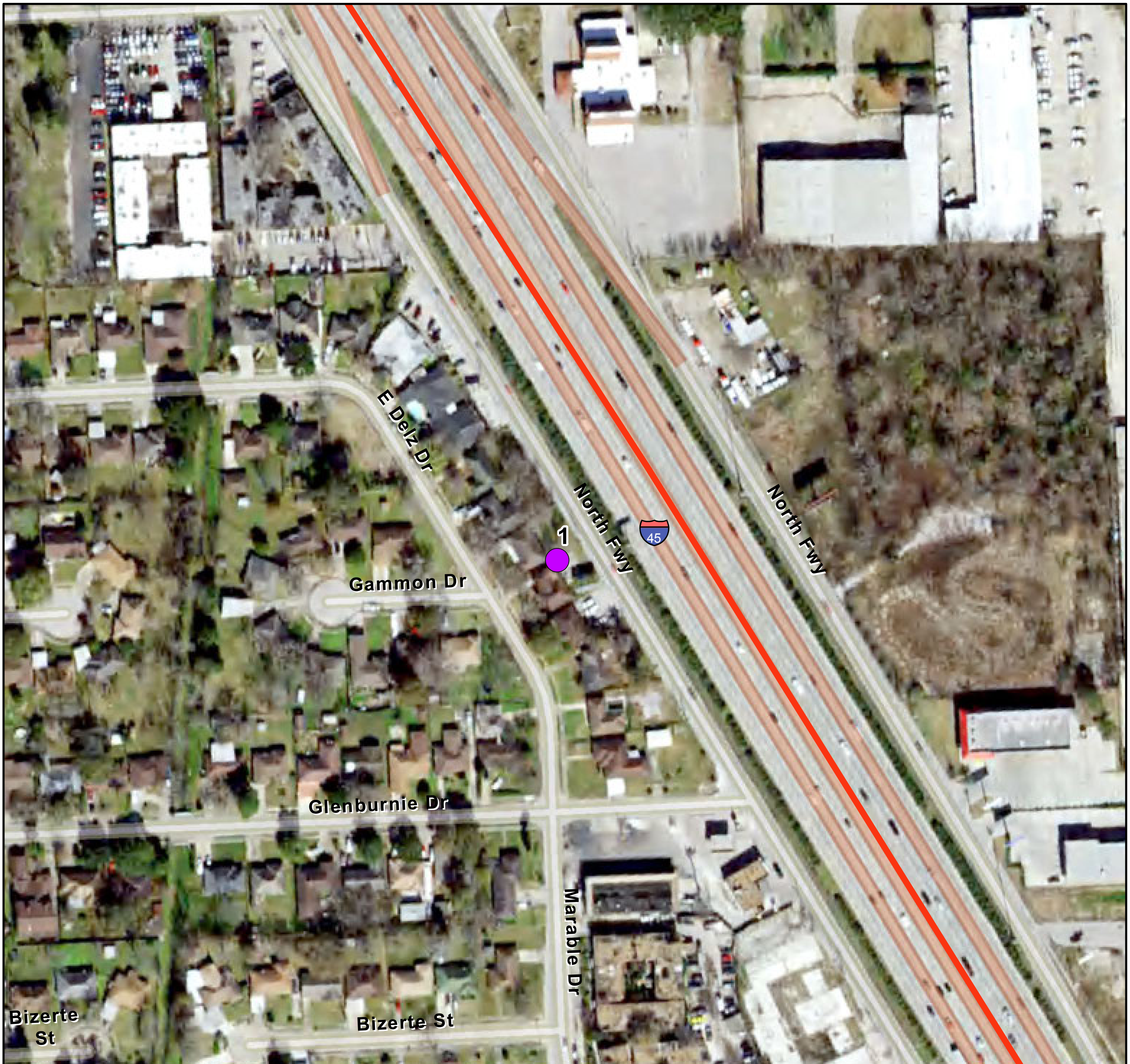
- Proposed Noise Validation Sites – Site 3
- Noise Measurement Data Sheet
- Screenshot of camera views
- Traffic Count and speeds data

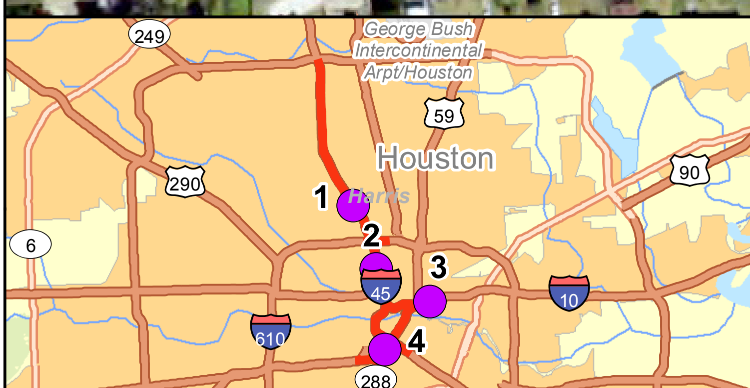
Appendix A.4: Site 4 Validation Site Data

- Proposed Noise Validation Sites – Site 4
- Noise Measurement Data Sheet
- Screenshot of camera views
- Traffic Count and speeds data

Appendix A.1: Site 1 Validation Site Data

- Proposed Noise Validation Sites – Site 1
- Noise Measurement Data Sheet
- Screenshot of camera views
- Traffic Count and speeds data





Proposed Noise Validation Sites

Legend

Validation Receivers

Proposed Alignment

N W E S

0 100 200 400 Feet

Sources: TNRISI (2015), ESRI, US Census Bureau, H-GAC, Photos Google Earth Pro and JACOBS

Noise Measurement Data Sheet

Site SITE 1			Date 05/30/2017
Noise Meter Model: Quest 2900 Type I Sound Level Meter	Response Fast Slow X	Weighting A X C ☐	Battery* 100% *replace if below 50%
Calibrator Model: QC-10/QC-20 Acoustic Calibrator	Calibrator @ 114 dBA Start: April 3rd, 2017 End		

Weather Data
Temp: 80 Humidity: 79% Wind Speed: 8 mph, variable Notes: scattered clouds, breeze from the North

Measurement Data

Event	Begin Time	End Time	L_{eq} (dBA)	L_{min} (dBA)	L_{max} (dBA)
1	10:15 am	10:25 am	77.3	73.9	86.3
2	10:30 am	10:40 am	76.9	72.3	81.8
3	10:43 am	10:53 am	77.1	72.7	84.1

Traffic Data and Average Speeds

Event	Direction	Autos	Medium Trucks	Heavy Trucks	Motorcycle	Buses
Total Average Hourly Count	North-Bound (ML & Frontage)	6,480	334	398	N/.A	N/A
Total Average Hourly Count	South-Bound (ML & Frontage)	6,404	282	374	N/A	N/A

***For traffic data and average speeds, see attached Site 1 Traffic Data Spreadsheet.**

Notes
(Major sources, background noise, unusual events, etc.)
Run 1 – 1-18 wheeler jack brakes
Run 2 – 1-car honk (double beep)
Run 3 – 1- 18 wheeler jack brakes
*For large scale map, see attached SITE 1 Map

Site 1 Southbound Screenshot

Site 1 Northbound Screenshot

SITE 1 TRAFFIC DATA

Site 1, NorthBound

Trial 1 (10:13)				Trial 2 (10:06)				Trial 3 (11:02)			
Frontage Road		Main Lanes		Frontage Road		Main Lanes		Frontage Road		Main Lanes	
Cars	186	Cars	827	Cars	162	Cars	911	Cars	204	Cars	950
Medium	11	Medium	48	Medium	9	Medium	35	Medium	10	Medium	54
Large	7	Large	56	Large	1	Large	61	Large	4	Large	70
Total	204	Total	931	Total	172	Total	1007	Total	218	Total	1074

Hourly	Frontage Road		Main Lanes		Frontage Road		Main Lanes		Frontage Road		Main Lanes	
	Before Ramp	After Ramp	Before Ramp	After Ramp	Before Ramp	After Ramp	Before Ramp	After Ramp	Before Ramp	After Ramp	Before Ramp	After Ramp
Cars	1116	1060	4962	5018	972	923	5466	5515	1224	1163	5700	5761
Medium	66	63	288	291	54	51	210	213	60	57	324	327
Large	42	40	336	338	6	6	366	366	24	23	420	421
Ramp	Cars	56			Cars	49			Cars	61		
	Medium	3			Medium	3			Medium	3		
	Large	2			Large	0			Large	1		
Speed	55.8 mph		59.2 mph		55.8 mph		58.4 mph		55.8 mph		59.8 mph	
Each Lane	Frontage Road		Main Lanes		Frontage Road		Main Lanes		Frontage Road		Main Lanes	
	Before Ramp	After Ramp	Before Ramp	After Ramp	Before Ramp	After Ramp	Before Ramp	After Ramp	Before Ramp	After Ramp	Before Ramp	After Ramp
Cars	558	530	1241	1254	486	462	1367	1379	612	581	1425	1440
Medium	33	31	72	73	27	26	53	53	30	29	81	82
Large	21	20	84	85	3	3	92	92	12	11	105	105

Total traffic	3,606	Total Time	31:21:00

Site 1, SouthBound

Trial 1 (9:26)				Trial 2 (9:57)				Trial 3 (9:48)			
Frontage Road		Main Lanes		Frontage Road		Main Lanes		Frontage Road		Main Lanes	
Cars	114	Cars	923	Cars	137	Cars	936	Cars	132	Cars	960
Medium	9	Medium	36	Medium	9	Medium	32	Medium	11	Medium	44
Large	4	Large	62	Large	3	Large	59	Large	6	Large	53
Total	127	Total	1021	Total	149	Total	1027	Total	149	Total	1057

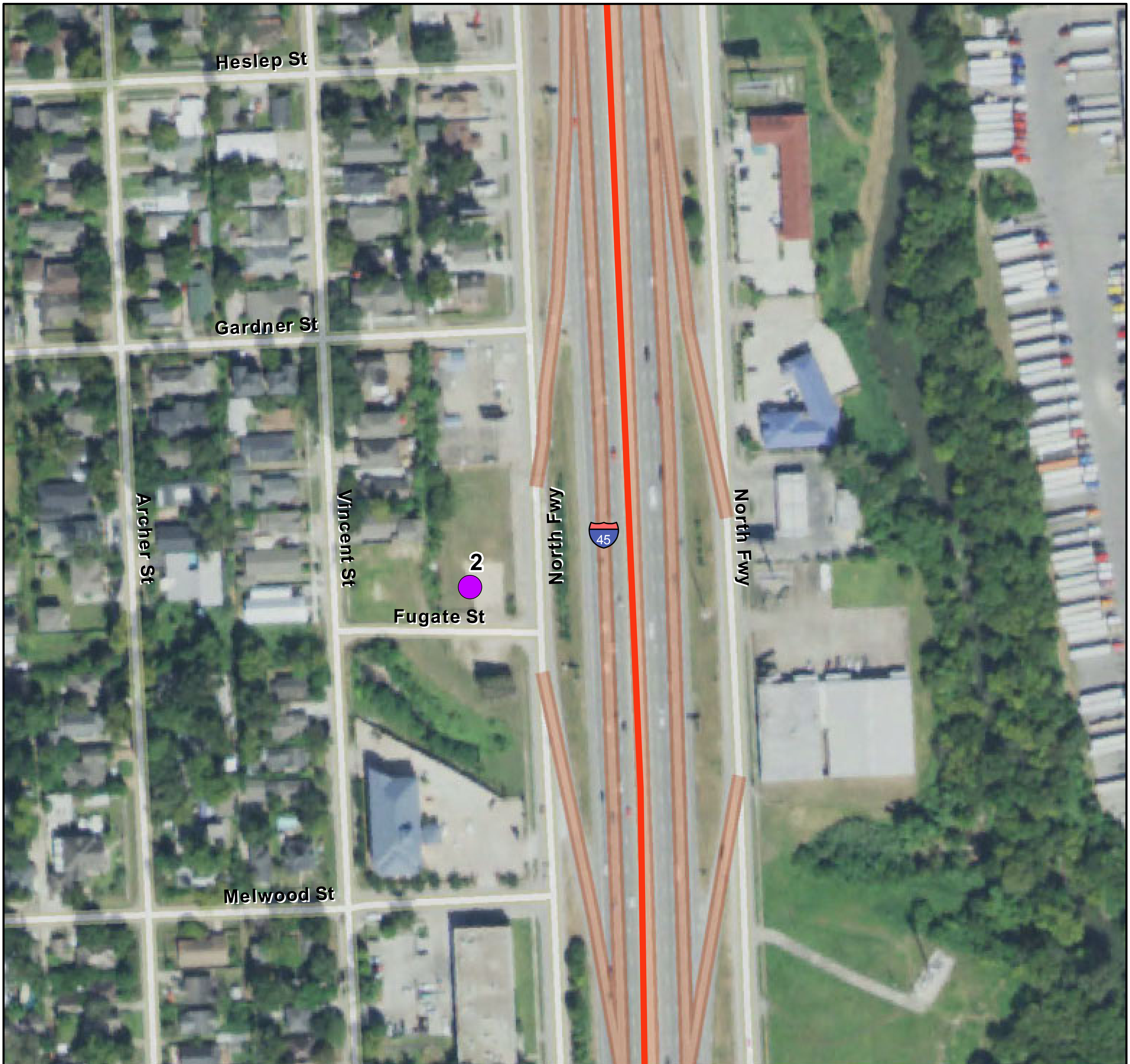
Hourly	Frontage Road		Main Lanes		Frontage Road		Main Lanes		Frontage Road		Main Lanes	
	Before Ramp	After Ramp	Before Ramp	After Ramp	Before Ramp	After Ramp	Before Ramp	After Ramp	Before Ramp	After Ramp	Before Ramp	After Ramp
Cars	684	718	5538	5504	822	863	5616	5575	792	832	5760	5720
Medium	54	57	216	213	54	57	192	189	66	69	264	261
Large	24	25	372	371	18	19	354	353	36	38	318	316
Ramp	Cars	34			Cars	41			Cars	40		
	Medium	3			Medium	3			Medium	3		
	Large	1			Large	1			Large	2		
Speed	55.8 mph		59.3 mph		55.8 mph		59.9 mph		55.8 mph		60.4 mph	
Each Lane	Frontage Road		Main Lanes		Frontage Road		Main Lanes		Frontage Road		Main Lanes	
	Before Ramp	After Ramp	Before Ramp	After Ramp	Before Ramp	After Ramp	Before Ramp	After Ramp	Before Ramp	After Ramp	Before Ramp	After Ramp
Cars	342	359	1385	1376	411	432	1404	1394	396	416	1440	1430
Medium	27	28	54	53	27	28	48	47	33	35	66	65
Large	12	13	93	93	9	9	89	88	18	19	80	79

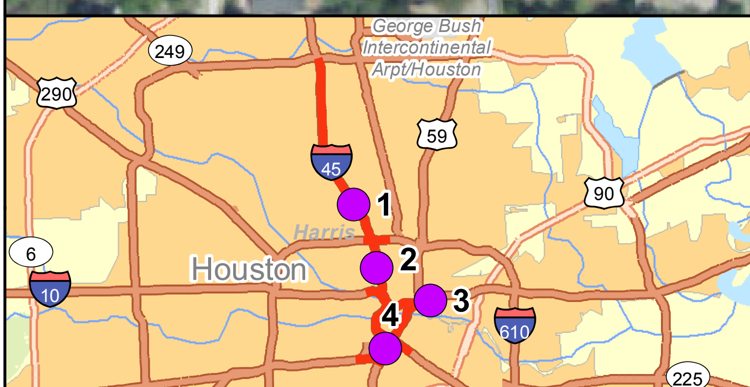
Total traffic	3,530	Total Time	29:11:00

HOV			
Trial #	T1	T2	T3
# of Cars	21	21	25
MPH	59.3	59.9	60.4

Appendix A.2: Site 2 Validation Site Data

- Proposed Noise Validation Sites – Site 2
- Noise Measurement Data Sheet
- Screenshot of camera views
- Traffic Count and speeds data





Proposed Noise Validation Sites

Legend

Validation Receivers

Proposed Alignment

N
W E
S

0 100 200 400 Feet

Sources: TNRIS (2016), ESRI, US Census Bureau, H-GAC, Photos Google Earth Pro and JACOBS

Noise Measurement Data Sheet

Site SITE 2 — Date 06/07/2017

Noise Meter	Response	Weighting	Battery*
Model: Quest 2900 Type I Sound Level Meter	Fast Slow X	A X C ☐	100% *replace if below 50%

Calibrator	Calibrator @ 114 dBA
Model: QC-10/QC-20 Acoustic Calibrator	Start: April 3rd, 2017 End

Weather Data

Temp: 88 Humidity: 48% Wind Speed: 10 mph, variable

Measurement Data

Event	Begin Time	End Time	L_{eq} (dBA)	L_{min} (dBA)	L_{max} (dBA)
1	12:55 pm	1:05 pm	69.6	63.2	84.9
2	1:05 pm	1:15 pm	67.3	61.9	72.7
3	1:20 pm	1:30 pm	67.7	62.7	73.3

Traffic Data and Average Speeds

Event	Direction	Autos	Medium Trucks	Heavy Trucks	Motorcycle	Buses
Total Average Hourly Count	North-Bound (ML & Frontage)	4,494	172	108	N/.A	N/A
Total Average Hourly Count	South-Bound (ML & Frontage)	4,850	168	178	N/A	N/A

***For traffic data and average speeds, see attached Site 2 Traffic Data Spreadsheet.**

Notes

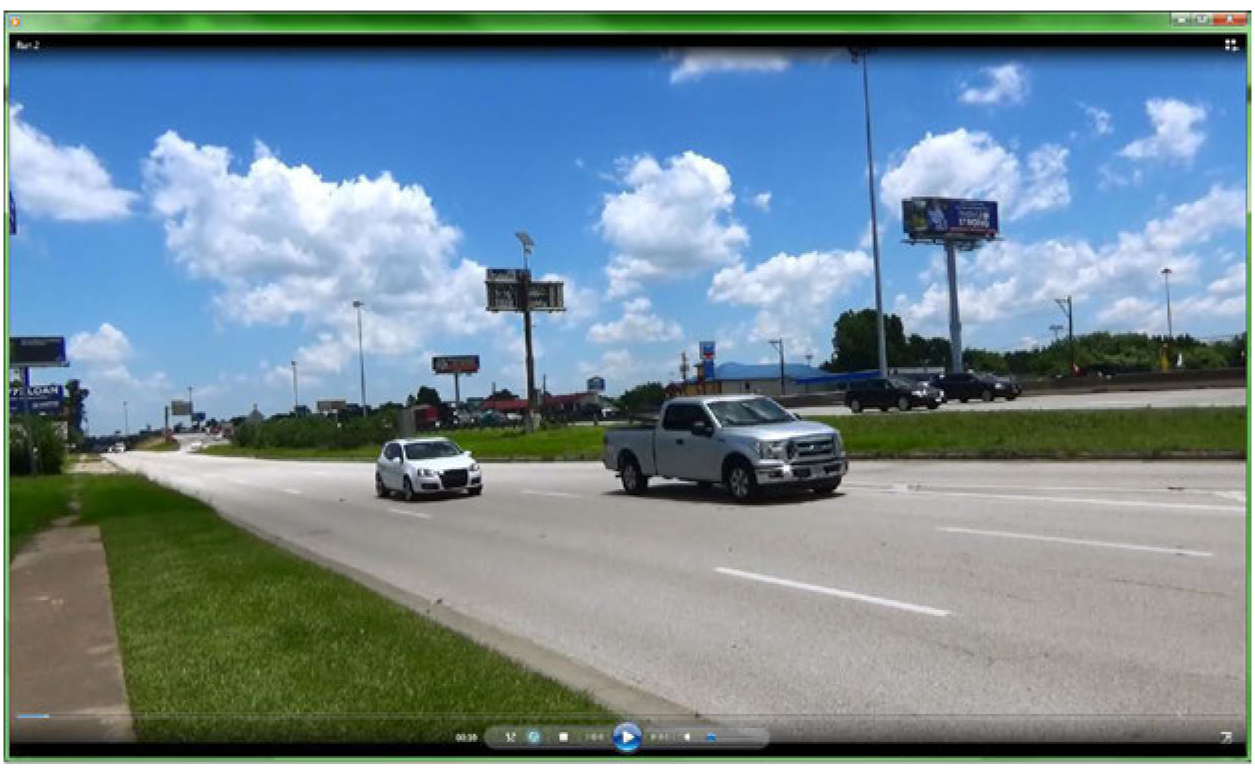
(Major sources, background noise, unusual events, etc.)

Funeral procession with Police escort – Event 1

Police Car siren – Event 2

*For large scale map, see attached SITE 2 Map

Site 2 Northbound Video Screenshot



Site 2 Southbound Video Screenshot

SITE 2 TRAFFIC DATA

Site 2, NorthBound

Trial 1 (9:59)				Trial 2 (10:03)				Trial 3 (10:01)			
Frontage Road		Main Lanes		Frontage Road		Main Lanes		Frontage Road		Main Lanes	
Cars	46	Cars	714	Cars	40	Cars	721	Cars	38	Cars	688
Medium	2	Medium	25	Medium	3	Medium	30	Medium	1	Medium	25
Large	1	Large	21	Large	0	Large	14	Large	1	Large	17
Total	49	Total	760	Total	43	Total	765	Total	40	Total	730

Hourly	Frontage Road		Main Lanes		Frontage Road		Main Lanes		Frontage Road		Main Lanes	
	Before Ramp	After Ramp	Before Ramp	After Ramp	Before Ramp	After Ramp	Before Ramp	After Ramp	Before Ramp	After Ramp	Before Ramp	After Ramp
Cars	276	456	4284	4464	240	474	4326	4560	228	426	4128	4326
Medium	12	18	150	156	18	36	180	198	6	18	150	162
Large	6	18	126	138	0	6	84	90	6	12	102	108
Ramp	Cars	180			Cars	234			Cars	198		
	Medium	6			Medium	18			Medium	12		
	Large	12			Large	6			Large	6		
Speed	41.8		58.3		40.3		62.5		42.3		62.7	
Each Lane	Frontage Road		Main Lanes		Frontage Road		Main Lanes		Frontage Road		Main Lanes	
	Before Ramp	After Ramp	Before Ramp	After Ramp	Before Ramp	After Ramp	Before Ramp	After Ramp	Before Ramp	After Ramp	Before Ramp	After Ramp
Cars	138	228	1071	1116	120	237	1082	1140	114	213	1032	1082
Medium	6	9	38	39	9	18	45	50	3	9	38	41
Large	3	9	32	35	0	3	21	23	3	6	26	27

Total traffic	2,387	Total Time	30:03:00

Site 2, SouthBound

Trial 1 (10:00)				Trial 2 (10:01)				Trial 3 (10:20)			
Frontage Road		Main Lanes		Frontage Road		Main Lanes		Frontage Road		Main Lanes	
Cars	69	Cars	819	Cars	46	Cars	720	Cars	56	Cars	715
Medium	2	Medium	29	Medium	3	Medium	26	Medium	2	Medium	22
Large	1	Large	29	Large	1	Large	30	Large	1	Large	27
Total	72	Total	877	Total	50	Total	776	Total	59	Total	764

Hourly	Frontage Road		Main Lanes		Frontage Road		Main Lanes		Frontage Road		Main Lanes	
	Before Ramp	After Ramp	Before Ramp	After Ramp	Before Ramp	After Ramp	Before Ramp	After Ramp	Before Ramp	After Ramp	Before Ramp	After Ramp
Cars	414	822	4914	4914	276	456	4320	4320	336	582	4290	4290
Medium	12	18	174	174	18	24	156	156	12	24	132	132
Large	6	12	174	174	6	6	180	180	6	6	162	162
Ramp	Cars	408			Cars	180			Cars	246		
	Medium	6			Medium	6			Medium	12		
	Large	6			Large	0			Large	0		
Speed	41.8		61.3		40.3		62.7		42.3		61.6	
Each Lane	Frontage Road		Main Lanes		Frontage Road		Main Lanes		Frontage Road		Main Lanes	
	Before Ramp	After Ramp	Before Ramp	After Ramp	Before Ramp	After Ramp	Before Ramp	After Ramp	Before Ramp	After Ramp	Before Ramp	After Ramp
Cars	207	411	1229	1229	138	228	1080	1080	168	291	1073	1073
Medium	6	9	44	44	9	12	39	39	6	12	33	33
Large	3	6	44	44	3	3	45	45	3	3	41	41

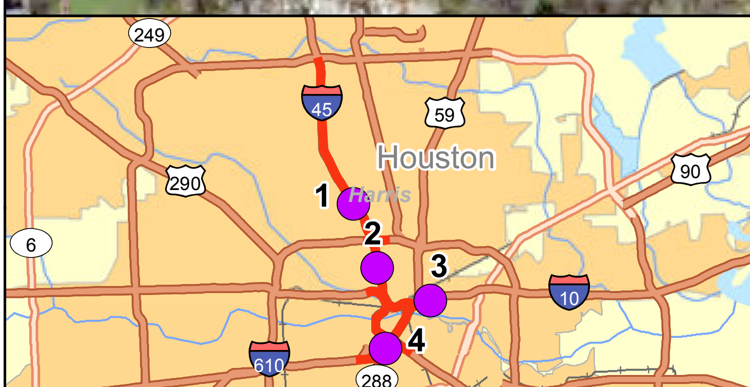
Total traffic	2,598	Total Time	30:21:00

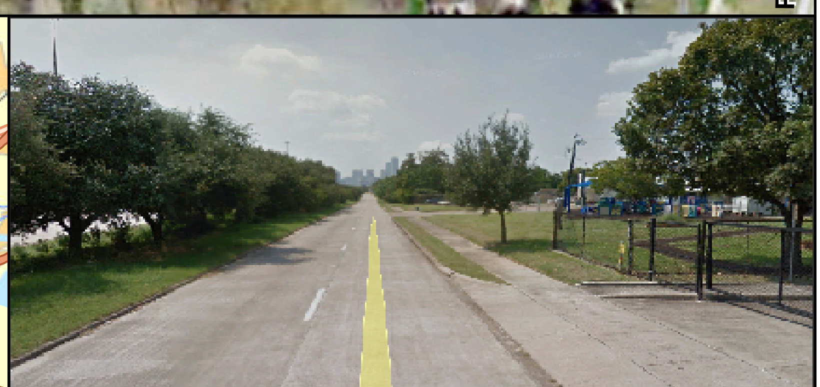
Ramp (SouthBound)					
Trial 1		Trial 2		Trial 3	
Entering Hwy	Exiting Hwy	Entering Hwy	Exiting Hwy	Entering Hwy	Exiting Hwy
34	68	51	30	46	41
2	1	2	1	2	2
0	1	1	0		0
Hourly					
204	408	306	180	276	246
12	6	12	6	12	12
0	6	6	0	0	0

Ramp (NorthBound)					
Trial 1		Trial 2		Trial 3	
Entering Hwy	Exiting Hwy	Entering Hwy	Exiting Hwy	Entering Hwy	Exiting Hwy
21	30	24	39	21	33
1	1	1	3	2	2
0	2	1	1	1	1
Hourly					
126	180	144	234	126	198
6	6	6	18	12	12
0	12	6	6	6	6

Appendix A.3: Site 3 Validation Site Data

- Proposed Noise Validation Sites – Site 3
- Noise Measurement Data Sheet
- Screenshot of camera views
- Traffic Count and speeds data





Proposed Noise Validation Sites

Legend

Validation Receivers

Proposed Alignment

Sources: TNRISI (2015), ESRI, US Census Bureau, H-GAC, Photos Google Earth Pro and JACOBS

Noise Measurement Data Sheet

Site SITE 3			Date 06/07/2017
Noise Meter Model: Quest 2900 Type I Sound Level Meter	Response Fast Slow X	Weighting A X C ☐	Battery* 100% *replace if below 50%
Calibrator Model: Model: QC-10/QC-20 Acoustic Calibrator	Calibrator @ 114 dBA Start: April 3rd, 2017 End		
Weather Data Temp: 84 Humidity: 8% Wind Speed: 8 mph, variable Notes: N/A			

Measurement Data

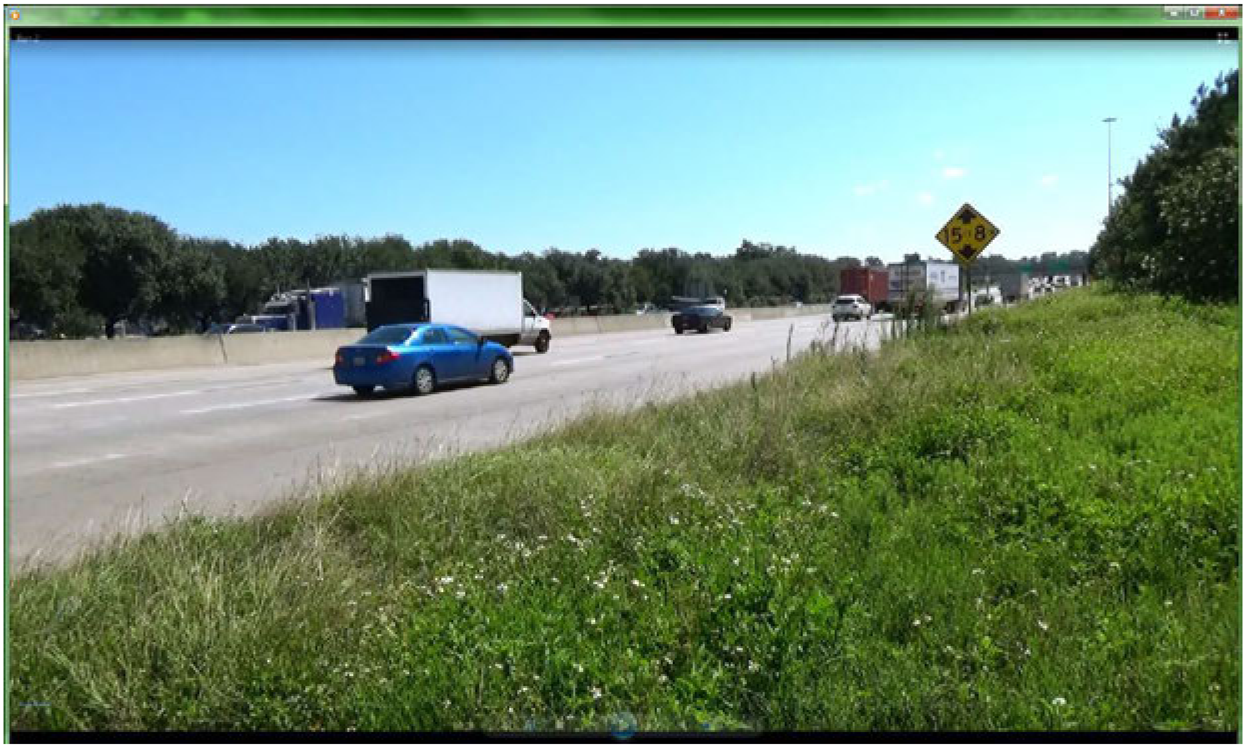
Event	Begin Time	End Time	L_{eq} (dBA)	L_{min} (dBA)	L_{max} (dBA)
1	10:30 am	10:40 am	71.5	65.8	76.2
2	10:45 am	10:54 am	71.6	66.5	76.1
3	10:55 am	11:05 am	70.6	66.6	74.1

Traffic Data and Average Speeds

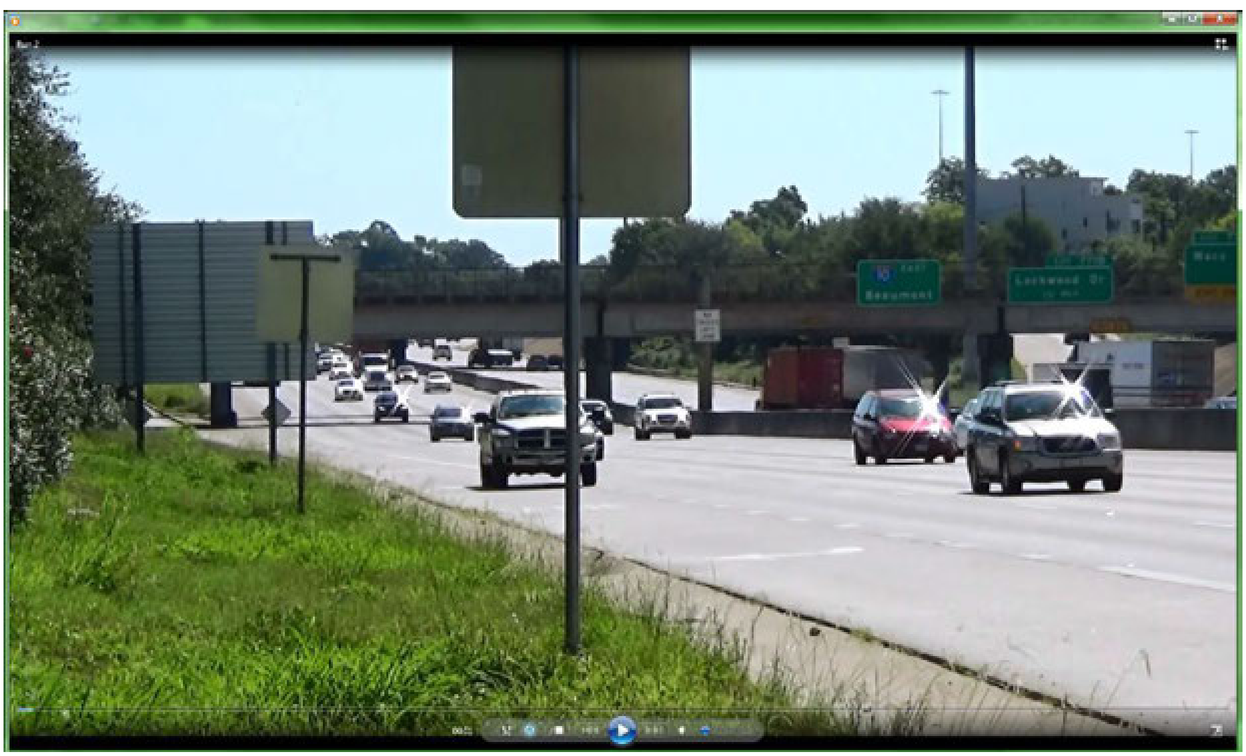
Event	Direction	Autos	Medium Trucks	Heavy Trucks	Motorcycle	Buses
Total Average Hourly Count	East-Bound (Main Lanes)	3,806	172	214	N/.A	N/A
Total Average Hourly Count	West-Bound (ML & Frontage)	3,910	252	268	N/A	N/A

***For traffic data and average speeds, see attached Site 3 Traffic Data Spreadsheet.**

Notes
(Major sources, background noise, unusual events, etc.)
Random background from building – Event 1
Funeral procession – Event 3
*For large scale map, see attached SITE 3 Map



Site 3 Eastbound Screenshot



Site 3 Westbound Screenshot

SITE 3 TRAFFIC DATA

Site 3, EastBound

Trial 1 (9:46)				Trial 2 (9:02)				Trial 3 (10:07)			
Frontage Road		Main Lanes		Frontage Road		Main Lanes		Frontage Road		Main Lanes	
Cars	N/A	Cars	645	Cars	N/A	Cars	630	Cars	N/A	Cars	628
Medium	N/A	Medium	20	Medium	N/A	Medium	32	Medium	N/A	Medium	34
Large	N/A	Large	25	Large	N/A	Large	42	Large	N/A	Large	40
Total	0	Total	690	Total	0	Total	704	Total	0	Total	702

Hourly	Frontage Road		Main Lanes		Frontage Road		Main Lanes		Frontage Road		Main Lanes	
	Before Ramp	After Ramp	Before Ramp	After Ramp	Before Ramp	After Ramp	Before Ramp	After Ramp	Before Ramp	After Ramp	Before Ramp	After Ramp
Cars	N/A	N/A	3870	3870	N/A	N/A	3780	3780	N/A	N/A	3768	3768
Medium	N/A	N/A	120	120	N/A	N/A	192	192	N/A	N/A	204	204
Large	N/A	N/A	150	150	N/A	N/A	252	252	N/A	N/A	240	240
Speed	45 mph		63.7 mph		45 mph		63.5 mph		45 mph		63.5 mph	
Each Lane	Frontage Road		Main Lanes		Frontage Road		Main Lanes		Frontage Road		Main Lanes	
	Before Ramp	After Ramp	Before Ramp	After Ramp	Before Ramp	After Ramp	Before Ramp	After Ramp	Before Ramp	After Ramp	Before Ramp	After Ramp
Cars	N/A	N/A	968	968	N/A	N/A	945	945	N/A	N/A	942	942
Medium	N/A	N/A	30	30	N/A	N/A	48	48	N/A	N/A	51	51
Large	N/A	N/A	38	38	N/A	N/A	63	63	N/A	N/A	60	60

Total traffic	2,096	Total Time	28:55:00

Site 3, WestBound

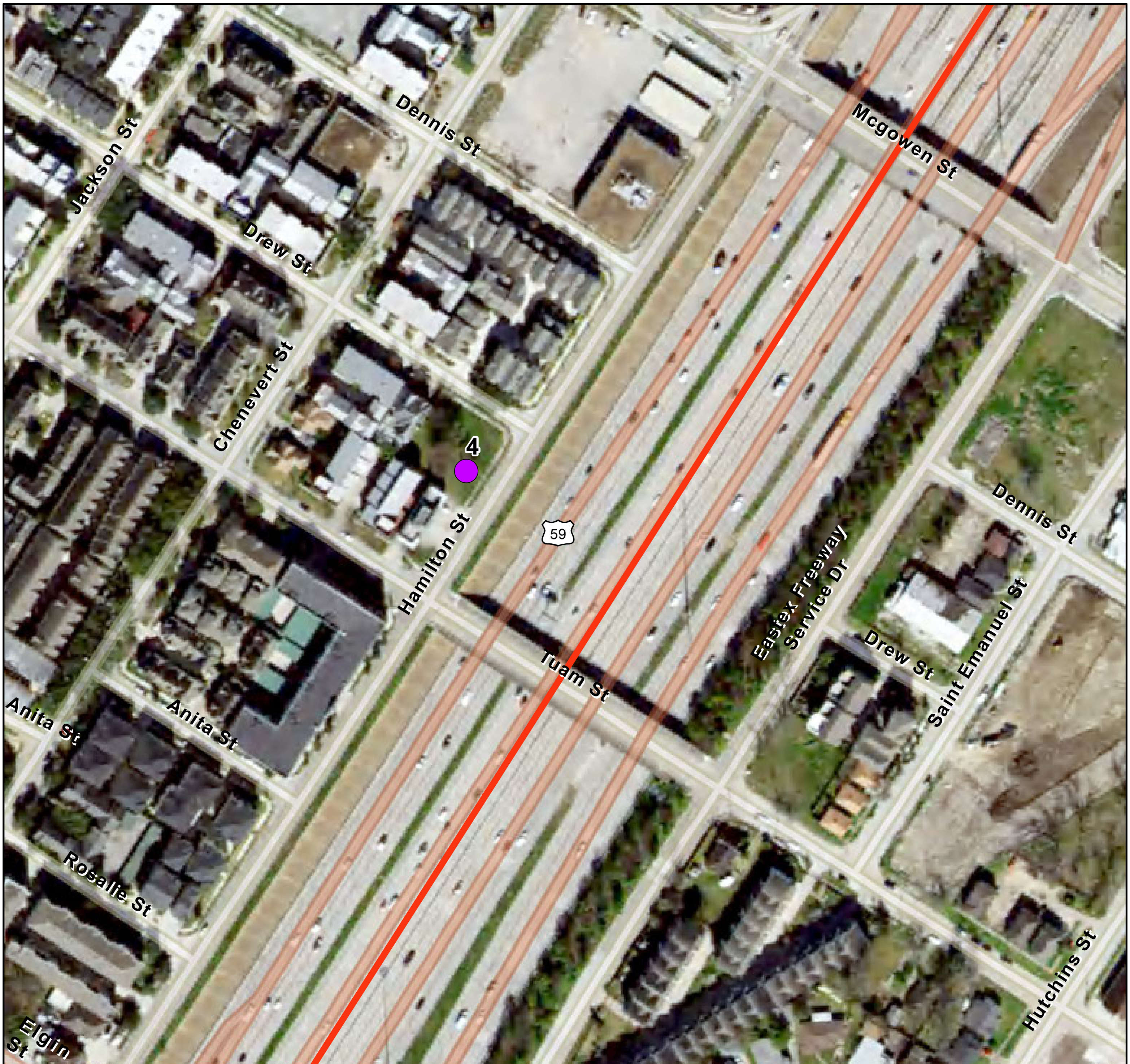
Trial 1 (9:58)				Trial 2 (8:47)				Trial 3 (10:04)			
Frontage Road		Main Lanes		Frontage Road		Main Lanes		Frontage Road		Main Lanes	
Cars	39	Cars	651	Cars	34	Cars	634	Cars	40	Cars	670
Medium	0	Medium	43	Medium	0	Medium	38	Medium	0	Medium	45
Large	0	Large	53	Large	0	Large	47	Large	0	Large	34
Total	39	Total	747	Total	34	Total	719	Total	40	Total	749

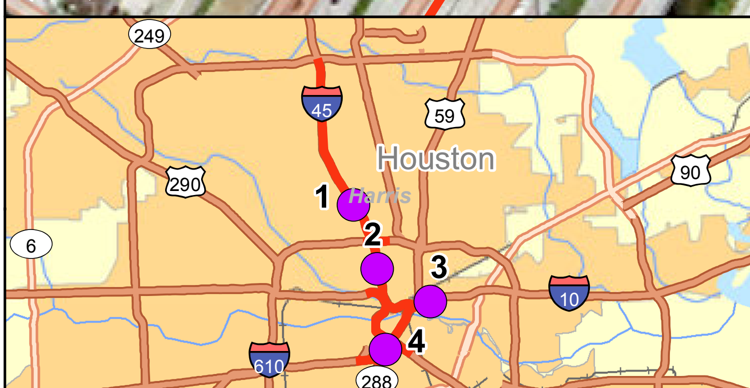
Hourly	Frontage Road		Main Lanes		Frontage Road		Main Lanes		Frontage Road		Main Lanes	
	Before Ramp	After Ramp	Before Ramp	After Ramp	Before Ramp	After Ramp	Before Ramp	After Ramp	Before Ramp	After Ramp	Before Ramp	After Ramp
Cars	234	234	3906	3906	204	214	3804	3804	240	252	4020	4020
Medium	0	0	258	258	0	0	228	228	0	0	270	270
Large	0	0	318	318	0	0	282	282	0	0	204	204
Speed	45 mph		64.7 mph		45 mph		62.3 mph		45 mph		64.4 mph	
Each Lane	Frontage Road		Main Lanes		Frontage Road		Main Lanes		Frontage Road		Main Lanes	
	Before Ramp	After Ramp	Before Ramp	After Ramp	Before Ramp	After Ramp	Before Ramp	After Ramp	Before Ramp	After Ramp	Before Ramp	After Ramp
Cars	234	234	977	977	102	107	951	951	120	126	1005	1005
Medium	0	0	65	65	0	0	57	57	0	0	68	68
Large	0	0	80	80	0	0	71	71	0	0	51	51

Total traffic	2,328	Total Time	28:49:00

Appendix A.4: Site 4 Validation Site Data

- Proposed Noise Validation Sites – Site 4
- Noise Measurement Data Sheet
- Screenshot of camera views
- Traffic Count and speeds data





Proposed Noise Validation Sites

Legend

Validation Receivers

Proposed Alignment

N
W E
S

0 100 200 400 Feet

Sources: TNRISI (2015), ESRI, US Census Bureau, H-GAC, Photos Google Earth Pro and JACOBS

Noise Measurement Data Sheet				
Site SITE 4			Date 06/06/2017	
Noise Meter Model: Quest 2900 Type I Sound Level Meter		Response Fast Slow X	Weighting A X C ☐	Battery* 100% *replace if below 50%
Calibrator Model: Model: QC-10/QC-20 Acoustic Calibrator	Calibrator @ 114 dBA Start: April 3rd, 2017 End			
Weather Data Temp: 83 Humidity: 70% Wind Speed: 8 mph, variable Notes: partly cloudy				

Measurement Data

Event	Begin Time	End Time	L_{eq} (dBA)	L_{min} (dBA)	L_{max} (dBA)
1	10:35	10:45	66.9	63.3	77.5
2	10:50	11:00	66.1	63.5	75.5
3	11:05	11:15	66.4	63.9	72.3

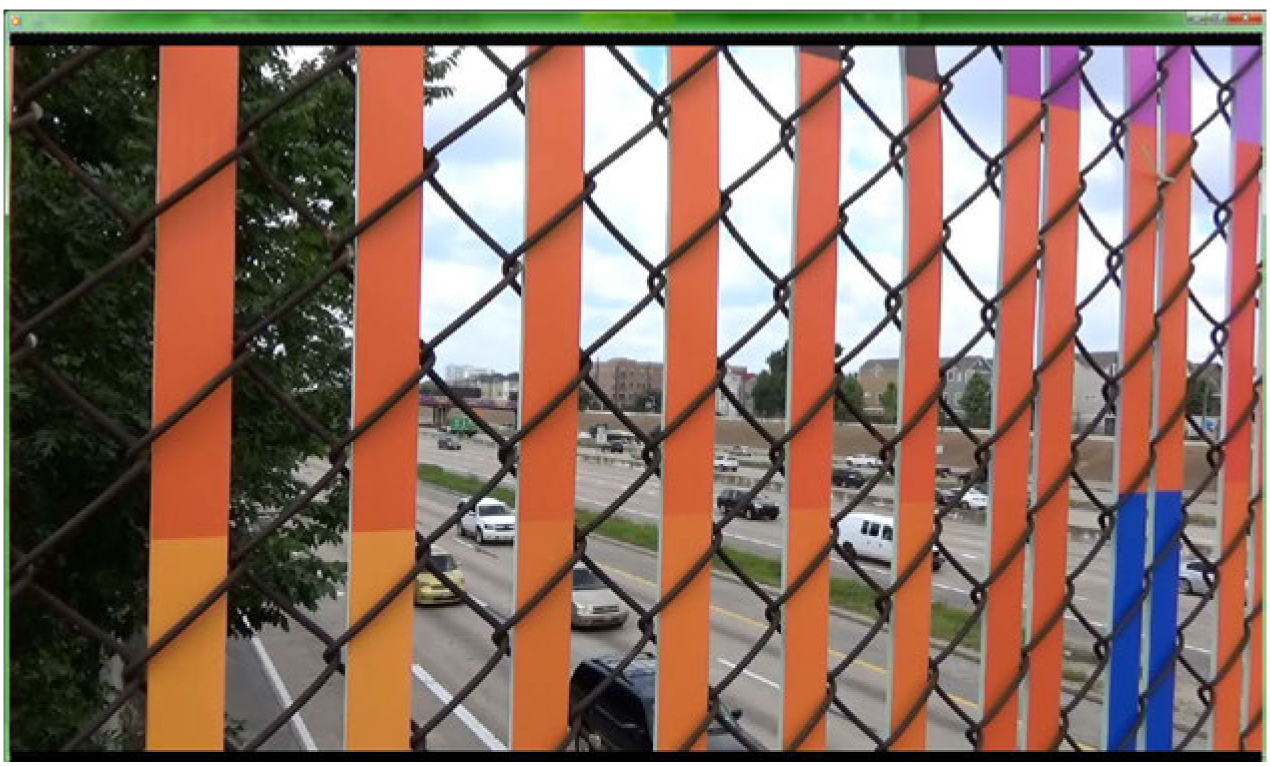
Traffic Data and Average Speeds

Event	Direction	Autos	Medium Trucks	Heavy Trucks	Motorcycle	Buses
Total Average Hourly Count	North-Bound (ML & Frontage)	7,942	326	298	N/.A	N/A
Total Average Hourly Count	South-Bound (ML & Frontage)	8,832	330	350	N/A	N/A

***For traffic data and average speeds, see attached Site 4 Traffic Data Spreadsheet.**

Notes
(Major sources, background noise, unusual events, etc.)
*For large scale map, see attached SITE 4 Map

Site 4 (view from Tuam St) Screenshot



Site 4 (view from McGowen St) Screenshot

SITE 4 TRAFFIC DATA

Site 4, NorthBound

Sequence	Trial 1 (10:30)						Trial 2 (10:06)						Trial 3 (9:54)					
	Chartres St		Main Lanes (US59)		Main Lanes (I45)		Chartres St		Main Lanes (US59)		Main Lanes (I45)		Chartres St		Main Lanes (US59)		Main Lanes (I45)	
Type Of Vehicle	Cars	38	Cars	726	Cars	598	Cars	58	Cars	712	Cars	552	Cars	68	Cars	692	Cars	527
	Medium	1	Medium	32	Medium	24	Medium	1	Medium	30	Medium	14	Medium	5	Medium	28	Medium	28
	Large	0	Large	28	Large	17	Large	0	Large	33	Large	10	Large	1	Large	40	Large	20
Vehicle Count	Total	39	Total	786	Total	639	Total	59	Total	775	Total	576	Total	74	Total	760	Total	575
Hourly	Chartres St		Main Lanes (US59)		Main Lanes (I45)		Chartres St		Main Lanes (US59)		Main Lanes (I45)		Chartres St		Main Lanes (US59)		Main Lanes (I45)	
	Before Ramp	After Ramp	Before Ramp	After Ramp	Before Ramp	After Ramp	Before Ramp	After Ramp	Before Ramp	After Ramp	Before Ramp	After Ramp	Before Ramp	After Ramp	Before Ramp	After Ramp	Before Ramp	After Ramp
Cars	228	228	4356	4356	3588	3588	348	348	4272	4272	3312	3312	408	408	4152	4152	3162	3162
Medium	6	6	192	192	144	144	6	6	180	180	84	84	30	30	168	168	168	168
Large	0	0	168	168	102	102	0	0	198	198	60	60	6	6	240	240	120	120
Ramp	Cars	N/A					Cars	N/A					Cars	N/A				
	Medium	N/A					Medium	N/A					Medium	N/A				
	Large	N/A					Large	N/A					Large	N/A				
Speed	32.4		62.9		62.9		36.3		62.7		63.2		35.1		61.8		61.8	
Each Lane	Chartres St		Main Lanes (US59)		Main Lanes (I45)		Chartres St		Main Lanes (US59)		Main Lanes (I45)		Chartres St		Main Lanes (US59)		Main Lanes (I45)	
	Before Ramp	After Ramp	Before Ramp	After Ramp	Before Ramp	After Ramp	Before Ramp	After Ramp	Before Ramp	After Ramp	Before Ramp	After Ramp	Before Ramp	After Ramp	Before Ramp	After Ramp	Before Ramp	After Ramp
Cars	76	76	1089	1089	897	897	116	116	1068	1068	828	828	136	136	1038	1038	791	791
Medium	2	2	48	48	36	36	2	2	45	45	21	21	10	10	42	42	42	42
Large	0	0	42	42	26	26	0	0	50	50	15	15	2	2	60	60	30	30

Total traffic	4,283	Total Time	30:30:00

Site 4, SouthBound

Sequence	Trial 1 (10:22)						Trial 2 (10:03)						Trial 3 (10:13)					
	Hamilton St		Main Lanes (US59)		Main Lanes (I45)		Hamilton St		Main Lanes (US59)		Main Lanes (I45)		Hamilton St		Main Lanes (US59)		Main Lanes (I45)	
Type Of Vehicle	Cars	39	Cars	805	Cars	703	Cars	38	Cars	785	Cars	604	Cars	52	Cars	774	Cars	616
	Medium	2	Medium	40	Medium	25	Medium	1	Medium	29	Medium	18	Medium	1	Medium	28	Medium	21
	Large	0	Large	52	Large	17	Large	0	Large	32	Large	18	Large	0	Large	37	Large	19
Vehicle Count	Total	41	Total	897	Total	745	Total	39	Total	846	Total	640	Total	53	Total	839	Total	656
Hourly	Hamilton St		Main Lanes (US59)		Main Lanes (I45)		Hamilton St		Main Lanes (US59)		Main Lanes (I45)		Hamilton St		Main Lanes (US59)		Main Lanes (I45)	
	Before Ramp	After Ramp	Before Ramp	After Ramp	Before Ramp	After Ramp	Before Ramp	After Ramp	Before Ramp	After Ramp	Before Ramp	After Ramp	Before Ramp	After Ramp	Before Ramp	After Ramp	Before Ramp	After Ramp
Cars	234	234	4830	4830	4218	4218	228	228	4710	4710	3624	3624	312	312	4644	4644	3696	3696
Medium	12	12	240	240	150	150	6	6	174	174	108	108	6	6	168	168	126	126
Large	0	0	312	312	102	102	0	0	192	192	108	108	0	0	222	222	114	114
Ramp	Cars	N/A					Cars	N/A					Cars	N/A				
	Medium	N/A					Medium	N/A					Medium	N/A				
	Large	N/A					Large	N/A					Large	N/A				
Speed	34.1		61.3		61.3		34.1		61.3		61.3		34.1		63.6		63.6	
Each Lane	Hamilton St		Main Lanes (US59)		Main Lanes (I45)		Hamilton St		Main Lanes (US59)		Main Lanes (I45)		Hamilton St		Main Lanes (US59)		Main Lanes (I45)	
	Before Ramp	After Ramp	Before Ramp	After Ramp	Before Ramp	After Ramp	Before Ramp	After Ramp	Before Ramp	After Ramp	Before Ramp	After Ramp	Before Ramp	After Ramp	Before Ramp	After Ramp	Before Ramp	After Ramp
Cars	78	78	1208	1208	1055	1055	76	76	1178	1178	906	906	104	104	1161	1161	924	924
Medium	4	4	60	60	38	38	2	2	44	44	27	27	2	2	42	42	32	32
Large	0	0	78	78	26	26	0	0	48	48	27	27	0	0	56	56	29	29

Total traffic	4,756	Total Time	30:38:00

Site 4, OverPasses

Sequence	Trial 1 (10:13)				Trial 2 (10:06)				Trial 1 (10:13)			
Road	Tuam St		Mc Gowan St		Tuam St		Mc Gowan St		Tuam St		Mc Gowan St	
Direction	West	East	West	East	West	East	West	East	West	East	West	East
Cars	1	0	44	35	1	3	36	41	0	6	24	65
Medium	1	0	3	4	0	0	1	3	0	0	2	2
Large	0	0	2	3	0	0	0	1	0	0	1	3
Total Count	Total	0	Total	42	Total	3	Total	45	Total	6	Total	70

Hourly	Tuam St		Mc Gowan St		Tuam St		Mc Gowan St		Tuam St		Mc Gowan St	
	West	East	West	East	West	East	West	East	West	East	West	East
Cars	6	0	264	210	6	18	216	246	0	36	144	390
Medium	6	0	18	24	0	0	6	18	0	0	12	12
Large	0	0	12	18	0	0	0	6	0	0	6	18
Speed	28.7		28.7		28.9		28.9		29		29	
Each Lane	Tuam St		Mc Gowan St		Tuam St		Mc Gowan St		Tuam St		Mc Gowan St	
Direction	West	East	West	East	West	East	West	East	West	East	West	East
Cars	3	0	132	105	3	9	108	123	0	18	72	195
Medium	3	0	9	12	0	0	3	9	0	0	6	6
Large	0	0	6	9	0	0	0	3	0	0	3	9