Appendix H
Traffic Analysis Memorandum

TRAFFIC ANALYSIS MEMORANDUM

Loop 9 Southeast
Corridor/Feasibility Study

From US 67 to IH 20
Dallas, Ellis, and Kaufman Counties, Texas
CSJ: 2964-10-002

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EXECUTIVE SUMMARY

The purpose of this technical memorandum is to summarize the traffic study performed to project future traffic growth in the Loop 9 (LP 9) corridor and identify capacity needs of this corridor to improve mobility, safety, and connectivity of the transportation system in the study area. The study limits are from United States Highway (US) 67 to Interstate Highway (IH) 20 where LP 9 would connect with the proposed State Highway (SH) 190 - East Branch.

This study uses the North Central Texas Council of Governments (NCTCOG) regional travel demand model as its basis of analysis and evaluates traffic growth potential for two scenarios: Baseline Forecast and Higher Growth Forecast. The Baseline Forecast utilizes historic traffic growth as well as the estimated population and employment growth between the base year (2012) and horizon year (2035) in the NCTCOG *2040 Demographic Forecast*. The Higher Growth Forecast considers future land use plans of jurisdictions within the study area, potential timing of different developments that are envisioned to occur in the vicinity of the corridor, and accelerated developments usually associated with the opening of a new road.

The results of the Baseline Forecast analysis show that a two-lane arterial road would be needed by 2025 between US 67 and IH 35E followed by the section between IH 35E to IH 20 opening by 2030. The US 67 to IH 35E section would need to be upgraded to a four-lane arterial by 2040 followed by the remaining sections opening by 2045. The four-lane frontage/four-lane tollway configuration for Duncanville Road to IH 35E is warranted by 2045, with the sections from US 67 to Duncanville Road and from IH 35E to IH 45 opening by 2050 and the section from IH 45 to IH 20 estimated by 2055. Finally, the six-lane frontage/six-lane tollway configuration for Duncanville Road to IH 45 would be warranted by 2065 followed by the section from US 67 to Duncanville Road by 2070 and IH 45 to US 67 by 2075.

The Higher Growth Forecast analysis demonstrates the need for constructing a two-lane configuration for the sections from US 67 to IH 35E and IH 35E to IH 45 by 2025, and finally IH 45 to IH 20 by 2030. Other intermediate configurations would be justified approximately 10 years apart. The ultimate configuration in this scenario is estimated warranted in 2060 for US 67 to IH 45 section and in 2065 for section from IH 45 to IH 20.

Diagrams of project phasing for both scenarios are shown below.

Diagram 1: Baseline Forecast Project Phasing

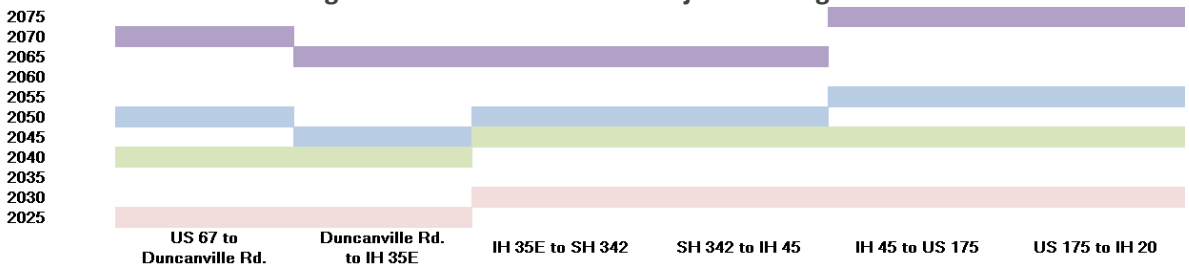
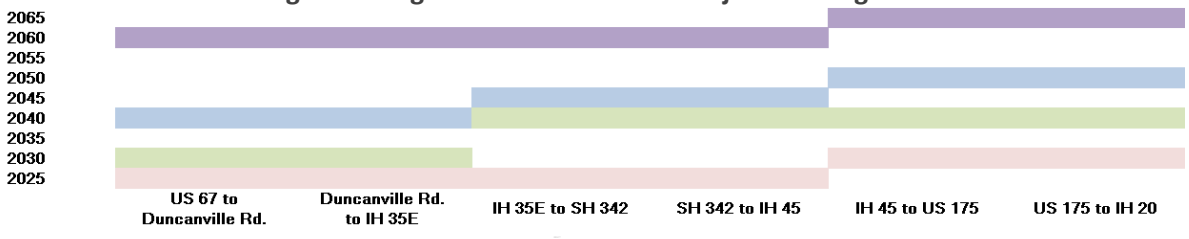


Diagram 2: Higher Growth Forecast Project Phasing



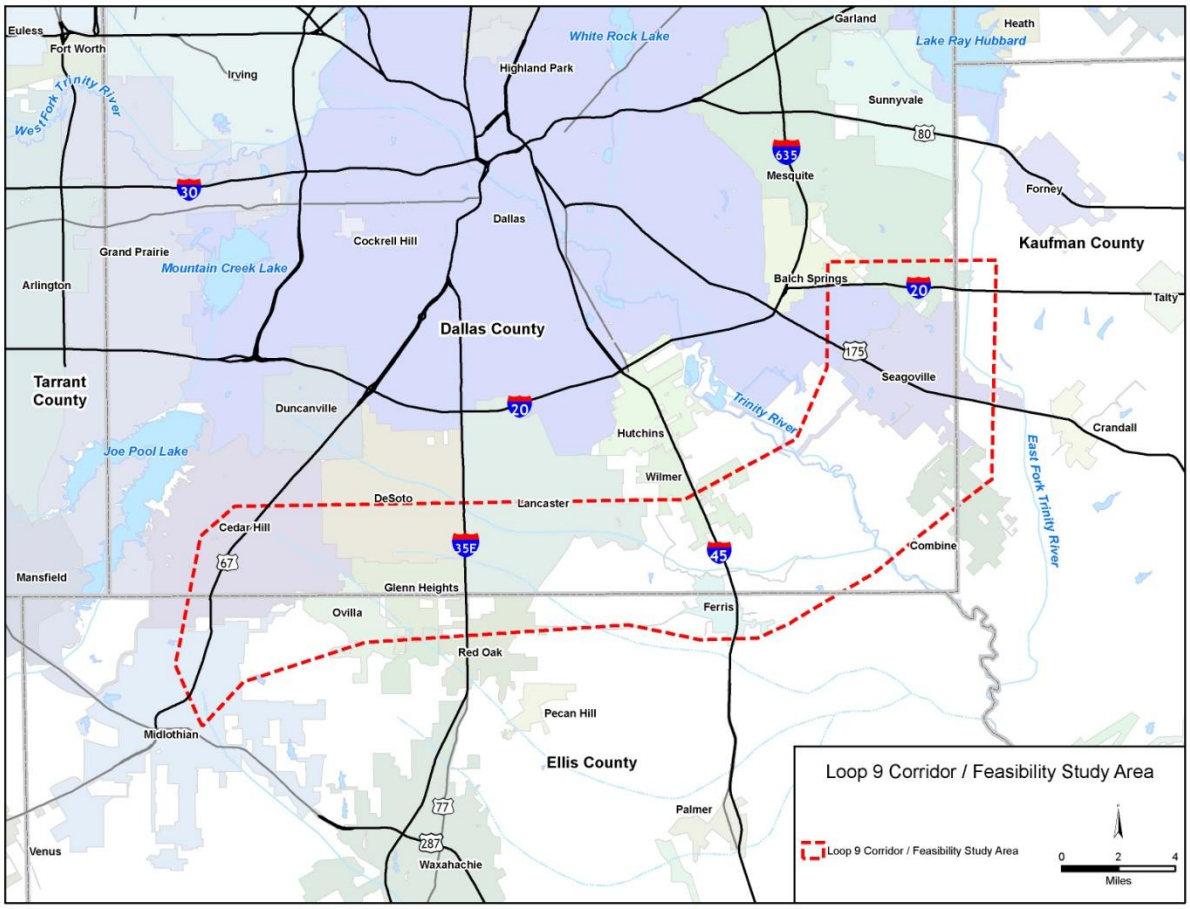
Year by which a 2-lane arterial section would be warranted
Year by which a 4-lane arterial section would be warranted
Year by which a 4 mainlanes and 4 frontage lanes section would be warranted
Year by which a 6 mainlanes and 6 frontage lanes section would be warranted

INTRODUCTION

The purpose of this technical memorandum is to provide traffic information to support the Loop 9 (LP 9) planning process thereby maximizing user benefits. As shown in **Figure 1** the study limits are from United States (US) 67 to Interstate Highway (IH) 20 where LP 9 would connect with the proposed State Highway (SH) 190 - East Branch. The LP 9 corridor traverses portions of Dallas, Ellis, and Kaufman Counties, and the cities of Cedar Hill, Midlothian, Desoto, Glenn Heights, Ovilla, Red Oak, Wilmer, Ferris, Lancaster, Combine, and Seagoville. This memorandum provides the following:

- A description of the methodology applied to project future traffic in the proposed LP 9 corridor
- An assessment of traffic capacity and level of service (LOS) for the forecast year of 2035

Figure 1: LP 9 Corridor Feasibility Study Area



Based on various design concepts for the LP 9 corridor, 16 travel demand network scenarios were modeled using the North Central Texas Council of Governments (NCTCOG) regional travel demand model. The transportation network scenarios are summarized in **Table 1**. The network scenarios varied based on three factors: the cross section of the LP 9 facility, the highway connections on the east and west ends of the LP 9 facility, and the type of tolling applied to the corridor. The three alternate connections for the west end of the project are US 287, US 67, and US 67 at Lake Ridge Parkway. On the

east end, the three potential connections are IH 45, IH 45 at Malloy Bridge Road, and IH 20. The modeled typical sections consist of 6 mainlanes and 6 frontage lanes (ultimate configuration), six-lane frontage section, and finally six-lane major arterial section with tolled bridge bypasses at major crossings. The three tolling concepts modeled are: tolling bypasses at major crossing arterials, corridor-wide mainlane tolling, and a non-toll facility.

An additional concept (Concept O) was modeled for a six-lane primary arterial with tolled bridges at major crossings and stretching from US 67 at Lake Ridge Parkway to IH 20 where it connect to SH 190 – East Branch. One feature of this design concept is the lack of continuous frontage roads along LP 9 where it crosses IH 35E, IH 45, and US 175. This feature is carried throughout the progression of project phases and to the ultimate configuration of the corridor.

This study provides analysis for four implementation phases. Phase 1, displayed in **Figure 2a**, will include the construction of one two-way frontage road. Additionally, the right-of-way (ROW) required for all phases will be purchased during Phase 1. Phase 2, illustrated in **Figure 2b**, is the construction of the paired frontage road, and each of the frontage roads will be converted to one-way roadways. The median will be left open for the future Phases 3 and 4. Phase 3 is the construction of isolated grade separations at specific high-volume intersections. Phase 4, presented in **Figure 2c,** is the construction of continuous tolled mainlanes in both directions.

Concept O was developed by the LP 9 project team and selected for analysis, because it is an intermediate phase of project progression and represents the average level of traffic attracted by the corridor compared to other progressive configurations. Thus, the Concept O base case volumes can be used to estimate the diverted traffic resulting from the upgrade to the next phase. Continuous frontage roads were added to this concept network to maximize the attractiveness of the facility.

Table 1: Loop 9 Corridor Travel Model Results

Scenario	Scenario Shapefile	Scenario Description	Design Concept	Section from IH 35 to Westmoreland Dr			Section from Westmoreland Dr to Joe Wilson		
				Daily Volume		Daily LOS	Daily Volume		Daily LOS
				Average	Max		Average	Max	
A	TxDOT_US67toIH45_Connected	Loop 9 coded based on the line diagram provided by TxDOT, but with an eastern terminus at IH 45 instead of IH 20 (appx. 19 miles)	6 mainlanes, 6 frontage road lanes	25,100	43,200	A	17,400	34,300	A
B	TxDOT_US67toIH20	Loop 9 coded based on the line diagram provided by TxDOT (appx. 34 miles)	6 mainlanes, 6 frontage road lanes	25,900	44,400	A	17,700	34,800	A
C	M2035_US287toIH20	Loop 9 as coded for Mobility 2035 (appx. 44 miles)	6 mainlanes, 6 frontage road lanes	22,500	31,300	A	21,600	38,800	A
D	M2035_US67toIH45_C	Loop 9 terminated in the east at IH 45 and realigned to connect to Malloy Bridge Rd and terminated in the west at US 67 and realigned to connect to Lake Ridge Pkwy (appx. 19 miles)	6 mainlanes, 6 frontage road lanes	20,300	29,000	A	16,900	32,600	A
E	M2035_US67toIH45	Loop 9 as coded for Mobility 2035, but terminated in the east at IH 45 and in the west at US 67 (appx. 19 miles)	6 mainlanes, 6 frontage road lanes	20,200	29,000	A	17,600	33,600	A
F	M2035ToolledBridgesUS287toIH20	Loop 9 coded as a 3-lane frontage road in each direction with a tolled bridge bypass alternative at each arterial crossing (appx. 44 miles)	3 lanes in each direction (frontage road or arterial) with tolled bypasses at each intersection (Coded as functional class 2 - -expressway--)	19,200	36,400	D	21,400	45,100	D
G	M2035TollBridges_US67toIH45_C	Loop 9 coded as a 3-lane frontage road in each direction with a tolled bridge bypass alternative at each arterial crossing, terminated in the east at IH 45 and realigned to connect to Malloy Bridge Rd and terminated in the west at US 67 an realigned to connect to Lake Ridge Pkwy (appx. 19 miles)	3 lanes in each direction (frontage road or arterial) with tolled bypasses at each intersection (Coded as functional class 2 - -expressway--)	13,400	32,100	C	23,300	38,500	D

Table 1: Loop 9 Corridor Travel Model Results

Scenario	Scenario Shapefile	Scenario Description	Design Concept	Section from IH 35 to Westmoreland Dr			Section from Westmoreland Dr to Joe Wilson		
				Daily Volume		Daily LOS	Daily Volume		Daily LOS
				Average	Max		Average	Max	
H	M2035TolledBridges_US67toIH45	Loop 9 coded as a 3-lane frontage road in each direction with a tolled bridge bypass alternative at each arterial crossing, but terminated in the east at IH 45 and in the west at US 67 (appx. 19 miles)	3 lanes in each direction (frontage road or arterial) with tolled bypasses at each intersection (Coded as functional class 2 --expressway--)	17,400	32,700	C	18,500	41,000	D
I	M2035_NoToll_US287toIH20	Loop 9 as coded for Mobility 2035, with main lane tolling removed (appx. 44 miles)	6 mainlanes, 6 frontage road lanes	49,200	59,000	B	42,000	61,200	B
J	M2035_NoToll_US67toIH45_C	Loop 9 terminated in the east at IH 45 and realigned to connect to Malloy Bridge Rd and terminated in the west at US 67 an realigned to connect to Lake Ridge Pkwy and with main lane tolling removed (appx. 19 miles)	6 mainlanes, 6 frontage road lanes	39,600	48,900	B	31,300	48,500	B
K	M2035_NoToll_US67toIH45	Loop 9 as coded for Mobility 2035, but terminated in the east at IH 45 and in the west at US 67 and with main lane tolling removed (appx. 19 miles)	6 mainlanes, 6 frontage road lanes	38,400	47,700	B	29,700	47,500	B
L	M2035_FrtgOnly_US287toIH20	Loop 9 coded as a 3-lane frontage road in each direction (appx. 44 miles)	3 frontage road lanes in each direction (Coded as functional class 7 --arterial--)	8,300	14,600	B	11,800	15,700	B
M	M2035_FrtgOnly_US67toIH45_C	Loop 9 coded as a 3-lane frontage road in each direction terminated in the east at IH 45 and realigned to connect to Malloy Bridge Rd and terminated in the west at US 67 an realigned to connect to Lake Ridge Pkwy (appx. 19 miles)	3 frontage road lanes in each direction (Coded as functional class 7 --arterial--)	7,500	13,500	B	9,900	13,500	B

Table 1: Loop 9 Corridor Travel Model Results

Scenario	Scenario Shapefile	Scenario Description	Design Concept	Section from IH 35 to Westmoreland Dr			Section from Westmoreland Dr to Joe Wilson		
				Daily Volume		Daily LOS	Daily Volume		Daily LOS
				Average	Max		Average	Max	
N	M2035_Frtg Only_US67to IH45	Loop 9 coded as a 3-lane frontage road in each direction, but terminated in the east at IH 45 and in the west at US 67 (appx. 19 miles)	3 frontage road lanes in each direction (Coded as functional class 7 --arterial--)	7,800	14,000	B	10,900	14,300	B
O	TXDOT_US67 tolH20_TollB ridge	Loop 9 coded as a 3-lane frontage road in each direction with a tolled bridge bypass alternative at each arterial crossing and terminated in the west at US 67 and realigned to connect to Lake Ridge Pkwy. The corridor connects with the proposed SH 190 East Branch at IH 20. (appx. 34 miles)	3 lanes in each direction (frontage road or arterial) with tolled bypasses at each intersection (Coded as functional class 2 --expressway--)	10,800	14,100	B	17,700	20,400	B

Figure 2a: Phase 1 – Two-Way Frontage Road

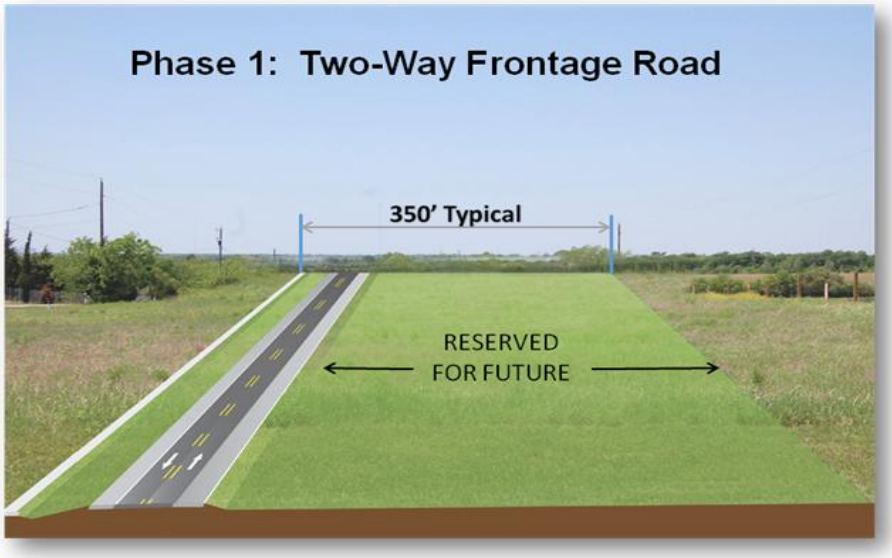


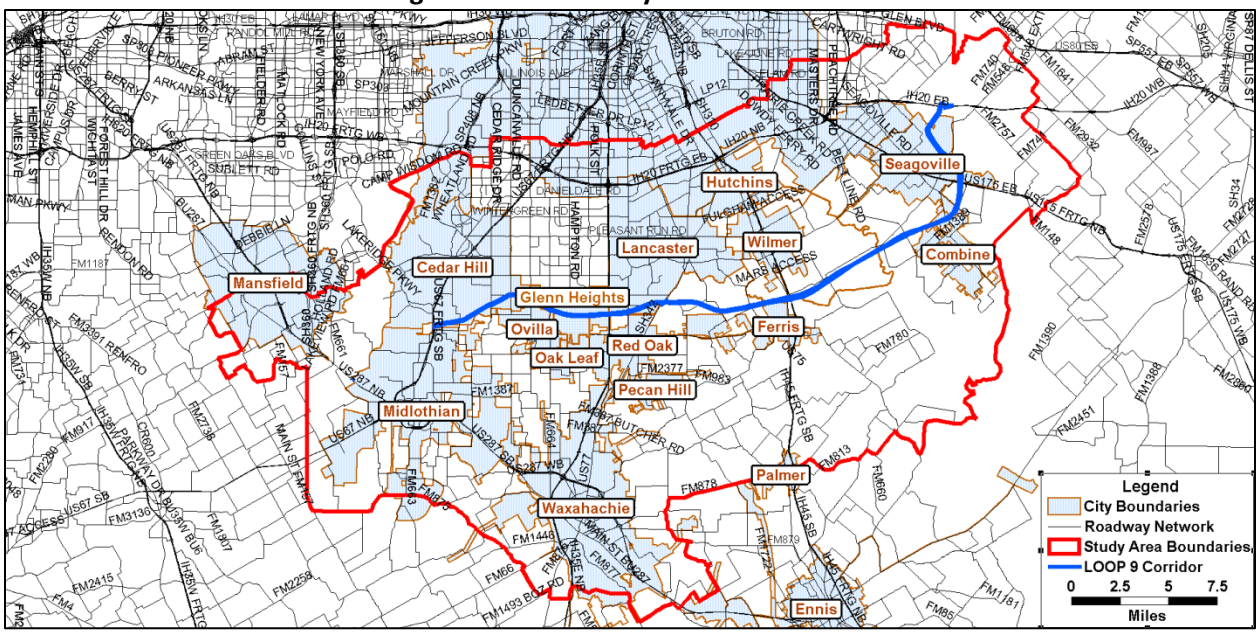
Figure 2b: Phase 2 – One-Way Frontage Roads

Figure 2c: Phase 4 - Continuous Toll Road

DATA AND METHODOLOGY

NCTCOG provided Atkins with demographic data, traffic analysis zones (TAZ), origin-destination data (OD), and loaded TransCAD network files for the base year (2012) and horizon year (2035). The regional NCTCOG Travel Demand Model results were used as a starting point for this analysis. To enhance and refine results for the LP 9 traffic study area, additional subarea analysis techniques were applied to the regional data. TransCAD planning software was utilized to produce results followed by some post-processing efforts to adjust for other factors not captured by these tools. The traffic study area was defined to include competing as well as feeder corridors to LP 9 which are likely to impact traffic on this corridor. The traffic study area is selected in such a way to capture shifts in travel routes as results of change in origin-destination patterns, to include long haul trips from major production and attraction centers, and finally include all connections with major roads. **Figure 3** displays the limits of the traffic study area.

Figure 3: Traffic Study Area Boundaries



The base transportation network scenario (referred to as “base network” in this memo) used in this study is a six-lane arterial section stretching from US 67 to IH 20 with tolled bridges at most crossings as modeled in Concept O. This LP 9 configuration most closely matched the line diagram of the tolled bridges scenario developed by the LP 9 project team. Adjustments were made to projected volumes of this scenario when evaluating each interim phase since traffic diversion depends upon the functional classification of a corridor (the higher the functional classification of a corridor, the higher the attractiveness of the corridor).

Modeling data from the NCTCOG travel model, including loaded roadway network, OD matrices, TAZ layer, and demographics, were provided. Refinements to the regional travel model traffic projections were incorporated through adjustments to the trips tables and traffic network assignment. Planning tools in TransCAD, the same software platform used by the NCTCOG model, were utilized extensively in

this analysis followed by post-processing adjustments for elements of modeling that could not be captured otherwise.

The NCTCOG model is a regional model. To provide sufficient accuracy needed for a corridor level study, a subarea model was created using the traffic study area boundary shown in **Figure 3**. To facilitate analysis of traffic growth along the corridor, the traffic study area was divided into 12 smaller areas referred to as traffic growth analysis (TGA) areas each defined by a set of east-west roadway links that represent competing routes to LP 9 for each designated area. These links, which provide a snapshot of traffic within an area, are later used to develop historic east-west traffic growth in each TGA area. **Figure 4** shows each TGA area and its set of links. Based on observations of significant increase and decrease in traffic volumes at major crossing roads in the base network, the corridor was divided into six analysis segments as described in **Table 2**.

Figure 4: Analysis Areas Represented by East-West Roadway Links

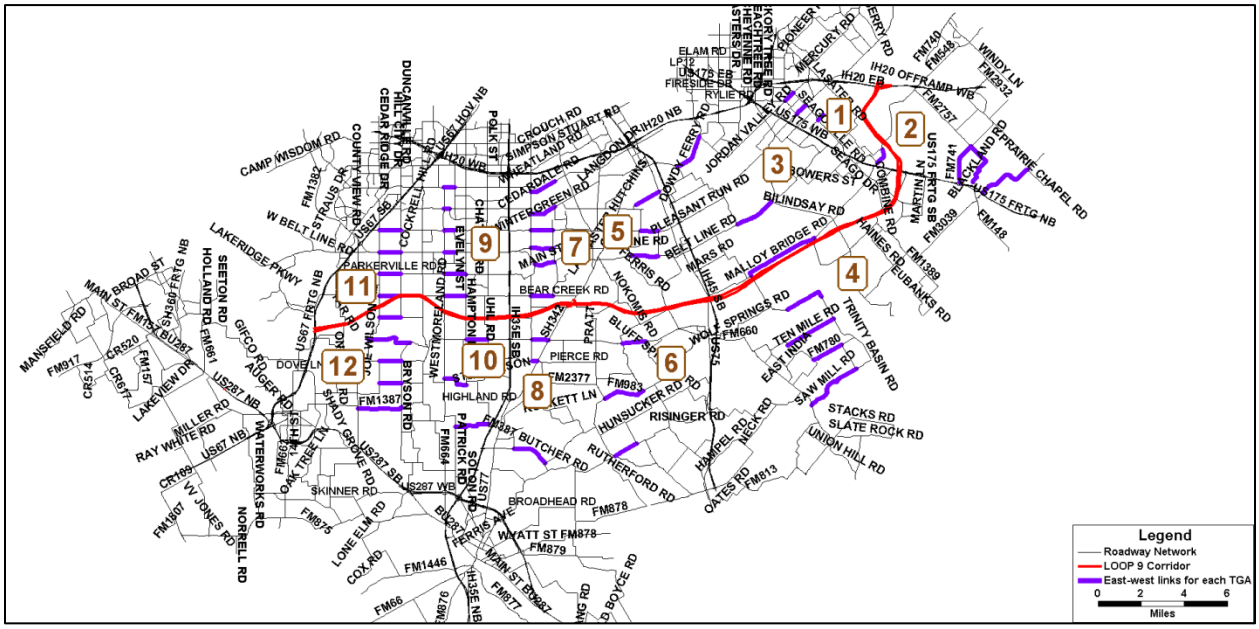


Table 2: Corridor Segment Description

1. IH 20 to US 175
2. US 175 to IH 45
3. IH 45 to SH 342
4. SH 342 to IH 35E
5. IH 35E to Duncanville Road
6. Duncanville Road to US 67

This subarea model was further refined and enhanced based on findings of a comprehensive review and analysis of demographic data, historic traffic growth, the transportation network, and existing and future land use information. Evaluation of the base year subarea model was performed, and necessary adjustments were made to correct for differences observed between projected volumes and historic traffic counts. These adjustments were carried over to the horizon year subarea model.

Traffic growth beyond 2035 was predicted under two demographic forecast conditions: Baseline Forecast and Higher Growth Forecast. The Baseline Forecast is based on historic traffic growth and projected traffic growth from NCTCOG travel model results between the base year and horizon year. The Higher Growth Forecast considers the future land use plans of jurisdictions within the traffic study area and potential timing of different developments that are envisioned to occur in the vicinity of the corridor to estimate an accelerated development timeline for the area adjacent to the LP 9 corridor.

Development of Subarea Model

Validation of Base Year Projected Daily Traffic Volumes

To analyze the historic trends of traffic in the traffic study area, Texas Department of Transportation (TxDOT) historic counts from 2000 to 2011 were coded into the base year model. Additionally there were key locations where historic counts were not available, therefore, saturation counts were obtained and coded into the base year model. The saturation counts for the traffic study area were available for years 1994, 1999, 2004, and 2009. **Figure 5** shows all TxDOT traffic count locations that were used for the validation of the base year subarea model. **Figure 6** displays locations where historic count data was available for the purpose of developing historic growth factors.

The percentage differences between the base year traffic projections from the NCTCOG travel demand model were relatively high at many locations within the subarea. **Figure 7** shows the differences between the historic traffic counts and projected volumes from the model. In general, daily volumes in the regional NCTCOG travel demand model projections are lower than historic traffic counts north of the corridor, between US 67 and SH 342, and south of the corridor around IH 35E (City of Red Oak). Volumes are overall higher than historic traffic counts between SH 342 and US 175, except for a few links south of the corridor. Finally, between IH 20 and US 175, the travel demand model projections are higher than historic counts north of the corridor and lower south of the corridor. These differences warranted refining the base year subarea model developed for this study which will be discussed under "Refinement of the OD or Trip Table" section.

Figure 5: TxDOT Traffic Count Locations Used for Validation of the Base Year Subarea Model

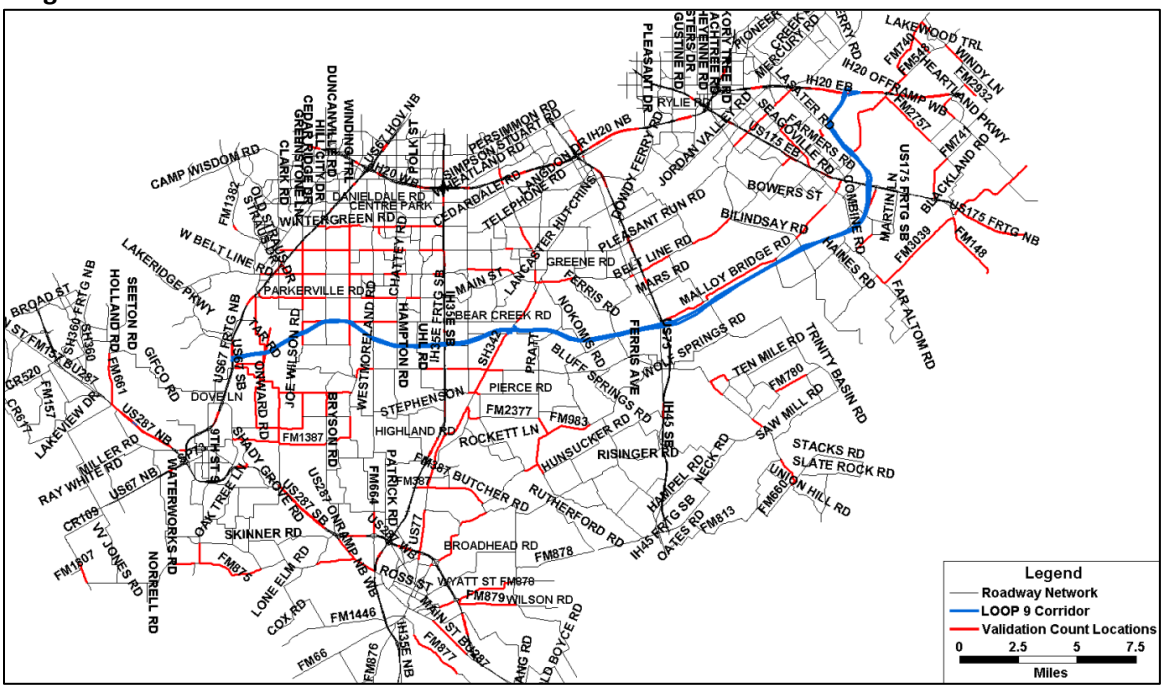


Figure 6: Historic Traffic Count Locations Used to Develop Traffic Growth Rates Beyond 2035

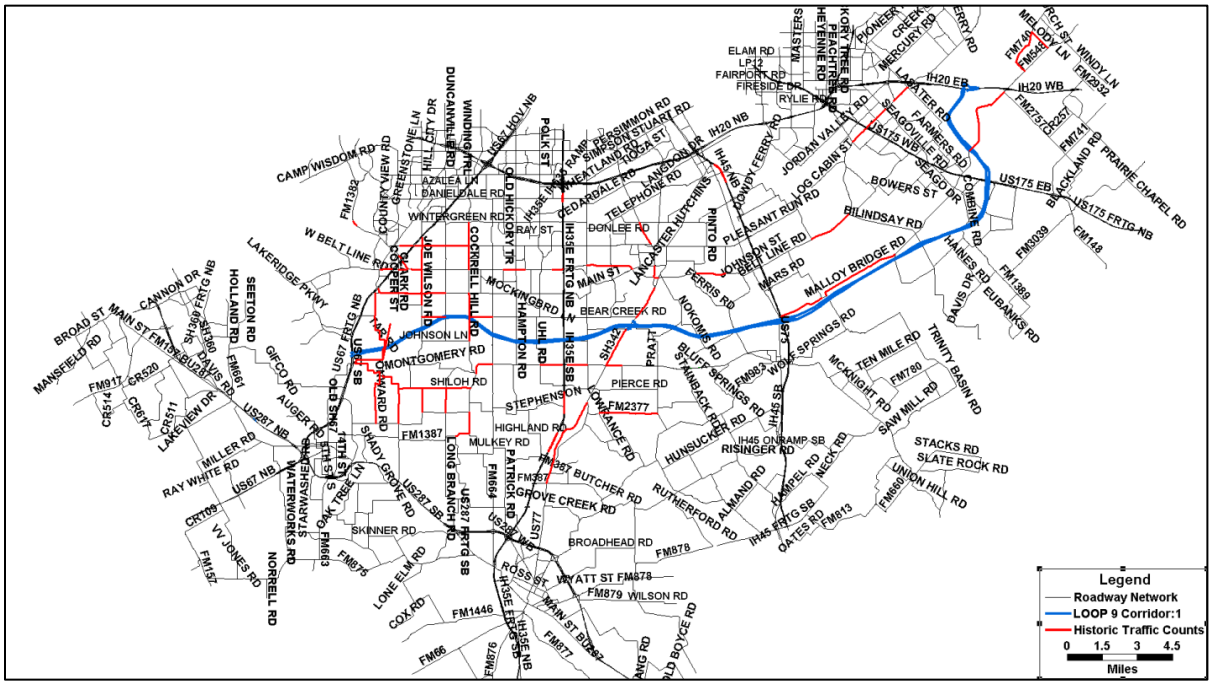
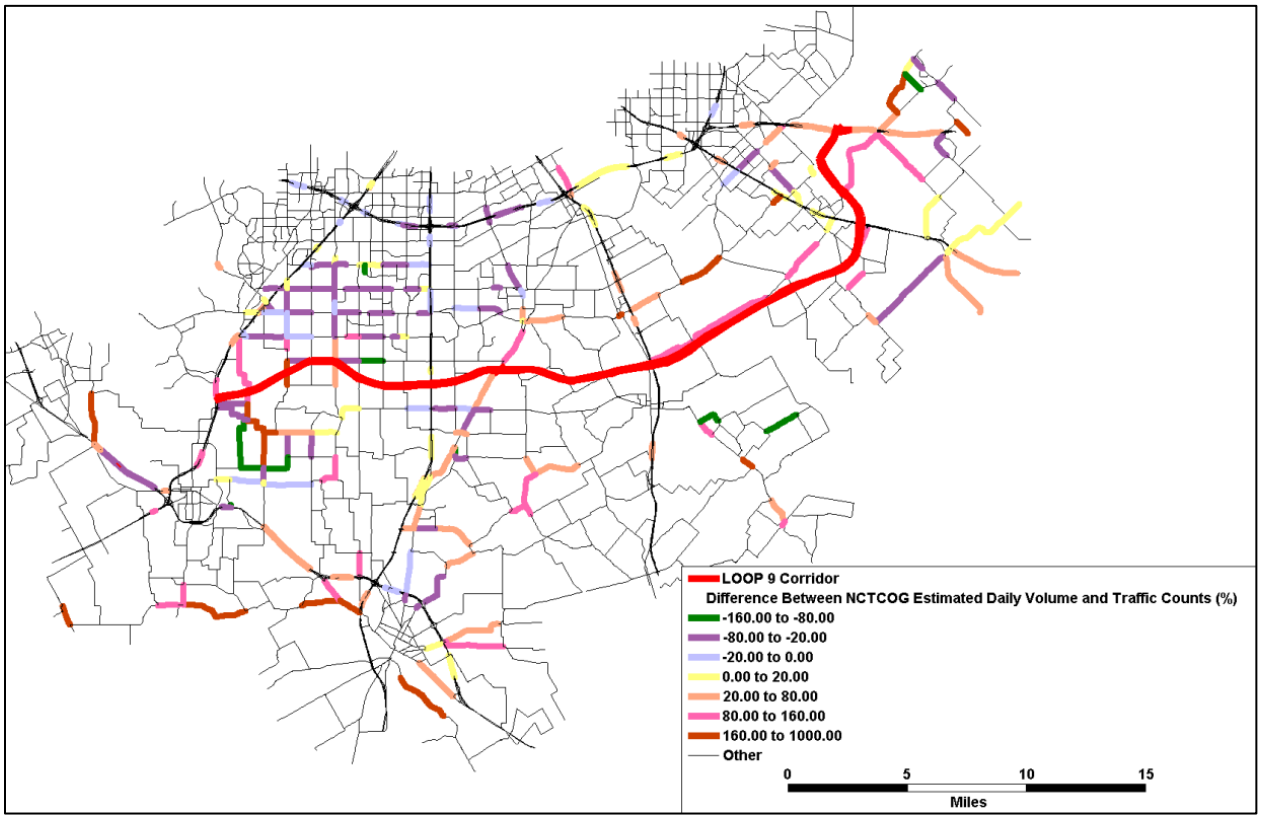


Figure 7: Differences between NCTCOG Projected Total Daily Volume and Traffic Counts (%)



Validation of Subarea Model Base Year Demographic Forecast

Demographic data and land use information were studied to identify potential subarea model refinements and better understand potential reasons for differences observed between base year model assigned traffic volumes and traffic counts. The official NCTCOG 2040 Demographic Forecast provides demographic forecasts at the "market" level. These market-level forecasts were further refined by NCTCOG to the Traffic Survey Zone (TSZ) level for travel demand modeling purposes only. The TSZ-level demographic data from NCTCOG were used for the Baseline Forecast. Evaluation of employment and population estimates not only provides valuable information on the scale of trips generated but also about travel patterns/distributions in the traffic study area. This information is used for developing OD matrices, which are the main input into the traffic assignment step. The discussion presented in this section provides the context for qualitative evaluation of the traffic assignment results produced after the OD matrix is modified based on validation of traffic counts (as will be discussed under "Refinement of the OD or Trip Table" section). Furthermore, this analysis influenced the development of the future demographic forecasts used in this report. It should be emphasized that demographics were not directly adjusted as part of subarea model development and were only studied to support the evaluation and adjustment of traffic assignment.

Census tract data from the 2000 and 2010 U.S. Census Bureau was obtained and analyzed to determine annual compound growth rates (ACGR) for the population of each census tract. Then, this growth factor was applied to 2010 census tract population to forecast the 2012 population numbers (referred to as

projected 2012) and compared with the NCTCOG forecast. For this comparison, NCTCOG TSZ-level data was aggregated to census tract level. **Figure 8** demonstrates the difference between NCTCOG's 2012 population forecast and the projected 2012 population. Negative numbers indicate census tracts where the projected 2012 level was lower than the NCTCOG forecast, while positive numbers indicate the projected 2012 level was higher. **Figures 9, 10, 11,** and **12** provide closer views of the areas northwest, northeast, southwest, and southeast of the corridor, respectively, along with labels for population difference, population ACGR between Census 2000 and Census 2010, and finally population ACGR between NCTCOG model 2012 and 2035.

Figure 8: Projected 2012 Population Compared with NCTCOG Forecasted 2012 Population

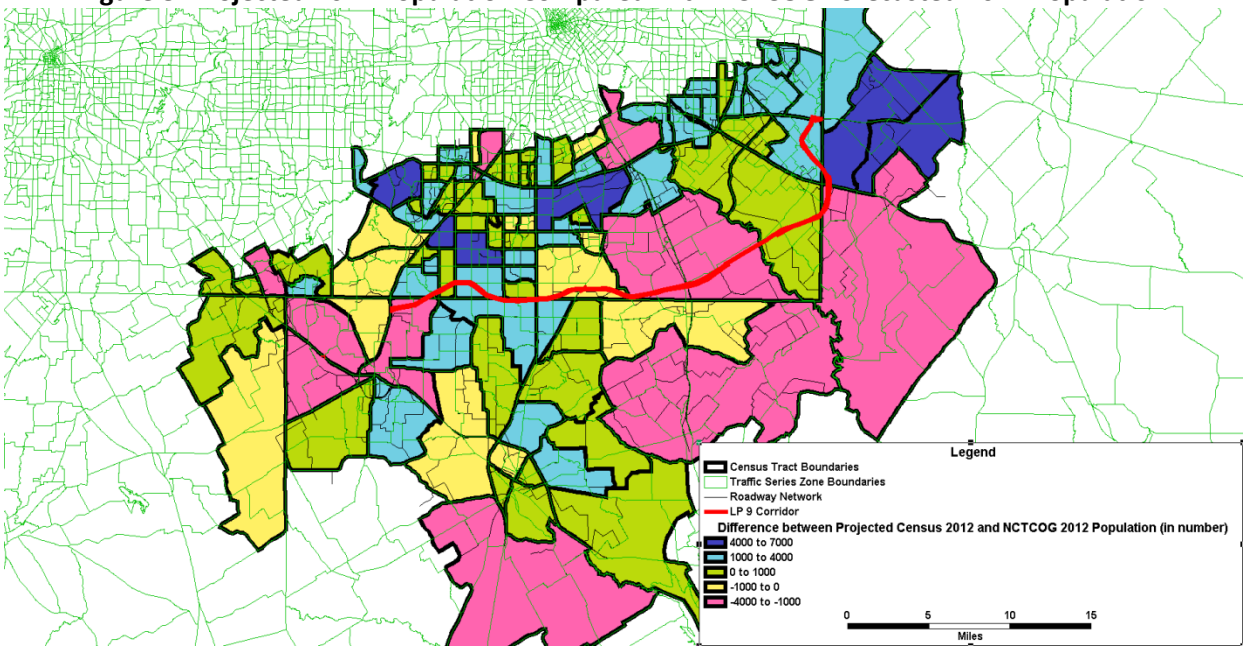


Figure 9: Projected 2012 Population Compared with NCTCOG Forecasted 2012 Population – Northwest of Corridor

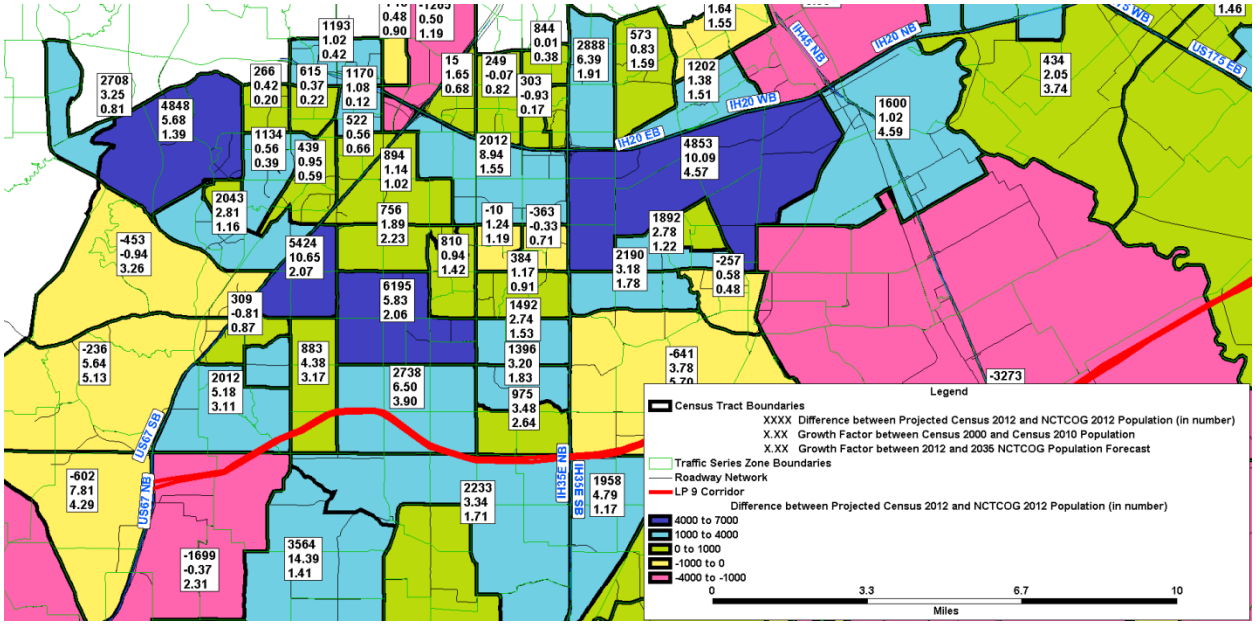


Figure 10: Projected 2012 Population Compared with NCTCOG Forecasted 2012 Population – Northeast of Corridor

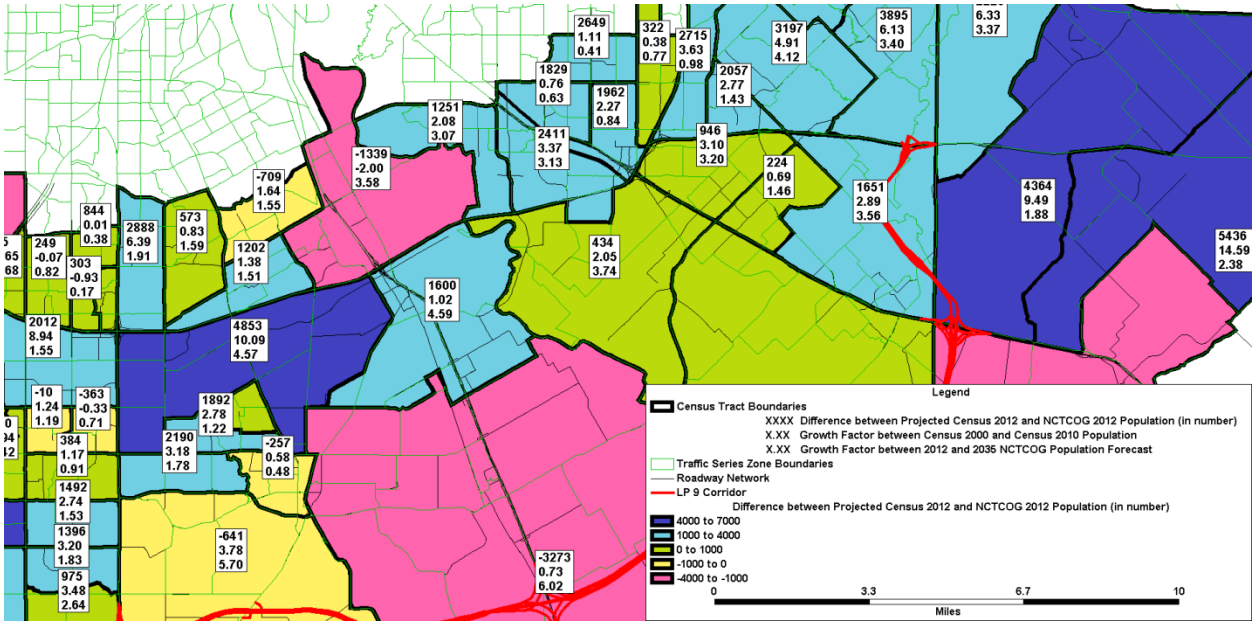


Figure 11: Projected 2012 Population Compared with NCTCOG Forecasted 2012 Population – Southwest of Corridor

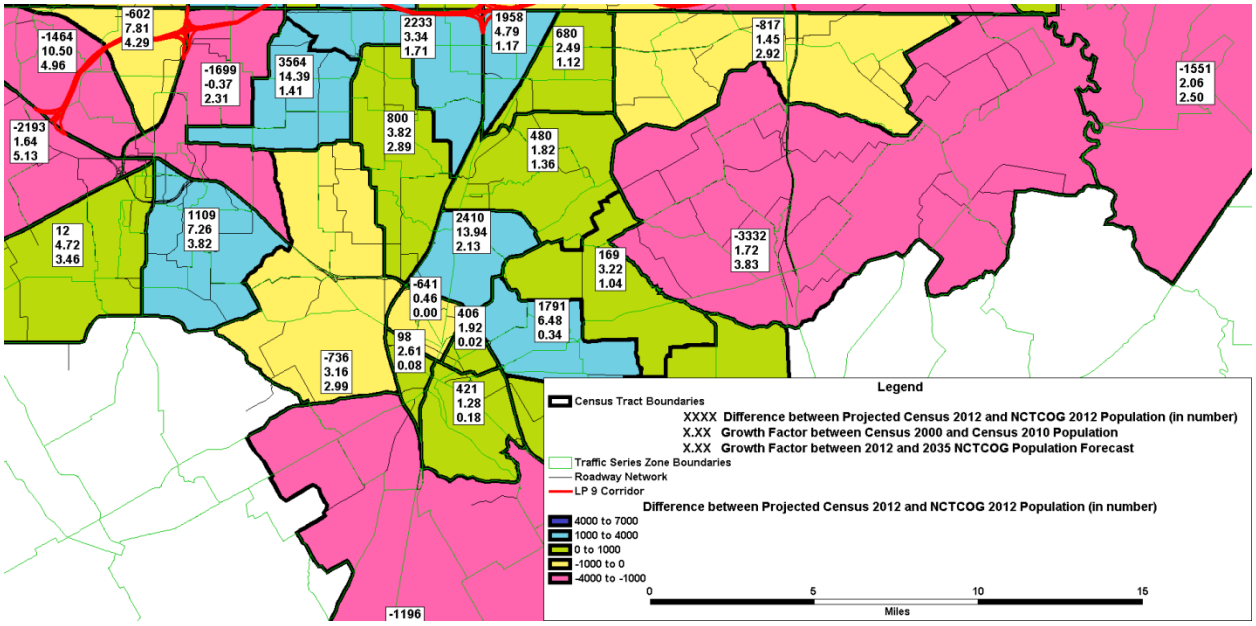
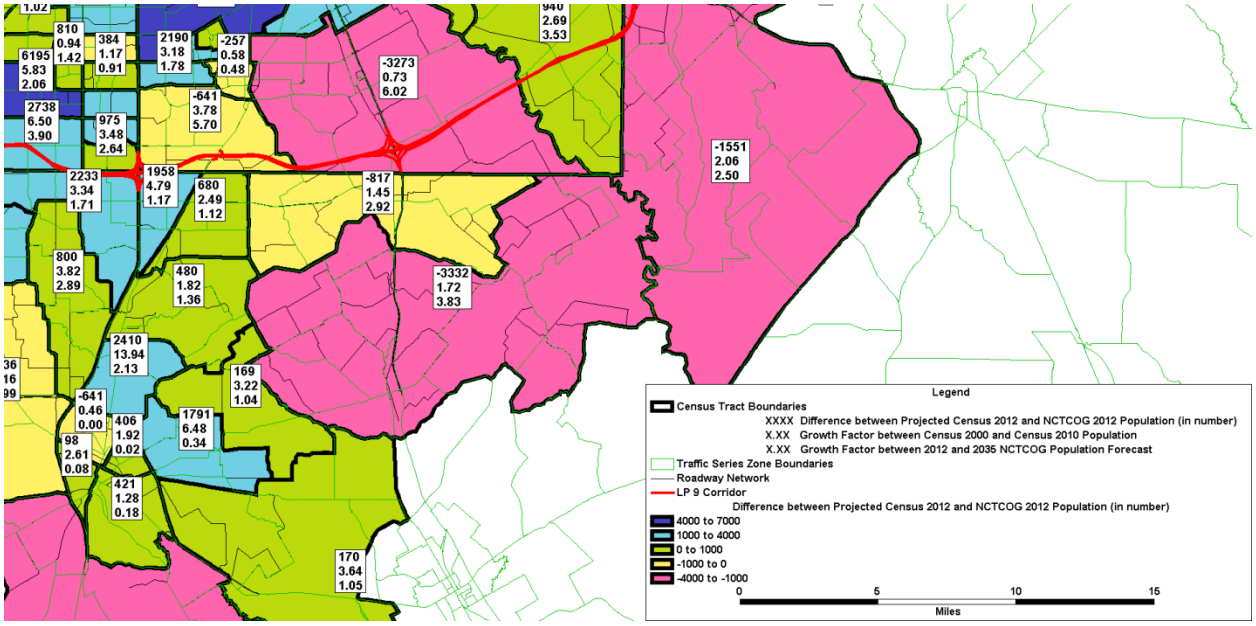


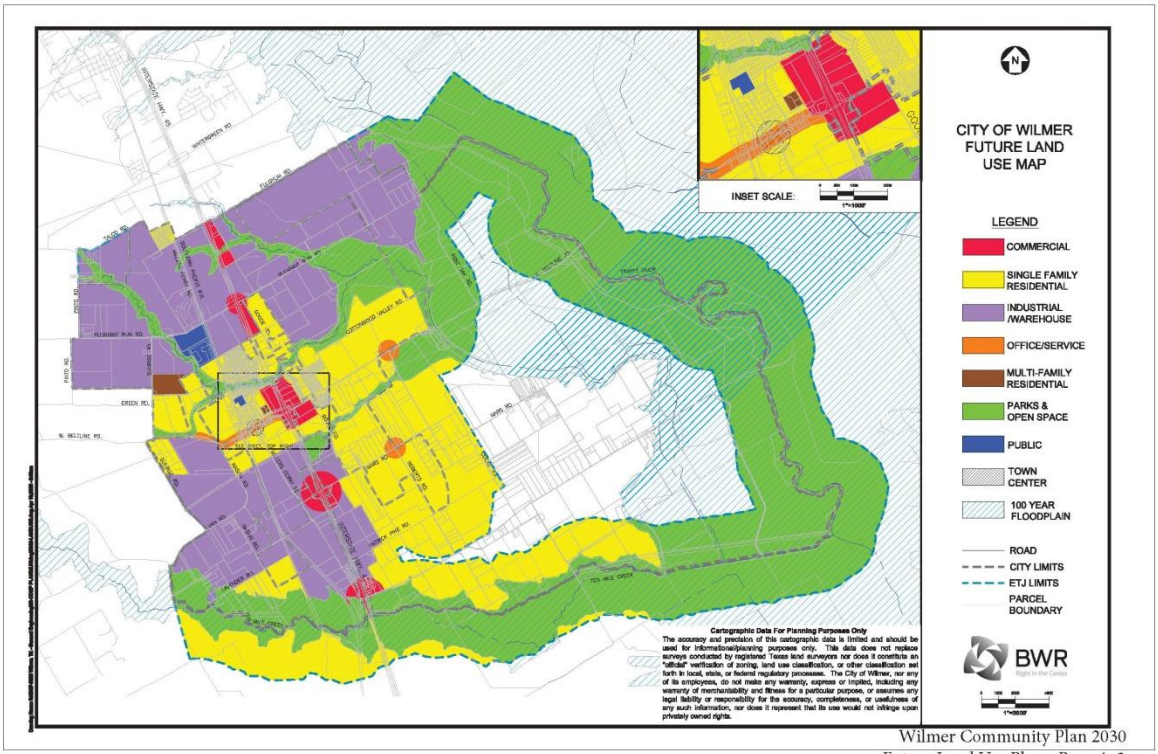
Figure 12: Projected 2012 Population Compared with NCTCOG Forecasted 2012 Population – Southeast of Corridor



As presented on the figures above, north of the LP 9 corridor and between US 67 and SH 342, the projected 2012 population is substantially higher than NCTCOG's forecast population. These areas are mostly located within jurisdictions of the cities of DeSoto and Lancaster. For these zones, the ACGR between Census 2000 and Census 2010 is high compared to the ACGR of the NCTCOG population forecast between 2012 and 2035. It is expected that the growth rate would be higher for zones/tracts with low-estimated population. It is possible that lower rates are justified in zones that are mostly developed with small percentage of vacant land. However, many of the zones to the south of Belt Line Road have sufficient vacant land to continue growth at the same rate as in the past. These zones are located between the cities of Glenn Heights and DeSoto and have a high potential for growth. The same trend is observed south of the corridor between US 67 and SH 342.

In contrast, the projected 2012 population is substantially lower than NCTCOG's forecasted population in tracts along the corridor between SH 342 and US 175. Despite this lower forecast, the Census 2000 to Census 2010 ACGR is lower than the ACGR based on NCTCOG's population forecasts. The census tract north of the corridor highlighted in pink covers the city of Wilmer and partly the International Inland Port of Dallas (IIPOD). **Figure 13** shows the future land use plan of the city of Wilmer obtained from the city's 2009 comprehensive plan. Based on this plan, the forecasted population of this city in 2030 ranges between 5,000 and 8,000. Projecting the 2012 population using a growth rate of 6.02 would mean that population in this area will be around 20,000 by year 2035, which seems quite high compared to historic trends of this areas.

Figure 13: City of Wilmer Future Land Use Plan (City of Wilmer 2009 Comprehensive Plan)



Wilmer Community Plan 2030
Future Land Use Plan - Page A-2

The tract highlighted in pink in the lower left mainly covers the city of Palmer. This area is comprised primarily of undeveloped lands, but, because of floodplain around this area and less relation to other cities around, higher growth in this area does not seem likely. The population in the area between IH 20 and US 175 is lower based on NCTCOG's forecast compared to projected 2012 population. However, when comparing with Google maps, census data seem too high especially because traffic volume estimates in this area exceed traffic counts.

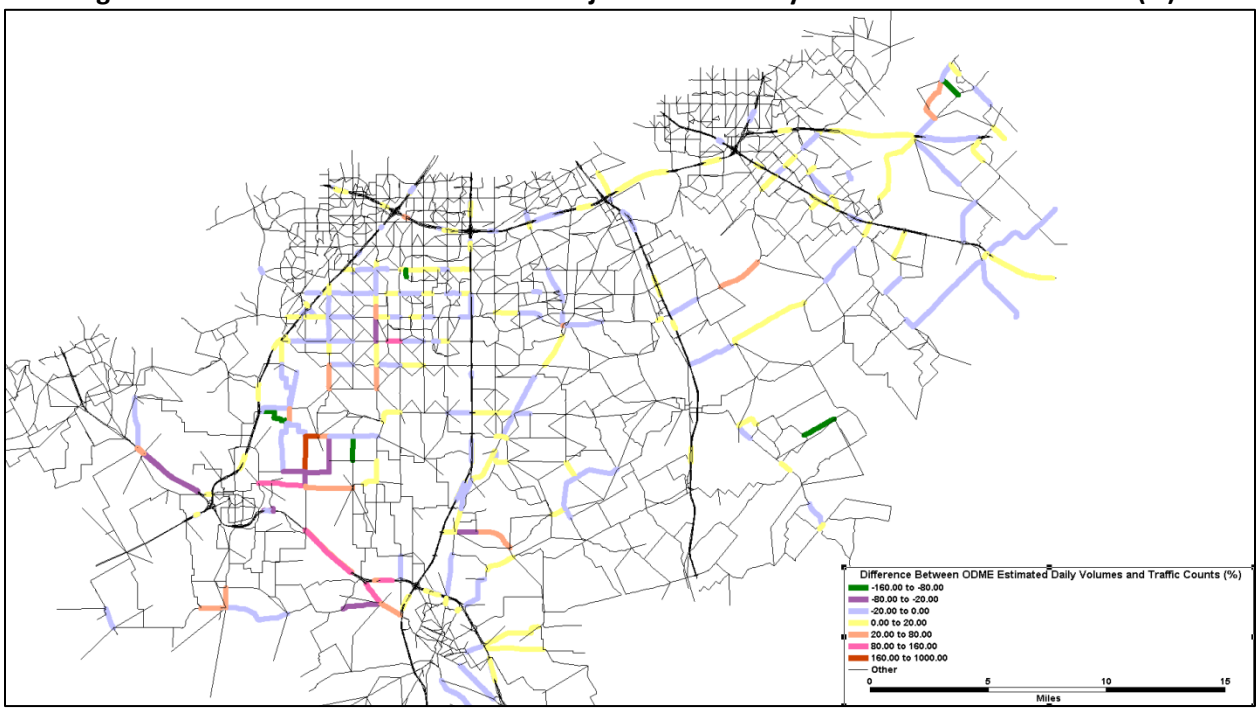
Refinement of the Origin-Destination (OD) or Trip Table

As previously demonstrated in **Figure 7**, the difference between the projected daily volumes from the NCTCOG regional travel model and historic TxDOT traffic counts were substantial at most traffic count locations within the traffic study area. Additionally, there are some differences between NCTCOG forecasted base year population compared to projected 2012 population forecasts based on the census. These differences indicate that some adjustment to the base year trip table may improve the performance of the subarea model.

The OD matrix estimation (ODME) of the TransCAD Planning Package Software was used to refine the OD tables from the regional travel model. ODME methods use traditional, typically static (i.e., one time period) traffic assignments to load trips from a matrix onto a network. Loaded flows are compared with available volumes to calculate an adjustment to the matrix that, when loaded again, will improve the match between assigned flows and counts. This procedure continues iteratively until the match between the flows loaded from the estimated matrix and the input volumes cannot be improved further. This method is deemed appropriate for this level of analysis and available information since traffic volumes were available at quite a few locations.

After performing the ODME, the resulted projected daily volumes were compared with traffic counts again at the same locations demonstrated in **Figure 7**. The results of this comparison are shown in **Figure 14**. As shown on this figure, the projected traffic volumes for the subarea model more closely align with historic TxDOT traffic counts at many locations. There are some locations south of the subarea model where differences are still significant, but this was deemed acceptable since they are far from the LP 9 corridor. The OD adjustment to the base year subarea model was then applied to the horizon year trip table.

Figure 14: Differences between ODME Projected Total Daily Volume and Traffic Counts (%)



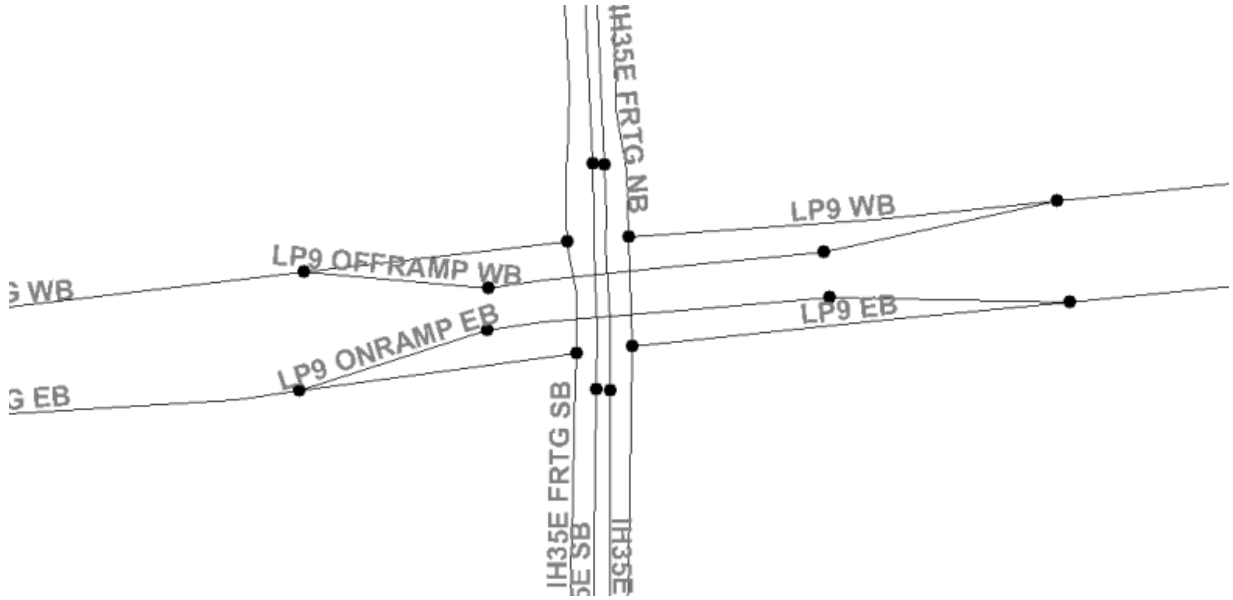
Development of Horizon Year Subarea Model

Adjustment to the Subarea Model Network

The base network model was originally coded so that through movement at major intersections at IH 35E, IH 45, and US 175 would be tolled. With this coding, non-tolled movements across these major facilities would be diverted to other parallel routes. This reduces the overall attractiveness of the LP 9 corridor as some travelers would change their paths to avoid the cost of tolled bridges. The original and adjusted network coding is shown in **Figures 15, 16, and 17**.

Figure 15: Original and Adjusted Network Coding at IH 35E

Original



Adjusted

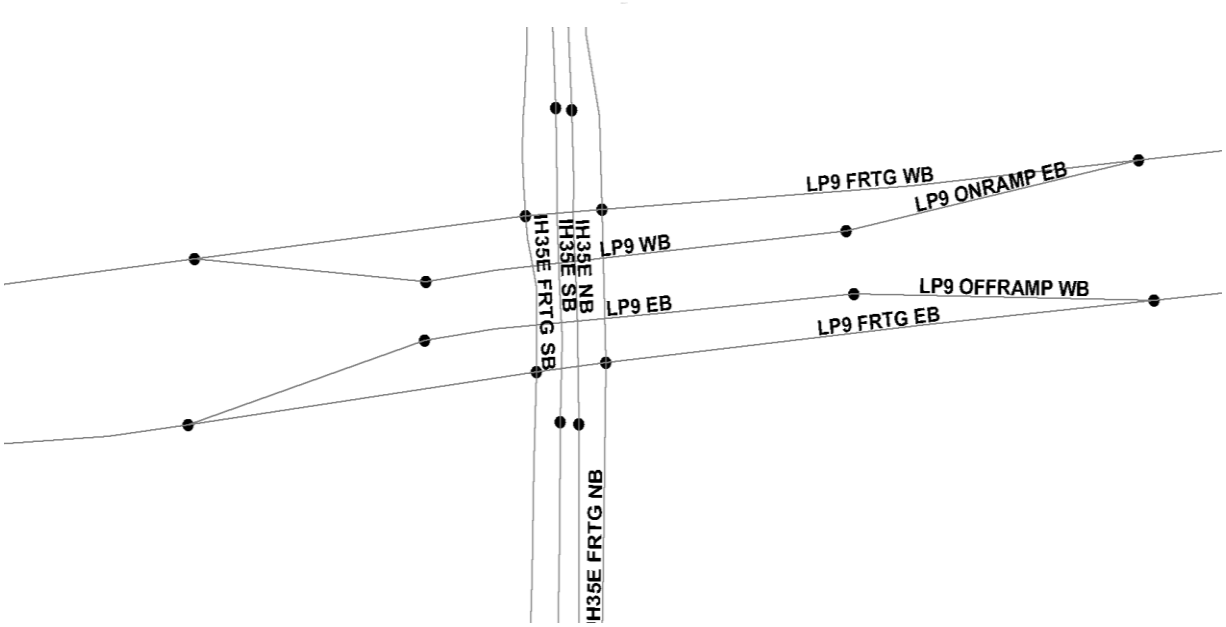
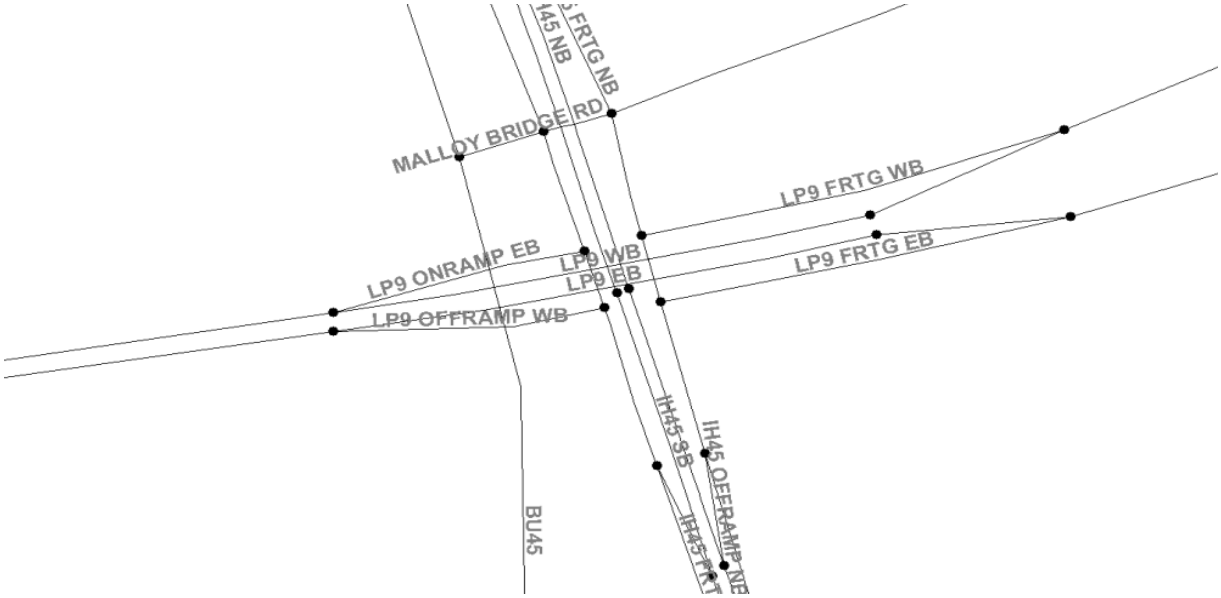


Figure 16: Original and Adjusted Network Coding at IH 45

Original



Adjusted

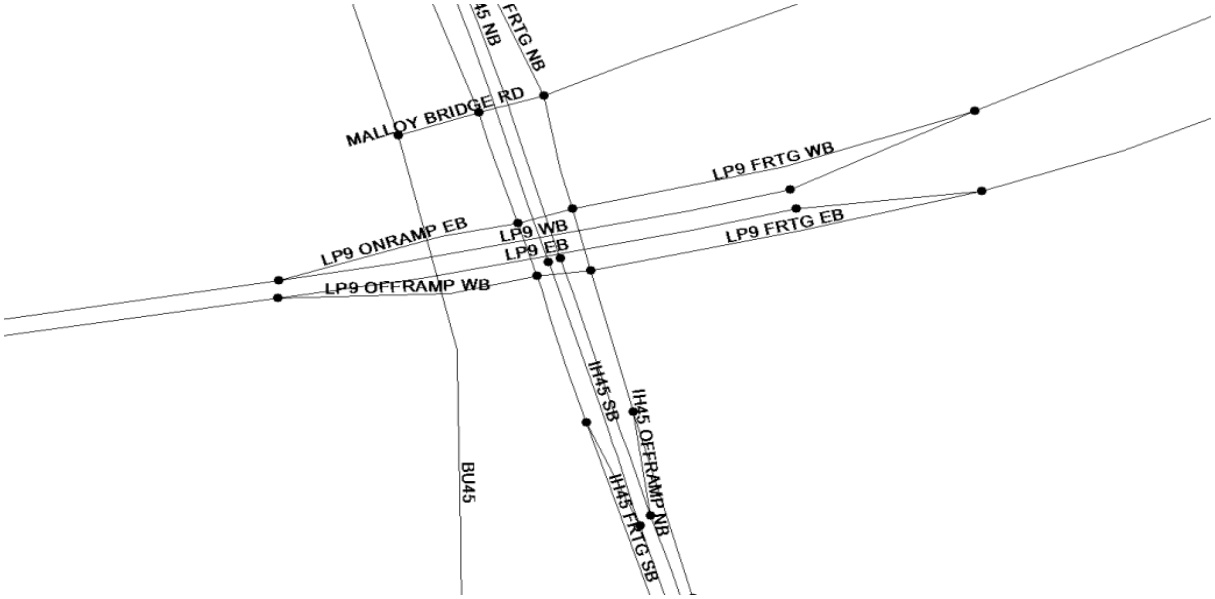
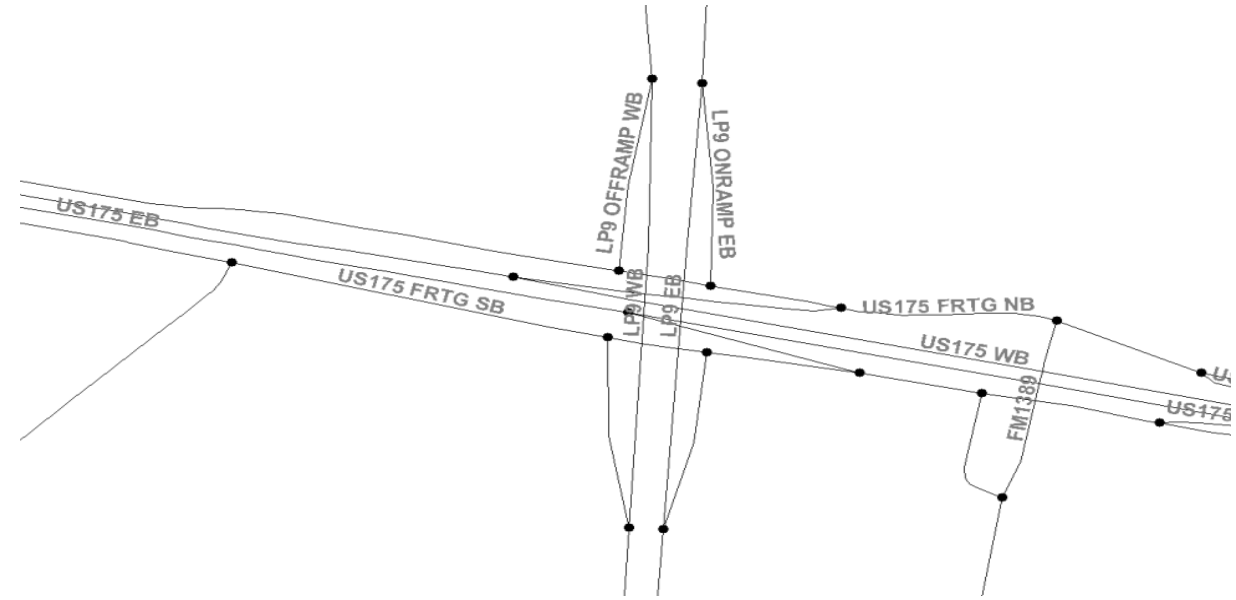
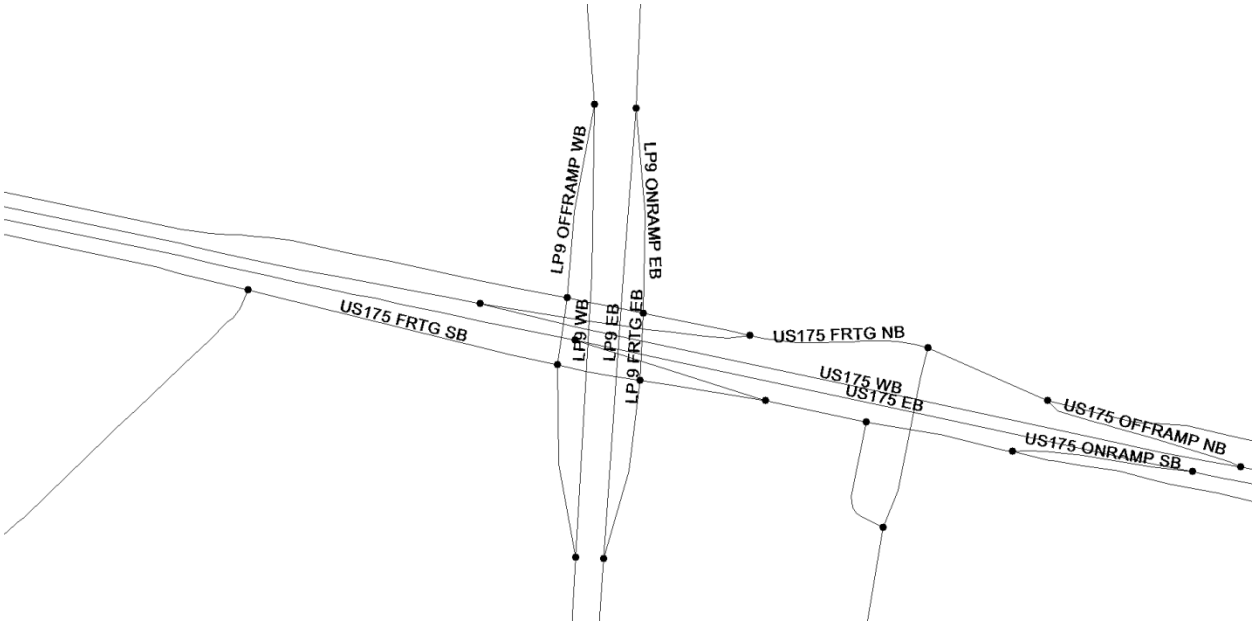


Figure 17: Original and Adjusted Network Coding at US 175

Original



Adjusted



Projected traffic volumes before and after network adjustments are presented in **Table 3**. The volumes are average daily traffic volumes on all links of a segment each weighted by their lengths.

The next step after performing network adjustments was to apply base year adjustment trip table to the horizon year trip table. Results of traffic assignment with the modified trip table and transportation network are shown in **Table 3**. The unadjusted horizon year subarea model yielded results similar to the regional NCTCOG travel model traffic projections. The network adjustments increased the traffic volumes on LP 9 for every segment except from US 67 to IH 35E compared to the unadjusted model. The final subarea model with the combined network and OD adjustments shows more consistent traffic volumes on LP 9 throughout the corridor. The results presented in last column of **Table 3** are the final projected traffic volumes for 2035 on which Baseline and Higher Growth Forecast growth rates are projected.

Table 3: Horizon Year (2035) Projected Average Daily Traffic (ADT) Volumes

Segment ID	Segment Description	NCTCOG	Subarea Model	Subarea Model_- Network Adjusted --(1)	(1) and Updated with Base Year OD Adjustments --(2)
1	IH 20 to US 175	11,000	10,800	14,500	10,300
2	US 175 to IH 45	13,200	14,300	16,100	14,300
3	IH 45 to SH 342	7,600	7,800	9,200	10,300
4	SH 342 to IH 35E	6,300	5,300	7,300	9,900
5	IH 35E to Duncanville Rd	13,900	15,400	12,900	18,600
6	Duncanville Rd to US 67	13,500	13,500	10,800	14,000

Projections of Future Traffic Volume Beyond 2035

Analysis of future traffic on LP 9 corridor was performed under two scenarios: Baseline Forecast and Higher Growth Forecast. Baseline Forecast is based on projected 2035 traffic volumes (modified results from the last column of **Table 3**) and assumes growth rates comparable with historic as well as NCTCOG's traffic growths. Higher Growth Forecast considers future land use plans of jurisdictions within traffic study area, potential timing of different developments that are envisioned to occur in the vicinity of the corridor, and accelerated growth in developments due to opening of a new road. The methodology and results of these two scenarios are discussed below.

Baseline Forecast Traffic Volume Projections

The traffic growth for the Baseline Forecast is based on the traffic volumes from the regional NCTCOG travel demand model at the locations presented in **Figure 4**. Since TxDOT traffic counts were not available at all these locations a limited set of count locations was selected as presented in **Figure 5**. **Table 4** shows the regional NCTCOG travel demand model projections and historic TxDOT traffic count ACGRs. Additionally, estimates of truck percentages on different segments of the corridor were derived from the regional NCTCOG travel demand model results. **Table 5** presents the growth rates and truck percentages that were used for the Baseline Forecast. An increase in truck percentage is expected

beyond 2035 due to the IIPOD. The highest inland port commercial trucks volumes on LP 9 are expected to travel between IH 35E and IH 45 and some would continue east towards IH 20 or west towards US 67.

As discussed earlier, the six-lane arterial section was used as the base network throughout these analyses. Changing the number of lanes or functional classification of a roadway alters the attractiveness of a facility. To reflect these changes different factors were used to convert projected traffic in the base network to each of the different phases of the project. **Table 6** lists these factors. Traffic LOS measures were used to evaluate justification to open the corridor or upgrade to the next phase. **Table 7** presents traffic volume thresholds for arterial and tollway facilities.

Traffic volumes that correspond to a LOS of B for arterials were deemed appropriate to justify opening phase 1 of the project since LOS A would indicate that the corridor is underutilized. For upgrade to next phases of the project, a LOS D or lower (E and F) was used. This would correspond to average daily traffic (ADT) volumes of 4,000 for phase 1; 12,000 for phase 2; and 38,000 for phases 3 or 4. An additional threshold of 60,000 ADT was used to evaluate implementation of grade separation at major arterial crossings. This value includes total approach volumes on crossing road and on LP 9 frontage roads and thus excludes mainlane volumes. **Table 8** and **Figure 18** present the Baseline Forecast projected traffic volumes for future years and the for ultimate configuration (six-lane frontage road and six-lane tollway section). **Table 9** and **Figure 19** present Baseline Forecast recommended opening years for crossing interchanges. **Figure 20** demonstrates project phasing diagram of the corridor for this scenario.

Table 4: Historic and Projected Traffic Volume Annual Compound Growth Rates

Traffic Growth Analysis Areas	Historic ACGR	NCTCOG Projected ACGR
1	1.0169	1.045
2	1.0169	
3	1.0369	1.063
4	1.0369	
5	1.0415	1.038
6	1.0599	
7	1.0399	1.027
8	1.0923	
9	1.0434	1.023
10	1.1015	
11	1.0588	1.010
12	1.0469	

Table 5: Baseline Forecast Assumed Annual Compound Growth Rates and Truck Percentages

	ACGR		Truck Percentages		
Traffic Growth Analysis Areas	2035-2045	After 2045	2035	2035-2045	After 2045
1,2	1.05	1.05	0.05	0.10	0.10
3,4	1.05	1.05	0.06	0.10	0.10
5,6	1.08	1.08	0.07	0.15	0.15
7,8	1.08	1.08	0.07	0.15	0.15
9,10,11,12	1.07	1.07	0.04	0.10	0.10

Table 6: LP 9 Facility Type Traffic Adjustment Factors

Base Network	Phase	Factor
6-Lane Frontage	2-Lane Frontage	0.64
6-Lane Frontage	4-Lane Frontage	0.80
6-Lane Frontage	4 Main Lanes and 4-Lane Frontage	1.10
6-Lane Frontage	6 Main Lanes and 6-Lane Frontage	1.70

Table 7: Criteria for Determination of Project Phasing - Traffic Volume Thresholds (Passenger Cars)

Arterial Level of Service					
Number of Lanes (Directional)	A	B	C	D	E
1	2,300	4,500	5,700	6,800	7,500
2	4,500	9,000	11,300	13,500	15,000
3	6,800	13,500	16,900	20,300	22,500
Freeway/Tollway Level of Service					
Number of Lanes (Directional)	**A**	**B**	**C**	**D**	**E**
1	5,300	8,700	12,800	16,300	19,200
2	10,800	17,300	25,700	32,600	38,300
3	16,100	25,900	38,500	48,900	57,500
4	21,500	34,500	51,300	65,200	76,700

Table 8: Baseline Forecast Projected Traffic Volumes (Passenger Car Traffic) and LOS for Warranted Configuration

Segment ID	Segment Description	2025	2030	2035	2040	2045	2050	2055	2060	2065	2070	2075
1	IH 20 to US 175	4,000	5,100	6,500	8,700	11,100	14,200	30,700	39,200	50,000	63,700	97,900
2	US175 to IH 45	5,200	6,700	8,500	11,200	14,300	18,300	39,600	27,700	64,500	82,300	124,100
3	IH 45 to SH 342	3,700	4,900	6,200	9,300	14,300	35,600	52,200	76,700	118,700	165,500	211,500
4	SH 342 to IH 35E	3,700	4,700	6,000	9,100	13,800	34,300	50,400	74,000	112,800	159,800	204,200
5	IH 35E to Duncanville Rd	6,700	8,500	10,700	16,100	38,200	53,600	75,100	105,300	147,700	207,100	264,100
6	Duncanville Rd to US 67	5,000	6,400	8,000	12,100	22,300	40,300	56,600	79,300	111,200	155,900	198,800

Segment ID	Segment Description	2025	2030	2035	2040	2045	2050	2055	2060	2065	2070	2075
1	IH 20 to US 175	NA	B	B	C	B	C	A	A	B	B	D
2	US175 to IH 45	B	B	B	B	B	C	A	A	B	B	D
3	IH 45 to SH 342	NA	B	B	C	B	A	A	B	D	E	F
4	SH 342 to IH 35E	NA	B	B	C	B	A	B	B	D	E	F
5	IH 35E to Duncanville Rd	B	B	C	C	A	B	B	C	D	F	F
6	Duncanville Rd to US 67	B	B	B	B	C	A	B	C	C	E	F

Projected year recommended to open as 2-lane section arterial

Projected year recommended to open as 4-lane section arterial

Projected year recommended to open as 4 mainlanes and 4 frontage lanes

Projected year recommended to open as 6 mainlanes and 6 frontage lanes

Figure 18: Line Diagram for Baseline Forecast Projected Traffic Volumes (Passenger Car Traffic) and for Ultimate Configuration

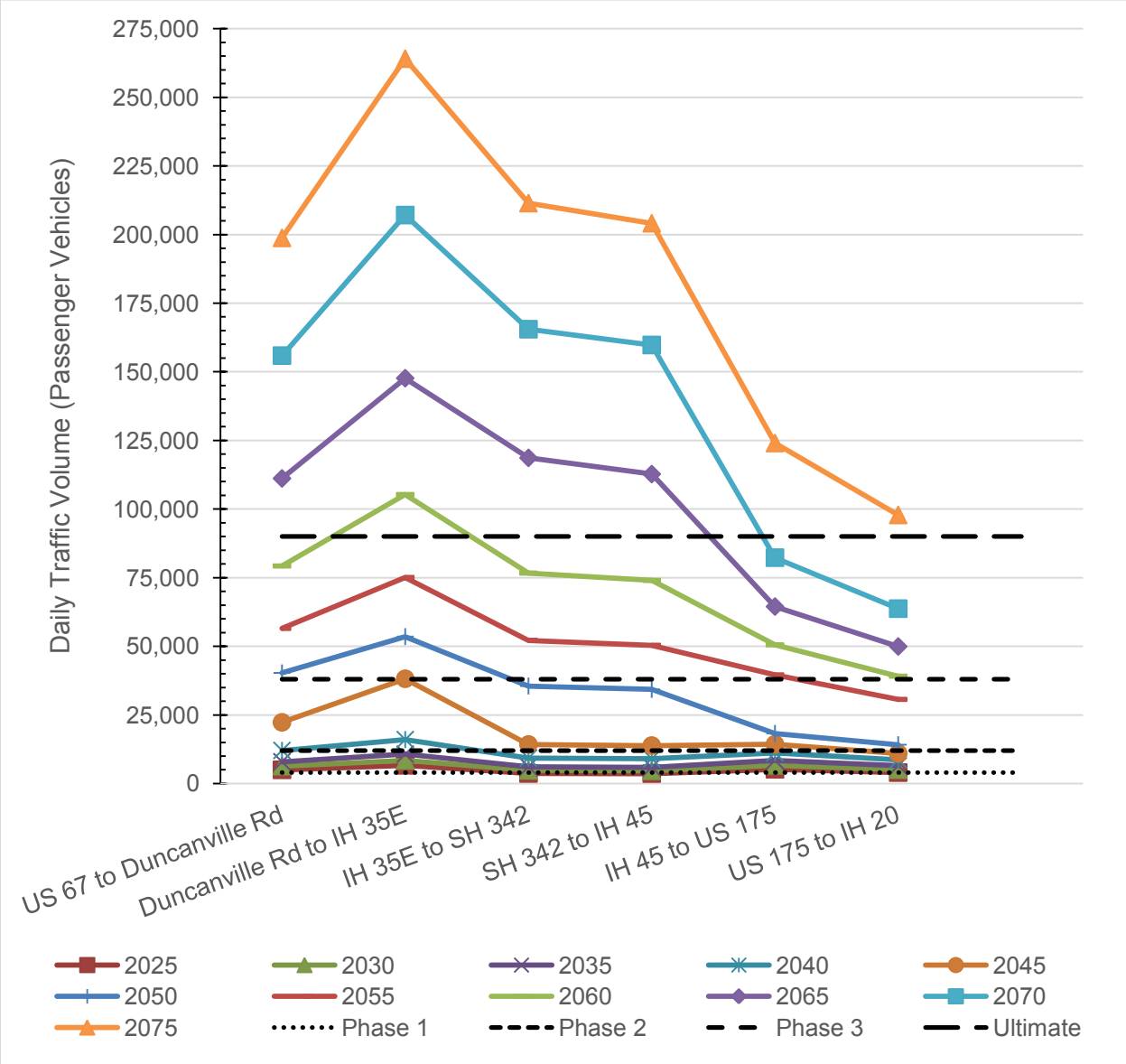


Table 9: Baseline Forecast Recommended Opening Years of Crossing Interchanges

	2025	2030	2035	2040	2045	2050	2055	2060	2065	2070	2075
At IH 20	8,300	10,600	13,500	17,300	22,000	28,100	35,900	45,800	58,400	64,500	71,200
Turnaround south of IH 20	6,800	8,700	11,000	14,100	18,000	22,900	29,200	37,300	47,600	52,500	58,000
Malloy Bridge Rd	9,300	11,800	15,000	19,200	24,500	31,200	39,800	50,800	64,900	71,600	79,100
US 175	13,600	17,300	22,000	28,100	35,900	45,800	58,400	74,500	95,100	105,000	116,000
Kaufman	9,900	12,600	16,000	20,500	26,100	33,300	42,500	54,200	69,200	76,400	84,300
Combine Rd	8,200	10,400	13,200	16,900	21,600	27,500	35,100	44,700	57,100	63,000	69,600
Combine Rd	9,600	12,200	15,500	19,800	25,300	32,300	41,200	52,500	67,000	74,000	81,700
Blindsay Rd	11,700	14,900	19,000	24,300	31,000	41,500	53,000	67,600	86,300	95,200	105,200
Bois D Arc Ln	10,800	13,800	17,500	22,400	28,600	36,400	46,500	59,300	75,700	83,600	92,200
Malloy Bridge Rd	12,300	15,700	20,000	25,600	32,600	41,600	53,100	67,800	86,500	95,500	105,400
IH 45	13,000	19,100	28,000	41,200	60,500	77,200	98,500	125,700	160,400	177,100	195,600
Ferris	9,100	13,300	19,500	28,700	42,100	53,800	68,600	87,600	111,800	123,400	136,200
Nokomis	5,100	7,500	11,000	16,200	23,800	30,400	40,700	51,900	66,200	73,100	80,700
Reindeer	4,500	6,500	9,500	14,000	20,600	26,200	33,500	42,700	54,500	60,100	66,400
McBride Rd	4,000	5,800	8,500	12,500	18,400	23,500	29,900	38,200	48,700	53,800	59,400
SH 342	8,900	13,000	19,000	28,000	41,100	52,400	66,900	85,300	108,900	120,200	132,700
Bluegrove	2,800	4,100	6,000	8,900	13,000	16,600	21,100	27,000	34,400	38,000	41,900
Houston School Rd	11,600	17,100	25,000	36,800	54,000	68,900	88,000	102,000	118,200	130,500	144,100
IH 35E	23,300	32,700	45,800	64,300	90,100	115,000	146,700	170,100	197,200	202,200	207,300
UHL RD	12,800	17,900	25,000	35,100	49,200	62,800	80,200	92,900	107,700	118,900	131,300
Hampton Rd	10,700	15,000	21,000	29,500	41,400	52,800	67,300	78,100	90,500	99,900	110,300
Westmorell Rd	9,700	13,600	19,000	26,700	41,200	52,500	67,000	77,700	90,100	99,400	109,800
Cockrell Hill Rd	19,400	27,100	38,000	53,300	74,800	95,500	121,800	141,200	163,700	180,700	199,500
Duncanville Rd	17,800	25,000	35,000	49,100	68,900	87,900	112,200	130,100	150,800	166,500	183,800
Joe Wilson Rd	15,300	21,400	30,000	42,100	59,100	75,400	96,200	111,500	129,200	142,700	157,500
Cedar Hill Rd	10,200	14,300	20,000	28,100	40,400	51,500	65,800	76,200	88,400	97,600	107,700
US 67	8,600	12,000	16,900	23,600	33,100	42,300	53,900	68,800	87,800	96,900	107,000

Figure 19: Line Diagram for Baseline Forecast Recommended Opening Years of Crossing Interchanges

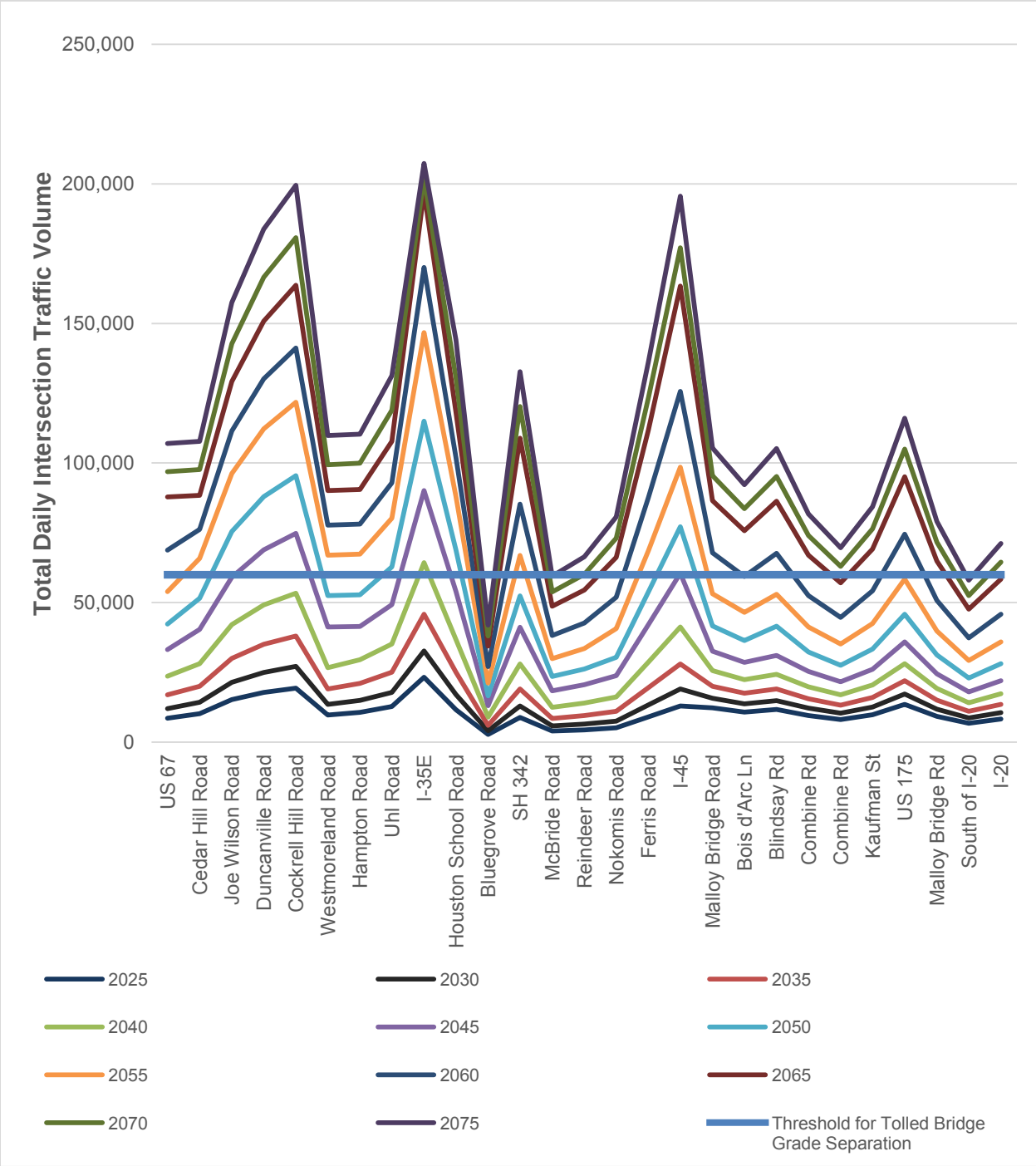
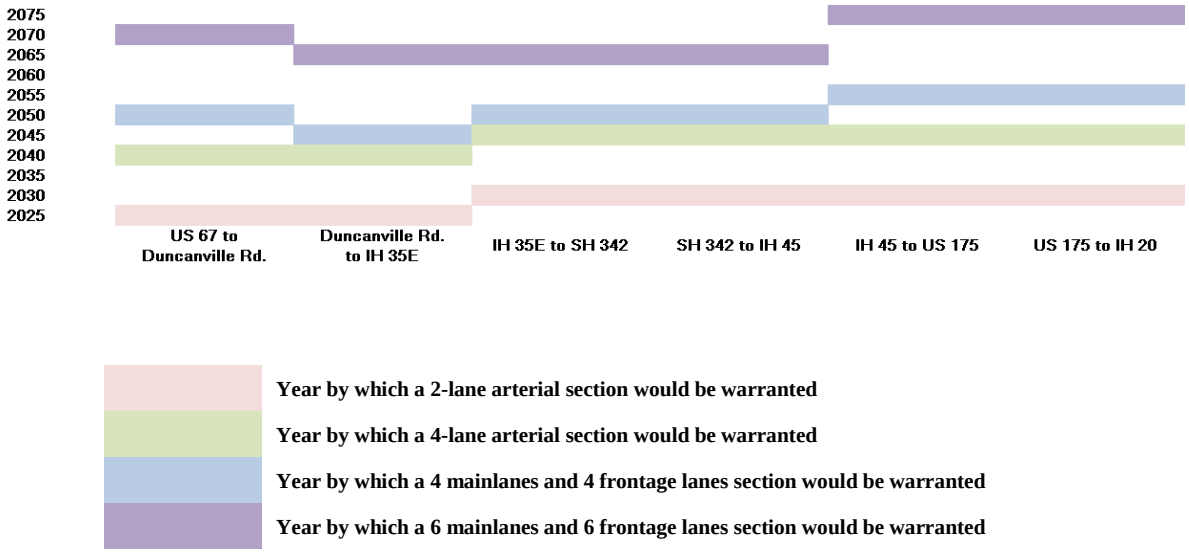


Diagram 3: Baseline Forecast Project Phasing



Higher Growth Forecast Traffic Volume Projections

As discussed earlier, the horizon year trip tables were adjusted based on base year validation of travel patterns for the subarea model. To identify zones where accelerated growth may occur due to the LP 9 project, historic and existing demographic growth and Google earth images were used. These demographic adjustments are used to simulate the link between land use and transportation. The Higher Growth Forecast shows how population and employment growth could be spurred by the construction of the LP 9 corridor. **Figures 20a and 20b** display identified zones where demographic adjustments were applied for the Higher Growth Forecast. **Table 10** provides a description of reasoning and adjustments used for each zone. This effort focused on assessing the traffic impacts of potential growth in the vicinity of the LP 9 corridor. Note that area of developed land was calculated based on NCTCOG's 2035 model employment and population estimates and assuming 3 persons per acre and 3 employees per 1,000 square feet (SF). **Table 11** demonstrates a comparison of employment rates for different land use types based on ITE Trip Generation Manual and the rate in this analysis. Available developable land for each zone was calculated by subtracting calculated area of its developed land and area of undevelopable land from the total area of the zone. Areas of undevelopable lands were assumed based on Google maps and floodplain shapefiles.

Figure 20a: Higher Growth Forecast-Identified Zones to Adjust for 2035 Demographics-US 67 to SH 342

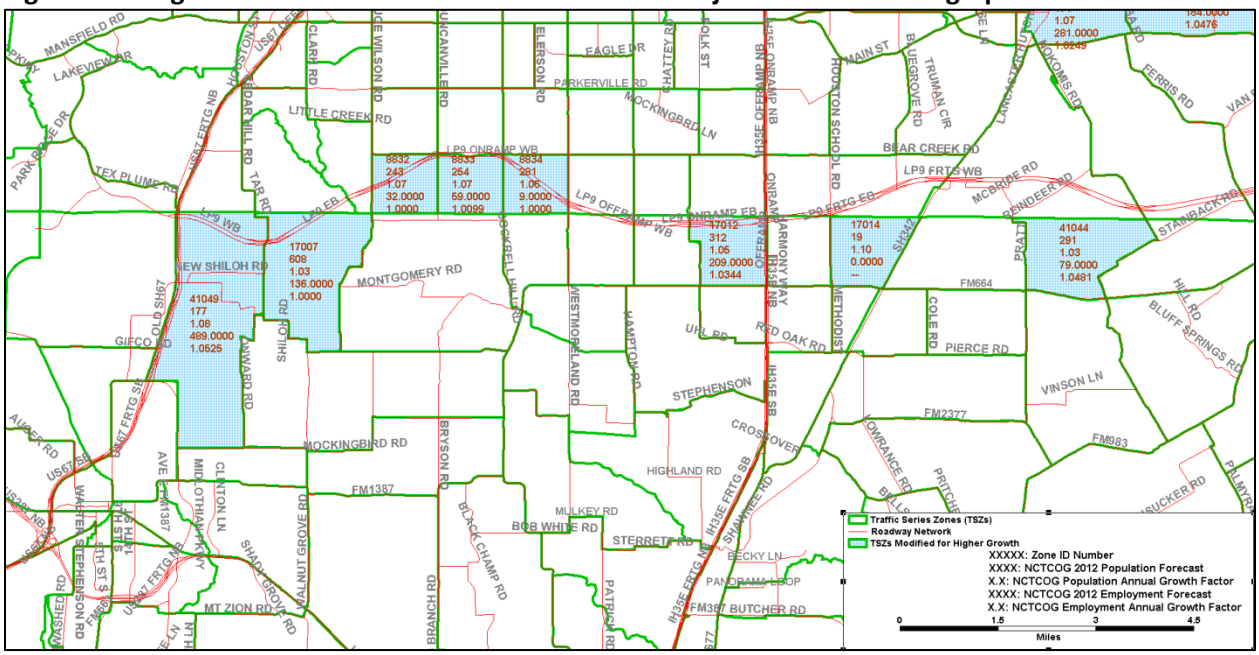


Figure 20b: Higher Growth Forecast-Identified Zones to Adjust for 2035 Demographics-SH 342 to IH 45

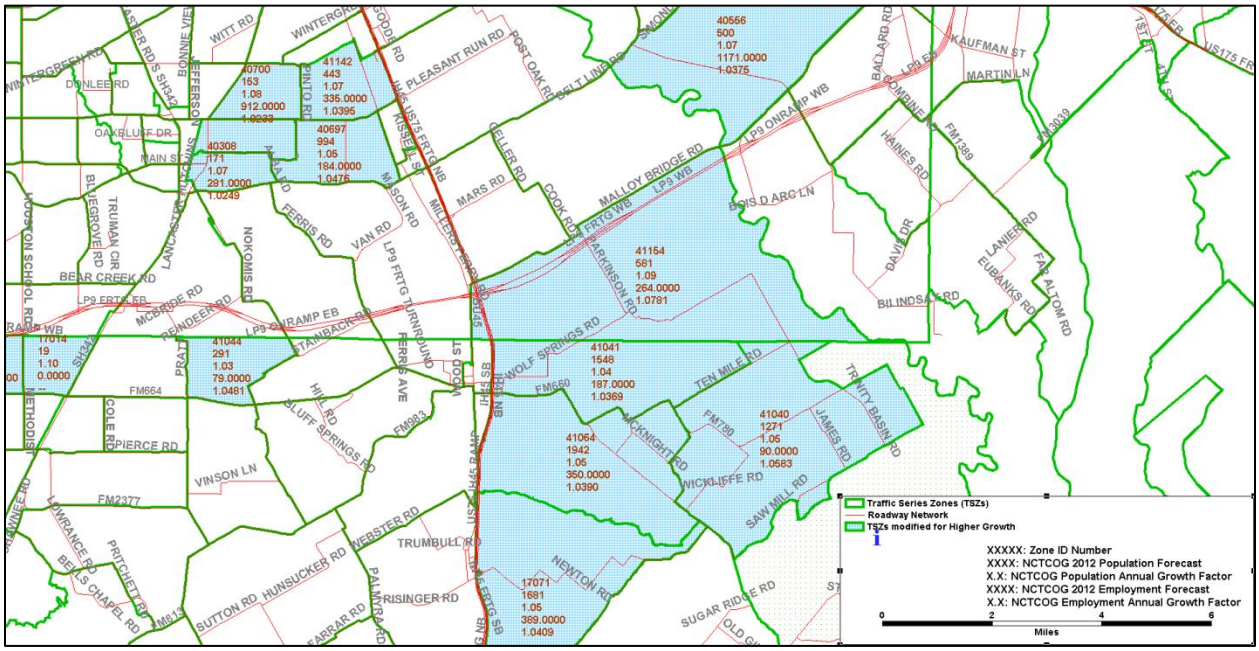


Table 10: Higher Growth Forecast Table of Description, Identified Zones to Adjust for 2035 Demographics

Zone ID	Description	Action
41049	This zone is designated as a Transit Station in City of Cedar Hill's comprehensive plan. It is planned for mixed-use developments and is to open by 2035.Higher employment is expected.	30% of available developable land translated to employment using 3 persons/1,000 SF
17007	This zone is designated as commercial and office in City of Cedar Hill's comprehensive plan. Higher employment is expected.	30% of available developable land translated to employment using 3 persons/1,000 SF
8832	This zone is designated as commercial and office in City of Cedar Hill's comprehensive plan. Higher employment is expected.	30% of available developable land translated to employment using 3 persons/1,000 SF
8833	This zone is designated as commercial and office in City of Cedar Hill's comprehensive plan. Higher employment is expected.	30% of available developable land translated to employment using 3 persons/1,000 SF
8834	This zone is designated as residential in City of Glenn Heights comprehensive plan. Higher population is expected.	30% of available developable land translated to population 3 households/acre
17012	This zone is designated as commercial / residential in City of Red Oak. Base year numbers are low and growth factors are low. Higher population and employment is expected.	30% of available developable land translated to population 3 households/acre and employment using 3 persons/1,000 SF
41044	This zone is designated as residential in City of Red Oak comprehensive plan. Higher population is expected.	30% of available developable land translated to population 3 households/acre
41142	This zone is designated as industrial land in IIPOD plan. Higher employment is expected.	30% of available developable land translated to employment using 3 persons/1,000 SF
40700	This zone is designated as industrial land in IIPOD plan. Higher employment is expected.	30% of available developable land translated to employment using 3 persons/1,000 SF
40254	This zone is designated as industrial land in IIPOD plan. Higher employment is expected.	30% of available developable land translated to employment using 3 persons/1,000 SF
40697	This zone is designated as industrial land in IIPOD plan. Higher employment is expected.	30% of available developable land translated to employment using 3 persons/1,000 SF
40308	This zone is designated as industrial land in IIPOD plan. Higher employment is expected.	30% of available developable land translated to employment using 3 persons/1,000 SF
40700	This zone is designated as industrial land in IIPOD plan. Higher employment is expected.	30% of available developable land translated to employment using 3 persons/1,000 SF

Table 10: Higher Growth Forecast Table of Description, Identified Zones to Adjust for 2035 Demographics

Zone ID	Description	Action
40254	This zone is designated as industrial land in IIPOD plan. Higher employment is expected.	30% of available developable land translated to employment using 3 persons/1,000 SF
41154	This zone is estimated higher for population in base year compared with projected 2012 population.	Population reduced by percentage difference between NCTCOG 2012 and Census 2010
41041	This zone is estimated higher for population in base year compared with projected 2012 population.	Population reduced by percentage difference between NCTCOG 2012 and Census 2010
41064	This zone is estimated higher for population in base year compared with projected 2012 population.	Population reduced by percentage difference between NCTCOG 2012 and Census 2010
41040	This zone is estimated higher for population in base year compared with projected 2012 population.	Population reduced by percentage difference between NCTCOG 2012 and Census 2010
17071	This zone is estimated higher for population in base year compared with projected 2012 population.	Population reduced by percentage difference between NCTCOG 2012 and Census 2010
40556	This zone is estimated lower for population in base year compared with projected 2012 population.	Population increased by percentage difference between NCTCOG 2012 and Census 2010

Table 11: Comparison of Number of Employee Rates

Land Use	Calculated Employees per 1,000 Square Feet based on the Report Rates
Light Industrial (110)*	2.3
Industrial Park (130)*	1.89
General Office Building (710)*	4.17
Research Center (760)*	2.2
Rate used for Higher Growth Scenario	3.00

***Source: 1987 ITE Trip Generation Report**

In the Higher Growth Forecast, the intention is to first identify developments that may occur as a result of opening of LP 9 as well as full potential of some growing developments in the traffic study area. This information was gathered from comprehensive plans of jurisdictions within the traffic study area and examining availability of vacant land using Google Maps images.

Some of these jurisdictions such as the cities of Cedar Hill, Glenn Heights, and Red Oak have considered LP 9 in their future land use plans. For example, the city of Cedar Hill's comprehensive plan shows office and commercial developments along the corridor (**Figure 21**) while the city of Glenn Heights's plans envision mixed residential and commercial developments in the vicinity of the corridor (**Figure 22**). City of Red Oak's future land use plan also notes mixed use developments along this corridor (**Figure 23**). City of DeSoto is considered a bedroom community with commercial and retail and some office developments scattered in the area. City of Midlothian is industrial based with future industrial site plans in the vicinity of the LP 9 interchange with US 67.

A major development in the traffic study area is the IIPOD, a regional intermodal development focused on logistics and freight distribution. It is a key driver in making Southern Dallas County a logistics hub and national distribution center. The development covers 234,000 acres and encompasses 10 municipalities. **Figure 24** shows a plan of this site. When built out, the project will serve as a significant inland port, much like similar public-private partnership developments in Kansas City (Edgerton) and Chicago (Clearpoint). The total project is estimated to take 30 plus years to complete. The inland port contributes to the increase in regional traffic in two parts: employment trips and commercial trips. A report produced by Southern California Association of Governments titled "Inland Port Feasibility Study" indicates that an inland port such as IIPOD could grow from generating approximately 3,500 daily truck trips to nearly 4,500 truck trips per day in ten years as presented in **Table 12**. Assuming IIPOD initiation on activities in 2010 and based on straight line extrapolation, this number would increase to 12,000 by 2075. Assuming, a 30% trip diversion by intermodal trains, the number of daily truck trips for this study was controlled to remain below 8,000 truck trips per day.

Table 12: Estimated 2005 and 2010 Port Truck Trips to Inland Empire Counties

2005 Truck Flows	Daily			Annual		
	San Bernardino	Riverside	Total	San Bernardino	Riverside	Total
Port to Region						
Import Loads	560	137	697	156,016	38,168	194,184
Empties, Chassis, Bobtails	736	180	916	205,050	50,148	255,198
Subtotal	1,296	317	1,613	361,066	88,316	449,382
Region to Port						
Export Loads	270	76	346	75,222	21,174	96,396
Empties, Chassis, Bobtails	1,227	346	1,573	341,842	96,396	438,238
Subtotal	1,497	422	1,919	417,064	117,569	534,633
Total						
Loads	830	213	1,043	231,238	59,342	290,580
Empties, Chassis, Bobtails	1,963	526	2,489	546,892	146,544	693,435
Grand Total	**2,793**	**739**	**3,532**	**778,130**	**205,885**	**984,015**
2010 Truck Flows						
Import Loads	768	188	956	213,965	52,377	266,342
Empties, Chassis, Bobtails	885	216	1,101	246,561	60,178	306,739
Subtotal	1,653	404	2,057	460,526	112,554	573,080
Region to Port						
Export Loads	310	87	397	86,366	24,238	110,604
Empties, Chassis, Bobtails	1,591	448	2,039	443,253	124,813	568,065
Subtotal	1,901	535	2,436	529,619	149,051	678,670
Total						
Loads	1,078	275	1,353	300,331	76,615	376,946
Empties, Chassis, Bobtails	2,476	664	3,140	689,814	184,990	874,804
Grand Total	**3,554**	**939**	**4,493**	**990,144**	**261,605**	**1,251,750**

Figure 21: City of Cedar Hill Future Land Use Plan

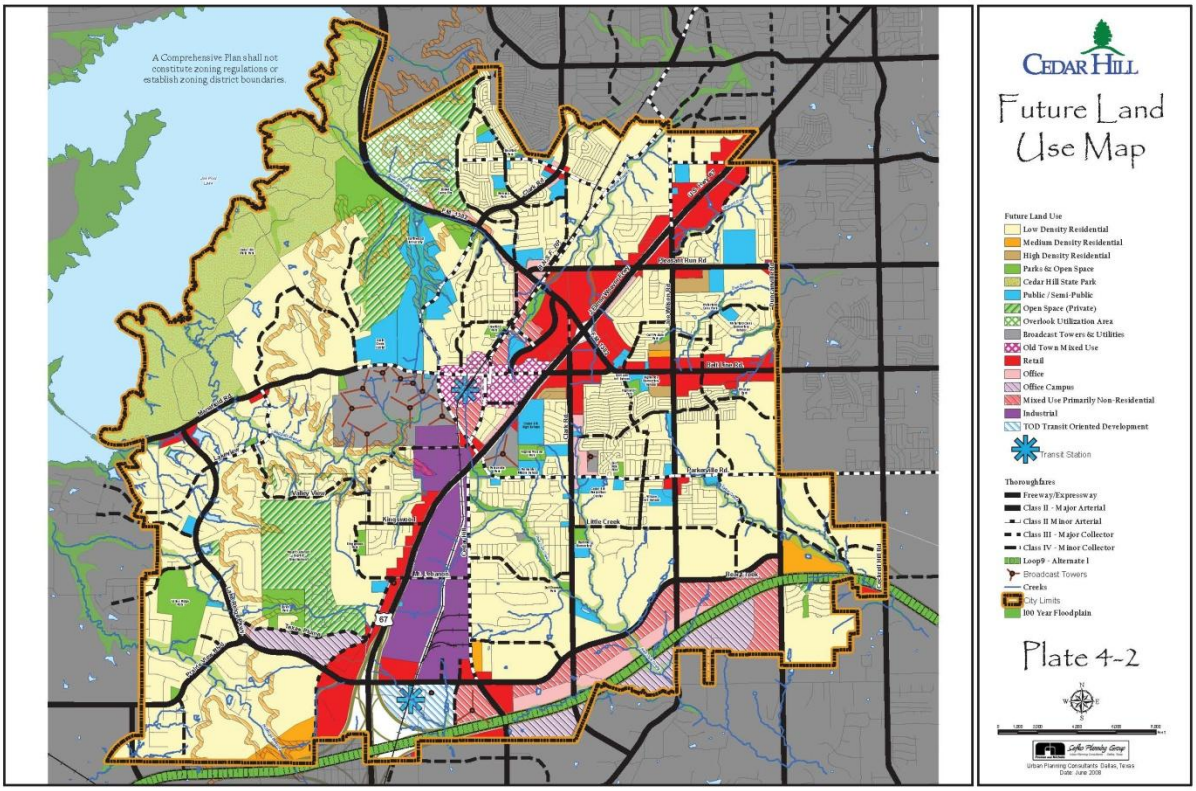


Figure 22: City of Glenn Heights Future Land Use Plan

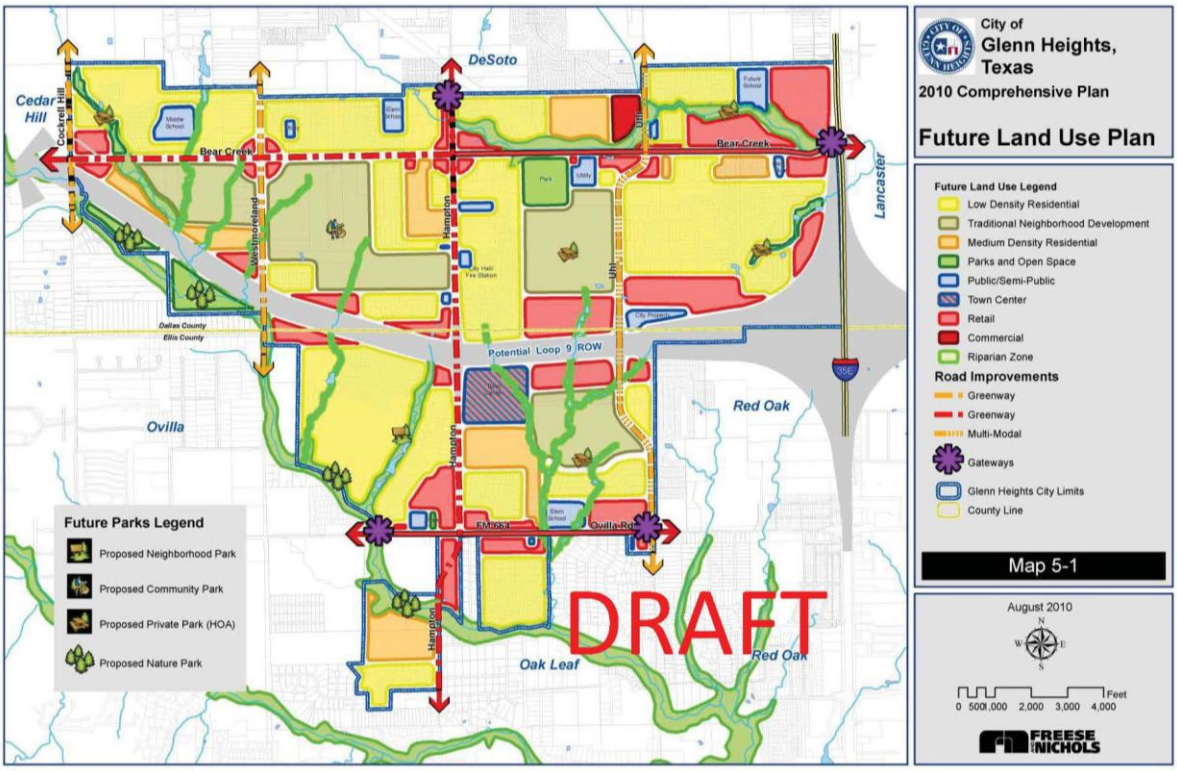


Figure 23: City of Red Oak Future Land Use Plan

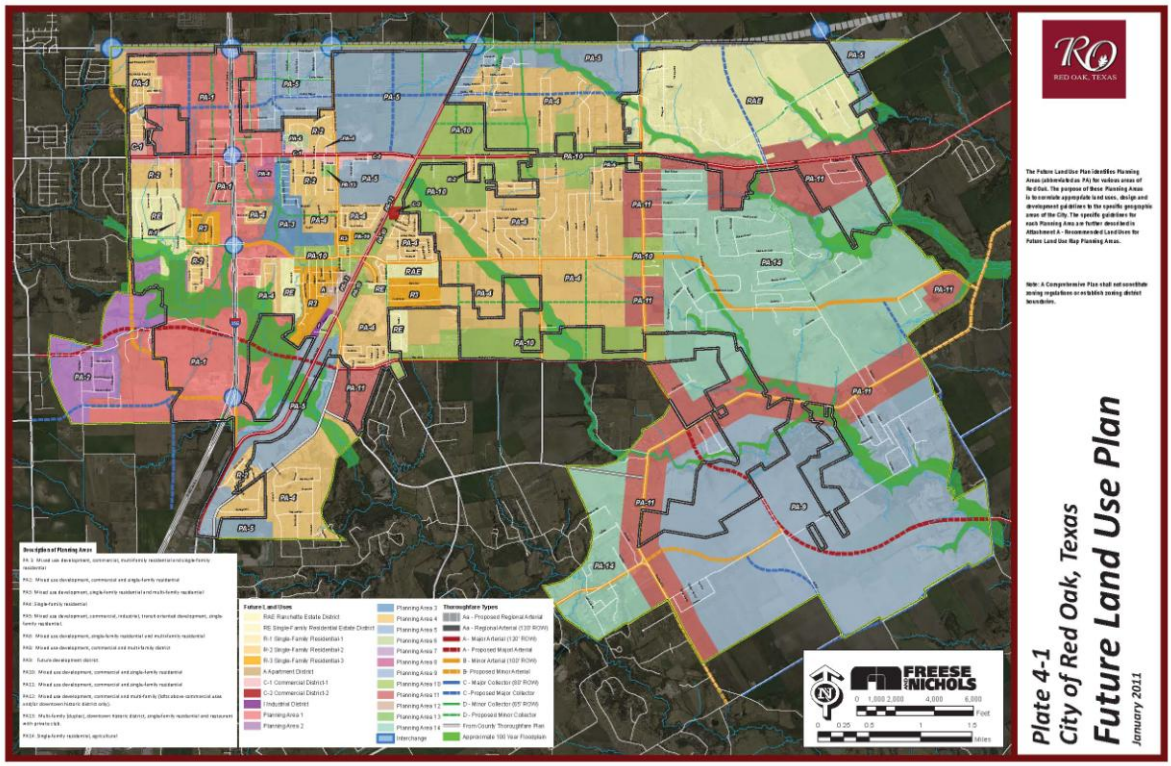
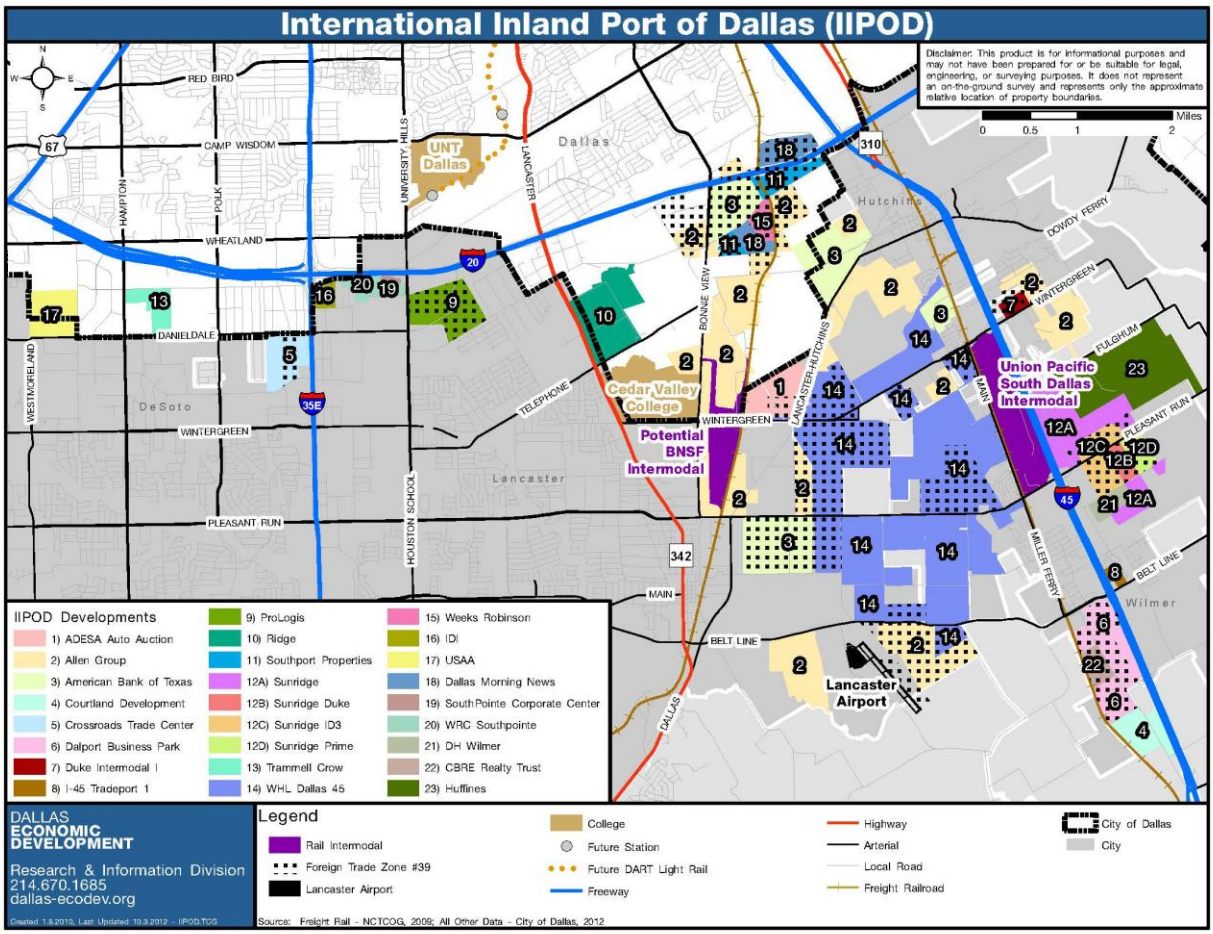


Figure 24: International Inland Port of Dallas



After adjustments to 2035 population and employment levels as part of the Higher Growth Forecast, further growth in developments along the corridor was used to project traffic volumes beyond 2035. It was assumed that for an area with a core city (partially developed land), traffic would grow at a moderate rate (increasing local traffic) for 5 years after a segment is opened. This is based on the assumptions that it takes developers a few years to account for the new transportation infrastructure in their planning. The highest growth in such areas is assumed to be in the second and third 5-year period after the facility opens. Based on this principle, it was assumed that accelerated development in Segments 3 through 6 would occur within the first 10 years after the segment opens. The accelerated development in areas 1 and 2 would occur approximately 15 to 20 years after opening due to the lower levels of existing development. After these timeframes, traffic was projected to grow relative to the continuing rate of demographic growth in an area.

To provide for such estimates, a set of zones as shown in **Figure 25** were identified to which higher growth rates were assigned based on future land use plans and their adjacency to the corridor. For simplicity, it was assumed that the selected zones would have available vacant land for this potential growth. For TGA areas 5 through 12, demographic growth rates of 1.06 was assumed for the first 10–15 years of corridor development and then reduced to 1.03 for later years. For TGA areas 1 through 4, on

the other hand, demographic growth rates of 1.03 was assumed for first 10–15 years and then increased to 1.05 afterwards. A growth rate of 1.02 per year was assumed for all other zones. The 2035 trip tables were expanded for future projections up to year 2055. Additionally, a more aggressive truck percentage was assumed for this scenario compared with Baseline Forecast as shown in **Table 13**.

Figure 25: Higher Growth Forecast Accelerated Growth Selected Zones

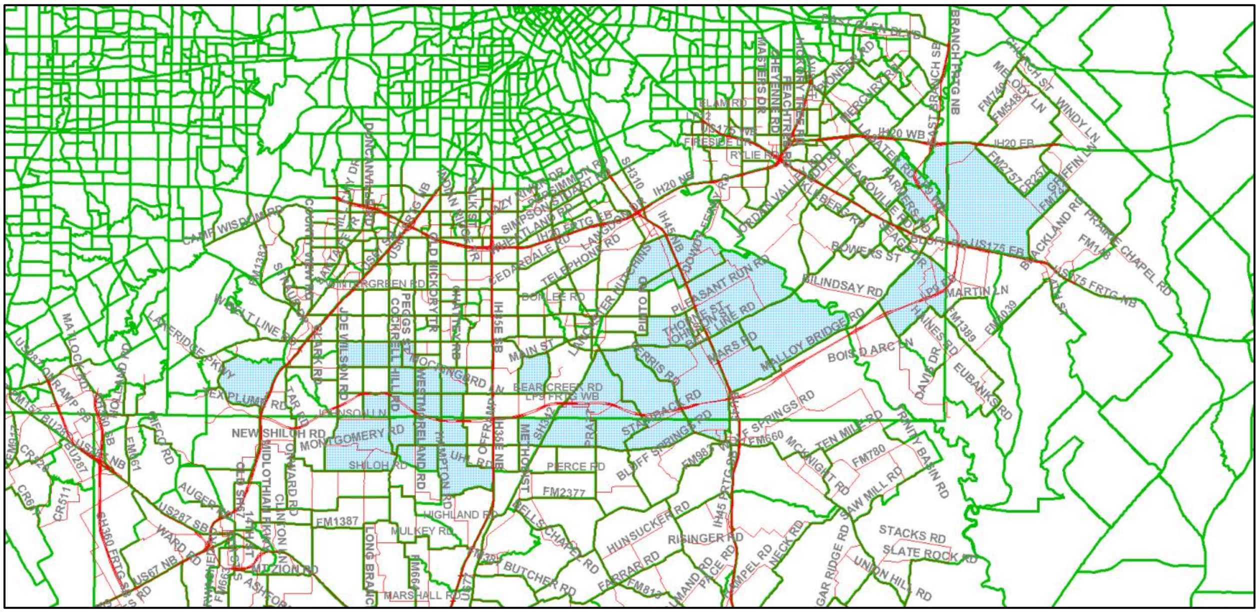


Table 13: Higher Growth Forecast Assumed Percentage of Trucks

TGA Areas	2035	2035-2045	After 2045
1,2	0.05	0.15	0.15
3,4	0.06	0.15	0.15
5,6	0.07	0.3	0.3
7,8	0.07	0.3	0.3
9,10	0.04	0.1	0.1

The results of this scenario are displayed in **Tables 14** and **15** and **Figures 26** and **27**, the Project phasing diagram is displayed in **Diagram 4**.

Table 14: Higher Growth Forecast Projected Traffic Volumes (Passenger Car Traffic) and LOS for Warranted Configuration

Segment ID	Location Description	2025	2030	2035	2040	2045	2050	2055	2060	2065	2070
1	IH 20 to US 175	5,000	5,900	7,000	11,400	20,800	45,000	60,300	76,900	93,200	103,400
2	US175 to IH 45	5,300	6,600	8,300	14,200	48,000	64,900	83,200	106,200	123,100	142,600
3	IH 45 to SH 342	5,700	7,200	9,600	18,800	46,200	69,600	100,100	127,700	148,100	171,700
4	SH 342 to IH 35E	6,300	7,800	9,700	20,400	47,400	71,300	99,100	126,400	146,500	169,900
5	IH 35E to Duncanville Rd	10,600	13,200	15,700	56,600	79,600	97,800	126,500	161,500	187,200	217,000
6	Duncanville Rd to US 67	6,900	9,400	11,200	40,400	52,100	77,200	99,800	127,400	147,700	171,200

Segment ID	Location Description	2025	2030	2035	2040	2045	2050	2055	2060	2065	2070
1	IH 20 to US 175	A	B	B	B	A	A	B	C	D	D
2	US175 to IH 45	B	B	B	B	A	B	C	C	D	D
3	IH 45 to SH 342	B	B	C	C	A	B	C	D	D	E
4	SH 342 to IH 35E	B	B	C	C	A	B	C	D	D	E
5	IH 35E to Duncanville Rd	C	B	C	B	C	C	D	E	F	F
6	Duncanville Rd to US 67	B	B	B	A	B	B	C	D	D	E

Projected year recommended to open as 2-lane section arterial

Projected year recommended to open as 4-lane section arterial

Projected year recommended to open as 4 mainlanes and 4 frontage lanes

Projected year recommended to open as 6 mainlanes and 6 frontage lanes

Figure 26: Line Diagram for Higher Growth Forecast Projected Traffic Volumes (Passenger Car Traffic) and for Ultimate Configuration

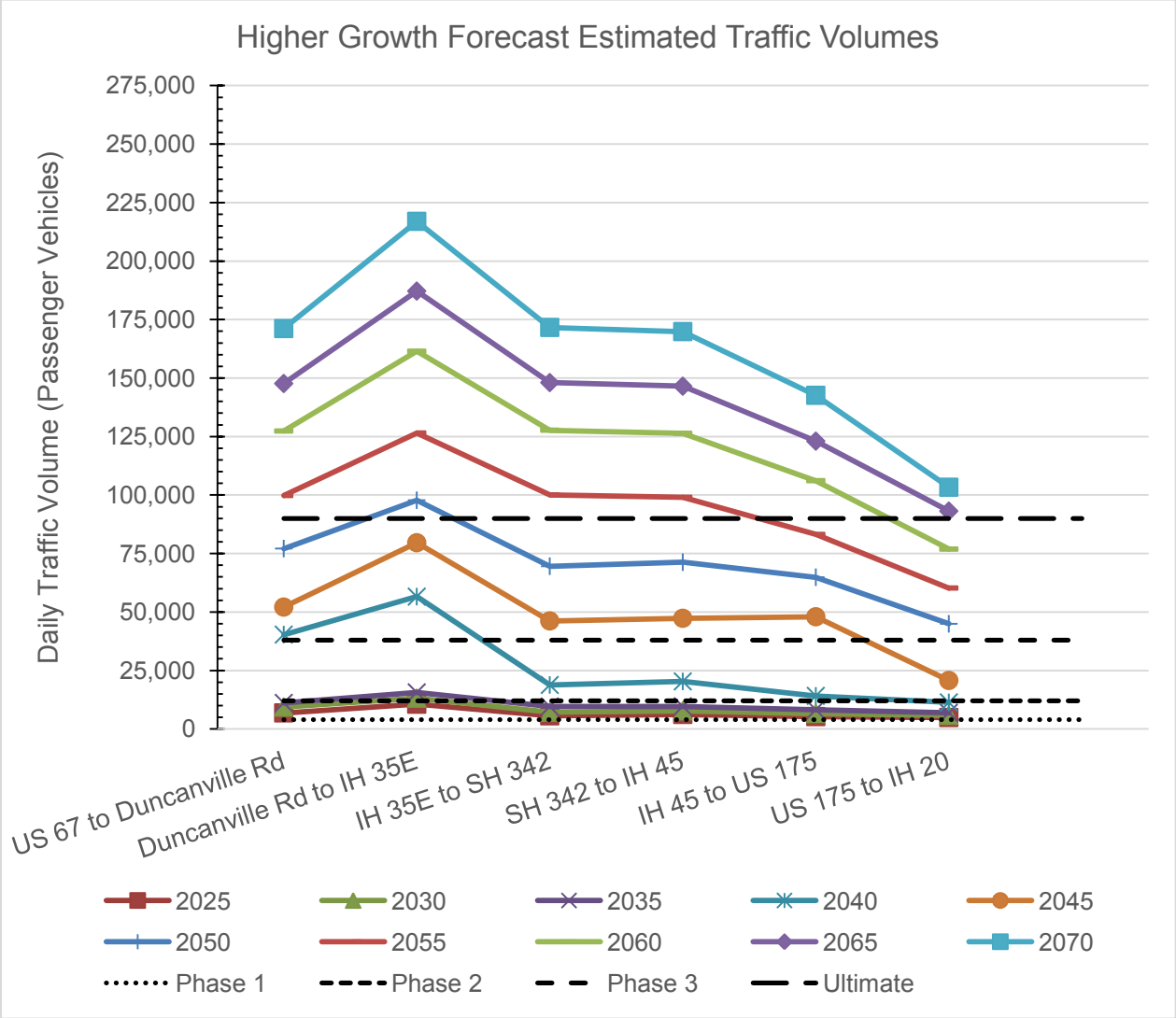
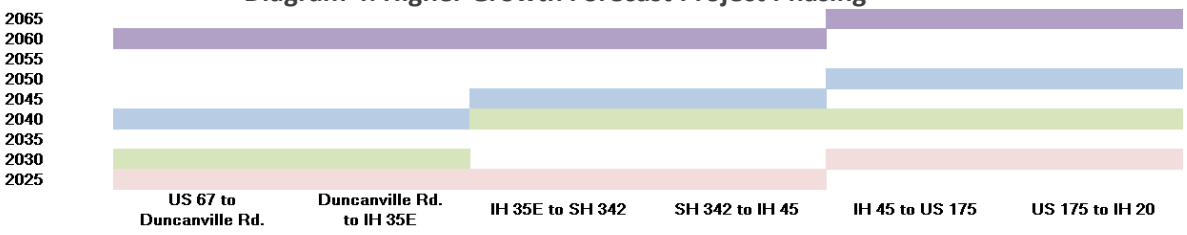


Table 15: Higher Growth Forecast Recommended Opening Years of Crossing Interchanges

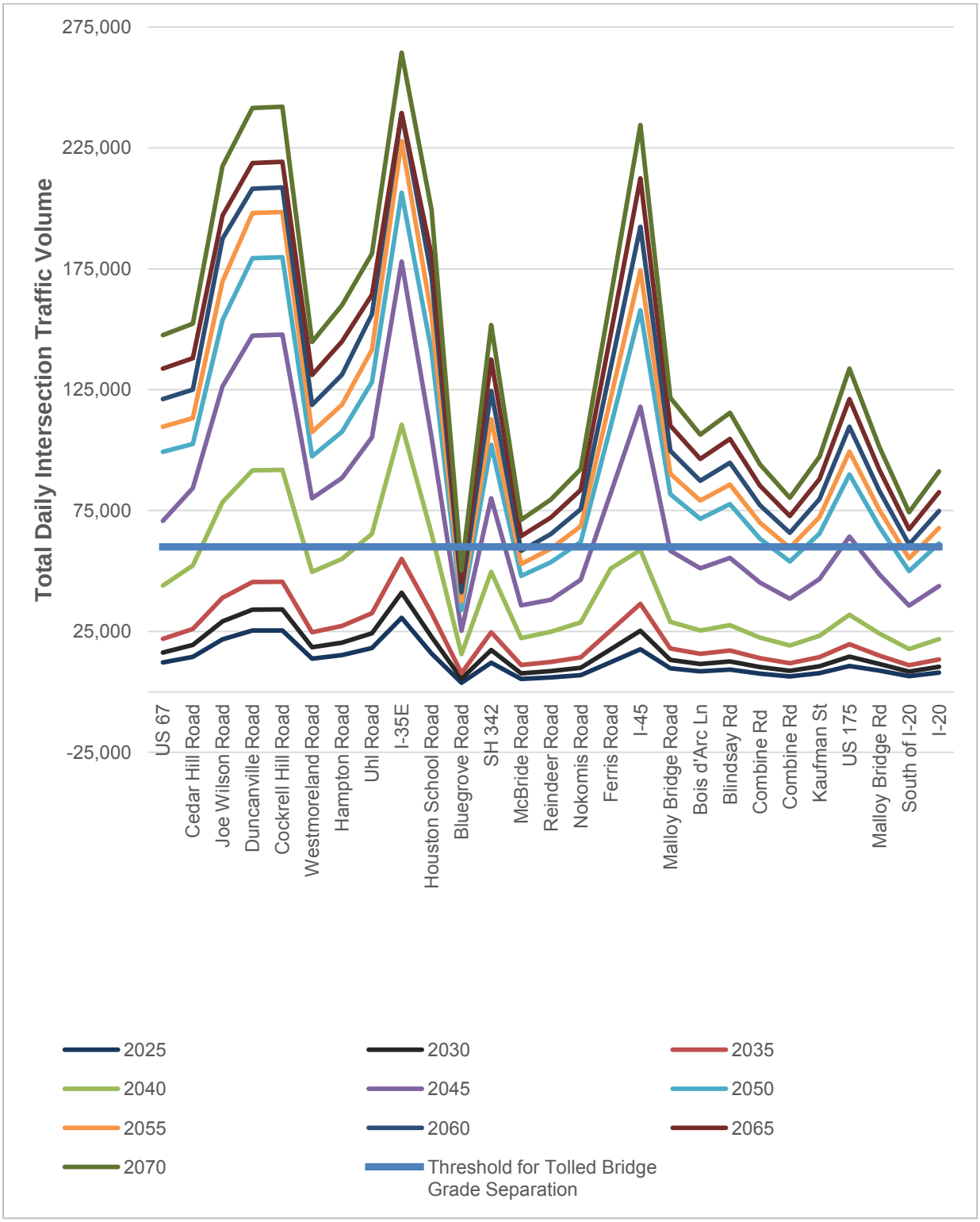
	2025	2030	2035	2040	2045	2050	2055	2060	2065	2070
At IH 20	8,000	10,400	13,500	21,800	43,800	61,400	67,800	74,800	82,600	91,200
Turnaround south of IH 20	6,500	8,500	11,000	17,800	35,700	50,000	55,200	61,000	67,300	74,300
Malloy Bridge Rd	8,900	11,500	15,000	24,200	48,600	68,200	75,300	83,100	91,800	101,300
US 175	10,700	14,600	19,800	31,900	64,200	90,000	99,400	109,700	121,100	133,700
Kaufman	7,800	10,600	14,400	23,200	46,700	65,500	72,300	79,800	88,100	97,300
Combine Rd	6,400	8,800	11,900	19,200	38,500	54,000	59,600	65,800	72,700	80,300
Combine Rd	7,600	10,300	14,000	22,500	45,200	63,400	70,000	77,300	85,300	94,200
Blindsay RD	9,300	12,600	17,100	27,600	55,400	77,700	85,800	94,800	104,600	115,500
Bois D Arc Ln	8,600	11,600	15,800	25,400	51,100	71,600	79,100	87,300	96,400	106,400
Malloy Bridge Rd	9,800	13,300	18,000	29,000	58,400	81,800	90,300	99,700	110,100	121,600
IH 45	17,700	25,400	36,400	58,700	118,000	157,800	174,300	192,400	212,400	234,500
Ferris	12,300	17,700	25,400	51,000	82,200	109,900	121,400	134,000	147,900	163,300
Nokomis	6,900	10,000	14,300	28,800	46,400	62,000	68,500	75,600	83,500	92,200
Reindeer	6,000	8,600	12,400	24,900	38,100	53,600	59,200	65,300	72,100	79,600
McBride Rd	5,400	7,700	11,100	22,300	35,800	48,000	52,900	58,400	64,500	71,200
SH 342	12,100	17,300	24,700	49,700	80,100	102,200	112,800	124,500	137,500	151,800
Bluegrove	3,800	5,500	7,800	15,700	25,300	33,900	37,400	41,300	45,600	50,300
Houston School Rd	15,900	22,700	32,500	65,400	105,300	140,900	155,600	171,800	180,500	199,300
IH 35E	30,700	41,100	55,000	110,500	178,000	206,400	227,800	239,400	239,400	264,400
UHL RD	18,100	24,300	32,500	65,400	105,300	128,100	141,500	156,200	164,200	181,200
Hampton Rd	15,200	20,400	27,300	55,000	88,500	107,600	118,800	131,200	144,900	159,900
Westmorell Rd	13,800	18,500	24,700	49,700	80,100	97,400	107,500	118,700	131,100	144,700
Cockrell Hill Rd	25,500	34,100	45,600	91,800	147,800	179,800	198,500	208,600	219,200	242,000
Duncanville Rd	25,400	34,000	45,500	91,600	147,400	179,400	198,000	208,100	218,700	241,500
Joe Wilson Rd	21,800	29,100	39,000	78,500	126,400	153,800	169,800	187,400	197,000	217,500
Cedar Hill Rd	14,500	19,400	26,000	52,300	84,300	102,500	113,200	125,000	138,000	152,300
US 67	12,200	16,300	21,900	44,000	70,800	99,300	109,700	121,100	133,700	147,600

Diagram 4: Higher Growth Forecast Project Phasing



Year by which a 2-lane arterial section would be warranted
Year by which a 4-lane arterial section would be warranted
Year by which a 4 mainlanes and 4 frontage lanes section would be warranted
Year by which a 6 mainlanes and 6 frontage lanes section would be warranted

Figure 27: Line Diagram for Higher Growth Forecast Recommended Opening Years of Crossing Interchanges



Analysis of Direct Connector Ramps

The need for different types of highway to highway interchanges along LP 9 was investigated at its intersection with US 67, IH 35E, IH 45, US 175, and IH 20. This high level analysis was performed to determine approximately when different types of interchanges would be warranted after LP 9 mainlanes open. This analysis was based on the traffic volumes of design concept B (see **Table 1**). This design concept, similar to Concept O, does not include continuous frontage roads through LP 9 interchanges with IH 35E, IH 45, and US 175.

The criteria used for this analysis are presented in **Table 16** and are based on total traffic interchanged at these intersections. This traffic includes all turning traffic volumes and not traffic passing through the intersection. The three-level interchange would consist of the mainlanes for the two facilities as the first two levels and the third level as a frontage road box to accommodate all turning movements. In the four-level interchange configuration, the same first two levels would exist with the mainlanes and frontage roads at the same level for the crossing facility. The LP 9 frontage roads would not be continuous at IH 35E, IH 45, and US 175 in the four-level scenario and feed traffic into the crossing facility's frontage roads. For the four-level interchange, the third level would consist of NB-EB, WB-SB, EB-NB, and SB-WB DC ramps and the NB-WB, EB-SB, WB-NB, and SB-EB DC ramps would occupy the fourth. The criteria presented in **Table 16** is based on the criteria used by South Carolina Department of Transportation (SCDOT) to recommended a preliminary interchange type based on the interchange location, type of intersecting facility, and total interchange traffic.

Table 16: Study Interchange Type Justification Criteria

Volume Range (ADT)	Recommendation (SCDOT)*	Recommendation (LP 9)
<15,000	Cloverleaf	3-level
15,000–25,000	Cloverleaf w/C-D roads OR semi-directional	Partial 4-level (paired DCs for heaviest movements)
>25,000	Directional OR semi-directional	Full 4-level

*Source: South Carolina DOT Preliminary Interchange Selection Criteria for Rural Freeways

Approach traffic volumes were extracted from concept B network assigned with 2035 estimated traffic volumes and used to estimate turning movement volumes through matrix balancing procedures. Baseline Forecast and Higher Growth Forecast were not differentiated in this analysis, and instead an annual traffic growth rate of 5 percent was used to extrapolate the 2035 traffic volumes to other projection years. The estimated traffic volumes were evaluated based on the criteria demonstrated in **Table 16**. In analysis of left turning movements where continuous frontage roads don't exist before opening of DC ramps, it is deemed reasonable to assume that DC pairs are warranted to open at the same time. For example, if the NB-EB DC is warranted to open in a certain year and the opposite DC movement is not available with the current configuration, it is assumed that the WB-SB DC would open at the same time.

The total interchanging traffic at the study interchange locations and years by which each interchange type is warranted are presented in **Table 17**.

Table 17: Total Interchanging Traffic and Warranted Interchange Types

	2035	2040	2045	2050	2055	2060	2065	2070
US 67	NA	**26,300**	33,700	43,000	54,900	70,100	89,500	114,200
IH 35E	NA	**11,200**	14,300	**18,200**	23,300	**29,800**	38,000	48,500
IH 45	NA	NA	**16,800**	21,400	**27,300**	34,900	44,500	56,800
US 175	NA	NA	NA	**8,900**	11,400	14,600	**18,600**	23,700
IH 20	NA	NA	NA	**26,900**	34,200	43,700	55,800	71,200

Years by which a 3-level interchange type is warranted
Years by which a partial 4-level interchange type is warranted
Years by which a full 4-level interchange type is warranted

Summary and Conclusion of Results for LP 9 Interchange at US 67

As shown in **Table 17**, by 2040, the full four-level interchange would be warranted at US 67 interchange with LP 9. The reason for relatively higher total volume at this interchange compared to others is that the roadway configuration at this location is fully connected and continuous. Since LP 9 corridor terminates at US 67, the EB to SB, EB to NB, SB to WB, and NB to WB movements is not relevant to this study. The LP 9 and US 67 interchange turning movement volumes in 2040 are presented in **Table 18**. Based on these results, all possible DC ramps are estimated justified by 2040.

Table 18: LP 9 and US 67 Turning Movement Volumes in 2040

Right	**Thru**	**Left**	1,300	**Right**
1,500	3,100	1,400	2,400	**Thru**
Left	1,500		4,600	**Left**
Thru	2,600	5,600	3,100	4,800
Right	5,600	**Left**	**Thru**	**Right**

Total Interchanged Traffic = 26,300

Summary and Conclusion of Results for LP 9 Interchange at IH 35E

The LP 9 and IH 35E turning traffic volumes are presented in **Table 19**. As shown in this table, the through movement through LP 9 corridor and left turn movements do not exist at this location. As presented in **Table 17**, the LP 9 and IH 35E interchange is estimated warranted first for a three-level interchange by approximately 2040. This interchange is justified as a partial four-level interchange by 2050 and a full four-level interchange by 2060. Recommended openings of DC ramps are presented in **Table 20**.

Table 19: LP 9 and US 67 Turning Movement Volumes in 2050

Right	**Thru**	**Left**	11,000	**Right**
400	24,700	-	-	**Thru**
Left	-		-	**Left**
Thru	-	-	17,900	3,100
Right	3,700	**Left**	**Thru**	**Right**

Total Interchanged Traffic = 18,200

Table 20: Recommended DC Ramps at LP 9 and IH 35E Interchange

DC Ramp Movement	Recommended Opening Year for DC Ramps
NB-EB	2050
WB-SB	2050
EB-NB	2060
SB-WB	2060
NB-WB	2050
EB-SB	2050
WB-NB	2050
SB-EB	2050

Summary and Conclusion of Results for LP 9 Interchange at IH 45

The LP 9 and IH 45 turning traffic volumes are presented in **Table 21**. As shown in this table, the through movement through LP 9 corridor and left-turn movements do not exist at this location. As presented in **Table 17**, the LP 9 and IH 45 interchange is estimated warranted for a partial four-level interchange by 2045 and a full four-level interchange by 2055. Recommended openings of DC ramps are presented in **Table 22**.

Table 21: LP 9 and IH 45 Turning Movement Volumes in 2045

Right	**Thru**	**Left**	8,300	**Right**
3,100	4,200	-	-	**Thru**
Left	-		-	**Left**
Thru	-	-	300	5,400
Right	-	**Left**	**Thru**	**Right**

Total Interchanged Traffic = 16,800

Table 22: Recommended DC Ramps at LP 9 and IH 45 Interchange

DC Ramp Movement	Recommended Opening Year
NB-EB	2045
WB-SB	2045
EB-NB	2045
SB-WB	2045
NB-WB	2055
EB-SB	2055
WB-NB	2045
SB-EB	2045

Summary and Conclusion of Results for LP 9 Interchange at US 175

The LP 9 and US 175 turning traffic volumes are presented in **Table 23**. As shown in this table, the through movement on LP 9 corridor and left-turn movements do not exist at this location. As presented in **Table 17**, the LP 9 and US 175 interchange is estimated warranted first for a three-level interchange by 2050. This interchange is justified as a partial four-level interchange by 2065 and a full four-level interchange beyond 2070. Recommended openings of DC ramps are presented in **Table 24**.

Table 23: LP 9 and US 175 Turning Movement Volumes in 2050

Right	**Thru**	**Left**	3,000	**Right**
-	-	-	2,200	**Thru**
Left	-		-	**Left**
Thru	900	-	-	12,100
Right	3,500	**Left**	**Thru**	**Right**

Total Interchanged Traffic = 18,600

Table 24: Recommended DC Ramps at LP 9 and US 175 Interchange

DC Ramp Movement	Recommended Opening Year
NB-EB	2065
WB-SB	2065
EB-NB	Beyond 2070
SB-WB	Beyond 2070
NB-WB	2065
EB-SB	2065
WB-NB	2065
SB-EB	2065

Summary and Conclusion of Results for LP 9 Interchange at IH 20

As shown in **Table 17**, by 2050, the full four-level interchange would be warranted at IH 20 interchange with LP 9. The reason for relatively higher total volume at this interchange compared to others is that similar to LP 9 and US 67 interchange, the existing configuration at this location is fully connected and continuous. The LP 9 and IH 20 interchange turning movement volumes in 2050 are presented in **Table 25**. Based on these results, all possible DC ramps are estimated justified by approximately 2050.

Table 25: LP 9 and US 175 Turning Movement Volumes in 2050

Right	**Thru**	**Left**	7,300	**Right**
1,000	-	7,300	600	**Thru**
Left	1,500		200	**Left**
Thru	600	4,600	-	200
Right	4,800	**Left**	**Thru**	**Right**

Total Interchanged Traffic = 26,900