C.0 APPENDIX C

C.1 TRAVEL DEMAND MODEL ANALYSIS

The *Fort Collins Transportation Master Plan 2004* (TMP) was developed as part of a requirement in the Fort Collins *City Plan* to update to the TMP every five years. This technical appendix addresses the development, application, and contributions of the Fort Collins Multimodal Travel Model to the *Fort Collins Transportation Master Plan 2004*.

The Fort Collins Multimodal Travel Model was developed by the City of Fort Collins to support efforts on the Mason Transportation Corridor project. It is loosely based on the travel model that was maintained by the North Front Range Metropolitan Planning Organization (MPO) in 1999. During development, several concerns with the older North Front Range model were addressed, additional features were added, and new data was utilized. A multimodal capability was developed, allowing both transit and roadway facilities to be included in the analysis. An additional update was conducted in 2003, resulting in the version of the model that is discussed in this report. Detailed documentation on the initial version developed for the Mason Transportation Corridor project and on the updated version 3.0 are attached to this report.

Considerable effort has been taken to ensure that the model conforms to industry norms and uses methodology that is considered reasonable and appropriate given the scope of the project. During the FTA New Starts federal funding application process for the Mason Transportation Corridor, the Fort Collins Travel Model was scrutinized and accepted by some of the country's top modeling experts. Separately, efforts were undertaken to ensure consistency with a similar model used by the North Front Range MPO. This stringent quality control process has ensured that the model is a reliable, defensible tool.

Various scenarios were tested using the model and resulting information was used to guide development of the plan. Potential changes to the existing Master Street Plan (MSP) were tested individually to quantify their value, and additional techniques such as unconstrained assignment and air quality analysis provided valuable information. Although travel model results did not dictate any one portion of the plan, they were considered along with many other factors throughout the plan's development.

C.2 PREPARING THE MODEL

In order to use the model for this effort, some updates were necessary. Updated data, roadway networks, and transit networks were developed for use in the future-year scenarios. New procedures were developed to estimate roadway level of service (LOS) and to adjust modeled volumes using base year count information. Some existing procedures were adjusted or modified to provide more relevant results.

C.2.1 Socioeconomic Data

Socioeconomic data consists of information about households, people, and employees in Fort Collins and the North Front Range region. For the base year, 1998 data was used. This data was created during the initial model development and was not changed for this exercise. For the forecast year, data was provided by the North Front Range MPO and the City's Advance Planning department.

Due to the regional scope of the model, it was necessary to provide socioeconomic data for Greeley, Loveland, and other North Front Range cities as well as for Fort Collins. It was also necessary to ensure that regional forecast totals remained consistent with totals defined by the North Front Range MPO and the state demographer. In order to create a dataset that was reasonably consistent with both MPO and City of Fort Collins numbers, data from the two sources was merged. For zones in the Fort Collins area, data provided by the City's Advance Planning department was used. For the rest of the region, data provided by the MPO was used. However, MPO data was factored to ensure that regional household, population, and employment totals matched the original MPO dataset.

In early stages of plan development, there was some uncertainty as to the future of the Fort Collins Growth Management Area (GMA) and therefore the preferred forecast socioeconomic dataset. To help the *City Plan* team quantify the effect of different potential GMAs, some sensitivity analysis was performed. This analysis is described further in section 5 of this appendix.

C.2.2 Roadway Networks

The existing transportation system is represented by a 1998 roadway network. To ensure local accuracy and regional consistency, two roadway networks were combined for use in the model. For the area in and immediately surrounding Fort Collins, a detailed roadway network developed by the City was used. The Fort Collins network was initially developed for use in the Mason Transportation Corridor project and has been continually maintained by the City of Fort Collins staff. During the recent update of the Fort Collins model, areas outside of Fort Collins were updated based on the regional roadway network maintained by the MPO.

To represent forecast conditions, two potential networks were created. The first, the existing and committed (E+C) network included all projects existing in 2003, as well as all projects with committed funding. The second forecast network was representative of the current MSP. This network had been created for previous efforts and was only modified to correct inaccuracies.

C.2.3 Transit Networks

Two primary transit networks were used in the TMP modeling analysis. The 1998 Transfort transit system was used in the base year scenario and for the existing plus committed scenario. A forecast network, including the Bus Rapid Transit (BRT) along the Mason Transportation Corridor was paired with the MSP roadway network to create the "Vision" scenario, representative of full buildout of the Master Street Plan and the transit system defined by the *Transfort Strategic Plan*.

C.3 INTERPRETING THE MODEL (POST-PROCESSING)

Based on the inputs described above, the travel model provides estimates of travel demand resulting from algorithms performed by the model. These estimates are verified against known information such as traffic counts and the results of travel surveys, but aggregate travel models are not perfect and experience some error when compared to real world conditions. Additionally, the output generated by the travel model is extensive and must be simplified and summarized in order to be useful. By post-processing the raw model results, many useful, more reliable pieces of information are made available.

C.3.1 Count-Based Volume Adjustment

Although modeled volumes for the base year are validated to be reasonably accurate, there is always some discrepancy between modeled volumes and traffic counts. This error is addressed by adjusting base year and forecast-year model volumes using count data. Since this adjustment can only take place where traffic count data exists, available traffic counts were used to estimate existing traffic volumes on major and minor arterial streets without count data. Model volumes were adjusted on roads in and immediately surrounding Fort Collins where a reliable estimate could be made. Model volumes were not adjusted elsewhere in the region or on collector streets, local streets, or I-25.

Volume adjustments were applied in a manner consistent with methods described in the National Cooperative Highway Research Program Report 255 (NCHRP 255). For each scenario, the modeled volumes are converted to adjusted volumes based on this methodology. In the base year scenario, the base volume and the modeled volume in the equations below are identical, so the resulting adjusted volume matches the base year count. For forecast scenarios, the modeled volume is increased or decreased based error in the base year model volume as compared to the base year traffic count. All model results, including level of service, vehicle miles traveled (VMT), and emissions of pollutants are based on adjusted model results.

Three specific methods are described in NCHRP 255 and can be applied as follows:

NCHRP 255 Adjustment Methods

Ratio Method:

$$AdjustedVolume = ModelVolume \times \frac{BaseCount}{BaseVolume}$$

Difference Method:

$$AdjustedVolume = ModelVolume + (BaseCount - BaseVolume)$$

Average Method:

This method is an average of the results of the *Ratio Method* and the *Difference Method*.

Where:

ModelVolume: The raw modeled volume, to be adjusted using NCHRP procedures

BaseCount: The base year traffic count

BaseVolume: The base year raw modeled volume. When the base year model is to be adjusted, *BaseVolume* is identical to *ModelVolume*.

For most roadways, the *Average Method* was used. However, in some special cases the *Average Method* produces unacceptably large or small adjustments due to inclusion of the *Ratio Method*. In these cases, the *Difference Method* is used instead. Table C.1 describes the cases in which a method other than the *Average Method* is used to adjust a modeled volume.

Table C.1
Average Method Determination

Condition	Implications	Method Used
$\frac{FutureVolume}{BaseVolume} > 3$	High modeled growth may cause the *Ratio Method* to result in unreasonably high adjusted volumes.	Difference Method
$\frac{BaseCount}{BaseVolume} > 1.5$	A large underestimation by the model in the base year may cause the *Ratio Method to* result in unreasonably low adjusted volumes.	Difference Method
$\frac{BaseVolume}{BaseCount} > 1.5$	A large overestimation by the model in the base year may cause the *Ratio* Method to result in unreasonably high adjusted volumes.	Difference Method
All other cases		Average Method

C.3.2 Roadway Level of Service

A useful measure of roadway facility performance is LOS, which measures the ability of a facility to carry vehicles using that roadway. As traffic volumes increase and congestion occurs, the volume to capacity (V/C) ratio increases as well. The V/C ratio is used to determine a roadway's level of service. Possible values of LOS include A, B, C, D, E, or F. On a simplified scale, A through C represents uncongested roadways, LOS D and E represent facilities that are becoming congested, and LOS F represents congested roadways.

The roadway LOS model was calibrated based on intersection level of service. Intersection turn movement counts were collected and used to compute level of service using Highway Capacity Manual (HCM) techniques and the Synchro software package. Intersection level of service was then compared to traffic model results to facilitate calibration of a link-based level of service algorithm.

To calibrate link level of service to intersection level of service, 2001 peak-hour directional volumes were required. The Fort Collins Multimodal Travel Model provides 1998 daily volumes, which were factored to 2001 peak-hour volumes using a growth rate of three percent per year. A factor peak-hour of 0.09 was used to convert daily volumes to peak-hour volumes. For two-way streets, a peak directional factor of 0.6 was applied to convert two-way volumes to peak directional volumes; for one-way streets, a peak factor of 1.20 (or 0.6/0.5) was applied to simulate directional peaking. Peak hour volumes are then compared to an hourly capacity to compute level of service.

The Fort Collins Multimodal Travel Model uses LOS C capacities for traffic assignment, but a LOS E capacity is preferred for level of service computation. A LOS E capacity indicates that when volume exceeds capacity on a roadway, the facility fails and receives a score of F.

Alternately, when LOS C capacity is exceeded, a roadway receives a score of D. To convert the model capacities to LOS E capacities, a factor of 1.3 was applied. To better replicate observed data, further adjustments were made to expressway capacities and arterial capacities. Upper limit model capacities are shown in Tables C.2 through C.5 and are broken down by facility type and area type as defined in the model documentation.

Table C.2 Model Capacities (LOS C)

Facility Type	Urban	Rural	CBD
Freeway	1500	1750	1500
Expressway	1000	1200	1000
Major Arterial	800	800	700
Minor Arterial	550	550	435
Collector	400	400	435
Ramp	800	800	800

Table C.3 LOS Capacities (LOS C)

Facility Type	Urban	Rural	CBD
Freeway	1500	1750	1500
Expressway	**830**	**1030**	**860**
Major Arterial	**750**	**960**	700
Minor Arterial	**700**	**740**	435
Collector	400	400	435
Ramp	800	800	800

Table C.4 Model Capacities (LOS E)

Facility Type	Urban	Rural	CBD
Freeway	1950	2275	1950
Expressway	1300	1560	1300
Major Arterial	1040	1040	910
Minor Arterial	715	715	560
Collector	520	520	560
Ramp	1040	1040	1040

Table C.5 LOS Capacities (LOS E)

Facility Type	Urban	Rural	CBD
Freeway	1950	2275	1950
Expressway	**1080**	**1340**	**1120**
Major Arterial	**980**	**1250**	910
Minor Arterial	**910**	**960**	560
Collector	520	520	560
Ramp	1040	1040	1040

*Capacities in **bold** were adjusted during LOS calibration.*

The Fort Collins Multimodal Travel model includes additional facility types not listed above. In the level of service model, principal arterials are treated as major arterials, and frontage roads are treated as minor arterials. Freeway ramps and expressway ramps are both treated simply as ramps.

Volume to capacity ratios are determined by dividing the peak hour directional traffic volume by the upper limit LOS E capacity from Table C.5. Highway Capacity Manual cutpoints shown in Table C.6 were applied separately for freeways/expressways and arterials to identify LOS for each link in the roadway network. Because this analysis is based on upper limit level of service capacities, a V/C ratio that exceeds a certain cutpoint receives the next score. Travel models are not typically designed to do planning at the collector level, so all collector streets are assigned LOS B.

Table C.6
LOS Cutpoints

LOS	Freeway/ Expressway	Arterial
A	0.31	0.51
B	0.51	0.67
C	0.71	0.79
D	0.87	0.91
E	1.01	1.00
F	n/a	n/a

C.3.3 Air Quality Analysis

By combining results of the Fort Collins Multimodal Travel Model with the Mobile6 Mobile Source Emission Factor Model created by the United States Environmental Protection Agency (EPA), mobile source emissions from the transportation system can be estimated.

The Mobile6 model produces emission factors for pollutant categories of interest. These categories are Carbon Monoxide (CO), Ozone precursors (VOC and NO_X), particulate matter (PM_{10} or $PM_{2.5}$) and Carbon Dioxide (CO_2). Problematic in winter, Carbon Monoxide can cause health problems, especially in those with heart disease and the elderly. Ozone is beneficial in the upper atmosphere, but causes problems when present in the lower atmosphere. Ozone is a component of smog that reduces visibility and will irritate and damage the respiratory system. Ozone is problematic in the summer months when volatile organic compounds (VOC) and nitrous oxides (NO_X) combine in the presence of sunlight. Carbon Dioxide does not have immediate health effects, but is believed to contribute to long term problems due to its status as a greenhouse gas. The CO_2 component of the Mobile6 model is still in draft form, so CO_2 was not modeled for this effort.

Particulate matter consists of very small particles that can cause lung problems and reduce visibility. Particulate matter is a component of diesel vehicle exhaust, gasoline vehicle exhaust, and dust from brake and tire wear. In addition, Ammonia (NH_3) and Sulfur dioxide (SO_2) emissions are reported as particulates. Although these gasses are not particulates in themselves, they take part in chemical reactions in the atmosphere that result in the formation of particulate matter. Previously, particulates were measured as PM_{10}, indicating particulates with a diameter of 10 microns or less. Recently, it has been determined that the most harmful particulates have a diameter of 2.5 microns or less, so $PM_{2.5}$ has become the new standard. Particulates with diameter between 2.5 and 10 microns make up only a small portion (7-13 percent) of the overall PM_{10} measurement. Information from air pollution monitoring stations shows that Fort Collins is currently in compliance with EPA standards for each of these pollutants.

C.3.3.1 Mobile6 Model Setup

As with previous versions, Mobile6 can be customized to reflect the characteristics of a particular region. For the State of Colorado, parameters and inputs to the Mobile6 model are updated and maintained by the Air Pollution Control Division of the Colorado Department of

Public Health and Environment (APCD). Separate parameter sets are maintained for each region of the state, including the North Front Range. For this effort, all Mobile6 input parameters were provided by or verified by the APCD. Table C.7 describes the input parameters used.

Table C.7
Mobile6 Inputs

Input Name	Input Information
Altitude	High Altitude (approximately 5500 mean feet above sea level)
Anti-Tampering Program	In 2025, no anti-tampering program was modeled. In 1998, the existing anti-tampering program was modeled.
Evaluation Month	January for winter and July for summer.
Fuel Program	Conventional Gasoline West Fuel Program; no reformulated fuels program is modeled.
Fuel RVP	Reid Vapor Pressure is modeled at 12.0 psi in the winter and 9.0 psi in the summer.
I/M Program	In 2025, no I/M program was modeled. In 1998, the existing I/M program was modeled.
Oxygenated Fuels	Modeled in the Winter only. Oxygenated fuel is modeled using 95 percent alcohol blend fuels with an oxygen content of 0.031 percent by weight. The remaining 5 percent is modeled as ether blend with an oxygen content of 0.027 percent by weight.
Pollutants	CO in the winter, VOC and NOX in the summer.
Particulates	SO_4, OCarbon, Ecarbon, Gas PM, NH_3, SO_2, Brake, and Tire. These represent all particulates modeled by Mobile6.
Particulate Size	$PM_{2.5}$ and PM_{10}
Temperatures	The minimum and maximum daily temperatures are provided.

For the 1998 scenarios, the I/M program and anti-tampering programs were modeled to reflect the existing program used in Fort Collins. For year 2025, these programs will not necessarily be in place, so the Mobile6 model was run without an I/M program or anti-tampering program.

The existing I/M program was modeled as an Idle Test and Repair (Computerized) program for all vehicles more than 5 years old. A compliance rate of 88 percent is assumed in the model, indicating that 88 percent of all vehicles complete the program and receive either a certificate or a waiver. Of the vehicles that complete the program, 0.08 percent are assumed to receive a waiver. The program is modeled as 100 percent effective for HC and 80 percent effective for CO and NOx. The anti-tampering program assumed in the model applies to all vehicles 1982 and newer and allows a 5-year grace period. The program checks for air pump system disablement, catalyst removal, and missing gas caps. As with the standard I/M program, there is an 88 percent compliance rate.

Vehicles built before 1981 are subject to yearly testing, with newer vehicles subject to testing every two years (after the 5 year grace period). As modeled, 21 percent of pre-1981 vehicles are expected to fail the emission test. This setup has been verified by the APCD to accurately represent the programs in place in Fort Collins.

C.3.3.2 Speed Post-Processor

One of the outputs from the equilibrium assignment process in the travel model is travel speed. However, these modeled speeds do not necessarily match observed speeds. To account for this error, a speed post-processor is used. The speed post-processor was reviewed and updated for this effort, and resulting speeds were used to perform air quality analysis.

C.3.3.3 Application of Mobile6 Factors with Travel Model Results

The Mobile6 model provides emission factors in grams per mile (g/mi) at specified conditions and at specified speeds. These factors are combined with outputs from the travel model to estimate certain pollutants emitted on Fort Collins streets in a given scenario. There are numerous valid methods to combine Mobile6 results and travel model results; for this effort, a link-based analysis was used. This approach provides additional capabilities as compared to an aggregate methodology and provides results that are reasonably consistent with those used in conformity analysis at the state level.

The link-based analysis requires the Mobile6 model to be run multiple times. The program is run once for each speed between 3 and 65 mph for freeways and arterial streets, once for local streets at 12.9 mph, and once for freeway ramps at 34.6 mph. The Mobile6 program does not allow alternate speeds for freeway ramps and local streets. The Mobile6 database output is then processed using a database program to arrive at a simplified set of emission factors by year, speed, time period, and facility type. Emission factors are then applied to model results based on output speed, facility type, time period, and traffic volume. This process results in an estimate of pollutant emissions for each link in the roadway network.

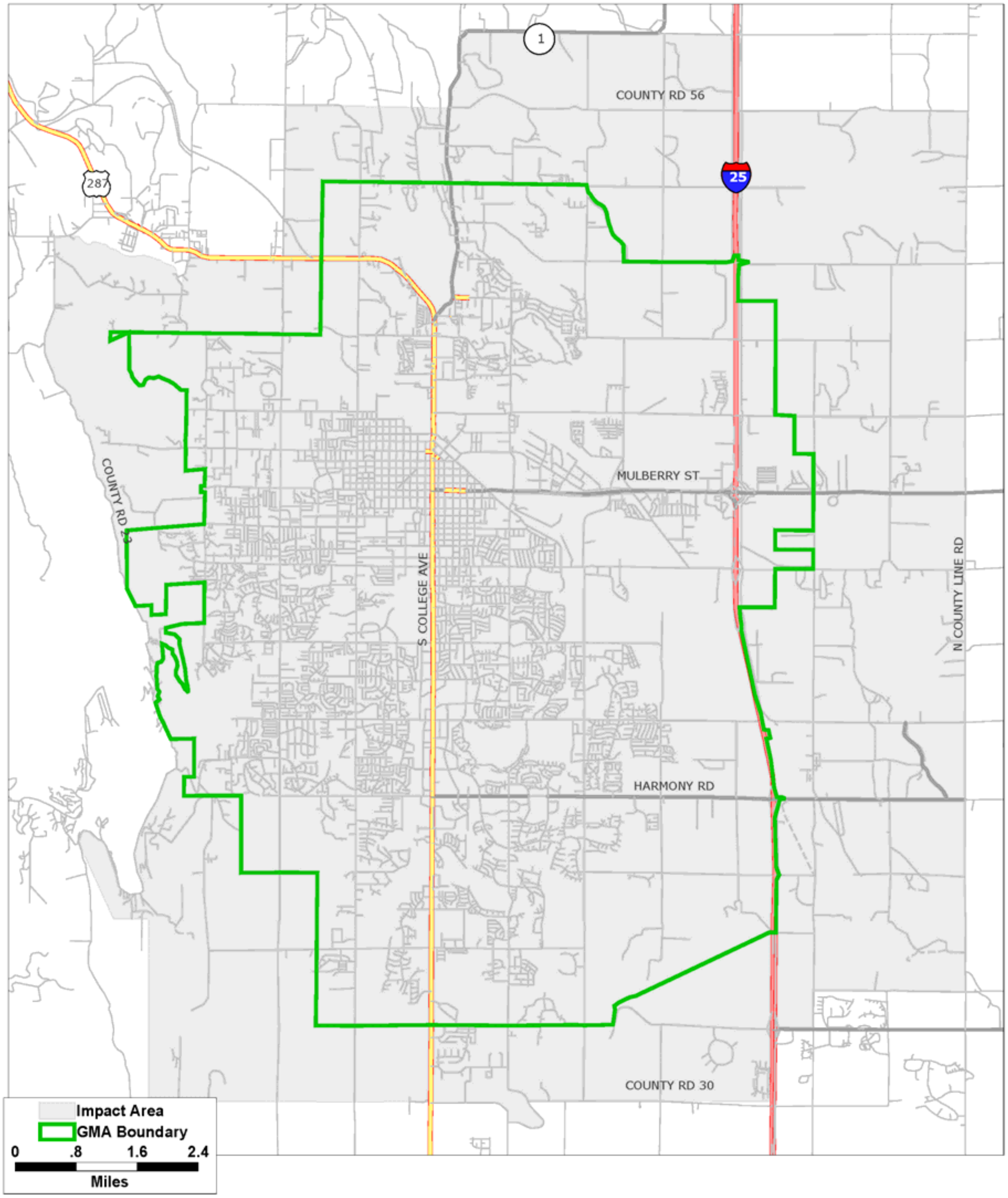
C.3.4 Summarizing the Model Results

Model results were summarized into regional totals and illustrative maps for use in this effort. Statistics are reported for the impact area shown in Figure C.1, which is slightly larger than the existing Fort Collins GMA. These figures were used to demonstrate the impacts of transportation and land use alternatives, and to present model results to city boards, the City Council, and the public.

VMT represents the distance traveled by vehicles on Fort Collins streets. This is used as a measure of the amount of travel taking place in Fort Collins and captures travel by vehicles originating in Fort Collins as well as travel to and from other places. VMT on local streets is not reported. For each roadway segment in the network, VMT is reported as the adjusted daily traffic volume multiplied by the segment length.

Air quality results are also summarized and reported for the impact area. Emissions of each pollutant are reported in tons per day and include emissions on collector streets, arterials, and freeways, as well as an estimate of emissions from local streets. Reported emission totals are based on the air quality analysis described above.

Figure C.1
Fort Collins Impact Area



C.4 PRIMARY MODEL SCENARIOS

To portray existing and future transportation needs in the City of Fort Collins, three (3) primary scenarios were modeled. These scenarios represent Fort Collins as it is today, as well as what Fort Collins might become by 2025. Each scenario represents a different combination of transportation and socioeconomic conditions. Table C.8 lists some performance statistics for each of the primary model scenarios.

Table C.8
Model Statistics for the Fort Collins Impact Area

Statistic Name	Existing Conditions	Exiting and Committed	Vision Plan	Fiscally Constrained	Enhanced Fiscally Constrained
VMT	2,629,000	5,037,000	4,902,000	5,047,000	5,029,000
Freeflow VHT*	73,000	138,000	131,000	137,000	135,000
Congested VHT*	146,000	508,000	259,000	415,000	355,000
Hours of Congestion Delay	73,000	370,000	128,000	278,000	219,000
Percent of Lane Miles Congested**	4.5 %	24.2 %	9.5 %	21.6 %	19.4 %

VMT, VHT and Delay statistics do not include local streets or collector streets.
** VHT indicates Vehicle Hours of Travel (i.e. segment travel time x adjusted segment volume)*
*** Percent of lane miles with level of service E or F, not including freeways, local streets, or collector streets*

C.4.1 Existing Conditions

The Existing Conditions scenario is represented by the 1998 roadway network, data, and transit network. In some cases, level of service graphics were modified to more accurately represent 2003 conditions. However, all citywide totals such as VMT and air quality data are presented using 1998 data. When the model was first updated for use by the City of Fort Collins, a calibration effort was undergone. This calibration ensured that the model provided reasonable results when compared to 1998 survey data and traffic counts. It is for this reason that the base year used in this analysis is 1998. Modeled level of service for the existing scenario is shown in Figure C.2. As expected, there is congestion on segments of Prospect, Timberline, Harmony, College, and in Old Town, as well as more moderate congestion on Shields and Lemay. VMT for the existing scenario is approximately 2.6 million, and results of the air quality analysis are shown in Figures C.7 through C.11. Existing conditions are represented by the corresponding labeled bars in the figure charts.

C.4.2 Existing And Committed

The E+C Scenario demonstrates the effects of future socioeconomic growth on today's roadway and transit system. In this scenario, 2025 population and employment forecasts are modeled against a transportation system with very few improvements. The only additions assumed in the E+C transportation system are roadway projects that have already been funded. No transit improvements are assumed beyond current service. The result of this analysis is an extremely congested roadway network and an inadequate transit system. In this case, nearly all Fort Collins arterial streets are heavily congested as shown in Figure C.3. Heavy congestion is seen outside of Fort Collins as well due to the lack of roadway improvements throughout the region (transit is not modeled outside of Fort Collins). VMT for the E+C scenario is considerably higher than today at about 5 million VMT per day. Results of the air quality analysis, shown in Figures C.7 through C.8, indicate a reduction in emissions as compared to existing conditions, primarily due to technology improvements and fleet turnover.

C.4.3 Vision Scenario

The third scenario represents the Vision Scenario and is shown in Figure C.4. In this case, all roadway projects in the current MSP are assumed to be built and all phases of the Transfort Strategic Plan are completed. Additionally, the 2025 roadway network maintained by the MPO is used for areas outside of Fort Collins. When modeled with 2025 socioeconomic data, results show a significant reduction in congestion and emissions over the E+C scenario. However, congestion in the Vision Scenario is noticeably worse than today, with corridors such as College, Prospect, Lemay, Shields, and Carpenter Road experiencing a significant increase in congestion. Increased traffic volumes on connections to I-25 are demonstrative of an increase in regional travel. Due to heavy regional growth, more people are expected to travel between Fort Collins and surrounding areas. While congestion is reduced in some areas due to roadway and transit improvements, overall congestion in Fort Collins increases as compared to today. Level of service for this scenario is shown in Figure C.4 and emissions are shown in Figures C.7 through C.11. There is not a significant change in VMT as compared to the E+C scenario, which decreases by only 2 percent to 4.9 million VMT per day.

C.4.4 Fiscally Constrained Scenarios

Based on observations of the existing, E+C, and vision scenarios as well as analysis of some individual improvements to the roadway system, two fiscally constrained scenarios were developed. These scenarios include the highest priority roadway improvements that are financially achievable. Although the fiscally constrained Capital Improvement Plan (CIP) defines a reduced set of transit improvements as well as roadway improvements, these transit improvements were not modeled for the fiscally constrained scenarios. To provide a better understanding of the impacts of funding decisions, both a fiscally constrained and an enhanced fiscally constrained scenario were evaluated. VMT was essentially unchanged from the E+C case at 5.0 million for each fiscally constrained scenario. Level of service analysis is shown in Figures C.5 and C.6, and air quality impacts are shown in Figures C.7 through C.11. Because the improvements selected in the fiscally constrained scenarios represent the most effective actions, improvements are seen in level of service and air quality results as compared to the E+C scenario. The fiscally constrained and enhanced fiscally constrained networks are represented in model scenarios 47 and 48 respectively. These scenarios were also run using trip distribution results from the E+C scenario for analysis purposes, resulting in scenarios 50 and 51.

Figure C.2
Existing Conditions Level of Service

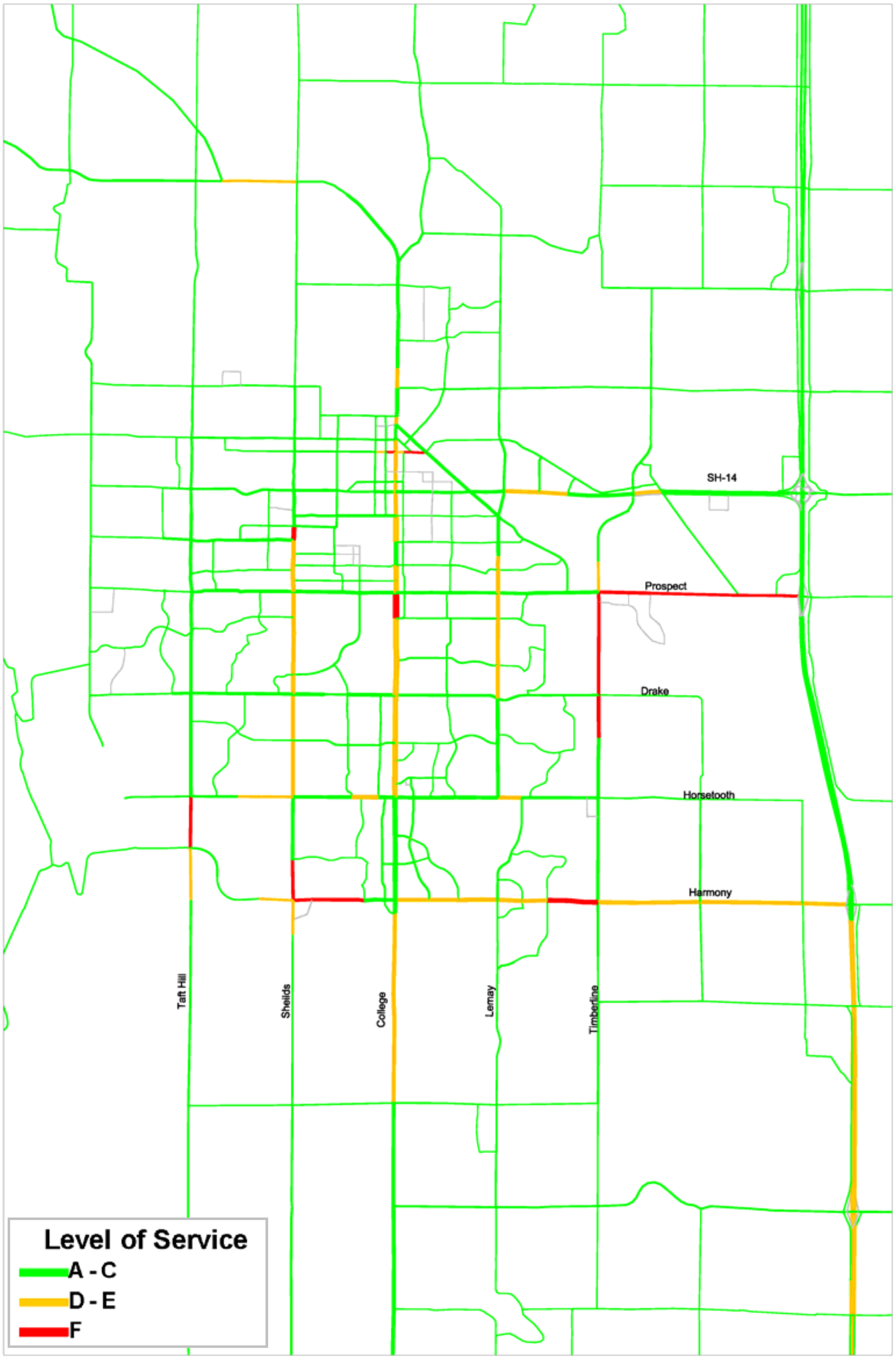


Figure C.3
Existing and Committed (2025) Level of Service

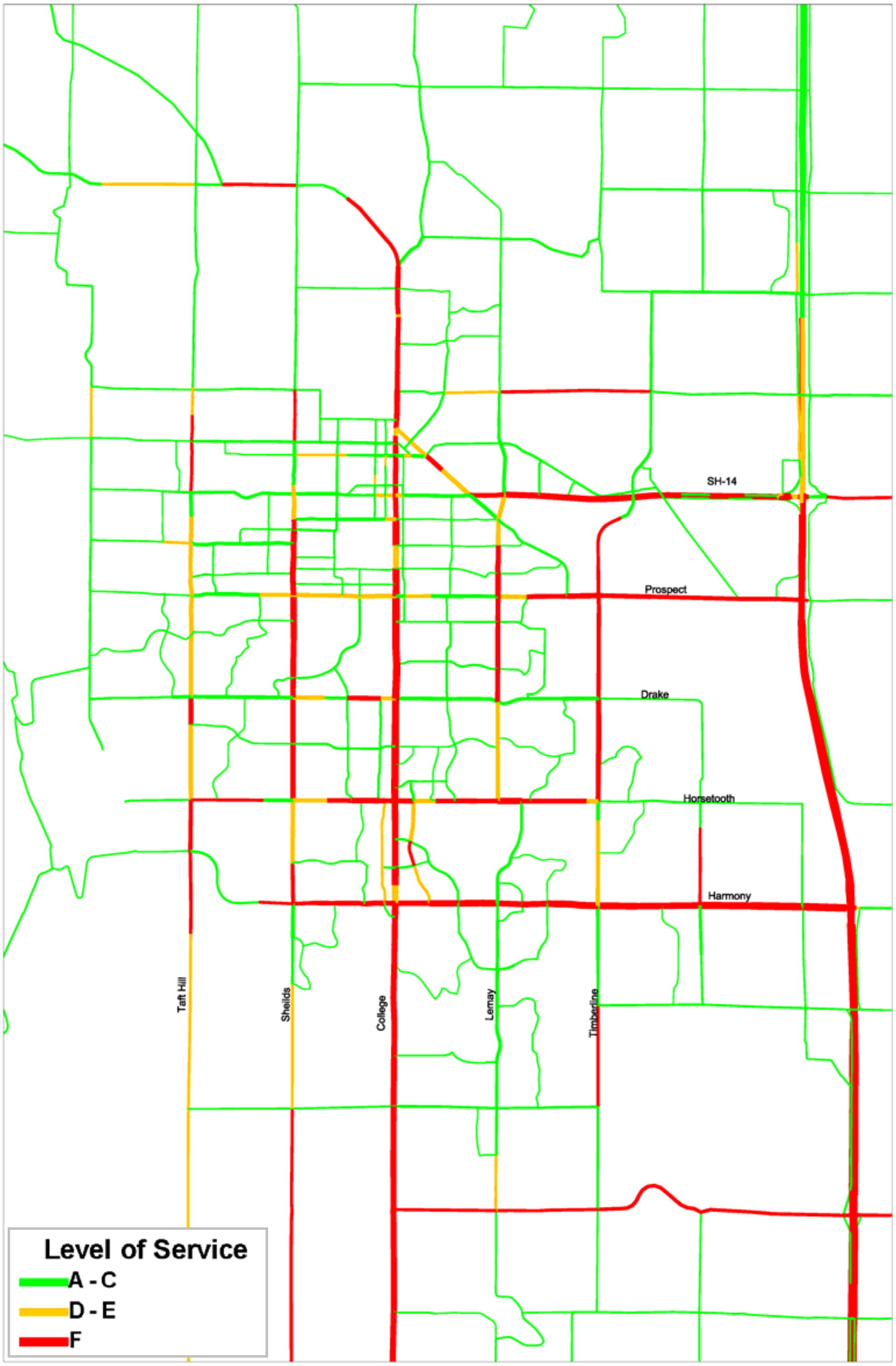


Figure C.4
Vision Plan (2025) Level of Service

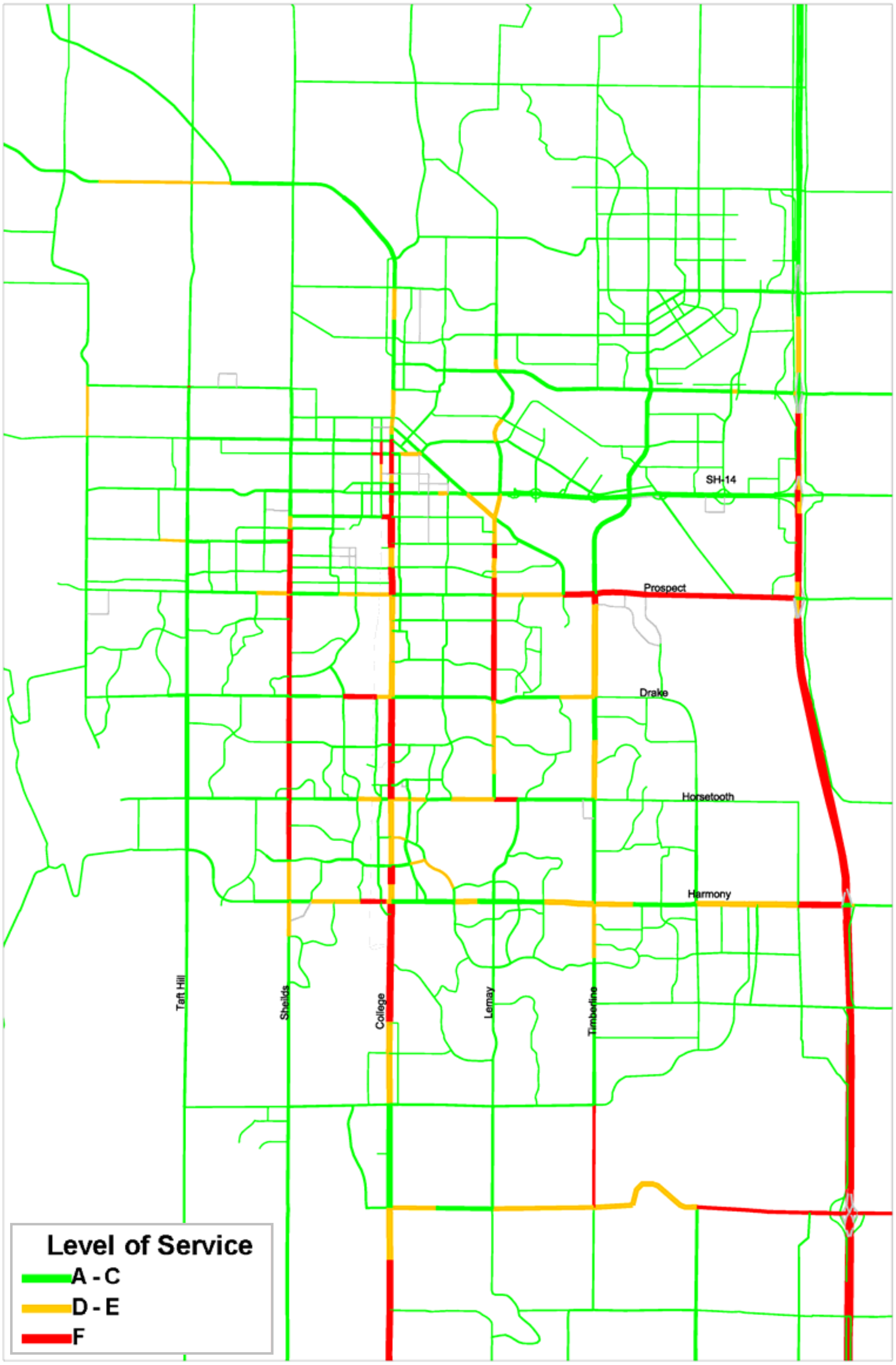


Figure C.5
Fiscally Constrained (2025) Level of Service

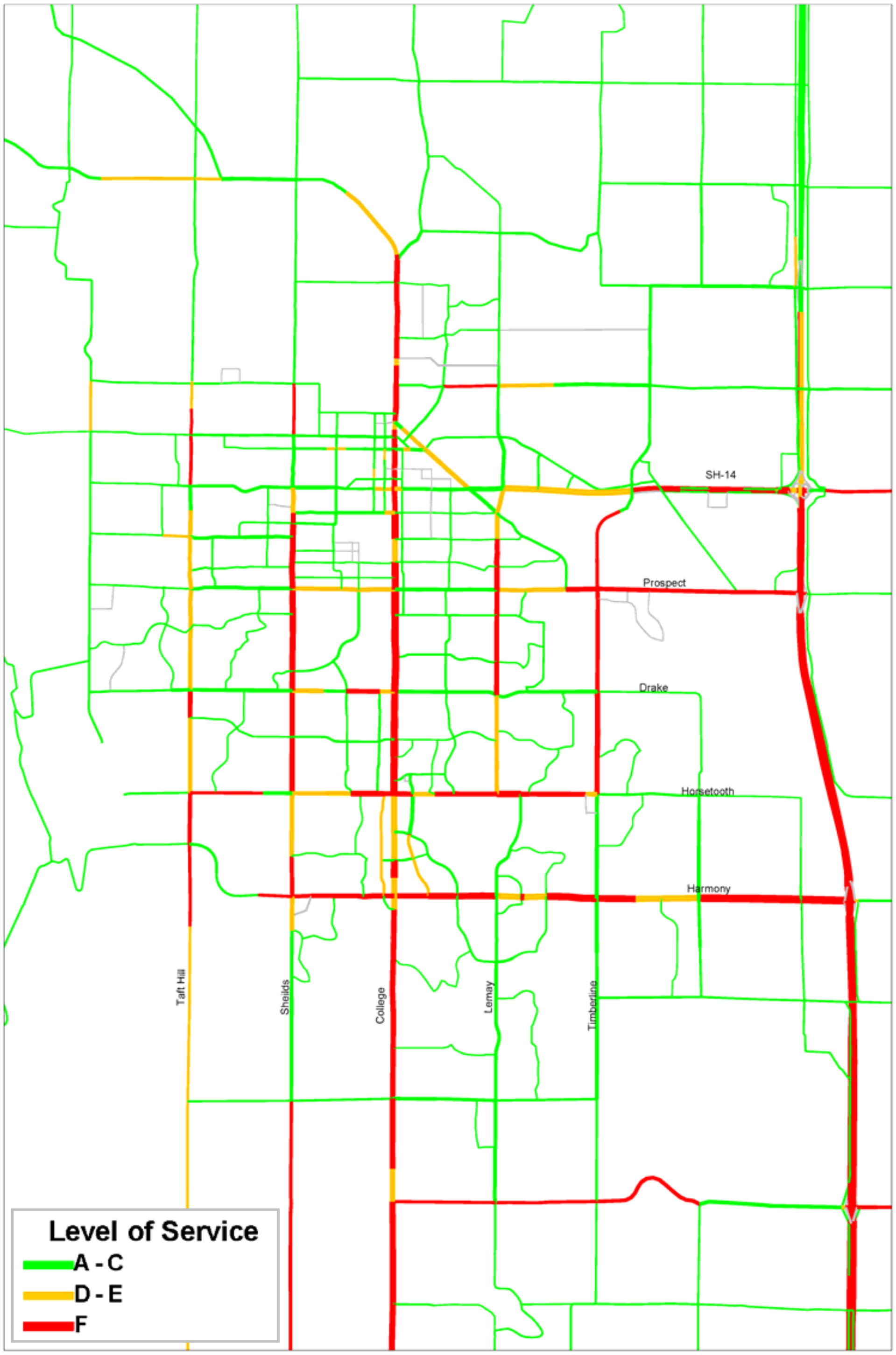


Figure C.6
Enhanced Fiscally Constrained Level of Service

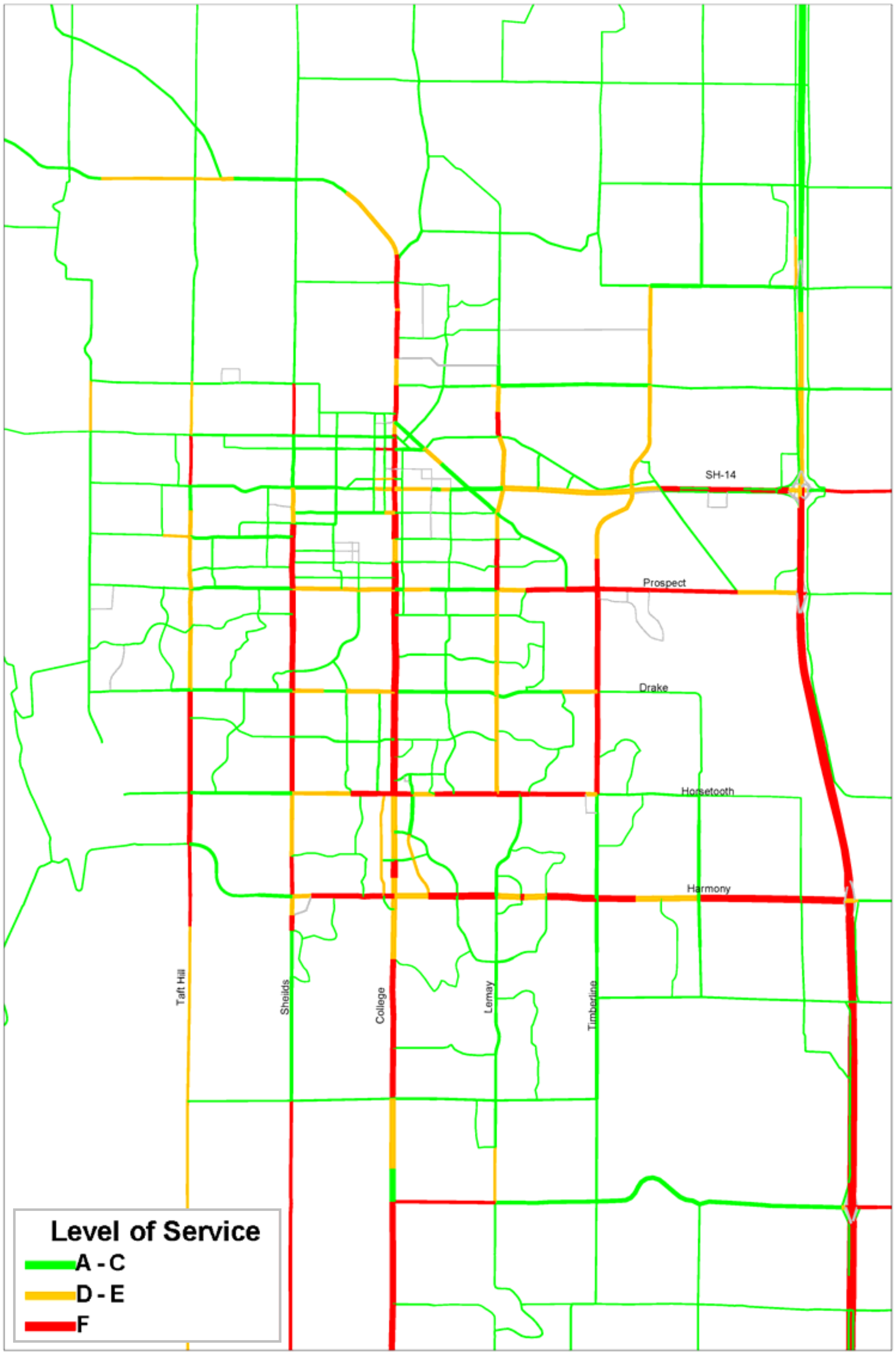


Figure C.7
Carbon Monoxide (CO) Emissions

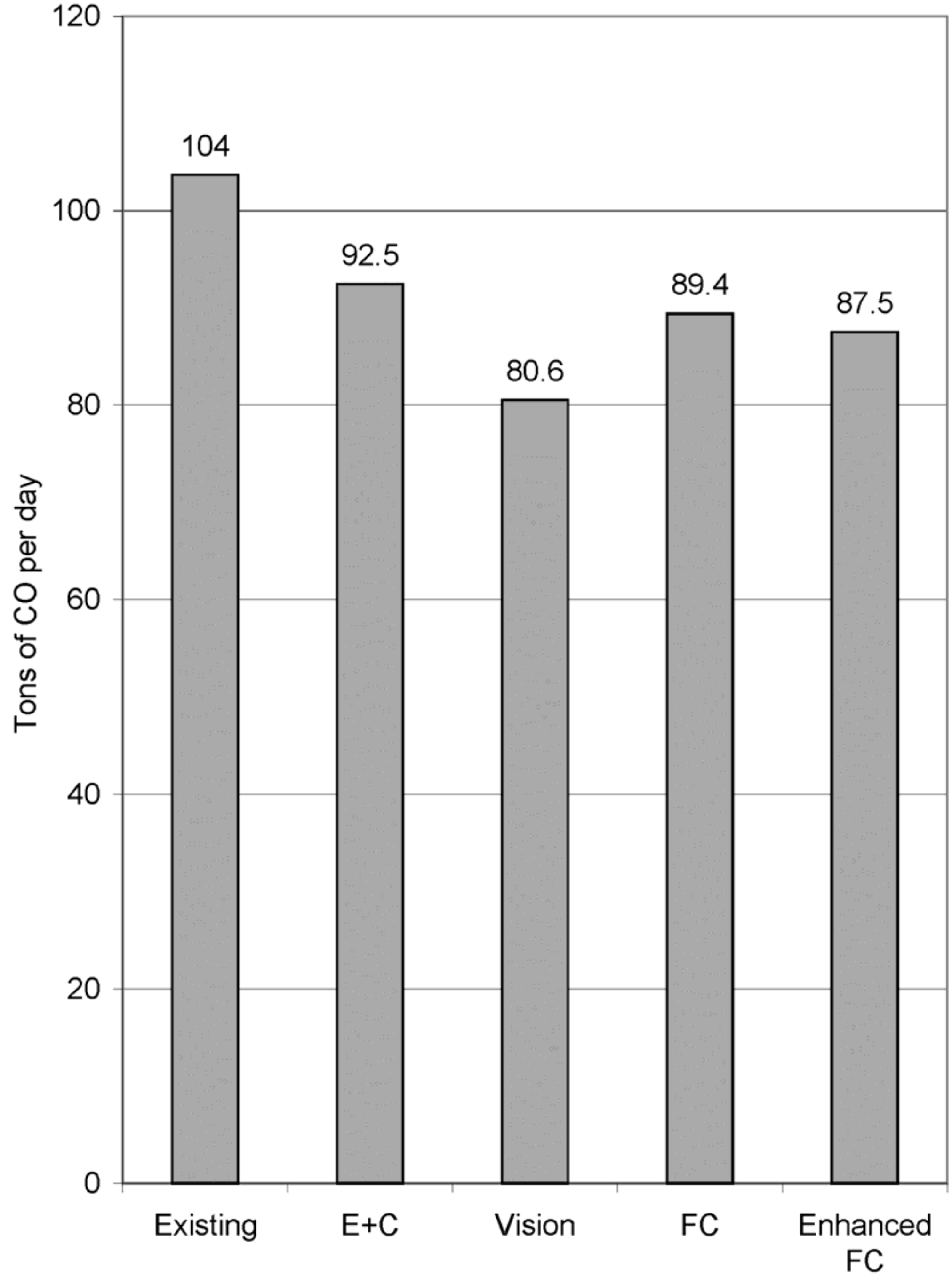


Figure C.8
Ozone Precursor Emissions of Nitrous Oxide (NO_x)

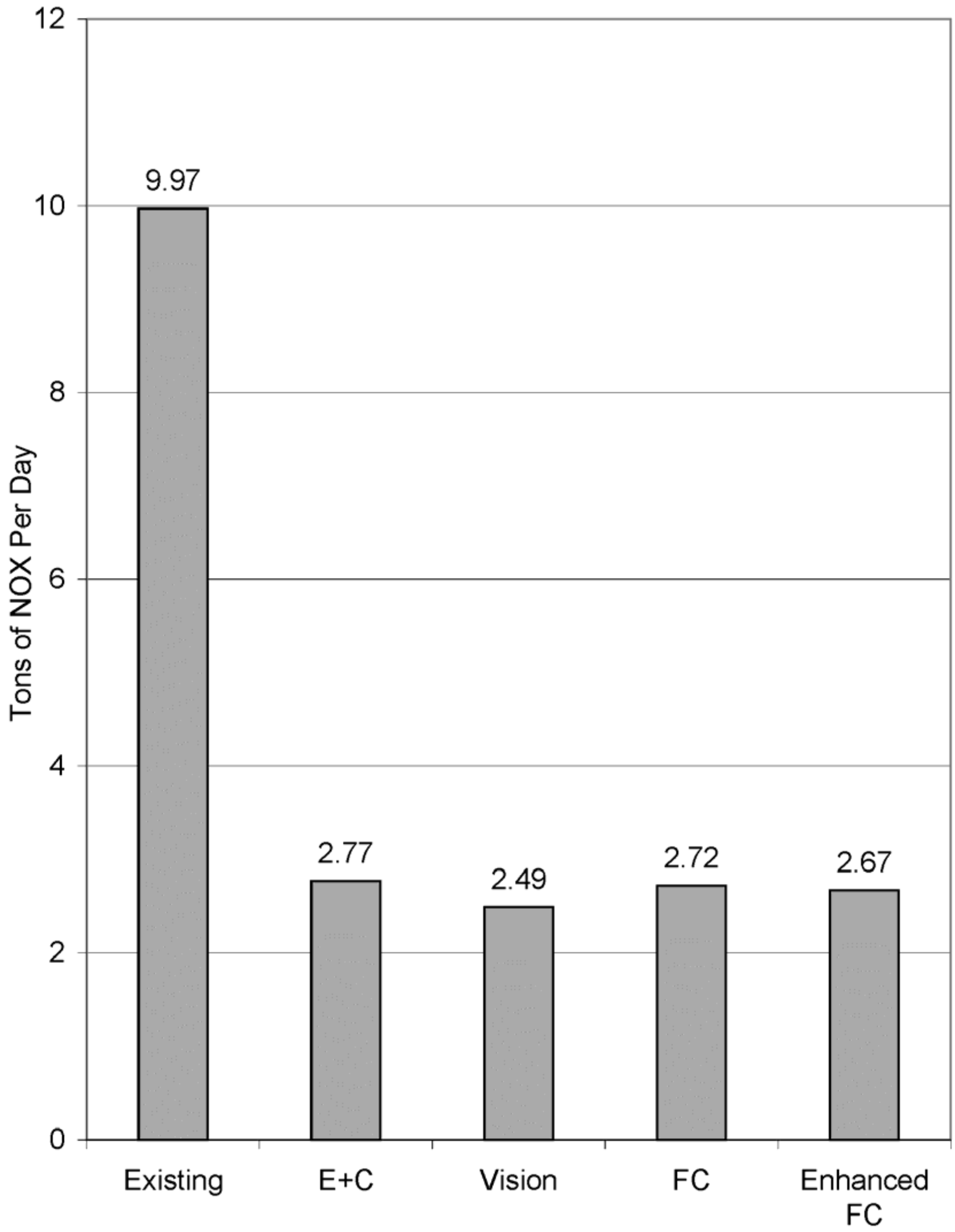


Figure C.9
Ozone Precursor Emissions of Volatile Compounds (VOC) Emissions

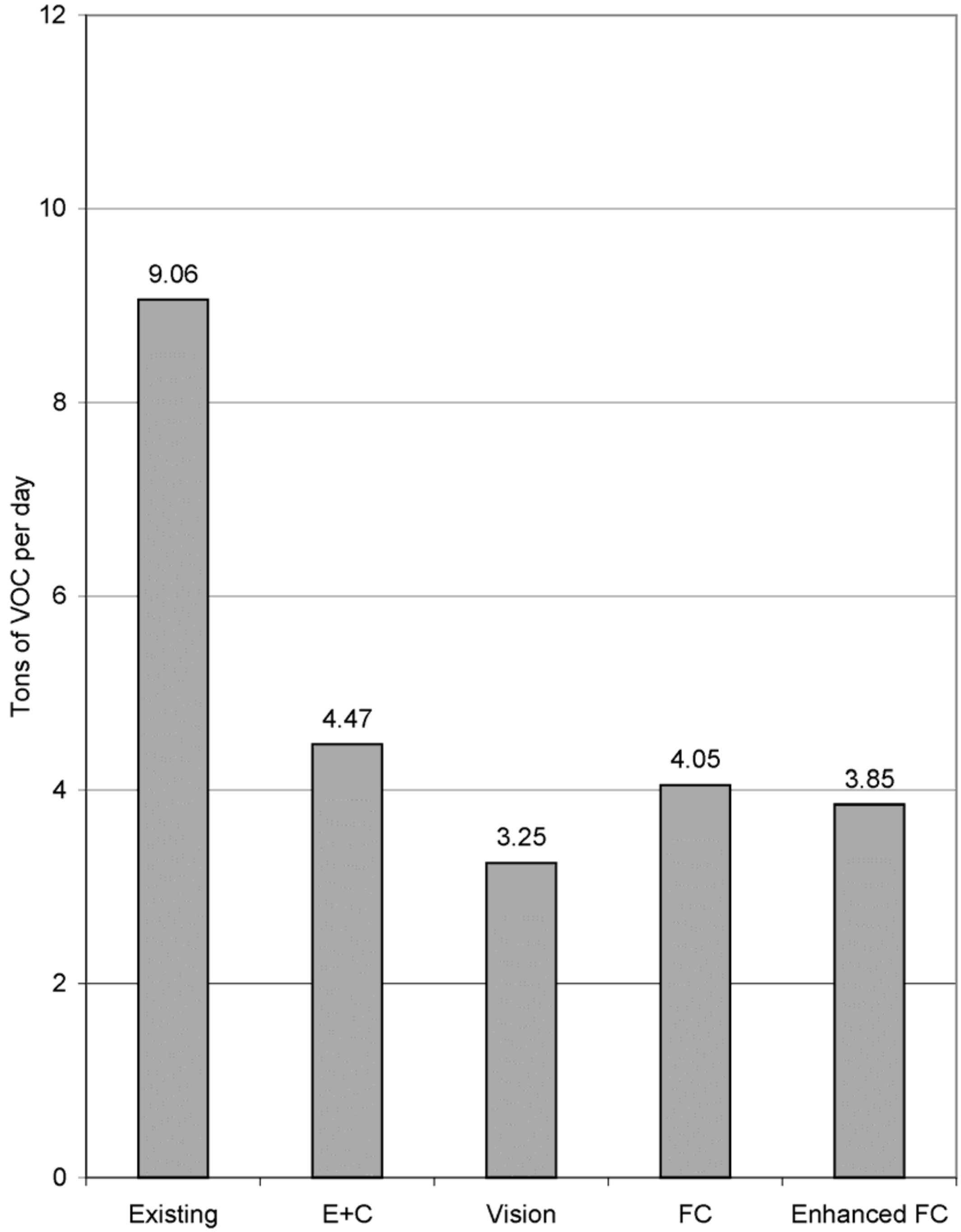


Figure C.10
Particulate ($PM_{2.5}$) Emissions by Type

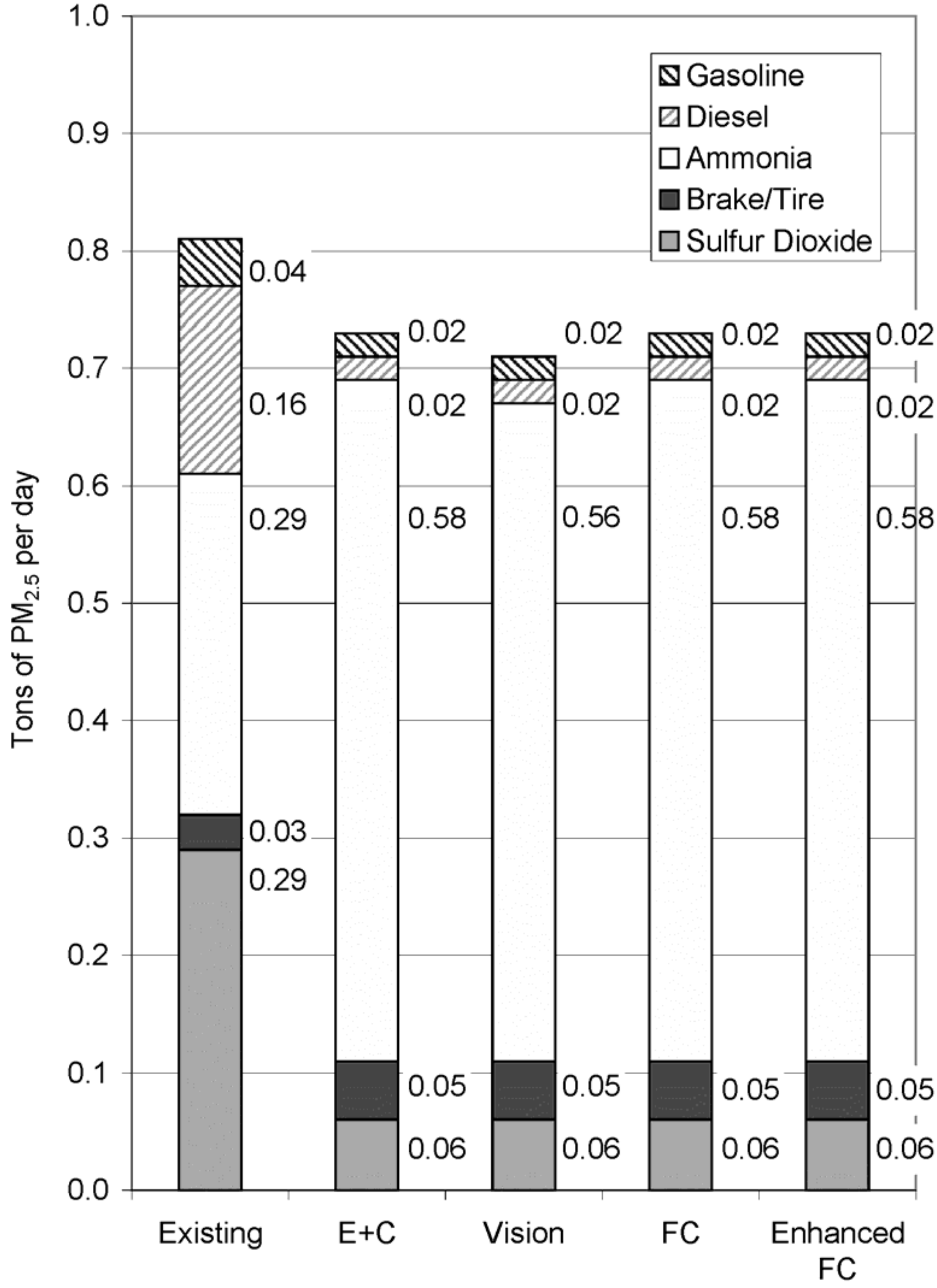
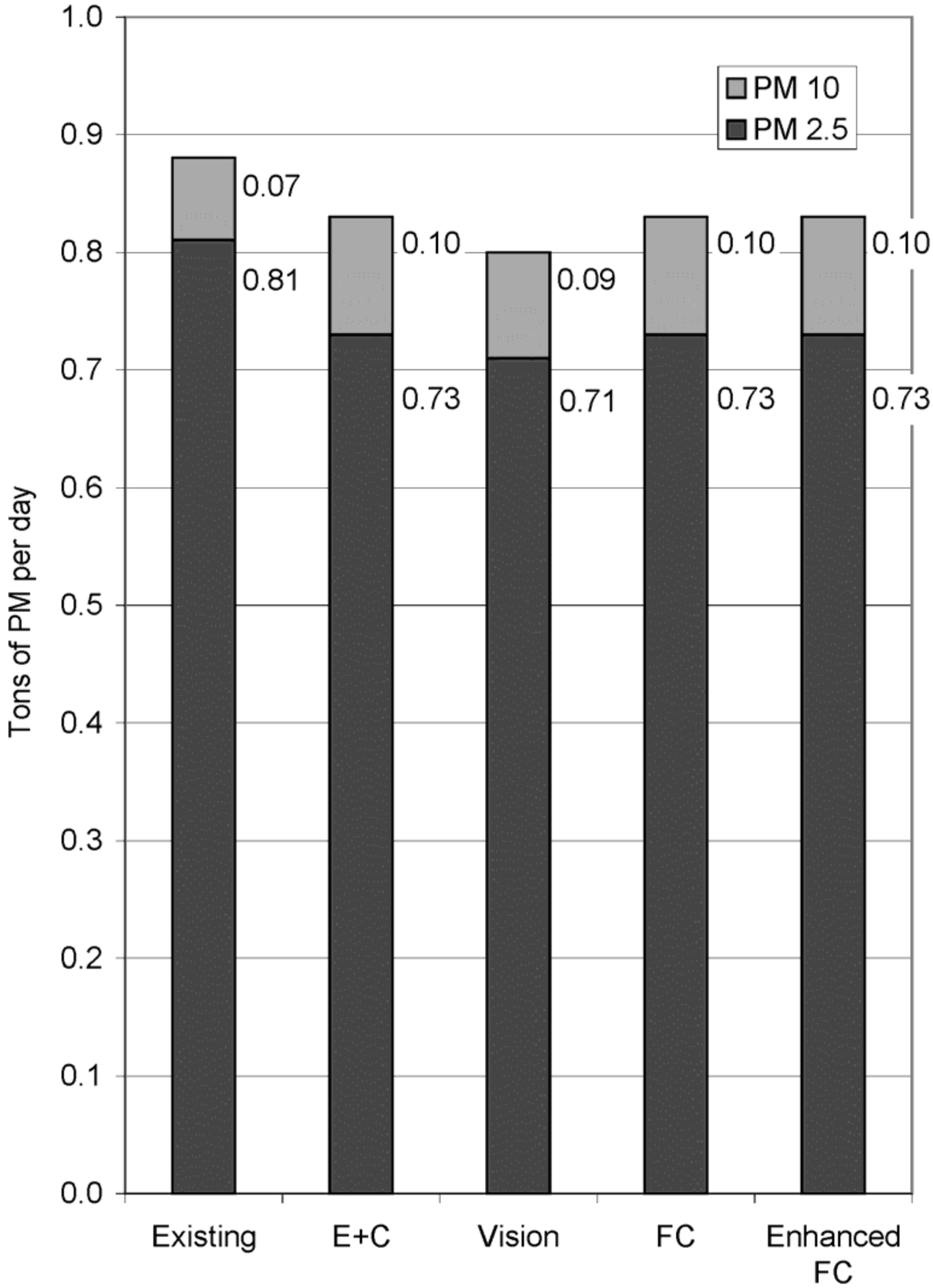


Figure C.11
Particulates by Size



C.5 SENSITIVITY TESTING

A variety of analysis was conducted using the transportation demand model to test the sensitivity of certain changes to the transportation network. These analyses included:

- Testing the potential for modifying the GMA boundary;
- Evaluating the effects of building out of congestion; and
- Evaluating the benefits of modifications to the MSP.

The potential of modifying the GMA boundary was tested to support the analysis that was being conducted by the *City Plan* team. The result of the analysis concluded that effects of modifying the GMA boundary were below the sensitivity of the travel model.

Four socioeconomic datasets were tested on a 2025 roadway and transit network. The datasets tested were representative of an expanded GMA, a contracted GMA, the existing GMA, and the existing GMA with a focus on infill development. The roadway and transit networks used were similar those used for the Vision Scenario. All four socioeconomic datasets were input to the travel model and the results were compared to determine impacts of potential GMA boundary adjustments. As expected, there was very little difference in model results between the three scenarios. For the remaining TMP efforts, it was assumed that the GMA boundary will stay the same.

The levels of congestion seen in the Vision Scenario raise an interesting question. What would be required to significantly reduce congestion in Fort Collins by 2025? To help answer this question, the model was run with unconstrained capacity. This allows the model to predict where people would travel if there were unlimited capacity – with no congestion – on every road in the North Front Range region. The resulting volumes were compared to capacities used in the level of service analysis to determine the number of lanes that would be required to maintain LOS E or better throughout the city. As shown in Figure C.12, maintaining this LOS would require, in addition to the improvements included in the MSP, that Shields, Prospect, and Carpenter Road be widened to six lanes. Lemay near Prospect and College north of Mulberry would also require six lanes. Harmony Road would need eight-lanes as it nears the freeway, as would College South of Trilby. College between Trilby and Mulberry would need eight to ten lanes. The unconstrained scenario is represented by model scenario 24.

The existing MSP defines I-25 as a four-lane divided highway – as it is today. The Colorado Department of Transportation (CDOT) maintains this facility, so a recommendation for improvements is outside the scope of this plan. However, analysis of the effects of a six-lane I-25 are shown in Figure C.13 indicates that there would be very little impact on the transportation system within Fort Collins when compared with the Vision scenario shown in Figure C.4. Such an improvement would primarily benefit those traveling to or from Fort Collins, other cities in the region, and beyond. A widened I-25 is represented by model scenario 29.

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Figure C.12

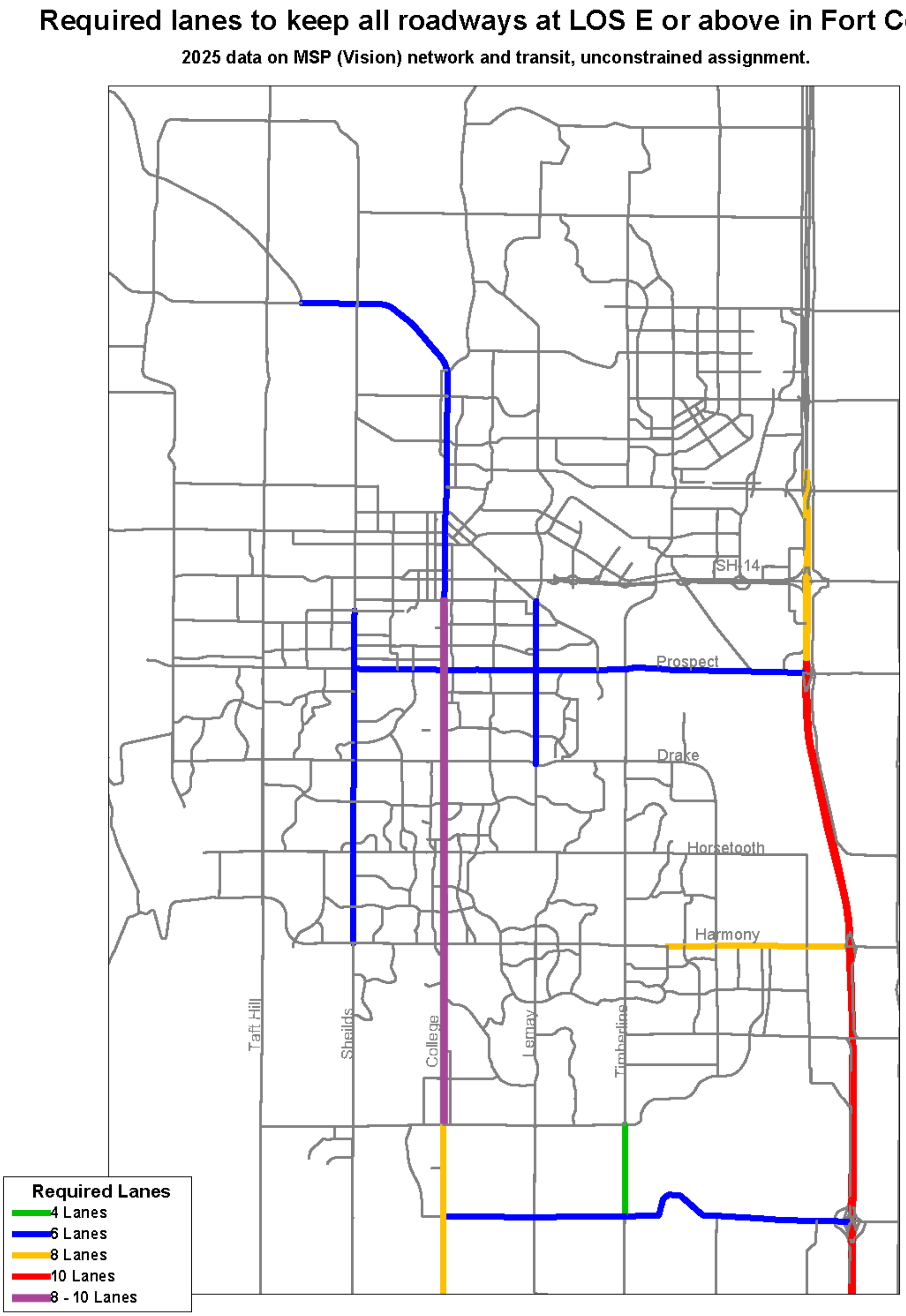
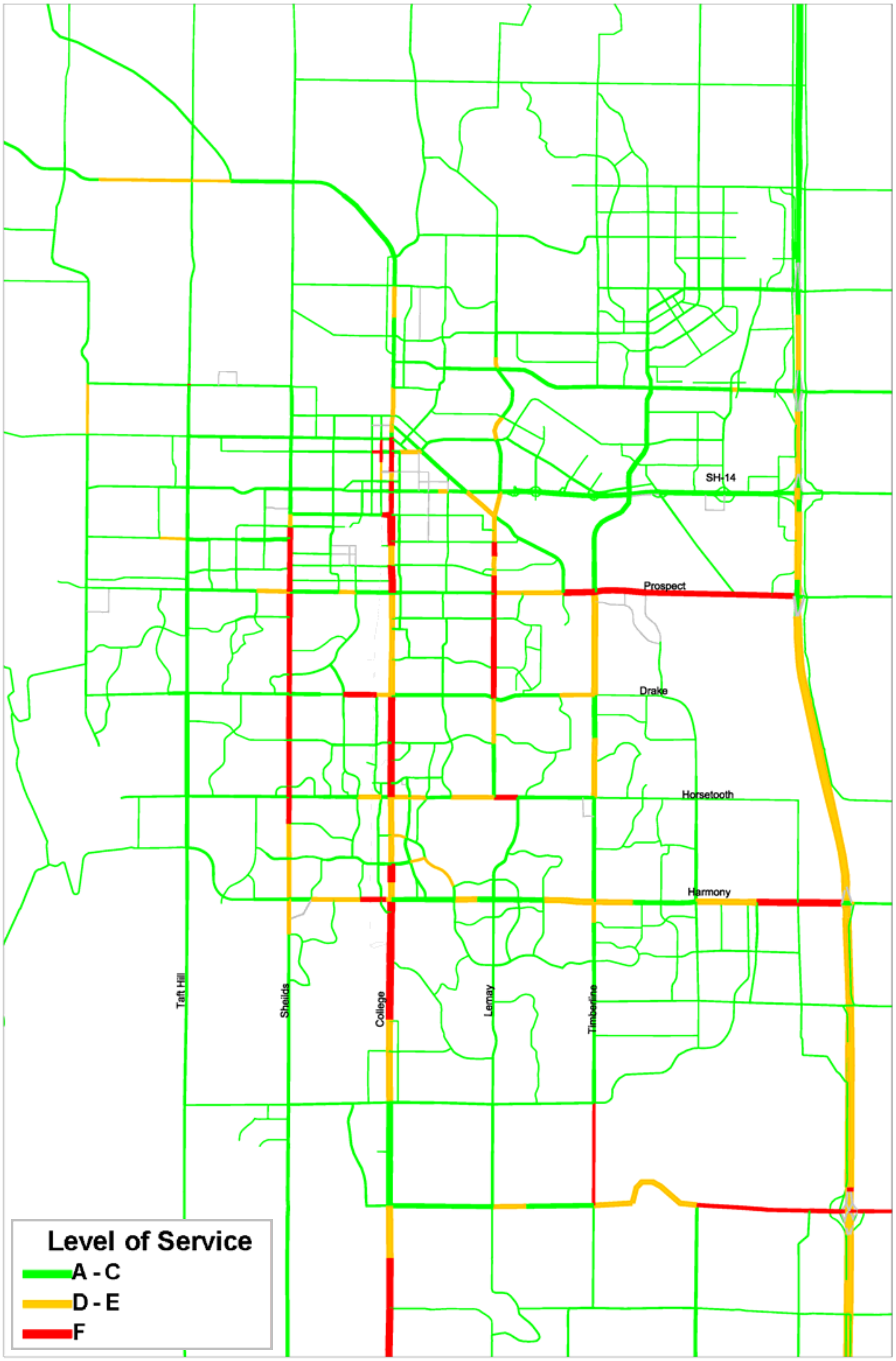

Required lanes to keep all roadways at LOS E or above in Fort Collins
2025 data on MSP (Vision) network and transit, unconstrained assignment.
SH 14
Prospect
Drake
Horsetooth
Harmony
Taft Hill
Sheilds
College
Lemay
Timberline
Required Lanes
4 Lanes
6 Lanes
8 Lanes
10 Lanes
8 - 10 Lanes

Figure C.13
Effects of a Six-Lane I-25



Potential modifications to the MSP were tested individually to evaluate their relative effectiveness in reducing congestion and improving level of service. Due to the localized nature of these improvements, level of service maps were used as a tool to evaluate the effectiveness for each option. In addition, the volumes on each roadway segment in the network were compared to the Vision Scenario to determine the diversion of traffic caused by the potential modifications. Regional summary data was not used in this analysis. The options tested are described in Table C.9.

Table C.9
Potential MSP Modifications

Alternative	Description	Figure No.
Timberline Road (36)*	Timberline Road is widened from 2 to 4 lanes between Trilby Road and Carpenter Road.	C.14
New Diagonal Facility (18)*	A new facility is built along the Union Pacific Railroad alignment to connect Timberline Road with Crossroads Blvd., with the through movement on Timberline south of Carpenter Rd. adjusted to direct traffic to the new facility. With this option in place, Boyd Lake Road is modeled as a 2-lane facility, as opposed to a 4-lane facility as defined in the Vision Plan.	C.15
New Diagonal Facility and Timberline Road (23)*	This option combines the Widening of Timberline Road between Trilby and Carpenter with the construction of the new facility connecting Timberline Road to Crossroads Blvd. Boyd Lake Road remains 2-lane.	C.16
Overland Trail (9)*	Overland Trail is extended of as a 4-lane facility connecting Drake Road and Horsetooth Road.	C.17
Centre Avenue (38)*	Centre Ave. is upgraded from a collector to an arterial, but remains a 2-lane facility.	C.18
Stuart Street (17)*	Stuart Street is extended as a collector to connect Lemay Ave. with Timberline Road.	C.19
I-25 Subarea (21)*	Improvements east of I-25 consistent with the I-25 subarea Plan.	C.20
Laurel Street (12)*	Reduce Laurel from its current status as a 4-lane major arterial to a 2-lane minor arterial.	C.21
LaPorte Avenue (33)*	LaPorte Avenue remains a 2-lane facility between Shields St. and Taft Hill Road. It is not widened to 4 lanes as defined in the Vision Plan.	C.22
Country Club Road (34)*	Country Club Road remains a 2-lane facility between Terry Lake Road and highway 11. It is not widened to 4 lanes as defined in the Vision Plan.	C.23
Vine Interchange (16)*	The interchange at Vine Drive and I-25, as defined in the Vision Plan, is not built.	C.24
McLelland Drive (35)*	McLelland Drive remains a collector street. It is not improved to a minor arterial as defined in the Vision Plan.	C.25
Mulberry Street (30)*	Mulberry Street is widened from 2 to 4 lanes between I-25 and County Road 5.	C.26
Prospect Road A (31)*	Prospect Road is widened from 2 to 4 lanes between I-25 and County Road 5.	C.27
County Road 5 (32)*	County Road 5 is widened from 2 to 4 lanes between Prospect road and Mulberry Street.	C.28
Carpenter Road A (37)*	Carpenter Road is extended from its current terminus at College Avenue to connect to Taft Hill Road as a 4-lane arterial.	C.29
Carpenter Road B (40)*	Carpenter Road is widened from 4 to 6 lanes between College Avenue and I-25.	C.30
Prospect Road B (39)*	Prospect Road is widened to 6 lanes between Lemay Ave. and I-25.	C.31

** Numbers indicate model scenario numbers used for each alternative.*

To illustrate the effects of each alternative described above, two sets of maps were created. The first set of maps shown in Figures C.14a through C.31a show, level of service and are similar to the maps shown earlier in Section C.4. The second set of maps shown in Figures 5.14b through 5.31b, demonstrate changes in predicted traffic patterns caused by changes to the roadway system. On these maps, green links indicate roadways where traffic volume decreases. A change in the network causes green facilities to become less desirable routes, either due to the lack of an improvement on the green route an improvement on a nearby red route. Conversely, segments colored with red indicate roadways where traffic volume increases. A change in the roadway network causes these links to become more desirable routes, either due to an improvement on the red route, or the lack of an improvement on a nearby green route. Roadways with little or no change are shown in gray, and roadway segments that differ from the Vision Scenario are shown with a light blue background.

Figure C.14a
Timberline Road LOS

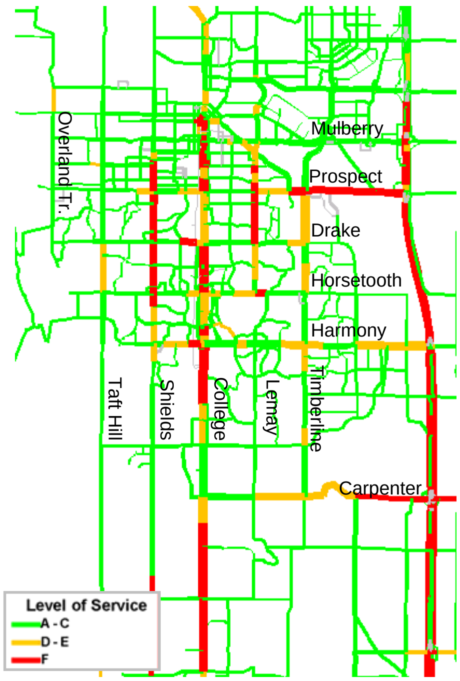


Figure C.14b
Timberline Road Traffic Diversion

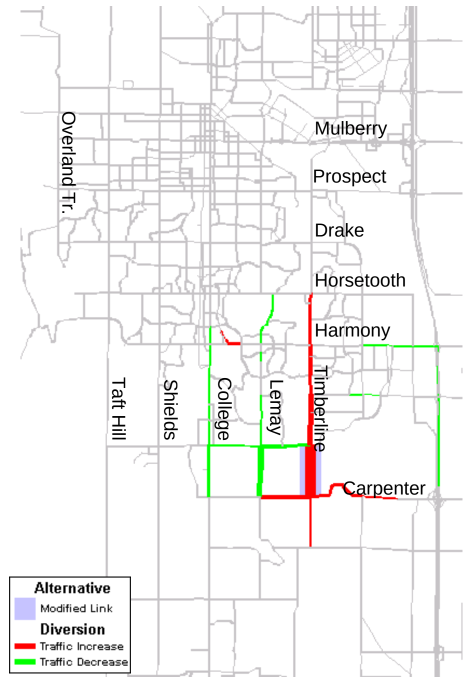


Figure C.15a
New Diagonal Facility LOS

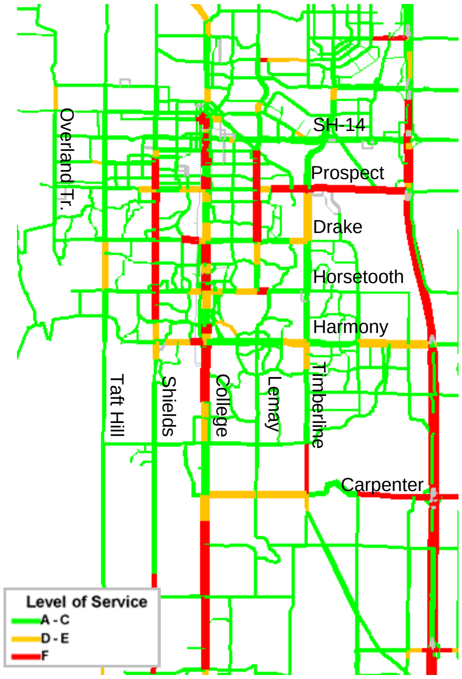


Figure C.15b
New Diagonal Facility Traffic Diversion

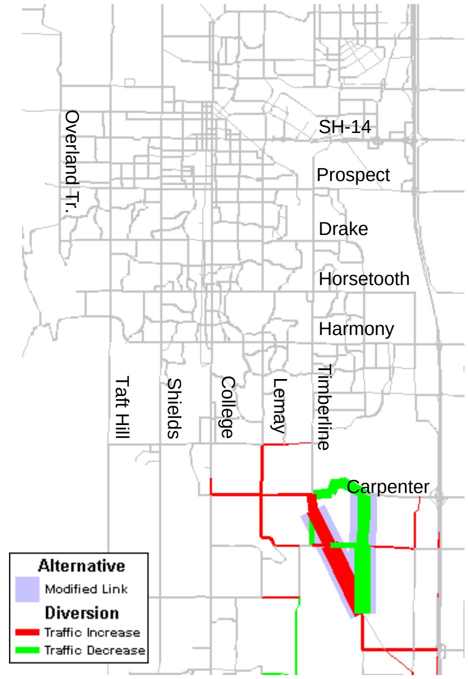


Figure C.16a
New Facility & Timberline LOS

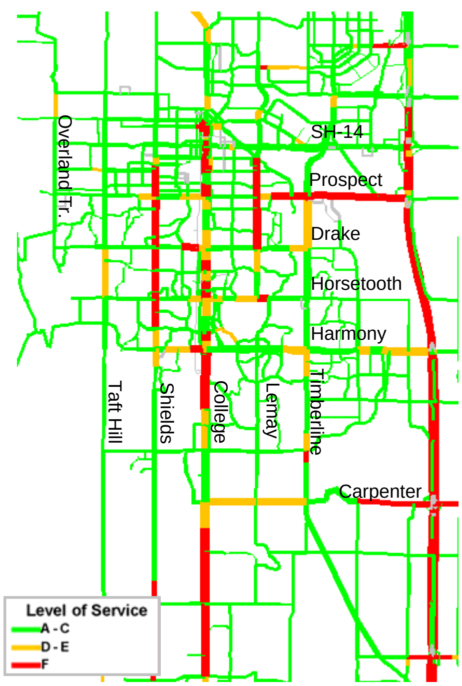


Figure C.16b
New Facility & Timberline Diversion

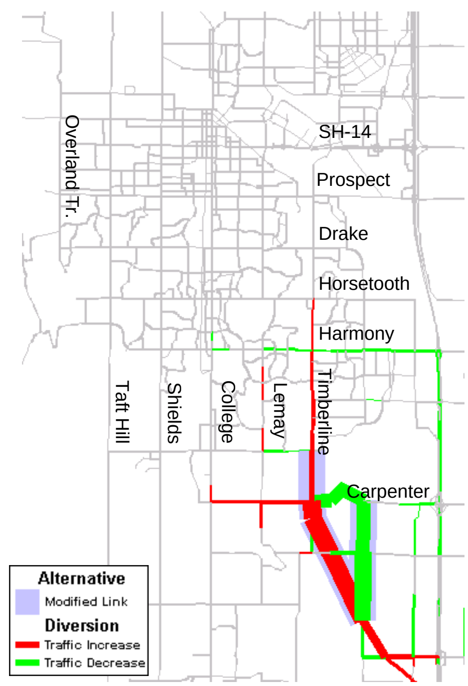


Figure C.17a
Overland Trail LOS

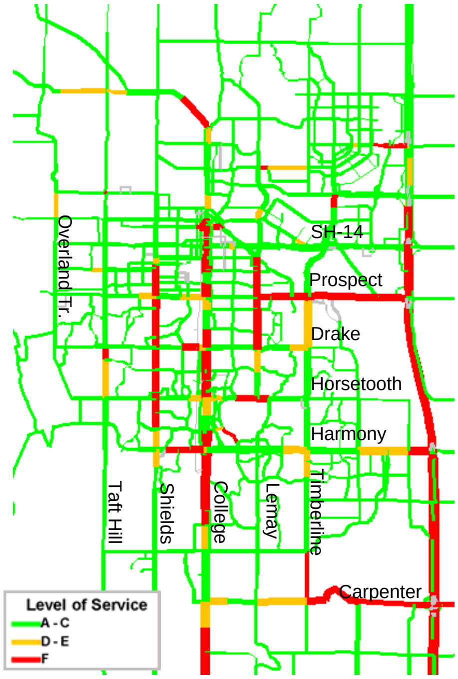


Figure C.17b
Overland Trail Traffic Diversion

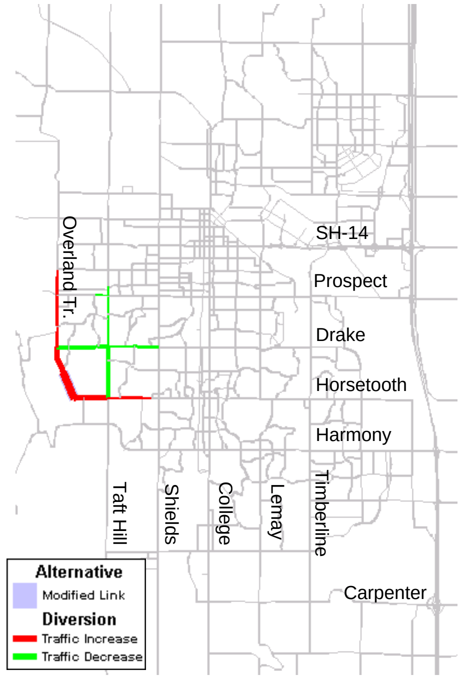


Figure C.18a
Centre Avenue LOS

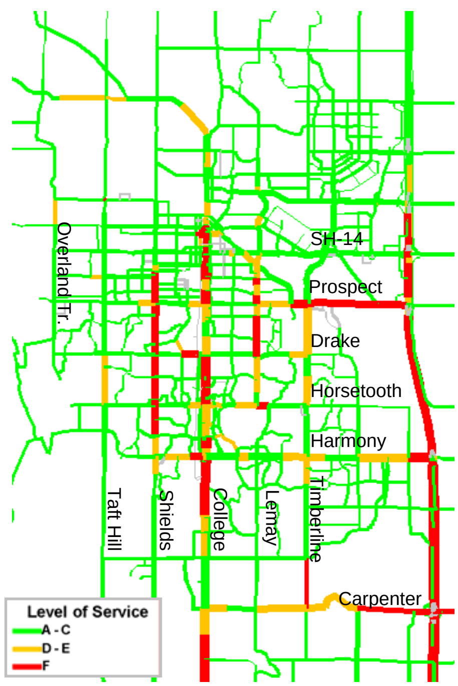


Figure C.18b
Centre Avenue Traffic Diversion

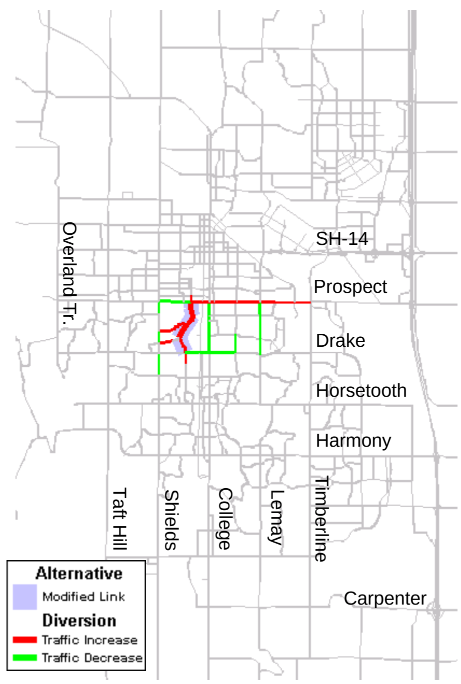


Figure C.19a
Stuart Street LOS

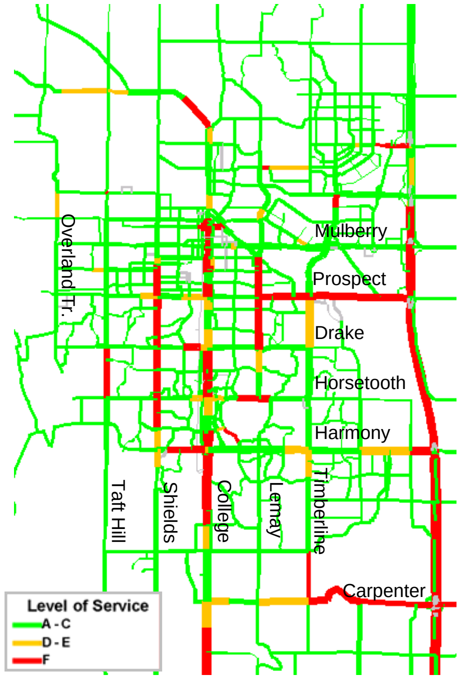


Figure C.19b
Stuart Street Traffic Diversion

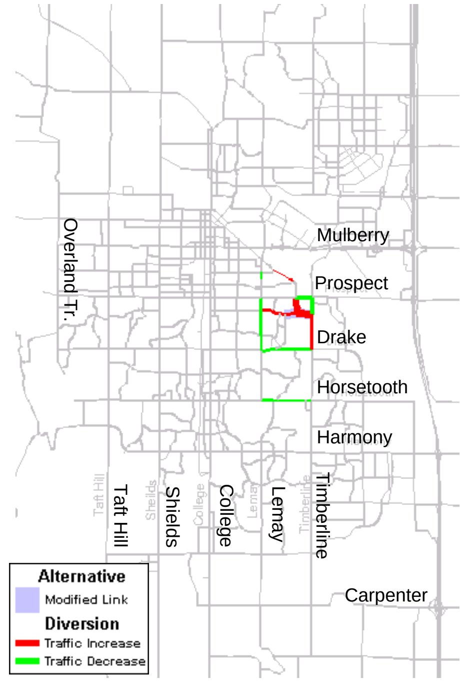


Figure C.20a
I-25 Subarea LOS

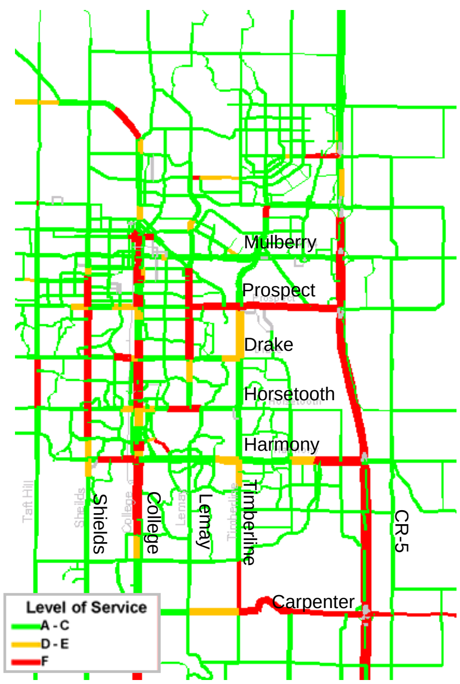


Figure C.20b
I-25 Subarea Traffic Diversion

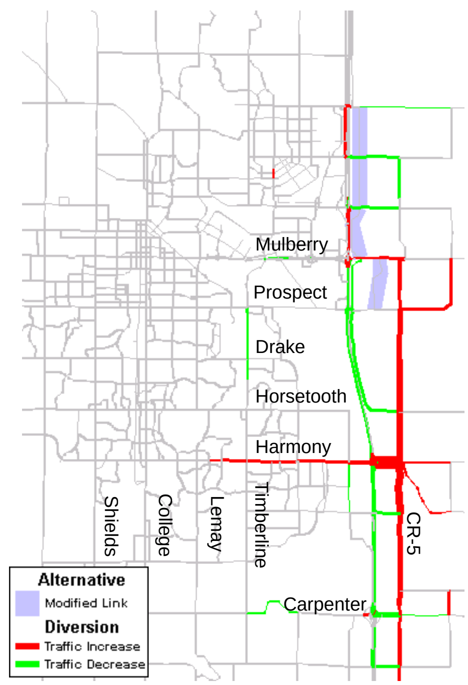


Figure C.21a
Laurel Street LOS

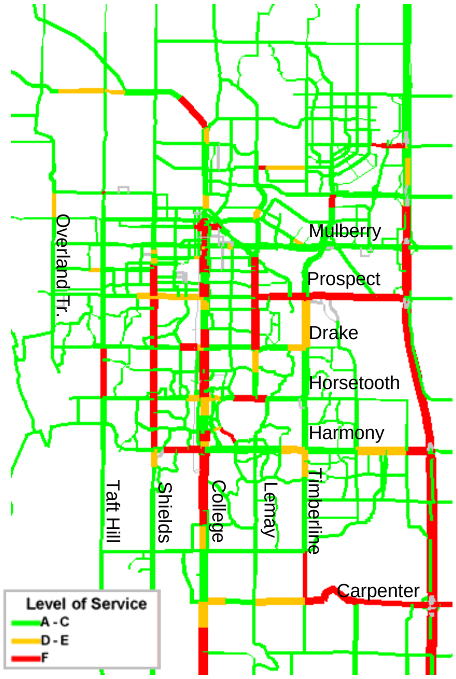


Figure C.21b
Laurel Street Traffic Diversion

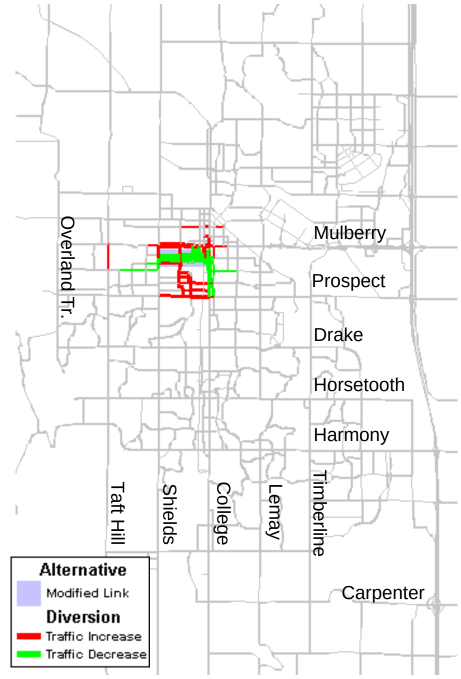


Figure C.22a
LaPorte Avenue LOS

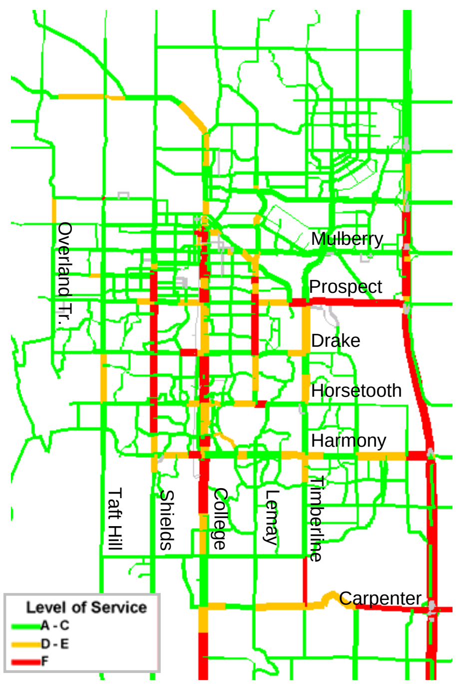


Figure C.22b
LaPorte Avenue Traffic Diversion

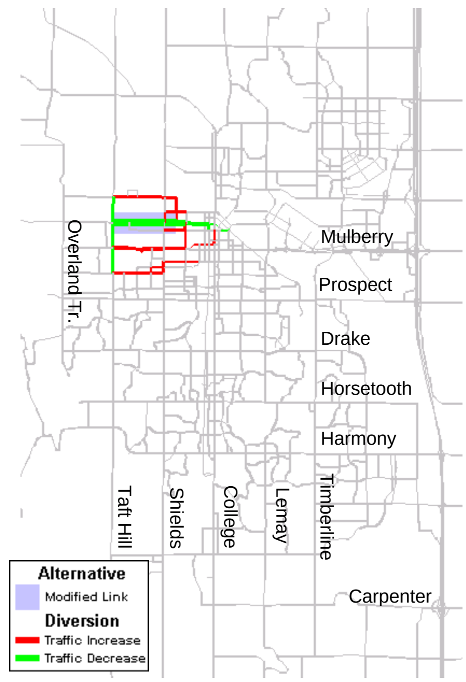


Figure C.23a
Country Club Road LOS

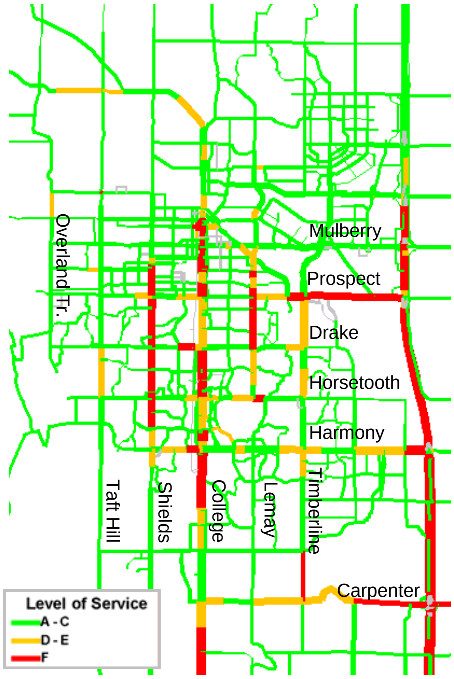


Figure C.23b
Country Club Road Traffic Diversion

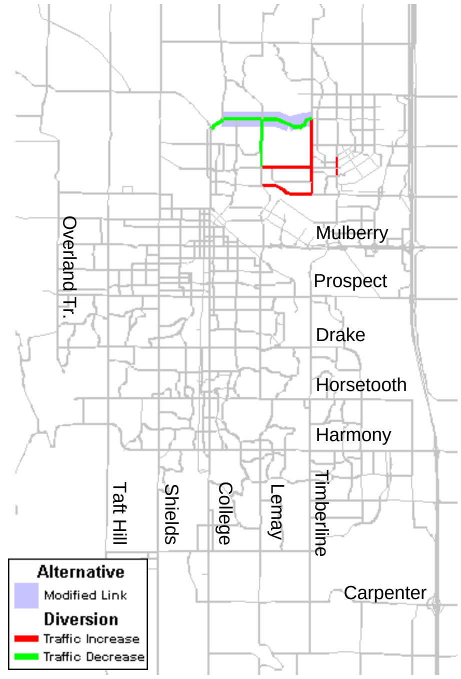


Figure C.24a
Vine Interchange LOS

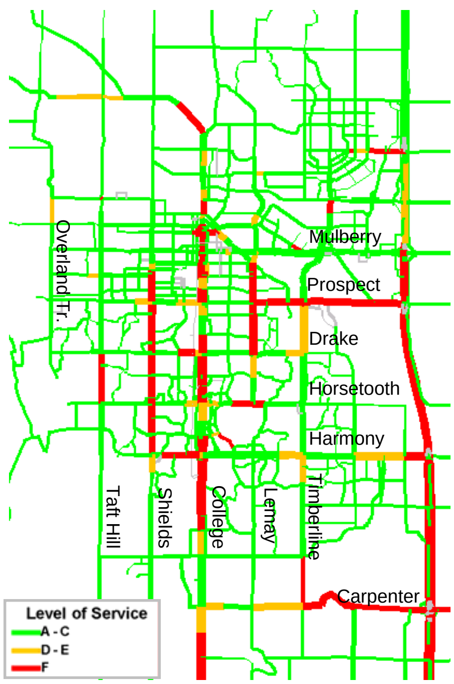


Figure C.24b
Vine Interchange Traffic Diversion

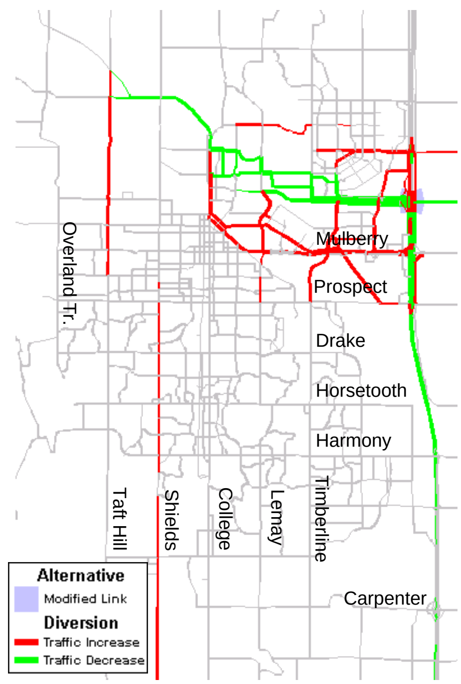


Figure C.25a
McLelland Drive LOS

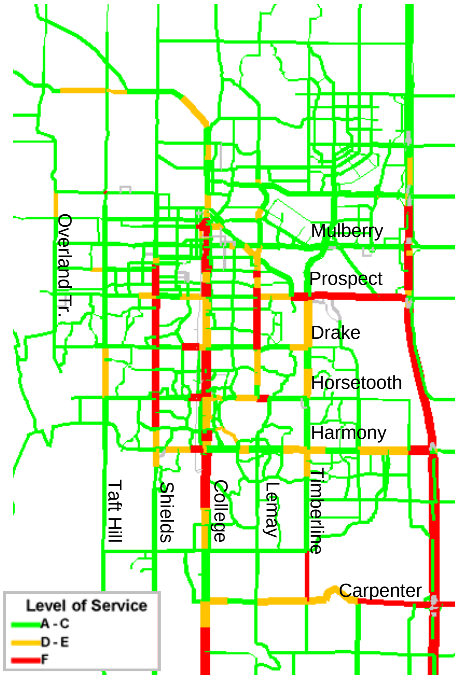


Figure C.25b
McLelland Drive Traffic Diversion

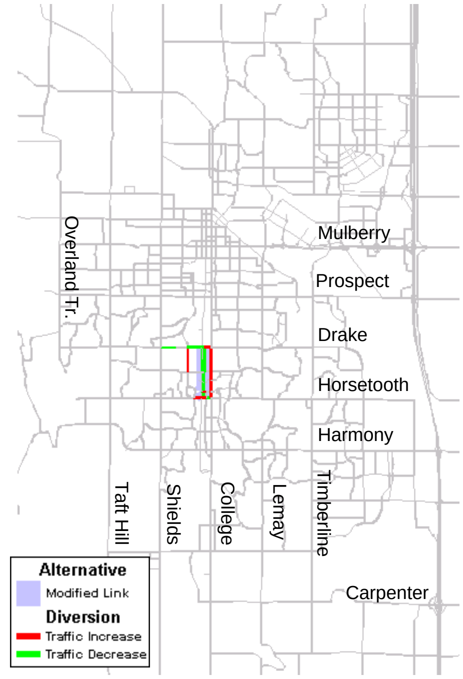


Figure C.26a
Mulberry Street LOS

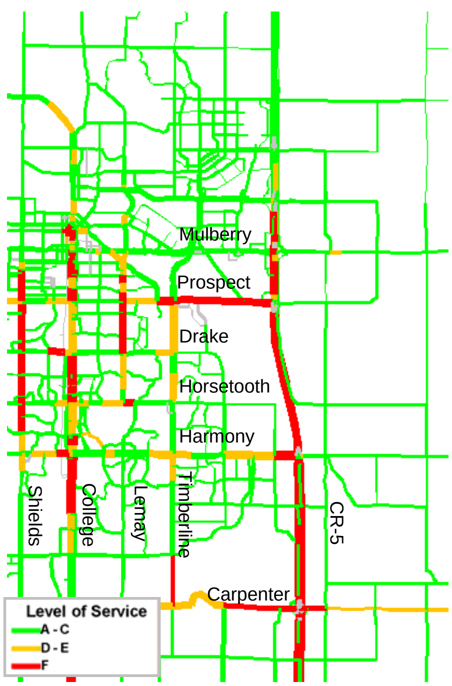


Figure C.26b
Mulberry Street Traffic Diversion

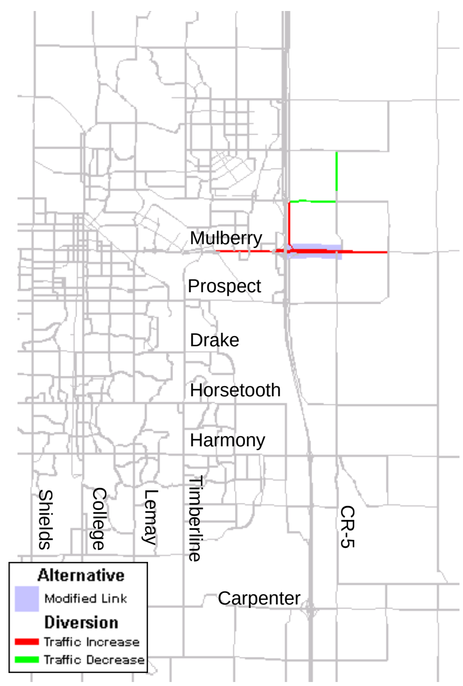


Figure C.27a
Prospect Road A LOS

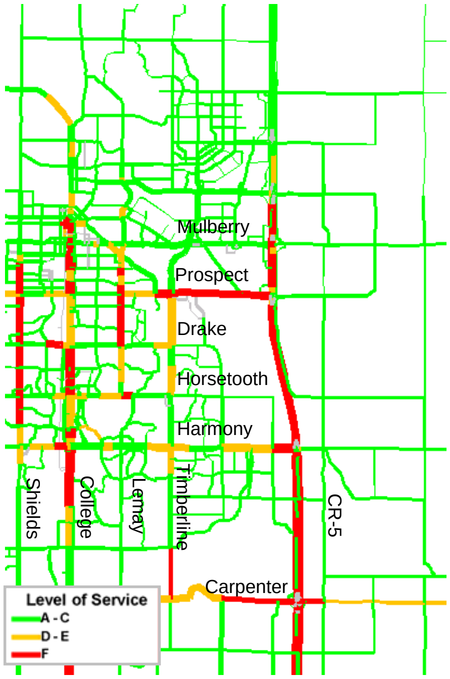


Figure C.27b
Prospect Road A Traffic Diversion

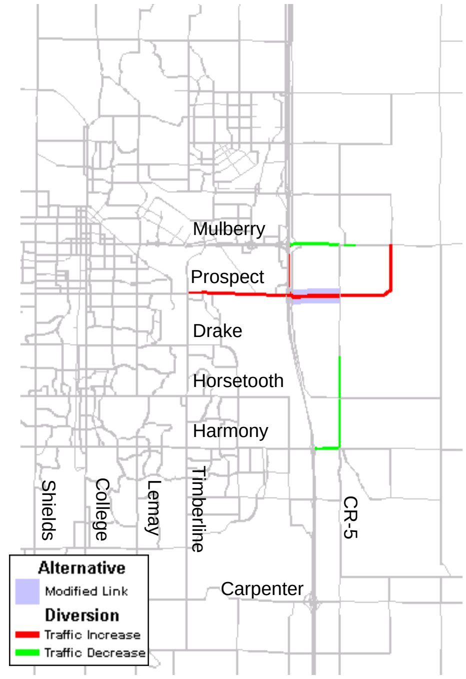


Figure C.28a
County Road 5 LOS

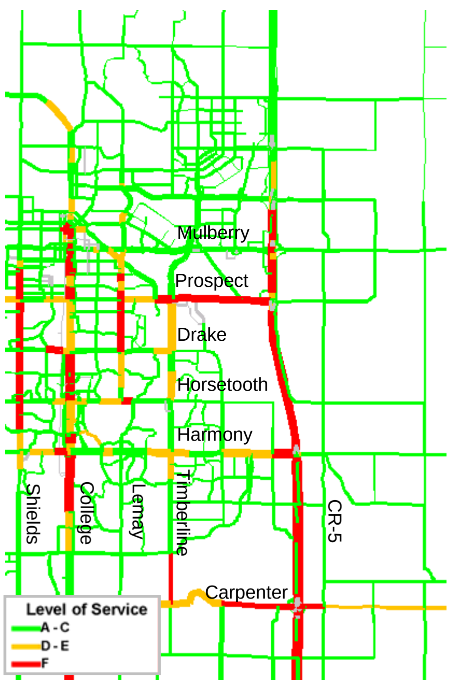


Figure C.28b
County Road 5 Traffic Diversion

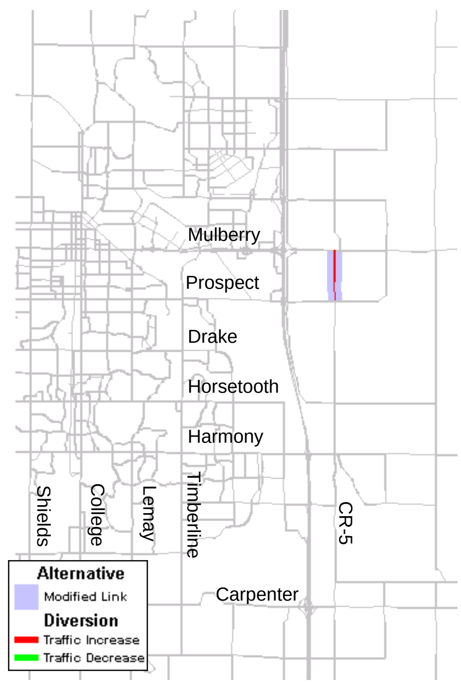


Figure C.29a
Carpenter Road A LOS

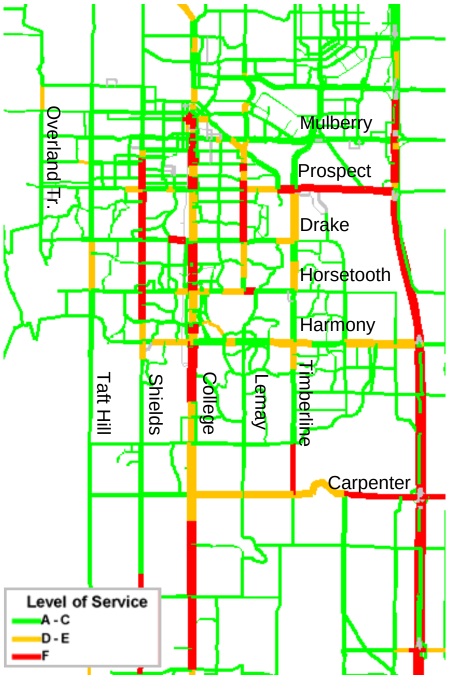


Figure C.29b
Carpenter Road A Traffic Diversion

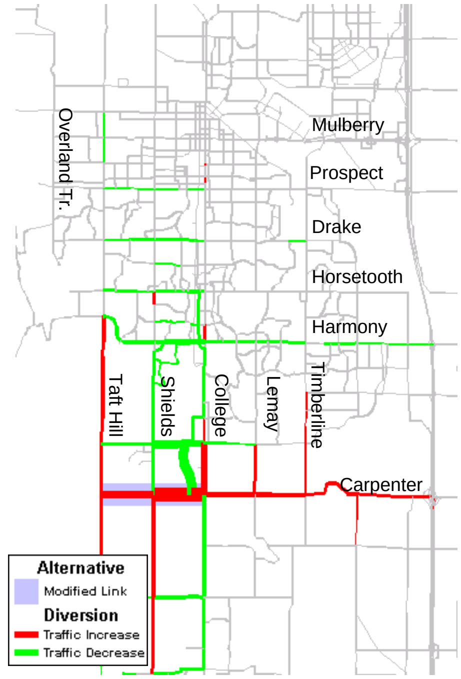


Figure C.30a
Carpenter Road B LOS

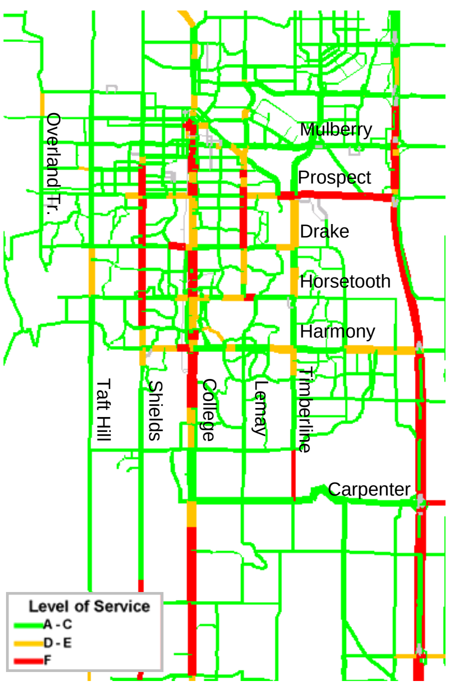


Figure C.30b
Carpenter Road B Traffic Diversion

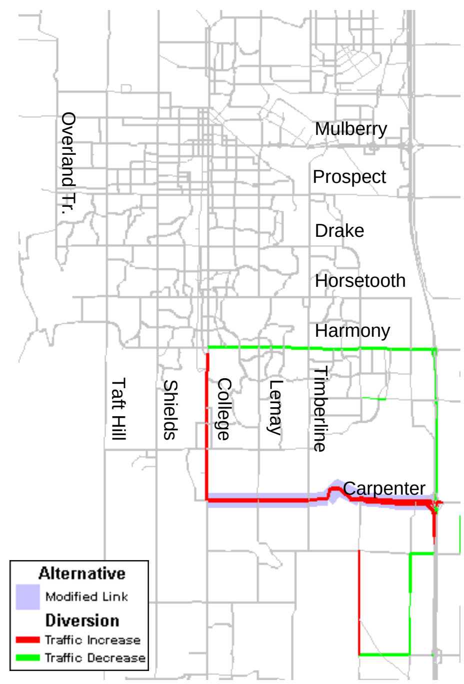


Figure C.31a
Prospect Road B LOS

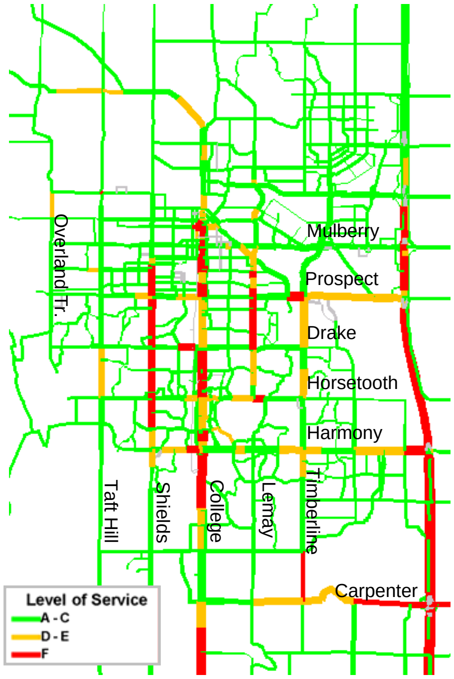


Figure C.31b
Prospect Road B Traffic Diversion