APPENDIX C
AIR QUALITY TECHNICAL REPORT

Air Quality Technical Report

North Houston Highway Improvement Project

From US 59/I-69 at Spur 527 to I-45 at Beltway 8 North
CSJ 0912-00-146
Prepared By: TxDOT Houston District
Date: March 2017

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.

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1.0 Introduction

TxDOT proposes to construct improvements to Interstate (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 proposed project is composed of three segments, Segments 1, 2 and 3, for which reasonable alternatives are evaluated in the Draft Environmental Impact Statement (DEIS) (see **Figure 1**).

This project is located within Harris County, which is part of the Houston-Galveston Area Council (H-GAC) and Houston-Galveston-Brazoria area that has been designated by EPA as a moderate nonattainment area for the 2008 Ozone National Ambient Air Quality Standard (NAAQS); therefore, transportation conformity rules apply.

Both the 2040 Regional Transportation Plan (RTP) and the 2017-2020 Transportation Improvement Program (TIP) were initially found to conform to the TCEQ State Implementation Plan (SIP) by FHWA and FTA on September 11, 2015 and December 19, 2016 respectively; however, the proposed project is not consistent with this conformity determination, because the project is not included in the RTP or TIP. TxDOT will not take final action on this environmental document until the proposed project is consistent with a currently conforming RTP and TIP.

This report includes a Carbon Monoxide (CO) analysis, a qualitative Mobile Source Air Toxics (MSAT) analysis, and a Congestion Management Process (CMP) analysis. A quantitative MSAT analysis and project-level CMP analysis will be conducted in the Final Environmental Impact Statement (FEIS). The project is not located within a CO or PM nonattainment or maintenance area; therefore, a project level hot-spot analysis is not required.

2.0 Project Description

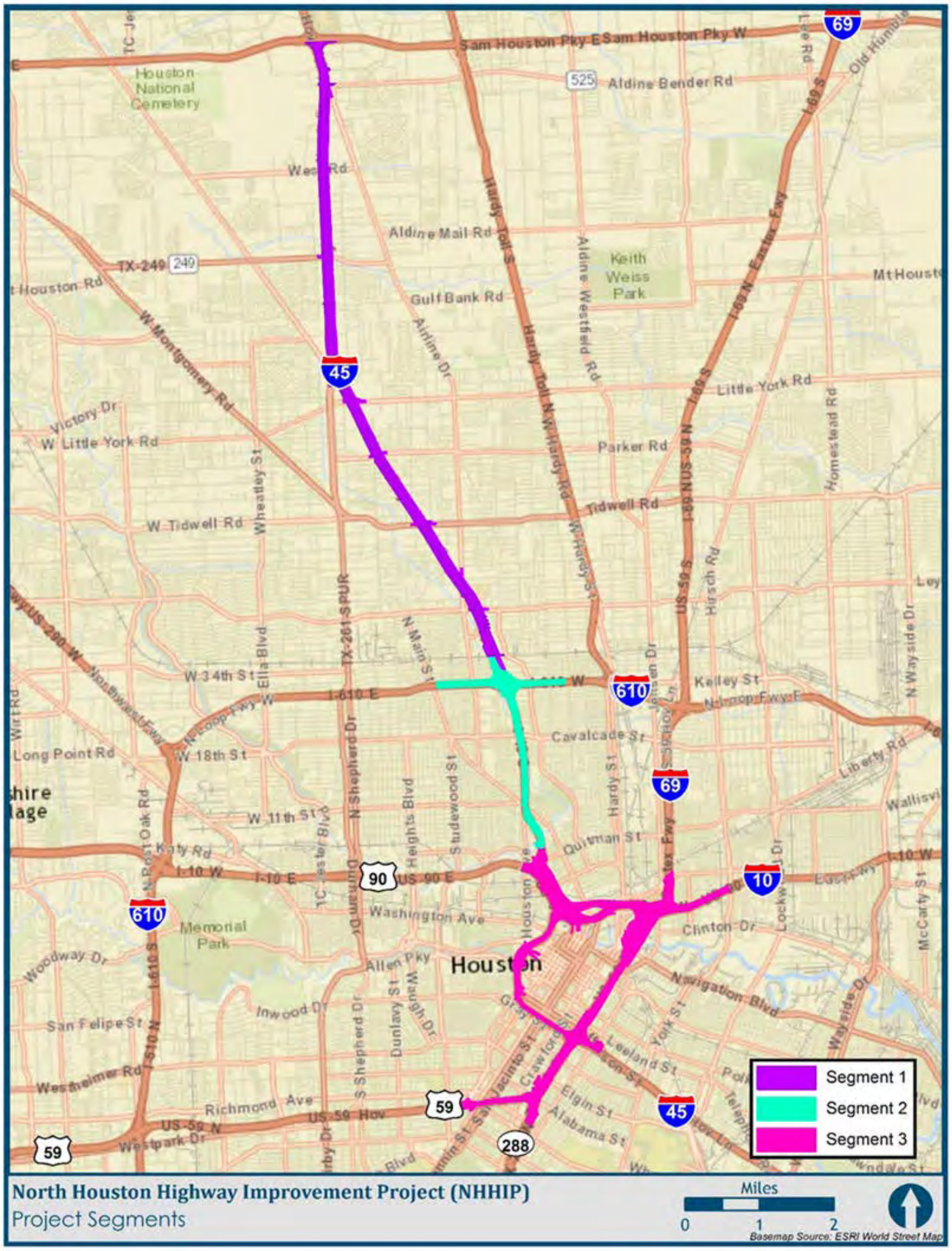
The three roadway segments and their existing typical section, as well as the proposed typical sections for each alternative, are described below.

Existing Facilities

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 frontage road lanes (two lanes in each direction), and a reversible high occupancy vehicle (HOV) lane in the middle, all within a variable right-of-way (ROW) 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).

Figure 1: Project Segments



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 347 acres.

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

I-45 within this segment primarily consists of eight at-grade general purpose lanes (four lanes in each direction), six frontage road lanes (three lanes in each direction), and a reversible HOV lane in the middle, all within a variable ROW 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 six frontage road lanes associated with the depressed section (three lanes in each direction) 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 south of Downtown Houston.

I-45 along the west side of Downtown Houston consists of six elevated general purpose lanes (three lanes in each direction) within an existing ROW of 205 feet. I-45 along the south side of Downtown Houston (the Pierce Elevated) consists of six elevated general purpose lanes (three lanes in each direction). I-10 north of Downtown Houston, between I-45 and US 59/I-69, consists of 10 general purpose lanes (five lanes in each direction) within an existing ROW of 420 feet. US 59/I-69 along the east side of Downtown Houston consists of six general purpose lanes (three lanes in each direction) within an existing ROW of 225 feet. 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 7.1 miles, and the existing ROW area is approximately 637 acres.

Proposed Alternatives

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

Segment 1, Alternative 4: Widen I-45 Mostly to the West (Proposed Recommended)

Alternative 4 would widen the existing I-45 on the west side of the roadway to accommodate four managed express (MaX) lanes. The proposed typical section would include eight general purpose lanes (four lanes in each direction), four MaX lanes (two lanes in each direction), and six frontage road lanes (three lanes in each direction), all at-grade. Alternative 4 would require approximately 200 to 225 feet of new ROW to the west of the existing I-45. This alternative would require small amounts of land to the east of the existing I-45 ROW at major intersections and between Crosstimbers Street and I-610. Approximately 212 acres of new ROW would be required for this alternative. The length of this alternative would be approximately 8.8 miles.

Segment 1, Alternative 5: Widen I-45 Mostly to the East

Alternative 5 would widen the existing I-45 along the east side of the roadway to accommodate four MaX lanes. The proposed typical section would include eight general purpose lanes (four lanes in each direction), four MaX lanes (two lanes in each direction), and six frontage road lanes (three lanes in each direction), all at-grade. Alternative 5 would require approximately 200 to 225 feet of new ROW to the east of the existing I-45. This alternative would require small amounts of land to the west of the existing I-45 ROW at major intersections. Approximately 239 acres of new ROW would be required for this alternative. The length of this alternative would be approximately 8.8 miles.

Segment 1, Alternative 7: Widen I-45 on Both Sides

Alternative 7 would widen the existing I-45 along both the east and west sides of the roadway to accommodate four elevated MaX lanes. The proposed typical section would include eight general purpose lanes (four lanes in each direction) at-grade, four elevated MaX lanes (two lanes in each direction) on a single structure constructed along the center of the roadway, and six frontage road lanes (three lanes in each direction) at-grade. Alternative 7 would require approximately 45 to 80 feet of new ROW along both sides of the existing I-45. Approximately 120 acres of new ROW would be required for this alternative. The length of this alternative would be approximately 8.8 miles.

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

Segment 2, Alternative 10: Add Four MaX Lanes to I-45 (Proposed Recommended)

Alternative 10 would widen the existing I-45 to accommodate four MaX lanes. Within the at-grade section of I-45, the proposed typical section would include eight general purpose lanes (four lanes in each direction), four MaX lanes (two lanes in each direction), and four frontage road lanes (two lanes in each direction), all at-grade. For this alternative, I-45 would be depressed from north of Cottage Street to Norma Street, a distance of approximately 1,800 feet. Within the depressed section of I-45, the proposed typical section would include eight below-grade general purpose lanes (four lanes in each direction), and four below-grade MaX lanes (two lanes in each direction), while the four frontage road lanes (two lanes in each direction) would be at-grade. The proposed I-45 and I-610 frontage roads would be continuous through the I-45/I-610 interchange. Alternative 10 would require new ROW for the at-grade section between I-610 and Cottage Street, and between Little White Oak Bayou and Norma Street. Approximately 19 acres of new ROW would be required for this alternative. The length of this alternative, including interchange improvements, would be approximately 4.5 miles.

This alternative provides an opportunity to include a structural “cap” over a portion of the depressed lanes of I-45 from north of Cottage Street to south of N. Main Street. This area could be used as open space. The open space option is conceptual only and would be separate from TxDOT’s roadway project. Any open space would require development and funding by parties other than TxDOT.

Segment 2, Alternative 11: Add Four Elevated MaX Lanes in the Center of I-45

Alternative 11 would widen the existing I-45 and add four elevated MaX lanes. Within the at-grade section of I-45, the proposed typical section would include eight general purpose lanes (four lanes in each direction) and four frontage road lanes (two lanes in each direction), all at-grade, while the four MaX lanes (two lanes in each direction) would be elevated on a single structure at the center of the roadway. Within the depressed section of I-45, the proposed typical section would include eight general purpose lanes (four lanes in each direction) below grade, four MaX lanes (two lanes in each direction) elevated on a single structure at the center of the roadway, and four frontage road lanes (two lanes in each direction) 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 for the at-grade section between I-610 and Cavalcade Street to accommodate the proposed improvements at the I-45/I-610 interchange. No new ROW would be required for the depressed section. Approximately 10 acres of new ROW would be required for this alternative. The length of this alternative, including interchange improvements, would be approximately 4.5 miles.

Segment 2, Alternative 12: Add Four MaX Lanes (Two Elevated) in the Center of I-45

Alternative 12 would widen the existing I-45 and add two elevated and two at-grade MaX lanes. Within the at-grade section of I-45, the proposed typical section would include eight general purpose lanes (four lanes in each direction) and four frontage road lanes (two lanes in each direction), all at-grade, while the four MaX lanes (two lanes in each direction) would be stacked (the two northbound MaX lanes would be at-grade and the two southbound MaX lanes would be elevated on a single structure along the center of the roadway). Within the depressed section of I-45, the proposed typical section would include eight general purpose lanes (four lanes in each direction) below grade, four MaX lanes (two lanes in each direction) that would be stacked (the two northbound MaX lanes would be below grade and the two southbound MaX lanes would be elevated on a single structure along the center of the roadway), and four frontage road lanes (two lanes in each direction) that 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 for the at-grade section between I-610 and Cavalcade Street to accommodate the proposed improvements at the I-45/I-610 interchange. No new ROW would be required for the depressed section. Approximately 12 acres of new ROW would be required for this alternative. The length of this alternative, including interchange improvements, would be approximately 4.5 miles.

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

Segment 3, Alternative 10: Widen I-45 to 10 Lanes

Alternative 10 is an "improve existing" alternative, with the existing interstate highways around Downtown Houston remaining in their current configuration. Alternative 10 would widen the existing I-45 within its existing footprint along the west and south sides of Downtown Houston. The elevated portion of I-45 west and south of Downtown would be reconstructed. The proposed typical section of the widened I-45 would include 10 elevated general purpose lanes; however, the lane configuration would be altered to have six northbound lanes and four southbound lanes. The I-45 MaX lanes proposed in Segments 1 and 2 would terminate in the Downtown area in Segment 3. The I-45 MaX lanes would be parallel to I-10 in the vicinity of the I-45/I-10 interchange and would terminate/begin at Milam Street/Travis Street, respectively. I-10 along the north side of Downtown, between I-45 and US 59/I-69, would be slightly realigned to accommodate four elevated I-10 express lanes (two lanes in each direction) on this segment of I-10. The I-10 express lanes would generally be parallel to I-10, and located on the north side of White Oak Bayou. West of the I-45/I-10 interchange, the I-10 express lanes would connect to the existing I-10 HOV lanes. US 59/I-69 along the east side of Downtown would generally remain in its current configuration. Alternative 10 would require new ROW along I-45 from I-10 to Houston Avenue and from Brazos Street to US 59/I-69. Alternative 10 would require approximately 76 acres of new ROW. The length of this alternative, including interchange improvements, would be approximately 4.4 miles.

Segment 3, Alternative 11: Realign I-45 along I-10 and US 59/I-69 (Proposed Recommended)

Alternative 11 would reroute I-45 to be coincident with US 59/I-69 on the east side of Downtown Houston. The existing elevated I-45 roadway along the west and south sides of Downtown would be removed and relocated 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," which would provide access to and from various Downtown streets. To improve safety and traffic flow in the north and east portions of the proposed project area, both I-10 and US 59/I-69 would be realigned 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, I-45 would begin to elevate to the interchange of I-45 and US 59/I-69 southeast of Downtown, while US 59/I-69 would remain depressed as it continues southwest toward 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 coincidental 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. Approximately 190 feet of 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. The existing Hamilton Street would be realigned to be adjacent to US 59/I-69 to serve as the southbound frontage road, and the existing St. Emanuel Street would serve as the northbound frontage road. Alternative 11 would require approximately 160 acres of new ROW, the majority of which would be for the I-10 and US 59/I-69 realignments, and to construct the proposed I-45 lanes adjacent to US 59/I-69 along the east side of Downtown. The length of this alternative, including roadway realignments and interchange improvements, would be approximately 12.0 miles.

This alternative provides an opportunity to include a structural “cap” over the proposed depressed lanes of I-45 and US 59/I-69 from approximately Commerce Street to Lamar Street. This area could be used as open space. The open space option is conceptual only and would be separate from TxDOT’s roadway project. Any open space project would require development and funding by parties other than TxDOT.

Segment 3, Alternative 12: Realign Northbound I-45 along US 59/I-69 and I-10

Alternative 12 would reroute northbound I-45 to be coincident with US 59/I-69 on the east side of Downtown Houston. An elevated structure would be constructed to accommodate four I-45 northbound general purpose lanes that would be located east of the existing US 59/I-69 general purpose lanes. Northbound I-45 traffic would continue on elevated lanes constructed between the I-10 general purpose lanes, then would move northward into Segment 2. Southbound I-45 traffic at the I-45/I-10 interchange northwest of Downtown would be directed onto one-way general purpose lanes along the west and south sides of Downtown, following the existing Pierce Elevated footprint. 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) are proposed to be located along the portion of the existing I-10 north of Downtown between the interchanges of I-10 and I-45, and I-10 and US 59/I-69. Near the US 59/I-69 interchange, the I-10 express lanes would be located at-grade in the center of the general purpose lanes, then would shift to become elevated and generally parallel to I-10, but located on the north side of White Oak Bayou. West of the I-45/I-10 interchange, the I-10 express lanes would connect to the existing I-10 HOV lanes. US 59/I-69 along the east side of Downtown would generally remain in its current configuration, with the I-45 one-way northbound lanes being immediately adjacent to this segment of US 59/I-69. Alternative 12 would require approximately 109 acres of new ROW. The length of this alternative, including interchange improvements, would be approximately 9.8 miles.

3.0 Carbon Monoxide (CO) Analysis

Background Information

Traffic for the estimated time of completion (ETC) year (2025) and design year (2035) is shown by segment and alternative in **Table 1**. Since the project would add capacity and the design year traffic volume is above 140,000 vehicles per day (vpd) for each alternative, a traffic air quality analysis (TAQA) is required to assess whether the project would adversely affect local air quality by contributing to CO levels that exceed the 1-hour or 8-hour CO NAAQS. The traffic data was obtained from CDM Smith (2015) and based on methodologies accepted by the TxDOT Transportation Planning and Programming (TP&P) Division.

Table 1: Projected Annual Average Daily Traffic and Design Hour Volume along I-45 Segments and Alternatives

Segment/Alternative	*AADT*		*DHV*	
	2025 (ETC)	2035 (Design)	2025 (ETC)	2035 (Design)
Segment 1, Alternative 4: Airline to Stokes	324,620	342,337	18,783	19,801
Segment 2, Alternative 10: Main St to Quitman Rd	239,916	257,894	14,394	15,473
Segment 3, Alternative 10				
Area 2: IH 10/IH 45 from Downtown Connectors to IH 69/US 59	138,229	156,757	14,462	16,400
Area 4: IH 45 Parallel with Pierce St	219,275	234,523	15,895	17,000
Segment 3, Alternative 11				
Area 1: IH 45/IH 10 from IH 10/IH 45 split to Downtown Connectors	350,293	386,130	27,684	30,600
Area 2: IH 10/IH 45 from Downtown Connectors to IH 69/US 59	266,267	294,307	21,511	23,900
Area 3: IH 45/US 59 from IH 10/IH 45 to SH 288	366,781	393,517	31,782	34,100
Segment 3, Alternative 12				
Area 2: IH 10/IH 45 from Downtown Connectors to IH 69/US 59	202,636	225,637	18,954	21,200
Area 3: IH 45/US 59 from IH 10/IH 45 to SH 288	375,642	403,002	31,219	33,500
Area 4: IH 45 Parallel with Pierce St	111,777	119,550	8,041	8,600

Analysis Methodology

CALINE3 is a steady-state Gaussian dispersion model designed to determine air pollution concentrations, and was considered an appropriate model to use for the CO analysis by the TxDOT Environmental Affairs Division. CO concentrations for the build alternatives were modeled for the ETC and design years using the latest version of CALINE3 and factoring in adverse meteorological conditions at receptors located at the ROW line. The following are the worst-case assumptions and input parameters used in the analysis, in accordance with Appendix D of TxDOT's Standard Operating Procedure for Complying with CO TAQA Requirements (2015):

- 1-hour background concentration of 2.5 ppm
- 8-hour background concentration of 1.9 ppm
- Averaging time of 60 minutes
- Atmospheric Stability Class of 6
- Mixing height of 1,000 meters
- Wind speed of 1 meter per second
- Winds blowing parallel to the roadway

Because of the similarity between the alternatives for Segments 1 and Segments 2, it was determined by the Houston District that one representative model would be sufficient for each of these segments. Each of the three alternatives for Segment 3 was modeled. The areas selected for modeling were based upon the highest AADT and best available schematic and typical sections data. **Figures 2-4** depict the areas used within each segment for the analysis. The emissions rates were gathered from the TxDOT Emission Rates Table (TxDOT Air Quality Toolkit, July 2014) and are identified in **Table 2** below.

Table 2: Emission Rates and Projected Vehicle Speeds

Segment/Alternative	Emissions Rates		
	2025	2035	Projected Speed
Segments 1 and 2 (main lanes and HOV)	1.5	1.4	60
Segments 1 and 2 (frontage roads)	1.6	1.5	45
Segment 3 (main lanes and HOV)	1.5	1.5	50

Figure 1: Segment 1 Analysis Area

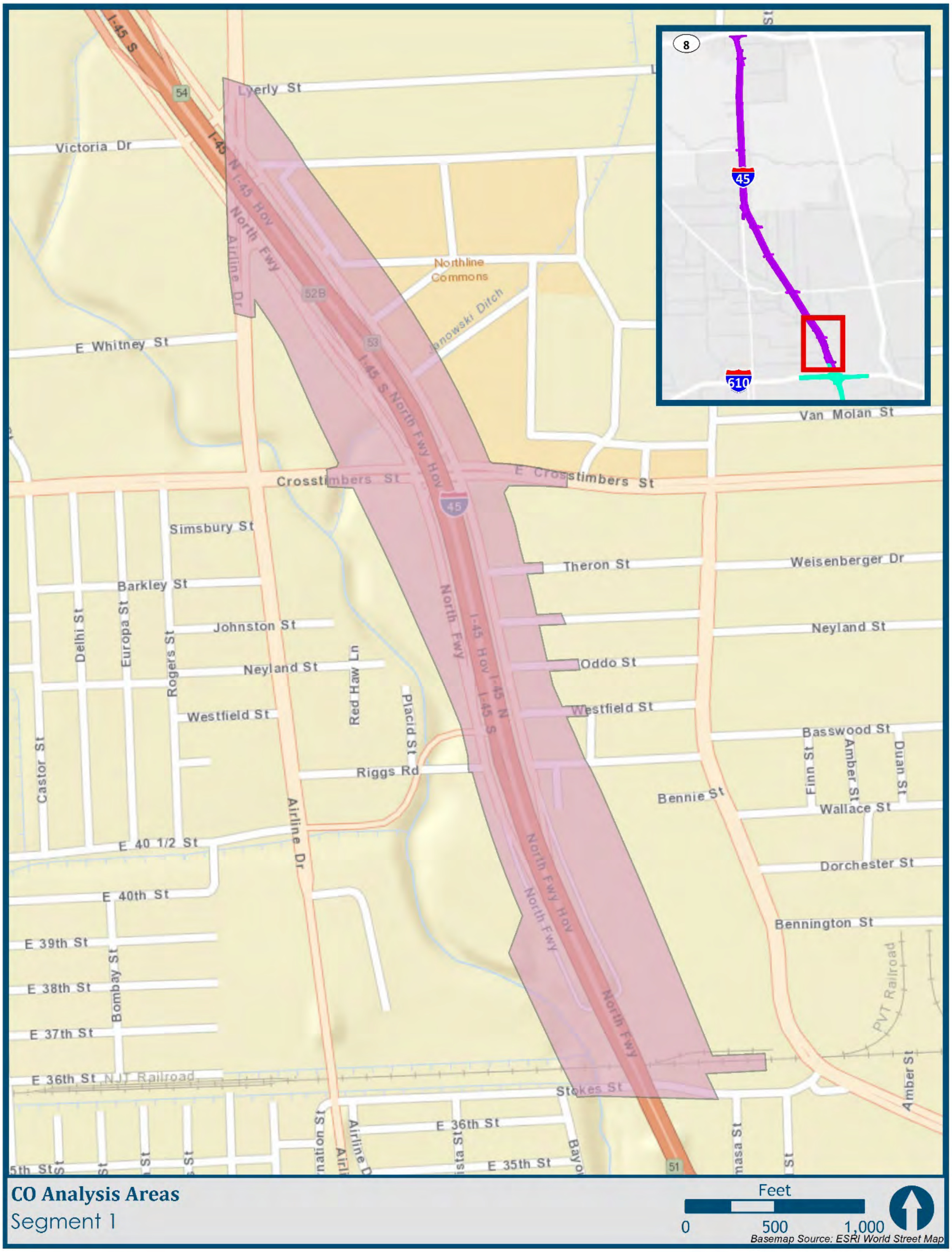


Figure 2: Segment 2 Analysis Area

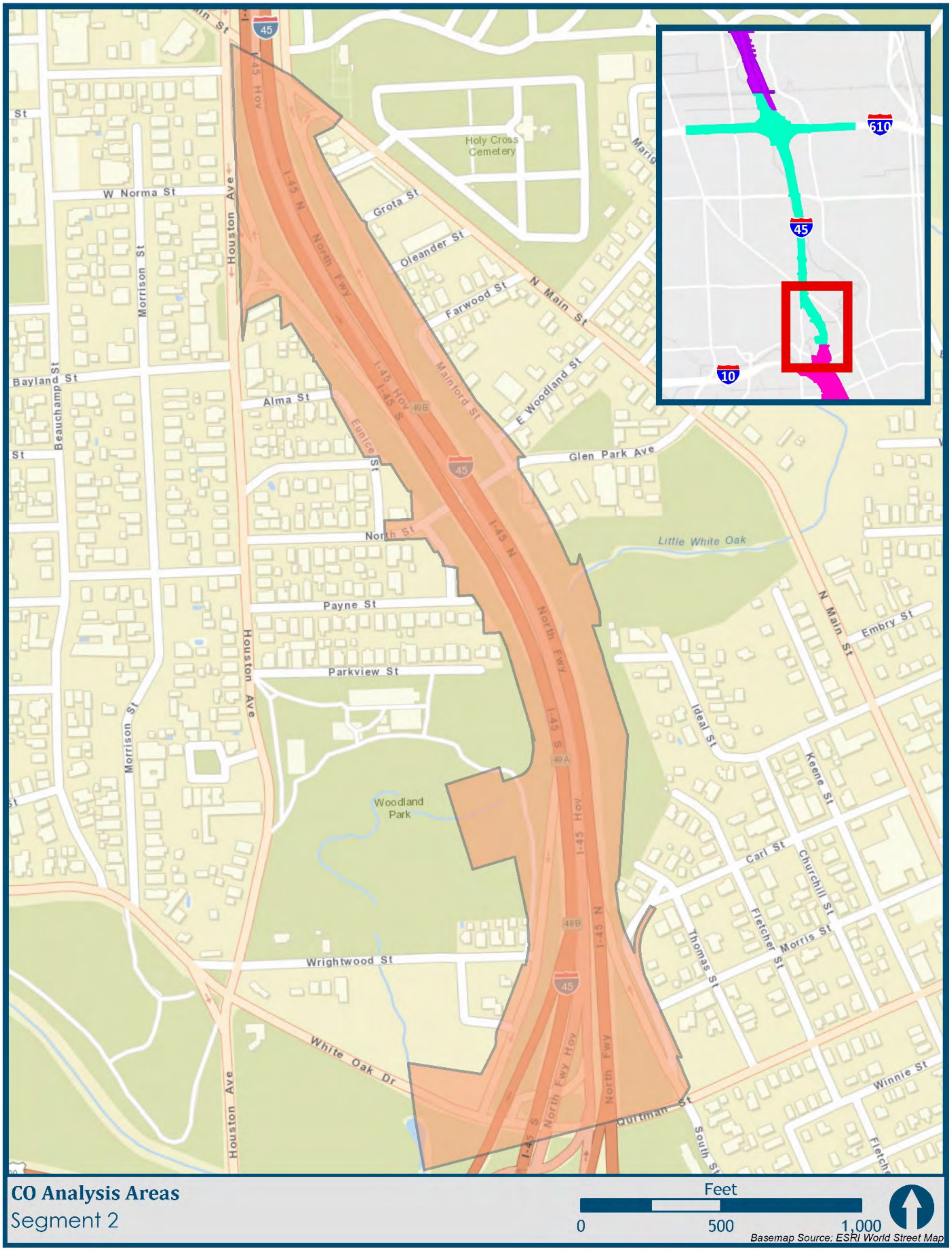


Figure 3: Segment 3 Analysis Areas

Receptor Locations

Receptors were modeled on the ROW line along areas with the highest design hour volume of vehicles (DHV) and narrowest ROW for each segment and alternative. A standard height of 5.9 feet was given to the receptors for all models to simulate the average height of a person. **Tables 3-7** detail the DHV, speed, and width of ROW at each receptor. Aerial maps depicting the receptor locations and project ROW for each alternative are found in **Appendix A.**

Segment 1

Alternative 4: The area from Airline Road to Stokes Road was selected as the modeled area for Segment 1 because it has the highest traffic volume along Segment 1. A receptor was placed at the narrowest ROW location, as well as at three additional locations with varying ROW width along the segment for the analysis. Because of the similarity between alternatives for Segment 1, Alternative 4 was selected to be representative for all three build alternatives.

Table 3: Receptor Descriptions (Segment 1, Alternative 4)

Segment 1, Alternative 4: Airline Rd to Stokes Rd						
	ROW Width	2025 Total DHV	2035 Total DHV	2025 Total AADT	2035 Total AADT	Speed
Receptor 1	490 feet	18,783	19,801	324,620	342,337	60 (main and HOV lanes), 45 (frontage roads)
Receptor 2	658 feet					
Receptor 3	591 feet					
Receptor 4	565 feet					

Segment 2

Alternative 10: The area from Main Street to Quitman Road along Segment 2 was selected as the modeled area for Segment 2 because it has the highest traffic volume along Segment 2. A receptor was placed at the narrowest ROW location, as well as at four additional locations with varying ROW width along the segment for the analysis. Because of the similarity between alternatives for Segment 2, Alternative 10 was selected to be representative for all three build alternatives.

Table 4: Receptor Descriptions (Segment 2, Alternative 10)

Segment 2, Alternative 10: Main St to Quitman Rd						
	ROW Width	2025 Total DHV	2035 Total DHV	2025 Total AADT	2035 Total AADT	Speed
Receptor 1	408 feet	14,394	15,473	239,916	257,894	60 (main and HOV lanes), 45 (frontage roads)
Receptor 2	387 feet					
Receptor 3	320 feet					
Receptor 4	325 feet					
Receptor 5	356 feet					

Segment 3

Alternative 10: The modeled areas for Segment 3, Alternative 10 are along the Pierce Elevated Bridge portion of I-45 (Area 4) and from I-10 (Downtown Connectors) to US 59 (Area 2). The ROW width is consistent along the bridge segment of Area 4, so four receptors on the ROW line on both sides of the roadway of Area 4 were selected for the analysis. The narrowest ROW for Area 2 varied by no more than two feet, so two receptors were placed in these areas on both sides of the road, and an additional receptor at a wider ROW was added for the analysis.

Table 5: Receptor Descriptions (Segment 3, Alternative 10)

Segment 3, Alternative 10: Area 2						
	ROW Width	**2025 Total DHV**	**2035 Total DHV**	**2025 Total AADT**	**2035 Total AADT**	**Speed**
Receptor 1	425 feet	14,462	16,400	138,229	156,757	50
Receptor 2	418 feet					
Receptor 3	416 feet					

Segment 3, Alternative 10: Area 4						
	ROW Width	**2025 Total DHV**	**2035 Total DHV**	**2025 Total AADT**	**2035 Total AADT**	**Speed**
Receptor 1	206 feet	15,895	17,000	219,275	234,523	50
Receptor 2						
Receptor 3						
Receptor 4						

Segment 3

Alternative 11: The area from the I-45 and I-10 split to the Downtown Connectors (Area 1), the area from the Downtown Connectors to US 59 (Area 2), and the area along US 59 and I-45 from I-10 to SH 288 (Area 3) were selected as the modeled areas for Segment 3 because of high traffic volume. For Area 1, receptors were placed at varying ROW widths on the southbound side because of the presence of White Oak Bayou on the ROW boundary on the northbound side. The narrowest ROW for Area 2 varied by no more than two feet, so two receptors were placed in these areas on both sides of the road, and an additional receptor at a wider ROW was included in the analysis. Along Area 3, a receptor was placed at the narrowest ROW location, as well as at two additional locations with varying ROW width for the analysis.

Table 6: Receptor Descriptions (Segment 3, Alternative 11)

Segment 3, Alternative 11: Area 1						
	ROW Width	2025 Total DHV	2035 Total DHV	2025 Total AADT	2035 Total AADT	Speed
Receptor 1	645 feet	27,684	30,600	350,293	386,130	50
Receptor 2	650 feet					
Receptor 3	630 feet					
Receptor 4	640 feet					
Segment 3, Alternative 11: Area 2						
	ROW Width	2025 Total DHV	2035 Total DHV	2025 Total AADT	2035 Total AADT	Speed
Receptor 1	490 feet	21,511	23,900	266,267	294,307	50
Receptor 2	418 feet					
Receptor 3	416 feet					
Segment 3, Alternative 11: Area 3						
	ROW Width	2025 Total DHV	2035 Total DHV	2025 Total AADT	2035 Total AADT	Speed
Receptor 1	411 feet	31,782	34,100	366,781	393,517	50
Receptor 2	373 feet					
Receptor 3	481 feet					

Segment 3

<u>Alternative 12:</u> The modeled areas for Alternative 12 are from I-45/I-10 (Downtown Connectors) to US 59 (Area 2), I-45/US 59 from I-10 to SH 288 (Area 3), and the Elevated Pierce Bridge portion of I-45 (Area 4). The narrowest ROW for Area 2 varied by no more than two feet, so two receptors were placed in these areas on both sides of the road, and an additional receptor at a wider ROW was added for the analysis. Along Area 3, a receptor was placed at the narrowest ROW location, as well as at two additional locations with varying ROW width for the analysis. The ROW width is consistent along the bridge segment of Area 4, so four receptors on the ROW line on both sides of the roadway of Area 4 were selected for the analysis.

Table 7: Receptor Descriptions (Segment 3, Alternative 12)

Segment 3, Alternative 12: Area 2						
	ROW Width	2025 Total DHV	2035 Total DHV	2025 Total AADT	2035 Total AADT	Speed
Receptor 1	438 feet	18,954	21,200	202,636	225,637	50
Receptor 2	418 feet					
Receptor 3	416 feet					
Segment 3, Alternative 12: Area 3						
	ROW Width	2025 Total DHV	2035 Total DHV	2025 Total AADT	2035 Total AADT	Speed
Receptor 1	287 feet	31,219	33,500	375,642	403,002	50
Receptor 2	280 feet					
Receptor 3	268 feet					

Segment 3, Alternative 12: Area 4						
	ROW Width	2025 Total DHV	2035 Total DHV	2025 Total AADT	2035 Total AADT	Speed
Receptor 1	206 feet	8,041	8,600	111,777	119,550	50
Receptor 2						
Receptor 3						
Receptor 4						

Analysis Results

The 1-hour CO NAAQS is 35 ppm, while the 8-hour NAAQS is 9 ppm, which are not to be exceeded more than once in a year. The CO background concentrations for this analysis were obtained from Appendix B of TxDOT's Standard Operating Procedure for Complying with CO TAQA Requirements (2015). Local concentrations of CO are not expected to exceed national standards at any time. The highest CO concentration result and percent of the 1-hour and 8-hour NAAQS per segment and alternative is recorded in **Tables 8-12**. The alternative with the highest 1-hour and 8-hour CO concentration is Segment 3, Alternative 12, along I-45/US 59 from I-10 to SH 288 (Area 3). This alternative includes a bridge highway section and has the highest traffic volume. This worst case scenario is 13 percent of the 1-hour NAAQS and 34 percent of the 8-hour NAAQS. The same area of Segment 3 resulted in much lower CO concentrations with Alternative 11 because of the depressed section design.

A table detailing the full results of the 1-hour and 8-hour CO concentrations per segment and alternative at each receptor can be found in **Appendix B**. The associated input and output CALINE3 files have been submitted with this technical report to TxDOT Houston for inclusion in the project files.

Segment 1

<u>Alternative 4:</u> Minor increases in CO concentrations from the ETC to design year would result in no appreciable change for the ten-year period. Because of the similarity between alternatives for Segment 1, Alternative 4 was selected to be representative of all three models. See **Table 8** for worst-case results.

Table 8: 1-Hour and 8-Hour CO Concentrations (Segment 1, Alternative 4)

Segment 1, Alternative 4	2025: Estimated Time of Completion (ETC)					
	1-Hour CO Concentration	1-Hour CO Background Concentration	8-Hour CO Background Concentration	8-Hour CO Concentration	1-Hour % NAAQS	8-Hour % NAAQS
	2.9	2.5	1.9	**2.1**	8%	24%
	2035: Design Year					

	1-Hour CO Concentration	1-Hour CO Background Concentration	8-Hour CO Background Concentration	8-Hour CO Concentration	1-Hour % NAAQS	8-Hour % NAAQS
	2.9	2.5	1.9	**2.1**	8%	24%

Segment 2

Alternative 10: Minor increases in CO concentrations from the ETC to design year would result in a minor change for the ten-year period. See **Table 9** for worst-case results.

Table 9: 1-Hour and 8-Hour CO Concentrations (Segment 2, Alternative 10)

Segment 2, Alternative 10	2025: Estimated Time of Completion (ETC)					
	1-Hour CO Concentration	1-Hour CO Background Concentration	8-Hour CO Background Concentration	8-Hour CO Concentration	1-Hour % NAAQS	8-Hour % NAAQS
	3.9	2.5	1.9	**2.7**	11%	30%
	2035: Design Year					
	1-Hour CO Concentration	1-Hour CO Background Concentration	8-Hour CO Background Concentration	8-Hour CO Concentration	1-Hour % NAAQS	8-Hour % NAAQS
	4.0	2.5	1.9	**2.8**	11%	31%

Segment 3

Alternative 10: Minor increases in CO concentrations from the ETC to design year would result in a minor change over the ten-year period. While both Area 2 and Area 4 have similar traffic volumes, the narrower ROW width in Area 4 results in higher CO concentrations. See **Table 10** for worst-case results.

Table 10: 1-Hour and 8-Hour CO Concentrations (Segment 3, Alternative 10)

Segment 3, Alternative 10	2025: Estimated Time of Completion (ETC)					
	1-Hour CO Concentration	1-Hour CO Background Concentration	8-Hour CO Background Concentration	8-Hour CO Concentration	1-Hour % NAAQS	8-Hour % NAAQS
Area 2	2.8	2.5	1.9	**2.1**	8%	23%
Area 4	3.3	2.5	1.9	**2.4**	9%	26%
Segment 3, Alternative 10	2035: Design Year					
	1-Hour CO Concentration	1-Hour CO Background Concentration	8-Hour CO Background Concentration	8-Hour CO Concentration	1-Hour % NAAQS	8-Hour % NAAQS
Area 2	3.0	2.5	1.9	**2.2**	9%	24%
Area 4	3.3	2.5	1.9	**2.4**	9%	26%

Segment 3

Alternative 11: Minor increases in CO concentrations from the ETC to design year would result in no appreciable change for the ten-year period. Though Area 3 has the highest traffic volume and smallest ROW width, the CO concentrations are the smallest because of the depressed section design. Despite a larger ROW width than Area 2, Area 1 resulted in the highest CO concentrations because of higher traffic volumes. See **Table 11** for worst-case results.

Table 11: 1-Hour and 8-Hour CO Concentrations (Segment 3, Alternative 11)

Segment 3, Alternative 11	2025: Estimated Time of Completion (ETC)					
	1-Hour CO Concentration	1-Hour CO Background Concentration	8-Hour CO Background Concentration	8-Hour CO Concentration	1-Hour % NAAQS	8-Hour % NAAQS
Area 1	3.1	2.5	1.9	**2.3**	9%	25%
Area 2	3.0	2.5	1.9	**2.2**	9%	24%
Area 3	2.5	2.5	1.9	**1.9**	7%	21%
Segment 3, Alternative 11	**2035: Design Year**					
	1-Hour CO Concentration	1-Hour CO Background Concentration	8-Hour CO Background Concentration	8-Hour CO Concentration	1-Hour % NAAQS	8-Hour % NAAQS
Area 1	3.2	2.5	1.9	**2.3**	9%	26%
Area 2	3.0	2.5	1.9	**2.2**	9%	24%
Area 3	2.5	2.5	1.9	**1.9**	7%	21%

Segment 3

Alternative 12: Minor increases in CO concentrations from the ETC to design year would result in a minor change for the ten-year period. As suspected, Area 3 has the highest CO concentration because it has the highest traffic volume and a comparably narrow ROW. Areas 2 and 4 are comparable in CO concentration because Area 2 has higher traffic, but Area 4 has narrower ROW, and vice versa. See **Table 12** for worst-case results.

Table 12: 1-Hour and 8-Hour CO Concentrations (Segment 3, Alternative 12)

Segment 3, Alternative 12	2025: Estimated Time of Completion (ETC)					
	1-Hour CO Concentration	1-Hour CO Background Concentration	8-Hour CO Background Concentration	8-Hour CO Concentration	1-Hour % NAAQS	8-Hour % NAAQS
Area 2	3.0	2.5	1.9	**2.2**	9%	24%
Area 3	4.4	2.5	1.9	**3.0**	13%	34%
Area 4	3.1	2.5	1.9	**2.3**	9%	25%
	2035: Design Year					

	1-Hour CO Concentration	1-Hour CO Background Concentration	8-Hour CO Background Concentration	8-Hour CO Concentration	1-Hour % NAAQS	8-Hour % NAAQS
Area 2	3.1	2.5	1.9	**2.3**	9%	24%
Area 3	4.5	2.5	1.9	**3.1**	13%	34%
Area 4	3.1	2.5	1.9	**2.3**	9%	25%

4.0 Mobile Source Air Toxics (MSAT)

Background

Controlling air toxic emissions became a national priority with the passage of the Clean Air Act Amendments (CAAA) of 1990, whereby Congress mandated that the U.S. Environmental Protection Agency (EPA) regulate 188 air toxics, also known as hazardous air pollutants. The EPA has assessed this expansive list in their latest rule on the Control of Hazardous Air Pollutants from Mobile Sources (Federal Register, Vol. 72, No. 37, page 8430, February 26, 2007), and identified a group of 93 compounds emitted from mobile sources that are listed in their Integrated Risk Information System (IRIS) (http://www.epa.gov/iris/). In addition, EPA identified seven compounds with significant contributions from mobile sources that are among the national and regional-scale cancer risk drivers from their 1999 National Air Toxics Assessment (NATA) (http://www.epa.gov/ttn/atw/nata1999/). These are acrolein, benzene, 1,3-butadiene, diesel particulate matter plus diesel exhaust organic gases (diesel PM), formaldehyde, naphthalene, and polycyclic organic matter. While FHWA considers these the priority mobile source air toxics, the list is subject to change and may be adjusted in consideration of future EPA rules.

<u>Motor Vehicle Emissions Simulator (MOVES)</u>

According to EPA, MOVES2014 is a major revision to MOVES2010 and improves upon it in many respects. MOVES2014 includes new data, new emissions standards, and new functional improvements and features. It incorporates substantial new data for emissions, fleet, and activity developed since the release of MOVES2010.

These new emissions data are for light- and heavy-duty vehicles, exhaust and evaporative emissions, and fuel effects. MOVES2014 also adds updated vehicle sales, population, age distribution, and vehicle miles travelled (VMT) data. MOVES2014 incorporates the effects of three new Federal emissions standard rules not included in MOVES2010.

These new standards are all expected to impact MSAT emissions and include Tier 3 emissions and fuel standards starting in 2017 (79 FR 60344), heavy-duty greenhouse gas regulations that phase in during model years 2014-2018 (79 FR 60344), and the second phase of light duty greenhouse gas regulations that phase in during model years 2017-2025 (79 FR 60344).

Since the release of MOVES2014, EPA has released MOVES2014a. In the November 2015 MOVES2014a Questions and Answers Guide, EPA states that for on-road emissions, MOVES2014a adds new options requested by users for the input of local VMT, includes minor updates to the default fuel tables, and corrects an error in MOVES2014 brake wear emissions. The change in brake wear emissions results in small decreases in PM emissions, while emissions for other criteria pollutants remain essentially the same as MOVES2014.

Using EPA's MOVES2014a model, as shown in **Figure 5**, FHWA estimates that even if VMT increases by 45 percent from 2010 to 2050 as forecast, a combined reduction of 91 percent in the total annual emissions for the priority MSAT is projected for the same time period.

MSAT Research

Air toxics analysis is a continuing area of research. While much work has been done to assess the overall health risk of air toxics, many questions remain unanswered. In particular, the tools and techniques for assessing project-specific health outcomes as a result of lifetime MSAT exposure remain limited. These limitations impede the ability to evaluate how the potential health risks posed by MSAT exposure should be factored into project-level decision-making within the context of the National Environmental Policy Act (NEPA). The FHWA, EPA, Health Effects Institute (HEI), and others have funded and conducted research studies to try to more clearly define potential risks from MSAT emissions associated with highway projects. The FHWA will continue to monitor the developing research in this emerging field.

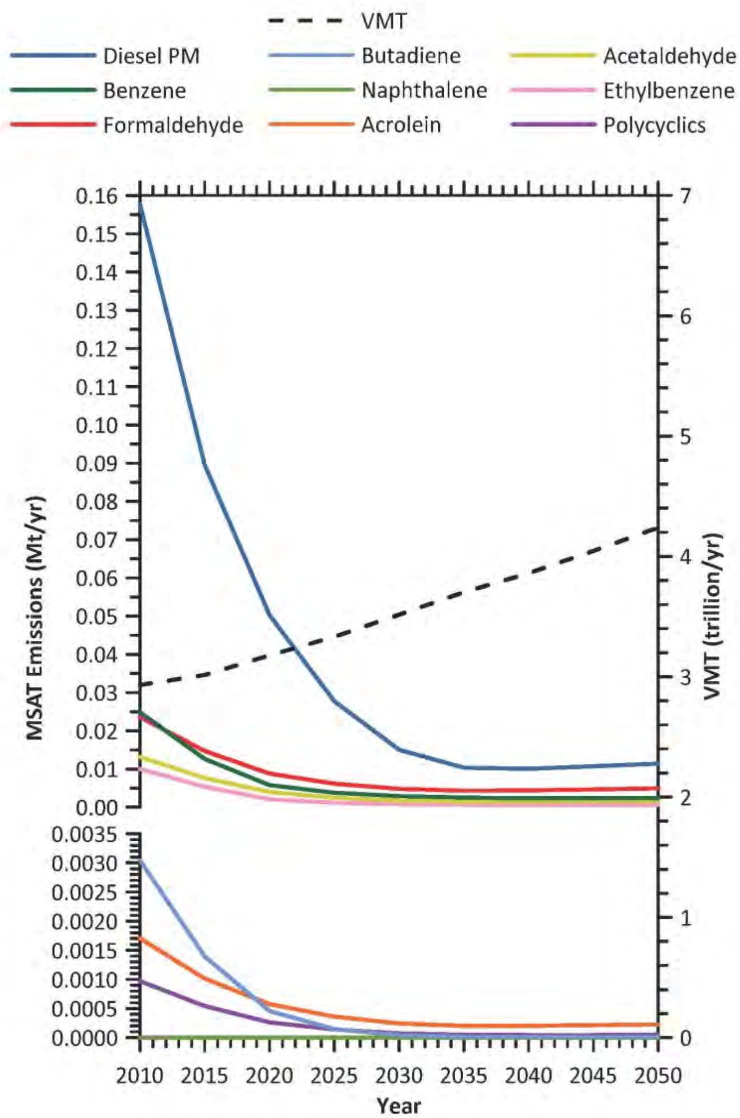
Project-Specific MSAT Information

A qualitative analysis provides a basis for identifying and comparing the potential differences among MSAT emissions, if any, from the various alternatives. The qualitative assessment presented below is derived in part from a study conducted by the FHWA entitled A Methodology for Evaluating Mobile Source Air Toxic Emissions Among Transportation Project Alternatives, found at: http://www.fhwa.dot.gov/environment/air_quality/air_toxics/research_and_analysis/mobile_source_air_toxics/msatemissions.pdf.

Figure 4: PROJECTED NATIONAL MSAT EMISSION TRENDS 2010 – 2050

FOR VEHICLES OPERATING ON ROADWAYS

USING EPA's Moves2014a Model



Source: EPA MOVES2014a model runs conducted by FHWA, September 2016.
Note: Trends for specific locations may be different, depending on locally derived information representing vehicle-miles travelled, vehicle speeds, vehicle mix, fuels, emission control programs, meteorological, and other factors.

For each alternative in this document, the amount of MSAT emitted would be proportional to the vehicle miles traveled, or VMT, assuming that other variables such as fleet mix are the same for each alternative. The VMT estimated for each of the Build Alternatives is slightly higher than that for the No Build Alternative, because the additional capacity increases the efficiency of the roadway and attracts rerouted trips from elsewhere in the transportation network. This increase in VMT would lead to higher MSAT emissions for the preferred action alternative along the highway corridor, along with a corresponding decrease in MSAT emissions along the parallel routes. The emissions increase is offset somewhat by lower MSAT emission rates due to increased speeds; according to EPA's MOVES2010b model, emissions of all of the priority MSAT decrease as speed increases. Because the estimated VMT under each of the Alternatives in Segment 3 are nearly the same, varying by less than six percent, it is expected there would be no appreciable difference in overall MSAT emissions among the various alternatives. For Segments 1 and 2, it is expected that the VMT difference would be no more than the highest percent change for Segment 3. Regardless of the alternative chosen, emissions will likely be lower than present levels in the design year as a result of EPA's national control programs that are projected to reduce annual MSAT emissions by over 80 percent between 2010 and 2050. Local conditions may differ from these national projections in terms of fleet mix and turnover, VMT growth rates, and local control measures. However, the magnitude of the EPA-projected reductions is so great (even after accounting for VMT growth) that MSAT emissions in the study area are likely to be lower in the future in nearly all cases.

The additional travel lanes contemplated as part of the project alternatives will have the effect of moving some traffic closer to nearby homes, schools, and businesses; therefore, under each alternative there may be localized areas where ambient concentrations of MSAT could be higher under certain Build Alternatives than the No Build Alternative. The localized increases in MSAT concentrations would likely be most pronounced along the expanded roadway sections that would be built at the Segment 3 portion of the project. However, the magnitude and the duration of these potential increases compared to the No Build alternative cannot be reliably quantified due to incomplete or unavailable information in forecasting project-specific MSAT health impacts. In sum, when a highway is widened, the localized level of MSAT emissions for the Build Alternative could be higher relative to the No Build Alternative, but this could be offset due to increases in speeds and reductions in congestion (which are associated with lower MSAT emissions). Also, MSAT will be lower in other locations when traffic shifts away from them. However, on a regional basis, EPA's vehicle and fuel regulations, coupled with fleet turnover, will over time cause substantial reductions that, in almost all cases, will cause region-wide MSAT levels to be significantly lower than today.

Incomplete or Unavailable Information for Project-Specific MSAT Health Impacts Analysis

In FHWA's view, information is incomplete or unavailable to credibly predict the project-specific health impacts due to changes in MSAT emissions associated with a proposed set of highway alternatives. The outcome of such an assessment, adverse or not, would be influenced more by the uncertainty introduced into the process through assumption and speculation rather than any genuine insight into the actual health impacts directly attributable to MSAT exposure associated with a proposed action.

The U.S. Environmental Protection Agency (EPA) is responsible for protecting the public health and welfare from any known or anticipated effect of an air pollutant. They are the lead authority for administering the Clean Air Act and its amendments and have specific statutory obligations with respect to hazardous air pollutants and MSAT. The EPA is in the continual process of assessing human health effects, exposures, and risks posed by air pollutants. They maintain the Integrated Risk Information System (IRIS), which is "a compilation of electronic reports on specific substances found in the environment and their potential to cause human health effects" (EPA, http://www.epa.gov/iris/). Each report contains assessments of non-cancerous and cancerous effects for individual compounds and quantitative estimates of risk levels from lifetime oral and inhalation exposures with uncertainty spanning perhaps an order of magnitude.

Other organizations are also active in the research and analyses of the human health effects of MSAT, including the HEI. Two HEI studies are summarized in Appendix D of FHWA's Interim Guidance Update on Mobile Source Air Toxic Analysis in NEPA Documents. Among the adverse health effects linked to MSAT compounds at high exposures are; cancer in humans in occupational settings; cancer in animals; and irritation to the respiratory tract, including the exacerbation of asthma. Less obvious is the adverse human health effects of MSAT compounds at current environmental concentrations (HEI, http://pubs.healtheffects.org/view.php?id=282) or in the future as vehicle emissions substantially decrease (HEI, http://pubs.healtheffects.org/view.php?id=306).

The methodologies for forecasting health impacts include emissions modeling; dispersion modeling; exposure modeling; and then final determination of health impacts – each step in the process building on the model predictions obtained in the previous step. All are encumbered by technical shortcomings or uncertain science that prevents a more complete differentiation of the MSAT health impacts among a set of project alternatives. These difficulties are magnified for lifetime (i.e., 70 year) assessments, particularly because unsupportable assumptions would have to be made regarding changes in travel patterns and vehicle technology (which affects emissions rates) over that time frame, since such information is unavailable.

It is particularly difficult to reliably forecast 70-year lifetime MSAT concentrations and exposure near roadways; to determine the portion of time that people are actually exposed at a specific location; and to establish the extent attributable to a proposed action, especially given that some of the information needed is unavailable.

There are considerable uncertainties associated with the existing estimates of toxicity of the various MSAT, because of factors such as low-dose extrapolation and translation of occupational exposure data to the general population, a concern expressed by HEI (http://pubs.healtheffects.org/view.php?id=282). As a result, there is no national consensus on air dose-response values assumed to protect the public health and welfare for MSAT compounds, in particular for diesel PM. The EPA (http://www.epa.gov/risk/basicinformation.htm#g) and the HEI (http://pubs.healtheffects.org/getfile.php?u=395) have not established a basis for quantitative risk assessment of diesel PM in ambient settings.

There is also the lack of a national consensus on an acceptable level of risk. The current context is the process used by the EPA as provided by the Clean Air Act to determine whether more stringent controls are required in order to provide an ample margin of safety to protect public health or to prevent an adverse environmental effect for industrial sources subject to the maximum achievable control technology standards, such as benzene emissions from refineries. The decision framework is a two-step process. The first step requires EPA to determine an "acceptable" level of risk due to emissions from a source, which is generally no greater than approximately 100 in a million. Additional factors are considered in the second step, the goal of which is to maximize the number of people with risks less than 1 in a million due to emissions from a source. The results of this statutory two-step process do not guarantee that cancer risks from exposure to air toxics are less than 1 in a million; in some cases, the residual risk determination could result in maximum individual cancer risks that are as high as approximately 100 in a million. In a June 2008 decision, the U.S. Court of Appeals for the District of Columbia Circuit upheld EPA's approach to addressing risk in its two step decision framework.

Information is incomplete or unavailable to establish that even the largest of highway projects would result in levels of risk greater than deemed acceptable. Because of the limitations in the methodologies for forecasting health impacts described, any predicted difference in health impacts between alternatives is likely to be much smaller than the uncertainties associated with predicting the impacts. Consequently, the results of such assessments would not be useful to decision makers, who would need to weigh this information against project benefits, such as reducing traffic congestion, accident rates, and fatalities plus improved access for emergency response, that are better suited for quantitative analysis.

Conclusion

In this document, a qualitative MSAT assessment has been provided relative to the various alternatives of MSAT emissions and has acknowledged that the project alternatives may result in increased exposure to MSAT emissions in certain locations, although the concentrations and duration of exposures are uncertain and, because of this uncertainty, the health effects from these emissions cannot be estimated.

5.0 Congestion Management Process Analysis

The congestion management process is a systematic process for managing congestion that provides information on transportation system performance and on alternative strategies for alleviating congestion and enhancing the mobility of persons and goods to levels that meet state and local needs. This project is within a Transportation Management Area (TMA) in a nonattainment area for ozone, is an FHWA project, and is adding capacity; therefore, a project level Congestion Management Process (CMP) analysis is required; however, this analysis will not be complete until this project is developed from H-GAC's CMP and included in the RTP and TIP. This process will occur during the development of the FEIS.

The region commits to operational improvements and travel demand reduction strategies at two levels of implementation: program level and project level. Program level commitments are inventoried in the regional CMP, which was adopted by H-GAC; they are included in the financially constrained MTP, and future resources are reserved for their implementation.

The CMP element of the plan carries an inventory of all project commitments (including those resulting from major investment studies) that details type of strategy, implementing responsibilities, schedules, and expected costs. At the project's programming stage, travel demand reduction strategies and commitments will be added to the regional TIP or included in the construction plans. The regional TIP provides for programming of these projects at the appropriate time with respect to the single occupancy vehicle (SOV) facility implementation and project-specific elements.

In an effort to reduce congestion and the need for SOV lanes in the region, TxDOT and H-GAC will continue to promote appropriate congestion reduction strategies through the Congestion Mitigation and Air Quality Improvement (CMAQ) program, the CMP, and the MTP. The congestion reduction strategies considered for this project would help alleviate congestion in the SOV study boundary, but would not eliminate it.

6.0 Construction Emissions

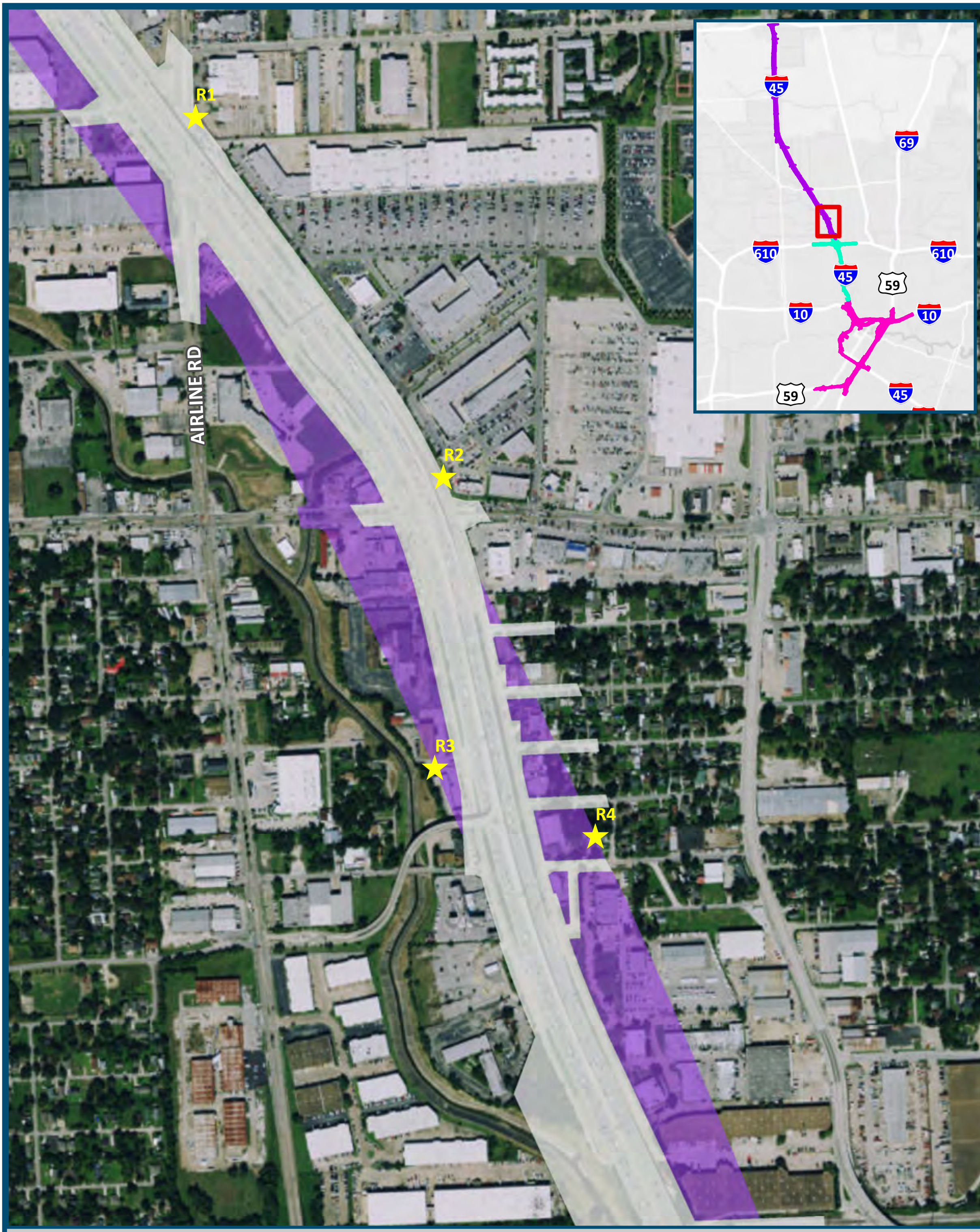
During the construction phase of this project, temporary increases in PM and MSAT emissions may occur from construction activities. The primary construction-related emissions of PM are fugitive dust from site preparation, and the primary construction-related emissions of MSAT are diesel particulate matter from diesel powered construction equipment and vehicles.

The potential impacts of particulate matter emissions would be minimized by using fugitive dust control measures contained in standard specifications, as appropriate. The Texas Emissions Reduction Plan (TERP) provides financial incentives to reduce emissions from vehicles and equipment. TxDOT encourages construction contractors to use this and other local and federal incentive programs to the fullest extent possible to minimize diesel emissions. Information about the TERP program can be found at: http://www.tceq.state.tx.us/implementation/air/terp/.

However, considering the temporary and transient nature of construction-related emissions, the use of fugitive dust control measures, the encouragement of the use of TERP, and compliance with applicable regulatory requirements; it is not anticipated that emissions from construction of this project would have any significant impact on air quality in the area.

APPENDIX A

Receptor Locations



Receptor Locations

Segment 1, Alternative 4

Basemap Source: ESRI World Imagery

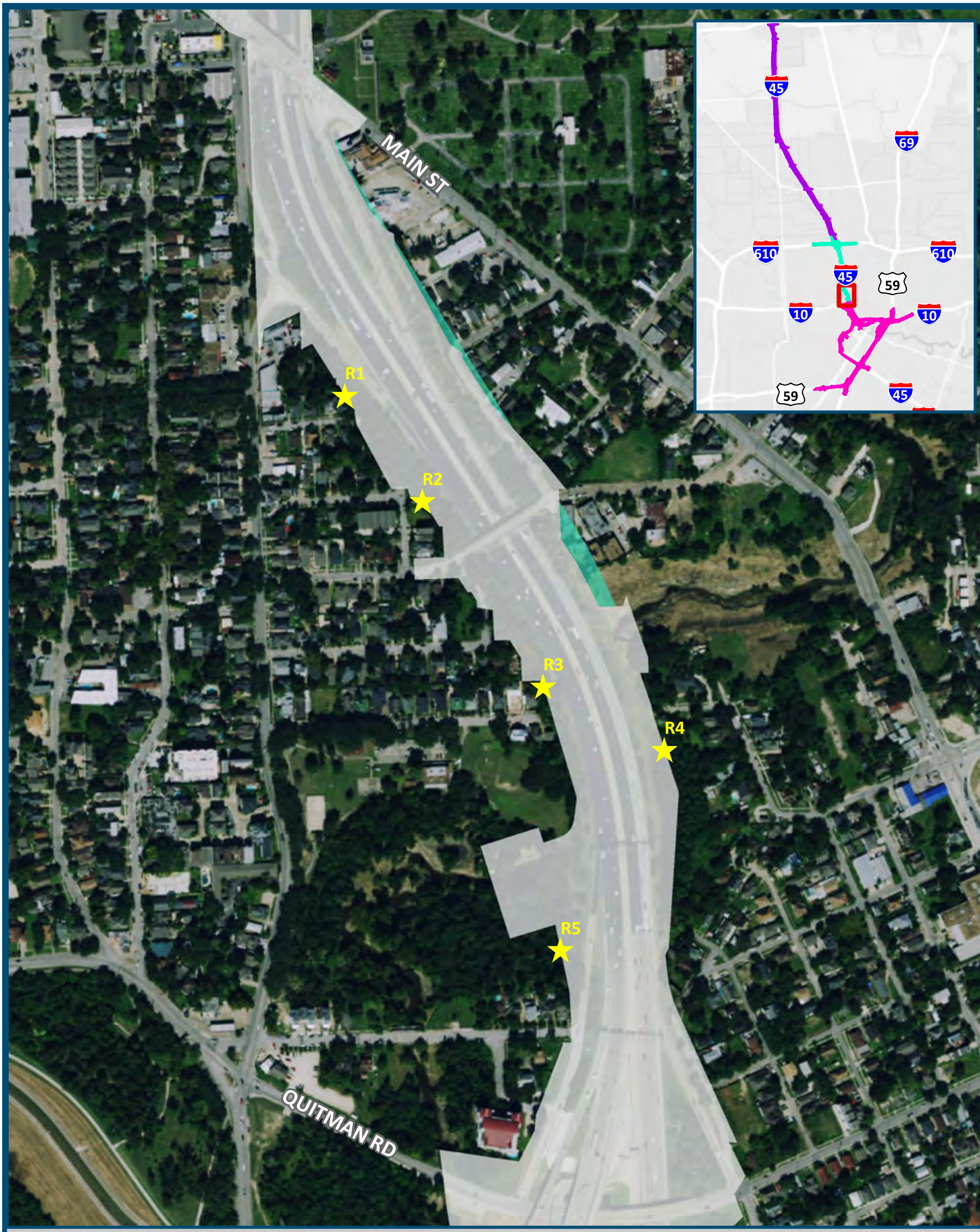
Receptor

Proposed ROW

Existing ROW

Feet

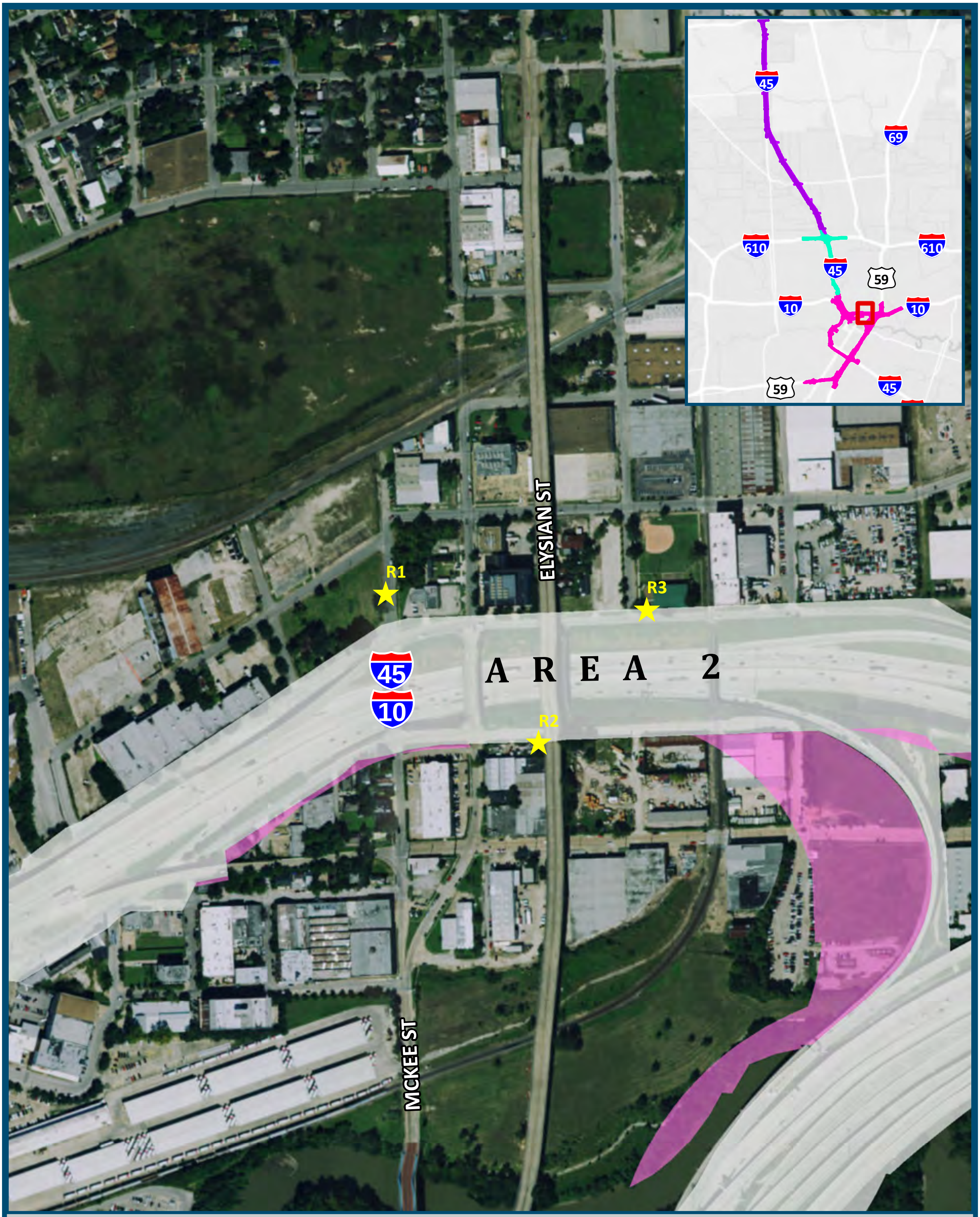
0 250 500



Receptor Locations
Segment 2, Alternative 10
Basemap Source: ESRI World Imagery

Receptor
Proposed ROW
Existing ROW

Feet
0 250 500



Receptor Locations

Segment 3, Alternative 10 (Area 2)

Basemap Source: ESRI World Imagery

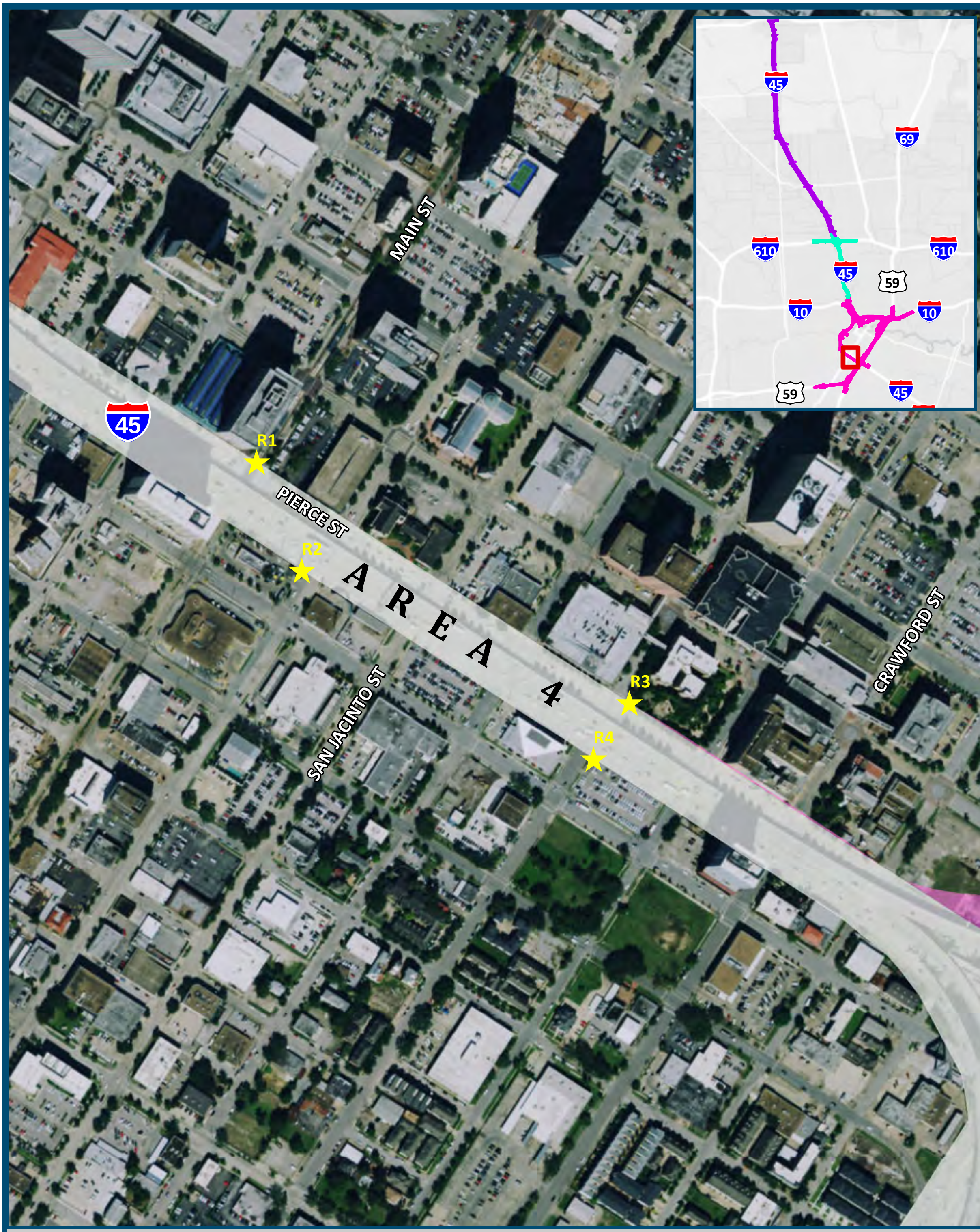
Receptor

Proposed ROW

Existing ROW

Feet

0 250 500



Receptor Locations

Segment 3, Alternative 10 (Area 4)

Receptor

Proposed ROW

Existing ROW

Feet

0 250 500

Basemap Source: ESRI World Imagery

Receptor Locations

Segment 3, Alternative 11 (Area 1)

Receptor

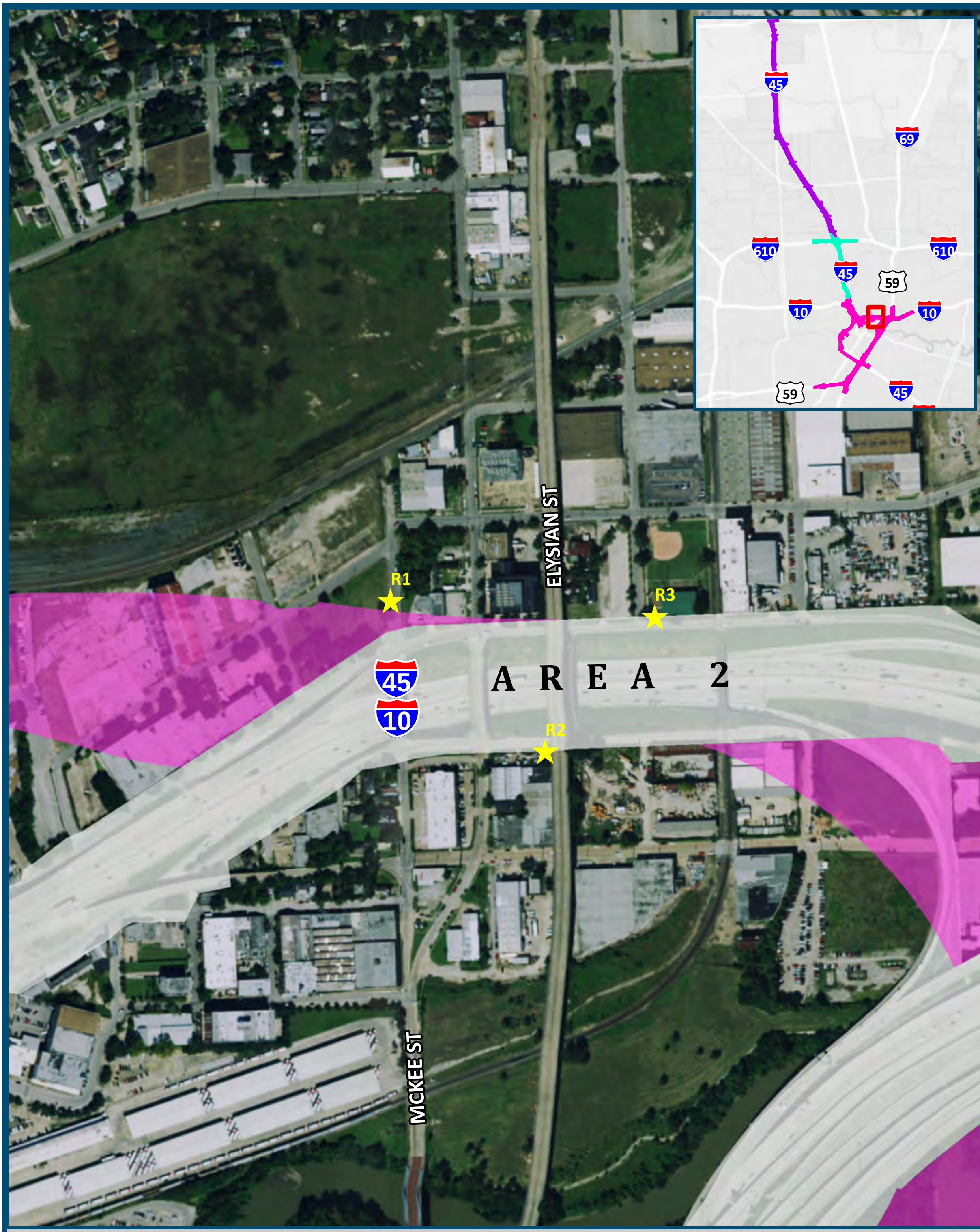
Proposed ROW

Existing ROW

Feet

0 250 500

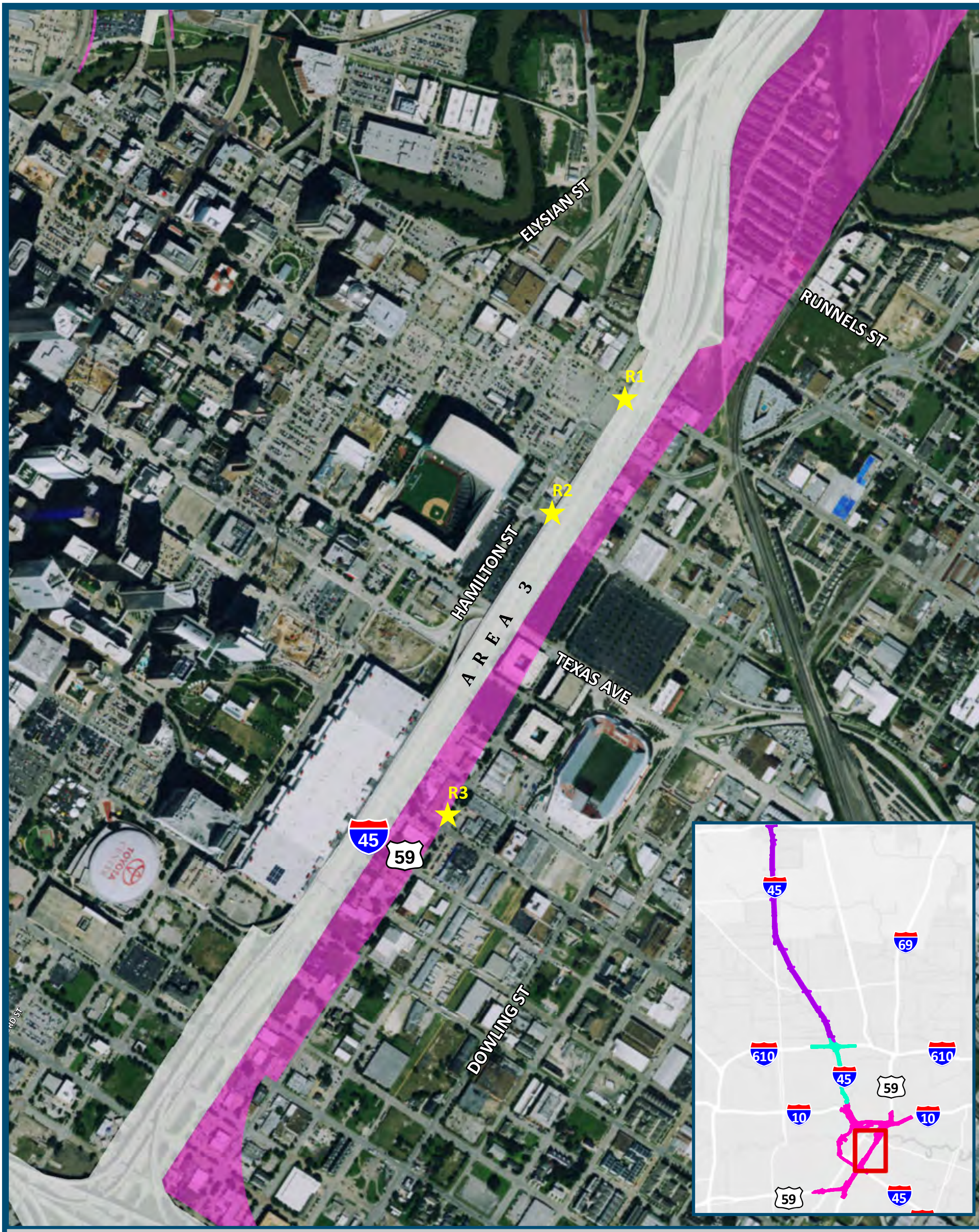
Basemap Source: ESRI World Imagery



Receptor Locations

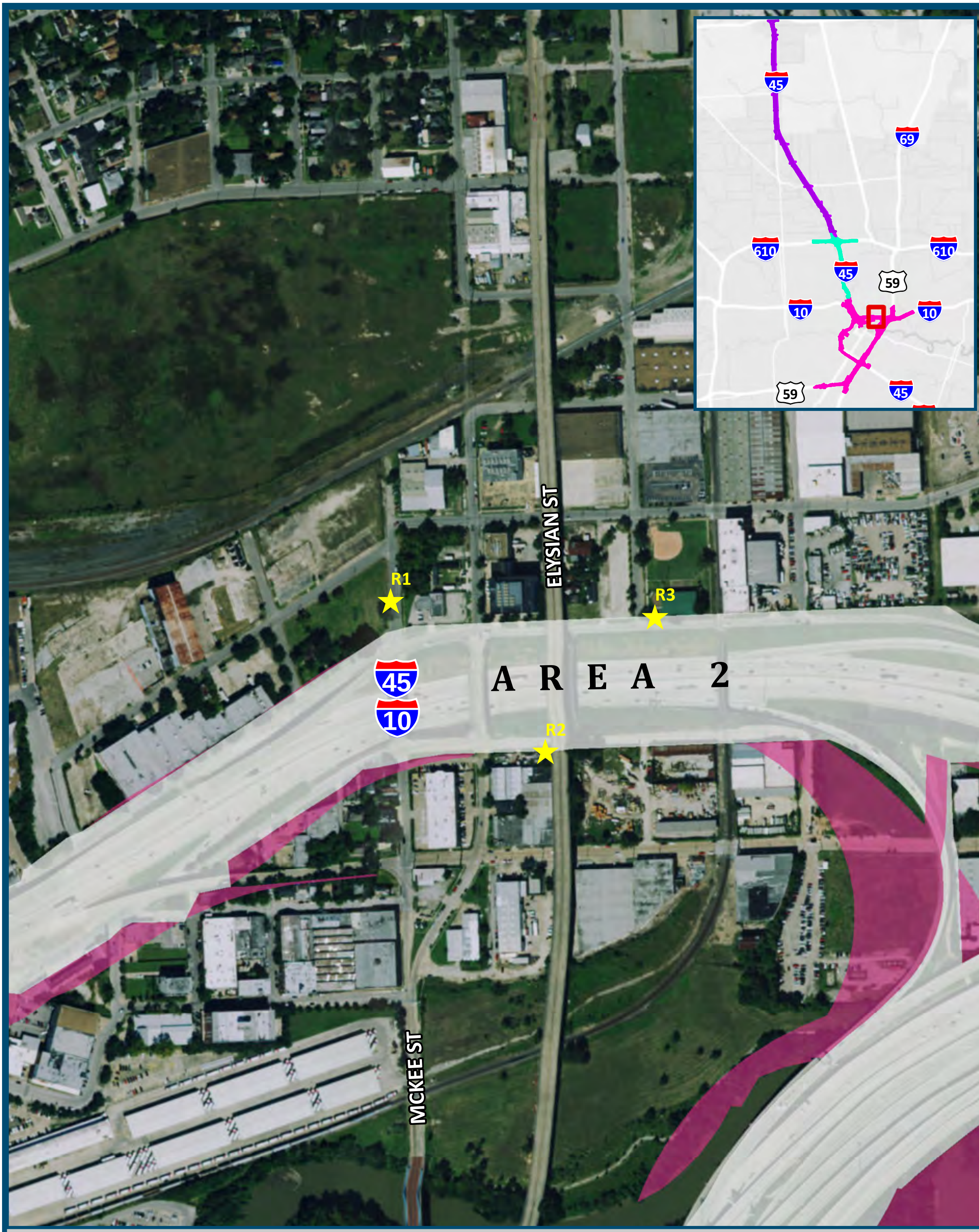
Segment 3, Alternative 11 (Area 2)

Basemap Source: ESRI World Imagery



Receptor Locations
Segment 3, Alternative 11 (Area 3)
Basemap Source: ESRI World Imagery

Receptor
Proposed ROW
Existing ROW
Feet
0 250 500



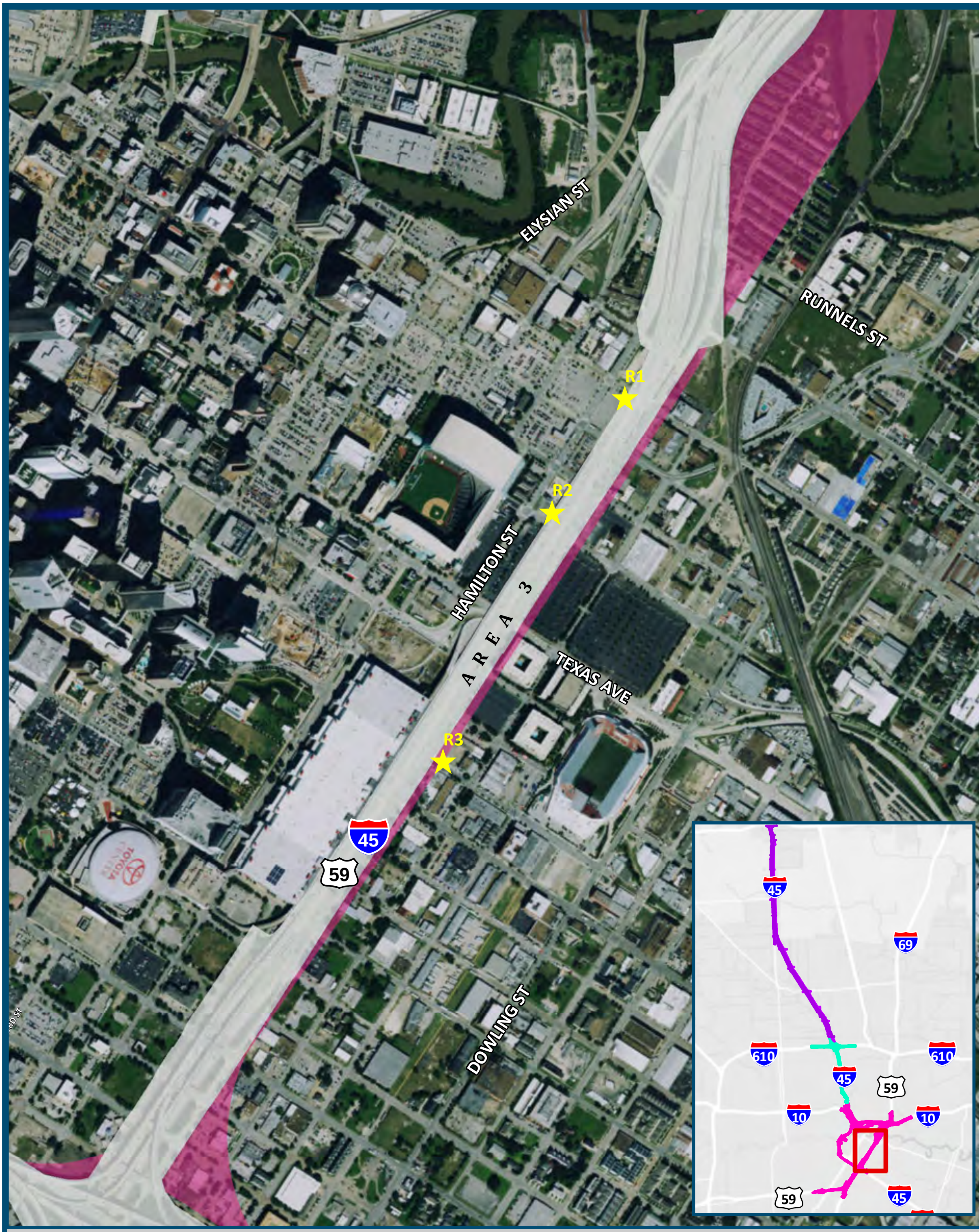
Receptor Locations

Segment 3, Alternative 12 (Area 2)

Receptor | Proposed ROW | Existing ROW

Feet 0 250 500

Basemap Source: ESRI World Imagery

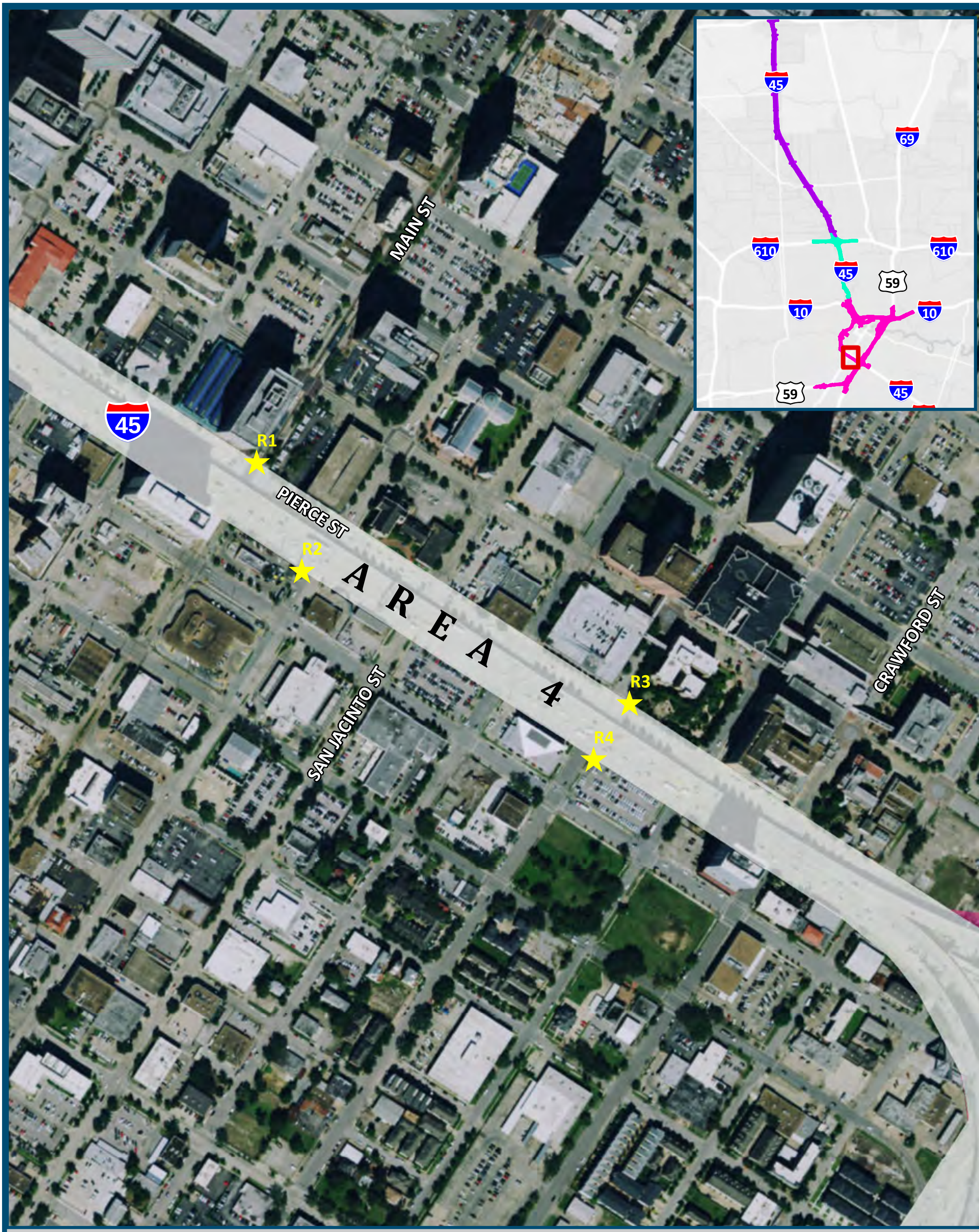


Receptor Locations
Segment 3, Alternative 12 (Area 3)

Receptor
Proposed ROW
Existing ROW

Feet
0 250 500

Basemap Source: ESRI World Imagery



Receptor Locations

Segment 3, Alternative 12 (Area 4)

Basemap Source: ESRI World Imagery

Receptor

Proposed ROW

Existing ROW

Feet

0 250 500

APPENDIX B

CO Concentration Results per Receptor

Segment/Alternative	2025: Estimated Time of Completion (ETC)				2035: Design Year			
Receptor	**1 Hour CO Concentration**	**1 Hour CO Background Concentration**	**8 Hour CO Background Concentration**	**8 Hour CO Concentration**	**1 Hour CO Concentration**	**1 Hour CO Background Concentration**	**8 Hour CO Background Concentration**	**8 Hour CO Concentration**
Segment 1, Alternative 4								
Receptor 1	2.9	2.5	1.9	**2.1**	2.9	2.5	1.9	**2.1**
Receptor 2	2.9	2.5	1.9	**2.1**	2.9	2.5	1.9	**2.1**
Receptor 3	2.9	2.5	1.9	**2.1**	2.9	2.5	1.9	**2.1**
Receptor 4	2.8	2.5	1.9	**2.1**	2.8	2.5	1.9	**2.1**
Segment 2, Alternative 10								
Receptor 1	2.7	2.5	1.9	**2.0**	2.7	2.5	1.9	**2.0**
Receptor 2	2.7	2.5	1.9	**2.0**	2.7	2.5	1.9	**2.0**
Receptor 3	2.9	2.5	1.9	**2.1**	2.9	2.5	1.9	**2.1**
Receptor 4	3.9	2.5	1.9	**2.7**	4.0	2.5	1.9	**2.8**
Receptor 5	2.7	2.5	1.9	**2.0**	2.7	2.5	1.9	**2.0**
Segment 3, Alternative 10								
Area 2								
Receptor 1	2.8	2.5	1.9	**2.1**	3.0	2.5	1.9	**2.2**
Receptor 2	2.8	2.5	1.9	**2.1**	2.8	2.5	1.9	**2.1**
Receptor 3	2.8	2.5	1.9	**2.1**	2.8	2.5	1.9	**2.1**
Area 4								
Receptor 1	3.3	2.5	1.9	**2.4**	3.3	2.5	1.9	**2.4**
Receptor 2	3.0	2.5	1.9	**2.2**	3.1	2.5	1.9	**2.3**
Receptor 3	3.2	2.5	1.9	**2.3**	3.2	2.5	1.9	**2.3**
Receptor 4	3.1	2.5	1.9	**2.3**	3.1	2.5	1.9	**2.3**

Highlighted Highest CO Concentration per Segment/Area (2025) **Highlighted** Highest CO Concentration per Segment/Area (2035)

Segment/Alternative	2025: Estimated Time of Completion (ETC)				2035: Design Year			
Receptor	1 Hour CO Concentration	1 Hour CO Background Concentration	8 Hour CO Background Concentration	8 Hour CO Concentration	1 Hour CO Concentration	1 Hour CO Background Concentration	8 Hour CO Background Concentration	8 Hour CO Concentration
Segment 3, Alternative 11								
Area 1								
Receptor 1	3.1	2.5	1.9	**2.3**	3.2	2.5	1.9	**2.3**
Receptor 2	3.1	2.5	1.9	**2.3**	3.2	2.5	1.9	**2.3**
Receptor 3	3.1	2.5	1.9	**2.3**	3.2	2.5	1.9	**2.3**
Receptor 4	3.0	2.5	1.9	**2.2**	3.0	2.5	1.9	**2.2**
Area 2								
Receptor 1	3.0	2.5	1.9	**2.2**	3.0	2.5	1.9	**2.2**
Receptor 2	2.8	2.5	1.9	**2.1**	2.8	2.5	1.9	**2.1**
Receptor 3	3.0	2.5	1.9	**2.2**	3.0	2.5	1.9	**2.2**
Area 3								
Receptor 1	2.5	2.5	1.9	**1.9**	2.5	2.5	1.9	**1.9**
Receptor 2	2.5	2.5	1.9	**1.9**	2.5	2.5	1.9	**1.9**
Receptor 3	2.5	2.5	1.9	**1.9**	2.5	2.5	1.9	**1.9**
Segment 3, Alternative 12								
Area 2								
Receptor 1	2.8	2.5	1.9	**2.1**	2.8	2.5	1.9	**2.1**
Receptor 2	2.9	2.5	1.9	**2.1**	3.1	2.5	1.9	**2.3**
Receptor 3	3.0	2.5	1.9	**2.2**	3.0	2.5	1.9	**2.2**
Area 3								
Receptor 1	4.4	2.5	1.9	**3.0**	4.5	2.5	1.9	**3.1**
Receptor 2	3.6	2.5	1.9	**2.6**	3.7	2.5	1.9	**2.6**
Receptor 3	3.8	2.5	1.9	**2.7**	3.9	2.5	1.9	**2.7**
Area 4								
Receptor 1	2.7	2.5	1.9	**2.0**	2.8	2.5	1.9	**2.1**
Receptor 2	2.9	2.5	1.9	**2.1**	3.0	2.5	1.9	**2.2**
Receptor 3	3.1	2.5	1.9	**2.3**	3.1	2.5	1.9	**2.3**
Receptor 4	2.7	2.5	1.9	**2.0**	2.8	2.5	1.9	**2.1**

Highlighted	Highest CO Concentration per Segment/Area (2025)
Highlighted	Highest CO Concentration for entire project (2025)
Highlighted	Highest CO Concentration per Segment/Area (2035)
Highlighted	Highest CO Concentration for entire project (2035)

APPENDIX C

Traffic Data Approval

NHHIP DEIS
Summary of Traffic Projection Methodology

Segments 1 and 2

For this study, the Houston-Galveston Area Council's 2035 Travel Demand Model (H-GAC TDM) in *Cube Voyager* was utilized. The base year (2014) and future year (2035) conformity networks were obtained from H-GAC. The existing and future year networks were both refined to accurately reflect the existing geometry, and access and connectivity in the downtown area.

Each of the 2035 alternatives (10, 11 and 12) were coded in the regional model and evaluated using H-GAC's 2014-Q3 Regional Growth Forecast Data. The 2035 future year traffic volumes for Segments 1 and 2 were obtained from the H-GAC TDM analysis.

Segment 3

In addition to the regional level travel demand model analysis which was used to conduct daily model runs for existing and future years to evaluate future travel patterns and demand for the three study segments, a detailed micro-simulation analysis (VISSIM) was also completed for Segment 3 of the project.

Segment 3 VISSIM models, including the no-build and the three build alternatives, were developed for both AM and PM peak period conditions. Existing traffic volumes (2011) were projected to 2014 and 2035 using the growth rates calculated from the H-GAC TDM. The VISSIM models were utilized to evaluate the operational impacts associated with the various, proposed transportation improvements in the downtown loop system.

Inputs to the VISSIM model included detailed traffic counts conducted in September 2011 (supplemented by May 2014 counts at key locations for validation) and traffic signal timing plans, obtained from Houston TranStar. The study area for VISSIM incorporates the freeways, access points in the downtown loop area, as well as the interchanges of I-10 and I-45, I-45 and US 59, US 59 and I-10, Spur 527/US 59 and US 59 and US 288.

From: Janie Temple
Sent: Tuesday, October 27, 2015 1:14 PM
To: Wahida Wakil
Cc: Darrin Willer; Wahida Wakil; Joel Salinas; Stephanie Guillot (sguillot@HNTB.com); Amar, Elizabeth Runey; Loney, Ashish G
Subject: NHHIP - Traffic Volumes and Growth Rates

Wahida,

I have reviewed the NHHIP DEIS methodology summary and the traffic volumes and growth rates and concur with the methodology. In addition, the resulting traffic volumes and growth rates are consistent with the methodology.

We look forward to working with your team on the other analyses being planned for this effort.

Janie

Talk. Text. Crash.