Final
Traffic Noise Analysis Technical Report

Loop 88, Segments 1 & 2

From US Highway 84 to US Highway 62/82
Lubbock County, Texas

CSJ: 1502-02-002

March 2020

Texas Department of Transportation, Lubbock District

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

1.0 INTRODUCTION AND PROJECT DESCRIPTION 1
2.0 TRAFFIC NOISE ANALYSIS 1
2.1 Sound and Traffic Noise 1
2.2 Ambient Noise Level Measurements 3
2.3 Traffic Noise Modeling 6
2.4 Modeled Noise Levels 7
2.5 Results 8
2.6 Noise Abatement 8
2.7 Noise Impact Contours 10
3.0 REFERENCES 11

Appendices

Appendix A Figures
Figure 1 Project Location on County Map
Figure 2 Project Location on Topographic Map
Figure 3 Proposed Typical Sections
Figures 4.1 through 4.13 Noise Receiver Locations and Land Use
Appendix B Ambient Noise Level Measurement Data Sheets
Appendix C Traffic Data Memo
Appendix D Traffic Analysis for Highway Design Table

Tables

Table 1: FHWA Noise Abatement Criteria (NAC) 2
Table 2: Ambient Noise Level Measurements dB(A) Leq 4
Table 3: Loop 88 Segments 1 & 2 Projected Traffic 7
Table 4: Traffic Noise Levels dB(A) Leq 7
Table 5: Predicted Noise Impact Contours 10

1.0 INTRODUCTION AND PROJECT DESCRIPTION

This technical report identifies and assesses existing and future traffic noise impacts associated with the proposed Segments 1 & 2 of Loop 88 from United States Highway (US) 84 to US 62/82 in Lubbock County, Texas.

The Texas Department of Transportation (TxDOT) Lubbock District proposes to construct Segments 1 and 2 of Loop 88 in Lubbock County, Texas. The proposed project would construct a controlled access facility consisting of a six-lane divided freeway (three lanes in each direction) with two-lane frontage roads, associated ramps and grade separated diamond intersections. Segment 1 of Loop 88 begins at United States Highway (US) 84 and Farm-to-Market (FM) 2641 intersection and generally follows FM 2641, then curves southward to follow County Road (CR) 1300 (Research Boulevard), where it then connects with Segment 2 at State Highway (SH) 114. Segment 2 of Loop 88 begins at the CR 1300/SH 114 intersection and generally follows CR 1300 to the south, before curving towards the southwest then back to the southeast to connect with the US 62/82 intersection and the beginning of Segment 3. The two segment designations are for construction phasing purposes. The logical termini for this project are US 84 to the north to US 62/82 to the south (**Figures 1** and **2** in **Appendix A**). Construction limits for the project are at US 84 and 0.5-mile northwest of US 62/82. The project length is approximately 16.05 miles. The proposed typical sections are included on **Figure 3** in **Appendix A**.

Land use adjacent to the proposed project includes agricultural, residential, commercial, and undeveloped properties. Residential properties consist of isolated houses on larger lots. The project would require residential displacements.

2.0 TRAFFIC NOISE ANALYSIS

This analysis was accomplished in accordance with TxDOT's (Federal Highway Administration [FHWA]-approved) *Guidelines for Analysis and Abatement of Roadway Traffic Noise* (2011). Traffic Noise Model version 2.5 (TNM 2.5) was utilized in this assessment.

2.1 Sound and Traffic 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.

The FHWA has established the following Noise Abatement Criteria (NAC) for various land use activity areas that are used as one of two means to determine when a traffic noise impact would occur (**Table 1**).

Table 1: FHWA Noise Abatement Criteria (NAC)

Activity Category	dB(A) Leq	Description of Land Use Activity Areas
A	57 (exterior)	Lands on which serenity and quiet are of extra-ordinary 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, amphitheaters, auditoriums, campgrounds, cemeteries, day care centers, hospitals, libraries, medical facilities, parks, picnic areas, places of worship, playgrounds, public meeting rooms, public or nonprofit institutional structures, radio studios, recording studios, recreation areas, Section 4(f) sites, schools, television studios, trails, and trail crossings.
D	52 (interior)	Auditoriums, day care centers, hospitals, libraries, medical facilities, places of worship, public meeting rooms, public or nonprofit institutional structures, radio studios, recording studios, schools, and television studios.

Table 1: FHWA Noise Abatement Criteria (NAC)

Activity Category	dB(A) Leq	Description of Land Use Activity Areas
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: FHWA and 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.

2.2 Ambient Noise Level Measurements

Since the project includes new locations, ambient noise level measurements were taken along the project corridor near the proposed right-of-way (ROW). Measurement locations were sited adjacent to potential residential receivers, where available (see **Figures 4.1** through **4.13**). Please note that the schematic is oriented north to south due to station numbering, and because the Noise Analysis closely follows the schematic, this report is also oriented north to south. All other environmental documents are oriented south to north for the ease of the reader.

Sound level measurements (shown in **Table 2**) were collected on April 9, 2019, using a Brüel & Kjær Type 2240 Integrating-averaging Sound Level Meter. Weather conditions were warm and sunny, with temperatures in the lower 90s (°F), and light and variable winds.

Table 2: Ambient Noise Level Measurements dB(A) Leq

Measurement Location	Location Description	Representing Receiver #s	Measured dB(A) Leq
A1	US 84 and CR 2641	R1	68.9
A2	CR 1600 and CR 2641	R2-R6	57
A3	CR 1500 and CR 2641	R7-R8	64.1
A4	North of CR 2641 and CR 179	None	71.8
A5	South of CR 1300 and CR 2641	None	29.7
A6	CR 1300 and CR 6400	R9-R12	32.8
A7	CR 6520 and Station Number (SN) 2584	R13-R15	51
A8	SH 114 and SN 2681	None	76
A9	CR 6800 and SN 2734	R17	54.8
A10	CR 6900 and SN 2787	None	66.3
A11	CR7000 and SN 2840	None	53.9
A12	Northeast of CR 1200 and CR 7100	None	61.2

Source: Blanton & Associates, 2020

Photos 1 through **3** of the sound measurement equipment at several of the locations are shown below. Copies of data sheets are included in **Appendix B**. The ambient sound level measurements ranged from 29 to 76 dB(A) within the project area.

Photo 1. Ambient Sound Measurements at Location A2.

Photo 2. Ambient Sound Measurements at Location A5.

Photo 3. Ambient Sound Measurements at Location A7.

2.3 Traffic Noise Modeling

The FHWA traffic noise modeling software was used to calculate predicted traffic noise levels. The model primarily considers the number, type, and speed of vehicles; roadway 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.

Traffic data provided by TxDOT included 2050 traffic volume projections (see **Table 3**) and a detailed stick diagram showing the improvements and traffic turning movements for the build condition. A copy of the traffic data memo used for the noise analysis is included in **Appendix C**.

Table 3: Loop 88 Segments 1 & 2 Projected Traffic

Location	Average Daily Traffic	
	2030	2050
Loop 88 Segment 1: From US 84 to CR 2255	3,150	5,100
Loop 88 Segment 2: CR 2255 to US 62/82	3,050	4,950

Source: TxDOT, 2020

2.4 Modeled Noise Levels

Predicted traffic noise levels were modeled at receiver locations (**Table 4** and **Figures 4.1** through **4.13**), which represent the land use activity areas adjacent to the proposed project that might be impacted by traffic noise and would potentially benefit from feasible and reasonable noise abatement.

Table 4: Traffic Noise Levels dB(A) Leq

Representative Receiver	NAC Category	NAC Level	2019 Field Measurement	Predicted 2050	Change (+/-)	Noise Impact
R1 Residence	B	67	68	70*	**+2**	**Yes**
R2 Residence	B	67	57	60*	+3	No
R3 Residence	B	67	57	60*	+3	No
R4 Residence	B	67	57	60*	+3	No
R5 Residence	B	67	57	60*	+3	No
R6 Residence	B	67	57	60*	+3	No
R7 Residence	B	67	64	65*	+1	No
R8 Residence	B	67	64	65*	+1	No
R9 Residence	B	67	32	59	**+27**	**Yes**
R10 Residence	B	67	32	59	**+27**	**Yes**
R11 Residence	B	67	32	58	**+26**	**Yes**
R12 Residence	B	67	32	57	**+25**	**Yes**
R13 Residence	B	67	51	55*	+4	No

Table 4: Traffic Noise Levels dB(A) Leq

Representative Receiver	NAC Category	NAC Level	2019 Field Measurement	Predicted 2050	Change (+/-)	Noise Impact
R14 Residence	B	67	51	56*	+5	No
R15 Residence	B	67	51	56*	+5	No
R17 Residence	B	67	54	60*	+6	No
Representative Receiver	**NAC Category**	**NAC Level**	**2030 Existing Model**	**Predicted 2050**	**Change (+/-)**	**Noise Impact**
R16 Residence	B	67	62	64	+2	No

*Predicted 2050 results were determined by adding the predicted modelled result to the ambient noise measurement, through decibel addition.

Source: Blanton & Associates, 2020

2.5 Results

As indicated in **Table 4**, the change between the 2019 Field Measurement and the Predicted 2050 measurements reflects the noise impacts to each receiver. Decibel addition was applied on receivers R1 through R8, R13 through 15, and R17. Receivers R1 through R8 will experience a 1-3 decibel increase in traffic noise volume. R9 through R12 will experience a 25-27 decibel increase in traffic noise volume due to an increase in the amount of traffic passing nearby with the proposed construction of Loop 88 roadway. R13 through R15 will experience a 4-5 decibel increase in traffic noise volume due to the close proximity of the proposed Loop 88 roadway increasing the amount of traffic passing nearby. R16 will experience a 2 decibel increase in traffic noise volume due to an increase in the amount of traffic passing nearby. R17 will experience a 6 decibel increase in traffic noise volume due to the close proximity of the proposed Loop 88 roadway.

2.6 Noise Abatement

As indicated in **Table 4**, the proposed project would result in traffic noise impacts 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

5 dB(A). To be "reasonable," the abatement measure must be able to reduce the noise level for at least one impacted, first-row receiver by at least 7 dB(A) and it must not exceed the cost-effectiveness criterion of $25,000 for each receiver that would benefit by a reduction of at least 5 dB(A).

Traffic management - Control devices could be used to reduce the speed of the traffic; however, the minor benefit of 1 dB(A) per 5 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 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.

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

> **R1** – This receiver represents three stand-alone single-family houses located southwest of the intersection US 84 and CR 2641 (**Figure 4.1**). A non-continuous noise barrier measuring approximately 416 feet in total length and up to 20 feet in height was modeled along the ROW line. Gaps were present within the noise barrier to accommodate access road requirements. This barrier would be sufficient to provide a 5 dB(A) noise reduction and meet the 7 dB(A) noise reduction design goal for the receivers. However, the total cost of the barrier would be $149,718. The cost of the barrier would exceed the cost effectiveness criteria or $25,000 per benefitted receiver; therefore, a noise barrier is not proposed for this location.
>
> **R9** – This receiver represents two stand-alone single-family houses and two manufactured homes located southeast of the intersection of CR 1300 and CR 6400 (**Figure 4.6**). A non-continuous noise barrier measuring approximately 575 feet in total length and up to 20 feet in height was modeled along the ROW line. Gaps were present within the noise barrier to accommodate access road requirements. This barrier would not be sufficient to provide a 5 dB(A) noise reduction or meet the 7 dB(A) noise reduction design goal for the receiver; therefore, a noise barrier is not proposed for this location.

R10 – This receiver represents four stand-alone single-family houses located along east of CR 1300 (**Figure 4.6**). A non-continuous noise barrier measuring approximately 388 feet in total length and up to 20 feet in height was modeled along the ROW line. Gaps were present within the noise barrier to accommodate access road requirements. This barrier would not be sufficient to provide a 5 dB(A) noise reduction or meet the 7 dB(A) noise reduction design goal for the receiver; therefore, a noise barrier is not proposed for this location.

R11 – This receiver represents a stand-alone single-family house located on east of CR 1300 (**Figure 4.6**). A non-continuous noise barrier, measuring approximately 163 feet in total length and up to 20 feet in height, was modeled along the ROW line. Gaps were present within the noise barrier to accommodate access road requirements. This barrier would not be sufficient to provide a 5 dB(A) noise reduction or meet the 7 dB(A) noise reduction design goal for the receiver; therefore, a noise barrier is not proposed for this location.

R12 – This receiver represents three stand-alone single-family houses located on east of CR 1300 (**Figure 4.6**). A non-continuous noise barrier, measuring approximately 594 feet in total length and up to 20 feet in height, was modeled along the ROW line. Gaps were present within the noise barrier to accommodate access road requirements. This barrier would not be sufficient to provide a 5 dB(A) noise reduction or meet the 7 dB(A) noise reduction design goal for the receiver; therefore, a noise barrier is not proposed for this location.

2.7 Noise Impact Contours

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 (2050) noise impact contours along Loop 88 in undeveloped areas within the project limits (**Table 5**). The distances shown below reflect contour locations calculated at the greatest distances from the proposed ROW line.

Table 5: Predicted Noise Impact Contours

Land Use	Impact Contour	Distance from the ROW
NAC category B & C	66 dB(A)	Within the ROW
NAC category E	71 dB(A)	Within the ROW

Source: Blanton & Associates, 2019

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 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.

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.

3.0 REFERENCES

Email from Julia Perschnick <JuliaPerschnick@txdot.gov.> Subject: Traffic Projection and Traffic Analysis Reports for Loop 88 Segments 1 & 2. November 14, 2019. (Note: TxDOT's concurrence with Consulting Engineer's method for traffic calculation is included in Appendix C.)

Entech. 2019a. Traffic Analysis for Highway Design Table. April 3, 2019

_____. 2019b. Traffic Projections for Lubbock Outer Loop 88 (Segments 1, 2, & 4), Lubbock County. Memo. October 17, 2019 (Note 2050 K-factor and %DHV information are included in Appendix C.)

Texas Department of Transportation. 2011. Guidelines for Analysis and Abatement of Roadway Traffic Noise.

Appendix A

Figures

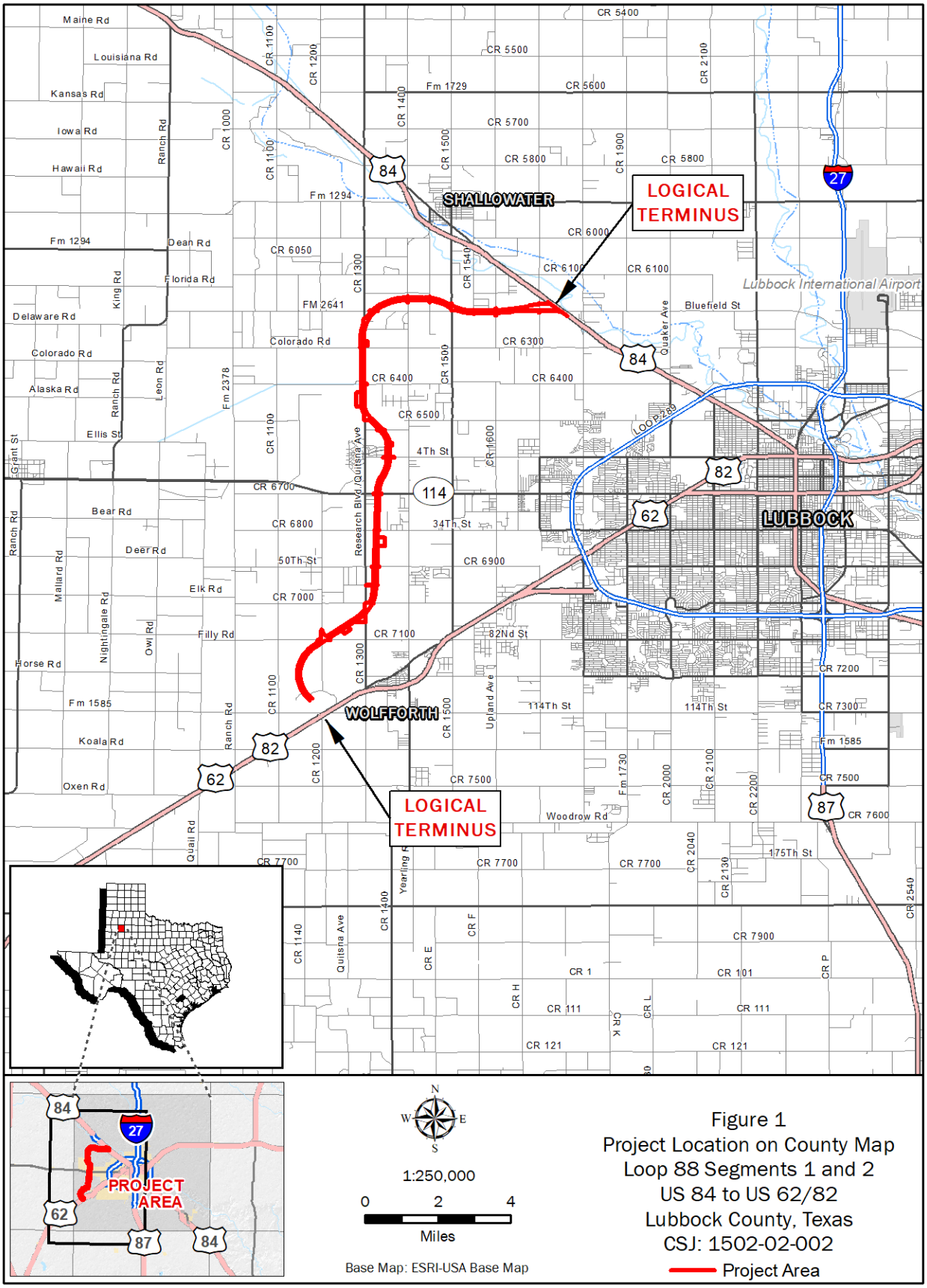
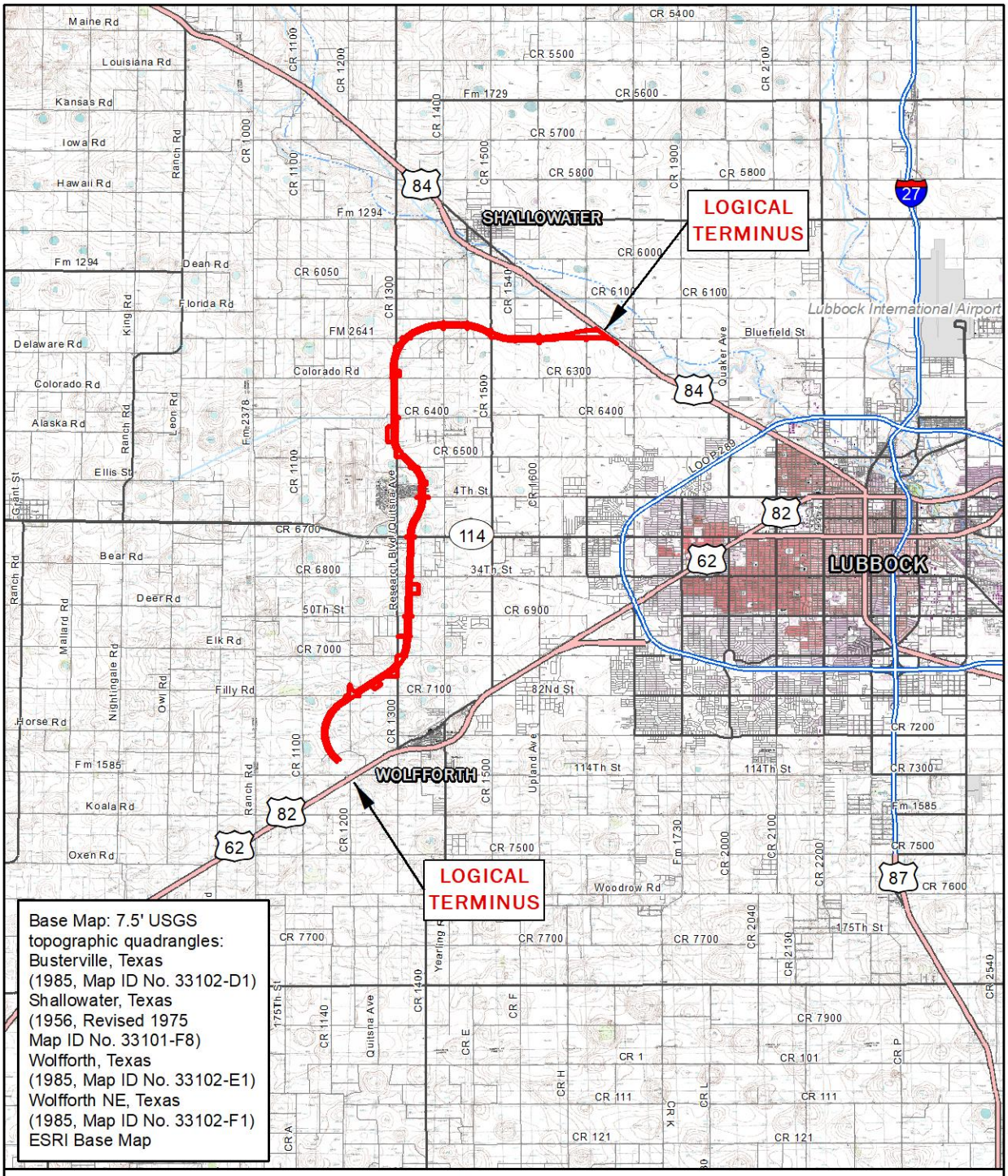


Figure 1
Project Location on County Map
Loop 88 Segments 1 and 2
US 84 to US 62/82
Lubbock County, Texas
CSJ: 1502-02-002
Project Area



Project Area

N
W E
S

1:250,000

0 2 4
Miles

Figure 2
Project Location on Topographic Base
Loop 88 Segments 1 and 2
US 84 to US 62/82
Lubbock County, Texas
CSJ: 1502-02-002

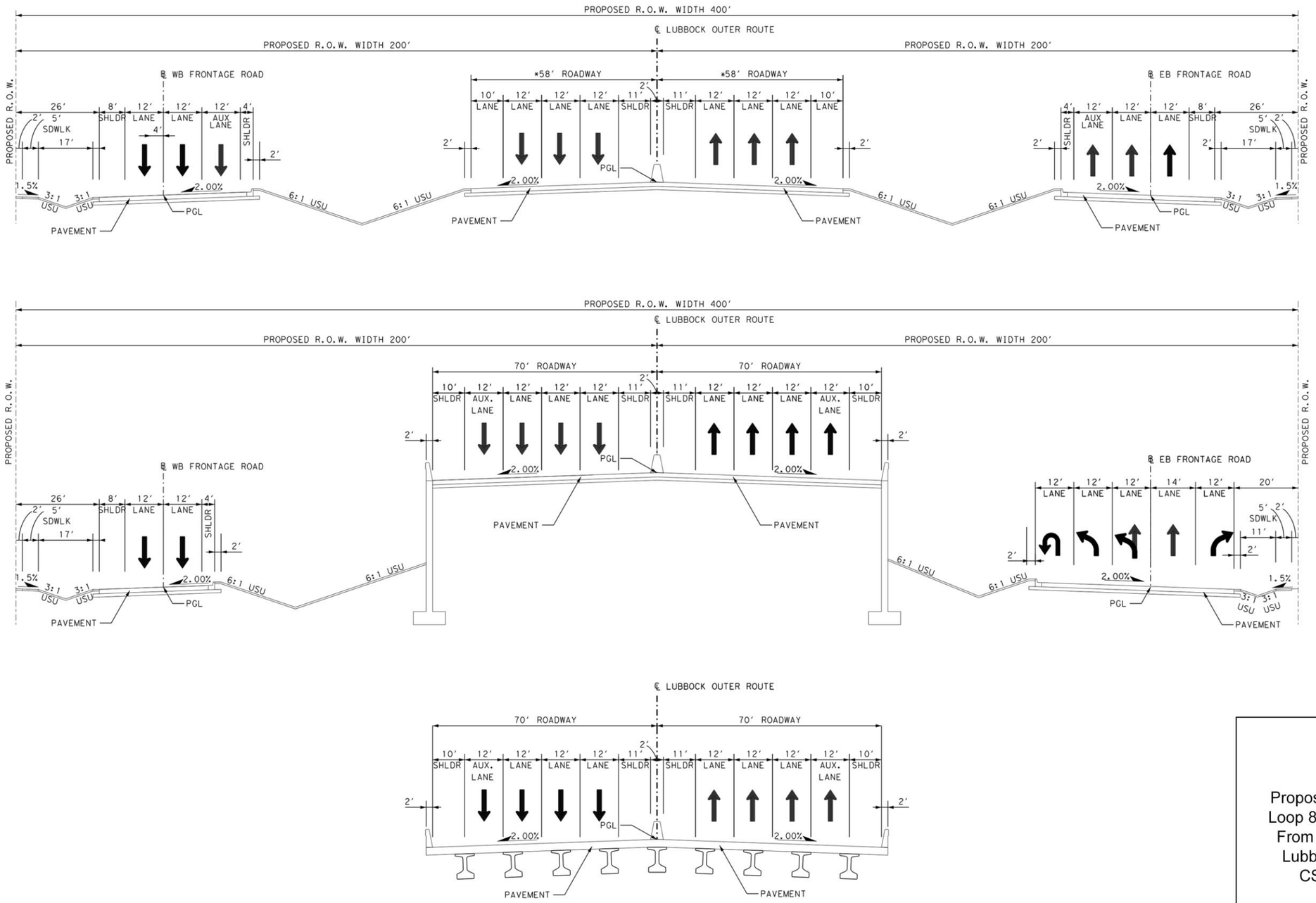


Figure 3
Proposed Typical Sections
Loop 88 Segments 1 and 2
From US 84 to US 62/82
Lubbock County, Texas
CSJ: 1502-02-002

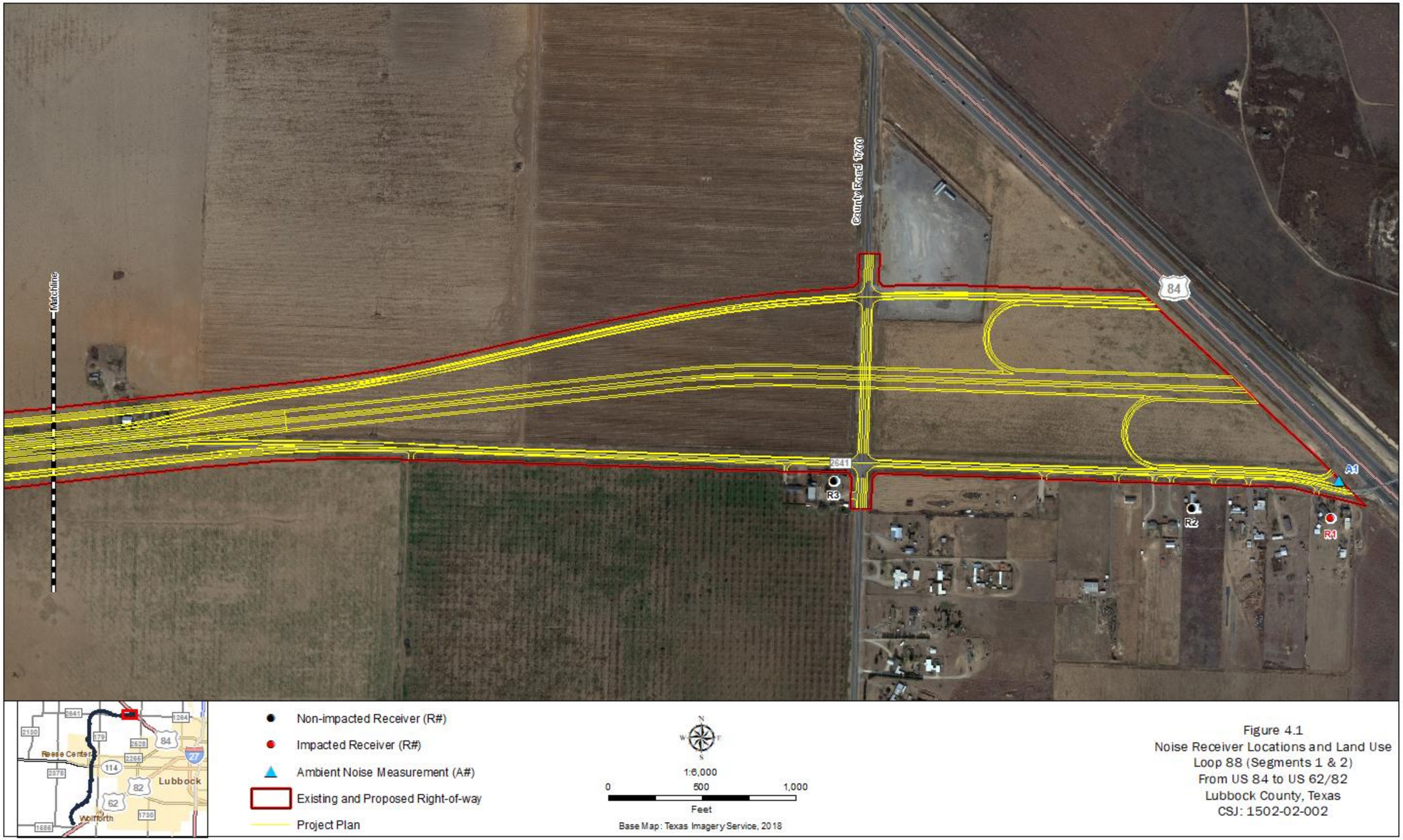


Figure 4.1
Noise Receiver Locations and Land Use
Loop 88 (Segments 1 & 2)
From US 84 to US 62/82
Lubbock County, Texas
CSJ: 1502-02-002

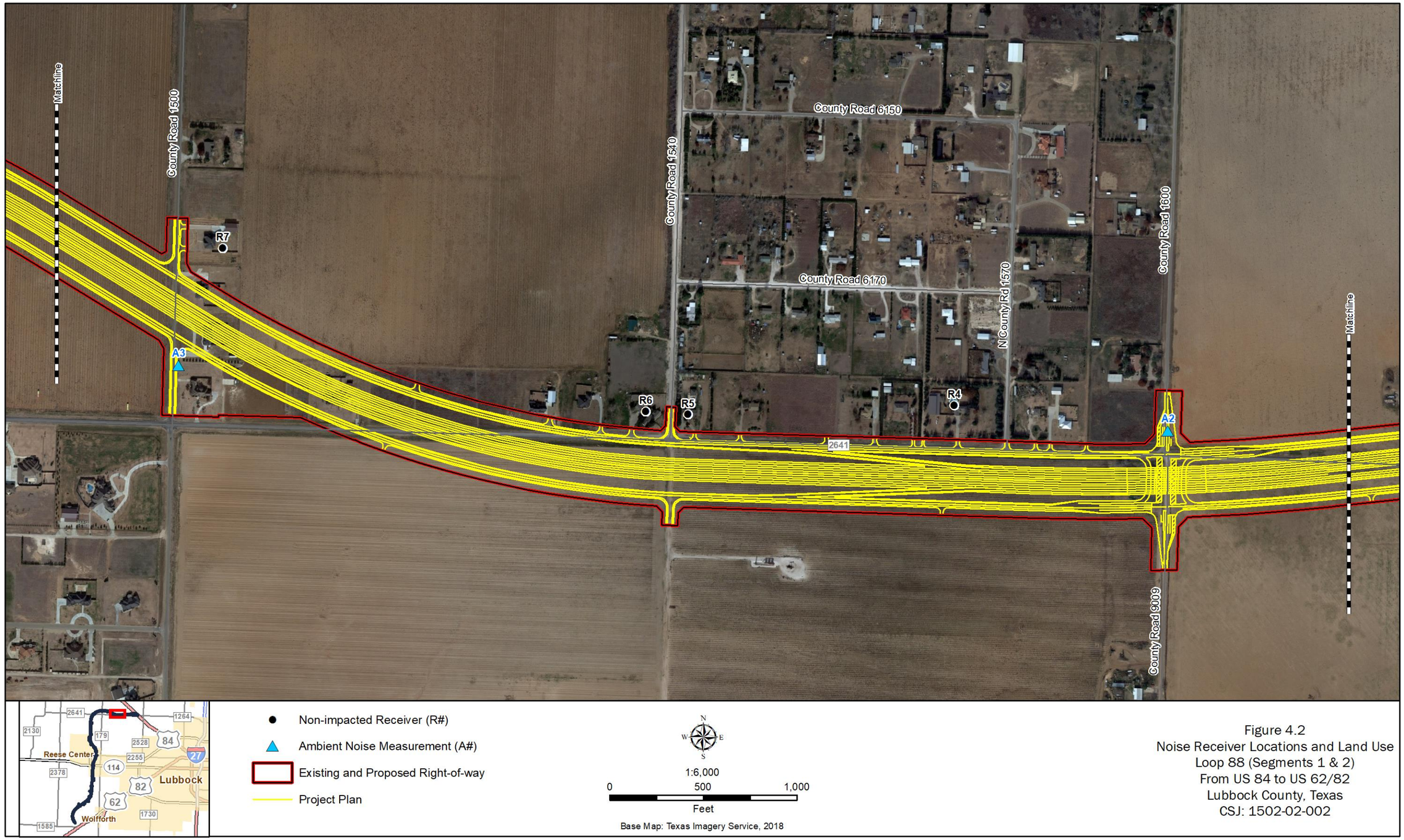
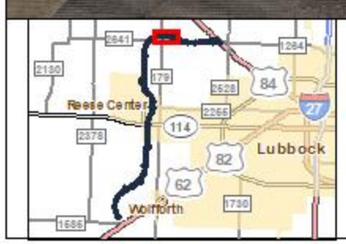


Figure 4.2
Noise Receiver Locations and Land Use
Loop 88 (Segments 1 & 2)
From US 84 to US 62/82
Lubbock County, Texas
CSJ: 1502-02-002



Non-impacted Receiver (R#)

Ambient Noise Measurement (A#)

Existing and Proposed Right-of-way

Project Plan

N
W
E
S

1:6,000

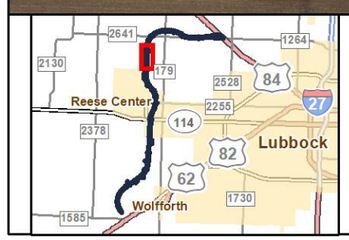
0 500 1,000

Feet

Base Map: Texas Imagery Service, 2018

Figure 4.3
Noise Receiver Locations and Land Use
Loop 88 (Segments 1 & 2)
From US 84 to US 62/82
Lubbock County, Texas
CSJ: 1502-02-002

Figure 4.4
Noise Receiver Locations and Land Use
Loop 88 (Segments 1 & 2)
From US 84 to US 62/82
Lubbock County, Texas
CSJ: 1502-02-002



Existing and Proposed Right-of-way

Project Plan

1:6,000

0 500 1,000

Feet

Base Map: Texas Imagery Service, 2018

Figure 4.5
Noise Receiver Locations and Land Use
Loop 88 (Segments 1 & 2)
From US 84 to US 62/82
Lubbock County, Texas
CSJ: 1502-02-002

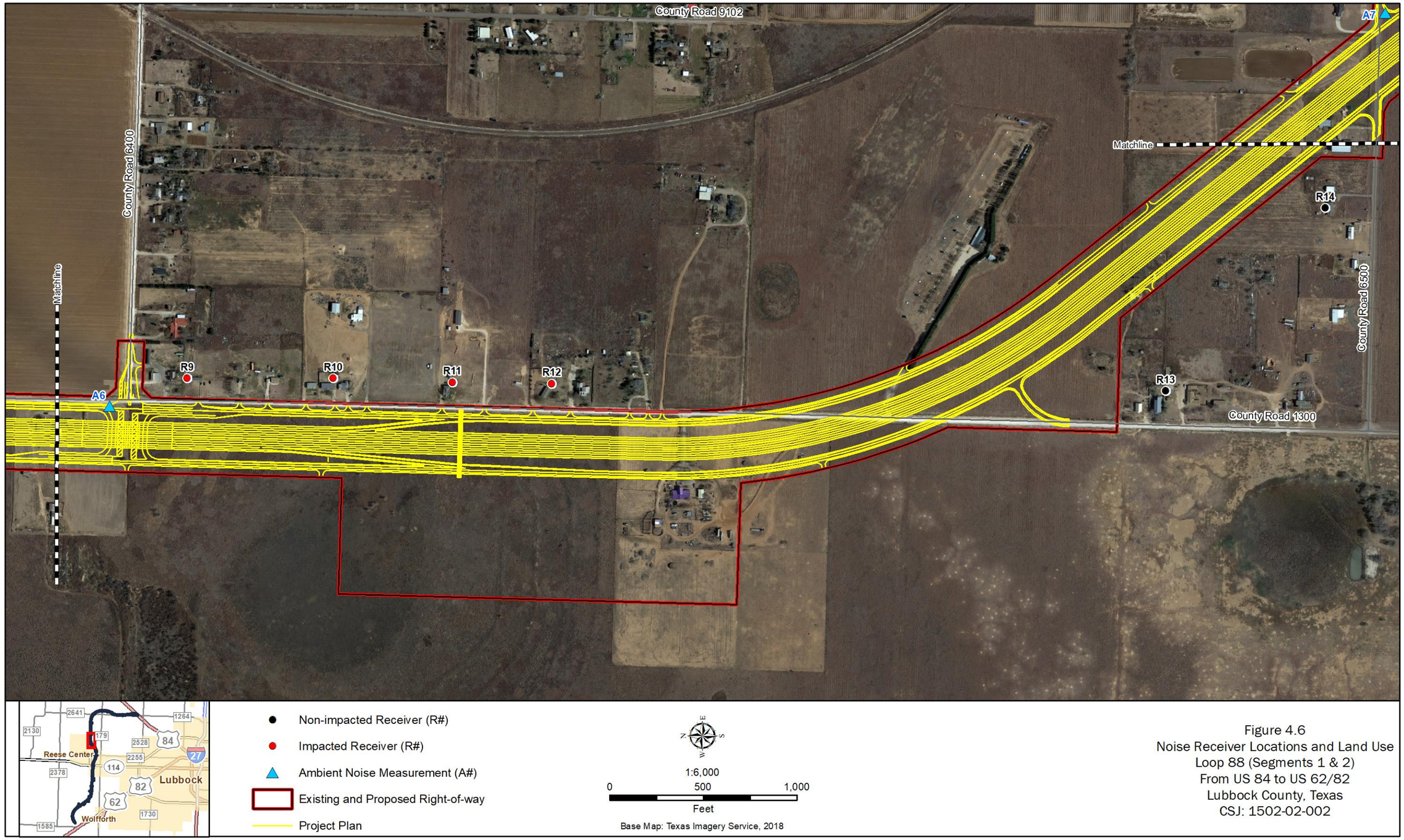


Figure 4.6
Noise Receiver Locations and Land Use
Loop 88 (Segments 1 & 2)
From US 84 to US 62/82
Lubbock County, Texas
CSJ: 1502-02-002

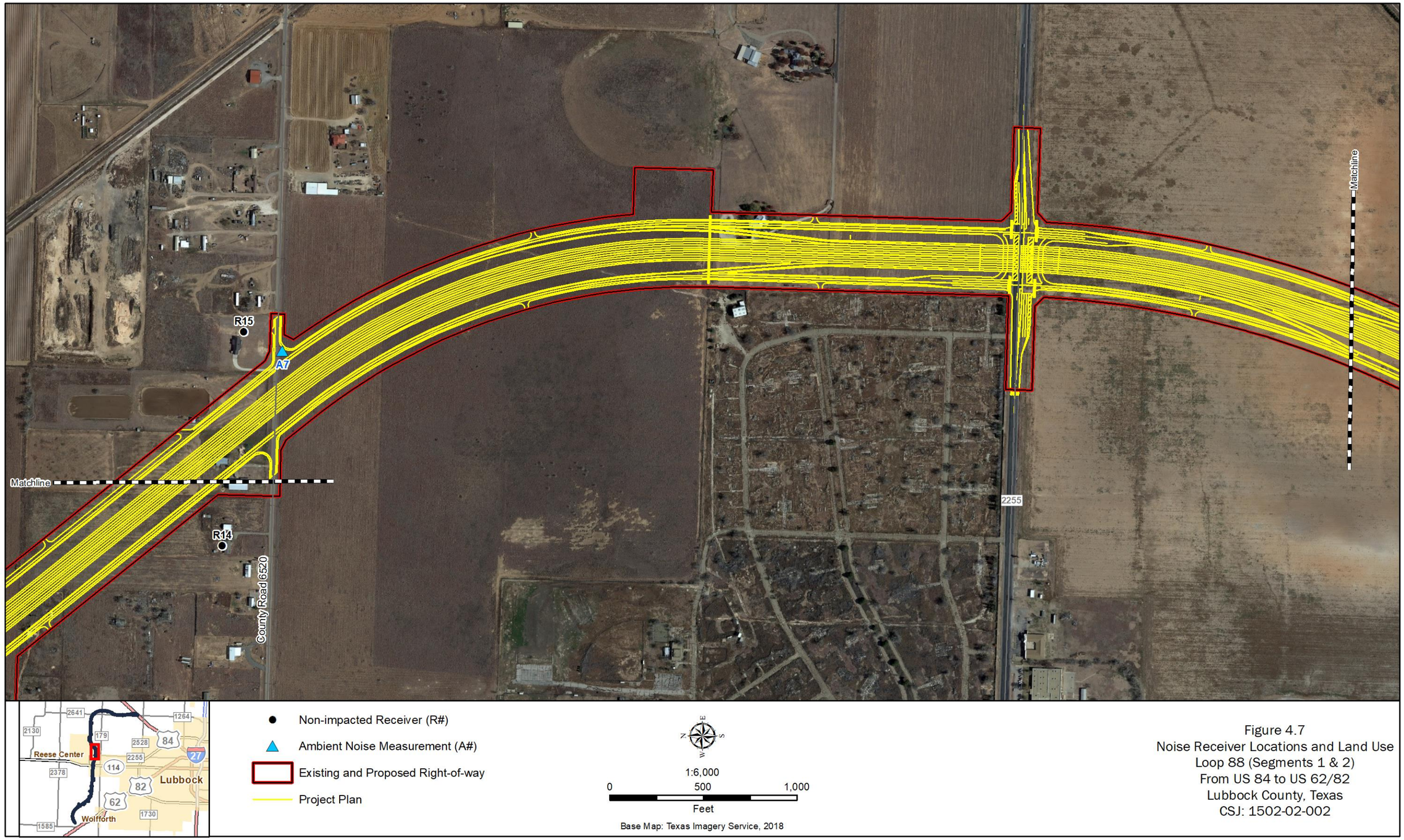


Figure 4.7
Noise Receiver Locations and Land Use
Loop 88 (Segments 1 & 2)
From US 84 to US 62/82
Lubbock County, Texas
CSJ: 1502-02-002

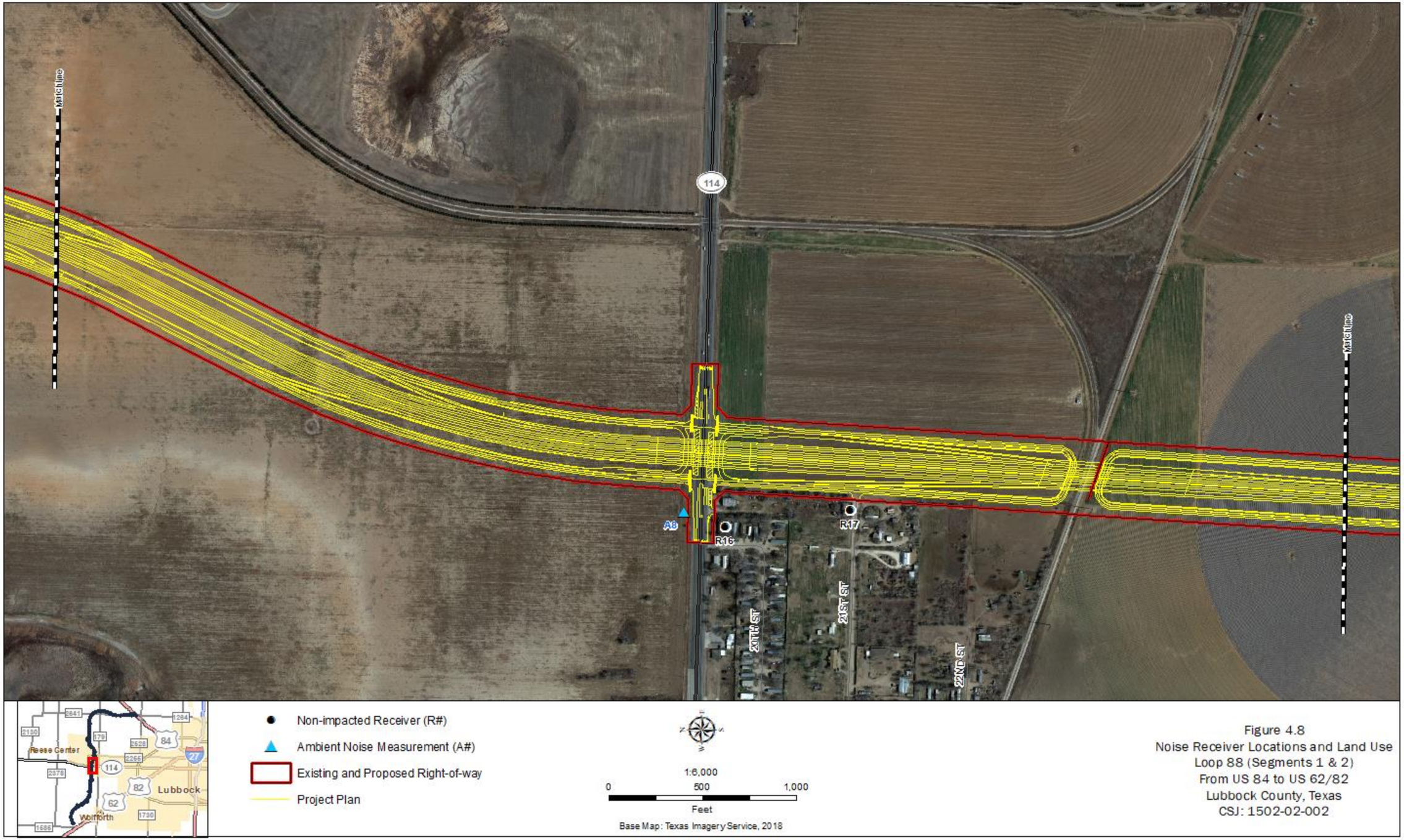
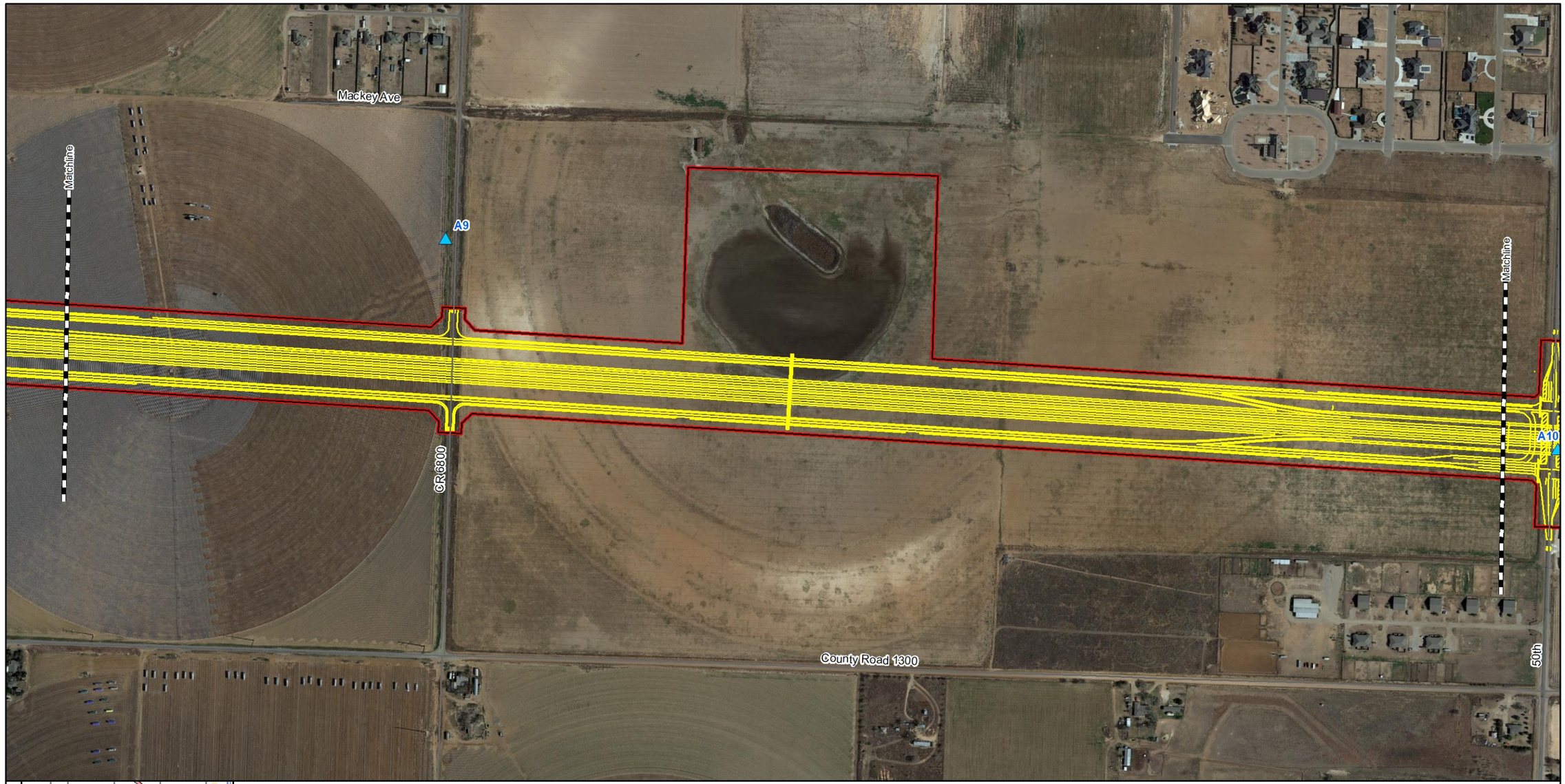
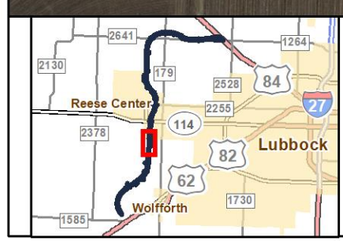


Figure 4.8
Noise Receiver Locations and Land Use
Loop 88 (Segments 1 & 2)
From US 84 to US 62/82
Lubbock County, Texas
CSJ: 1502-02-002





Ambient Noise Measurement (A#)

Existing and Proposed Right-of-way

Project Plan

N E S W

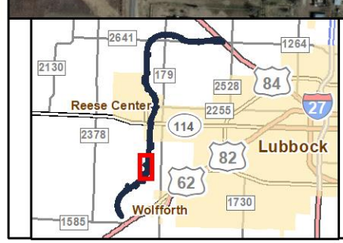
1:6,000

0 500 1,000

Feet

Base Map: Texas Imagery Service, 2018

Figure 4.9
Noise Receiver Locations and Land Use
Loop 88 (Segments 1 & 2)
From US 84 to US 62/82
Lubbock County, Texas
CSJ: 1502-02-002



Ambient Noise Measurement (A#)

Existing and Proposed Right-of-way

Project Plan

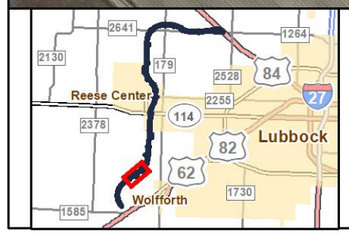
1:6,000

0 500 1,000

Feet

Base Map: Texas Imagery Service, 2018

Figure 4.10
Noise Receiver Locations and Land Use
Loop 88 (Segments 1 & 2)
From US 84 to US 62/82
Lubbock County, Texas
CSJ: 1502-02-002



Ambient Noise Measurement (A#)

Existing and Proposed Right-of-way

Project Plan

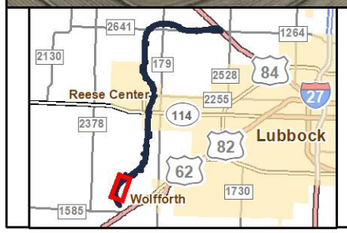
1:6,000

0 500 1,000

Feet

Base Map: Texas Imagery Service, 2018

Figure 4.11
Noise Receiver Locations and Land Use
Loop 88 (Segments 1 & 2)
From US 84 to US 62/82
Lubbock County, Texas
CSJ: 1502-02-002



Ambient Noise Measurement (A#)

Existing and Proposed Right-of-way

Project Plan

1:6,000

0 500 1,000

Feet

Base Map: Texas Imagery Service, 2018

Figure 4.12
Noise Receiver Locations and Land Use
Loop 88 (Segments 1 & 2)
From US 84 to US 62/82
Lubbock County, Texas
CSJ: 1502-02-002

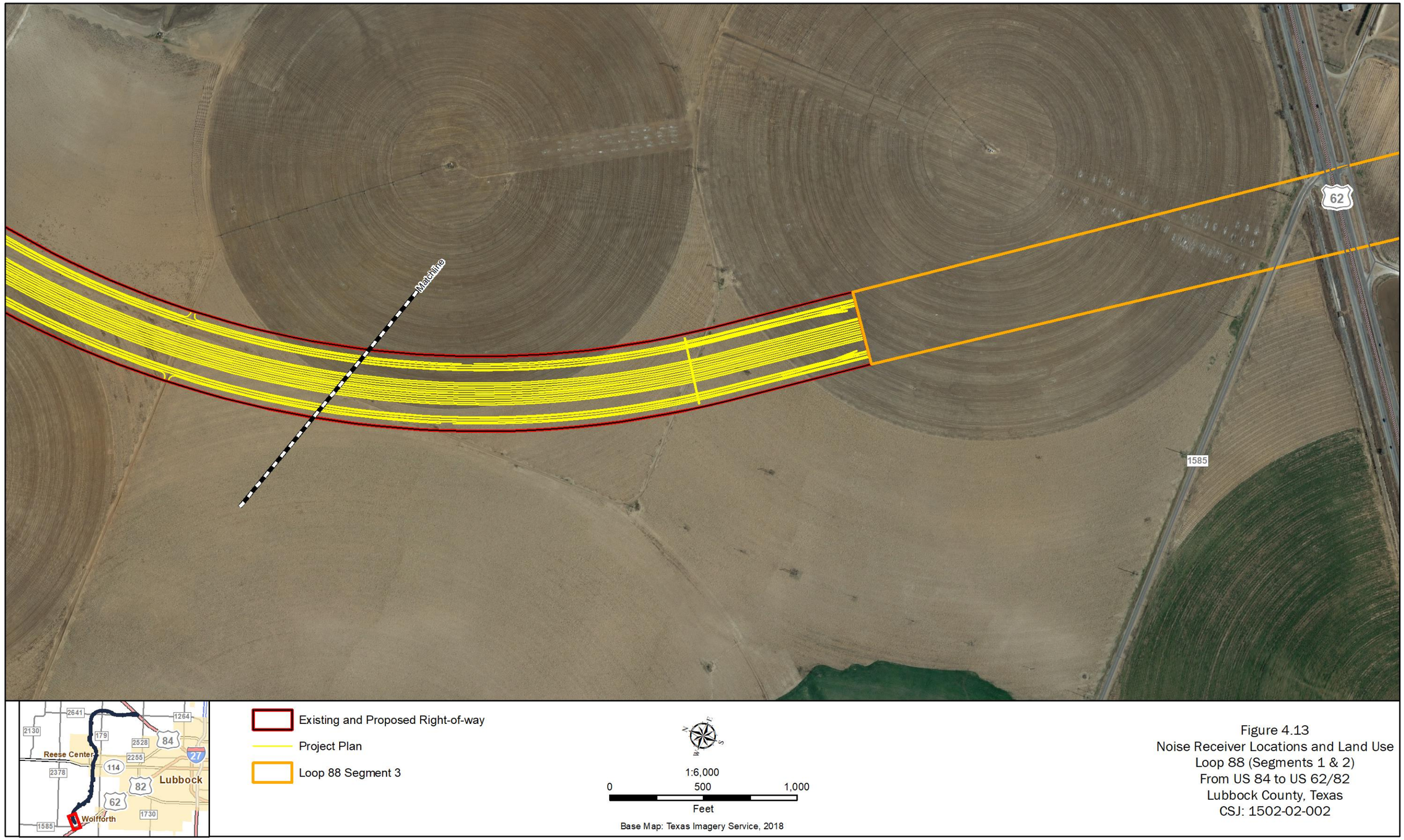


Figure 4.13
Noise Receiver Locations and Land Use
Loop 88 (Segments 1 & 2)
From US 84 to US 62/82
Lubbock County, Texas
CSJ: 1502-02-002

Appendix B

Ambient Noise Level Measurement Data Sheets

Traffic Noise Measurement Data Sheet

Project Loop 88 – Segment 1 & 2 (CSJ: 1502-02-002) Date 4/9/2019

Location ANM #1 US 84 & ~~FM 2641~~ CR 2641

Purpose Ambient Noise Meansurements

Operator Blanton & Associates Initials JH / RR

Equipment

Calibrator B&K 4231 Calibrator

Analyzer B&K Type 2240 Meter

Calibration 94 dBa

Weather/Conditions

Clear/Dry Sunny / Dry

Wind 3 mph SE → NW

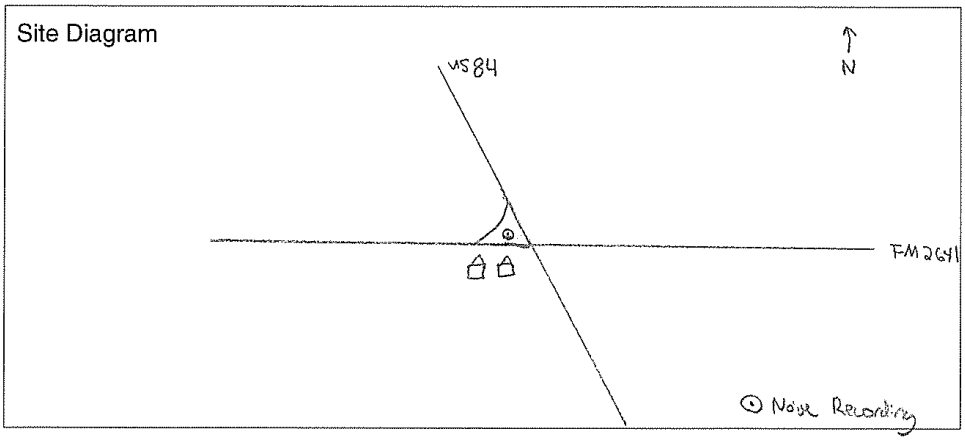
Measurement

Time 9:02 - 9:17

Duration 15 minutes

L_{eq}(A) 68.9 dBa

Site Diagram



Notes: Located on level area within ROW

Note: Measurements should be taken in areas when frequent human outdoor activity occur.

Traffic Noise Measurement Data Sheet

Project Loop 88 – Segment 1 & 2 (CSJ: 1502-02-002) Date 4/9/2019

Location ANM #2 ~~FM2641~~ CR2641 + CR1600

Purpose Ambient Noise Meansurements

Operator Blanton & Associates Initials JH / RR

Equipment

Calibrator B&K 4231 Calibrator

Analyzer B&K Type 2240 Meter

Calibration 94 dBa

Weather/Conditions

Clear/Dry Sunny / Dry

Wind 3 mph SE → NW

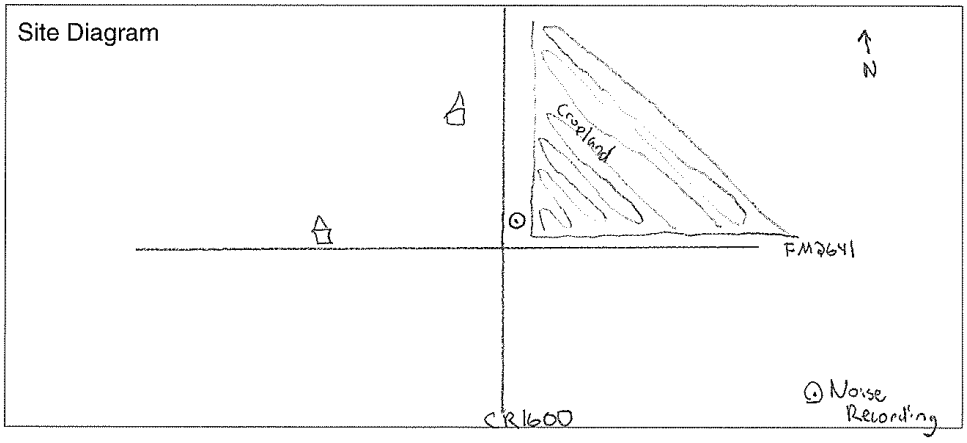
Measurement

Time 9:25 – 9:40

Duration 15 minutes

L_{eq}(A) 57 dBa

Site Diagram



Notes:

Note: Measurements should be taken in areas when frequent human outdoor activity occur.

Traffic Noise Measurement Data Sheet

Project Loop 88 – Segment 1 & 2 (CSJ: 1502-02-002) Date 4/9/2019

Location ANM #3 ~~FM2641~~ CR2641 and CR1500

Purpose Ambient Noise Meansurements

Operator Blanton & Associates Initials JH / RR

Equipment

Calibrator B&K 4231 Calibrator

Analyzer B&K Type 2240 Meter

Calibration 94 dBa

Weather/Conditions

Clear/Dry Sunny / Dry

Wind 5 mph SW–NE

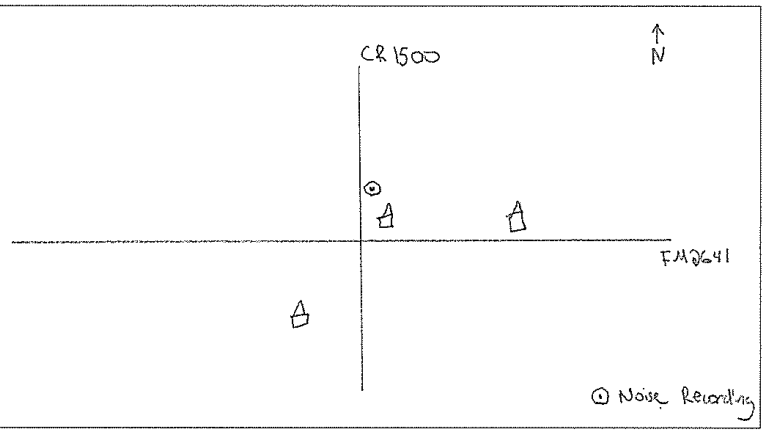
Measurement

Time 9:47 – 10:02

Duration 15 minutes

L_{eq}(A) 64.1 dBa

Site Diagram



Notes:

Note: Measurements should be taken in areas when frequent human outdoor activity occur.

Traffic Noise Measurement Data Sheet

Project Loop 88 – Segment 1 & 2 (CSJ: 1502-02-002) Date 4/9/2019

Location ANM #4 ~~FM 2641~~ CR 2641 and FM 179

Purpose Ambient Noise Meansurements

Operator Blanton & Associates Initials JH / RR

Equipment

Calibrator B&K 4231 Calibrator

Analyzer B&K Type 2240 Meter

Calibration 94 dBa

Weather/Conditions

Clear/Dry Sunny / Dry

Wind 4 mph SE → NW

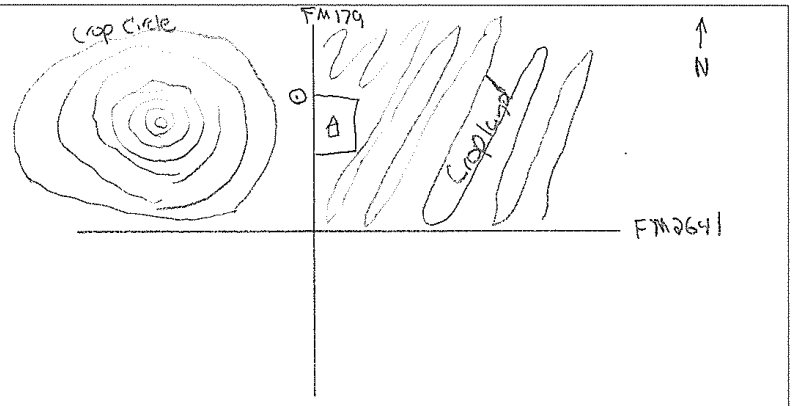
Measurement

Time 11:43 – 11:58

Duration 15 minutes

L_{eq}(A) 71.8 dBa

Site Diagram



Notes: _____

Note: Measurements should be taken in areas when frequent human outdoor activity occur.

Traffic Noise Measurement Data Sheet

Project Loop 88 – Segment 1 & 2 (CSJ: 1502-02-002) Date 4/9/2019

Location ANM #5 South of ~~FM 2641~~ CR 2641 + CR 300

Purpose Ambient Noise Meansurements

Operator Blanton & Associates Initials JH / RR

Equipment

Calibrator B&K 4231 Calibrator

Analyzer B&K Type 2240 Meter

Calibration 94 dBa

Weather/Conditions

Clear/Dry Sunny / Dry

Wind 2 mph SE → NW

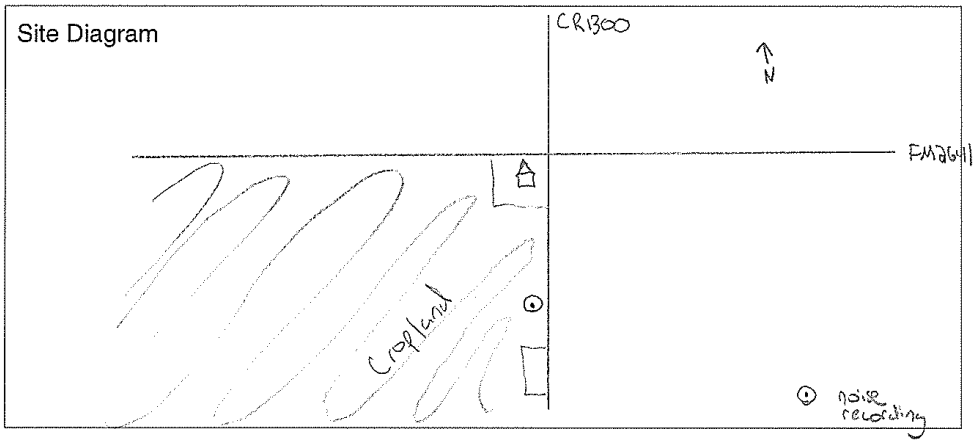
Measurement

Time 12:04 – 12:19

Duration 15 minutes

Leq(A) 29.7 dBa

Site Diagram



Notes:

Note: Measurements should be taken in areas when frequent human outdoor activity occur.

Traffic Noise Measurement Data Sheet

Project Loop 88 – Segment 1 & 2 (CSJ: 1502-02-002) Date 4/9/2019

Location ANM #6 CR 6400 & CR 1300

Purpose Ambient Noise Meansurements

Operator Blanton & Associates Initials JH / RR

Equipment

Calibrator B&K 4231 Calibrator

Analyzer B&K Type 2240 Meter

Calibration 94 dBa

Weather/Conditions

Clear/Dry Sunny / Dry

Wind 2 mph SE → NW

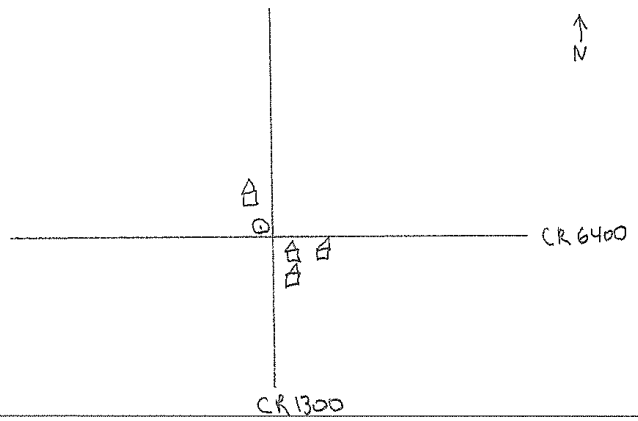
Measurement

Time 12:07 – 12:42

Duration 15 minutes

L_{eq}(A) 32.8 dBa

Site Diagram



Notes:

Note: Measurements should be taken in areas when frequent human outdoor activity occur.

Traffic Noise Measurement Data Sheet

Project Loop 88 – Segment 1 & 2 (CSJ: 1502-02-002) Date 4/9/2019

Location ANM #7 CR ~~6020~~ CR6520 & CR1300

Purpose Ambient Noise Meansurements

Operator Blanton & Associates Initials JH / RR

Equipment

Calibrator B&K 4231 Calibrator

Analyzer B&K Type 2240 Meter

Calibration 94 dBa

Weather/Conditions

Clear/Dry Sunny / Dry

Wind 3 mph SE → NW

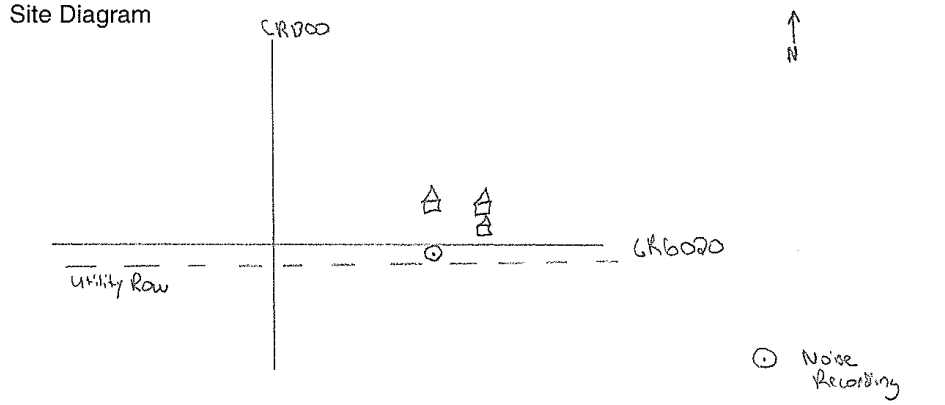
Measurement

Time 12:53 - 1:08

Duration 15 minutes

L_{eq}(A) 51.0 dBa

Site Diagram



Notes:

Note: Measurements should be taken in areas when frequent human outdoor activity occur.

Traffic Noise Measurement Data Sheet

Project Loop 88 – Segment 1 & 2 (CSJ: 1502-02-002) Date 4/9/2019

Location ANM 8 East of SH 114 – TX ~~309~~ Spur CR 1300

Purpose Ambient Noise Meansurements

Operator Blanton & Associates Initials JH / RR

Equipment

Calibrator B&K 4231 Calibrator

Analyzer B&K Type 2240 Meter

Calibration 94 dBa

Weather/Conditions

Clear/Dry Sunny / Dry

Wind 3 mph SE → NW

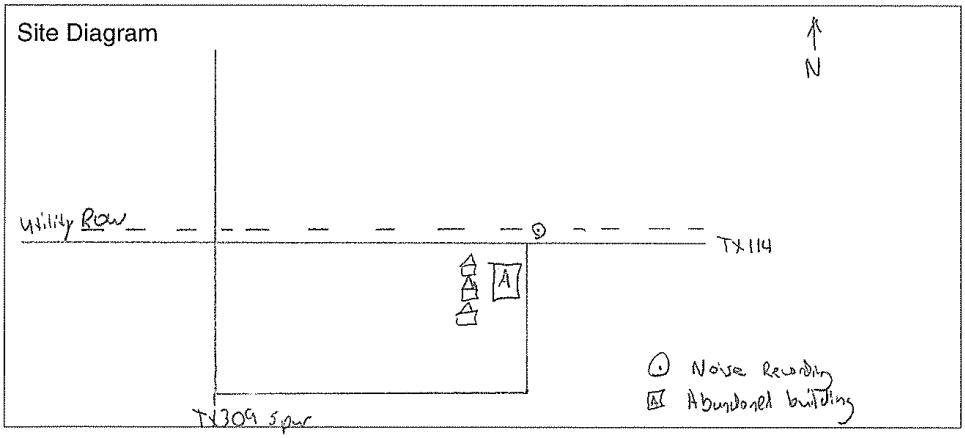
Measurement

Time 1:21 – 1:36

Duration 15 minutes

L_{eq}(A) 76.0 dBa

Site Diagram



Notes:

Note: Measurements should be taken in areas when frequent human outdoor activity occur.

Traffic Noise Measurement Data Sheet

Project Loop 88 – Segment 1 & 2 (CSJ: 1502-02-002) Date 4/9/2019

Location ANM #9 East of ~~34th~~ CR6800 st & CR1300

Purpose Ambient Noise Meansurements

Operator Blanton & Associates Initials JH / RR

Equipment

Calibrator B&K 4231 Calibrator

Analyzer B&K Type 2240 Meter

Calibration 94 dBa

Weather/Conditions

Clear/Dry Sunny / Dry

Wind 2 mph SE→NW

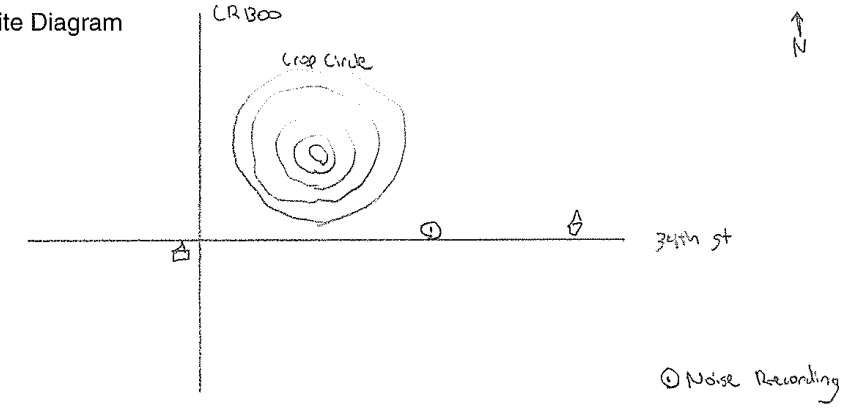
Measurement

Time 1:51 - 2:06

Duration 15 minutes

L_{eq}(A) 54.8 dBa

Site Diagram



Notes:

Note: Measurements should be taken in areas when frequent human outdoor activity occur.

Traffic Noise Measurement Data Sheet

Project Loop 88 – Segment 1 & 2 (CSJ: 1502-02-002) Date 4/9/2019

Location ANM #10 ~~50th st~~ CR 6900 & CR 1300

Purpose Ambient Noise Meansurements

Operator Blanton & Associates Initials JH / RR

Equipment

Calibrator B&K 4231 Calibrator

Analyzer B&K Type 2240 Meter

Calibration 94 dBa

Weather/Conditions

Clear/Dry Sunny / Dry

Wind 5 mph SE → NW

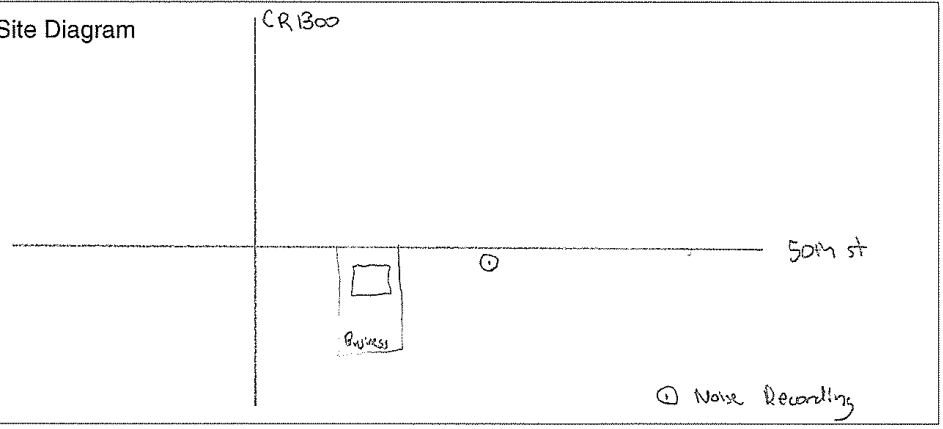
Measurement

Time 2:29 - 2:44

Duration 15 minutes

L_{eq}(A) 66.3 dBa

Site Diagram



Notes:

Note: Measurements should be taken in areas when frequent human outdoor activity occur.

Traffic Noise Measurement Data Sheet

Project Loop 88 – Segment 1 & 2 (CSJ: 1502-02-002 Date 4/9/2019

Location ANM #11 66th Street ~~ CR1300 / CR7000

Purpose Ambient Noise Meansurements

Operator Blanton & Associates Initials JH / RR

Equipment

Calibrator B&K 4231 Calibrator

Analyzer B&K Type 2240 Meter

Calibration 94 dBa

Weather/Conditions

Clear/Dry Sunny / Dry

Wind 5 mph SE → NW

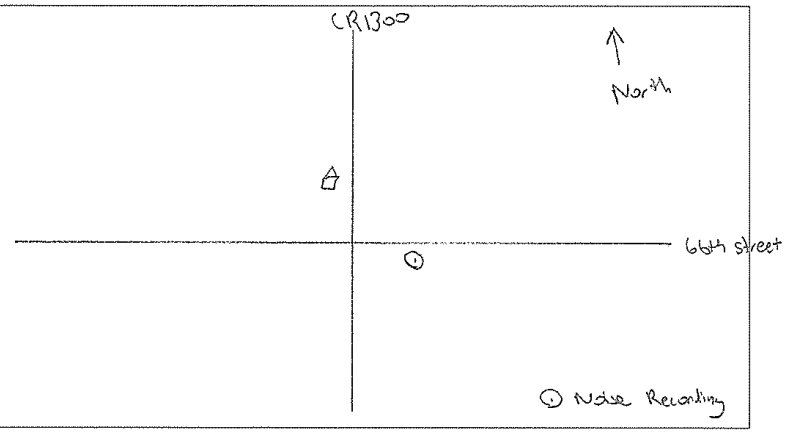
Measurement

Time 2:52 - 3:07

Duration 15 minutes

L_{eq}(A) 53.9 dBa

Site Diagram



Notes:

Note: Measurements should be taken in areas when frequent human outdoor activity occur.

Traffic Noise Measurement Data Sheet

Project Loop 88 – Segment 1 & 2 (CSJ: 1502-02-002 Date 4/9/2019

Location ANM #12 CR 7100 & CR 1200

Purpose Ambient Noise Meansurements

Operator Blanton & Associates Initials JH / RR

Equipment

Calibrator B&K 4231 Calibrator

Analyzer B&K Type 2240 Meter

Calibration 94 dBa

Weather/Conditions

Clear/Dry Sunny / Dry

Wind 9 mph SE → NW

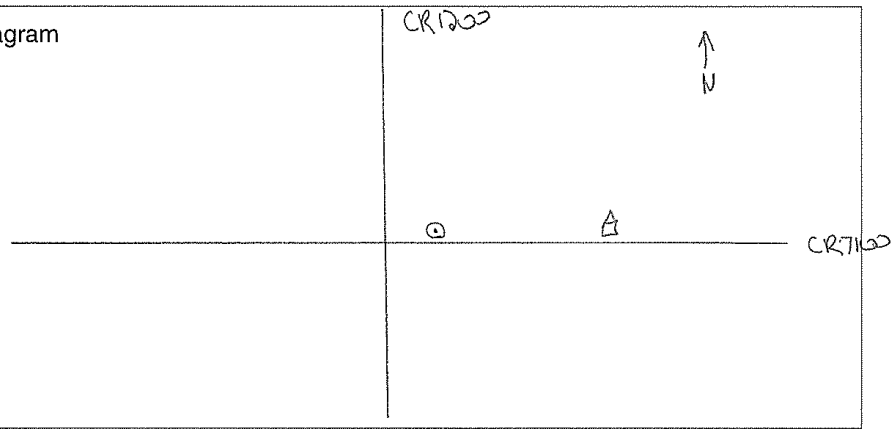
Measurement

Time 3:20 - 3:35

Duration 15 minutes

L_{eq}(A) 61.2 dBa

Site Diagram



Notes:

Note: Measurements should be taken in areas when frequent human outdoor activity occur.

Appendix C

Traffic Data Memo

MEMORANDUM

DATE:	October 17, 2019
TO:	Michael Ponce, PE – ENTECH Civil Engineers, Inc.
FROM:	Kurt Schulte, AICP- Walter P Moore
PROJECT TITLE:	Traffic Projections for Lubbock Outer Loop 88 (Segment 1, 2 & 4)
TXDOT CSJ/ CONTRACT NO.:	CSJ: P5313-0005-16-1 / 36-6IDP5313
SUBJECT:	Traffic Data and Projections Memorandum

PURPOSE OF TECHNICAL MEMORANDUM

This technical memorandum documents the development of forecasts to determine Average Daily Traffic (ADT) along the proposed Lubbock Outer Loop for the following analyses years –opening year 2030, design year 2050 (opening year +20), and pavement design year 2060 (opening year +30). Travel Demand Models for 2017 and 2045 were used to develop growth rates for determining volumes for years 2030, 2050, and 2060.

TABLE OF CONTENTS

Introduction 1
Project and Report Scope 2
Traffic Projections Methodology 2
TxDOT TCDS Counts 3
2018 Collected Counts 5
TDM Modeling 6
Texas Application Guide 6
Texpack Model Setup 6
Study Area 6
Demographic, Employment, and External Stations Data 8
Traffic Analysis Zone 8
External Stations 8
Population 11
Employment 11
Network Models 14
2017 Base Model Validation 16
2045 No Build Scenario 18
2045 Build Scenario 19
Proposed Schematics 19
Coded 2045 Build Network 20
Performance Measures for the Lubbock Outer Loop 21
Existing and Future Daily Volumes 21
No Build Versus Build Volumes 21
Volume to Capacity Ratio 21
VMT and VHT Comparison 21
Model 29
Post-Processing Volumes 29

APPENDIXES

Appendix A – Traffic Projections

LIST OF FIGURES

Figure 1: Project Vicinity Map....1
Figure 2: Traffic Projections Methodology....3
Figure 3: Traffic Count Locations....4
Figure 4: Integrated Texas Package (Texpack)....6
Figure 5: Study Area....7
Figure 6: Traffic Analysis Zones....9
Figure 7: Change in Population....12
Figure 8: Change in Employment....13
Figure 9: 2017 Lubbock Road Network Functional Classification....15
Figure 10: Validation of 2017 Daily Model Volumes....17
Figure 11: 2045 Lubbock Network No Build Scenario....18
Figure 12: 2045 Lubbock Network with Proposed Outer Loop (Build Scenario)....20
Figure 13: 2017 Daily Volumes....22
Figure 14: 2045 No Build Daily Volumes....23
Figure 15: 2045 Build Daily Volumes....24
Figure 16: Difference Between 2045 Build and No Build Volumes....25
Figure 17: 2017 Existing Volume to Capacity Ratio....26
Figure 18: 2045 No Build Scenario Volume to Capacity Ratio....27
Figure 19: 2045 Build Scenario Volume to Capacity Ratio....28

LIST OF TABLES

Table 1: Year 2017 and Year 2045 Daily Volumes at External Stations....10
Table 2: Year 2017 and Year 2045 Population....11
Table 3: Year 2017 and Year 2045 Employment....11
Table 4: Total Lane-Miles by Functional Class....14
Table 5: Comparison of counts versus Model Volumes by Functional Class....16
Table 6: VMT and VHT Comparison....21

INTRODUCTION

Walter P Moore (WPM) performed preliminary engineering services as a sub-consultant to Entech Civil Engineers, Inc. (Entech) for TxDOT's Contract No. 36-6IDP5313 Work Authorization No.1. Under this contract, WPM was responsible for developing traffic projections for the proposed Lubbock Outer Loop for three segments, which are shown graphically in **Figure 1**. The interchanges at US 62/82 and US 87 were considered as part of Segment 3 and hence, not considered for analysis purposes.

- Segment 1 – project limit extends from SH 114 to US 84 approximately 9.40 miles.
- Segment 2 – project limit extends from US 62/82 to SH 114 approximately 6.31 miles (excluding US 62/82 interchange).
- Segment 4 – project limit extends from US 87 to US 84 approximately 9.37 miles (excluding US 87 interchange).

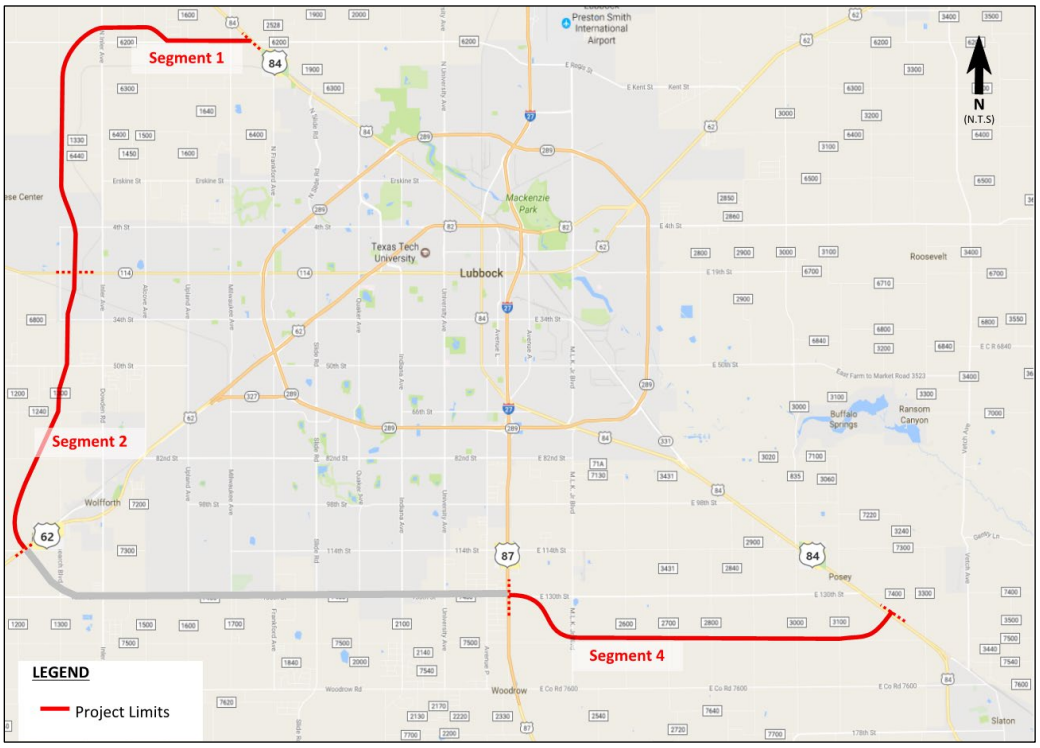


Figure 1: Project Vicinity Map

PROJECT AND REPORT SCOPE

This report documents the scope of the following sub tasks/ services:

- Traffic data collection.
- Coordination with the Lubbock Metropolitan Planning Organization (MPO) and TxDOT's Transportation Planning and Programming (TPP) Division for travel demand modeling data.
- Review of the base year network and demographic/ socioeconomic data and perform model validation using observed traffic counts.
- Develop traffic forecasts under no build and build alternatives for the main lanes, ramps, cross streets, interchanges, and intersections.
- Develop the opening year, design year (opening year + 20), and pavement design year (opening year + 30) travel forecast daily traffic projection volumes.

TRAFFIC PROJECTIONS METHODOLOGY

Travel demand models provided for this study include 2012, 2017, and 2045 planning horizons. To derive growth rates that will be used in projecting daily traffic volumes on the outer loop for the desired opening year (2030) and design years (2050 and 2060), the study considered 2017 model a better option to use as base year for traffic projection than using 2012 as base year model. The rationale is largely due to availability of 2017 historical counts for use in model validation. Additionally, 2018 counts were collected for the present study for use in estimating peak hour turning movements at intersections. Thus, the 2017 base year model represents existing traffic conditions and the 2045 model represents traffic conditions that account for future population and employment activities 28 years into the future. These models provided the bases for projecting traffic volumes for the outer loop segments following the steps outlined in **Figure 2**.

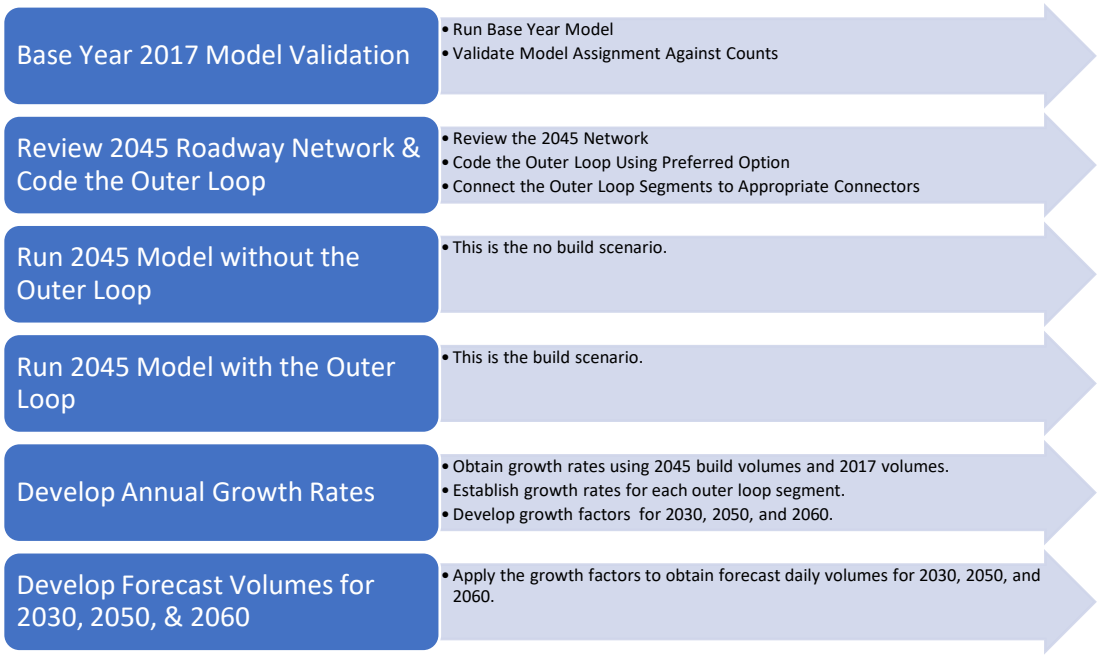


Figure 2: Traffic Projections Methodology

TXDOT TCDS COUNTS

Average Daily Traffic (ADT) counts for year 2017 were obtained from TxDOT's Traffic Count Database System (TCDS) following this link http://txdot.ms2soft.com/tcds/tsearch.asp?loc=Txdot&mod=. ADTs of more than 400 count locations were obtained from TCDS and coded in the existing travel demand model for use in validating existing conditions. **Figure 3** shows the locations of traffic counts coded in the model. The TCDS counts are further discussed in subsequent section discussing model validation.

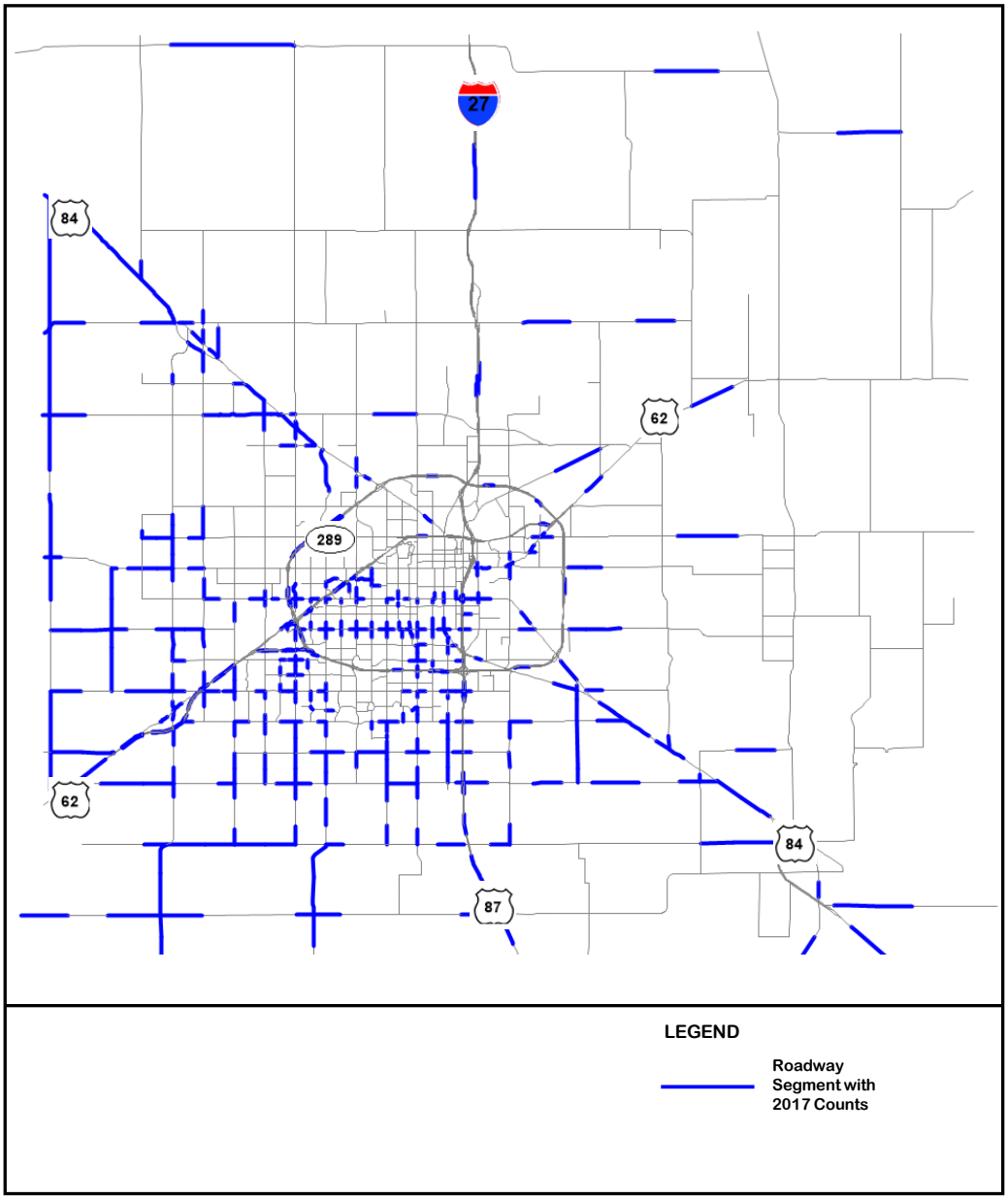


Figure 3: Traffic Count Locations

2018 COLLECTED COUNTS

Tube counts and turning movements traffic counts were collected on May 17 to 24, 2017 at several locations within the vicinity of the proposed outer loop. 24-hour bi-directional tube counts at 17 locations collected in May 2017. These traffic volumes can be found in **Appendix A**.

- 24-hour bi-directional at the following locations:
    1. EB/WB FM 6200 west of US 84
    2. EB/WB FM 2641 east of CR 1540
    3. NB/SB Research Boulevard north of Erskine Street
    4. EB/WB 4th Street east of Research Boulevard
    5. EB/WB 19th Street east of Research Boulevard
    6. EB/WB 34th Street east of Research Boulevard
    7. EB/WB 50th Street east of Research Boulevard
    8. EB/WB 66th Street east of Research Boulevard
    9. EB/WB East Clovis Road east of Research Boulevard
    10. NB/SB Research Boulevard north of Main Street
    11. NB/SB Highway 82 north of 114th Street
    12. EB/WB 114th Street east of Highway 82
    13. EB/WB E 130th Street east of US 87
    14. EB/WB E 146th Street west of Martin Luther King Boulevard
    15. EB/WB E 146th Street east of CR 2600
    16. EB/WB E 146th Street east of Fiddlewood Avenue
    17. NB/SB US 84 south of CR 7400
- Turning movement counts from 6:00 AM to 6:00PM were observed at the following nine locations:
    1. US 84 at FM 7400
    2. US 84 at FM 6200
    3. CR 1600 at FM 6200
    4. Martin Luther King Boulevard at E 146th Street
    5. Hwy 62 at FM 1585 SB
    6. Hwy 62 at FM 1585 NB
    7. FM 2641 at Inler Avenue
    8. US 87 SBFR at E 130th Street
    9. US 87 NBFR at E 130th Street

TDM Modeling

The following section describes in detail the input data, modeling process, analysis of model outputs, post-processing of model volumes, and the resulting traffic projections for opening year 2030 and design years 2050 and 2060.

Texas Application Guide

The Texas A & M Transportation Institute has developed an integrated model system called "TexPACK Application Guide: The Integrated Texas Package System" on behalf of the TxDOT's TPP Division. The TexPACK model system for Lubbock has models for planning years 2012, 2017, and 2045. These models were used for this study. The following section show the TexPACK model setup.

Texpack Model Setup

The Integrated Texas Package (TexPACK) streamlines the modeling process by integrating the input data, the model process, and output of each model process. **Figure 4** provides a snap shot of the TexPACK three-step model process.

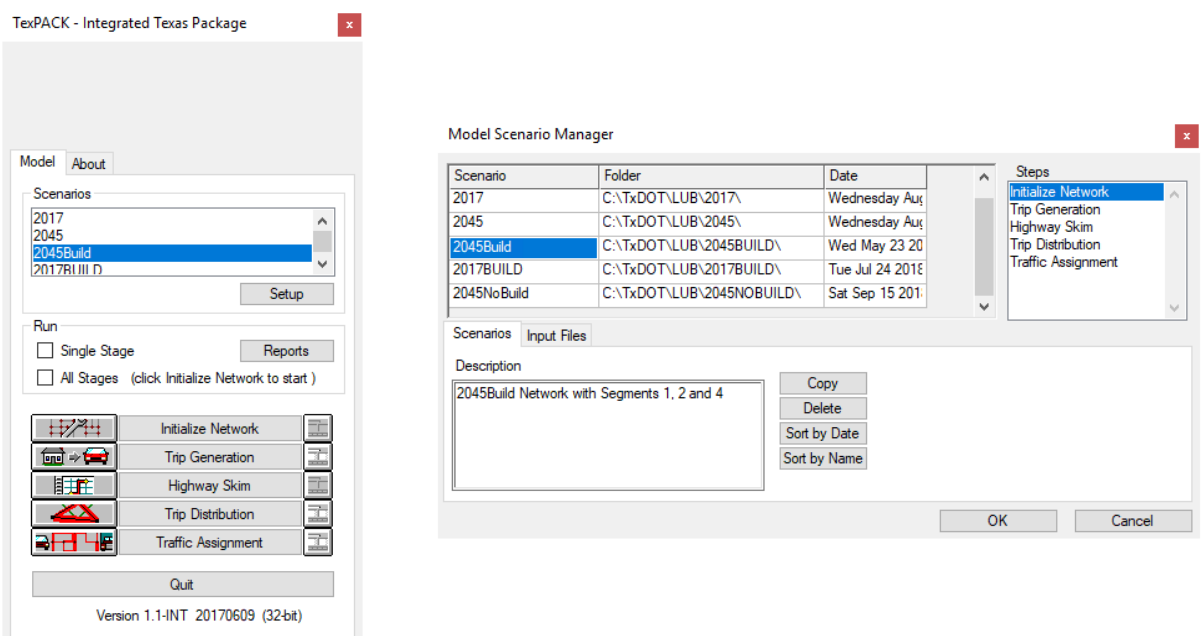


Figure 4: Integrated Texas Package (Texpack)

STUDY AREA

The Lubbock regional model extends beyond the metro planning area as shown in **Figure 5**.

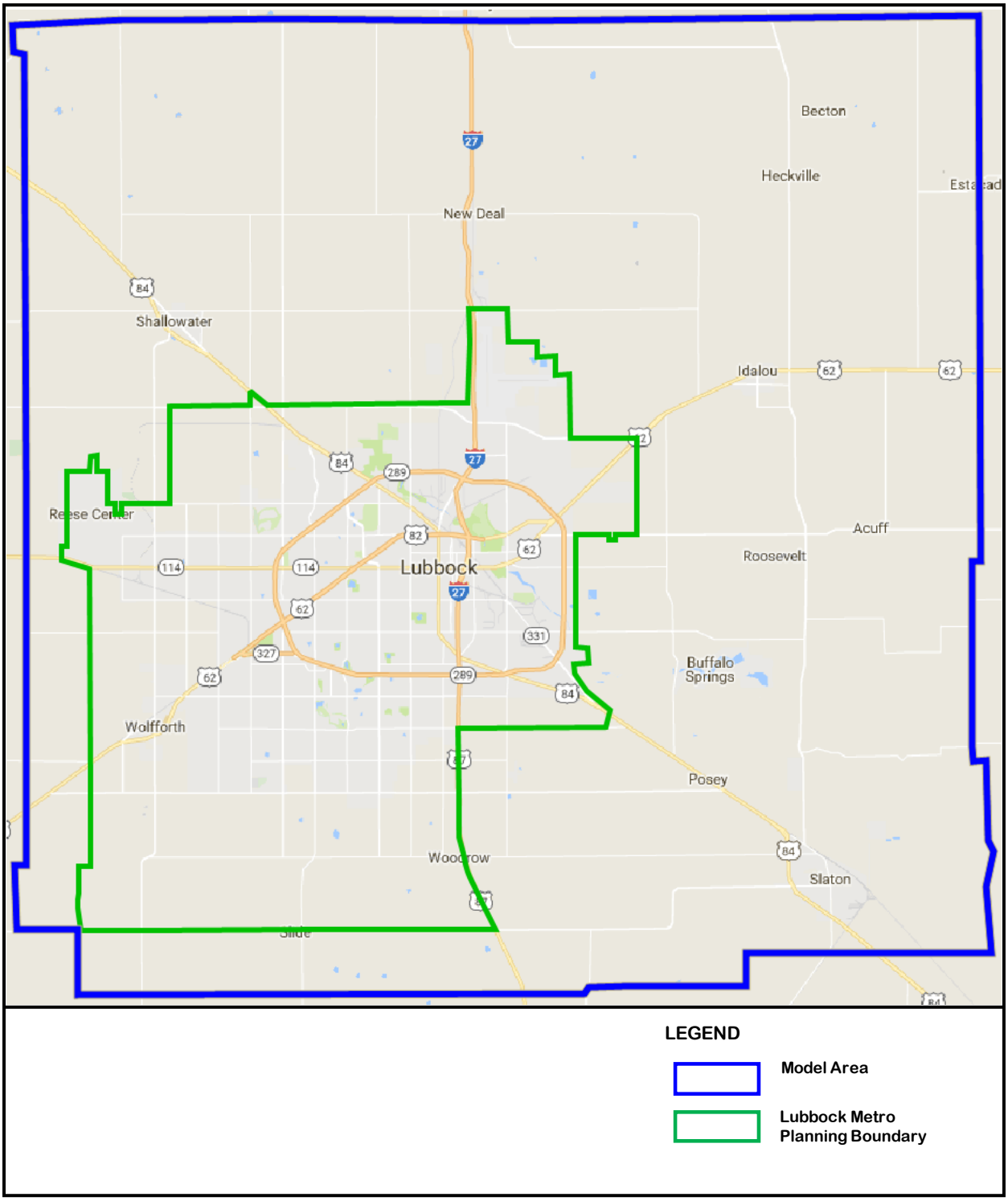


Figure 5: Study Area

DEMOGRAPHIC, EMPLOYMENT, AND EXTERNAL STATIONS DATA

Demographic data on population and number of households, as well as employment data were collected for the study area and aggregated at the unit termed as traffic analysis zone (TAZ). The TAZs defined for the study area, along with population and employment data are discussed below.

Traffic Analysis Zone

The study area depicted in **Figure 6** is divided into units to link information about activities, travel, and transportation to physical locations in the study area. These transportation analysis units are better known as Traffic Analysis Zones or TAZs. The TAZs vary in size depending on the density and nature of urban development. In the central business district (CBD), zones may be as small as a single block while in the undeveloped area they may be as large as 10 or more square miles. The zones attempt to bound homogeneous urban activities; that is, a zone may be all residential, all commercial, all industrial, etc. Zones also should consider natural boundaries and census designations. Moreover, consideration should also be given to jurisdictional boundaries, such as County or MPO (Metropolitan Planning Organization) boundaries.

An important consideration in establishing zones is their comparability with the transportation network to be used. Generally, the network should form the boundaries of the zones.

In a transportation planning model, trips begin and end on the so called “zone centroid”, which is considered the central point of each TAZ. These centroids are also nodes in the model network. Zone centroids are usually taken at the center of a zone, which consist of a variety of land uses bounded by the roadway network, census tracts, or other geographic or municipal boundaries. However, in some cases the zone centroid could be placed to a different location in the zone to better reflect the trip generation in the TAZ.

The Lubbock models have defined internal and external zones or stations. The study area is divided into 738 internal traffic analysis zones plus 16 reserved zones for future use. In addition to internal zones, 22 external stations are defined representing roadways that extends outside of the study area boundary. The TAZs depicted in **Figure 6** are numbered as follows:

- TAZ 1 to TAZ 738 are classified as internal zones
- TAZ 739 to TAZ 755 are classified as dummies or reserved zones (future land use)
- TAZ 756 to TAZ 778 are classified as external stations

External Stations

External stations represent roadways that extend outside the study area. Daily traffic volumes from and to areas outside the study area are obtained from observed traffic counts for existing conditions, which is defined for year 2017. **Table 1** presents a summary of the external daily volumes in the 2017 and 2045 models. Total volumes by quadrant are also given in the table. Percent external traffic by quadrant are as follows: north quadrant 21%, east quadrant 11%, south quadrant 25%, and west quadrant 43%. This percent share of external traffic by quadrant will be helpful when discussing traffic diversion to the proposed outer loop.

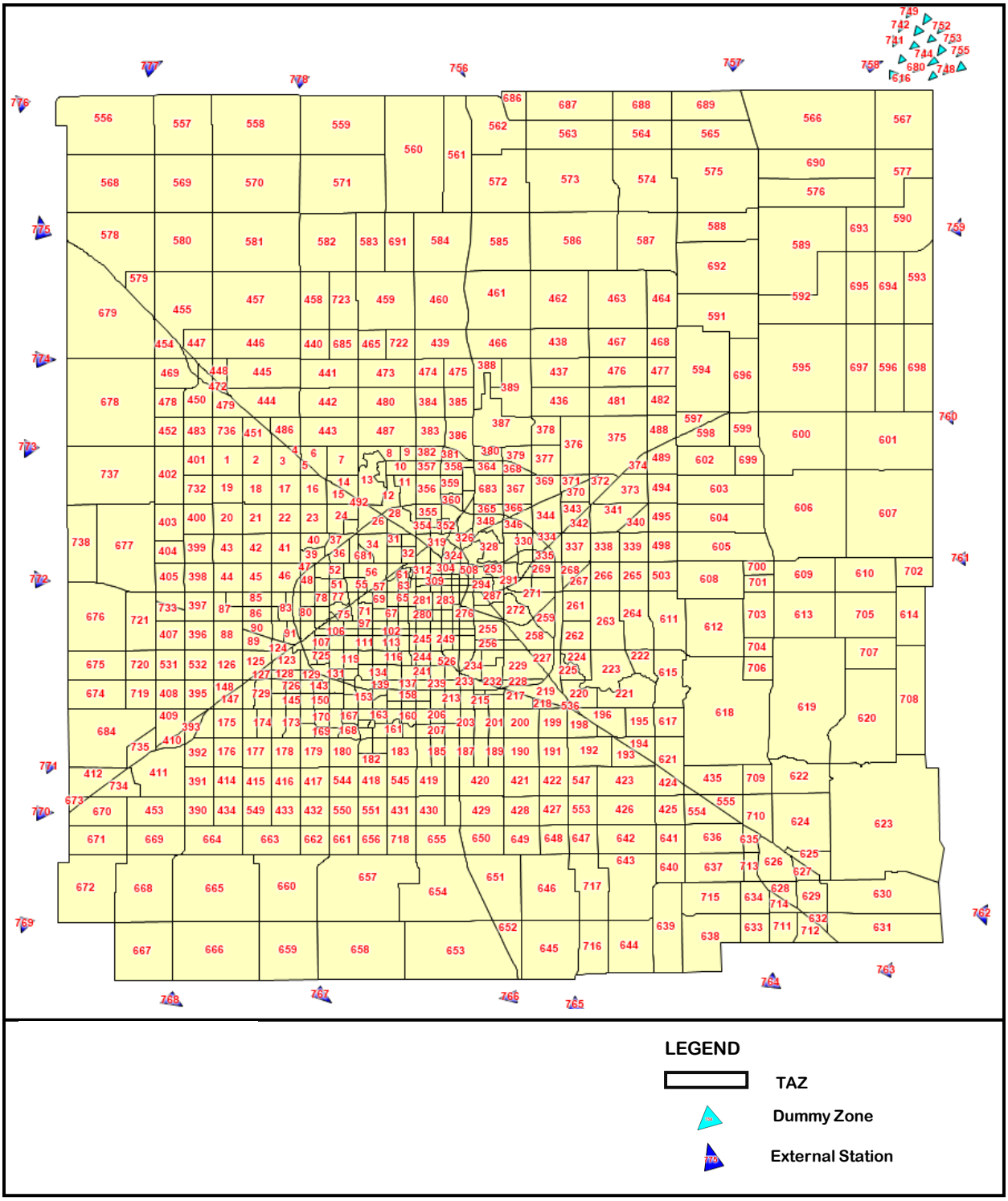


Figure 6: Traffic Analysis Zones

Table 1: Year 2017 and Year 2045 Daily Volumes at External Stations

Quadrant	TAZ#	Street Name	DailyVolumes				
			2017	2045	Change	% Total Change	% Annualized Growth
NORTH	777	FM 179	283	358	75	26.5%	0.9%
	778	FM 2528	516	653	137	26.6%	0.9%
	756	IH 27	13,727	19,129	5,402	39.4%	1.4%
	757	M 400 north	628	948	320	51.0%	1.8%
	758	FM 789	872	1,104	232	26.6%	1.0%
	Sub Total		16,026	22,192	6,166	38.5%	1.4%
EAST	759	FM 1527	138	175	37	26.8%	1.0%
	760	Idalou Rd (US 62/82)	6,805	8,620	1,815	26.7%	1.0%
	761	Acuff Rd	667	868	201	30.1%	1.1%
	762	FM 2150	1,176	1,490	314	26.7%	1.0%
	Sub Total		8,786	11,153	2,367	26.9%	1.0%
SOUTH	763	US 84 southeast	9,095	11,520	2,425	26.7%	1.0%
	764	FM 400 south	1,058	1,340	282	26.7%	1.0%
	765	FM 2192	365	463	98	26.8%	1.0%
	766	US 87 south	7,443	10,295	2,852	38.3%	1.4%
	767	FM 1730	1,701	3,029	1,328	78.1%	2.8%
	768	FM 179	195	274	79	40.5%	1.4%
	Sub Total		19,857	26,921	7,064	35.6%	1.3%
WEST	769	FM 41	725	919	194	26.8%	1.0%
	770	US 62/82 southwest	8,105	11,258	3,153	38.9%	1.4%
	771	FM 1585	2,290	4,151	1,861	81.3%	2.9%
	772	19th St	11,920	15,098	3,178	26.7%	1.0%
	773	FM 2641	334	423	89	26.6%	1.0%
	774	Drew St	200	254	54	27.0%	1.0%
	775	US 84 northwest	9,289	11,766	2,477	26.7%	1.0%
	776	FM 597	358	454	96	26.8%	1.0%
	Sub Total		33,221	44,323	11,102	33.4%	1.2%
Grand Total			77,890	104,589	26,699	34.3%	1.2%

Population

Table 2 summarizes the total population in the study area for 2017 and 2045. In 28 years, the study area will add close to 100,000 people, which translates to a 1.1% increase annually. As can be seen in **Figure 7(following page)**, significant growth in population will occur to the south and west of Loop 289. Growth is also expected to the north and east within proximity to Loop 289.

Table 2: Year 2017 and Year 2045 Population

Planning Year	Population	Change from 2017	Percent Change	AGR %
2017	303,264			
2045	399,393	96,129	31.7%	1.1%

Employment

Total employment in the study area for 2017 and 2045 is given in **Table 3**. In 28 years, the study area will add nearly 60,000 jobs, which translates to a 1.4% increase annually. Nearly two-thirds of the projected employment growth will be located inside and within proximity to Loop 289 as depicted in **Figure 8**.

Table 3: Year 2017 and Year 2045 Employment

Planning Year	Employment	Change from 2017	Percent	AGR %
2017	149,899			
2045	209,791	59,892	40.0%	1.4%

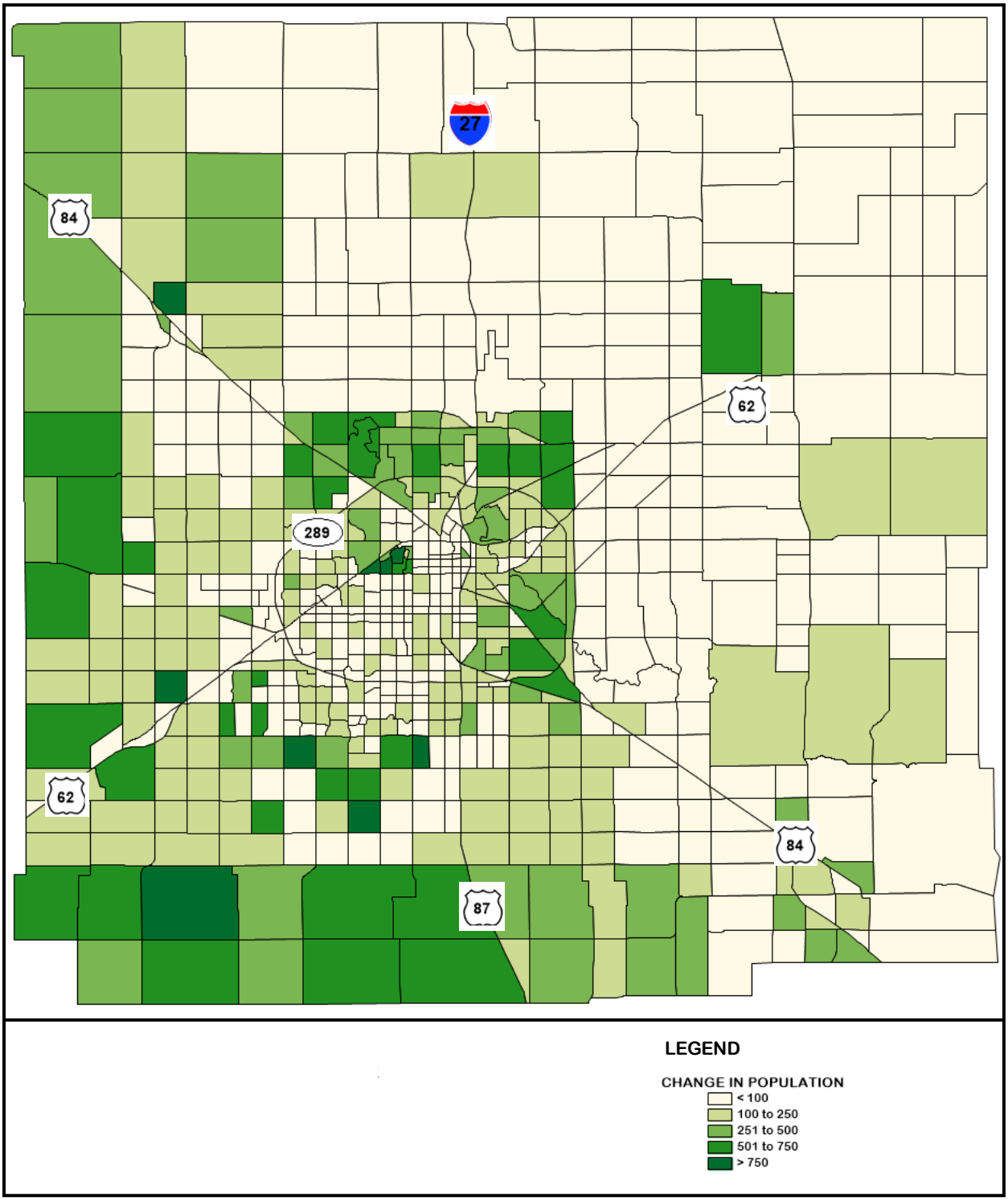


Figure 7: Change in Population

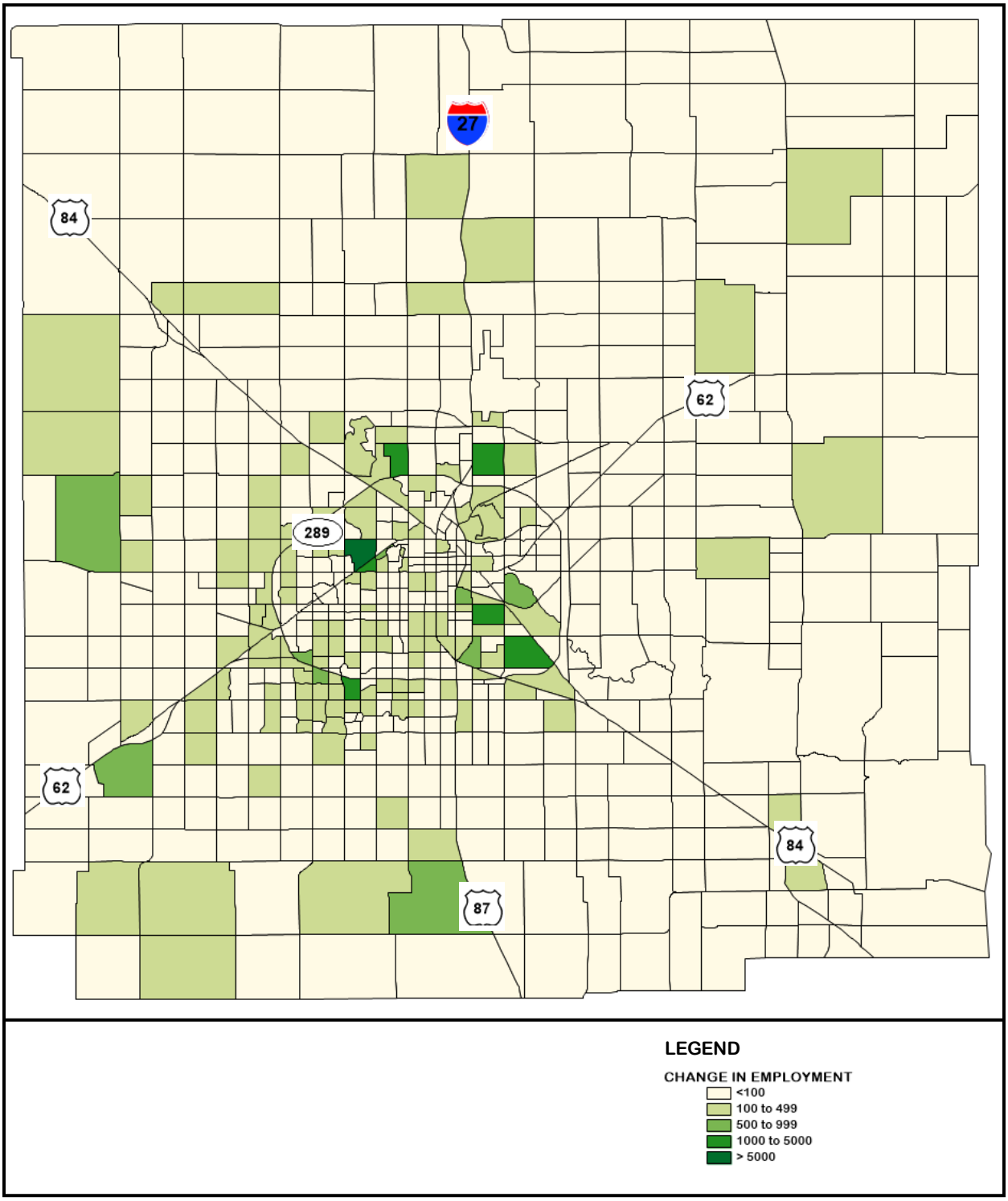


Figure 8: Change in Employment

NETWORK MODELS

The network model for the study area requires coding of link and node attributes in order to include the new Loop 88. In the model, all roadways classified as collector or greater throughout the study area were included. Data is encoded to describe both the links and the nodes. A link is a vector that describes connectivity between two nodes. A node represents an end of a link. Typically, a node can be an intersection or an intermediate point between intersections. Attributes coded for the links and nodes were already coded in the TexPACK models.

Functional classification is the process by which streets and highways are grouped into classes or systems according to the character of service they are intended to provide. Basic to this process is the recognition that individual roads and streets do not serve travel independently, but rather, most travel involves movement through a network of roads. Developing a functional classification system is a method to channelize traffic in a logical and efficient manner.

The functional classification for the Lubbock network model is summarized in **Table 4** and is shown graphically in **Figure 9**. As **Table 4** indicates, Interstate/Freeway lane-miles comprise relatively small proportion of the network while arterials and collectors comprise more than three-quarters of the total mileage. This distribution is quite typical for roadway coverage of regional models with relatively lower city center development density like Lubbock.

Table 4: Total Lane-Miles by Functional Class

Functional Class	Lane-Miles	Percent
Interstate Freeways	98.4	3.2%
Other Freeways	228.9	7.5%
Expressways	34.2	1.1%
Principal Arterials	1053.5	34.4%
Minor Arterials	724.7	23.7%
Collectors	560.1	18.3%
Frontage Roads	306.1	10.0%
Ramps	56.6	1.8%
Total	**3062.5**	**100.0%**

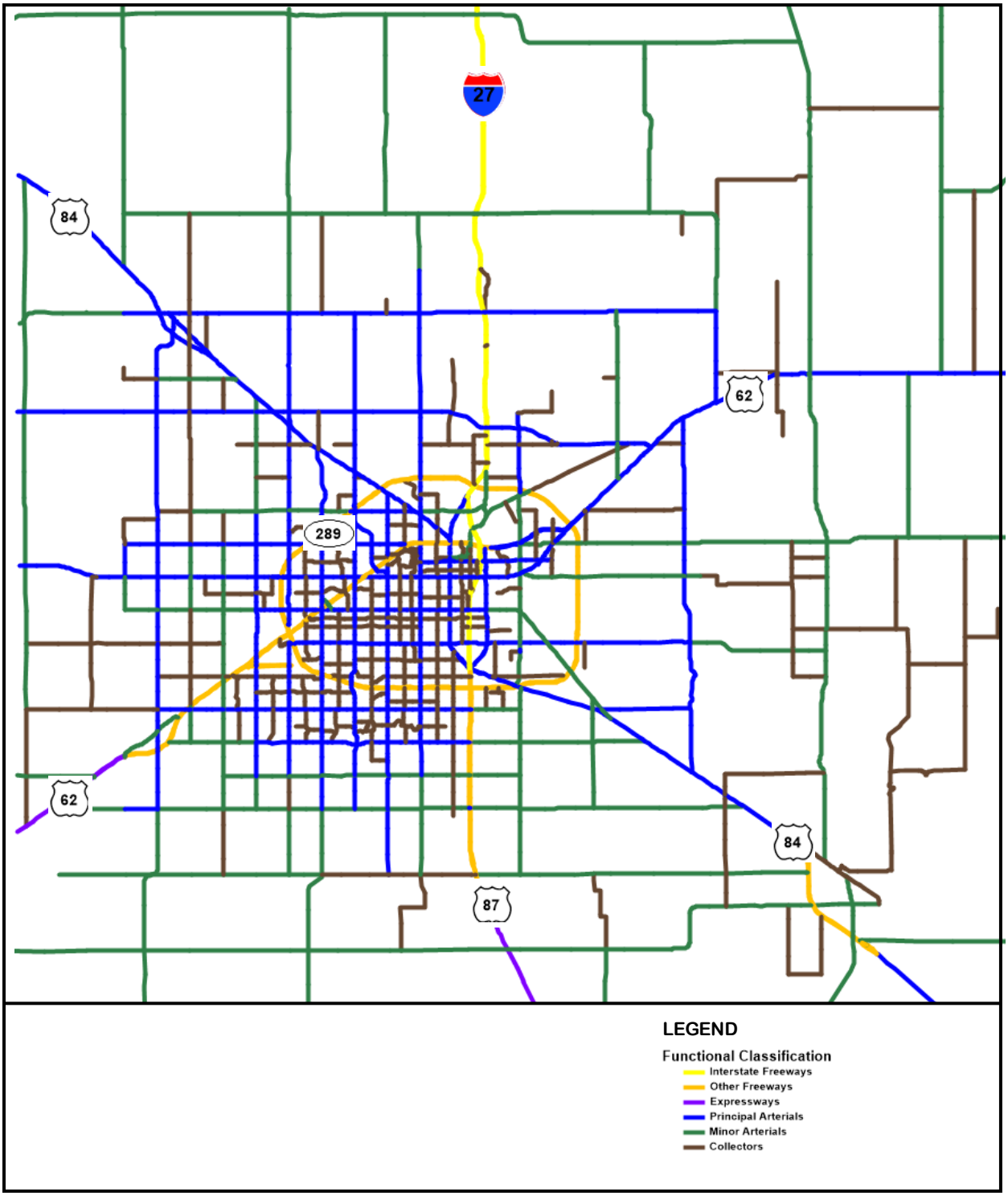


Figure 9: 2017 Lubbock Road Network Functional Classification

2017 BASE MODEL VALIDATION

The analysis in this report uses the 2017 model to represent existing traffic conditions for the study area. To ensure results from the model reasonably replicate existing ground conditions, model volumes were compared to available 2017 traffic counts described earlier and depicted in **Figure 2**.

Counts from over 400 locations that were coded in the existing model were compared to daily model volumes. Comparison of counts versus model volumes by functional class is presented in **Table 5**.

Table 5: Comparison of counts versus Model Volumes by Functional Class

Functional Class	Counts	Model Volumes	Change	Percent
Interstate Freeways	139,027	138,117	-910	-0.65%
Other Freeways	354,543	348,225	-6,318	-1.78%
Expressways	69,554	61,492	-8,062	-11.59%
Principal Arterials	2,669,720	2,605,089	-64,631	-2.42%
Minor Arterials	254,671	259,195	4,524	1.78%
Collectors	223,546	166,287	-57,259	-25.61%
Frontage Roads	222,197	199,676	-22,521	-10.14%
Ramps	14,958	15,253	295	1.97%
Total	3,948,216	3,793,334	-154,882	-3.92%

Goodness of fit between model volumes and observed counts can also provide a measure of the reasonableness of model prediction. Observed traffic counts in over 400 locations depicted in **Figure 2** were compared to predicted 2017 daily model volumes. Result of model correlation is depicted in **Figure 10**, which shows some variability in model prediction typical in a regional model when comparison is made on a link by link basis rather than comparing volumes along screenlines or cutlines that can better capture loading of trips in large and highly aggregated zonal trips. Overall, goodness of fit with an R-square over 85% indicates the model is reasonably replicating existing traffic conditions in the study area.

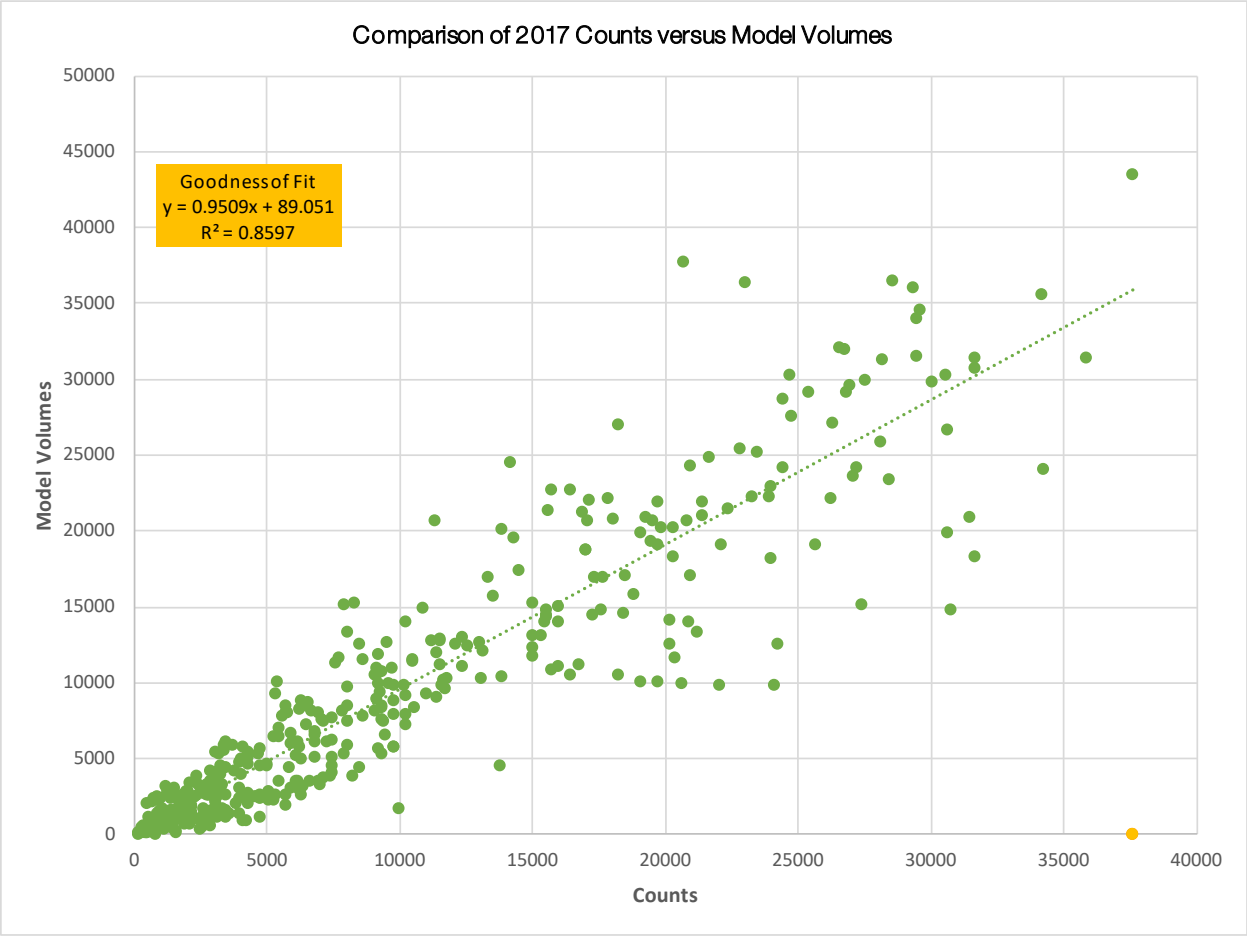


Figure 10: Validation of 2017 Daily Model Volumes

2045 NO BUILD SCENARIO

The 2045 network was built from 2017 network by adding committed projects. Added roadways to the 2045 network is depicted in red in **Figure 11**. This network along with forecast demographics and employment formed the basis for estimating future daily traffic on roadways within the Lubbock metro planning area. The forecast volumes are discussed in subsequent section.

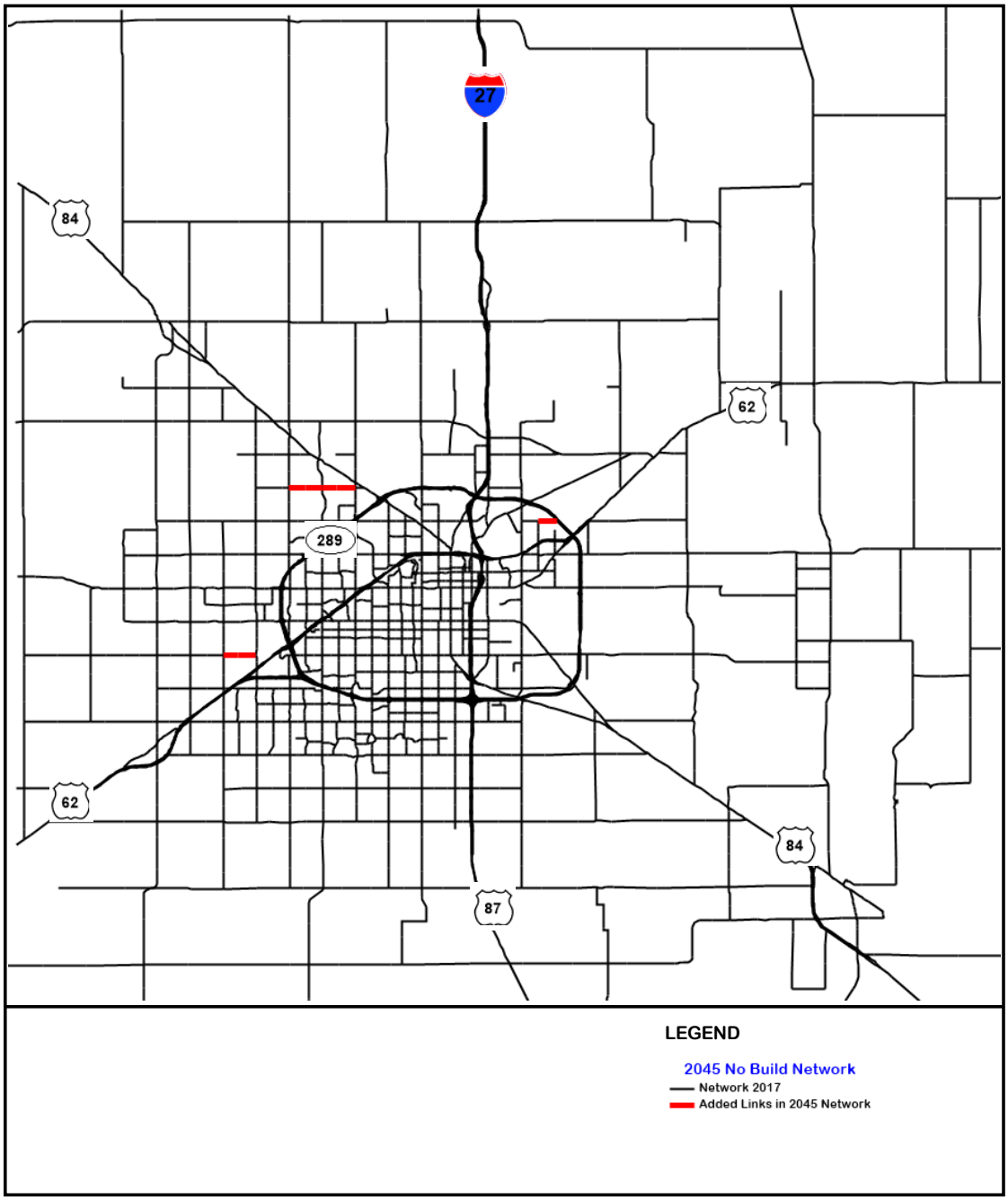


Figure 11: 2045 Lubbock Network No Build Scenario

2045 BUILD SCENARIO

The 2045 network was built from 2017 network by adding committed projects. Added roadways to the 2045 network is depicted in red in **Figure 12** This network along with forecast demographics and employment formed the basis for estimating future daily traffic on roadways within the Lubbock metro planning area. The forecast volumes are discussed in subsequent section.

Proposed Schematics

Proposed schematics for the outer loop included segments 1, 2, and 4. Segment 3 schematic was already completed and submitted to TxDOT in January 2018. This segment is included in the present modeling as part of the complete outer loop. Schematic drawings are shown below. Major intersections are listed for each segment.

Segment 1: From US 84 to Highway 114 (19th Street)

Segment 1 limits extend between east of Highway 114 (19th Street) and US Highway 84. There are six major intersections in segment 1 (excluding US Highway 84 interchange and SH 114 intersection):

- CR 2255 (4th Street)
- CR 6400
- FM 179
- CR 1600
- CR 1700 (Milwaukee Ave)
- US 84

Segment 2: From Highway 114 (19th Street) to US 62/82

Segment 2 limits extend between US Highway 62/82 and Highway 114 (19th Street). There are two major intersections in segment 2 (excluding US Highway 62/82 interchanges and SH 114 intersection):

- CR 7100
- CR 6900

Segment 4: From US 87 to US 84

Segment 4 limits extend between US 87 to US 84. There are four major intersections in segment 4 (excluding US 87/US 84 interchanges):

- CR 2500
- CR 2700
- CR 2900
- CR 3100

Coded 2045 Build Network

The proposed schematics was added to the 2045 no build network. To ensure appropriate distribution of traffic onto the outer loop, centroid connectors were reconnected, and additional existing roadways were added to the model to provide better access to the outer loop as can be seen in **Figure 12**.

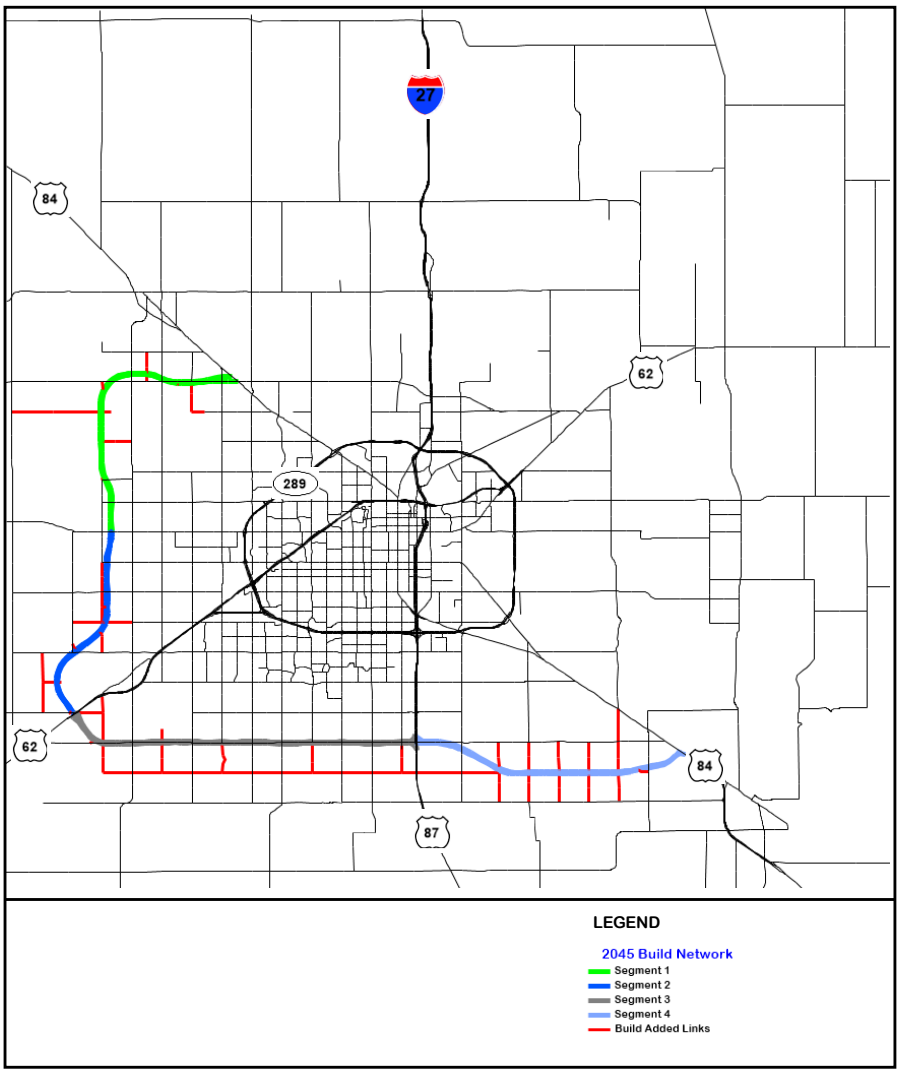


Figure 12: 2045 Lubbock Network with Proposed Outer Loop (Build Scenario)

PERFORMANCE MEASURES FOR THE LUBBOCK OUTER LOOP

To evaluate the potential impact of proposed outer loop on traffic distribution in the study area, existing and projected daily traffic volumes, volume to capacity ratio, vehicle miles travel (VMT), and vehicle hours travel (VHT) performance measures are presented in this section.

Existing and Future Daily Volumes

Existing daily volumes is presented in **Figure 13**. Daily volumes for no build and build conditions are shown in **Figure 14** and **Figure 15**, respectively.

As can be seen in the figures, traffic along major arterial roads will increase with increased population and employment in the study area. Construction of the outer loop will decrease traffic on portions of heavily travelled arterials, such as on US 84 and US 62/82.

No Build Versus Build Volumes

Figure 16 depicts graphically the impact of the outer loop on traffic pattern within the study area. The outer loop draws some traffic from Loop 289 and other major arterial corridors, thus improving travel times in those routes while at the same time will increase traffic in some routes/roadways, and intersections.

Volume to Capacity Ratio

A good measure to evaluate the impact of proposed capacity improvements, such as the outer loop, is to look at volume to capacity ratio (VCR) of roadways in the study area. VCRs for existing 2017 and future 2045 no build and build conditions are presented in **Figures 17** to **19**. As shown, existing roadway capacity on sections and at intersections of major arterial routes, such as US 84, US 87, US 62/82, and Highway 114, will not be sufficient to meet increased future traffic volumes. The proposed outer loop will provide some relief in some areas while may worsen delays at some locations if no improvements are done in tandem with the outer loop. A good example is along US 84 south of the outer loop entrance on segment 4 and on the north of the outer loop entrance on segment 1.

VMT and VHT Comparison

A comparison of vehicle miles travel (VMT) and vehicle hours travel (VHT) are given in **Table 6**. By 2045 VMT will increase by 43% without the outer loop. With the outer loop, VMT will increase by another 1%. With respect to VHT, by 2045 total time spent on travel in the study area will increase by 45% without the outer loop. The impact of the outer loop on VHT, however, will be 0.1%.

Table 6: VMT and VHT Comparison

Performance Measure	2017	2045 No Build	2045 Build
VMT	6,964,177	9,951,194	10,038,286
VHT	183,088	265,538	265,325

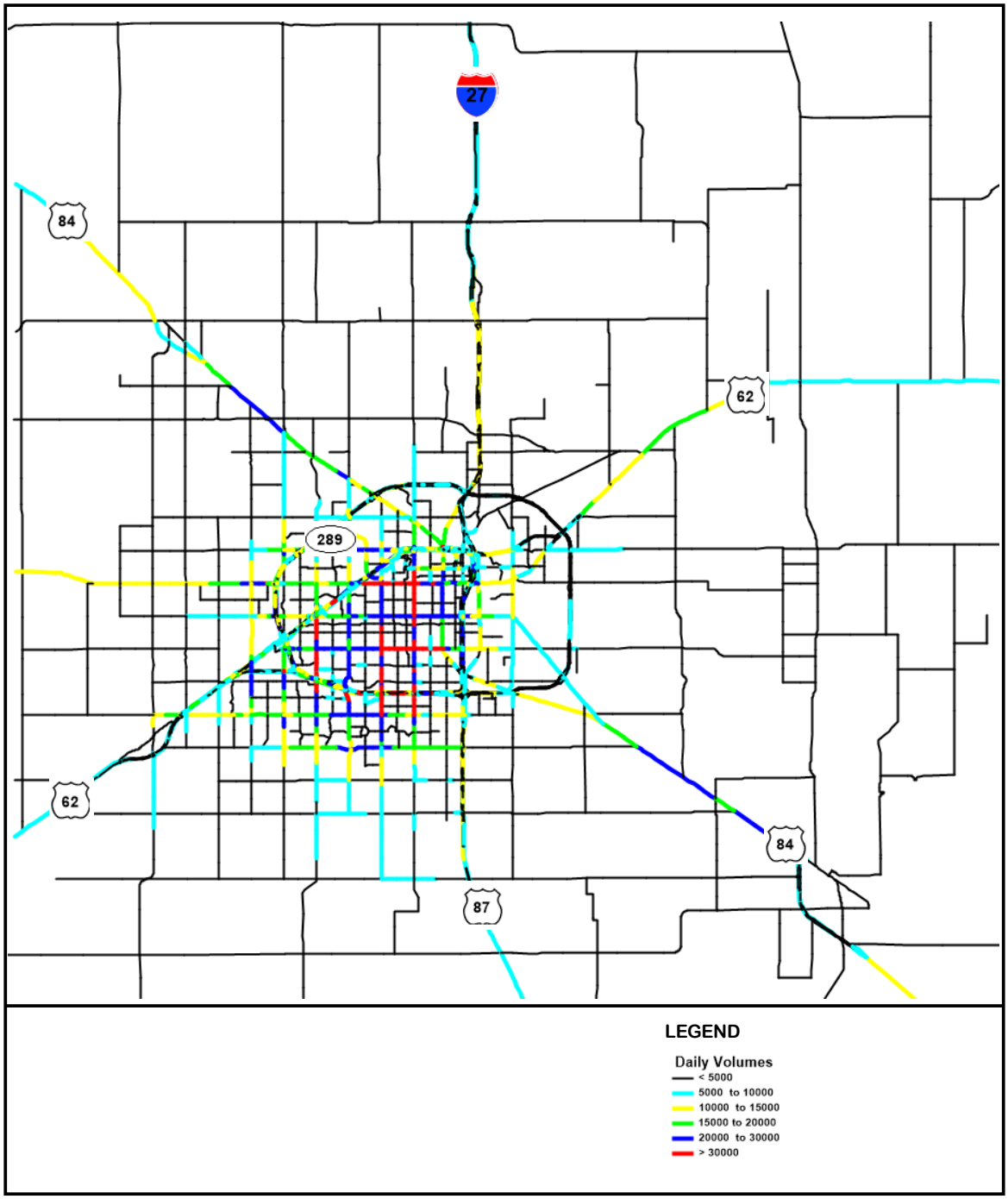


Figure 13: 2017 Daily Volumes

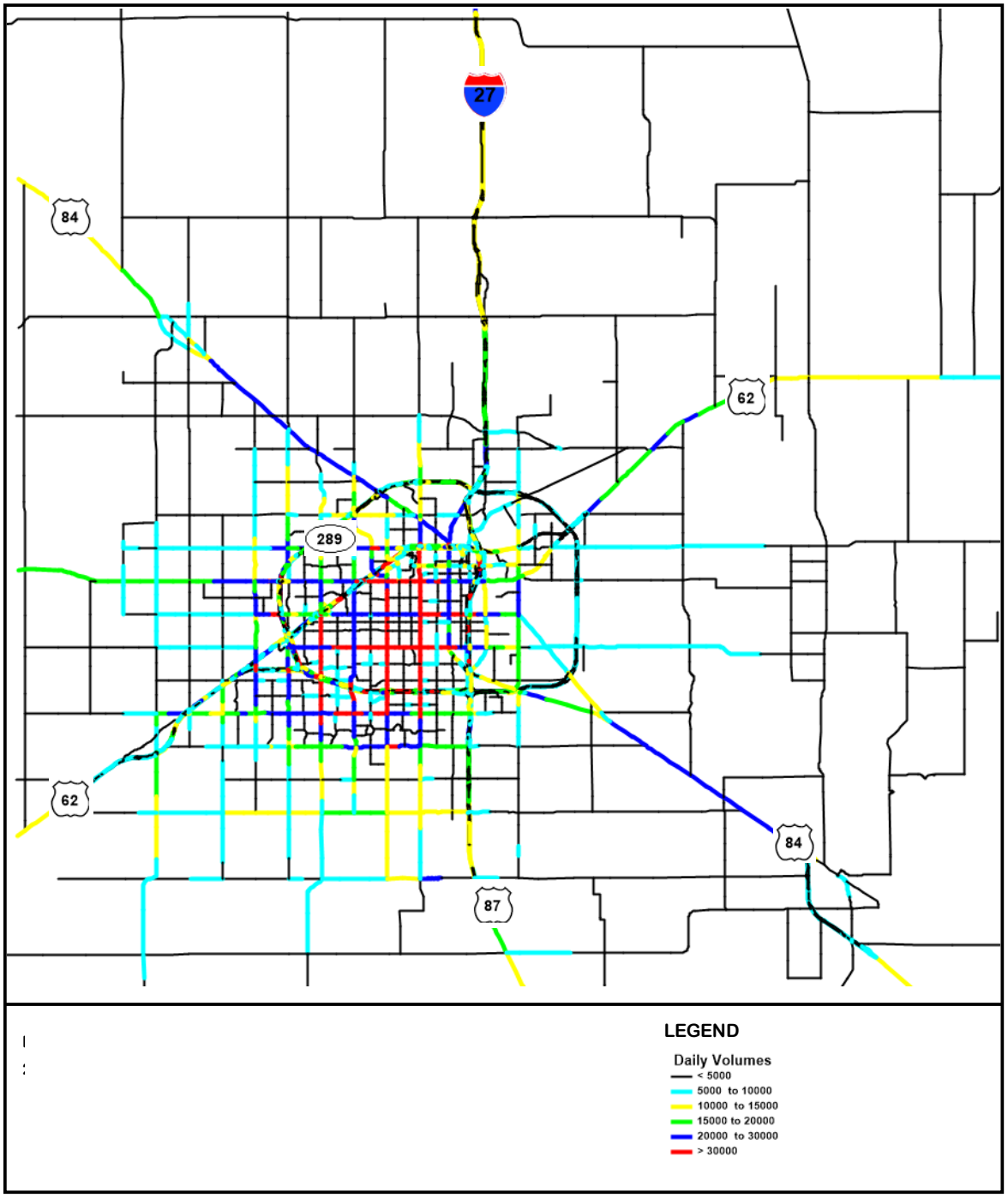


Figure 14: 2045 No Build Daily Volumes

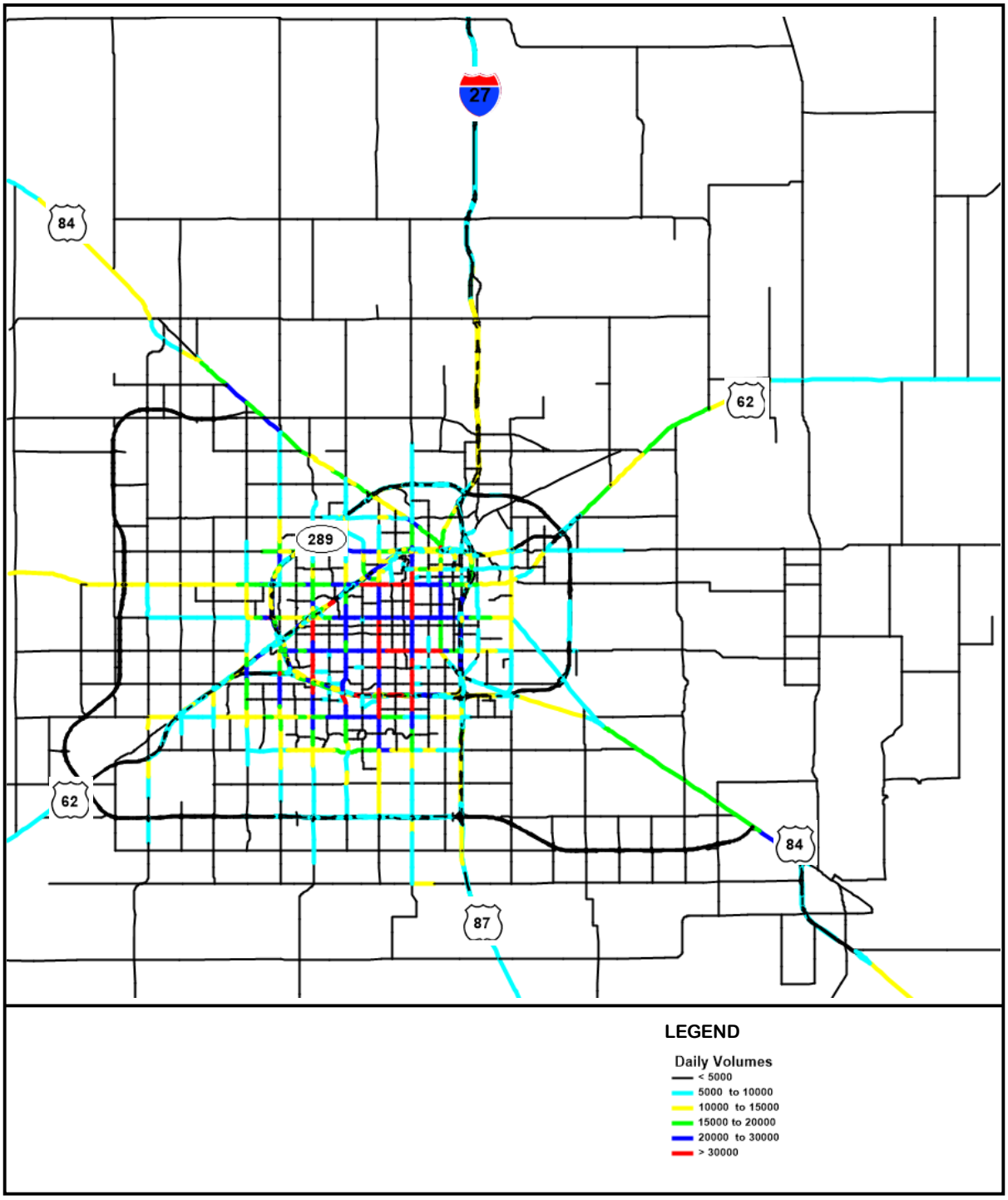


Figure 15: 2045 Build Daily Volumes

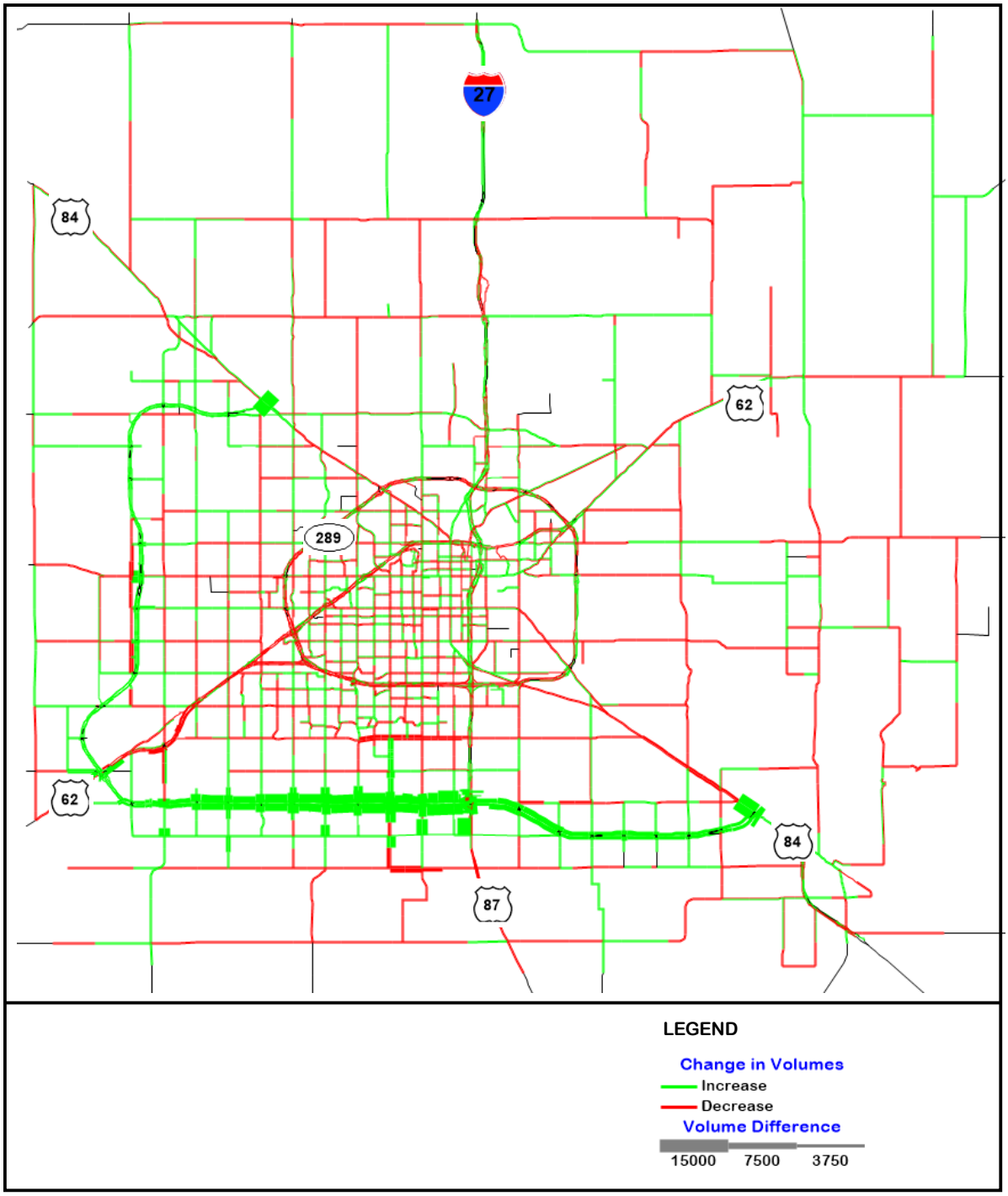


Figure 16: Difference Between 2045 Build and No Build Volumes

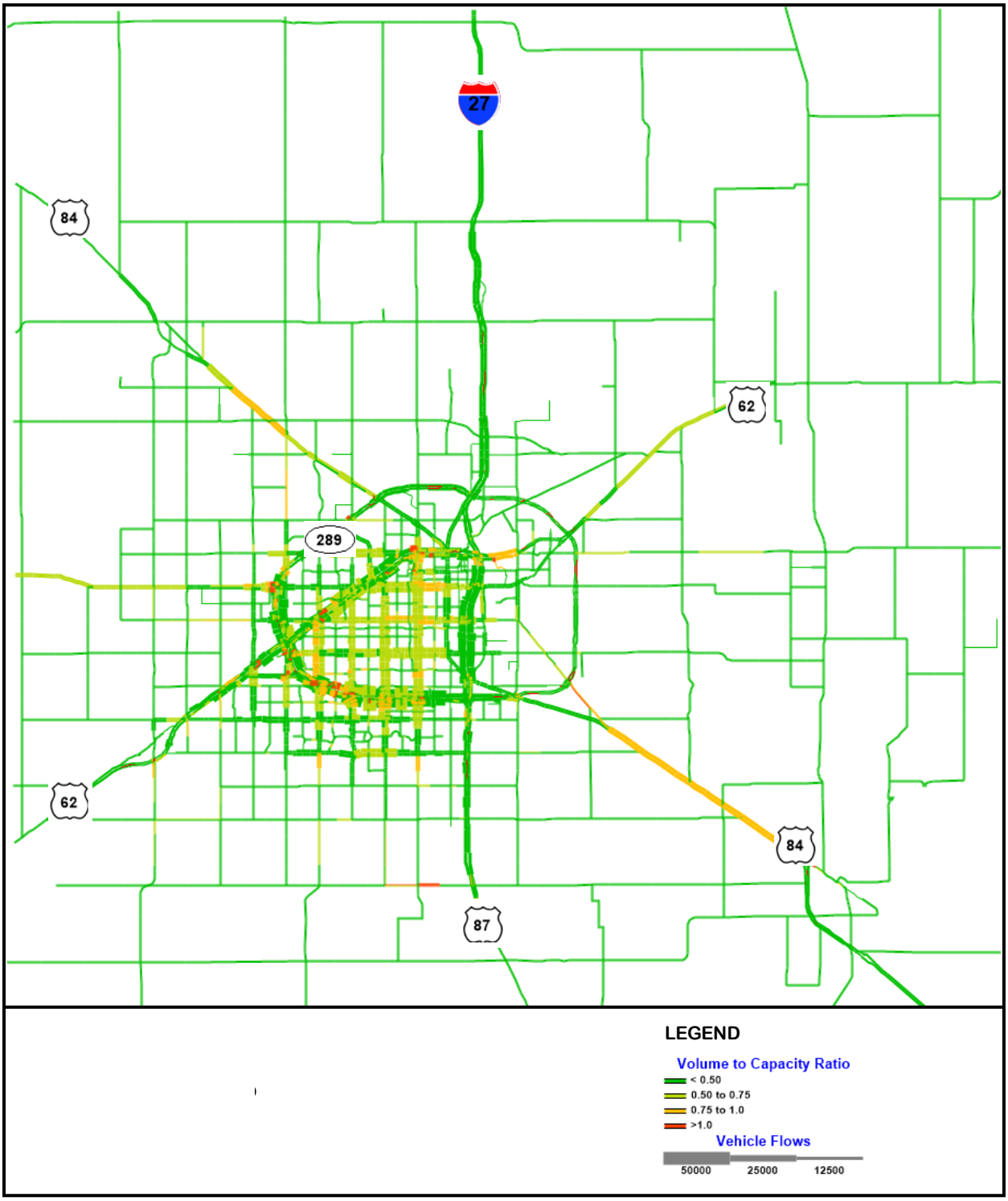


Figure 17: 2017 Existing Volume to Capacity Ratio

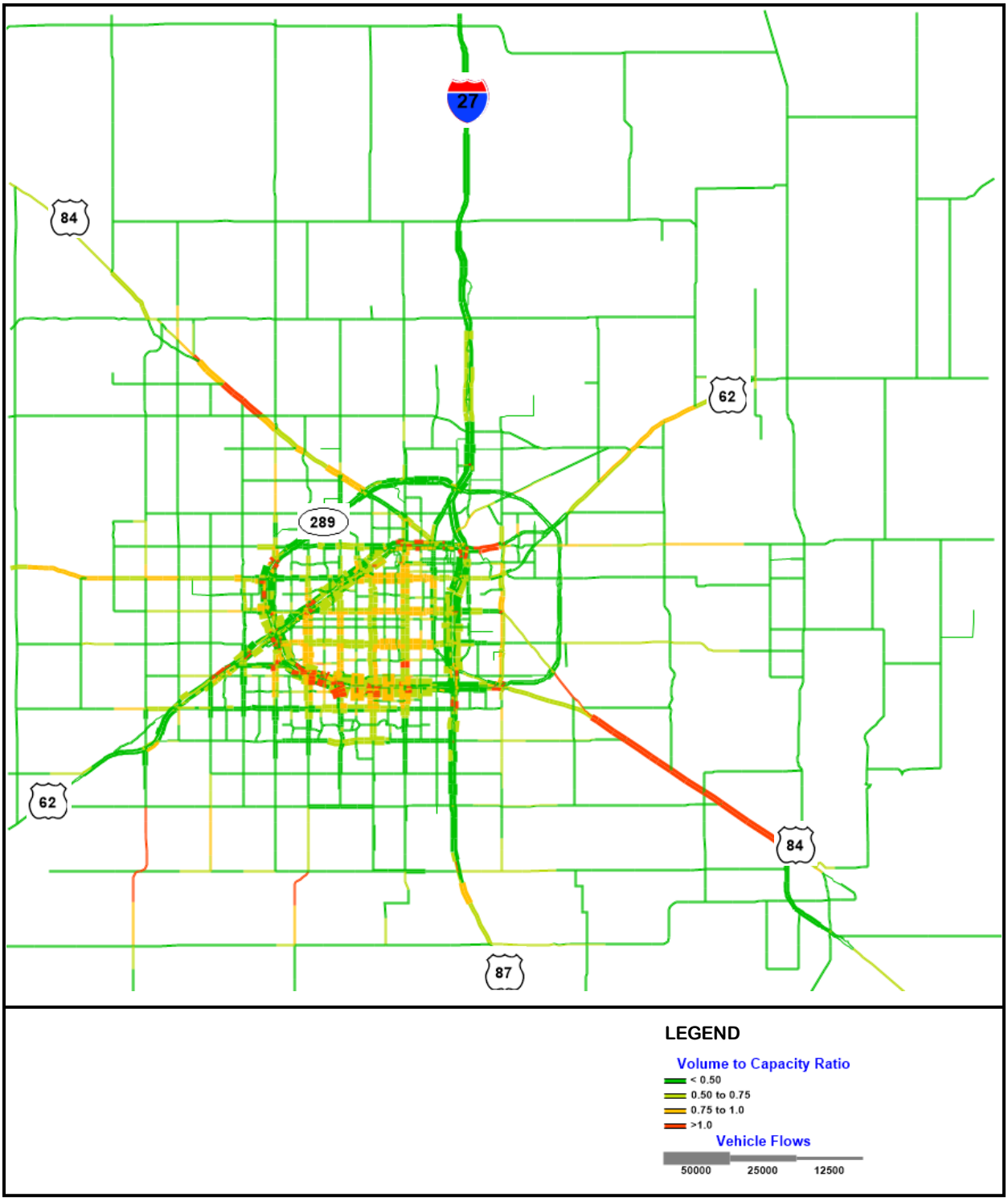


Figure 18: 2045 No Build Scenario Volume to Capacity Ratio

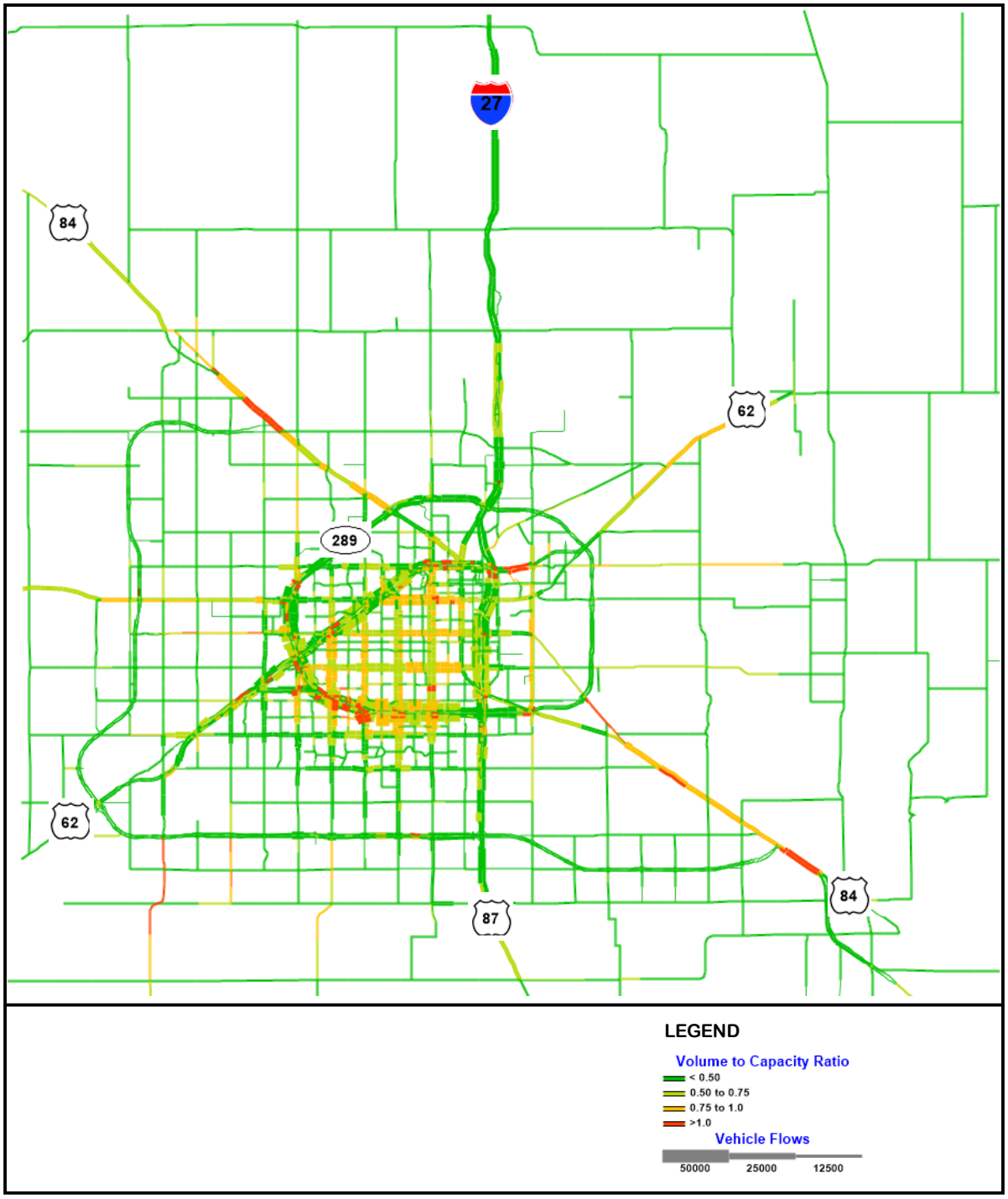


Figure 19: 2045 Build Scenario Volume to Capacity Ratio

MODEL

The unadjusted 2045 build daily volumes by segment were obtained for all main lane links, ramps, frontage roads, u-turn movements, and intersection turning movements.

There are several locations where the model shows low volumes or no volume such as u-turns and/or turn movements at intersections. These reasons may include, but not limited to:

- Frontage roads access – The outer loop schematics has interchanges nearly every mile. These close interchanges with very few collector streets connected to the frontage roads in between ramps would likely not have traffic exiting the ramp to make a u-turn to get into the opposite direction of travel. Likewise, turn movements at intersections are also impacted by the lack of access on the frontage road as modeled than what can be observed on the ground.
- Collector streets and local streets connections - Regional models do not include local streets and some collector streets. The rationale for excluding these streets in the regional context is largely to ensure that these types of roadways will not be serving as roadways that carry large traffic for inter-jurisdiction travel instead of serving for local area access.
- Connector locations – where centroid connectors are connected to roadways have impact on u-turn and intersection turning movements.

The travel demand model volumes was adjusted in a post-process traffic valancing, to account for ground conditions that cannot be represented/ replicated in all details in a regional model representation. The next section outlines the model adjustment process.

POST-PROCESSING VOLUMES

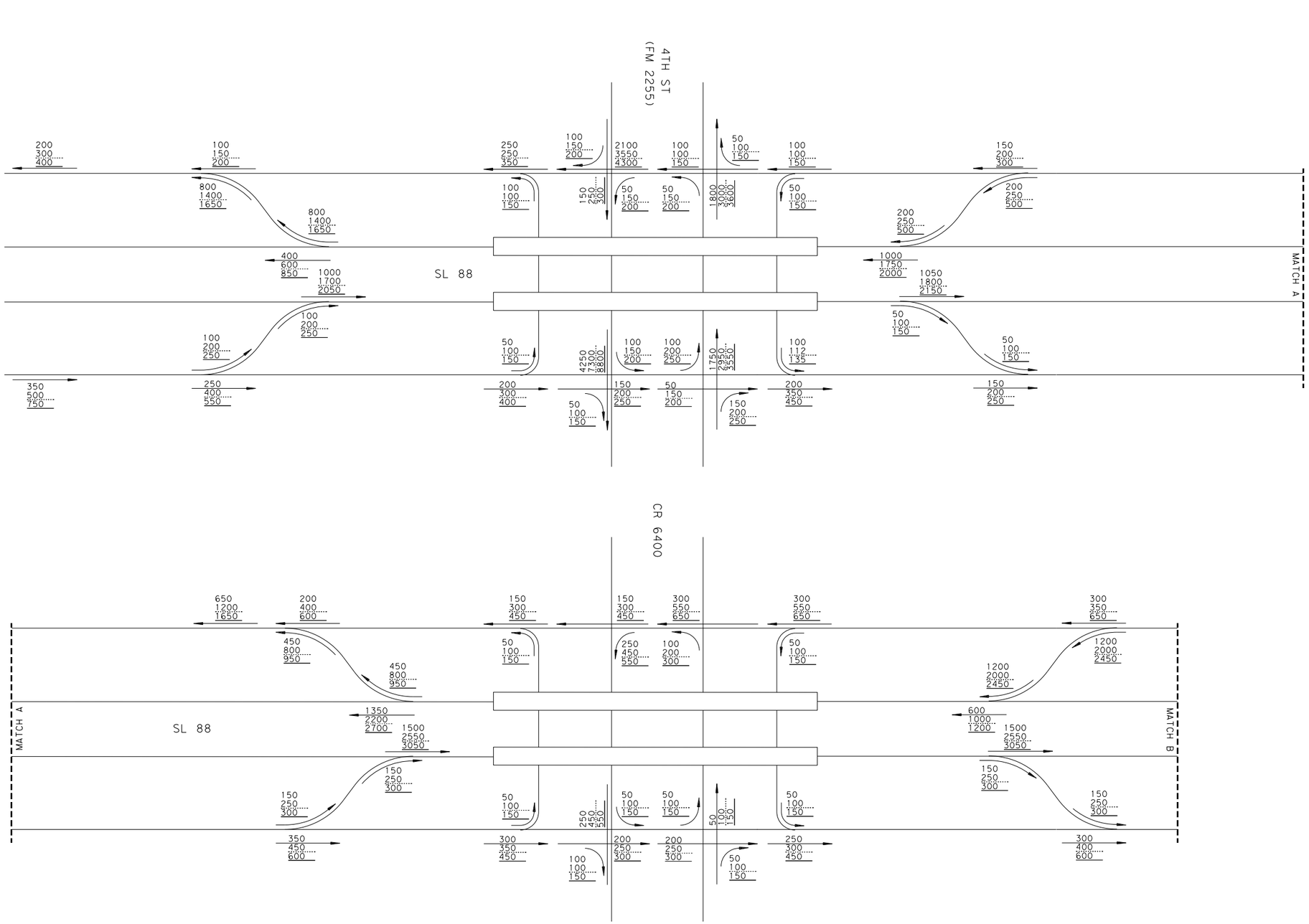
In adjusting the model volumes, the following assumptions were adopted as minimum vehicles per day (vpd):

- As much as possible, volumes on the main lanes are maintained to its unadjusted values.
- Volumes at the interchanges are adjusted to balance main lanes and frontage volumes.
- Forecast volumes are rounded to the nearest 50 vehicles
- 50/100/150 vpd for u-turns, intersection turning movements and ramps if there were a low or zero volumes.

Forecast daily volumes for each segment 1, 2, and 4 are shown in **Appendix A**.

APPENDIX A -
TRAFFIC PROJECTIONS

SEGMENT 1



LEGEND
XXXX - 2030 AADT
XXXX - 2050 AADT
XXXX - 2060 AADT

PRELIMINARY
FOR REVIEW ONLY
THESE DOCUMENTS ARE PRELIMINARY AND SUBJECT TO CHANGE. THEY ARE NOT INTENDED FOR CONSTRUCTION OR BIDDING. THEY WERE PREPARED BY, OR UNDER THE SUPERVISION OF:
Engineer: THOMAS D. DUNCAN, P.E.
P.E. No.: 98353
Date: August 14, 2019

LUBBOCK

SEGEMENT 1
FORECASTED VOLUMES

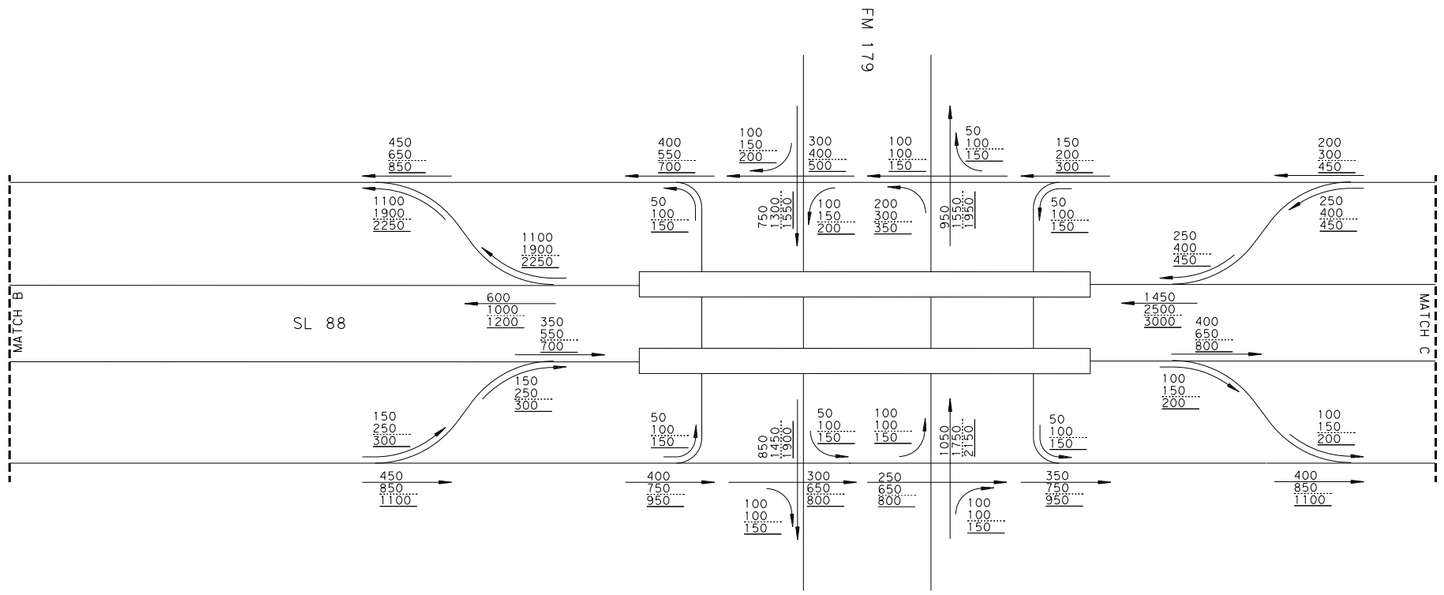
SHEET 1 OF 3
SCALE: N.T.S.

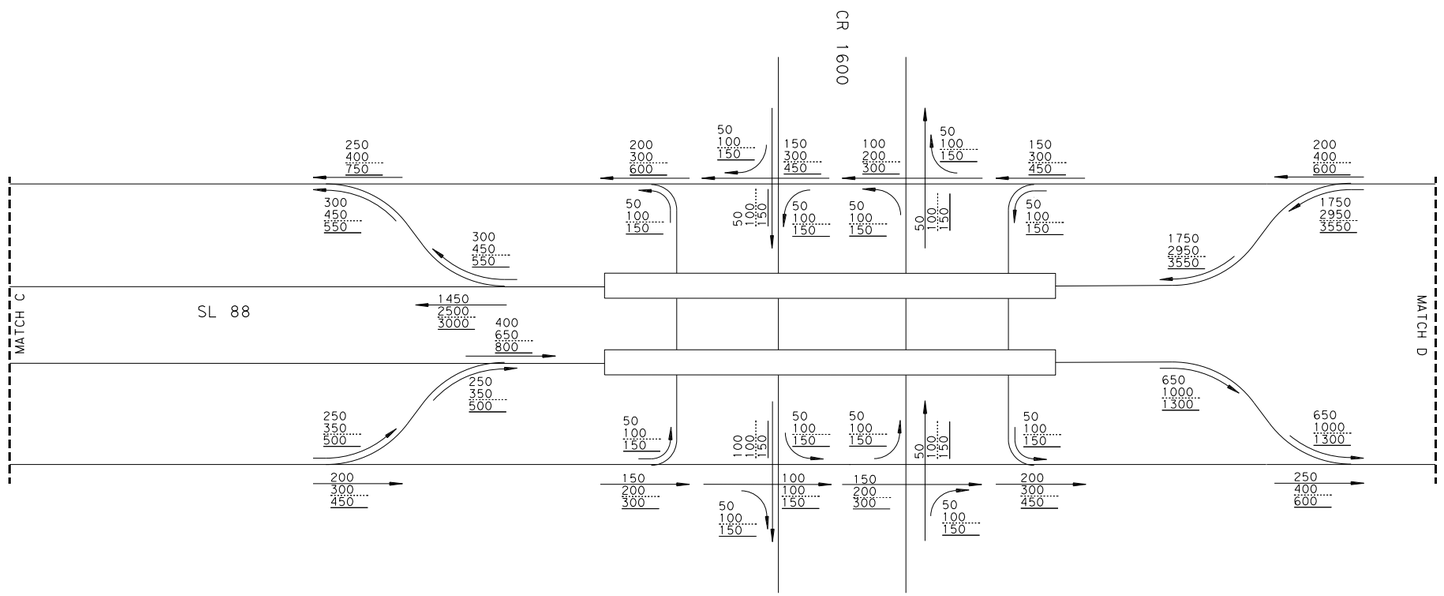
WALTER P MOORE
WALTER P. MOORE AND ASSOCIATES, INC.
1301 McKINNEY, SUITE 1100
HOUSTON, TEXAS 77010
Texas Firm Registration No. F-1856

Texas Department of Transportation
© 2016

FED. RD. DIV. NO.	FEDERAL AID PROJECT NO.		SHEET NO.
.	.		.
STATE	STATE DIST. NO.	COUNTY	
TEXAS	.	.	
CONT.	SECT	JOB	HIGHWAY NO.
XXXX	XX	XXX	.

Plotted: August 14, 2019 11:41:05 AM
Design File: P:\M03\2016\16072-01 TxDOT LBB Sct&Env Outer Route WA1 (Entech)\Traffic\Cad\Traffic\M03-16072-01-SEGMENT-01_SHT-01.dgn





LEGEND
XXXX - 2030 AADT
XXXX - 2050 AADT
XXXX - 2060 AADT

PRELIMINARY
FOR REVIEW ONLY
THESE DOCUMENTS ARE PRELIMINARY AND SUBJECT TO CHANGE. THEY ARE NOT INTENDED FOR CONSTRUCTION OR BIDDING. THEY WERE PREPARED BY, OR UNDER THE SUPERVISION OF:
Engineer: THOMAS D. DUNCAN, P.E.
P.E. No.: 98353
Date: August 14, 2019

LUBBOCK

SEGEMENT 1
FORECASTED VOLUMES

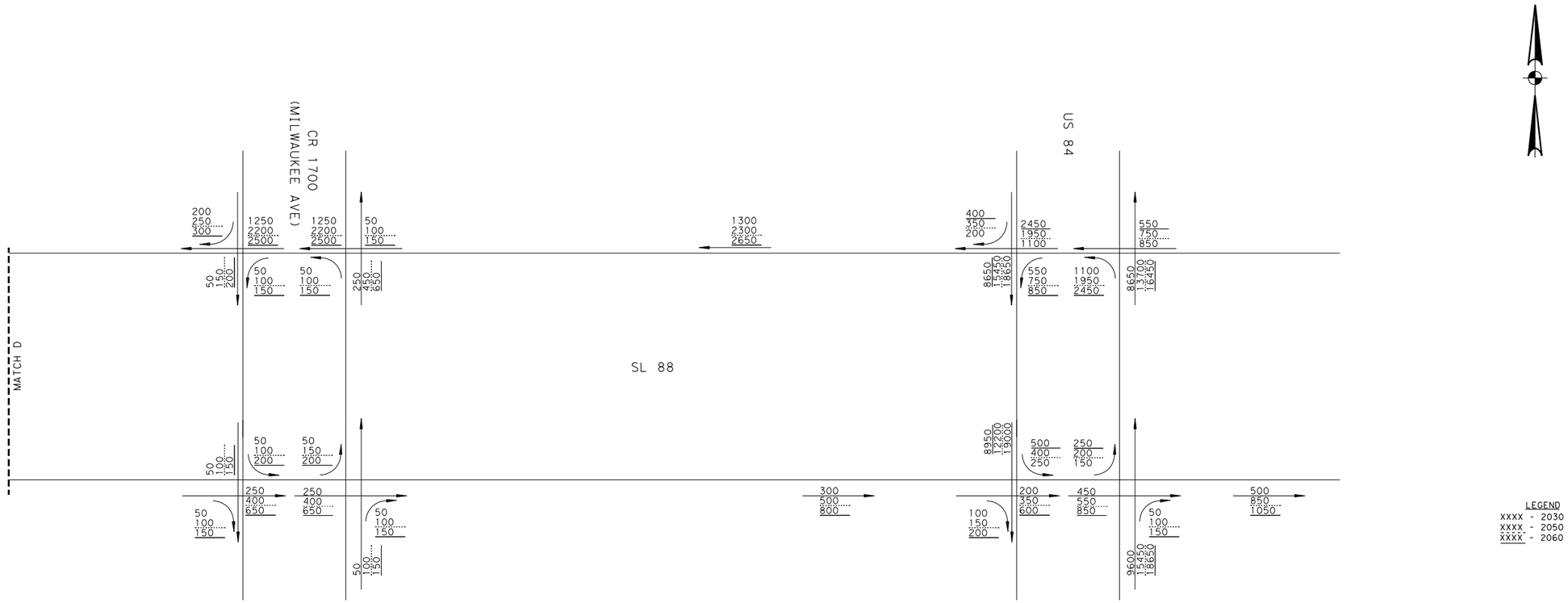
SHEET 2 OF 3
SCALE: N.T.S.

WALTER P MOORE
WALTER P. MOORE AND ASSOCIATES, INC.
1301 McKINNEY, SUITE 1100
HOUSTON, TEXAS 77010
Texas Firm Registration No. F-1856

Texas Department of Transportation
© 2016

FED. RD. DIV. NO.	FEDERAL AID PROJECT NO.		SHEET NO.
.	.		.
STATE	STATE DIST. NO.	COUNTY	
TEXAS	.	.	
CONT.	SECT	JOB	HIGHWAY NO.
XXXX	XX	XXX	.

Plotted: August 14, 2019 11:41:06 AM
Design File: P:\M03\2016\16072-01 TxDOT LBB Sch&Env Outer Route WA1 (Entech)\Traffic\Cad\Traffic\M03-16072-01-SEGMENT-01_SHT-02.dgn



LEGEND
XXXX - 2030 AADT
XXXX - 2050 AADT
XXXX - 2060 AADT

PRELIMINARY
FOR REVIEW ONLY
THESE DOCUMENTS ARE PRELIMINARY AND SUBJECT TO CHANGE. THEY ARE NOT INTENDED FOR CONSTRUCTION OR BIDDING. THEY WERE PREPARED BY, OR UNDER THE SUPERVISION OF:
Engineer: THOMAS D. DUNCAN, P.E.
P.E. No.: 98353
Date: August 14, 2019

LUBBOCK

SEGEMENT 1
FORECASTED VOLUMES

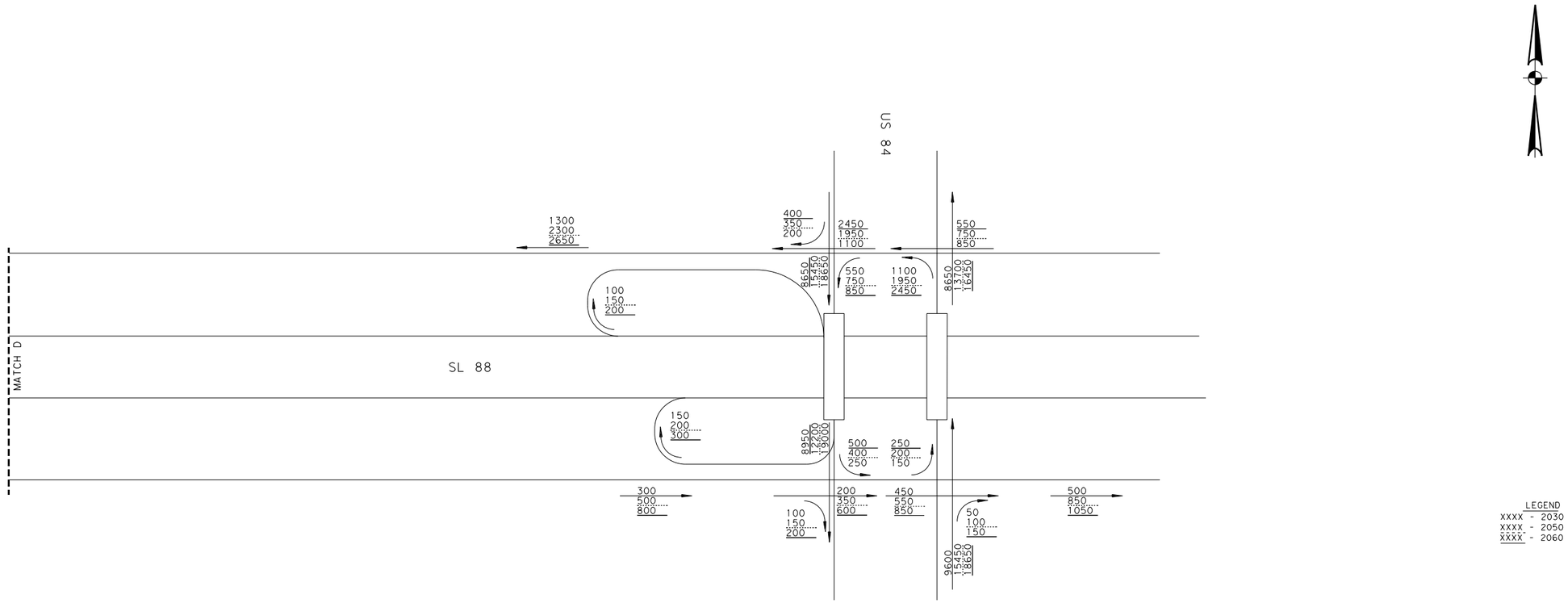
SHEET 3 OF 3
SCALE: N.T.S.

WALTER P MOORE
WALTER P. MOORE AND ASSOCIATES, INC.
1301 McKINNEY, SUITE 1600
HOUSTON, TEXAS 77010
Texas Firm Registration No. F-1856

Texas Department of Transportation
© 2016

FED. RD. DIV. NO.	FEDERAL AID PROJECT NO.		SHEET NO.
.	.		.
STATE	STATE DIST. NO.	COUNTY	
TEXAS	.	.	
CONT.	SECT	JOB	HIGHWAY NO.
XXXX	XX	XXX	.

Plotted: August 14, 2019 11:41:07 AM
Design File: P:\M03\2016\16072-01 TxDOT LBB Sct&Env Outer Route WA1 (Entech)\Traffic\Cad\Traffic\M03-16072-01-SEGMENT-01_SHT-03.dgn



LEGEND
XXXX - 2030 AADT
XXXX - 2050 AADT
XXXX - 2060 AADT

PRELIMINARY
FOR REVIEW ONLY
THESE DOCUMENTS ARE PRELIMINARY AND SUBJECT TO CHANGE. THEY ARE NOT INTENDED FOR CONSTRUCTION OR BIDDING. THEY WERE PREPARED BY, OR UNDER THE SUPERVISION OF:
Engineer: THOMAS D. DUNCAN, P.E.
P.E. No.: 98353
Date: April 03, 2019

LUBBOCK

SEGEMENT 1
FORECASTED VOLUMES

SHEET 3 OF 3
SCALE: N.T.S.

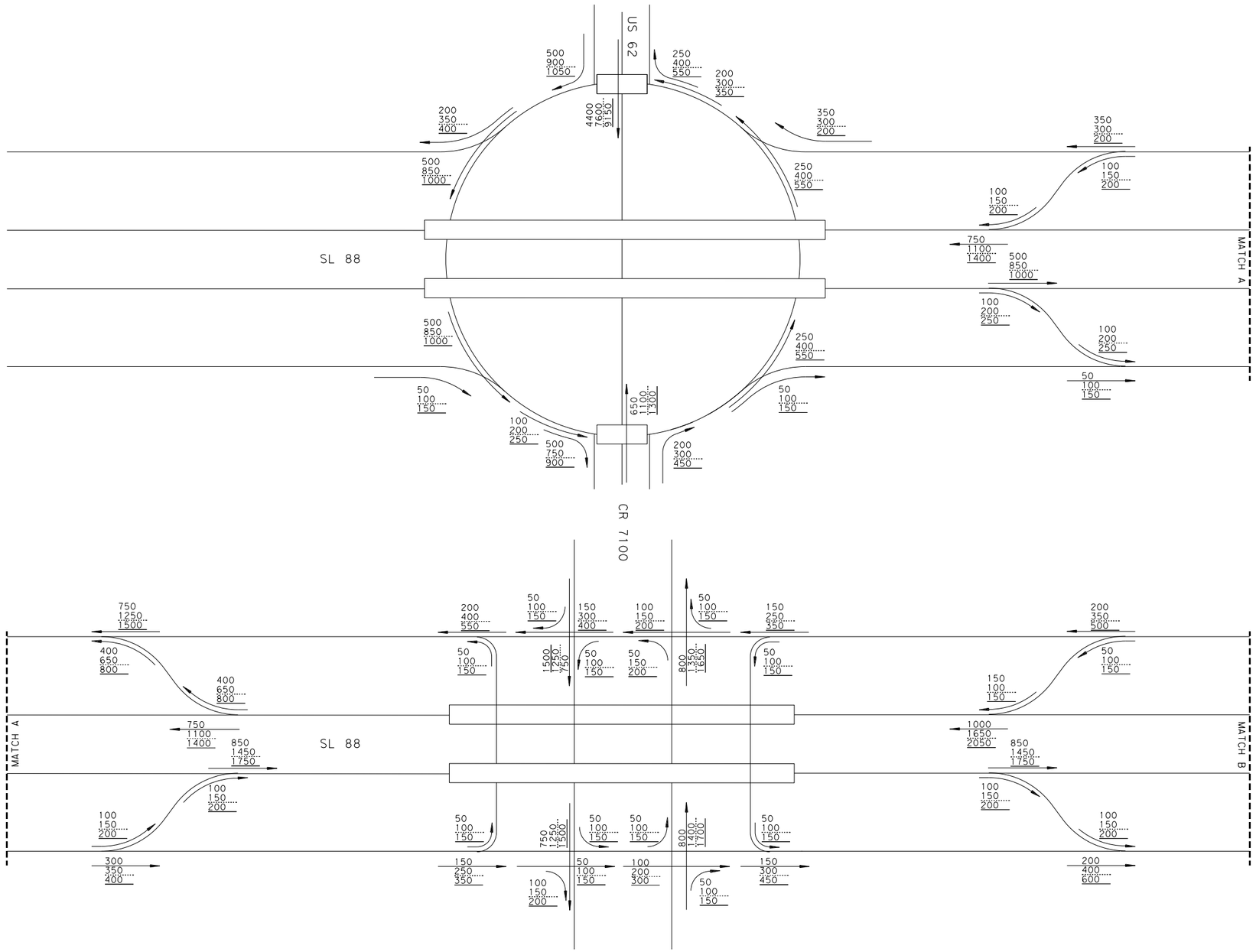
WALTER P MOORE
WALTER P. MOORE AND ASSOCIATES, INC.
1301 McKINNEY, SUITE 1100
HOUSTON, TEXAS 77010
Texas Firm Registration No. F-1856

Texas Department of Transportation
© 2016

FED. RD. DIV. NO.	FEDERAL AID PROJECT NO.		SHEET NO.
.	.		.
STATE	STATE DIST. NO.	COUNTY	
TEXAS	.	.	
CONT.	SECT	JOB	HIGHWAY NO.
XXXX	XX	XXX	.

Plotted: April 03, 2019 11:45:16 AM
Design File: P:\M03\2016\16072-01 TxDOT LBB Sect&Env Outer Route WA1 (Entech)\Traffic\Cad\Traffic\M03-16072-01-SEGMENT-01_SHT-03.dgn

SEGMENT 2



LEGEND
XXXX - 2030 AADT
XXXX - 2050 AADT
XXXX - 2060 AADT

PRELIMINARY
FOR REVIEW ONLY
THESE DOCUMENTS ARE PRELIMINARY AND SUBJECT TO CHANGE. THEY ARE NOT INTENDED FOR CONSTRUCTION OR BIDDING. THEY WERE PREPARED BY, OR UNDER THE SUPERVISION OF:
Engineer: THOMAS D. DUNCAN, P.E.
P.E. No.: 98353
Date: August 14, 2019

LUBBOCK

SEGEMENT 2
FORECASTED VOLUMES

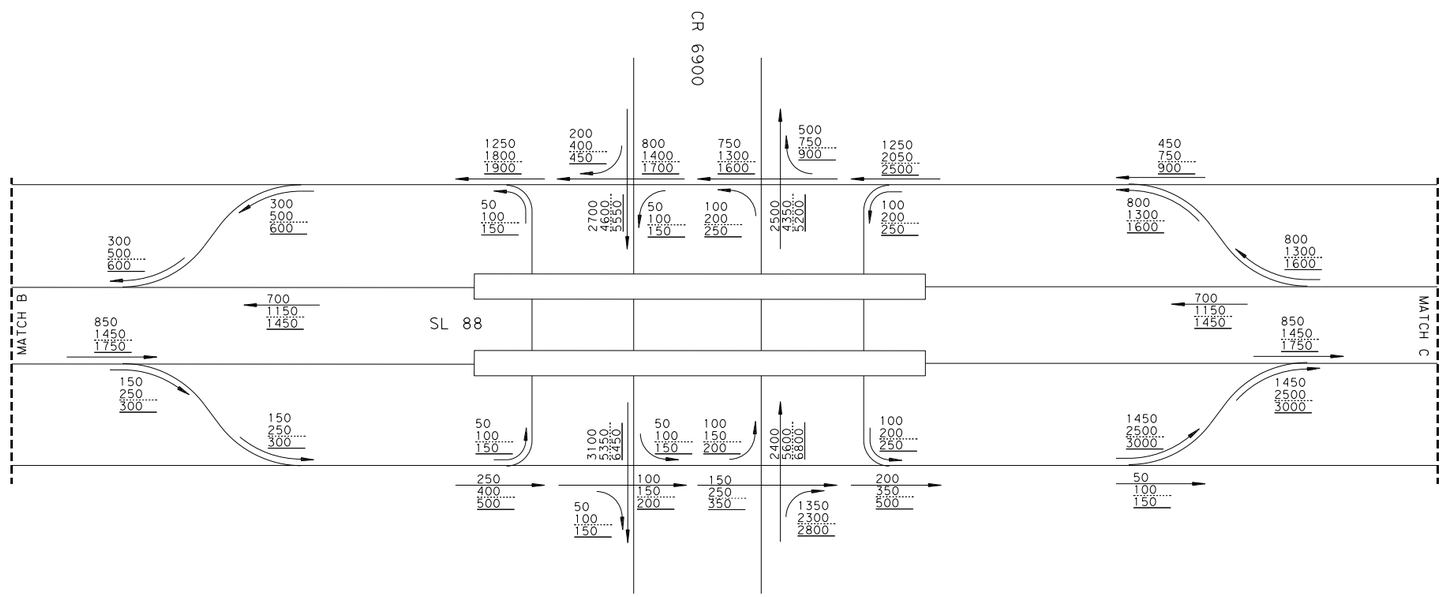
SHEET 1 OF 3
SCALE: N.T.S.

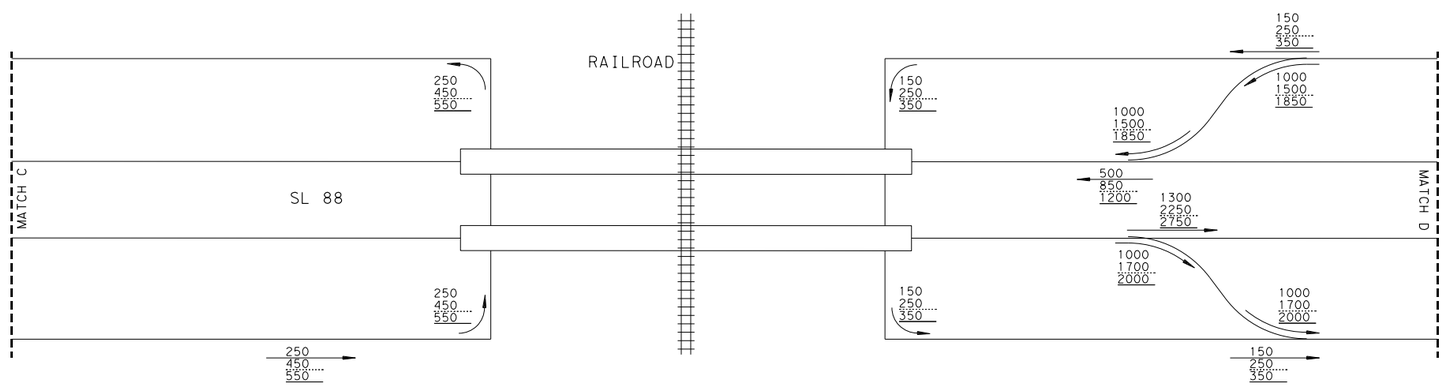
WALTER P MOORE
WALTER P. MOORE AND ASSOCIATES, INC.
1301 McKINNEY, SUITE 1100
HOUSTON, TEXAS 77010
Texas Firm Registration No. F-1856

Texas Department of Transportation
© 2016

FED. RD. DIV. NO.	FEDERAL AID PROJECT NO.		SHEET NO.
.	.		.
STATE	STATE DIST. NO.	COUNTY	
TEXAS	.	.	
CONT.	SECT	JOB	HIGHWAY NO.
XXXX	XX	XXX	.

Plotted: August 14, 2019 11:41:07 AM
Design File: P:\M03\2016\16072-01 TxDOT LBB Sct&Env Outer Route WA1 (Entech)\Traffic\Cad\Traffic\M03-16072-01-SEGMENT-02_SHT-01.dgn





LEGEND
XXXX - 2030 AADT
XXXX - 2050 AADT
XXXX - 2060 AADT

PRELIMINARY
FOR REVIEW ONLY
THESE DOCUMENTS ARE PRELIMINARY AND SUBJECT TO CHANGE. THEY ARE NOT INTENDED FOR CONSTRUCTION OR BIDDING. THEY WERE PREPARED BY, OR UNDER THE SUPERVISION OF:
Engineer: THOMAS D. DUNCAN, P.E.
P.E. No.: 98353
Date: August 14, 2019

LUBBOCK

SEGEMENT 2
FORECASTED VOLUMES

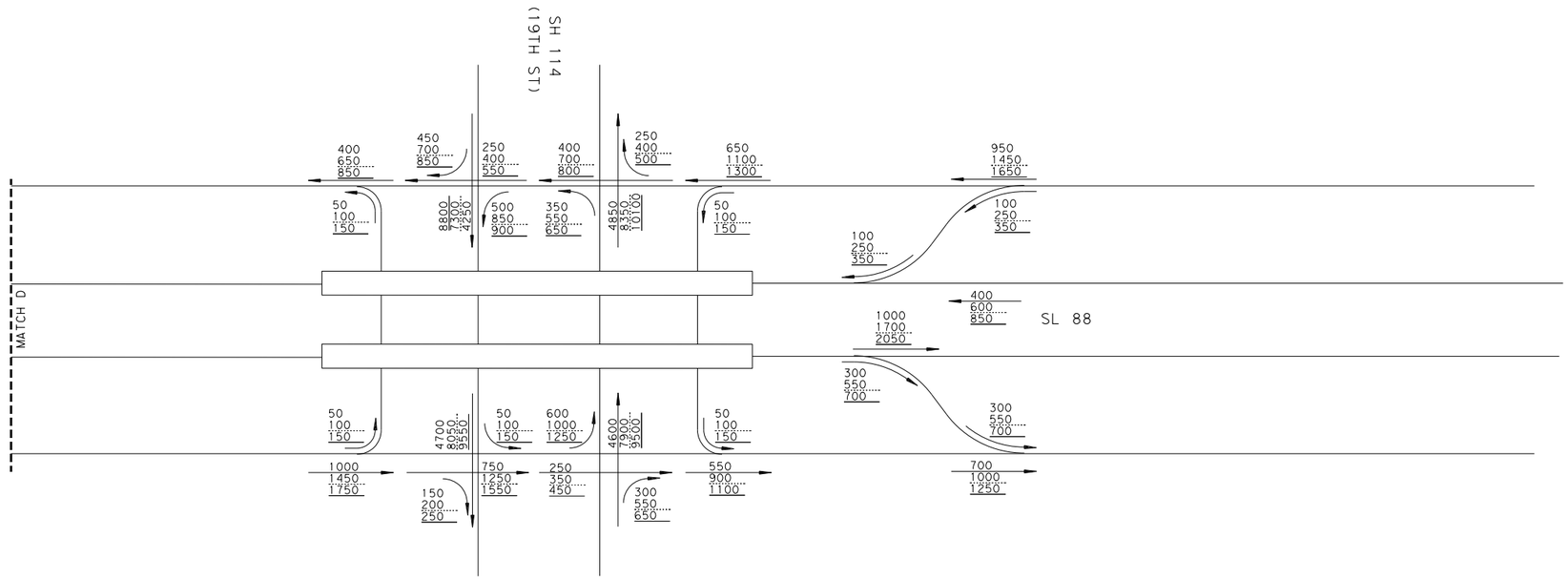
SHEET 2 OF 3
SCALE: N.T.S.

WALTER P MOORE
WALTER P. MOORE AND ASSOCIATES, INC.
1301 McKINNEY, SUITE 1100
HOUSTON, TEXAS 77010
Texas Firm Registration No. F-1856

Texas Department of Transportation
© 2016

FED. RD. DIV. NO.	FEDERAL AID PROJECT NO.		SHEET NO.
.	.		.
STATE	STATE DIST. NO.	COUNTY	
TEXAS	.	.	
CONT.	SECT	JOB	HIGHWAY NO.
XXXX	XX	XXX	.

Plotted: August 14, 2019 11:41:08 AM
Design File: P:\M03\2016\16072-01 TxDOT LBB Sch&Env Outer Route WA1 (Entech)\Traffic\Cad\Traffic\M03-16072-01-SEGMENT-02_SHT-02.dgn



LEGEND
XXXX - 2030 AADT
XXXX - 2050 AADT
XXXX - 2060 AADT

PRELIMINARY
FOR REVIEW ONLY
THESE DOCUMENTS ARE PRELIMINARY AND SUBJECT TO CHANGE. THEY ARE NOT INTENDED FOR CONSTRUCTION OR BIDDING. THEY WERE PREPARED BY, OR UNDER THE SUPERVISION OF:
Engineer: THOMAS D. DUNCAN, P.E.
P.E. No.: 98353
Date: August 14, 2019

LUBBOCK

SEGEMENT 2
FORECASTED VOLUMES

SHEET 3 OF 3
SCALE: N.T.S.

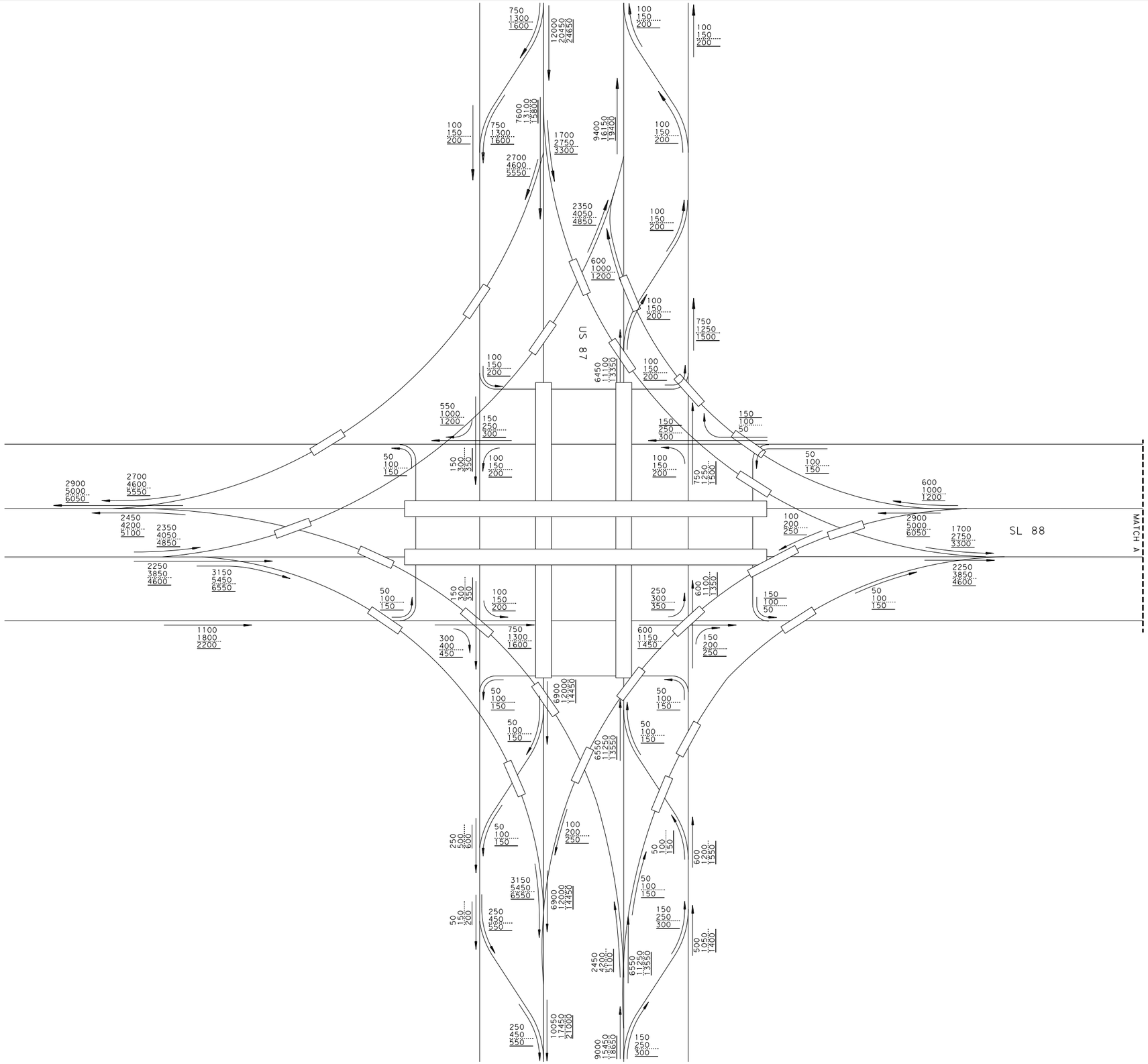
WALTER P MOORE
WALTER P. MOORE AND ASSOCIATES, INC.
1301 McKINNEY, SUITE 1600
HOUSTON, TEXAS 77010
Texas Firm Registration No. F-1856

Texas Department of Transportation
© 2016

FED. RD. DIV. NO.	FEDERAL AID PROJECT NO.		SHEET NO.
.	.		.
STATE	STATE DIST. NO.	COUNTY	
TEXAS	.	.	
CONT.	SECT	JOB	HIGHWAY NO.
XXXX	XX	XXX	.

Plotted: August 14, 2019 11:41:09 AM
Design File: P:\M03\2016\16072-01 TxDOT LBB Sch&Env Outer Route WA1 (Entech)\Traffic\Cad\Traffic\M03-16072-01-SEGMENT-02_SHT-03.dgn

SEGMENT 4



LEGEND
XXXX - 2030 AADT
XXXX - 2050 AADT
XXXX - 2060 AADT

PRELIMINARY
FOR REVIEW ONLY
THESE DOCUMENTS ARE PRELIMINARY AND SUBJECT TO CHANGE. THEY ARE NOT INTENDED FOR CONSTRUCTION OR BIDDING. THEY WERE PREPARED BY, OR UNDER THE SUPERVISION OF:
Engineer: THOMAS D. DUNCAN, P.E.
P.E. No.: 98353
Date: 7/3/2019

LUBBOCK

SEGEMENT 4
FORECASTED VOLUMES

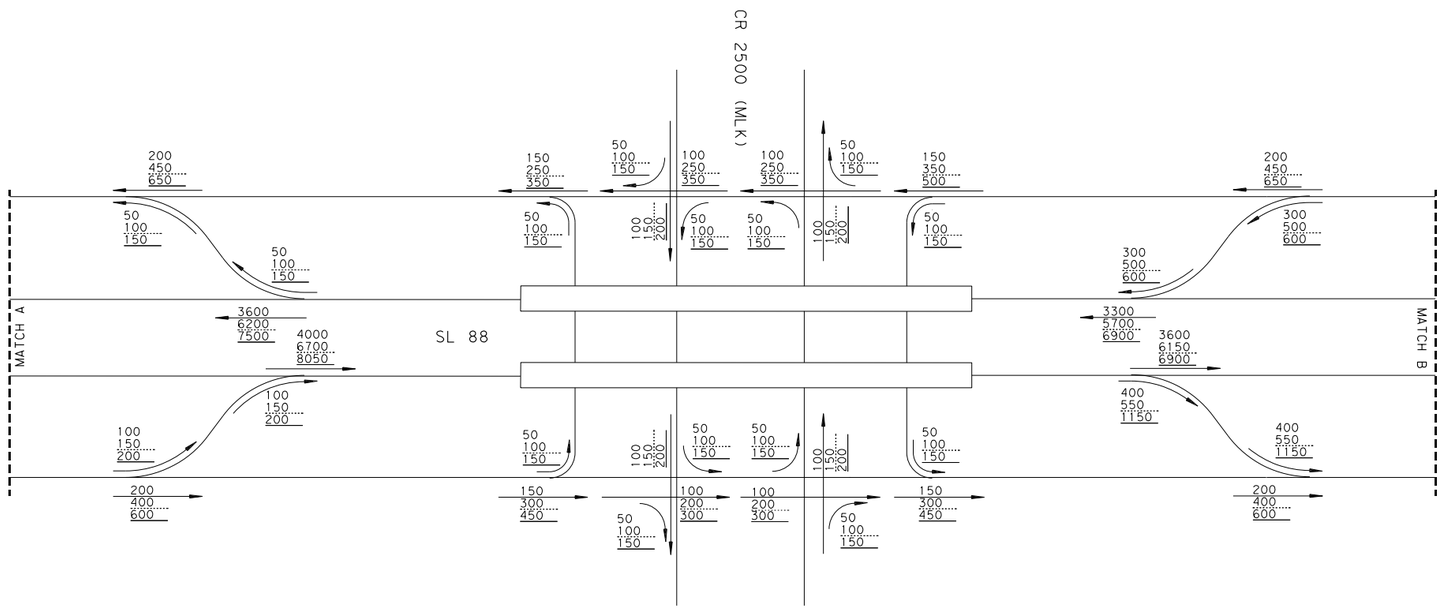
SHEET 1 OF 4
SCALE: N.T.S.

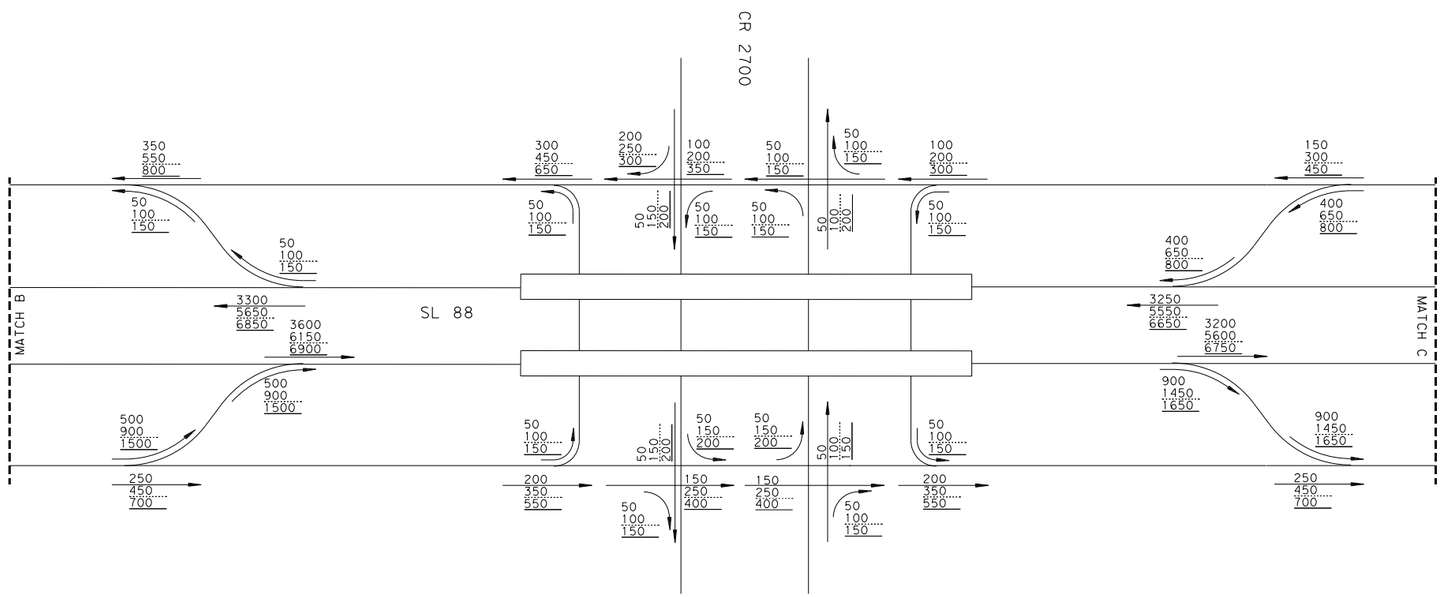
WALTER P MOORE
WALTER P. MOORE AND ASSOCIATES, INC.
1504 McKINNEY, SUITE 1900
HOUSTON, TEXAS 77010
Texas Firm Registration No. F-1856

Texas Department of Transportation
© 2016

FED. RD. DIV. NO.	FEDERAL AID PROJECT NO.		SHEET NO.
.	.		.
STATE	STATE DIST. NO.	COUNTY	
TEXAS	.	.	
CONT.	SECT	JOB	HIGHWAY NO.
XXXX	XX	XXX	.

Plotted: 7/3/2019 1:03:23 PM
Design File: P:\M03\2016\16072-01 TxDOT LBB Sch&Env Outer Route WA1 (Entech)\Traffic\Cad\Traffic\M03-16072-01-SEGMENT-04_SHT-01.dgn





LEGEND
XXXX - 2030 AADT
XXXX - 2050 AADT
XXXX - 2060 AADT

PRELIMINARY
FOR REVIEW ONLY
THESE DOCUMENTS ARE PRELIMINARY AND SUBJECT TO CHANGE. THEY ARE NOT INTENDED FOR CONSTRUCTION OR BIDDING. THEY WERE PREPARED BY, OR UNDER THE SUPERVISION OF:
Engineer: THOMAS D. DUNCAN, P.E.
P.E. No.: 98353
Date: 7/3/2019

LUBBOCK

SEGEMENT 4 FORECASTED VOLUMES

SHEET 2 OF 4

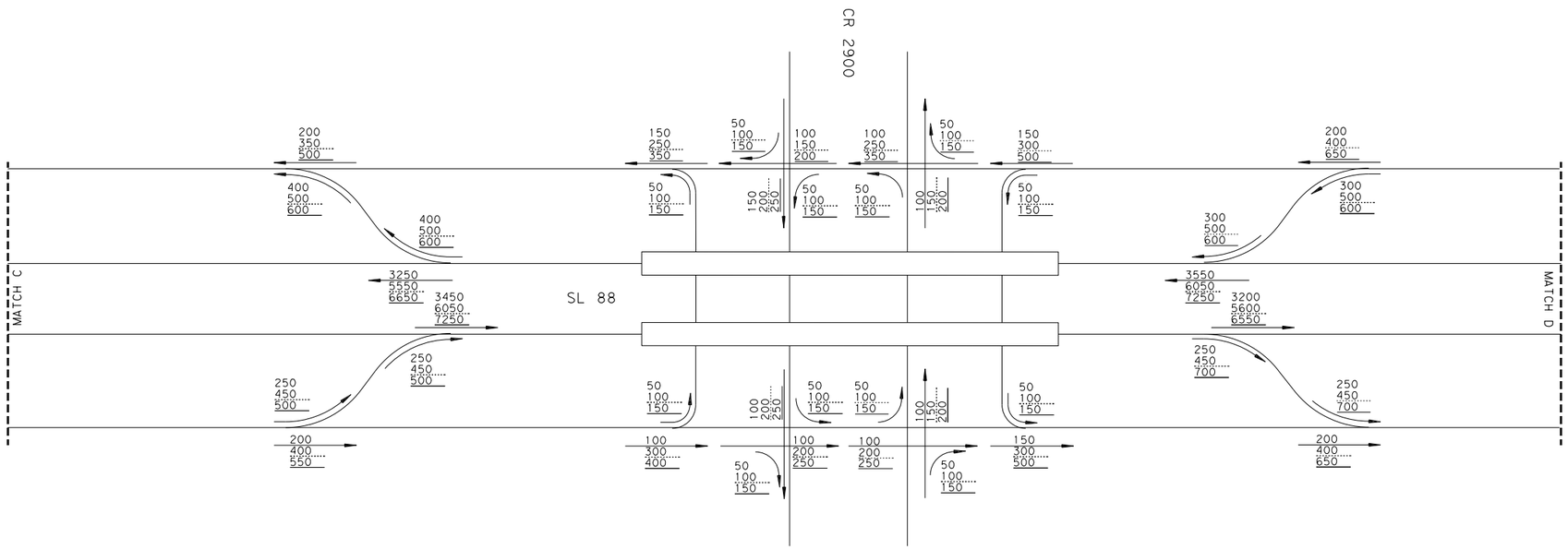
SCALE: N.T.S.

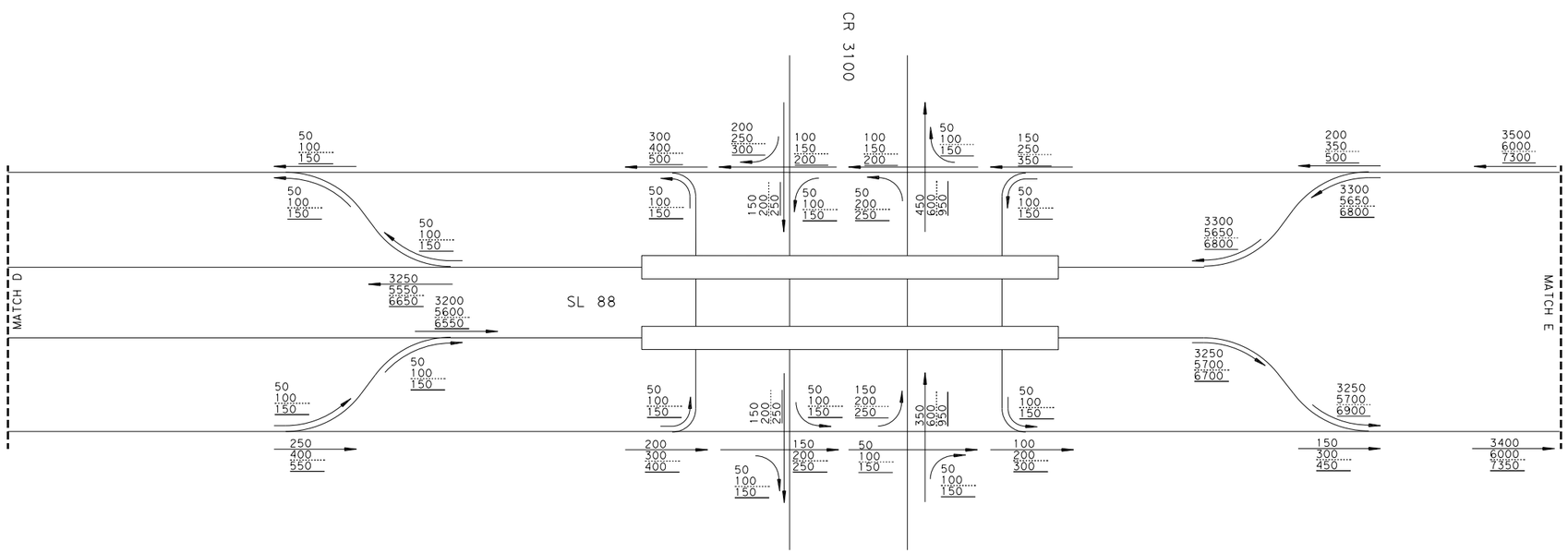
WALTER P MOORE
WALTER P. MOORE AND ASSOCIATES, INC.
1301 McKINNEY, SUITE 1100
HOUSTON, TEXAS 77010
Texas Firm Registration No. F-1856

Texas Department of Transportation
© 2016

FED. RD. DIV. NO.	FEDERAL AID PROJECT NO.		SHEET NO.
.	.		.
STATE	STATE DIST. NO.	COUNTY	
TEXAS	.	.	
CONT.	SECT	JOB	HIGHWAY NO.
XXXX	XX	XXX	.

Plotted: 7/3/2019 1:03:39 PM
Design File: P:\M03\2016\16072-01 TxDOT LBB Sch&Env Outer Route WA1 (Entech)\Traffic\Cad\Traffic\M03-16072-01-SEGMENT-04_SHT-02.dgn





LEGEND
XXXX - 2030 AADT
XXXX - 2050 AADT
XXXX - 2060 AADT

PRELIMINARY
FOR REVIEW ONLY
THESE DOCUMENTS ARE PRELIMINARY AND SUBJECT TO CHANGE. THEY ARE NOT INTENDED FOR CONSTRUCTION OR BIDDING. THEY WERE PREPARED BY, OR UNDER THE SUPERVISION OF:
Engineer: THOMAS D. DUNCAN, P.E.
P.E. No.: 98353
Date: 7/3/2019

LUBBOCK

SEGEMENT 4
FORECASTED VOLUMES

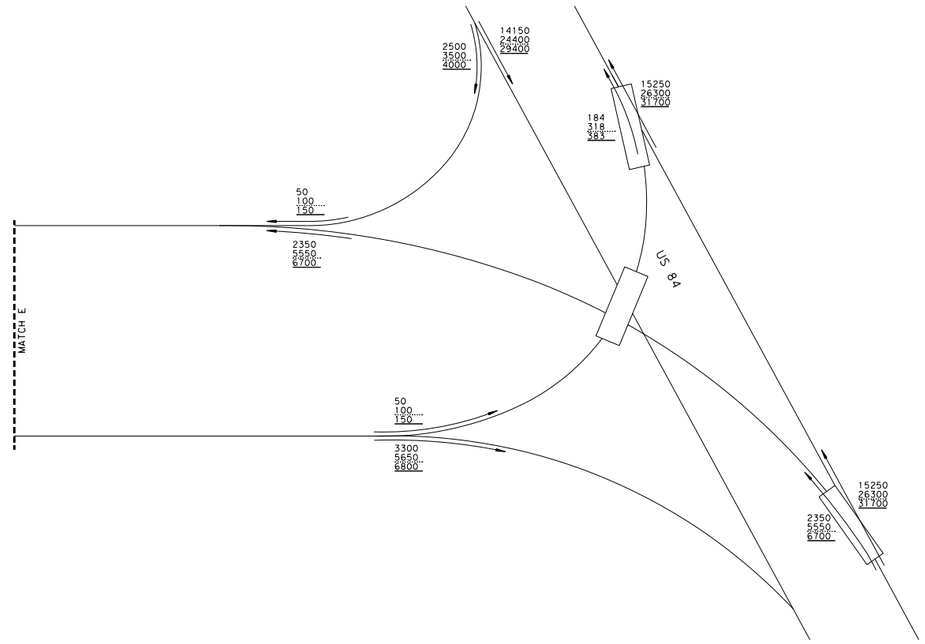
SHEET 3 OF 4
SCALE: N.T.S.

WALTER P MOORE
WALTER P. MOORE AND ASSOCIATES, INC.
1021 N McKINNEY, SUITE 1900
HOUSTON, TEXAS 77010
Texas Firm Registration No. F-1856

Texas Department of Transportation
© 2016

FED. RD. DIV. NO.	FEDERAL AID PROJECT NO.		SHEET NO.
.	.		.
STATE	STATE DIST. NO.	COUNTY	
TEXAS	.	.	
CONT.	SECT	JOB	HIGHWAY NO.
XXXX	XX	XXX	.

Plotted: 7/3/2019 1:03:55 PM
Design File: P:\M03\2016\16072-01 TxDOT LBB Sect&Env Outer Route WA1 (Entech)\Traffic\Cad\Traffic\M03-16072-01-SEGMENT-04_SHT-03.dgn



LEGEND
XXXX - 2030 AADT
XXXX - 2050 AADT
XXXX - 2060 AADT

PRELIMINARY
FOR REVIEW ONLY
THESE DOCUMENTS ARE PRELIMINARY AND SUBJECT TO CHANGE. THEY ARE NOT INTENDED FOR CONSTRUCTION OR BIDDING. THEY WERE PREPARED BY, OR UNDER THE SUPERVISION OF:
Engineer: THOMAS D. DUNCAN, P.E.
P.E. No.: 98353
Date: 7/3/2019

LUBBOCK

SEGEMENT 4
FORECASTED VOLUMES

SHEET 4 OF 4
SCALE: N.T.S.

WALTER P MOORE
WALTER P. MOORE AND ASSOCIATES, INC.
1301 McKINNEY, SUITE 1100
HOUSTON, TEXAS 77010
Texas Firm Registration No. F-1856

Texas Department of Transportation
© 2016

FED. RD. DIV. NO.	FEDERAL AID PROJECT NO.		SHEET NO.
.	.		.
STATE	STATE DIST. NO.	COUNTY	
TEXAS	.	.	
CONT.	SECT	JOB	HIGHWAY NO.
XXXX	XX	XXX	.

Plotted: 7/3/2019 1:04:10 PM
Design File: P:\M03\2016\16072-01 TxDOT LBB Sch&Env Outer Route WA1 (Entech)\Traffic\Cad\Traffic\M03-16072-01-SEGMENT-04_SHT-04.dgn

Appendix D

Traffic Analysis for Highway Design Table

TRAFFIC ANALYSIS FOR HIGHWAY DESIGN

Lubbock

May 22, 2019

Description of Location	Average Daily Traffic 2030	Average Daily Traffic 2050	Base Year Dir Dist %	Base Year K Factor	Base Year Percent Trucks ADT	Base Year Percent Trucks DHV	ATHWLD	Percent Tandem Axles in	Total Number of Equivalent 18k Single Axle Load Applications One Direction Expected for a 20 Year Period (2020 to 2040) Flexible Pavement	SN	Rigid Pavement	SLAB
LP 88 Segment 1	3,150	5,100	50 -50	10	12.4	11.6						

Data for Use in Air & Noise Analysis		
	Base Year	
Vehicle Class	% of ADT	% of DHV
Light Duty	87.6	88.5
Medium Duty	3.2	3.7
Heavy Duty	9.2	7.8

Description of Location	Average Daily Traffic 2030	Average Daily Traffic 2060	Base Year Dir Dist %	Base Year K Factor	Base Year Percent Trucks ADT	Base Year Percent Trucks DHV	ATHWLD	Percent Tandem Axles in	Total Number of Equivalent 18k Single Axle Load Applications One Direction Expected for a 20 Year Period (2020 to 2040) Flexible Pavement	SN	Rigid Pavement	SLAB
LP 88 Segment 1	3,150	6,250	50 -50	10	12.4	11.6						

TRAFFIC ANALYSIS FOR HIGHWAY DESIGN

Lubbock

May 22, 2019

Description of Location	Average Daily Traffic 2030	Average Daily Traffic 2050	Base Year Dir Dist %	Base Year K Factor	Base Year Percent Trucks ADT	Base Year Percent Trucks DHV	ATHWLD	Percent Tandem Axles in	Total Number of Equivalent 18k Single Axle Load Applications One Direction Expected for a 20 Year Period (2020 to 2040) Flexible Pavement	SN	Rigid Pavement	SLAB
LP 88 Segment 2	3,050	4,950	50 -50	10	12.4	11.6						

Data for Use in Air & Noise Analysis		
	Base Year	
Vehicle Class	% of ADT	% of DHV
Light Duty	87.6	88.5
Medium Duty	3.2	3.7
Heavy Duty	9.2	7.8

Description of Location	Average Daily Traffic 2030	Average Daily Traffic 2060	Base Year Dir Dist %	Base Year K Factor	Base Year Percent Trucks ADT	Base Year Percent Trucks DHV	ATHWLD	Percent Tandem Axles in	Total Number of Equivalent 18k Single Axle Load Applications One Direction Expected for a 20 Year Period (2020 to 2040) Flexible Pavement	SN	Rigid Pavement	SLAB
LP 88 Segment 2	3,050	6,100	50 -50	10	12.4	11.6						