Appendix A4

AIR QUALITY TECHNICAL REPORT

FOR THE

I-25 (US 36 to 104th Avenue) Environmental Assessment

Prepared for:

Colorado Department of Transportation
Region 1
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List of Acronyms and Abbreviations

APCD	Air Pollution Control Division
CARB	California Air Resources Board
CEQ	Council on Environmental Quality
CH_4	methane
CO	carbon monoxide
CO_2	carbon dioxide
CDOT	Colorado Department of Transportation
DRCOG	Denver Regional Council of Governments
EA	environmental assessment
EPA	Environmental Protection Agency
FHU	Felsburg Holt and Ullevig
FHWA	Federal Highway Administration
GHG	greenhouse gas
I-25	Interstate 25
IRIS	Integrated Risk Information System
LOS	level of service
µm	micrometers
$\mu g/m^3$	micrograms per cubic meter
mph	miles per hour
MOVES	Motor Vehicle Emissions Simulator
MMT	million metric tons
MSAT	Mobile Source Air Toxics
N_2O	nitrous oxide
NAAQS	National Ambient Air Quality Standards
NEPA	National Environmental Policy Act
NO_x	nitrogen oxides
OTIS	Online Transportation Information System
PoAQC	project of air quality concern
$PM_{2.5}$	particulate matter smaller than 2.5 microns
PM_{10}	particulate matter smaller than 10 microns
ppb	parts per billion
ppm	parts per million
RTD	Regional Transportation District
RTP	Regional Transportation Plan
SIP	State Implementation Plan
TIP	Transportation Improvement Program
US 36	United States Highway 36
USDOT	United States Department of Transportation
VMT	vehicle miles traveled
VOC	volatile organic compound
vph	vehicles per hour
vpd	vehicles per day

1.0 Project Description

An air quality evaluation was completed for the Interstate 25 (I-25) North, United States Highway 36 (US36) to 104th Avenue project. Colorado Department of Transportation (CDOT), in cooperation with the Federal Highway Administration (FHWA), is preparing a template Environmental Assessment (EA) for the I-25 North, US 36 to 104th Avenue project. The Regional Transportation District (RTD) is a cooperating agency.

The I-25 North, US 36 to 104th Avenue project includes improvements to relieve congestion and improve safety on I-25 from US 36 to 104th Avenue in Adams County and the City of Thornton, Colorado (**Figure 1** and **Figure 2**). The project will provide improvements to an approximately 4-mile segment of I-25 between US 36 and 104th Avenue. The current cross section of I-25 between US 36 and 104th Avenue generally includes three general-purpose lanes and one Express Lane along the inside shoulder, with an auxiliary lane between 84th Avenue and Thornton Parkway. The inside shoulder varies in size between 2 and 12 feet, and the outside shoulder varies between 10 and 12 feet. There is a 2-foot inside shoulder and a 2-foot buffer between the Express Lane and the nearest general-purpose lane.

Proposed improvements associated with this project are as follows:

- Adding a fourth general-purpose lane in each direction from 84th Avenue to Thornton Parkway, with the northbound general-purpose lane extending to 104th Avenue,
- Constructing continuous acceleration and deceleration lanes between the I-25/84th Avenue interchange and the I-25/Thornton Parkway interchange,
- Widening the inside and outside shoulders to a consistent 12-foot width,
- Accommodating a proposed median transit station and pedestrian bridge for the Thornton Park-n-Ride just south of 88th Avenue, and
- Replacing the 88th Avenue bridge.

The proposed typical section on I-25 will consist of four 12-ft general-purpose lanes, a 12-ft Express Lane along the inside traveled way, and a 12-ft outside auxiliary lane between each interchange. Additionally, the inside and outside shoulders will be widened to 12 feet, and the Express Lane buffer will be widened to 4 feet, and a 2-foot barrier will separate the northbound and southbound lanes of I-25. Surrounding the median station will be a 2-foot concrete barrier separating the Express Lanes from the bus station and bus lanes.

2.0 Air Quality Assessment

2.1 Overview

This air quality technical report presents an overall analysis performed as part of the EA for assessing potential air quality impacts from the Proposed Action. The overall analysis evaluates the emission levels of both criteria air pollutants and mobile source air toxic pollutants (MSATs) in accordance with the Clean Air Act and its amendments for designated nonattainment and/or attainment/maintenance areas. Emissions of these pollutants are a concern because of the potential risk to public health (**Section 3.6**).

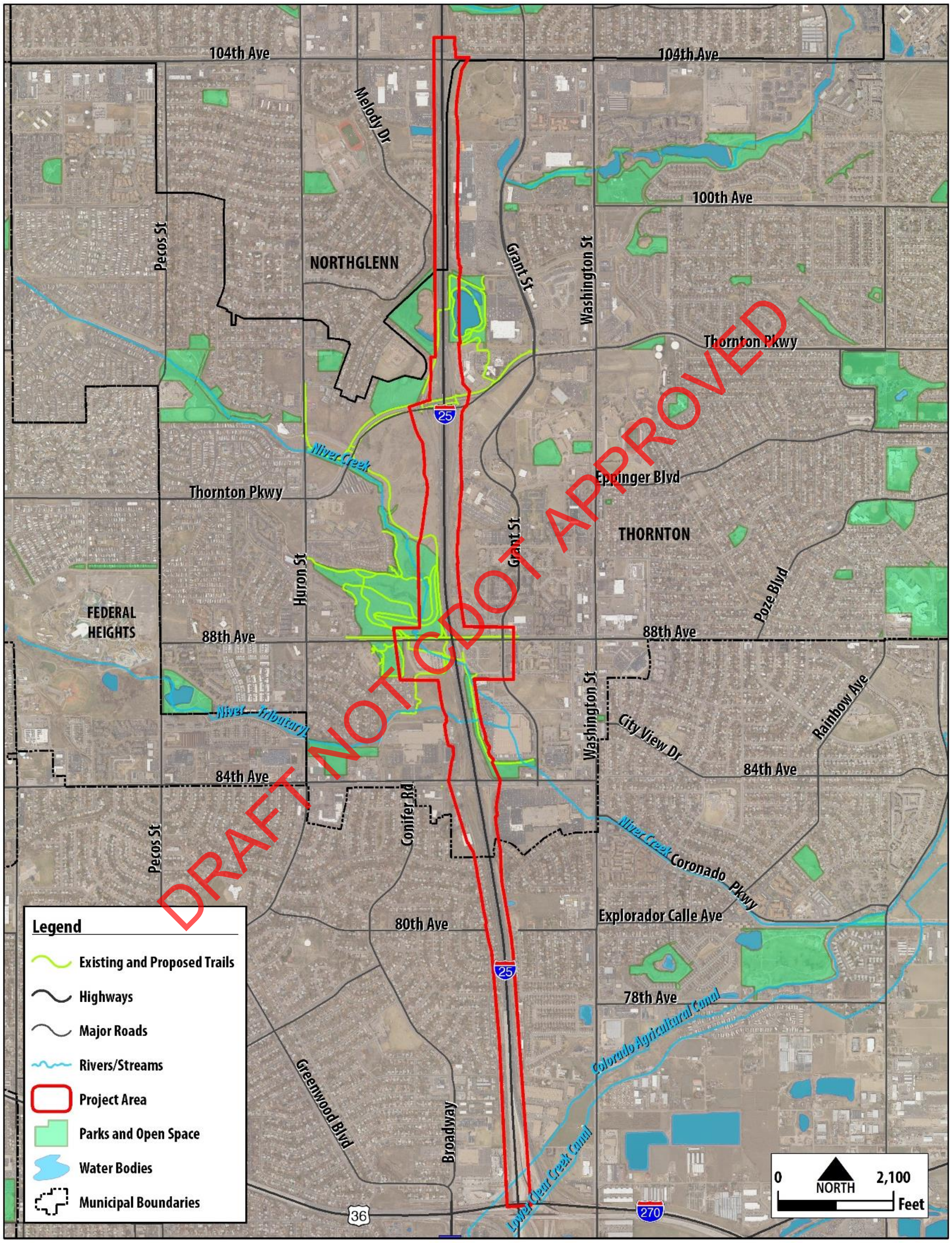
For overall perspective, there has been a trend of decreasing total pollutant emissions nationwide from MSATs for several decades, even when allowing for the growing number of vehicle miles traveled (VMT). These improving results derive from several successful emission control regulations. On-road sources account for varying amounts of the overall emissions but tend to be declining even though national VMT more than doubled over the past 30 years. Advances in vehicle technology and cleaner fuels have been major reasons for the improvements. Several recent federal regulations on vehicle emissions are expected to continue the trend of improvement and further lower vehicle emissions in the future.

Figure 1. Project Vicinity

Source: FHU, 2019

DRAFT NOT CDOT APPROVED

Figure 2. Project Area



Source: FHU, 2019

2.2 Background

2.2.1 Regional Conformity

In air quality non-attainment and maintenance areas, the Clean Air Act requires that regional transportation plans (RTP), transportation improvement programs (TIP), and individual projects cannot:

- cause new violations of a National Ambient Air Quality Standards (NAAQS)
- increase the frequency or severity of existing violations of the NAAQS
- delay attainment of the NAAQS

The transportation conformity process is the mechanism used by a responsible metropolitan planning organization, in this case the Denver Regional Council of Governments (DRCOG), to assure that Clean Air Act requirements are met for planned transportation improvements within the region. The fiscally-constrained RTP and TIP must identify all projects that are expected to receive federal funds or that will require FHWA or Federal Transit Administration approval. These projects and other regionally significant projects regardless of funding source must be included in a regional emissions analysis that demonstrates conformity to the State Implementation Plans (SIPs) to comply with the Clean Air Act.

Road improvement projects cannot be built unless the regional road system in aggregate conforms to the regional SIPs. Individual projects can demonstrate regional conformity by being part of a conforming fiscally-constrained RTP (which looks at longer-range transportation planning) and TIP. The current 2040 RTP and current 2018–2021 TIP are the adopted fiscally-constrained conforming plans for DRCOG.

For the I-25 North, US 36 to 104th Avenue Proposed Action, some of the improvements are included in the current fiscally-constrained 2040 RTP; for example, the RTP includes the addition of one new southbound lane on I-25 from US 36 to Thornton Parkway but does not include the new northbound lane from Thornton Parkway to 104th Avenue. However, the current TIP does not include construction funds for any of the associated project improvements. Therefore, multiple improvements related to the Proposed Action must be incorporated into the current fiscally-constrained 2040 RTP and the relevant conformity documents, as well as a meaningful phase included in the TIP, before a National Environmental Policy Act (NEPA) decision document can be signed. In addition, the improvements must be added to the TIP before construction can begin.

2.2.2 Local Conformity

Individual projects within air quality nonattainment or maintenance areas, such as the Denver metropolitan area, must demonstrate that they will not cause violations of the NAAQS in localized areas known as hot spots. Three NAAQS pollutants are primary concerns for the Denver region: carbon monoxide (CO), suspended particulate matter (PM_{10}), and ozone. However, only two of these (CO and PM_{10}) are potential hot spot pollutants.

CO hot spots are most likely to be a concern where traffic is congested and slow moving, such as congested, high-volume intersections. Because most PM_{10} emissions from vehicles in the Denver region are from road dust, a hot spot is most likely in an area with high traffic volumes traveling at relatively high speeds on unswept roads. In contrast, ozone is influenced by regional pollutant emissions and is not a hot spot concern. Hot spot modeling for CO was performed for the project (**Section 4.3**).

To address PM_{10}, an interagency consultation conference call for this project was held on November 1, 2018. Staff from FHWA, CDOT, Colorado Department of Public Health and Environment – Air Pollution Control Division (APCD), and DRCOG participated. It was concluded that the Proposed Action was not expected to be a project of air quality concern (PoAQC) in terms of federal conformity screening criteria for particulate matter.

Because the Proposed Action is a highway expansion project, consideration was given to whether a substantial increase in the number of diesel vehicles is expected. CDOT traffic data from the Online Transportation Information System (OTIS) for the study area segments of I-25 showed heavy trucks currently represent approximately 5.5 percent of total traffic. The largest predicted increase in 2040 traffic volumes between the No Action Alternative and Proposed Action among the I-25 segments was approximately 8 percent

(FHU, 2018), which correlates to fewer than 1,000 more trucks per day on I-25. The Proposed Action is not expected to draw heavy trucks disproportionately because I-25 is already a major trucking corridor.

The project does not include any new or expanded bus or rail terminals or transfer points. Some interchange intersections in the project area are signalized and have relatively poor levels of service, but heavy truck traffic is not substantial in this regard (**Section 4.1**). The Denver Metro SIP for PM_{10} does not identify any locations, areas, or categories as sites of actual or potential violation of the PM_{10} NAAQS. Therefore, quantitative PM_{10} analysis is not needed and a qualitative discussion is provided. **Section 4.1** describes the analysis methods, with findings discussed further in **Section 4.3.1**.

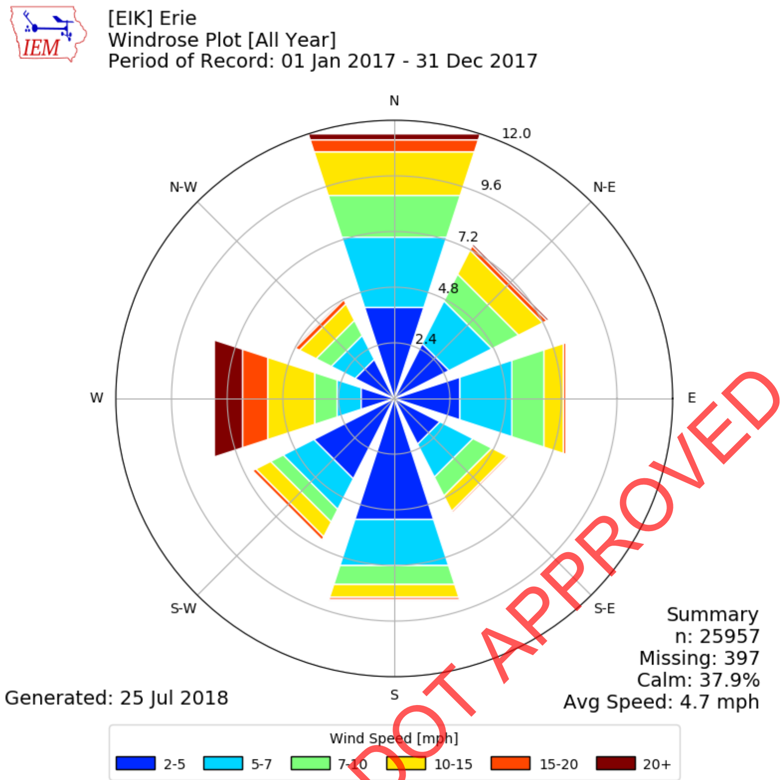
3.0 Affected Environment

The project is within the largest metropolitan area in Colorado. Based on the 2010 census, the seven-county Denver metropolitan area has approximately 2.8 million residents. The primary air quality issues of concern for this project are pollutants associated with the operation of vehicles on roadways. These issues include direct emissions of pollutants from vehicles, secondary pollutants formed from direct emissions, and road dust. Air quality issues related to road construction are also a potential short-term concern.

3.1 Local Setting

The study area lies in the northern Denver metropolitan area. The study area elevation is approximately 5,300 feet above sea level. The much higher Front Range of the Rocky Mountains is located westward, while the Great Plains are eastward and lower in elevation. The coldest month for the study area usually is January, with an average daily temperature range of 16 to 44 degrees Fahrenheit. The warmest month usually is July, with an average daily temperature range of 56 to 88 degrees Fahrenheit (Intellicast, 2018). Thermal inversions are known to occur in the study area during times of low winds. The study area generally receives about 14 inches of precipitation annually, with the wettest months generally being May and July (U.S. Climate Data, 2018). Prevailing winds in the study area can be somewhat variable due to local topography, but the prevailing winds from a monitoring location near ground surface tend to come in from all directions with predominance from the north (**Figure 3**).

Figure 3. Erie, CO Prevailing Winds in 2017



Source: Iowa Environmental Mesonet windrose data, accessed August 2018.

3.2 National Ambient Air Quality Standards Overview

The Clean Air Act of 1970 and its amendments led to the United States Environmental Protection Agency (EPA) establishing NAAQS for criteria air pollutants: CO, lead, nitrogen dioxide, ozone, particulate matter, and sulfur dioxide (**Table 1**). In 1997, EPA changed the ozone standard (which was revised in 2008 and again in 2015) and added a new standard for $PM_{2.5}$, though implementation of these two NAAQSs was delayed until 2004. Because motor vehicles are important contributors of CO, nitrogen dioxide, ozone precursors, and particulate matter, only these criteria pollutants will be discussed in detail in subsequent sections.

Under the Clean Air Act, cities and regions are required to determine their compliance with the NAAQS. Areas that do not meet a NAAQS are classified as nonattainment for that NAAQS. These classifications are long term and do not change often. The Denver metropolitan area has been in attainment of the sulfur dioxide, nitrogen dioxide, and lead NAAQSs for more than 30 years. The Denver metropolitan area was a nonattainment area for CO, ozone (1-hour), and PM_{10} beginning in the early 1970s; therefore, those three pollutants have historically been concerns in the Denver region. The region included in the nonattainment areas at the time was all or part of the following current counties: Denver, Jefferson, Boulder, Adams, Arapahoe, Douglas, and Broomfield.

Successful air quality improvement actions over many years have resulted in cleaner air and the Denver region meeting all of the NAAQS that were in force in 2001. EPA reclassified the Denver region as an attainment/maintenance area in 2001 and 2002 for CO, ozone (1-hour), and PM_{10}; regional maintenance plans were developed for all three pollutants. The study area is within all three of these maintenance areas.

Subsequently, EPA designated nonattainment areas around the United States for the new $PM_{2.5}$

and 8-hour ozone NAAQS in 2004. Because no areas in Colorado have been designated as nonattainment for $PM_{2.5}$, it is not a major issue in the state. However, ozone is again a concern in the Denver region. The Denver region officially became a nonattainment area for the 8-hour ozone NAAQS on November 20, 2007. The 8-hour ozone nonattainment area includes the seven-county metropolitan area, plus parts of Larimer and Weld counties.

Table 1. National Ambient Air Quality Standards

Pollutant	Averaging Time	Primary Standard
Carbon Monoxide	8 hours	9 ppm
	1 hour	35 ppm
Lead	Rolling 3 month average	0.15 µg/m^3
Nitrogen Dioxide	1 hour	100 ppb
	1 year	53 ppb
Ozone*	8 hours	0.070 ppm
	1 year	12 µg/m^3
Particulate Matter <2.5 µm ($PM_{2.5}$)	24 hours	35 µg/m^3
Particulate Matter <10 µm (PM_{10})	24 hours	150 µg/m^3
Sulfur Dioxide	1 hour	75 ppb

Source: *EPA, 2016*

Notes: ppb = parts per billion
ppm = parts per million
µg/m3 = micrograms per cubic meter
µm micrometers

**For ozone, a final rule was signed October 1, 2015, and became effective December 28, 2015, to update the 2008 ozone standards. These 2008 ozone standards remain in effect in some areas, including in Colorado. Revocation of the 2008 ozone standards and transitioning to the current (2015) standards will be addressed in the implementation rule for the current standards.*

3.2.1 Carbon Monoxide

CO is an odorless, colorless gas that is most commonly formed by incomplete combustion of fuel. CO is dangerous because it interferes with the body's ability to absorb oxygen. High concentrations of CO can cause dizziness, headaches, loss of vision, impaired dexterity, and even death, if the concentration is high enough. Major sources of CO include vehicle exhaust, coal burning, and forest fires. CO is most commonly a concern in localized areas around the CO sources, such as near congested road intersections. CO can be a regional concern if concentrations are high enough and disperse into the surrounding area.

3.2.2 Nitrogen Dioxide

The atmosphere is approximately 80 percent nitrogen gas. When fuel is burned at high temperature in air, this nitrogen can react with oxygen that is also present in air to form gases such as nitrogen dioxide and other oxides of nitrogen (NO_x) compounds. NO_x can contribute to ozone formation, particulate matter formation, and acid deposition. Common sources of NO_x are vehicles and coal-fired electrical power plants. Nitrogen dioxide can damage cells in lungs and plants and damage water quality. Nitrogen dioxide can be transported over great distances and is a regional concern.

3.2.3 Ground Level Ozone

Ground-level ozone is a gas that is formed by chemical reactions between other pollutants in the atmosphere. NO_x and hydrocarbons in the presence of sunlight and certain weather conditions can form ozone, which is a strong oxidizing agent that can damage cells in lungs and plants. ozone can cause eye irritation, coughing, and lung damage.

There are no specific sources of ozone because it is not emitted directly. However, ozone concentrations are affected through concentrations of the precursor pollutants NO_x and hydrocarbons. Automotive sources of NO_x include vehicle exhaust. Automotive sources of hydrocarbons include fuel evaporation and vehicle exhaust. Ozone is a regional concern because it takes time for ozone to form and the pollutants can drift a considerable distance in that time (California Air Resources Board [CARB], 2002). Rural/undeveloped areas can have ozone problems because of transported pollutants, even if there are no major local emissions of the precursors (CARB, 2002).

3.2.4 Particulate Matter

Particulate matter (both PM_{10} and $PM_{2.5}$) is a complex mix of very small solid particles and liquid droplets. Particulate matter is a concern because it can be inhaled deeply into the lungs and can interfere with lung function or lead to other health effects. Particulate matter can aggravate asthma, diminish lung capacity, and cause lung or heart problems. Particulate matter can also cause haze. Sources of particulate matter include road dust, smoke, and diesel engine exhaust. Particulate matter can be a concern around the sources, but winds can disperse particulate matter over a larger area and cause regional concerns.

3.3 NAAQS Monitoring Data Overview

Several air quality monitoring stations in the Denver region measure the criteria air pollutants; however, none are in the study area. The closest active monitoring station for the NAAQS of interest is the Welby station in Adams County, located at 3174 East 78th Avenue. Monitoring stations at other locations in the region have been active in the past. Though the Welby station is outside the study area, it provides the monitoring data nearest the study area.

The most recent complete data set available from the EPA[1] is from 2017. The following subsections summarize monitoring data for the three pollutants subject to maintenance plans in the Denver region (CO, PM_{10} and ozone).

3.3.1 Carbon Monoxide

Since 1996, no state-operated monitors have recorded a violation of the 8-hour CO standard (APCD, 2017). The 2017 measured values for NAAQS comparison at the Welby station for 1 hour and 8 hours are 2.0 ppm and 1.5 ppm, respectively. These values are below their respective NAAQS (**Table 1**).

3.3.2 Nitrogen Dioxide and Ozone

Nitrogen dioxide is a criteria pollutant and an ozone precursor. The 2017 measured values for NAAQS comparison at the Welby station for 1-hour and annually are 58.5 and 14.4 ppb, respectively. The measured values are below their respective NAAQS (**Table 1**). The other major ozone precursor pollutant (hydrocarbons) is not a NAAQS pollutant.

For the Welby ozone monitoring station, the 2017 measured value for NAAQS comparison for 8 hours is 0.068 ppm. The measured ozone concentration was below the ozone NAAQS. The highest ozone concentrations tend to occur in the western metropolitan area, not near the study area.

3.3.3 Particulate Matter

Measured concentrations of PM_{10} in the Denver region generally have not violated the NAAQS since the early 1990s (CAQCC, 2005). For the Welby station, the 2017 measured value for NAAQS comparison for 24 hours is 55 $\mu g/m^3$. This value is below the NAAQS (**Table 1**).

3.4 Transportation and Circulation System

The transportation and circulation system evaluated for this report includes I-25 and streets and highways within the study area (**Figure 4**) that are likely to be affected by changes in traffic patterns resulting from the Proposed Action. The study area includes interchanges to the north (104th Avenue) and south (US 36/I-25 and I-76 and ramps to/from the north and south). The study area extends east/west along 104th Avenue, Thornton Parkway, and 84th Avenue to the nearest major arterials.

Data pertaining to traffic volumes and level of service (LOS) in this report are drawn from the project's traffic study (FHU, 2018). LOS at various intersections of interest were assessed for morning and afternoon peak traffic hours (**Table 2**). LOS indicates intersection congestion and potential hot spots for air pollutants from vehicles. LOS A describes the best traffic operation of free-flowing, light volume traffic, and LOS F represents the worst condition of heavy traffic congestion.

[1] https://www.epa.gov/outdoor-air-quality-data/interactive-map-air-quality-monitors

Figure 4. Traffic Study Area

Table 2. 2040 Proposed Action Levels of Service

Intersection	2040 Proposed Action Alternative LOS (AM/PM)
104th Avenue & I-25 SB Ramps	B/B
104th Avenue & I-25 NB Ramps	B/B
Thornton Parkway & I-25 SB Ramps	B/B
Thornton Parkway & I-25 NB Ramps	D/B
84th Avenue & I-25 SB Ramps	C/C
84th Avenue & I-25 NB Ramps	B/C

Source: FHU, 2018

3.5 Sensitive Receptors

Locations where people spend extended periods of time are likely to be the most sensitive receptors. Those receptors closest to roads are the most likely to be directly affected by roadway pollutants. These types of locations in the study area include homes, businesses, churches, schools, and recreation areas.

3.6 Other Air Quality Considerations

Toxic air pollutants and general construction activities were two other air quality topics that were considered.

3.6.1 Toxic Air Pollutants

The qualitative assessment that follows is derived from FHWA's Updated Interim Guidance on Mobile Source Air Toxic Analysis in NEPA Documents Memorandum, dated October 2016.

Background

In addition to the criteria air pollutants for which there are NAAQS, EPA also regulates air toxics. Most air toxics originate from human-made sources, including on-road mobile sources, non-road mobile sources (e.g., airplanes), area sources (e.g., dry cleaners), and stationary sources (e.g., factories or refineries). Other toxics are emitted from the incomplete combustion of fuels or as secondary combustion products. Metal air toxics also result from engine wear or from impurities in oil or gasoline.

EPA identified nine compounds with substantial contributions from mobile sources that are among the national and regional-scale cancer risk drivers or contributors and non-cancer hazard contributors from the 2011 National Air Toxics Assessment (FHWA, 2016):

- 1,3-butadiene
- Acetaldehyde
- Acrolein
- Benzene
- Diesel particulate matter (diesel PM)
- Ethylbenzene
- Formaldehyde
- Naphthalene
- Polycyclic organic matter

While FHWA considers these the priority MSATs, the list is subject to change and may be adjusted in consideration of future EPA rules.

According to EPA's latest rule on the Control of Hazardous Air Pollutants from Mobile Sources (Federal Register, Vol. 72, No. 37, page 8430, February 26, 2007), controls are required to dramatically decrease MSAT emissions through cleaner fuels and cleaner engines. Based on an FHWA analysis using EPA's Motor Vehicle Emissions Simulator (MOVES) 2014a model, as shown on **Figure 5**, even if VMT increases by 45 percent from 2010 to 2050 as forecast, a combined reduction of 91 percent in the total annual emissions for the priority MSAT is projected for the same time period.

Summary of Existing Credible Scientific Evidence Relevant to Evaluating the Impacts of MSATS

Research into the health impacts of MSATs is ongoing. For different emission types, various studies show that some emissions are statistically associated with adverse health outcomes through epidemiological studies (frequently based on emissions levels found in occupational settings) or that animals demonstrate adverse health outcomes when exposed to large doses.

EPA is in the process of assessing the risks of various kinds of exposures to these pollutants. The EPA Integrated Risk Information System (IRIS) is a database[2] of human health effects that may result from exposure to various substances found in the environment.

The following toxicity information for the nine priority compounds was taken from the IRIS database in August 2018. This information is taken verbatim from EPA's IRIS database and represents the Agency's most current evaluations of the potential hazards and toxicology of these chemicals or mixtures.

- **1,3-butadiene:** Carcinogenic to humans
- **Acetaldehyde:** Probable human carcinogen based on sufficient evidence of carcinogenicity in animals
- **Acrolein:** Data are inadequate for an assessment of human carcinogenic potential
- **Benzene:** Human carcinogen and known/likely human carcinogen
- **Diesel engine exhaust:** Likely to be carcinogenic to humans
- **Ethylbenzene:** Not classifiable as to human carcinogenicity
- **Formaldehyde:** Probable human carcinogen based on limited evidence of carcinogenicity in humans
- **Naphthalene:** Possible human carcinogen but carcinogenic potential cannot be determined
- **Polycyclic organic matter**: Not identified in IRIS

FHWA, EPA, Health Effects Institute, and others have funded and conducted research studies to more clearly define potential risks from MSAT emissions associated with highway projects. FHWA will continue to monitor the developing research in this field.

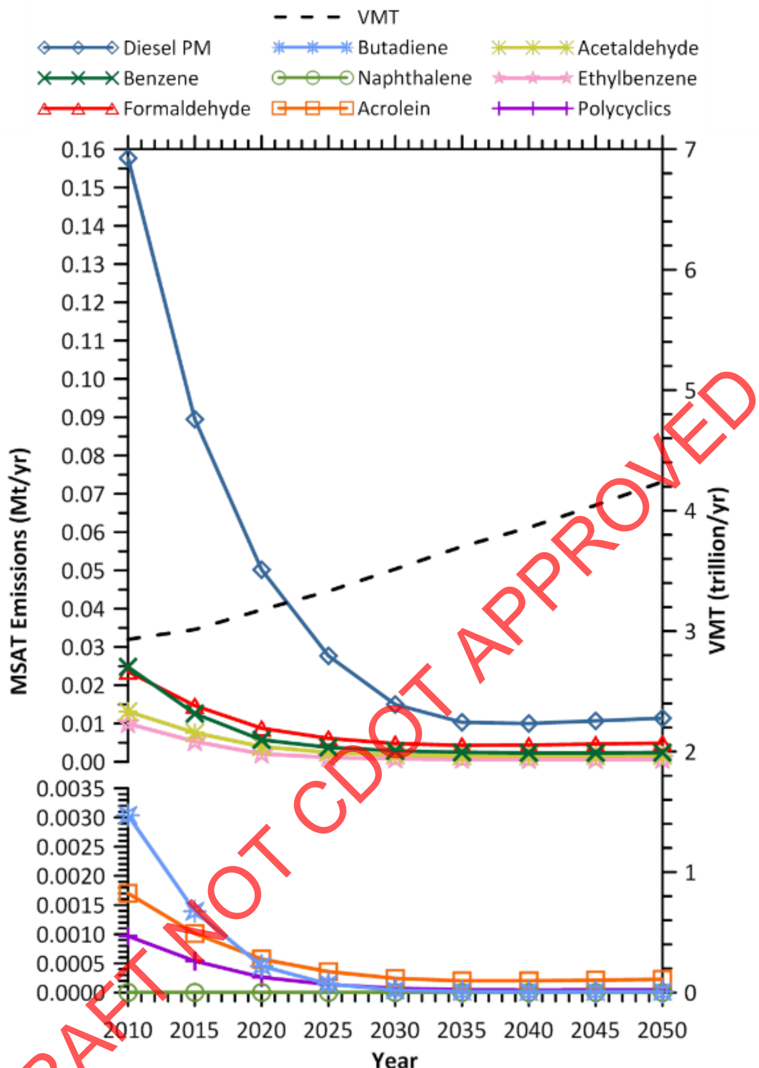
Additional studies have reported that proximity to roadways is related to adverse health outcomes, particularly respiratory problems (South Coast Air Quality Management District, 2000; Sierra Club, 2004; and Environmental Law Institute, 2005). Much of this research is not specific to MSATs but instead surveys the full spectrum of both NAAQS and other pollutants. FHWA cannot evaluate the validity of these studies, but more importantly, the studies do not provide information that would be useful to alleviate the uncertainties listed previously and enable a more comprehensive evaluation of the health impacts specific to this project.

3.6.2 Construction

Finally, air quality impacts from construction can be a concern. Long-term construction projects near sensitive receptors can represent health concerns. As with MSATs, there are no ambient air standards, specifically for construction, or direct mechanisms for assessing such impacts.

[2] http://www.epa.gov/iris

Figure 5. FHWA Projected National MSAT Emission Trends



Source: FHWA, 2016

4.0 Impact Evaluation

Because of the past and present regional air quality challenges in the Denver metropolitan area (including the study area), infrastructure projects that might exacerbate the air quality problems must meet certain requirements before they can proceed. In general, projects of the type considered in the EA must be analyzed with respect to the potential impact on air quality at both the regional and local levels. The region of influence examined for air quality in this project is around the highways and streets described in **Section 3.4**.

4.1 Methodology for Impact Evaluation

In August 2018, CDOT developed a proposed analytical method for review by APCD. On September 20, 2018, CDOT provided email communication of the project-level approach for the I-25 North, US 36 to 104th Avenue project. APCD was provided 11 business days for review and comment. In response, an interagency consultation conference call for this project was held on November 1, 2018, including staff from FHWA, CDOT, APCD, and DRCOG. This call addressed:

- APCD questions regarding the DRCOG RTP and land use plan
- the request for quantitative NOx and VOC analysis
- the conclusion the project is not expected to be a PoAQC for PM10.

CDOT will request APCD concurrence on this air quality assessment and technical report as the EA progresses.

This analytical method documented that the project's air quality analysis should consist of the following components:

- **Carbon Monoxide Microscale Analysis**: **Section 4.3** addresses CO at the most congested intersection to show that the Proposed Action would not cause local violations of the NAAQS. For this project, the intersection at Thornton Parkway and the I-25 northbound ramp is forecasted to have a 2040 LOS of D or worse and, therefore, is considered in this analysis (**Figure 6**).

  Areas likely to become CO hot spots are identified primarily on traffic volumes and congestion. A determination is then made whether a detailed analysis is needed. Generally, the need for CO hot spot analysis is assessed with respect to three criteria, as provided by the EPA:

  - The LOS of a project intersection is or will be D, E, or F.
  - The project affects locations identified in the SIP as sites of actual or potential violations of the CO NAAQS.
  - A project intersection is one of the top three in the SIP with respect to highest traffic volume or worst LOS.

  The intersection selection process chooses the most congested and heavily trafficked intersections for CO analysis, with these worst-case intersections also representing less congested intersections and areas. If an intersection does not meet any of the selection criteria, it is unlikely to be a hot spot and does not need to be assessed further. If an intersection meets one of the criteria, it may be modeled for CO concentrations. If the congested intersections do not show hot spot pollution problems, less congested intersections will not either.

- **Particulate Matter**: A hot spot analysis for PM_{10} is required only for PoAQC, previously discussed in **Section 2.2.2**. The determination of whether a Proposed Action meets the definition of a PoAQC is made by assessing five criteria provided by EPA:

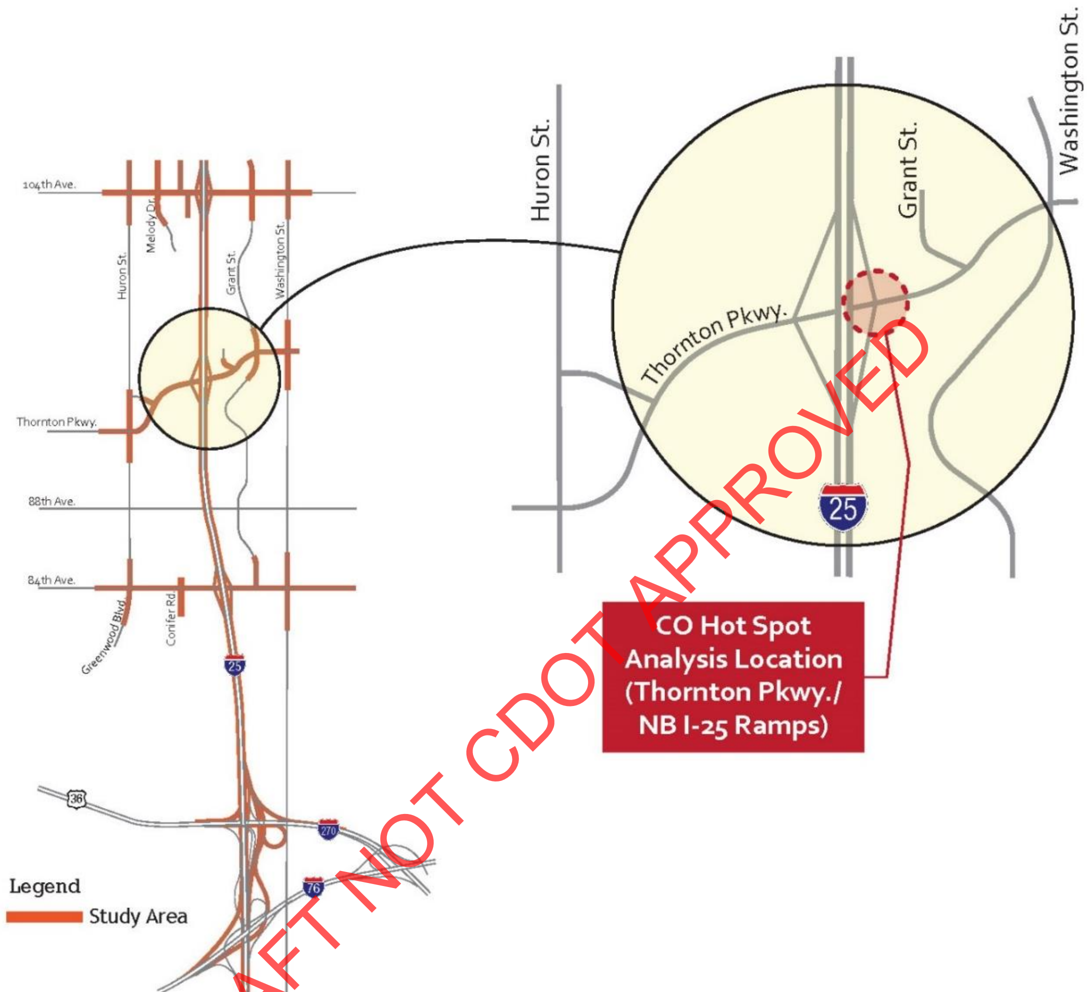
  - New highway projects with a substantial number of diesel vehicles and expanded highway projects that have a substantial increase in the number of diesel vehicles.
  - Projects affecting intersections functioning at LOS D, E, or F with a substantial number of diesel vehicles or those that will change to LOS D, E, or F because of increased traffic volumes from a substantial number of diesel vehicles related to the project.

- New bus and rail terminals and transfer points that have a substantial number of diesel vehicles congregating at a single location.
- Expanded bus and rail terminals and transfer points that substantially increase the number of diesel vehicles congregating at a single location.
- Projects in or affecting locations, areas, or categories of sites that are identified in the SIP as sites of violation or possible violation.

This project does not meet these criteria. Therefore, the Proposed Action is not a PoAQC in terms of federal conformity screening criteria for particulate matter and a microscale analysis is not required. **Section 4.3.1** presents a qualitative discussion of particulate matter.

- **Other Criteria Pollutants**: A qualitative discussion is provided in **Section 4.3** for criteria pollutants affecting regional ozone nonattainment, including ozone, NO_x, and hydrocarbons.
- **Air Toxics Emissions:** A qualitative review of the priority MSAT emissions is provided for the project (**Section 4.3**).
- **Greenhouse Gas Emissions:** Per the CDOT NEPA Manual Appendix F (2017), a summary assessment (**Section 5.0**) of the direct, indirect, and cumulative effects of greenhouse gas (GHG) emissions from the project is provided, including a comparative analysis of global, statewide, and project-generated GHG emissions.
- **Construction Evaluation:** Construction activities may be sources of temporary emissions from fugitive dust or equipment exhaust. A qualitative discussion is provided of potential air quality emissions during the construction phase.
- **Cumulative and Indirect Effects:** EAs require assessment of the Proposed Action, in combination with other actions that could result in cumulative environmental impacts. The air quality technical report includes a qualitative discussion of anticipated cumulative and indirect effects.

Figure 6. CO Hot Spot Analysis Location



Source: FHU, 2019

4.2 No Action Alternative

The No Action condition incorporates programmed roadway improvements. For this segment of I-25, there are no other programmed interstate improvements. All off-system improvements in the current fiscally-constrained 2040 RTP have been included in the 2040 No Action scenario traffic analysis. These other transportation improvement projects have committed or identified funds for construction and will be built regardless of whether any other improvements are made.

From the microsimulation traffic operations evaluation for this project (FHU, 2018), the total hours of peak hour delay would be higher for the 2040 No Action Alternative compared with the Proposed Action. On the contrary, peak hour VMT would be higher under the Proposed Action (**Table 3**). Based on this information, total daily traffic volumes in the project area for the No Action Alternative would be expected to be less than those associated with the Proposed Action. Because tailpipe emissions for low-speed vehicles tend to be disproportionately higher, the greater traffic congestion for the 2040 No Action Alternative would be expected to produce more emissions of CO, nitrogen dioxide, and particulate matter even with the higher VMT expected for the Proposed Action.

Table 3. 2040 PM Network Performance Metrics

	No Action	Proposed Action
Total Delay (hours)	2,325	2,065
VMT (veh-mi)	98,375	111,475

Source: FHU, 2018

4.3 Proposed Action

4.3.1 Impacts (Direct and Indirect)

The following subsections describe anticipated direct and indirect impacts of the Proposed Action.

Carbon Monoxide Microscale Analysis

One study area intersection predicted to function at LOS D in 2040 (**Table 2**) was selected for CO hot spot analysis — the intersection at Thornton Parkway and the I-25 northbound ramps (**Figure 6**). A "worst case" situation was modeled and reviewed for the intersection to ensure that the year of maximum CO emissions was considered. For this "worst case" model, the highest CO emissions factors (2015) were combined with the highest traffic volumes (2040). These artificial conditions were purposely devised to maximize CO concentrations associated with the project to ensure that the maximum potential CO concentrations were adequately considered. For this CO hot spot analyses, the highest predicted traffic volumes were used in the analysis, which in this case includes morning peak hour traffic volumes. The model results were compared to the NAAQS.

Table 4 summarizes the CO model results. The model output data (**Appendix A**) provides 1-hour average CO concentrations. To calculate 8-hour CO results, the 1-hour model results were multiplied by a persistence factor of 0.552, which was received from APCD. This correction is needed because the average hourly traffic over 8 consecutive hours will be less than the peak hour traffic that is modeled, and the meteorological conditions, including wind speed and direction, may vary during that time.

Table 4. Maximum Modeled Carbon Monoxide Concentration

Thornton Parkway and the I-25 NB Ramp Intersection Concentration	1-Hour CO (ppm)	8-Hour CO (ppm)
Modeled	1.6	0.9
Background Concentration	4.5	2.5
Total CO Concentration *(modeled plus background)*	**6.1**	**3.4**
NAAQS	*35*	*9*

Source: FHU Air Quality Modeling Results, 2018

Year 2040 CO background concentrations were also used for the "worst case" results because APCD reported higher results in 2040 than the 2018 background concentration. A 1-hour CO background concentration of 4.5 ppm and an 8-hour CO background of 2.5 ppm were used. The maximum 1-hour CO concentration predicted for any intersection in the study area is 6.1 ppm, which is below the NAAQS of 35 ppm (**Table 1**). The maximum 8-hour CO concentration predicted is 3.4 ppm, which is below the NAAQS of 9 ppm (**Table 1**). Therefore, no CO hot spots in violation of the NAAQS are predicted and no mitigation for CO is required.

CO concentrations are expected to decrease at the target intersections in the future. This is primarily because vehicles will be emitting less CO. This benefit will be from vehicle emission regulation and will be realized regardless of whether the proposed improvements are made.

Particulate Matter Discussion

The Proposed Action is a highway expansion project (i.e., on an existing facility) that primarily serves gasoline-powered vehicle traffic. As summarized in this section, this project fits the criteria of a project that does not require a PM_{10} hot spot analysis.

For projects on a new highway or expressway, EPA defines that 8 percent or more of the average annual daily traffic on heavily traveled roads constitutes a "significant" volume of diesel truck traffic (EPA, 2015). This percentage has been applied for expanded highway projects given that a substantial increase in diesel vehicles has not been defined for expanded highway projects.

Traffic information in CDOT's OTIS indicates that heavy trucks currently represent approximately 5.5 percent of I-25 traffic in the project area (**Section 2.2.2**). CDOT's OTIS projections for 2040 are the same. The difference in 2040 numbers of diesel trucks (**Table 5**) between the Proposed Action and the No Action Alternative is calculated to be less than 8 percent through the study area.

Table 5. Truck Daily Volume Estimates

Location	2040 Daily Numbers of I-25 Diesel Trucks		Difference Between Proposed Action and No Action
	No Action	Proposed Action	
I-25/104th Avenue	10,997	11,107	1.0%
I-25/Thornton Parkway	11,754	12,471	5.7%
I-25/84th Avenue	10,988	11,913	7.8%

Source: Calculated from CDOT OTIS Data

PM_{10} is the subject of a comprehensive Maintenance Plan for the Denver area, and traffic emissions are major considerations in the Maintenance Plan. PM_{10} concentrations around Denver have been below the NAAQS even with the past growth in traffic volumes. In 2040, daily emissions of PM_{10} are expected to increase by 8.3 tons per day (tpd) from 2015 levels, but the projected 2040 emissions of 39.0 tpd remain below the emissions budget of 55 tpd for PM_{10} (DRCOG, 2017b). Therefore, the Proposed Action is not expected to cause or contribute to violations of the PM_{10} NAAQS. The Proposed Action is not expected to interfere with the Maintenance Plan or its goals. Finally, the project does not include:

- Intersections functioning at LOS D, E, or F that also have a substantial number of diesel vehicles
- Bus or rail terminals and transfer points with a substantial number of diesel vehicles congregating
- Locations, areas, or categories of sites identified in the SIP as sites of violation or possible violation

Therefore, no impacts are expected, and no mitigation is necessary for PM_{10}.

Other Criteria Pollutants (Nitrogen Oxides and Ozone)

Although motor vehicles do not directly emit ground-level ozone, motor vehicle emissions of NO_x and vaporous hydrocarbons called volatile organic compounds (VOCs) contribute to ozone formation. ozone is created when sunlight reacts with NO_x and VOCs. This reaction takes place over several hours, which allows mixing and dispersion in the atmosphere; therefore, ozone is considered a regional, rather than a localized, pollutant.

Emissions of ozone precursors near a location may not be crucial because the precursors need time to mix and rely on particular weather conditions before ozone is formed. In that time, because the precursors can drift a considerable distance, the pollution may not be near the emission source. The entire Denver metropolitan area is subject to ozone precursor emission reduction strategies developed for the ozone Action Plan for the Denver nonattainment area. All projects in the Denver ozone nonattainment area must, in the aggregate, conform to the ozone SIP and must be compatible with regional ozone mobile source emission budgets to comply with the NAAQS. That analysis must occur at the regional level through development of the RTP. Therefore, including the proposed improvements in the conforming 2040 RTP will satisfy conformity for the ozone NAAQS.

Air Toxics Emissions

Based on FHWA's 2016 Updated Interim Guidance on Mobile Source Air Toxics in NEPA Analysis, national trend data projecting substantial overall reductions in automotive emissions are expected due to stricter engine and fuel regulations issued by EPA. Because of that and the expected operational improvements on I-25 from the Proposed Action, improved overall vehicle speeds would be expected to decrease MSAT emissions compared with the No Action Alternative. It was concluded at the interagency consultation conference call that this project is a minor widening of an existing highway with low potential for MSAT effects. For these reasons, the following qualitative MSAT discussion has been prepared.

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

For the alternatives in the EA, the amount of MSAT emitted would be proportional to the VMT, assuming other variables were the same. The estimated VMT for the Proposed Action is slightly higher than that of the No Action Alternative (**Table 3**) because the additional capacity increases the efficiency of the roadway and attracts rerouted trips from elsewhere in the transportation network.

This increase in VMT would lead to higher MSAT emissions for the Proposed Action along the I-25 corridor but with a corresponding decrease in MSAT emissions along the parallel routes. The emissions increase from VMT would be offset somewhat by lower MSAT emission rates due to increased vehicle speeds. According to the EPA's MOVES2014 model, emissions of all the priority MSATs decrease as speed increases. Also, 2040 emissions likely would be lower than present levels regardless as a result of EPA's national control programs that are projected to reduce annual MSAT emissions by more than 90 percent between 2010 and 2050 (FHWA, 2016). Local conditions may differ from these national projections in terms of fleet mix and turnover, VMT growth rates, and local control measures. However, the magnitude of the EPA-projected reductions is so great that MSAT emissions in the study area are likely to be lower in the future in nearly all cases, even after accounting for VMT growth.

The additional travel lanes contemplated as part of the Proposed Action would have the effect of moving some traffic closer to nearby homes, schools, and businesses; therefore, localized areas may be subject to higher ambient concentrations of MSATs than for the No Action Alternative. This could be true throughout the project corridor, but the localized increases in MSAT concentrations would likely be most pronounced near homes by 88th Avenue. At this location, the proposed highway realignment will be more pronounced in moving closer to residences. However, the magnitude and duration of these potential increases compared to the No Action Alternative cannot be reliably quantified due to incomplete or unavailable information in forecasting project-specific MSAT health impacts.

The localized level of MSAT emissions for the Proposed Action could be higher relative to the No Action Alternative due to realignment, but this could be offset due to increases in speeds and reductions in congestion that are associated with lower MSAT emissions. Also, MSATs would be lower in other locations when traffic shifts away from them. However, on a regional basis, EPA's vehicle and fuel regulations, coupled with fleet turnover, will over time cause substantial reductions that, in almost all cases, will cause region-wide MSAT levels to be substantially lower than today.

Construction Impacts

The overall construction project has the potential to last many months. Construction activities may be sources of temporary air quality impacts from fugitive dust or equipment emissions. Adjoining properties in the study area would be near construction activities when the proposed project is built. Construction emissions differ from regular traffic emissions in several ways:

- Construction emissions last only for the duration of the construction period.
- Construction activities generally are short term, and depending on the nature of the construction operations, could last from seconds (e.g., a truck passing) to months (e.g., constructing a bridge).
- Construction can involve other emission sources, such as fugitive dust from ground disturbance.
- Construction emissions tend to be intermittent and depend on the type of operation, location, and function of the equipment, as well as the equipment usage cycle. Traffic emissions are present in a more continuous fashion after construction activities are completed.
- Construction emissions tend to be from mobile sources with diesel engines.

The Proposed Action would be similar in nature to other highway projects, and the construction emissions should be representative of projects of this type and magnitude. These types of projects generally do not cause meaningful air quality impacts.

4.3.2 Mitigation

Given that air pollutants are not predicted to exceed the NAAQS in the future as a result of implementing the Proposed Action, mitigation measures for air quality are not necessary for the project. Future emissions from on-road mobile sources will be minimized globally through several federal regulations. The Denver area SIPs for CO, ozone, and PM_{10} will serve to avoid and minimize pollutant emissions from project roads.

Because neighboring areas could be exposed to construction-related emissions, particular attention will be given to minimizing total emissions near sensitive areas such as homes. To address the temporary elevated air emissions that may be experienced during construction, standard construction best practices should be incorporated into construction contracts where feasible. Best practices include following relevant CDOT construction specifications and implementing the following:

- Maintain engines and exhaust systems on equipment in good working order. Maintain equipment regularly. Equipment is subject to inspection by the project manager to ensure maintenance is implemented.
- Control fugitive dust systematically through implementation of CDOT's Standard Specifications for Road and Bridge Construction, particularly Sections 107.24, 209 and 250, and APCD's Air Pollutant Emission Notification requirements.
- Allow no excessive idling of inactive equipment or vehicles.
- Use low-sulfur fuel construction equipment and vehicles to reduce pollutant emissions.
- Locate stationary equipment as far from sensitive receivers as possible (when conditions allow).
- Retrofit older construction vehicles to reduce emissions.

Table 6. Impacts on Air Quality Resources

Context	No Action Alternative	Proposed Action
The study area lies in the northern Denver metropolitan area, which historically had been a nonattainment area for carbon monoxide, ozone, and particulate matter of 10 microns in diameter or smaller. Many air quality improvement actions over several decades have resulted in better air quality in the Denver area. Currently, the Denver metropolitan area is classified as a nonattainment area for ozone (8-hour) and an attainment/maintenance area for carbon monoxide and particulate matter.	**Permanent Impacts** I-25 traffic congestion would continue and worsen over time. These conditions typically increase emissions, although this would be countered by improvements in the vehicle fleet over time. It is not expected to cause exceedances of criteria for any priority pollutants, nor would it result in changes in traffic volumes, vehicle mix, or any other factor that would cause an increase in MSATs.	**Permanent Impacts** I-25 traffic congestion would lessen, thereby reducing overall vehicle emissions. Not expected to cause exceedances of criteria for any priority pollutants. Despite an increase in traffic volume, MSAT emissions in the study area would likely be lower in the future based on EPA national control programs projected to reduce MSATs. The maximum 8 hour CO concentration predicted is 3.4 ppm, which is below the NAAQS of 9 ppm. Local and regional conformity requirements will be met;. **Temporary Impacts** Construction activities would generate dust from earthmoving and bridge demolition and diesel emissions from construction equipment. These would be temporary, lasting only during the construction period.

5.0 Cumulative Impacts

NEPA requires assessment of the Proposed Action, in combination with other actions that could result in cumulative environmental impacts. Cumulative impacts are defined in the Council on Environmental Quality (CEQ) regulations as "the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency or person undertakes such other actions." The CEQ notes that "cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time." Cumulative impacts were evaluated by comparing the potential impacts from the Proposed Action and other past, current, or proposed actions in the area to establish whether, in the aggregate, the actions could result in substantive environmental impacts.

5.1 NAAQS Pollutants

The study area is part of the Denver metropolitan area that has been growing and developing steadily for more than 100 years. This historical growth and development has been a major contributor to air quality problems that have been observed in the metropolitan area, culminating in the designation by EPA of local nonattainment areas in the 1970s. However, several air quality improvement actions over the past decades have resulted in better air quality and the redesignation of the metropolitan area by EPA from nonattainment to maintenance for all NAAQS pollutants by 2002. Denver was subsequently designated nonattainment for the 8-hour ozone NAAQS when that standard was revised.

For much of the past century, the study area has been increasingly developed to a point of becoming highly developed. Such growth would be expected to result in more vehicle traffic in the area and may lead to more vehicle emissions.

Maintenance Plans are in place for the Denver metropolitan area. One of the main purposes of these plans is to ensure compliance with the NAAQS for at least 10 years into the future. Because these plans consider air quality impacts from probable growth in the maintenance areas from both vehicles and other pollutant sources, by their nature the plans are cumulative.

DRCOG is responsible for monitoring regional growth and regularly examines regional impacts of this kind through their regional conformity evaluations. These conformity evaluations are regularly updated, particularly for the RTP and TIP, to reflect recent changes including expanded roads. These evaluations are cumulative for the jurisdiction and are necessary to demonstrate ongoing conformity to the SIPs. If an evaluation result indicates that NAAQS violations may occur either from a specific project or from general growth, preventative actions would be necessary to ensure that the NAAQS are met. Therefore, mechanisms are in place to ensure that cumulative changes in air quality in the study area, regardless of pollutant source, do not lead to violations of the NAAQS.

The Proposed Action is intended to benefit regional transportation and alleviate traffic congestion. Improved traffic flow generally leads to fewer emissions from mobile sources, and this may lead to reduced emissions over the long term even with more vehicles in the area. Construction of the Proposed Action may generate additional vehicle trips during construction and require some traffic rerouting, but these should be temporary and not create substantial adverse effects.

There are potentially mixed outcomes from the Proposed Action. Whereas more efficient roads may sustain higher intersection LOS and higher average vehicle speeds that should reduce most emissions, the improvements could also attract more traffic that could increase the number of emission sources. Most vehicle emissions per mile are expected to decrease in the future because of cleaner vehicles. On the whole, traffic and emission sources may increase on a local scale; however, traffic and overall emissions should improve on the larger regional scale from the Proposed Action.

The net cumulative effect on regional air quality with the Proposed Action is considered in the regional conformity analysis performed by DRCOG for the RTP and TIP. Finally, there are federal air quality regulations that future cumulative growth within the Denver metropolitan area must continue to meet. Therefore, regulatory controls are in place to ensure that there are no cumulative air quality impacts from the combination of air pollutant sources in the Denver metropolitan area.

5.2 Global Climate Change

Climate change is an important national and global concern. While the earth has gone through many natural changes in climate in its history, there is general agreement that the earth's climate is currently changing at an accelerated rate and will continue to do so for the foreseeable future. Anthropogenic (human-caused) GHG emissions contribute to this rapid change. Carbon dioxide (CO_2) makes up the largest component of these GHG emissions. Other prominent transportation GHGs include methane (CH_4) and nitrous oxide (N_2O).

Many GHGs occur naturally. Water vapor is the most abundant GHG and makes up approximately two-thirds of the natural greenhouse effect. However, burning fossil fuels and other human activities are adding to the concentration of GHGs in the atmosphere. Many GHGs remain in the atmosphere for time periods ranging from decades to centuries. GHGs trap heat in the earth's atmosphere. Because atmospheric concentration of GHGs continues to climb, the planet will continue to experience climate-related phenomena. For example, warmer global temperatures can cause changes in precipitation and sea levels.

To date, no national standards have been established regarding GHGs, nor has the EPA established criteria or thresholds for ambient GHG emissions pursuant to its authority to establish motor vehicle emission standards for CO_2 under the Clean Air Act. However, there is a considerable body of scientific literature addressing the sources of GHG emissions and their adverse effects on climate, including reports from the Intergovernmental Panel on Climate Change, the US National Academy of Sciences, and EPA and other federal agencies.

GHGs are different from other air pollutants evaluated in federal environmental reviews because their impacts are not localized or regional due to their rapid dispersion into the global atmosphere, which is characteristic of these gases. The affected environment for CO2 and other GHG emissions is the entire planet. In addition, from a quantitative perspective, global climate change is the cumulative result of numerous and varied emissions sources (in terms of both absolute numbers and types), each of which makes a relatively small addition to global atmospheric GHG concentrations. In contrast to broad-scale actions such as actions involving an entire industry sector or very large geographic areas, it is difficult to isolate and understand the GHG emissions impacts for a particular transportation project. Furthermore, there is currently no scientific methodology for attributing specific climatological changes to a particular transportation project's emissions.

Under NEPA, detailed environmental analysis should focus on issues that are substantial and meaningful to decision-making.[3] Based on the nature of GHG emissions and the exceedingly small potential GHG impacts of the Proposed Action, as discussed below and shown in **Table 7**, FHWA has concluded that the GHG emissions from the Proposed Action would not result in "reasonably foreseeable significant adverse impacts on the human environment" (40 CFR 1502.22(b)). The GHG emissions from the project build alternatives would not be substantial and would not play a meaningful role in determining an environmentally preferable alternative or the selection of a preferred alternative. More detailed information on GHG emissions "is not essential to a reasoned choice among reasonable alternatives" (40 CFR 1502.22(a)) or to deciding in the best overall public interest based on a balanced consideration of transportation, economic, social, and environmental needs and impacts (23 CFR 771.105(b)). For these reasons, no alternatives-level GHG analysis has been performed for this project.

The context in which the emissions from the Proposed Action would occur, together with the expected GHG emissions contribution from the project, illustrates why the project's GHG emissions would not be substantial and would not be a substantial factor in the decision-making. The transportation sector is the second largest source of total GHG emissions in the United States, behind electricity generation. The transportation sector was responsible for approximately 27 percent of all anthropogenic (human caused) GHG emissions in the United States in 2010.[4] Most transportation GHG emissions result from fossil fuel combustion. CO_2 makes up the largest component of these GHG emissions. U.S. CO_2 emissions from the consumption of energy

[3] See 40 CFR 1500.1(b), 1500.2(b), 1500.4(g), and 1501.7.

[4] Calculated from data in EPA, Inventory of Greenhouse Gas Emissions and Sinks, 1990-2010.

accounted for about 18 percent of worldwide energy consumption CO_2 emissions in 2010.[5]. U.S. transportation CO_2 emissions accounted for about 6 percent of worldwide CO_2 emissions.[6]

While the contribution of GHGs from transportation in the United States as a whole is a large component of U.S. GHG emissions, as the scale of analysis is reduced, GHG contributions become quite small. In this analysis, CO_2 was used because of its predominant role in GHG emissions. **Table 7** presents the relationship between current and projected Colorado highway CO_2 emissions and total global CO_2 emissions, as well as provides information on the scale of the project relative to statewide travel activity.

Based on emissions estimates from EPA's MOVES model[7] and global CO_2 estimates and projections from the Energy Information Administration, CO_2 emissions from motor vehicles in the entire state of Colorado contributed less than one-tenth of 1 percent of global emissions in 2010 (0.0348 percent). These emissions are projected to contribute an even smaller fraction (0.0261 percent) in 2040[8]. VMT in the project study area represents 1.1 percent of total Colorado travel activity; and the project itself would increase statewide VMT by less than 1 percent. (Note that the project study area, as defined for the MSAT analysis, includes travel on many other roadways in addition to the Proposed Action.)

[5] Calculated from data in U.S. Energy Information Administration International Energy Statistics, Total Carbon Dioxide Emissions from the Consumption of Energy, http://www.eia.gov/cfapps/ipdbproject/IEDIndex3.cfm?tid=90&pid=44&aid=8, accessed February 25, 2013.

[6] Calculated from data in EIA figure 104: http://www.eia.gov/forecasts/archive/ieo10/emissions.html and EPA table ES-3: http://epa.gov/climatechange/emissions/downloads11/US-GHG-Inventory-2011-Executive-Summary.pdf

[7] http://www.epa.gov/otaq/models/moves/ index.htm. EPA's MOVES model can be used to estimate vehicle exhaust emissions of carbon dioxide (CO_2) and other GHGs. CO_2 is frequently used as an indicator of overall transportation GHG emissions because the quantity of these emissions is much larger than that of all other transportation GHGs combined, and because CO_2 accounts for 90 to 95 percent of the overall climate impact from transportation sources. MOVES includes estimates of both emissions rates and VMT, and these were used to estimate the Colorado statewide highway emissions in **Table 5**.

[8] Colorado emissions represent a smaller share of global emissions in 2040 because global emissions increase at a faster rate.

Table 7. Statewide and Project Emissions Potential, Relative to Global Totals

	Global CO_2 Emissions, MMT[9]	Colorado Motor Vehicle CO_2 Emissions, MMT[10]	Colorado Motor Vehicle Emissions, % of Global Total	Project Study Area VMT, % of Statewide VMT	Percent Change in Statewide VMT due to Project
Current Conditions (2012)	29,670	10.3	0.0348%	1.10%	(None)
Future Projection (2040)	45,500	11.9	0.0261%	0.85%	0.85%

Table Notes: MMT = million metric tons.

Sources: Global emissions estimates are from International Energy Outlook 2010 data for Figure 104, projected to 2040.

Nevada emissions and statewide VMT estimates are from MOVES2010b.

FHWA estimates the Proposed Action could result in a potential increase in global CO_2 emissions in 2040 of 0.00044 percent (less than one-thousandth of 1 percent), and a corresponding increase in Colorado's share of global emissions in 2040 of 0.0265 percent. This very small change in global emissions is within the range of uncertainty associated with future emissions estimates.[11, 12]

5.3 Mitigation for Global GHG Emissions

To help address the global issue of climate change, United States Department of Transportation (USDOT) is committed to reducing GHG emissions from vehicles traveling on our nation's highways. USDOT and EPA are working together to reduce these emissions by substantially improving vehicle efficiency and shifting toward lower carbon intensive fuels. The agencies have jointly established new, more stringent fuel economy and first ever GHG emissions standards for model year 2012-2025 cars and light trucks, with an ultimate fuel economy standard of 54.5 miles per gallon for cars and light trucks by model year 2025. Further, on September 15, 2011, the agencies jointly published the first ever fuel economy and GHG emissions standards for heavy-duty trucks and buses.[13] Increasing use of technological innovations that can improve fuel economy, such as gasoline-

[9] These estimates are from the EIA's *International Energy Outlook 2010* and are considered the best-available projections of emissions from fossil fuel combustion. These totals do not include other sources of emissions, such as cement production, deforestation, or natural sources; however, reliable future projections for these emissions sources are not available.

[10] MOVES projections suggest that Colorado motor vehicle CO_2 emissions may increase by 14.9 percent between 2010 and 2040; more stringent fuel economy/GHG emissions standards will not be sufficient to offset projected growth in VMT.

[11] For example, Figure 114 of the Energy Information Administration's *International Energy Outlook 2010* shows that future emissions projections can vary by almost 20 percent, depending on which scenario for future economic growth proves to be most accurate.

[12]When an agency evaluates reasonably foreseeable significant adverse effects on the human environment in an environmental impact statement and there is incomplete or unavailable information, the agency is required to make clear that such information is lacking (40 CFR 1502.22). The methodologies for forecasting GHG emissions from transportation projects continue to evolve, and the data provided should be considered in light of the constraints affecting the currently available methodologies. As previously stated, tools such as EPA's MOVES model can be used to estimate vehicle exhaust emissions of carbon dioxide (CO_2) and other GHGs. However, only rudimentary information is available about the GHG emissions impacts of highway construction and maintenance. Estimation of GHG emissions from vehicle exhaust is subject to the same types of uncertainty affecting other types of air quality analysis, including imprecise information about current and future estimates of VMT, vehicle travel speeds, and the effectiveness of vehicle emissions control technology. Finally, there is currently no scientific methodology that can identify causal connections between individual source emissions and specific climate impacts at a particular location.

[13] For more information on fuel economy proposals and standards, see the National Highway Traffic Safety Administration's Corporate Average Fuel Economy website: http://www.nhtsa.gov/fuel-economy/.

and diesel-electric hybrid vehicles, will improve air quality and reduce CO_2 emissions in future years.

Consistent with its view that broad-scale efforts hold the greatest promise for meaningfully addressing the global climate change problem, FHWA is engaged in developing strategies to reduce transportation's contribution to GHGs—particularly CO_2 emissions—and to assess the risks to transportation systems and services from climate change.

To assist States and MPOs in performing GHG analyses, FHWA has developed a *Handbook for Estimating Transportation GHG Emissions for Integration into the Planning Process*. The Handbook presents methodologies reflecting good practices for evaluating GHG emissions at the transportation program level and will demonstrate how such evaluation may be integrated into the transportation planning process.

FHWA has also developed a tool for use at the statewide level to model a large number of GHG reduction scenarios and alternatives for use in transportation planning, climate action plans, scenario planning exercises, and in meeting state GHG reduction targets and goals. To assist states and MPOs in assessing climate change vulnerabilities to their transportation networks, FHWA has developed a draft vulnerability and risk assessment conceptual model and has piloted it in several locations.

At the state level, several programs are underway in Colorado to address transportation GHGs. The Governor's Climate Action Plan, adopted in November 2007, includes measures to adopt vehicle CO_2 emissions standards and to reduce vehicle travel through transit, flex time, telecommuting, ridesharing, and broadband communications.

CDOT issued a Policy Directive on Air Quality in May 2009. This Policy Directive was developed with input from several agencies, including the State of Colorado's Department of Public Health and Environment, EPA, FHWA, Federal Transit Administration, RTD, and Denver Regional Air Quality Council. This Policy Directive and implementation document, the CDOT Air Quality Action Plan, address unregulated MSATs and GHGs produced from Colorado's state highways, interstates, and construction activities.

As a part of CDOT's commitment to addressing MSATs and GHGs, CDOT's program-wide activities include:

- Researching pavement durability opportunities with the goal of reducing the frequency of resurfacing and/or reconstruction projects.
- Developing air quality educational materials, specific to transportation issues, for citizens, elected officials, and schools, including development of vehicle idling reduction programs for schools and communities.
- Offering outreach to communities to integrate land use and transportation decisions to reduce growth in VMT, such as smart growth techniques, buffer zones, transit-oriented development, walkable communities, access management plans, etc.
- Committing to research additional concrete additives that would reduce the demand for cement.
- Expanding Transportation Demand Management efforts statewide to better use the existing transportation mobility network.
- Continuing to diversify the CDOT fleet by retrofitting diesel vehicles, specifying the types of vehicles and equipment contractors may use, purchasing low-emission vehicles, such as hybrids, and purchasing cleaner burning fuels through bidding incentives where feasible.
- Exploring congestion and/or right-lane only restrictions for motor carriers.
- Funding truck parking electrification.
- Researching additional ways to improve freight movement and efficiency statewide.
- Committing to use ultra-low sulfur diesel for non-road equipment statewide.
- Developing a low-VOC emitting tree landscaping specification.

Even though project-level mitigation measures will not have a substantial impact on global GHG emissions because of the exceedingly small amount of GHG emissions involved, the above-identified activities are part of a program-wide effort by FHWA and CDOT to adopt a practical means to avoid and minimize environmental impacts in accordance with 40 CFR 1505.2(c).

5.4 Summary

This technical report does not incorporate an analysis of the GHG emissions or climate change effects of each alternative because the potential change in GHG emissions is very small in the context of the affected environment. Because of the insignificance of the GHG impacts, those impacts will not be meaningful to a decision on the environmentally preferable alternative or to a choice among alternatives. As outlined above, FHWA is working to develop strategies to reduce transportation's contribution to GHGs—particularly CO_2 emissions—and to assess the risks to transportation systems and services from climate change. FHWA will continue to pursue these efforts as productive steps to address this important issue. Finally, the construction best practices described previously represent practicable project-level measures that, while not substantially reducing global GHG emissions, may help reduce GHG emissions on an incremental basis and could contribute in the long term to meaningful cumulative reduction when considered across the Federal-aid highway program.

Table 8. Summary of Impacts to Air Quality Resources

Context	No Action Alternative	Responsible Branch
The project area lies in the northern Denver metropolitan area, which historically had been a nonattainment area for carbon monoxide, ozone, and particulate matter of 10 microns in diameter or smaller. Many air quality improvement actions over several decades have resulted in better air quality in the Denver area. Currently, the Denver metropolitan area is classified as a nonattainment area for ozone (8-hour) and an attainment/maintenance area for carbon monoxide and particulate matter.	**Permanent Impacts** I-25 traffic congestion would continue and worsen over time. These conditions typically increase emissions, although this would be countered by improvements in the vehicle fleet over time. It is not expected to cause exceedances of criteria for any priority pollutants, nor would it result in changes in traffic volumes, vehicle mix, or any other factor that would cause an increase in Mobile Source Air Toxics (MSATs).	**Permanent Impacts** I-25 traffic congestion would lessen, thereby reducing overall vehicle emissions. The Proposed Action is not expected to cause exceedances of criteria for any priority pollutants. Despite an increase in traffic volume, MSAT emissions in the study area would likely be lower in the future based on Environmental Protection Agency (EPA) national control programs projected to reduce MSATs. The maximum 8 hour carbon monoxide concentration predicted is 3.4 parts per million, which is below the National Ambient Air Quality Standards of 9 parts per million. Local and regional conformity requirements will be met. **Temporary Impacts** Construction activities would generate dust from earthmoving and bridge demolition and diesel emissions from construction equipment. These would be temporary, lasting only during the construction period.

Table 9. Summary of Mitigation for Air Quality Resources Impacts

Impact	Mitigation Commitment	Responsible Branch	Timing/Phase that Mitigation will be Implemented
Air emissions during construction from construction vehicles and equipment.	Maintain engines and exhaust systems on equipment in good working order. Maintain equipment on a regular basis. Equipment will be subject to inspection by the project manager to ensure maintenance. Control fugitive dust through implementation of CDOT's Standard Specifications for Road and Bridge Construction, particularly Sections 107.24, 209, and 250, and Air Pollution Control Division's Air Pollutant Emission Notification requirements.	CDOT Construction	Design Construction

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APPENDIX A. CAL3QHC MODEL OUTPUT FILES

CAL3QHC: LINE SOURCE DISPERSION MODEL - VERSION 2.0 Dated 13045 PAGE 1
JOB: I25 North US 36 to 104th Ave RUN: AM Peak Worst Case

DATE : 8/16/18
TIME : 13:10:20

The MODE flag has been set for calculating concentrations for POLLUTANT: CO

SITE & METEOROLOGICAL VARIABLES

VS = 0.0 CM/S VD = 0.0 CM/S Z0 = 175. CM
U = 1.0 M/S CLAS = 4 (D) ATIM = 60. MINUTES MIXH = 1000. M AMB = 0.0 PPM

LINK VARIABLES

LINK DESCRIPTION	X1	Y1	X2	Y2	LENGTH (FT)	BRG (DEG)	TYPE	VPH	EF (G/MI)	H (FT)	W (FT)	V/C	QUEUE (VEH)
1. EB_Thornton_LT Que	908.0	1095.0	806.2	1076.4	103.	260.	AG	93.	100.0	0.0	11.5	0.55	5.3
2. EB_Thornton_T_1 Que	912.0	1071.0	841.9	1058.2	71.	260.	AG	36.	100.0	0.0	12.0	0.36	3.6
3. EB_Thornton_T_2 Que	910.0	1083.0	839.9	1070.2	71.	260.	AG	36.	100.0	0.0	12.5	0.36	3.6
4. NB_ramp_LT Que	950.0	1045.0	947.8	952.2	93.	181.	AG	85.	100.0	0.0	12.0	0.44	4.7
5. NB_ramp_T_LT Que	962.0	1045.0	961.9	1042.8	2.	181.	AG	85.	100.0	0.0	12.0	0.01	0.1
6. WB_Thornton_T_1 Que	995.0	1137.0	1202.0	1178.1	211.	79.	AG	69.	100.0	0.0	12.0	0.83	10.7
7. WB_Thornton_T_2 Que	992.0	1150.0	1199.1	1190.9	211.	79.	AG	69.	100.0	0.0	13.0	0.83	10.7
8. WB_Thornton_T_3 Que	997.0	1125.0	1204.0	1166.1	211.	79.	AG	69.	100.0	0.0	12.0	0.83	10.7
9. EB_Thornton_T_1 Apr	11.0	906.0	958.0	1078.0	962.	80.	AG	505.	5.6	0.0	32.0		
10. EB_Thornton_T_2 Apr	9.0	918.0	956.0	1090.0	962.	80.	AG	505.	5.6	0.0	32.5		
11. NB_ramp_T_LT Apr	937.0	0.0	955.0	1111.0	1111.	1.	AG	220.	11.1	0.0	32.0		
12. WB_Thornton_T_1 Apr	1775.0	1292.0	949.0	1128.0	842.	259.	AG	575.	15.5	0.0	32.0		
13. WB_Thornton_T_2 Apr	1772.0	1304.0	947.0	1141.0	841.	259.	AG	575.	15.5	0.0	33.0		
14. WB_Thornton_T_3 Apr	1777.0	1280.0	951.0	1116.0	842.	259.	AG	575.	15.5	0.0	32.0		
15. EB_Thornton_T_1 Dprt	958.0	1078.0	1785.0	1242.0	843.	79.	AG	693.	3.4	0.0	32.0		
16. EB_Thornton_T_2 Dprt	956.0	1090.0	1782.0	1254.0	842.	79.	AG	693.	3.4	0.0	32.5		
17. NB_ramp_T_LT Dprt	955.0	1111.0	839.0	2285.0	1180.	354.	AG	505.	11.1	0.0	32.0		
18. WB_Thornton_T_1 Dprt	949.0	1128.0	2.0	956.0	962.	260.	AG	647.	9.6	0.0	32.0		
19. WB_Thornton_T_2 Dprt	947.0	1141.0	0.0	968.0	963.	260.	AG	647.	9.6	0.0	33.0		
20. WB_Thornton_T_3 Dprt	951.0	1116.0	4.0	944.0	962.	260.	AG	647.	9.6	0.0	32.0		
21. EB_Thornton_T_3	1066.0	1087.0	1787.0	1230.0	735.	79.	AG	595.	11.1	0.0	32.0		
22. NB_ramp_RT_1	949.0	0.0	972.0	966.0	966.	1.	AG	595.	11.1	0.0	32.0		
23. NB_ramp_RT_2	972.0	966.0	1066.0	1087.0	153.	38.	AG	595.	11.1	0.0	32.0		
24. WB_Thornton_RT_1	1770.0	1316.0	1043.0	1172.0	741.	259.	AG	280.	15.5	0.0	32.0		
25. WB_Thornton_RT_2	1043.0	1172.0	945.0	1204.0	103.	288.	AG	280.	15.5	0.0	32.0		

PAGE 2
JOB: I25 North US 36 to 104th Ave RUN: AM Peak Worst Case

DATE : 8/16/18
TIME : 13:10:20

ADDITIONAL QUEUE LINK PARAMETERS

LINK DESCRIPTION	CYCLE LENGTH (SEC)	RED TIME (SEC)	CLEARANCE LOST TIME (SEC)	APPROACH VOL (VPH)	SATURATION FLOW RATE (VPH)	IDLE EM FAC (gm/hr)	SIGNAL TYPE	ARRIVAL RATE
1. EB_Thornton_LT Que	120	86	2.0	220	1600	48.40	1	3
2. EB_Thornton_T_1 Que	120	33	2.0	395	1600	48.40	1	3
3. EB_Thornton_T_2 Que	120	33	2.0	395	1600	48.40	1	3
4. NB_ramp_LT Que	120	79	2.0	215	1600	48.40	1	3
5. NB_ramp_T_LT Que	120	79	2.0	5	1600	48.40	1	3
6. WB_Thornton_T_1 Que	120	64	2.0	575	1600	48.40	1	3
7. WB_Thornton_T_2 Que	120	64	2.0	575	1600	48.40	1	3
8. WB_Thornton_T_3 Que	120	64	2.0	575	1600	48.40	1	3

RECEPTOR LOCATIONS

RECEPTOR	COORDINATES (FT) X	Y	Z
1. R-01	987.0	795.0	6.0
2. R-02	1048.0	1034.0	6.0
3. R-03	1025.0	1005.0	6.0
4. R-04	994.0	965.0	6.0
5. R-05	989.0	925.0	6.0
6. R-06	1185.0	1092.0	6.0
7. R-07	1001.0	1206.0	6.0
8. R-08	1034.0	1196.0	6.0
9. R-09	1074.0	1197.0	6.0
10. R-10	1114.0	1205.0	6.0
11. R-11	1244.0	1230.0	6.0
12. R-12	950.0	1362.0	6.0
13. R-13	868.0	1044.0	6.0
14. R-14	828.0	1037.0	6.0
15. R-15	788.0	1029.0	6.0
16. R-16	658.0	1005.0	6.0
17. R-17	898.0	1050.0	6.0
18. R-18	929.0	929.0	6.0
19. R-19	803.0	1135.0	6.0
20. R-20	916.0	1291.0	6.0
21. R-21	924.0	1203.0	6.0
22. R-22	894.0	1152.0	6.0

JOB: I25 North US 36 to 104th Ave RUN: AM Peak Worst Case

MODEL RESULTS

REMARKS : In search of the angle corresponding to
the maximum concentration, only the first
angle, of the angles with same maximum
concentrations, is indicated as maximum.

WIND ANGLE RANGE: 0.-355.

WIND ANGLE (DEGR)	* CONCENTRATION (PPM) 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
0.	0.6332	0.9088	0.8313	0.7540	0.7037	0.9351	0.0557	0.0297	0.0154	0.0083	0.0010	0.1900	0.8345	0.6680	0.5202
5.	0.5684	0.8962	0.8287	0.7570	0.6701	0.9005	0.0306	0.0145	0.0066	0.0031	0.0004	0.1303	0.8471	0.6884	0.5392
10.	0.5052	0.9062	0.8463	0.7747	0.6453	0.8849	0.0137	0.0056	0.0028	0.0014	0.0012	0.0802	0.8639	0.7156	0.5623
15.	0.4477	0.9080	0.8555	0.7880	0.6255	0.8715	0.0055	0.0019	0.0026	0.0021	0.0029	0.0474	0.8745	0.7398	0.5870
20.	0.3994	0.9103	0.8670	0.8072	0.6106	0.8663	0.0017	0.0005	0.0039	0.0037	0.0049	0.0270	0.8881	0.7696	0.6157
25.	0.3653	0.9107	0.8670	0.8116	0.5925	0.8683	0.0004	0.0001	0.0058	0.0056	0.0071	0.0161	0.9055	0.8073	0.6513
30.	0.3429	0.9215	0.8680	0.8094	0.5726	0.8856	0.0001	0.0000	0.0077	0.0075	0.0092	0.0110	0.9379	0.8631	0.7044
35.	0.3219	0.9114	0.8470	0.7822	0.5457	0.9058	0.0000	0.0001	0.0094	0.0092	0.0110	0.0090	0.9698	0.9161	0.7574
40.	0.3044	0.8911	0.8127	0.7380	0.5176	0.9349	0.0004	0.0004	0.0106	0.0104	0.0124	0.0084	1.0098	0.9772	0.8216
45.	0.2856	0.8663	0.7716	0.6851	0.4902	0.9705	0.0018	0.0023	0.0150	0.0147	0.0170	0.0061	1.0567	1.0429	0.8975
50.	0.2558	0.8406	0.7296	0.6307	0.4587	1.0084	0.0056	0.0090	0.0270	0.0264	0.0287	0.0039	1.1135	1.1159	0.9845
55.	0.2113	0.8086	0.6835	0.5722	0.4176	1.0382	0.0156	0.0281	0.0565	0.0546	0.0561	0.0020	1.1699	1.1863	1.0731
60.	0.1527	0.7660	0.6292	0.5048	0.3590	1.0621	0.0372	0.0664	0.1102	0.1054	0.1044	0.0007	1.2297	1.2591	1.1644
65.	0.0969	0.6834	0.5416	0.4147	0.2812	1.0181	0.0912	0.1566	0.2258	0.2144	0.2051	0.0008	1.2244	1.2619	1.1929
70.	0.0517	0.5669	0.4302	0.3115	0.1956	0.9166	0.1904	0.3070	0.4063	0.3835	0.3590	0.0040	1.1535	1.1927	1.1460
75.	0.0226	0.4276	0.3078	0.2091	0.1177	0.7624	0.3406	0.5148	0.6426	0.6036	0.5579	0.0138	1.0102	1.0454	1.0153
80.	0.0078	0.2879	0.1954	0.1242	0.0598	0.5769	0.5281	0.7541	0.9030	0.8451	0.7751	0.0367	0.8158	0.8410	0.8200
85.	0.0020	0.1697	0.1085	0.0652	0.0247	0.3929	0.7237	0.9851	1.1440	1.0673	0.9732	0.0775	0.6092	0.6203	0.6021
90.	0.0004	0.0856	0.0519	0.0304	0.0080	0.2417	0.8947	1.1712	1.3306	1.2386	1.1218	0.1355	0.4346	0.4298	0.4093
95.	0.0000	0.0369	0.0221	0.0137	0.0019	0.1355	1.0202	1.2937	1.4472	1.3457	1.2055	0.2025	0.3124	0.2957	0.2713
100.	0.0000	0.0152	0.0095	0.0064	0.0004	0.0766	1.0850	1.3340	1.4752	1.3717	1.2036	0.2683	0.2477	0.2233	0.1953
105.	0.0000	0.0047	0.0033	0.0025	0.0001	0.0427	1.1204	1.3459	1.4795	1.3823	1.1804	0.3150	0.2155	0.1845	0.1535
110.	0.0001	0.0009	0.0006	0.0005	0.0006	0.0261	1.1318	1.3339	1.4592	1.3748	1.1377	0.3454	0.2004	0.1636	0.1319
115.	0.0011	0.0001	0.0000	0.0000	0.0027	0.0186	1.1259	1.3108	1.4280	1.3605	1.0917	0.3649	0.1992	0.1536	0.1179
120.	0.0032	0.0000	0.0000	0.0002	0.0055	0.0157	1.1110	1.2829	1.3924	1.3432	1.0491	0.3801	0.1982	0.1454	0.1085
125.	0.0057	0.0000	0.0000	0.0008	0.0087	0.0143	1.0907	1.2519	1.3539	1.3210	1.0099	0.3946	0.1956	0.1375	0.1019
130.	0.0085	0.0000	0.0000	0.0021	0.0119	0.0111	1.0503	1.1997	1.2947	1.2752	0.9608	0.4045	0.1893	0.1287	0.0963
135.	0.0114	0.0000	0.0000	0.0038	0.0151	0.0080	1.0326	1.1781	1.2650	1.2540	0.9356	0.4158	0.1833	0.1230	0.0938
140.	0.0126	0.0000	0.0000	0.0044	0.0167	0.0050	1.0181	1.1608	1.2386	1.2328	0.9133	0.4247	0.1753	0.1176	0.0923
145.	0.0149	0.0002	0.0004	0.0057	0.0197	0.0023	1.0062	1.1466	1.2175	1.2140	0.8950	0.4325	0.1680	0.1147	0.0925
150.	0.0211	0.0016	0.0025	0.0101	0.0270	0.0005	0.9851	1.1245	1.1920	1.1884	0.8836	0.4426	0.1622	0.1141	0.0932
155.	0.0344	0.0048	0.0069	0.0204	0.0421	0.0000	0.9849	1.1272	1.1964	1.1921	0.8836	0.4555	0.1579	0.1142	0.0932

160.	*	0.0603	0.0102	0.0151	0.0416	0.0710	0.0001	0.9828	1.1300	1.2065	1.2000	0.8871	0.4819	0.1537	0.1125	0.0899
165.	*	0.1023	0.0193	0.0293	0.0771	0.1178	0.0004	0.9808	1.1355	1.2179	1.2076	0.8916	0.5221	0.1475	0.1063	0.0813
170.	*	0.1699	0.0373	0.0565	0.1373	0.1914	0.0018	0.9882	1.1521	1.2319	1.2151	0.8932	0.5689	0.1315	0.0909	0.0655
175.	*	0.2538	0.0646	0.0952	0.2136	0.2812	0.0057	0.9987	1.1784	1.2507	1.2260	0.8940	0.6103	0.1067	0.0691	0.0462
180.	*	0.3411	0.0998	0.1411	0.2943	0.3723	0.0140	1.0069	1.2093	1.2735	1.2423	0.8967	0.6297	0.0762	0.0453	0.0277
185.	*	0.4121	0.1391	0.1872	0.3641	0.4423	0.0276	1.0036	1.2348	1.2996	1.2664	0.9101	0.6240	0.0467	0.0251	0.0137
190.	*	0.4529	0.1747	0.2248	0.4081	0.4783	0.0455	0.9834	1.2515	1.3377	1.3091	0.9328	0.5948	0.0244	0.0121	0.0059
195.	*	0.4627	0.2027	0.2499	0.4230	0.4823	0.0646	0.9489	1.2383	1.3583	1.3458	0.9757	0.5474	0.0115	0.0062	0.0032
200.	*	0.4495	0.2234	0.2648	0.4155	0.4641	0.0803	0.9063	1.2039	1.3668	1.3778	1.0282	0.5076	0.0064	0.0048	0.0033
205.	*	0.4131	0.2412	0.2711	0.3857	0.4243	0.0898	0.8632	1.1577	1.3619	1.3965	1.0867	0.4751	0.0058	0.0056	0.0044

PAGE 4

JOB: I25 North US 36 to 104th Ave RUN: AM Peak Worst Case

WIND ANGLE RANGE: 0.-355.

WIND ANGLE (DEGR)	*	CONCENTRATION (PPM) 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
210.	*	0.3868	0.2669	0.2859	0.3658	0.3962	0.0955	0.8343	1.1334	1.3808	1.4333	1.1690	0.4513	0.0066	0.0068	0.0057
215.	*	0.3633	0.3000	0.3074	0.3513	0.3714	0.0993	0.8192	1.1024	1.3773	1.4447	1.2486	0.4322	0.0079	0.0083	0.0071
220.	*	0.3437	0.3361	0.3320	0.3448	0.3507	0.1030	0.8152	1.0782	1.3705	1.4500	1.3326	0.4172	0.0086	0.0091	0.0077
225.	*	0.3258	0.3663	0.3533	0.3399	0.3316	0.1123	0.8150	1.0611	1.3611	1.4520	1.4158	0.4055	0.0110	0.0116	0.0099
230.	*	0.3101	0.3891	0.3704	0.3376	0.3151	0.1293	0.8198	1.0477	1.3478	1.4504	1.4939	0.3943	0.0168	0.0176	0.0153
235.	*	0.2956	0.4056	0.3814	0.3368	0.3001	0.1579	0.8222	1.0308	1.3221	1.4343	1.5495	0.3762	0.0305	0.0314	0.0282
240.	*	0.2836	0.4110	0.3934	0.3416	0.2877	0.2033	0.8243	1.0128	1.2871	1.4039	1.5896	0.3477	0.0560	0.0570	0.0519
245.	*	0.2724	0.4249	0.4088	0.3511	0.2777	0.2808	0.7933	0.9668	1.2092	1.3169	1.5361	0.3113	0.1118	0.1124	0.1044
250.	*	0.2644	0.4551	0.4340	0.3701	0.2752	0.3977	0.7317	0.8905	1.0891	1.1782	1.4025	0.2691	0.2016	0.2012	0.1891
255.	*	0.2666	0.5089	0.4746	0.4075	0.2901	0.5532	0.6381	0.7784	0.9257	0.9888	1.1889	0.2343	0.3216	0.3193	0.3031
260.	*	0.2745	0.5822	0.5313	0.4590	0.3202	0.7258	0.5245	0.6413	0.7331	0.7656	0.9192	0.2095	0.4544	0.4493	0.4302
265.	*	0.2930	0.6609	0.5963	0.5226	0.3701	0.8845	0.4126	0.5010	0.5382	0.5421	0.6389	0.1941	0.5731	0.5639	0.5445
270.	*	0.3182	0.7264	0.6572	0.5859	0.4234	1.0076	0.3213	0.3823	0.3704	0.3533	0.3978	0.1839	0.6593	0.6438	0.6261
275.	*	0.3463	0.7638	0.7014	0.6366	0.4699	1.0927	0.2575	0.2909	0.2469	0.2176	0.2254	0.1772	0.7072	0.6813	0.6667
280.	*	0.3748	0.7633	0.7212	0.6661	0.4996	1.1349	0.2181	0.2319	0.1730	0.1415	0.1316	0.1734	0.7118	0.6690	0.6578
285.	*	0.3957	0.7455	0.7254	0.6814	0.5165	1.1618	0.1888	0.1912	0.1297	0.0985	0.0802	0.1725	0.7135	0.6476	0.6387
290.	*	0.4134	0.7200	0.7187	0.6931	0.5315	1.1749	0.1654	0.1589	0.1037	0.0769	0.0580	0.1782	0.7136	0.6195	0.6118
295.	*	0.4227	0.6978	0.7068	0.7143	0.5517	1.1767	0.1471	0.1344	0.0887	0.0672	0.0496	0.1865	0.7170	0.5922	0.5844
300.	*	0.4339	0.6860	0.6921	0.7319	0.5782	1.1669	0.1352	0.1173	0.0806	0.0637	0.0471	0.1955	0.7244	0.5695	0.5601
305.	*	0.4446	0.6828	0.6722	0.7427	0.6103	1.1481	0.1317	0.1069	0.0778	0.0637	0.0472	0.2049	0.7332	0.5520	0.5388
310.	*	0.4536	0.6825	0.6418	0.7374	0.6430	1.1140	0.1296	0.1021	0.0756	0.0628	0.0459	0.2156	0.7364	0.5330	0.5135
315.	*	0.4740	0.6991	0.6240	0.7304	0.6835	1.0902	0.1303	0.1002	0.0748	0.0624	0.0446	0.2281	0.7427	0.5266	0.4981
320.	*	0.4984	0.7217	0.6157	0.7115	0.7134	1.0657	0.1335	0.1009	0.0750	0.0623	0.0429	0.2418	0.7460	0.5253	0.4849
325.	*	0.5275	0.7555	0.6269	0.6927	0.7334	1.0453	0.1386	0.1030	0.0757	0.0623	0.0403	0.2582	0.7480	0.5296	0.4752
330.	*	0.5593	0.7963	0.6521	0.6732	0.7408	1.0204	0.1442	0.1057	0.0763	0.0617	0.0362	0.2775	0.7405	0.5354	0.4660
335.	*	0.5996	0.8395	0.6986	0.6773	0.7437	1.0217	0.1499	0.1079	0.0763	0.0599	0.0302	0.3055	0.7521	0.5545	0.4695
340.	*	0.6395	0.8774	0.7466	0.6940	0.7463	1.0213	0.1470	0.1027	0.0709	0.0532	0.0225	0.3192	0.7653	0.5751	0.4739
345.	*	0.6800	0.9042	0.7883	0.7157	0.7461	1.0142	0.1355	0.0907	0.0601	0.0424	0.0143	0.3179	0.7822	0.5981	0.4805
350.	*	0.6918	0.9172	0.8165	0.7361	0.7468	0.9966	0.1142	0.0721	0.0449	0.0294	0.0076	0.2950	0.8002	0.6219	0.4896
355.	*	0.6764	0.9182	0.8300	0.7485	0.7309	0.9700	0.0855	0.0501	0.0289	0.0173	0.0032	0.2496	0.8189	0.6456	0.5036

MAX	*	0.6918	0.9215	0.8680	0.8116	0.7468	1.1767	1.1318	1.3459	1.4795	1.4520	1.5896	0.6297	1.2297	1.2619	1.1929
DEGR.	*	350	30	30	25	350	295	110	105	105	225	240	180	60	65	65

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JOB: I25 North US 36 to 104th Ave   RUN: AM Peak Worst Case

MODEL RESULTS

REMARKS : In search of the angle corresponding to the maximum concentration, only the first angle, of the angles with same maximum concentrations, is indicated as maximum.

WIND ANGLE RANGE: 0.-355.

WIND ANGLE (DEGR)	*	CONCENTRATION (PPM) 16	17	18	19	20	21	22
0.	*	0.4814	0.8394	0.5387	0.0403	0.2844	0.2773	0.1166
5.	*	0.4860	0.8436	0.6032	0.0537	0.3036	0.2968	0.1336
10.	*	0.4958	0.8408	0.6601	0.0634	0.3029	0.2968	0.1411
15.	*	0.5086	0.8363	0.7122	0.0683	0.2813	0.2761	0.1401
20.	*	0.5221	0.8382	0.7646	0.0708	0.2627	0.2582	0.1396
25.	*	0.5363	0.8470	0.8054	0.0717	0.2450	0.2409	0.1402
30.	*	0.5600	0.8619	0.8522	0.0723	0.2302	0.2266	0.1424
35.	*	0.5815	0.8951	0.8826	0.0733	0.2179	0.2155	0.1465
40.	*	0.6118	0.9436	0.8971	0.0741	0.2066	0.2068	0.1517
45.	*	0.6561	1.0059	0.8918	0.0790	0.1965	0.2022	0.1597
50.	*	0.7210	1.0771	0.8635	0.0964	0.1886	0.2041	0.1834
55.	*	0.8039	1.1461	0.8114	0.1380	0.1805	0.2125	0.2349
60.	*	0.9079	1.2154	0.7294	0.2169	0.1741	0.2317	0.3273
65.	*	0.9729	1.2147	0.6231	0.3660	0.1770	0.2863	0.4954
70.	*	0.9780	1.1464	0.5056	0.5817	0.1901	0.3839	0.7371
75.	*	0.8984	1.0075	0.3992	0.8341	0.2239	0.5335	1.0206
80.	*	0.7417	0.8205	0.3145	1.0696	0.2834	0.7223	1.2915
85.	*	0.5456	0.6223	0.2611	1.2298	0.3642	0.9187	1.4876
90.	*	0.3611	0.4553	0.2345	1.2885	0.4540	1.0898	1.5730
95.	*	0.2231	0.3379	0.2229	1.2587	0.5390	1.2027	1.5512
100.	*	0.1437	0.2756	0.2193	1.1562	0.6087	1.2457	1.4170
105.	*	0.1000	0.2458	0.2189	1.0733	0.6549	1.2467	1.2866
110.	*	0.0783	0.2348	0.2201	1.0088	0.6900	1.2152	1.1574
115.	*	0.0689	0.2425	0.2206	0.9677	0.7160	1.1615	1.0447
120.	*	0.0647	0.2483	0.2250	0.9464	0.7350	1.0946	0.9524
125.	*	0.0632	0.2536	0.2301	0.9331	0.7489	1.0235	0.8788
130.	*	0.0620	0.2559	0.2357	0.9110	0.7505	0.9428	0.8243
135.	*	0.0627	0.2594	0.2487	0.8959	0.7499	0.8823	0.7839
140.	*	0.0625	0.2581	0.2586	0.8758	0.7434	0.8307	0.7599

145.	*	0.0618	0.2550	0.2695	0.8524	0.7335	0.7916	0.7537
150.	*	0.0597	0.2503	0.2826	0.8293	0.7134	0.7591	0.7703
155.	*	0.0550	0.2440	0.2978	0.8088	0.7054	0.7554	0.7964
160.	*	0.0467	0.2354	0.3117	0.7914	0.6887	0.7486	0.8333
165.	*	0.0346	0.2230	0.3256	0.7694	0.6677	0.7426	0.8689
170.	*	0.0221	0.1996	0.3174	0.7372	0.6298	0.7221	0.8820
175.	*	0.0118	0.1656	0.2883	0.6966	0.5744	0.6872	0.8720
180.	*	0.0051	0.1236	0.2381	0.6548	0.5070	0.6386	0.8436
185.	*	0.0017	0.0810	0.1756	0.6197	0.4380	0.5813	0.8085
190.	*	0.0008	0.0459	0.1136	0.5967	0.3799	0.5375	0.7819
195.	*	0.0014	0.0229	0.0631	0.5929	0.3326	0.5035	0.7701
200.	*	0.0026	0.0114	0.0296	0.5996	0.2996	0.4845	0.7695
205.	*	0.0039	0.0082	0.0139	0.6123	0.2796	0.4782	0.7751

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JOB: I25 North US 36 to 104th Ave RUN: AM Peak Worst Case

WIND ANGLE RANGE: 0.-355.

WIND ANGLE (DEGR)	*	CONCENTRATION (PPM) 16	17	18	19	20	21	22
210.	*	0.0052	0.0078	0.0055	0.6379	0.2696	0.4787	0.7906
215.	*	0.0065	0.0089	0.0022	0.6623	0.2624	0.4749	0.7991
220.	*	0.0071	0.0097	0.0011	0.6909	0.2597	0.4701	0.8081
225.	*	0.0090	0.0123	0.0010	0.7230	0.2586	0.4648	0.8181
230.	*	0.0141	0.0187	0.0006	0.7609	0.2583	0.4618	0.8334
235.	*	0.0258	0.0335	0.0003	0.8008	0.2538	0.4595	0.8524
240.	*	0.0471	0.0609	0.0005	0.8533	0.2394	0.4586	0.8867
245.	*	0.0944	0.1210	0.0026	0.8602	0.2062	0.4334	0.8822
250.	*	0.1713	0.2181	0.0095	0.8229	0.1589	0.3819	0.8379
255.	*	0.2762	0.3491	0.0259	0.7307	0.1065	0.3048	0.7414
260.	*	0.3961	0.4968	0.0561	0.5898	0.0603	0.2143	0.5969
265.	*	0.5083	0.6337	0.0996	0.4248	0.0279	0.1292	0.4288
270.	*	0.5937	0.7406	0.1497	0.2712	0.0102	0.0647	0.2722
275.	*	0.6420	0.8100	0.1959	0.1524	0.0028	0.0260	0.1515
280.	*	0.6421	0.8357	0.2286	0.0823	0.0006	0.0094	0.0806
285.	*	0.6293	0.8514	0.2441	0.0415	0.0001	0.0024	0.0398
290.	*	0.6062	0.8574	0.2473	0.0221	0.0001	0.0005	0.0206
295.	*	0.5806	0.8576	0.2448	0.0140	0.0008	0.0005	0.0127
300.	*	0.5571	0.8536	0.2418	0.0110	0.0021	0.0013	0.0099
305.	*	0.5362	0.8446	0.2416	0.0103	0.0037	0.0026	0.0093
310.	*	0.5111	0.8182	0.2428	0.0077	0.0054	0.0041	0.0068
315.	*	0.4958	0.8029	0.2512	0.0052	0.0057	0.0043	0.0044
320.	*	0.4829	0.7886	0.2623	0.0029	0.0079	0.0063	0.0024
325.	*	0.4733	0.7777	0.2753	0.0011	0.0133	0.0113	0.0012
330.	*	0.4638	0.7601	0.2890	0.0002	0.0248	0.0223	0.0022
335.	*	0.4673	0.7693	0.3034	0.0005	0.0438	0.0406	0.0062
340.	*	0.4706	0.7825	0.3277	0.0019	0.0804	0.0763	0.0167

345.	*	0.4733	0.7994	0.3631	0.0059	0.1306	0.1255	0.0355
350.	*	0.4752	0.8168	0.4140	0.0139	0.1883	0.1822	0.0619
355.	*	0.4781	0.8302	0.4742	0.0259	0.2438	0.2367	0.0911
MAX	*	0.9780	1.2154	0.8971	1.2885	0.7505	1.2467	1.5730
DEGR.	*	70	60	40	90	130	105	90

THE HIGHEST CONCENTRATION OF 1.5896 PPM OCCURRED AT RECEPTOR 11.

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JOB: I25 North US 36 to 104th Ave RUN: AM Peak Worst Case

DATE : 8/16/18
TIME : 13:10:20

RECEPTOR - LINK MATRIX FOR THE ANGLE PRODUCING
THE MAXIMUM CONCENTRATION FOR EACH RECEPTOR

	*	CO/LINK (PPM)														
	*	ANGLE (DEGREES)														
	*	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
LINK #	*	350	30	30	25	350	295	110	105	105	225	240	180	60	65	65
1	*	0.0134	0.0000	0.0000	0.0000	0.0071	0.0027	0.0000	0.0000	0.0000	0.0091	0.0123	0.0108	0.0138	0.0447	0.0787
2	*	0.0047	0.0000	0.0000	0.0000	0.0023	0.0003	0.0000	0.0000	0.0000	0.0045	0.0041	0.0039	0.0571	0.0742	0.0385
3	*	0.0046	0.0000	0.0000	0.0000	0.0026	0.0006	0.0000	0.0000	0.0000	0.0037	0.0039	0.0039	0.0190	0.0380	0.0347
4	*	0.0380	0.0000	0.0000	0.0000	0.0564	0.0000	0.0000	0.0000	0.0000	0.0228	0.0125	0.0166	0.0018	0.0045	0.0044
5	*	0.0006	0.0000	0.0000	0.0000	0.0018	0.0000	0.0000	0.0000	0.0000	0.0008	0.0004	0.0005	0.0004	0.0005	0.0004
6	*	0.0053	0.0579	0.0508	0.0443	0.0077	0.0685	0.0823	0.0924	0.0923	0.1096	0.1076	0.0071	0.0524	0.0428	0.0351
7	*	0.0056	0.0524	0.0468	0.0425	0.0082	0.0579	0.1045	0.1301	0.1414	0.1520	0.1233	0.0078	0.0517	0.0418	0.0355
8	*	0.0052	0.0645	0.0557	0.0467	0.0075	0.0816	0.0676	0.0697	0.0634	0.0846	0.0893	0.0069	0.0518	0.0433	0.0345
9	*	0.0112	0.0000	0.0000	0.0000	0.0122	0.0015	0.0000	0.0000	0.0000	0.0149	0.0203	0.0100	0.1252	0.1370	0.1421
10	*	0.0108	0.0000	0.0000	0.0000	0.0117	0.0022	0.0000	0.0000	0.0000	0.0127	0.0190	0.0101	0.0684	0.0737	0.0812
11	*	0.0614	0.0000	0.0000	0.0002	0.0467	0.0010	0.0000	0.0000	0.0000	0.0217	0.0114	0.0325	0.0248	0.0176	0.0121
12	*	0.0196	0.1143	0.1003	0.0835	0.0370	0.1364	0.1809	0.2261	0.2493	0.2169	0.2307	0.0327	0.1674	0.1496	0.1257
13	*	0.0193	0.1071	0.0951	0.0801	0.0356	0.1185	0.2112	0.2828	0.3292	0.2916	0.3297	0.0354	0.1587	0.1435	0.1250
14	*	0.0199	0.1234	0.1068	0.0876	0.0387	0.1574	0.1613	0.1949	0.2107	0.1759	0.1809	0.0307	0.1720	0.1525	0.1240
15	*	0.0055	0.0450	0.0363	0.0281	0.0120	0.0765	0.0322	0.0364	0.0381	0.0250	0.0241	0.0067	0.0340	0.0331	0.0256
16	*	0.0055	0.0402	0.0333	0.0264	0.0114	0.0603	0.0350	0.0402	0.0424	0.0307	0.0299	0.0071	0.0405	0.0371	0.0288
17	*	0.0585	0.0000	0.0000	0.0019	0.0929	0.0400	0.0000	0.0000	0.0000	0.0078	0.0094	0.2422	0.0242	0.0213	0.0238
18	*	0.0213	0.0000	0.0000	0.0000	0.0225	0.0129	0.0000	0.0000	0.0000	0.0124	0.0300	0.0224	0.0189	0.0286	0.0453
19	*	0.0209	0.0000	0.0000	0.0000	0.0220	0.0166	0.0000	0.0000	0.0000	0.0084	0.0261	0.0225	0.0088	0.0156	0.0289
20	*	0.0220	0.0000	0.0000	0.0000	0.0233	0.0099	0.0000	0.0000	0.0000	0.0168	0.0339	0.0223	0.0371	0.0495	0.0688
21	*	0.0008	0.1033	0.0652	0.0283	0.0001	0.2788	0.0842	0.0936	0.0974	0.0050	0.0271	0.0012	0.0313	0.0430	0.0365
22	*	0.3010	0.0000	0.0000	0.0000	0.1539	0.0000	0.0000	0.0000	0.0000	0.0108	0.0059	0.0558	0.0000	0.0000	0.0000
23	*	0.0281	0.1649	0.2343	0.3057	0.1189	0.0026	0.0000	0.0000	0.0000	0.0322	0.0246	0.0188	0.0082	0.0117	0.0100
24	*	0.0014	0.0483	0.0419	0.0299	0.0012	0.0235	0.1001	0.1743	0.2153	0.1731	0.2260	0.0006	0.0494	0.0471	0.0411
25	*	0.0071	0.0002	0.0013	0.0062	0.0132	0.0271	0.0725	0.0054	0.0000	0.0090	0.0071	0.0213	0.0130	0.0112	0.0122

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JOB: I25 North US 36 to 104th Ave   RUN: AM Peak Worst Case

DATE : 8/16/18
TIME : 13:10:20

RECEPTOR - LINK MATRIX FOR THE ANGLE PRODUCING
THE MAXIMUM CONCENTRATION FOR EACH RECEPTOR

CO/LINK (PPM)

LINK #	16	17	18	19	20	21	22
ANGLE (DEGREES)	70	60	40	90	130	105	90
1	0.0428	0.0001	0.0000	0.0114	0.0000	0.0000	0.0000
2	0.0100	0.0090	0.0000	0.0005	0.0000	0.0000	0.0000
3	0.0106	0.0005	0.0000	0.0017	0.0000	0.0000	0.0000
4	0.0064	0.0010	0.1203	0.0004	0.0000	0.0000	0.0000
5	0.0003	0.0003	0.0005	0.0001	0.0000	0.0000	0.0000
6	0.0216	0.0626	0.0343	0.0421	0.0443	0.0726	0.0800
7	0.0218	0.0581	0.0318	0.0404	0.0477	0.0861	0.0832
8	0.0214	0.0654	0.0372	0.0429	0.0420	0.0622	0.0728
9	0.1503	0.1093	0.0005	0.0040	0.0000	0.0000	0.0000
10	0.0855	0.0507	0.0003	0.0078	0.0000	0.0000	0.0000
11	0.0074	0.0409	0.0913	0.0061	0.0002	0.0000	0.0004
12	0.0859	0.1876	0.0835	0.1535	0.0851	0.1669	0.2746
13	0.0862	0.1691	0.0804	0.1462	0.0904	0.1921	0.3043
14	0.0849	0.2055	0.0873	0.1553	0.0813	0.1506	0.2352
15	0.0197	0.0494	0.0269	0.0351	0.0189	0.0307	0.0376
16	0.0209	0.0564	0.0257	0.0379	0.0197	0.0332	0.0437
17	0.0176	0.0146	0.0013	0.0400	0.2086	0.1674	0.1007
18	0.0641	0.0051	0.0001	0.1132	0.0000	0.0000	0.0229
19	0.0471	0.0016	0.0001	0.2539	0.0001	0.0000	0.1357
20	0.0869	0.0143	0.0002	0.0636	0.0000	0.0000	0.0046
21	0.0358	0.0378	0.0386	0.0689	0.0432	0.0772	0.0849
22	0.0004	0.0000	0.0572	0.0000	0.0001	0.0000	0.0000
23	0.0113	0.0099	0.1431	0.0104	0.0066	0.0017	0.0036
24	0.0307	0.0563	0.0328	0.0376	0.0265	0.0514	0.0592
25	0.0086	0.0099	0.0034	0.0155	0.0356	0.1547	0.0297