The Texas Guide to Accepted Mobile Source Emission Reduction Strategies (MOSERS)

Third Edition 2021

Module 1:
Overview of Transportation Air Quality

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About This Guide

The third edition of the Texas Guide to Accepted Mobile Source Emission Reduction Strategies was developed by the Texas A&M Transportation Institute (TTI) for the Texas Department of Transportation (TxDOT), as part of the TTI-TxDOT “Air Quality and Conformity” Interagency Contract.

This guide is an updated and enhanced version of the 2007 edition of the Texas Guide to Accepted Mobile Source Emission Reduction Strategies, and it is designed for use among Texas transportation practitioners who are undertaking air quality planning. The intent of this guidebook is to provide guidance and resources for practitioners to understand and evaluate mobile source emissions reduction strategies. These resources can be used by all areas that are developing air quality plans and incorporating transportation emission reductions into their plans.

This third edition of the guidebook consists of two modules. Module 1 provides an overview of transportation and air quality planning, and discusses key topics relating to federal regulations, transportation conformity, mobile source emissions modeling, and transportation control measures. Module 2 contains a comprehensive set of analysis methods that can be used in the evaluation of emissions reductions achievable through the adoption of MOSERS. This guidebook contains updated graphics, easy-to-navigate charts, and comprehensive resource listings to help the reader gain an understanding of the subject matter and identify other resources for further reading.

Module 1
Overview of Transportation Air Quality

This module of the guidebook covers a range of topics related to transportation and air quality planning. The first chapter covers the basics of transportation and air quality planning. It includes an overview of the National Ambient Air Quality Standards (NAAQS), the regulation of key (criteria) pollutants, and an explanation of attainment designations. Transportation planning and transportation air quality concepts are also introduced in this chapter.

The second chapter focuses on the topic of transportation conformity. It discusses air quality planning as it relates to the State Implementation Plan (SIP) and covers the requirements of transportation conformity. This is followed by a chapter that introduces the air quality and emissions modeling process, including emissions inventories, on-road emissions analysis, and an overview of the MOtor Vehicle Emission Simulator (MOVES) model.

Key topics relating to mobile source emission reduction strategies (MOSERS) are then introduced, which distinguishes MOSERS from transportation control measures (TCMs). This chapter also presents a comprehensive listing and categorization of MOSERS that are discussed in further detail in Module 2 of this guide. The fifth chapter of this module then discusses the utilization of MOSERS, their inclusion in SIP and conformity documents, and documentation requirements.

The final two chapters then cover the methodologies and data sources that can be used for evaluation of MOSERS, as well as available analytical approaches, tools, and methods. The guidebook distinguishes between on-model and off-model analysis approaches, and discusses the main analytical blocks for the analysis of MOSERS. Analytical approaches and tools, including travel demand models, travel demand model post-processors, traffic simulation models, sketch planning tools, and empirical comparisons are also discussed.

1.0 The Basics

This chapter provides an overview of the main pollutants involved in the relationship between air quality and transportation, the standards by which these pollutants are regulated (NAAQS), and an explanation of attainment designations.

1.1 Air Pollutants

This section discusses the major air pollutants produced and emitted by mobile sources in three categories: criteria pollutants, air toxics, and greenhouse gases. The section also discusses relevant regulations pertinent to these types of pollutants.

Criteria Pollutants

The United States Environmental Protection Agency (EPA), in response to the Clean Air Act of 1970 (CAA) and subsequent amendments, established NAAQS for several pollutants that adversely affect human health and welfare. These are termed *criteria pollutants*. EPA, through state or local air quality agencies, monitors these six criteria pollutants against NAAQS:

- Carbon monoxide (CO)
- Particulate matter (PM)
- Ground-level ozone (O_3)
- Nitrogen dioxide (NO_2)
- Lead (Pb)
- Sulfur dioxide (SO_2)

Of these six pollutants, transportation is a major contributor to three: CO, PM, NO_2, and ground-level ozone. Exposure to these pollutants can cause or exacerbate health problems and even increase mortality rates. Ozone also contributes to what is typically experienced as smog. CO, NO_2, and PM are directly emitted from motor vehicles. Ground-level ozone is formed through a complex chemical reaction between two pollutants emitted from motor vehicles: hydrocarbons (HC), also known as volatile organic compounds (VOCs), and oxides of nitrogen (NO_x) in the presence of sunlight. HC and NO_x are called *precursor pollutants*. Table 1 provides a summary of these emissions and their effects on human health and welfare.

Quick Facts

❖ Ground level ozone is the major pollutant of concern in Texas.

❖ Ground level ozone concentrations peak in the summertime.

Table 1. Major Criteria Air Pollutants from Transportation.

Pollutant	Transportation Source	Most at Risk	Human Health and Welfare Effects
Ground Level Ozone (O_3) Colorless or bluish gas	Formed from HC and NO_x emissions from combustion engines in the presence of sunlight	Children, elderly, adults active outdoors, and people with respiratory diseases	Inflammation and irritation of the respiratory tract. Breathing difficulty, coughing, and throat irritation. Can affect lung function and worsen asthma attacks.
Particulate Matter (PM) Airborne solid or liquid particles, smaller than 10 microns (PM_{10}) in diameter or smaller than 2.5 microns ($PM_{2.5}$)	Combustion engines, specifically diesel, and re-entrained road dust	People with lung disease and/or cardiovascular disease	Can trigger asthma attacks and cause wheezing, coughing, and respiratory irritation in individuals with sensitive airways. May carry toxic materials deep into the respiratory system.
Carbon Monoxide (CO) Odorless and colorless gas	Incomplete combustion of carbon-based fuels in motor vehicles	Those with cardiovascular disease, pregnant women, and young children	Reduces the amount of oxygen reaching the body's organs and tissues. Cardiovascular patients may experience chest pain or other symptoms. CO affects mental alertness and vision, causes dizziness, and can lead to unconsciousness or death.
Nitrogen Dioxide (NO_2)	Combustion of fuels	Children, elderly, and people with asthma	Can irritate the respiratory tract, aggravate respiratory disease. May contribute to development of asthma.

The NAAQS contain two types of national ambient air quality standards; *primary standards* addressing public health protection and *secondary standards* covering public welfare protection, including protection against decreased visibility and damage to the environment. Based on the measurements gathered from air quality monitoring in a region, an area receives a NAAQS designation for a criteria pollutant as shown in Figure 1.

Attainment	**An area that meets the national primary or secondary ambient air quality standard for the pollutant.**
Nonattainment	**An area that does not meet (or that contributes to ambient air quality in a nearby area that does not meet) the national primary or secondary ambient air quality standard for the pollutant.**
Unclassifiable	**An area that cannot be classified on the basis of available information as meeting or not meeting the national primary or secondary ambient air quality standard for the pollutant.**

Figure 1. NAAQS Designations for a Pollutant.

The 2008 ground-level ozone standard was 0.075 ppm (75 parts per billion) for the fourth highest daily maximum eight-hour average concentration over the course of three years. Under this standard, the nonattainment designation for the O_3 eight-hour average is classified according to the degree that an area is exceeding the 0.075 ppm limit:

Extreme	0.175 ppm and above
Severe-17	0.119 up to but not including 0.175 ppm
Severe-15	0.113 up to but not including 0.119 ppm
Serious	0.100 up to but not including 0.113 ppm
Moderate	0.086 up to but not including 0.100 ppm
Marginal	0.076 up to but not including 0.086 ppm

In October 2015, EPA revised the 8-hour ozone NAAQS to 0.070 ppm (70 parts per billion). EPA updated the thresholds for classification categories as follows:

Extreme	0.163 ppm and above
Severe-17	0.111 up to but not including 0.163 ppm
Severe-15	0.105 up to but not including 0.111 ppm
Serious	0.093 up to but not including 0.105 ppm
Moderate	0.081 up to but not including 0.093 ppm
Marginal	0.071 up to but not including 0.081 ppm

Additional information is available on TCEQ's "State Ozone Designation Recommendation" website at https://www.tceq.texas.gov/airquality/sip/eighthour.html. An updated list of nonattainment/maintenance status for each county in Texas can be found at https://www3.epa.gov/airquality/greenbook/anayo_tx.html.

The NAAQS for CO is 35 ppm when measured hourly and 9 ppm when measured as an eight-hour non-overlapping average, both not to be exceeded more than once per year. The nonattainment designation for the CO eight-hour average is further classified as to the degree of nonattainment:

Serious	16.5 ppm and above
Moderate	9.1 up to 16.4 ppm

The air quality standards for particulate matter were revised by EPA in 2012. The new standards tightened the annual $PM_{2.5}$ standard from 15 μg/m^3 to 12 μg/m^3, and retained the 24-hour fine particle standard at 35 μg/m^3. EPA also decided to retain the 24-hour PM_{10} standard of 150 μg/m^3.

In January 2010, EPA revised the 1-hour NO_2 NAAQS to 100 ppb and retained annual average NO_2 NAAQS of 53 ppb. Currently, no area in Texas is exceeding NO_2 for these thresholds. Because the near-road environment is the primary location where short-term exposures to NO_2 occur, EPA requires urban areas with more than 500,000 population to install at least one monitor near a major road. In 2018, EPA retained the NO_2 NAAQS.

Mobile Source Air Toxics

In addition to these criteria pollutants, EPA has also identified a set of pollutants known as mobile source air toxics (MSATs). These are compounds emitted from highway vehicles that are known or suspected to cause cancer and other serious health and environmental effects. EPA estimates that MSATs account for as much as half of all cancers attributed to outdoor sources of air toxics. Although MSATs are becoming increasingly important in the air quality field, they do not have NAAQS associated with them at this time. The EPA master list of MSATs is quite extensive and contains over 425 identified compounds emitted from highway vehicles. EPA developed a list of priority MSATs that were identified as having the greatest influence on health:

- Acetaldehyde
- Acrolein
- Benzene
- 1, 3-butadiene
- Diesel PM + Diesel exhaust organic gases
- Ethylbenzene
- Formaldehyde
- Naphthalene
- Polycyclic Organic Matter

While there are no NAAQS associated with MSATs (unlike criteria pollutants), MSAT analyses may be required for specific projects as part of the National Environmental Policy Act (NEPA) requirements during the project development process.

Greenhouse Gases

Climate change attributed to increasing greenhouse gases (GHG) emissions has become a major concern in the last two decades. The EPA Administrator signed a final action in 2009 under the Clean Air Act, finding that GHGs constitute a threat to public health and welfare, and that the GHG emissions from motor vehicles contribute to the climate change problem.

The principal greenhouse gas associated with transportation activities is carbon dioxide (CO_2), which is a byproduct of fossil fuel combustion. Other GHGs from transportation include methane (CH_4) and nitrous oxide (N_2O). Currently there is no NAAQS regulating the GHG emissions from transportation activities. The primary means by which GHGs are addressed in the transportation sector are through EPA rulemaking that has established fuel economy standards for light- and heavy-duty vehicles. Several states and local agencies also implement GHG-reduction measures and conduct GHG inventories as part of state-level regulations, climate action plans, or voluntary programs.

1.2 Why Care about Transportation and Air Quality?

The 1970 Clean Air Act was the initial comprehensive federal law that regulates air emissions from area, stationary, and mobile sources as defined in Figure 2.

Area Sources are small sources of air toxics producers such as gasoline stations and dry cleaners.

Stationary Sources are places or objects that release pollutants and do not move around. Stationary sources include power plants, incinerators, houses, etc.

Mobile Sources are moving objects that release pollution; mobile sources include cars, trucks, buses, planes, trains, motorcycles, and gasoline-powered lawn mowers.

Figure 2. Definitions of Air Emissions Sources.

Mobile sources are divided into two groups:

- Road vehicles, which include cars, trucks, and buses
- Non-road vehicles, which include construction equipment, trains, planes, and lawn mowers

The CAA created EPA and authorized it to establish, maintain, and enforce NAAQS to protect public health and the environment. EPA identified six air pollutants as criteria pollutants as listed in the previous section and developed standards for each pollutant. The setting of pollutant standards was coupled with directing the states to develop SIPs applicable to appropriate industrial sources in the state.

The United States Department of Transportation (USDOT) and EPA issued several policy documents in 1978 to assure the integration of transportation and air quality planning and describe the acceptable planning process to satisfy the requirements. In 1980, The USDOT issued regulations on air quality conformance that required transportation plans, programs, and projects to conform to the approved SIPs in nonattainment areas. These regulations also required that the priority for transportation funds be given to TCMs that contributed to reducing air pollution emissions from transportation sources. The regulation prohibited the use of federal funds on major transportation projects in an area if that area's transportation plan or program was found to be in violation of these requirements.

1.3 Transportation Planning

State and local governments use the transportation planning process to decide which transportation projects to fund. The transportation planning process involves developing a series of plans and programs that TxDOT, metropolitan planning organizations (MPOs), and partner agencies have prepared. These documents effectively guide the departments and local officials' planning and programming activities to ensure that TxDOT plans and develops projects that best address state, regional, and local transportation needs. Transportation planning includes a number of steps:

- Preparing an inventory of existing systems and evaluating existing conditions
- Forecasting future population and employment growth, including assessing projected land uses in the region and identifying major growth corridors
- Identifying current and projected future transportation problems and needs, and analyzing various transportation improvement strategies to address those needs
- Developing long-range plans and short-range programs of alternative capital improvement and operational strategies for moving people and goods
- Estimating the impact of recommended future improvements to the transportation system on environmental features, including air quality
- Developing a financial plan for securing sufficient revenues to cover the costs of implementing strategies
- Prioritizing implementation of improvements
- Monitoring system performance

TxDOT is responsible for the state-maintained road network, which is commonly referred to as *on-system* facilities. MPOs are responsible for planning for transportation infrastructure in the current and expected urbanized areas with populations over 50,000 over a 20-year forecast period. Figure 3 illustrates the most important transportation planning documents that TxDOT and MPOs develop: Metropolitan Transportation Plan (MTP), Unified Transportation Program (UTP), Transportation Improvement Program (TIP), and Statewide Transportation Improvement Program (STIP). Table 2 summarizes the various plans and programs that TxDOT and its partner agencies develop and use.

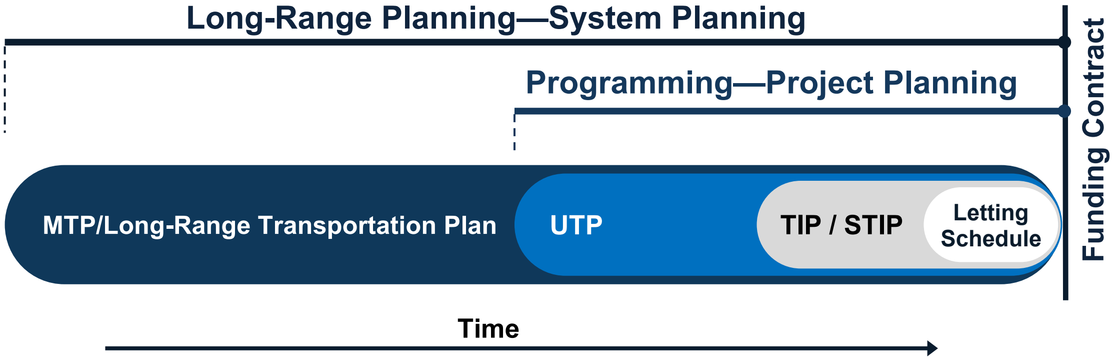

Figure 3. Key Transportation Planning Documents.

Table 2. Texas Transportation Plans and Programs.

Plan/Program	Developed By	Approved By	Time Period	Content	Update Cycle
TxDOT Strategic Plan	TxDOT	Texas Transportation Commission	5 Years	TxDOT's operational goals and strategies	Every 2 Years
Statewide Long-Range Transportation Plan (SLRTP)	TxDOT	Texas Transportation Commission	20+ Years	Future goals, strategies, and performance measures for the multimodal transportation system	Every 4 Years
Metropolitan Transportation Plan (MTP) Attainment	MPO	MPO Policy Board	20+ Years	Policies, programs, and projects for development that respond to adopted goals and expenditures for state and federal funds over the next 20+ years	Every 5 Years
Metropolitan Transportation Plan Nonattainment	MPO	MPO Policy Board	20+ Years	Policies, programs, and projects for development that respond to adopted goals and expenditures for state and federal funds over the next 20+ years	Every 4 Years*
Unified Transportation Program (UTP)	TxDOT	Texas Transportation Commission	10 Years	Multimodal projects authorized for planning/development activities over a 10-year period	Annual
Transportation Improvement Programs (TIPs)—TxDOT Rural	TxDOT Districts	Governor (delegated to TxDOT)	4 Years	Multimodal transportation projects/investments	Every 2 Years
Transportation Improvement Programs—MPO	MPOs	MPO Policy Board	4 Years	Multimodal transportation projects/investments	Every 2 Years
Statewide Transportation Improvement Program (STIP)	TxDOT	United States Department of Transportation (Federal Highway Administration [FHWA]/Federal Transit Authority [FTA])	4 Years	Multimodal transportation projects/investments	Every 2 Years
State Implementation Plan (SIP)	Texas Commission on Environmental Quality (TCEQ) and Nonattainment MPOs	Environmental Protection Agency	N/A	A description of control strategies or measures to deal with pollution for areas that fail to achieve National Ambient Air Quality Standards	Revised as Needed

* Update/approval dependent on a transportation conformity determination that demonstrates projects meet all air quality conformity requirements of the Clean Air Act Amendments.

1.4 Additional Resources

Air Pollutants

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US Environmental Protection Agency. Technology Transfer Network – Air Toxics website. *Pollutants and Sources*. Last updated September 26, 2018. http://www.epa.gov/ttn/atw/pollsour.html

US Environmental Protection Agency website. *Climate Change Regulatory Initiatives*. Last updated January 6, 2017. https://19january2017snapshot.epa.gov/climatechange/climate-change-regulatory-initiatives_.html

US Environmental Protection Agency. *Key Issues, Website and Programs for EPA's Office of Transportation and Air Quality* website. Last updated September 12, 2019.

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Federal Highway Administration website. *Planning*. Last updated May 16, 2019. http://www.fhwa.dot.gov/planning/index.cfm

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Texas Department of Transportation. *Transportation Planning Process Manual*. September 2001.

2.0 Overview of Transportation Conformity

This chapter provides an overview of transportation conformity, including the elements and requirements of general conformity and project-level conformity as well as the consequences of failing conformity.

2.1 Air Quality Planning and the State Implementation Plan

Air quality planning is the principal framework for national, state, and local efforts to protect air quality from certain manmade pollution sources. In Texas, the TCEQ administers air quality planning through the development of the SIP. The TCEQ develops the SIP to demonstrate how and when Texas will attain air quality standards established under the federal Clean Air Act.

The SIP is a written plan for cleaning the air in those areas of the state that do not meet the levels of air pollutions set in the NAAQS. It contains a collection of policies, guidance, and regulations that outline efforts the state will make to try to meet the NAAQS. For each pollutant or precursor, the SIP assigns emissions reduction values for each source type: on-road motor vehicles, non-road equipment and vehicles, stationary equipment, and area sources (e.g., dry cleaners and fuel stations).

Areas not conforming to NAAQS within each state may be designated nonattainment and are then subject to additional planning and control requirements. In Texas, the TCEQ allocates emissions reduction budgets to individual pollution sources (i.e., mobile, point, and area). The SIP then assigns specific emissions reduction levels to each source category. For the on-road mobile source category of emissions, the emissions reduction level is further refined into a regulatory limit on emissions, referred to as a *motor vehicle emissions budget* for on-road mobile sources.

An emissions inventory of the pollutants or their known precursors from point, area, and mobile sources in the nonattainment area is required. The emissions inventory also includes a biogenic (natural) emissions category. All O_3 nonattainment areas, classified as marginal and above, and CO areas must conduct these inventories and submit them to EPA every three years until attainment. This provision is important because it means that SIPs need to be periodically updated when changes in the overall level of emissions over earlier estimates are anticipated or when new emission factors are approved by EPA. Emissions reductions needed to achieve the NAAQS are determined based on the emissions inventory.

2.2 Transportation Conformity

Transportation conformity is the process that links transportation planning and air quality planning for the purpose of ensuring that changing transportation plans continue to meet established emissions budgets in the SIP, as shown in Figure 4.

Figure 4. Transportation Conformity.

The CAA requires transportation conformity for nonattainment and maintenance areas. The goal of conformity is to ensure that FHWA and FTA funding and approvals are given to transportation projects that will not:

- cause or contribute to any new violations of the National Ambient Air Quality Standards,
- increase the frequency or severity of NAAQS violations, or
- delay timely attainment of the NAAQS or any required interim milestone.

The CAA requires that transportation and air quality planning be integrated in areas designated as nonattainment or maintenance areas by EPA. Nonattainment or maintenance areas are those that fail or failed in the past to meet NAAQS for the criteria pollutants defined in the CAA. In Texas, a consultative group of reviewing agencies representing EPA, FHWA, FTA, TCEQ, TxDOT, and MPOs located in nonattainment and maintenance areas carries out the transportation conformity process.

A conformity determination is applicable to the MTP, RTP, or TIP and is required in the following instances:

- When an MPO's MTP/RTP or TIP is amended to include new project(s), or changes to existing projects, of air quality significance that were not included in a previously conforming MTP/RTP and TIP
- When a region's air quality goals change (typically under the NAAQS)
- When there are changes in the SIP related to an area's motor vehicle emissions budget
- Every four years (as required under federal regulation)

2.3 Project-Level Conformity

In addition to regional transportation conformity, some projects are also required to conform to project-level conformity requirements. A transportation project is subject to transportation conformity if it meets all of the following:

- Is located within a nonattainment or maintenance area for ozone, CO, NO_2, or PM
- Is not exempt from transportation conformity per 40 CFR 93.126
- Has FHWA/FTA funding, needs an FHWA/FTA decision, or is regionally significant (regardless of federal involvement)

All transportation projects subject to conformity are required to meet the following project-level conformity requirements:

- Come from the currently conforming MTP and TIP
- Have a design concept and scope that have not changed significantly from those in the MTP and TIP

In PM nonattainment and maintenance areas, projects coming from currently conforming MTPs and TIPs must demonstrate compliance with any control measures in the SIP. In carbon monoxide and PM nonattainment and maintenance areas, additional analysis may be necessary to determine if a project has localized air quality impacts. This localized air analysis is referred to as a *hot-spot analysis*.

2.4 Failure of Transportation Conformity

If a regional conformity determination is not made on the MTP, RTP, or TIP during the required schedule, the area has a one-year grace period to make the determination before there is a conformity lapse. During this one-year grace period, only the following types of projects can proceed:

- Exempt projects
- Transportation control measures in approved SIP
- Projects approved by FHWA/FTA before the lapse

2.5 Additional Resources

Air Quality and SIP

US Congress. Clean Air Act Amendments of 1990. Public Law No. 549. 1990.

Code of Federal Regulations. Title 40, Chapter 1, Subchapter C, Part 51, *Requirements for Preparation, Adoption, and Submittal of Implementation Plans*.

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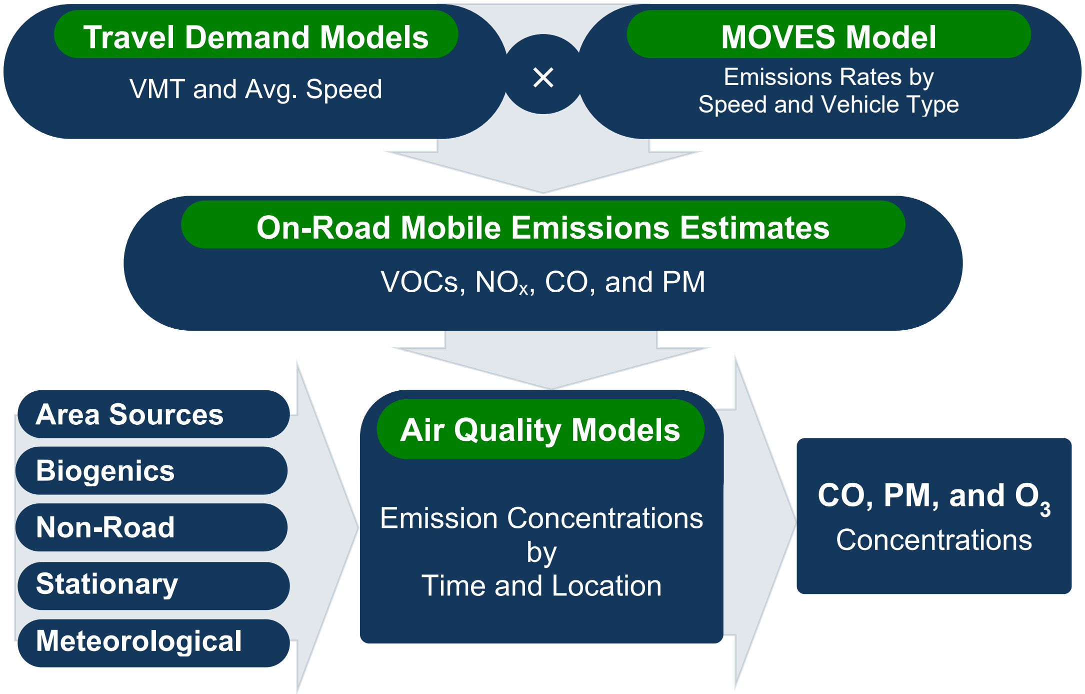
3.0 Air Quality Modeling

This chapter introduces and discusses the emissions factor modeling process. An overview of the MOVES model, the current emissions factor model, is given, along with its relationship to the analysis of mobile source emissions.

3.1 On-Road Emissions Analysis

On-road emissions analysis is a complex process requiring large amounts of data and significant time to analyze and report. Efforts to evaluate the air quality impact of on-road vehicles are by nature interdisciplinary and require the interaction of three different models and related areas of expertise: *travel demand models*, *emissions factor models*, and *air quality models*. Figure 5 illustrates these components.



Adapted from: Meyer and Miller, Urban Transportation Planning

Figure 5. Air Quality Modeling Components.

Travel demand models determine the amount of transportation activity occurring in a region based on an understanding of the daily activities of individuals and employers, as well as the resources and transportation infrastructure available to households and individuals when making their activity and travel decisions.

Emissions factor models convert information on driving conditions, vehicle and driver behavior, and environmental factors into estimates of motor vehicle emissions rates. They are based on the relationship between vehicle activities and vehicle emissions.

EPA has developed a computer model called MOtor Vehicle Emission Simulator (MOVES) to estimate motor vehicle emissions. MOVES estimates emissions rates based on vehicle type, average speed, ambient temperature, and other factors. The product of the transportation activity and the emissions rates from MOVES results in emissions estimates for each modeled pollutant. MOVES is presented in more detail later in this chapter.

It is very important that estimates of transportation activity and emissions rates be in balance with respect to fidelity, accuracy, and precision to ensure the reasonableness of the emissions estimates. Planners should understand the different aspects of each of the components when considering them in their policy analysis.

Air quality models, which broadly include *dispersion* and *photochemical* models, translate emissions inventories into predicted ambient pollutant concentrations that carry through space and time. In the context of transportation air quality analysis, dispersion models are typically used for estimating near-road concentrations of CO and PM. Dispersion models use data on emissions, meteorological conditions, and topographic characteristics to compute the dispersion of pollutants and predict the concentrations of pollutants at certain locations over specified time periods. Photochemical models are much more complex than dispersion models since they take into account the chemistry of the atmosphere and the formation of secondary pollutants such as ozone in addition to the dispersion of primary and secondary pollutants. Photochemical models are used mainly for regional analysis of ground-level ozone and other criteria pollutants.

3.2 Emission Factors and Inventories

An emission factor is a representative value relating the quantity of a pollutant released to the atmosphere with an activity associated with the release of that pollutant. These factors are usually expressed as the weight of the pollutant divided by a unit weight, volume, travel distance, or duration of the activity emitting the pollutant. In most cases, these factors are simply averages of all available data of acceptable quality.

An emission inventory is an estimate of the total emissions in an urban area measured over time. Emission inventories can be compared with air pollutant levels in an area to determine if increased emissions decrease the air quality. Emission inventories have many purposes, including those involving ambient dispersion modeling and analysis, control strategy development, and screening sources for compliance investigations.

Emission factors and emission inventories have long been fundamental tools for air quality management. Emission factors are important for developing emission control strategies. The passage of the CAA increased the need for criteria pollutant emission factors and inventories.

Ideally, data from source-specific emissions tests or continuous emissions monitors are preferred for estimating a source's emissions because these data provide the best representation of the tested source's emissions. However, test data from individual sources are not always available, and they may not reflect the variability of actual emissions over time. Therefore, emission factors are frequently the best or only method available for estimating emissions.

3.3 MOVES Model

The MOVES emissions model is a computer program designed by EPA to estimate air pollution emissions from mobile sources. As part of a broad array of strategies enacted to fulfill the CAA mandates, EPA has incorporated into MOVES a number of emissions estimation methodologies that can be used in the support of emissions reduction strategies. MOVES has replaced EPA's previous emissions model for on-road mobile sources, MOBILE6.2. MOVES is based on a large amount of new vehicle emission testing data collected in the last decade. MOVES can be used to estimate exhaust and evaporative emissions as well as brake and tire wear emissions from all types of on-road vehicles.

MOVES incorporates substantial new emissions testing data and accounts for changes in vehicle technology. MOVES uses a disaggregate emissions estimation algorithm that provides much more flexibility for input and output options than the previous generation of vehicle emissions models. This approach enables MOVES to perform estimation at different analysis levels, such as at the national, regional/county, and local/project level. Emissions modeling for SIP and regional conformity purposes are done at the regional/county level and are required to use local information of the region for inputs.

Table 3 provides a summary list of the most important MOVES user input parameters being used to extract the emission factors needed for analyzing MOSERS.

Table 3. User Input Parameters in MOVES.

• Geographical Area • Pollutants • Vehicle Type Distribution • Vehicle Age Distribution • Road Type • Time Periods	• Vehicle Operation Characteristics • Temperature and Humidity • Inspection and Maintenance (I/M) Programs • Fuel Formulation and Supply

The MOVES model is equipped with default drive cycles that are based on national-level data representing different vehicle classes and roadway types. MOVES uses a simplified road classification based on the Highway Performance Monitoring System (HPMS) functional classes, which are further differentiated as rural and urban. For on-road vehicles, the model uses 13 vehicle types that roughly correspond to HPMS vehicle classes. MOVES offers two options for calculation of emissions. The first option (inventory approach) produces total emissions in units of mass as the output, based on user-provided vehicle miles traveled (VMT) and vehicle population data. The second option (emissions rate approach) generates a lookup table of emission rates as the output, which the user can then apply to VMT and vehicle population data outside of the model to calculate total emissions.

3.4 Additional Resources

On-Road Emission Analysis
Cambridge Systematics, Inc. *A Sampling of Emissions Analysis Techniques for Transportation Control Measures*. Federal Highway Administration, Washington, DC, October 2000.

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US Department of Transportation. *Overview of Travel Demand Management Measures: Final Report*. DOT-T-94-11. January 1994.

Emission Factors and Inventories
California Environmental Protection Agency: Air Resources Board website. *Mobile Source Emissions Inventory*. Last updated February 27, 2019.
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US Environmental Protection Agency website. *Technology Transfer Network Clearinghouse for Inventories and Emissions Factors (CHIEF)*. Last updated July 31, 2018. https://www.epa.gov/chief

MOVES Model

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US Environmental Protection Agency. *Using MOVES for Estimating State and Local Inventories of On-road Greenhouse Gas Emissions and Energy Consumption, Final Report*. November 2012.

Transportation Demand Management Institute. *TDM Case Studies and Commuter Testimonials*. Association for Commerce Transportation, Washington, DC, August 1997.

US Environmental Protection Agency. *Technical Guidance on the Use of MOVES2010 for Emission Inventory Preparation in State Implementation Plans and Transportation Conformity*. Office of Transportation and Air Quality, April 2010.

4.0 Mobile Source Emissions Reduction Strategies

This chapter covers key subjects regarding mobile source emission reduction strategies, including a summary of legislation and regulations, strategies, utilization of strategies, and documentation of mobile source emission reduction strategy programs.

4.1 Introduction

State and local transportation agencies have a long history of implementing strategies to reduce air pollutant emissions in nonattainment and maintenance areas. There are many possible strategies that can be used to reduce mobile source emissions. These include transportation strategies that reduce emissions through improving vehicle technologies, fuels, or maintenance practices, capacity improvement projects to construct additional general-purpose lanes, and transportation control measures (TCM). The Federal Transportation Conformity Rule defines TCM as:

- emissions control measures listed in Clean Air Act Section 108(f)(1)(a), and
- any measure that reduces emissions by reducing vehicle use or improving traffic flow (i.e., reducing congestion).

The term TCM encompasses elements of both transportation supply management (TSM) and transportation demand management (TDM). TSM generally refers to the use of low capital–intensive transportation improvements to increase the operational efficiency of transportation facilities and services. These can include traffic flow improvements and high-occupancy vehicle (HOV) lanes. TDM generally refers to policies, programs, and actions that are directed toward decreasing the use of single-occupant vehicles, including carpool and vanpool programs, parking management, and park-and-ride lots. TDMs also can include activities to encourage shifting or spreading peak travel periods. In practice, there is considerable overlap among these concepts, and TCM, TSM, and TDM are often used interchangeably. Only approved TCMs can be included in a state's SIP.

Since 1991, the Congestion Mitigation and Air Quality Improvement (CMAQ) program has provided funds to states to implement programs that help areas meet the NAAQS for ozone, CO, and PM, and relieve congestion. CMAQ funds can be used for transportation strategies that can be documented to have emission and congestion reduction benefits in nonattainment and maintenance areas, whether or not they are in approved SIPs. Transportation strategies can be funded or implemented directly by transportation agencies (CMAQ-eligible projects). CMAQ-eligible projects are commonly referred to as TCMs, although not all of them are considered TCMs according to the conformity rule.

Beginning in 1998, EPA allowed projects under the Voluntary Mobile Source Emissions Reduction Program (VMEP) to be used for SIP emission reduction credit. These are small-scale, voluntary projects, some of which are very similar to TCMs. There are other (non-transportation) strategies that are typically implemented by state air agencies or require state and local government actions. Examples of such strategies are I/M programs, land use policies, and fuel tax rate increases.

To minimize confusion over the use of TCM in different contexts, this guide introduces a new term to encompass all of these measures: Mobile Source Emission Reduction Strategies.

Mobile Source Emission Reduction Strategies

A set of project types known to reduce mobile source emissions and assist in meeting the NAAQS.

Mobile source emission reduction strategies (MOSERS) help to reduce on-road mobile source emissions from transportation sources by reducing VMT, reducing the number or length of vehicle trips, or changing traffic flow. They may include types listed in Section 108 of the CAA. Measures that reduce emissions by improving general vehicle technologies, fuels, or maintenance practices are not included as mobile source emission reduction strategies; however, measures that upgrade or replace older vehicles or vehicle parts with vehicles with newer emissions control technologies may be included. As shown in Table 4, different terminology is used to refer to MOSERS depending on the type of application and the place they are documented.

Table 4. Measures Terminology.

Terminology	Description
Transportation Control Measure (TCM)	• Commitments are identified in approved SIP • To meet attainment demonstration and reasonable further progress requirement
Voluntary Mobile Emission Reduction Measures (VMEP)	• Voluntary measures aiming at reducing emissions in addition to the mandated reductions • Commitments are identified in approved SIP
Transportation Emission Reduction Measures (TERM)	• Commitments are not identified in SIP • Utilized in conformity demonstration as additional emission reduction credits
Weight of Evidence	• May be documented but not credited in SIP

4.2 Legislation and Regulations

This section provides a summary of the legislation and regulations regarding the mobile source emission reduction strategies over the past three decades.

Clean Air Act, 1970

- Establishes the National Ambient Air Quality Standards and SIP requirements.

Clean Air Act Amendments, 1977 and 1981

- SIPs are required to contain transportation control plans that included programs to reduce mobile source emissions (1977).
- Regulations require transportation plans, programs, and projects to conform to approved SIPs, giving priority to transportation control measures (1981).

Clean Air Act Amendments, 1990

- Sixteen categories of TCMs are identified (Section 108).
- Severe and extreme ozone areas are required to adopt specific and enforceable transportation control strategies as necessary to demonstrate attainment. A parallel requirement is established for serious carbon monoxide nonattainment areas.

Intermodal Surface Transportation Efficiency Act (ISTEA), 1991

- Authorizes the CMAQ Program to provide funding for surface transportation and other related projects that contribute to air quality improvements and congestion mitigation.

The Conformity Rule, 1993

- Plans, programs, and projects must provide for the timely implementation of TCMs.

Transportation Equity Act for the 21st Century (TEA-21), 1998

- Reauthorizes CMAQ and expanded provisions to improve bicycle and pedestrian facilities.

Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (SAFETEA-LU), 2005

- Reauthorizes the CMAQ program.
- Requires the Secretary of Transportation to evaluate and assess the effectiveness of a representative sample of CMAQ projects and to maintain a database of the various projects.

Moving Ahead for Progress in the 21st Century Act (MAP-21), 2012

- Places an emphasis on projects that reduce PM emissions.
- Ozone and carbon monoxide areas are permitted to spend CMAQ funds on projects that reduce PM_{10}.
- States and MPOs with $PM_{2.5}$ areas must give priority to projects proven to reduce $PM_{2.5}$, including diesel retrofits.
- States and MPOs are now permitted to obligate CMAQ funds to install diesel retrofit technology on both on-road and non-road equipment and vehicles used in highway construction (clean construction).
- Requires the Secretary of Transportation, in consultation with EPA, to assess emission reductions, air quality, and health impacts of actions funded under the CMAQ program since the enactment of SAFETEA-LU.

Fixing America's Surface Transportation (FAST) Act, 2015

- FHWA has developed guidance and rules related to various aspects of the legislation.

- Continues the CMAQ Program and adds eligibility for verified technologies for non-road vehicles and non-road engines used in port-related freight operations.
- Amends the eligible uses of CMAQ funds set aside for $PM_{2.5}$ and adds a new exemption for states with low population density.

4.3 Categorizing Mobile Source Emission Reduction Strategies

In this guide, the various mobile source emission reduction strategies are divided into a set of 17 categories (see Figure 6). The first 14 are the consolidated categories of TCMs listed in the CAA Section 108. Strategies 15, 16, and 17 are non-CAA measures used by organizations to reduce emission from mobile sources. Module 2 of this guide covers in detail the description, data requirements, and generic analysis approaches for these measures. The remainder of this chapter provides general information regarding the utilization and documentation of the strategies.

1. Improved Public Transit
2. Improved High-Occupancy Vehicle Facilities
3. Employer-Based Transportation Management Programs
4. Trip-Reduction Ordinances
5. Traffic Flow Improvements
6. Park-and-Ride/Fringe Parking
7. Vehicle Use Limitations/Restrictions
8. Area-Wide Rideshare Incentives
9. Bicycle and Pedestrian Programs
10. Reducing Extended Vehicle Idling
11. Extreme Low-Temperature Cold Starts
12. Work Schedule Changes
13. Activity Centers
14. Accelerated Vehicle Retirement
15. Parking Management
16. Vehicle Replacements, Retrofits and Repowering
17. Pricing Strategies

Figure 6. Categories of Mobile Source Emission Reduction Strategies.

4.4 Additional Resources

Transportation Control Measures

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Legislation and Regulation

Texas Administrative Code, Title 30, Part 1, Chapter 101, Subchapter A, *General Air Quality Rules*.

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Mobile Source Emission Reduction Strategies

Cambridge Systematics, Inc. *Transportation Control Measure Information Document*. Report No. 400-R-92-006. Office of Mobile Sources, US Environmental Protection Agency, Washington, DC, March 1992.

US Environmental Protection Agency website. Advance Control Measures & Programs. Last modified on October 23, 2017. https://www.epa.gov/advance/advance-control-measures-programs

Federal Highway Administration. *MAP-21 – Moving Ahead for Progress in the 21st Century* website. Last modified on November 7, 2018. http://www.fhwa.dot.gov/map21/

Federal Highway Administration. *Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users* website. http://www.fhwa.dot.gov/safetealu/

Wilson, Richard D., Acting Assistant Administrator for Air and Radiation, US Environmental Protection Agency. *Guidance on Incorporating Voluntary Mobile Source Emission Reduction Programs in State Implementation Plans (SIPs)*. Memorandum. October 24, 1997.

Howitt, Arnold M., and Elizabeth M. Moore. *Linking Transportation and Air Quality Planning: Implementation of the Transportation Conformity Regulations in 15 Nonattainment Areas*. EPA 420-R-99-011. US Environmental Protection Agency, March 1999.

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US Environmental Protection Agency. *Reducing Mobile Source Emissions under the Clean Air Act*. 2011.

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Transportation Research Board. *The Congestion Mitigation and Air Quality Improvement Program: Assessing 10 Years of Experience*. Special Report 264. 2002.

5.0 Utilization of MOSERS

This chapter overviews the topics related to implementation of mobile source emission reduction strategies (MOSERS): interaction between strategies, including MOSERS in SIPs; responsibilities of MPOs and other implementing agencies; claiming emission credit; and documentation of MOSERS.

5.1 Use of MOSERS

To maximize the benefits that can be achieved through the implementation of MOSERS, strategies must be planned and implemented in a coordinated manner. If strategies are not coordinated, they may conflict with one another and actually reduce the amount of emission credit gained in the region. The interaction between different mobile source emissions reduction strategies can be classified as follows:

- *Directly additive* — Projects are unrelated and affect different portions or markets in the transportation system.
- *Sequentially additive* — Projects generally affect the same portion or market in the transportation system, but are neither coordinated nor supporting measures. The effect of these project pairs is less than directly additive.
- *Synergistic* — Projects generally affect the same portion or market in the transportation system and act in supporting roles. The effect of these project pairs is greater than directly additive.
- *Conflicting or overlapping* — Conflicting and overlapping (affect the same causes in non-exclusive ways) incentives reduce individual project effectiveness.

In general, documentation of the strategies for inclusion in SIPs and conformity documents requires that individual projects or types of strategies be evaluated and documented independently. This can pose a challenge to MPOs on taking proper credits of mobile source emission reduction strategy projects to prevent double counting. In cases where synergistic credits are sought, proper documentation, including justification of assumptions, is required to demonstrate proper analysis for synergistic measures. Likewise, net effects of conflicting and overlapping strategies need to be properly credited. In general, conservative estimates should be made for these cases.

5.2 Inclusion of MOSERS in SIPs

Nonattainment and maintenance areas can include MOSERS in SIPs as TCMs to support the SIP demonstration or as contingency measures. If mobile source emission reduction strategies are included as TCMs in the SIP, they must be implemented, and timely implementation must be demonstrated as part of the conformity determination.

EPA’s guidance on inclusion of mobile source emissions reduction strategies in SIPs has a set of criteria that must be met before approval will be considered. These criteria are listed in Appendix A. The requirements include a complete description of the measure and its estimated emissions reduction benefit, evidence of adoption of the measure, obligation of funding, evidence of approvals, and existence of a monitoring program to enforce the measure.

Transportation Control Measure (TCM)

A Mobile Source Emission Reduction Strategy when included in a SIP

The TCM rule requires MPOs to submit specific TCM commitments and to ensure adequate funding, implementation, and emissions reductions through the TIP and MTP process. MPOs have an opportunity to revise the TIP and MTP to provide additional TCMs as necessary to achieve fully anticipated emission reductions. The rule also defines the responsibilities for both the MPO and implementing agencies on matters for TCM reporting. These reports cover annual estimates of emissions credits, a five-year rolling inventory, and assurances that funding is committed to these projects. Even in the case of MOSERS that are not included in the SIP but are used for conformity credits such as transportation emission reduction measures (TERMS), there is the risk of a conformity lapse if they are not implemented in a timely manner and are unable to substitute with a similar emission benefit yielding project.

TCMs must be implemented in a timely manner. This means that they must receive maximum priority for approval, funding, and timely implementation. The funding schedule of these TCMs must be consistent with the SIP schedule for implementation in a timely manner. If the implementation of a TCM has been delayed beyond the scheduled implementation date(s) in the approved SIP, then it cannot be included in the emissions analysis. In such cases, a process of TCM substitution can be used to replace TCMs in approved SIPs with alternate TCMs without the need to go through a full SIP revision. Appendix B provides more information on the responsibilities of the MPO and implementing agencies as defined in the TCM Rule and other, including further details regarding the timely implementation of TCMs, criteria for demonstrating implementation of TCMs in TIPs, and TCM substitution provisions. Additionally, VMEPs are not considered as TCMs, but they may also be included in the SIP.

5.3 Emission Credit for MOSERS

MOSERS credits (i.e. emission credits) can be taken in either the SIP or the conformity documents, each of which have their own advantages and disadvantages, as summarized in Table 5. There is no professional consensus on the best location to record these credits. This decision should be made at a local level, taking into account the level of commitment for a project and the certainty of it being implemented.

Table 5. Advantages and Disadvantages of MOSERS in SIP and Conformity Documents.

	State Implementation Plan	Transportation Conformity Determination
Advantages	• Regions can take credits toward attainment. • TCMs that are included in approved SIPs may proceed during a conformity lapse. • Including mobile source emission reduction strategies in the SIP may be an ultimate effort to prevent federal sanctions. • Inclusion in the SIP demonstrates good faith toward attainment goals. • Project descriptions are more specific. • Projects are incorporated into the CFR.	• It can help make up for inadequate reductions. • A lesser degree of commitment is required from the implementing agency. • There is more flexibility so that projects might be moved from one year to the next or the scope expanded or contracted. • The detail of documentation is less than required for the SIP.
Disadvantages	• SIP proposals are legally binding and enforceable. • Implementation is required by the date indicated. • Regions will face possible federal sanctions if MOSERS are not implemented. • It is a difficult process to modify the scope or implementation date of the project and requires public hearings for changes. • Regions may feel that the projects are "micromanaged." • It reduces the available motor vehicle emissions budget for conformity determinations. • If all reductions are listed as SIP MOSERS, there may be no additional credits available to pass conformity.	• Projects listed in these documents do not advance during conformity sanctions. • If projects are not implemented in time, conformity cannot be demonstrated.

For the MOSERS that are planned in the SIP, if MOSERS implementation has been assured, or the measure has been partially implemented and it can be demonstrated that it is providing quantifiable emissions reduction benefits for the part that is implemented, then it should be included in an emissions analysis. If the MOSERS has been delayed beyond the scheduled implementation date(s) in the approved SIP, then it should not be included in the emissions analysis.

5.4 Emission Credit Duration

Another issue to consider for the utilization of MOSERS is the duration of the credits, which varies according to the individual strategies' expected project lifetime. Project lifetimes are not definitive and no clear guidance currently exists regarding project life for various MOSERS. Project life varies between project types and may be defined by annual funding commitments, use of available capacity, or other means. Until more definitive conclusions are developed on the emissions project life of a strategy, professional judgment will continue to be necessary. Realistic and conservative assumptions must be used in consideration of project lifetimes and in the decline of emissions benefits over the project life. Table 6 is an example of general guidance for determining project lifespan.

Table 6. Expected Project Lifespan.

Service Lifespan	Type of Strategy and Facility
1–2 years	Existing transit service improvements, TDM programs, ridesharing and vanpool programs, and pricing and fare strategies
2–4 years	Intersection improvements
3 years	Signalization improvements
4–5 years	Telecommunications/telework programs
10–12 years	Intelligent transportation systems (ITS), new buses or alternative fuel buses, bicycle/pedestrian facilities, and park-and-ride lots
20 years	Roadway improvements including HOV
30–35 years	For rail transit systems, parking structures, and pavements

Source: Transportation Research Board Special Report 264, 2002.

For some MOSERS, the amount of emission reductions declines over time. For example, intersection signal retiming may show immediate benefits, but these benefits are eroded as additional demand is attracted to the intersection, resulting in a decreased level of service. The declining emission benefit is assumed to decrease in a linear manner each year until the project life is expended. For these signal retiming projects, one-half of the initial emissions benefit is taken for each year of the project's life as a means of "annualizing" the emission benefit.

Where SIP credits are claimed, EPA allows areas to claim credit for emission reductions under the Voluntary Mobile Source Emissions Reduction Program (VMEPs). VMEPs encompass many mobile source control measures, some of which are mobile source emission reduction strategies. However, EPA's guidance establishes a cap on the SIP credit allowed for VMEPs to three percent of the total projected future year emissions reductions required to attain the NAAQS. EPA notes that the emissions reduction potential of VMEPs is generally a fraction of one ton per day.

5.5 Documentation of MOSERS

Good documentation of MOSERS is crucial for gaining emission credit for submitted measures and for determining conformity with the SIP. This section discusses best practices in the documentation of MOSERS and provides a recommended format for this documentation.

Proper documentation should demonstrate the use of appropriate analysis methods and provide details of the methodology used for each measure. Proper documentation can help to expedite the interagency consultation partner review process. The methodologies are discussed in further detail in the next module of this guide.

Consistent use of units with complete descriptions of all data and assumptions used is recommended. Appendix C contains a sample form showing the recommended documentation elements for complete documentation. The MPO or documenting agency should ensure consistency between the emissions evaluations conducted through off-model analyses and the travel demand model-based analyses. Two examples are provided in Appendix D to demonstrate differences in documentation practices.

A variety of tables can be generated to display a summary of project listings and their travel and emission benefits. A sample of summary documentation is provided in Appendix E.

A complete, accurate description of units is required to avoid confusion during review. It is recommended to perform dimensional analysis checks on analysis steps as part of continued quality control. This quality control step can save valuable reviewing time and ensure that benefit estimates are accurate and calculated correctly. In rare cases this is found to be a problem, but efforts should be made during the preparation of each document to minimize the effects of improper analysis.

The MPO should also ensure consistency between the emissions evaluated in the travel demand model and off-model analyses. This is of concern for hydrocarbon emissions as precursors to ozone. There is no consistent method for reporting these types of emissions in analysis tools.

Hydrocarbons can be reported several ways according to the type of interest. The most common usages are the following:

- Volatile organic compounds
- Hydrocarbons
- Total organic gases (TOGs)
- Reactive organic gases (ROGs)

Hydrocarbons or VOCs?

In Texas, VOC is used to report hydrocarbons for all regulatory purposes.

The use of conservative assumptions is recommended. Including conservative assumptions during analysis will prevent a region from over-committing and failing to reach project goals. If the assumptions are applicable to other project types, then the assumption should be used. If the assumption varies, justification or proper referencing should be provided to the reviewing agency.

All factors used in the TCM analysis should be well documented. Proper and complete documentation will prevent any omissions that might confuse reviewing agencies. Omissions and lack of references are important keys used by reviewing agencies to request additional information, resulting in delays.

It is extremely important that strong consideration be given to documenting the actual impacts of MOSERS projects. For many TDM programs, data are limited on the actual changes to travel impacts, given costs of data collection to evaluate program effectiveness. However, for evaluation methods to become more accurate, data of this nature are required so that refinements to the analysis techniques may be made.

Careful planning should be directed at validating MOSERS inputs. Doing so ensures that project scope and other planning assumptions, from which emission credits are derived, are verified for the given credit applied to emission budgets.

5.6 Additional Resources

US Environmental Protection Agency. *Approval and Promulgation of Implementation Plans, Georgia: Approval of Revisions for a Transportation Control Measure*. April 2000.

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6.0 Methodologies and Information Sources

This chapter provides an overview of the analysis methodologies and potential data sources for MOSERS analysis. This overview includes defining the terms *on-model* and *off-model*, followed by a review of the general analysis steps for three broad MOSERS types and a summary of data collection methods widely used for MOSERS analyses.

6.1 On-Model versus Off-Model

Transportation/air quality analysis typically refers to two types of analyses: on-model and off-model. *On-model* analysis refers to those projects whose travel effects can be quantified using travel demand model networks and other methods. For those projects that cannot be adequately represented within a travel demand model, *off-model* techniques are used.

Off-model techniques vary widely. Some techniques are as simple as back of the envelope calculations, whereas others are in the form of computer interfaces using a set of generalized equations.

Are MOSERS On-Model or Off-Model?

MOSERS are quantified using off-model techniques while using on-model sources for data.

6.2 General Approach

Although models and equations may process inputs differently for MOSERS analysis, their overall approach is very similar. MOSERS analysis can be broken down into four general steps, in which various relationships may define the result. Figure 7 shows the general analysis blocks for MOSERS analysis. MOSERS analysis involves estimating the changes in each of the input blocks as the result of an emission reduction strategy. This is achieved using Vehicle Activity Analysis and Emissions Modeling.

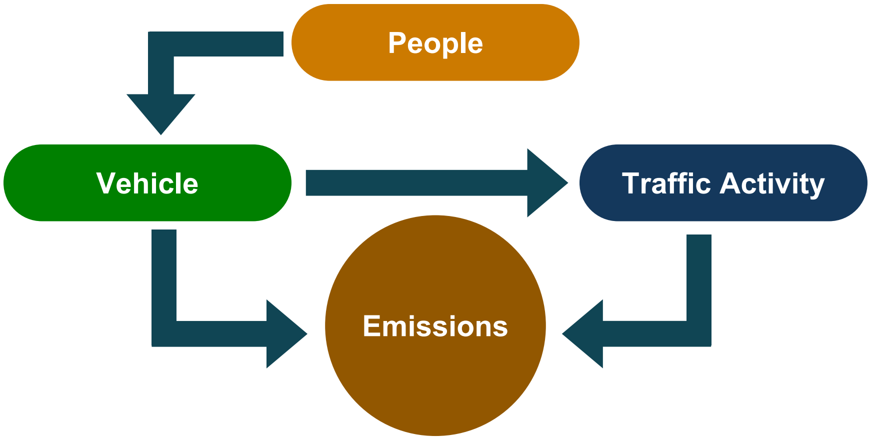

Figure 7. MOSERS Analysis Blocks.

In general, MOSERS can be categorized into three broad types: trip behavior modification, vehicle and fuel technology, and transportation system improvement.

People refers to the population that is affected by the project. This may be as small as an office building or as large as regional participation in a specific program. This analysis block can be expressed as person trips, mode share, travel time, and trip ends. Strategies that involve a change in this block are generally known as **Trip Behavior Modification** strategies.

Traffic Activity refers to how the participants' mode of travel is improved. This can be a change in overall travel speed, regional speed, or corridor speed, as well as reduced numbers of vehicle accelerations and idling times. Strategies that directly influence the parameters of this block are referred to as **System Improvement** strategies.

Vehicle refers to the activity people conduct with their personal mode of transportation. This can be vehicle trips, peak vehicle trips, vehicle miles traveled, and engine starts. Strategies that involve a change in this block are known as **Vehicle and Fuel Technology** strategies.

Finally, *Emissions* refers to how pollutants from the personal mode of transportation are affected. In most cases, differences between before and after emission rates are used to determine benefits.

Comprehensive emissions assessments include running, evaporative, crankcase, engine start, and diurnal emissions. Emission factors for each component are provided by EPA's MOVES emission model, used outside of California. California uses the EMFAC emission model. EMFAC is maintained by the California Air Resources Board.

The MPO and/or TCEQ develop emission factors. These factors reflect daily temperatures, vehicle mix and age distribution, fuel characteristics, I/M programs, and other factors representative for the local area.

6.3 Off-Model Analysis of MOSERS

This section provides an overview of the analytical approach for each broad type of MOSERS. Figure 8 graphically summarizes the analytical approach for these types of strategies.

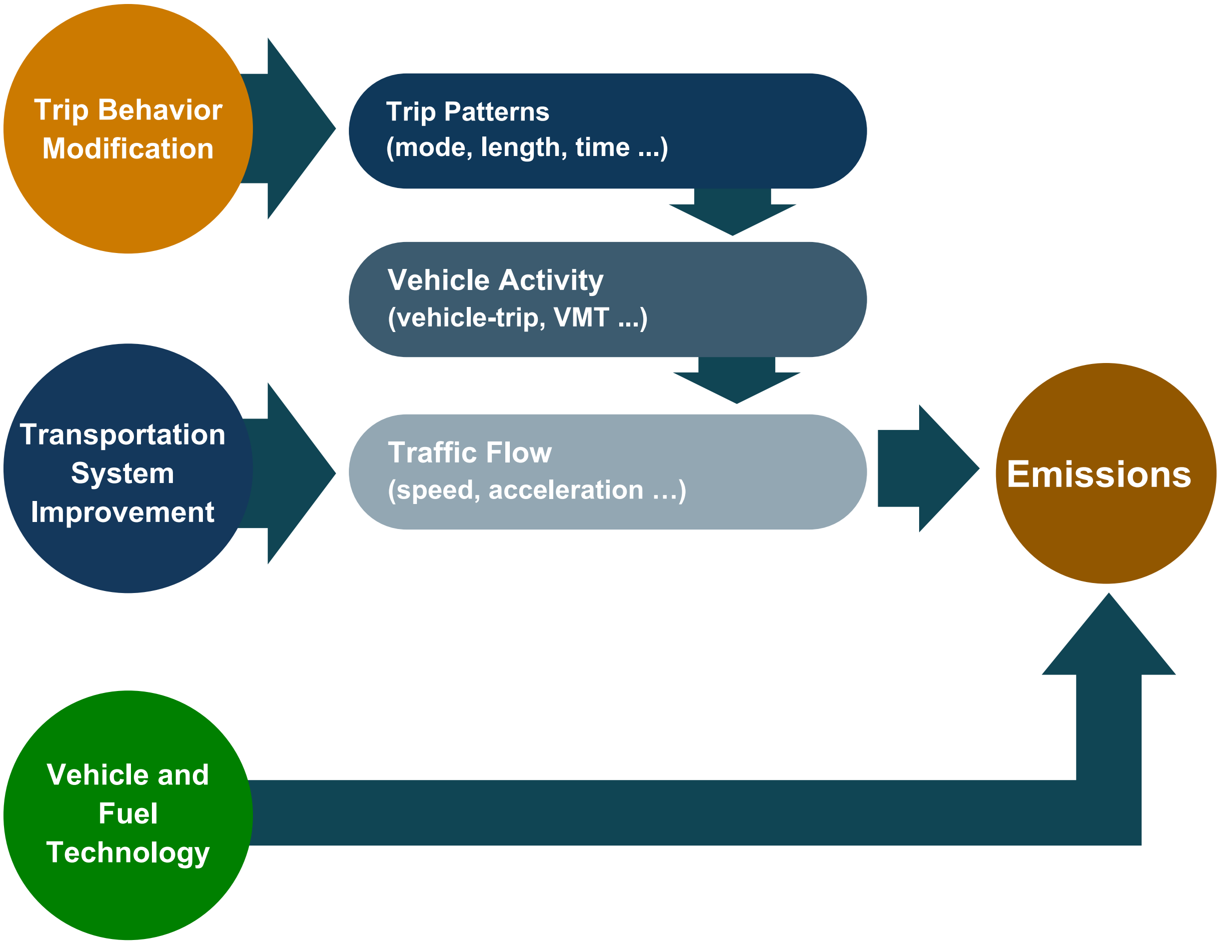

Figure 8. Off-Model Analysis Flow Chart.

Trip Behavior Modification Strategies

For projects whose goal is to modify travel behaviors, the following generalized steps may be used.

1. First, the project scope (physical limits, use, and participants) must be defined. This is a critical step to the overall process. Though some strategies will require inputs readily available, others will require some assumptions. Assumptions may be developed from survey data, experiences from other similar areas, or use of mode choice models. These assumptions should be well documented and reviewed periodically to ensure that they are reasonable. This should result in the *number of person trips affected*.
2. Second, the person trips are transformed into *vehicle trips*. This can be done by dividing person trips by an appropriate regional or corridor average vehicle occupancy (AVO). If employer-based strategies are used, an AVO specific to that center would be preferable to regional or corridor averages.
3. Third, the vehicle trips are applied over a certain length to yield *changes in VMT*. Again, regional or corridor average trip lengths can be used, but preference should be given to data that are as close to project level as possible.

4. Fourth, *changes in speed* (project level or regionally) are determined. Speed changes may be determined using elasticity. Elasticity states how a percent change in an input variable affects a percent change in an output variable. They are developed through direct observation or from results obtained by an approved mode choice model. Elasticity is generally not valid outside the range of values developed for them, nor applicable between different regions.

The travel results are then used with emission factors derived from MOVES. Trip-end emissions and VMT-related emissions are calculated from steps two through four.

System Improvement Strategies

The focus of these project types is to optimize the flow within the transportation system given the current and future travel demand on it. Examples of these projects include HOV lanes, freeway ramp metering, and traffic signal coordination. These projects seek to directly affect local, corridor, or regional travel speeds by reducing delays and smoothing vehicle accelerations. Hard vehicle accelerations can increase emission rates for certain pollutants by 10 times normal running emission rates. To capture the emissions changes of these strategies, the following generalized steps may be used.

1. First, the project scope is defined by determining the number of vehicles (volume or ADT) impacted by the strategy. These data can be gathered from the field directly through observation or by consulting local or state traffic databases for current volumes.
2. Second, determine changes in system performance measures such as average speed or delay (a surrogate for idling time) through traffic simulation software or other sketch-planning methods. Only in rare cases should estimates based on professional judgement be used to determine travel impacts. In these cases, justification of the estimate should be provided to the reviewing agencies and included in the documentation.
3. Third, the system performance changes are translated into emission changes using MOVES. Before and after emission rates for corresponding before and after speeds are applied to the project scope to determine the daily emission benefits.

Vehicle and Fuel Technology Strategies

Projects founded in modifications to vehicles or fuels for cleaner burning engines, fuels, or systems directly affect the base emissions rate. An example of a project fitting this strategy is alternative-fuel vehicles. These projects do not seek to modify either travel behavior or system performance; instead, they seek to alter the fleet emission characteristics by lowering overall emission rates.

Vehicle or fuel technology projects simply require a scope and the change in emission rates. The scope is then applied to the difference in emission rates from before and after the project implementation.

6.4 Information Sources

There are three primary methods of accumulating data in order to analyze MOSERS:

- *Current available data* — The information can be compiled from data sources available to the agency performing analysis. The available data sources may include TxDOT traffic data sets and regional travel demand models.
- *Field data collection by the agency* — In order to fill gaps in the current data or to acquire information that is simply not available to the professional, personnel from the organization must go out to the field and collect it.
- *Professional judgment* — When no data are available or the agency is unable to collect it, agency personnel can rely on their experience and professional knowledge. All assumptions should be based on existing technical guidance and approved methodologies to make an educated estimate of the needed data, or use data from other similar regions.

It is suggested that data be collected both before and after implementation of the measures to confirm inputs and improve the analysis process. This process may require several years because of the time required to implement some MOSERS.

Data types and requirements vary between MOSERS. Variables relevant to a specific mobile source emission reduction strategy (e.g., average vehicle speed near an intersection before MOSERS) are not required for other measures, such as bicycle lanes.

Transportation professionals should be aware of the spatial scale of an individual mobile source emission reduction strategy when evaluating its effectiveness. The mobile source emission reduction strategy may have impacts on local, corridor, or regional areas.

The smaller the intended effect of a mobile source emission reduction strategy, the larger the number of ambient air quality observations that must be collected before and after implementation in order to show any measurable effect with an acceptable level of confidence.

In order to obtain the most accurate estimate of mobile source emission reduction strategy effectiveness for a specific region, data specific to that region must be used. Variables such as regional VMT, trips per person, and regional trips by mode will vary based upon the characteristics of the region itself. This includes the availability of differing transit modes, land use patterns and geographic characteristics of the area, and socioeconomic characteristics. Mobile source emission reduction strategy-related travel, VMT, and mobile source emissions changes will vary according to these characteristics. If local data are not used, then the reviewing agencies may require justification of the utilized data.

The following provides an overview of the most relevant data for a MOSERS analysis in Texas.

Texas Department of Transportation

TxDOT, through district offices and the Transportation Planning and Programming Division (TPP) in Austin, can provide most of the available data on the regional roadway system.

Engineers and professionals in these offices can provide the expertise regarding any aspect of the system in a nonattainment area. TxDOT performs a regular program of traffic counts and highway performance in all districts within the state. The most recent data from these analyses are an excellent place to start gathering needed data.

TPP performs annual statewide system traffic counts, urban area saturation counts on a five-year cycle for all 25 urban areas, vehicle classifications, and automated traffic recordings (ATRs) used for annual, seasonal, daily, and hourly traffic analysis.

Urban area travel surveys are conducted, including individual surveys for households, workplaces, special traffic generators, external traffic, travel times, vehicle operating characteristics, and onboard transit. Travel demand models are calibrated, validated, and applied for each of 25 urban study areas to provide traffic assignment data for alternative transportation system scenarios and long-range plan updates. Special studies are conducted for HOV projects, TIP and long-range plan (LRP) air quality conformity analysis, and on-road mobile source emissions analysis used for urban airshed modeling.

MPOs in a near or new nonattainment area should already have an established relationship with TPP through efforts on the TIP and LRP development.

Texas Commission on Environmental Quality

Environmental data that are not confidential are available from TCEQ databases. TCEQ is responsible for developing the SIP, defining air quality modeling parameters, and developing control strategies to reduce air pollution.

The TCEQ Monitoring Operations Division collects information around the state on meteorological conditions as well as levels of criteria pollutants. The meteorological data are available electronically and in hard copy through the TCEQ's Data Management Section. The most current information available is on the TCEQ website.

United States Census Bureau

The U.S. Census Bureau can provide data on freight movement and vehicle fleet characteristics through its Census Transportation Planning Package. It is a set of 12 CD-ROM discs with special tabulations of place-of-work and transportation data focused on the data needs of transportation officials. Census data can provide demographic information for a region.

Field Data Collection

If available sources cannot provide the comprehensive data required to analyze an individual MOSERS, local agencies may need to collect their own locally specific data for required variables. Depending on the mobile source emission reduction strategy, this process may entail traffic surveys, field surveys, home interviews for travel behavior, local business surveys, or parking surveys.

For example, parking lot utilization rates in areas with implemented parking management programs may require a planner to physically observe the lot(s) before and after implementation in order to deduce utilization rates. Data from the regional travel demand model or traffic analysis by TxDOT do not provide parking data of a quality high enough for analysis of the measure. The local agency must collect it.

The parameters used in this guide's emission calculations (Module 2) may require field collection to obtain the travel impact of the measure. For example, the number of commuters that have shifted to rideshare or transit as part of an employer-based program can be inferred from traffic count or transit ridership data, but concluding that the cause is the specific MOSERS requires surveys by the agency of the businesses involved or individual commuters.

Professional Judgment
If no data can be found, collected, or inferred from existing data, transportation planners may rely on their professional judgment to determine values of factors used in determining mobile source emission reduction strategy effectiveness. This method should be used only as a last resort.

6.5 Additional Resources

Cambridge Systematics, Inc. *A Sampling of Emissions Analysis Techniques for Transportation Control Measures*. Federal Highway Administration, Washington, DC, October 2000.

Cambridge Systematics, Inc. *Transportation Control Measure Information Document*. Report No. 400-R-92-006. Office of Mobile Sources, US Environmental Protection Agency, Washington, DC, March 1992.

Eisinger, D. S., et al. *Transportation Control Measures: State Implementation Plan Guidance*. Prepared for US Environmental Protection Agency, Washington, DC, September 1990.

Harvey, G., et al. *A Manual of Transportation-Air Quality Modeling for Metropolitan Planning Organizations*. Developed for National Association of Regional Councils, Washington, DC, November 1992.

Knapp, Keith K., K. S. Rao, Jason A. Crawford, and Raymond A. Krammes. *The Use and Evaluation of Transportation Control Measures*. Report No. FHWA/TX-94/1279-6. Texas Transportation Institute, College Station, TX, 1994.

Texas Natural Resource Conservation Commission. *Revisions to the State Implementation Plan for the Control of Ozone Air Pollution*. May 2000.

7.0 Analytical Approaches and Tools

This chapter provides an overview of the analytical approach that can used to estimate the emissions benefits of MOSERS, including travel demand models, travel demand model post-processing, traffic simulation models, sketch planning tools, and empirical comparison.

7.1 Benefits of Standardized Analysis Methods

A variety of simulation tools are required to evaluate a typical range of strategies selected for a region. As described in this section, no single analysis tool can successfully evaluate all mobile source emission reduction strategy project types. As a result, a region or state may elect to adopt a standardized set of analysis methods.

Standardization provides several benefits. First, reviewing agencies become familiar with these methods. As a result, review of off-model analyses can be expedited. Fewer questions of estimated emission benefits may be raised during review. Second, inter-regional comparisons can be made. In particular, reviewing agencies may desire to compare assumptions. In many cases, these planning assumptions significantly impact the estimated emissions benefits. Though not required during formal review, MPOs or the state could review project cost-effectiveness. Suggested projects might then be developed by maximizing the cost-effectiveness under fiscally constrained transportation plans. Finally, generalizations regarding mobile source emission reduction strategies can be made once a significant number of projects are evaluated in a like manner.

7.2 Travel Demand Models

The travel demand model for a region is composed of many smaller traffic analysis zones and a transportation structure or network connecting each of the zones. Travel demand models do not provide a local street level of detail and are focused on a more homogenous area. Many factors characterize the transportation network. These factors include the monetary cost and availability (time) of travel by mode between each pair of traffic analysis zones. The model's future conditions are a function of the proposed transportation network given demands from forecasted population and employment characteristics for each traffic analysis zone. The model calculations are powered by travel survey data, which are used to predict trip generation by type in each traffic analysis zone, how these trips are distributed, which modes of travel are used, and what paths each trip takes in the network. This is also referred to as the "four-step" modeling process of trip generation, trip distribution, mode choice, and trip assignment.

Travel demand models are good tools for estimating the impacts of large-scale projects that can be translated to the model's transportation network, but are weak for estimating small-scale projects at a local level. Because of the regional nature of the travel demand model, changes in VMT and speeds are identified across the entire transportation network. Table 7 provides a list of MOSERS suitable for being analyzed using a travel demand model.

The use of regional travel demand models, when possible, may be better received by reviewing agencies. Reviewers typically have a higher confidence in the results obtained from the travel demand models because they are more familiar with its analysis concepts (four-step process). MPOs invest a great deal of staff time and data collection efforts toward the regional travel demand model. In addition, validation and calibration processes are performed on these models.

The models are also dynamic. For this reason, vehicle demand is redistributed on the transportation network as projects are evaluated. Redistribution better simulates traveler decisions made based on rate and cost (monetary and time) of travel. Redistribution may also impact other projects on the transportation network, which can then be evaluated simultaneously for any adverse impacts or lessened credits.

Table 7. Strategies for Representing MOSERS in Travel Demand Models.

Measure	Strategy
Area-wide Rideshare Incentives	• Increase time due to meeting pool members at park-and-ride lot or other locations. • Reduce time and cost due to HOV use and ridesharing. • Reduce access time at destination to represent preferential parking. • Change auto occupancy.
Area-wide Employer Trip Reduction Strategies	• Reduce the number of vehicle trips by traffic analysis zone (TAZ).
Improved Public Transit	• Reduce transit travel time and/or wait time. • Reduce transit passenger cost. • Change transit network to reflect improvements in service.
High-Occupancy Vehicle Lanes	• Recode the network with HOV links parallel to existing links. • Reduce travel time and cost for rideshare vehicles between zones connected by HOV lanes.
Parking Management	• Increase parking costs. • Increase link capacity and speeds to reflect parking restraints or reduce travel time and cost for nonscheduled road users. • Increase access (walk) time at destination to represent parking restraints.
Bicycle and Pedestrian Programs	• Reduce trip generation rates for shorter trips.
Vehicle Use Limitations and Restrictions	• Set infinitely high impedance values for specific links, or delete links from the network. • Reduce the number of vehicle trips by TAZ.
Traffic Flow Improvements	• Adjust travel times, turn penalties, parking, and capacities for individual links and nodes.

7.3 Travel Demand Model Post-Processors

These analysis tools take the information provided by the travel demand models in the form of trip tables and process the results outside of the travel demand model once the network scenario is modeled. They typically have interfaces to an emission factor model or have the emission factors coded into the program. Some tools also reconcile VMT between the regional travel demand models and the Highway Performance Monitoring System.

Post-processing tools can provide sound analysis methodologies directly to data generated from the regional travel demand model. Some post-processing tools can evaluate a variety of TDM projects. The capabilities of a post-processor are independent of other technologies used by other available post-processing tools.

Not all post-processors estimate both travel and emissions impacts. Some perform only one of the functions. The FHWA TDM Evaluation Model is an example of a post-processor that can estimate VMT impacts of TDM projects but does not have the capability to estimate emission changes from those projects. In this case, the analyst is required to use the TDM Evaluation Model results with trip-end and/or VMT-related emission factors in an additional post-processing procedure.

Use of post-processing tools requires experience with regional travel demand models. If staff members are not experienced with regional travel demand models, they should seek assistance from experienced modelers before proceeding with these tools.

7.4 Traffic Simulation Models

Classified as either microscopic or macroscopic in nature, traffic simulation models are another available resource and are suited to analyze impacts of some mobile source emission reduction strategy projects. Because the model environment is physical in nature (lanes, intersections, traffic volumes, turning movements, etc.), these tools are not suited for evaluating projects influencing travel behavior.

These tools explicitly represent most traffic control devices (signals, stop signs, yield signs, etc.) without the use of surrogate measures to account for these controls. In contrast, travel demand models cannot directly evaluate improvements of signal coordination in a corridor, but use surrogates (adjustments to travel time or link capacity) to model their impacts.

When properly calibrated, microsimulation tools can provide better estimates of traffic flow than travel demand models. In addition, the travel outputs generated by these tools are comparable to actual field measurements.

Microscopic models are able to estimate the speed profile of vehicles and idling time. In addition, they can provide indications of acceleration rates. Because of this, they can evaluate the impacts from changes in acceleration and idling. These are two impacts provided by traffic signal hardware and timing improvements.

Microsimulation tools can better represent the road network than travel demand models. Their use is best for arterial streets and freeway sections. The tools can often account for vehicle interactions in merge and weaving areas, as well as along arterial streets as vehicles accelerate and decelerate.

Microsimulation tools are limited to evaluating the range of traffic flow improvement projects and a limited number of market-based strategies. In addition, there is no single microsimulation tool that can evaluate all of the project types that can be evaluated by simulation tools.

Traffic simulation tools are not responsive to shifts in travel demand. They use traffic volumes supplied by the user but cannot forecast changes in demand within the network because of other network changes. These tools also lack a mode choice model and mechanisms for distributing trips on the network.

Some tools are not equipped with an emissions estimation module and require post-analysis to estimate changes in trip-end emissions, start emissions, and diurnal emissions. Even if a specific tool does provide a method for estimating emissions, a good understanding of the base emission rates and application is required to accurately interpret the results. They may not reflect the regional characteristics or VMT and vehicle fleet mixtures.

For network tools, a considerable amount of calibration is required to obtain reasonable estimates of traffic variables and thus emissions. For example, FRESIM has nearly 20 embedded parameters that the user can change to calibrate the model to local conditions. Calibration is among the more difficult tasks in any modeling effort.

Some simulation packages include vehicle emission factors. These emission factors may require adjustment to represent local conditions. A thorough review of the program's internal emission factor data is required prior to any adjustments. This ensures that analysis staff is aware of the nature of the emission factors and their use within the package before making adjustments that may not be appropriate.

7.5 Off-Network Analyses or Sketch-Planning Tools

These tools entail a more formal process than use of empirical comparisons. They typically estimate travel and emission impacts from a variety of MOSERS types. They are best at estimating gross impacts of projects. In contrast to previous tools, these techniques are not validated or calibrated and are less rigorous in nature. Few regions evaluate the accuracy of these techniques through comparisons of before and after studies. These tools typically use regional travel data generated through the travel demand modeling process or other means in conjunction with the characteristics of the mobile source emission reduction strategy to estimate regional emission impacts.

In most cases, sketch-planning tools are easy to use. They do not require a great deal of training to operate or use, in contrast to regional travel demand models. Data are supplied to the tools, and then the tools generate output.

Some sketch-planning tools attempt to segregate impacts to work and non-work trips and by the peak and off-peak periods. Unlike the travel demand models, these tools chain trips together for defining the trip purpose. This is a more accurate representation of the true purpose of a trip, such as a work trip with one or more intermediate stops before reaching the final destination. So, differences will exist between regional travel demand model trip tables and the trips used by these tools.

Once foundation data are input for use, many projects can be evaluated sequentially, or staff may experiment with project scopes to determine desired levels of effectiveness. The ability to analyze several projects in a rapid fashion allows MPO staff to quickly process many projects in a short amount of analysis time.

Agency reviewers may perceive the use of these tools as a black box if sufficient documentation is not provided or if they lack experience using and judging the tools' results. Care should also be taken by MPO staff using these tools so that they fully understand how the data are used and what the results indicate.

Some tools can require extensive data collection from the travel demand model and various other sources. This may require a majority of the total analysis effort. Data from a variety of sources including the census and regional travel demand model are required. Mining or transforming surrogate data into the proper input data can be labor intensive.

If data for these tools are not available, staff may rely on the use of assumptions to complete the analysis. If assumptions are used, they should be clearly indicated or summarized for the reviewing agency. If the assumptions are not referenced from other documents where values were used, then sufficient justification should be provided for the reviewing agency to determine if the assumption is acceptable or not.

For some mobile source emission reduction strategy projects, planning assumptions regarding the scope of the project in mobile source emission reduction strategies of vehicle trip, VMT, and speed changes must be made. These assumptions are typically made for supply management projects in lieu of simulating the effects. Again, reasonable assumptions should be made and well documented.

7.6 Empirical Comparisons

This is one of the simplest methods for estimating the emission impacts of mobile source emission reduction strategy projects. It is also one of the least precise and least accurate methods. Planners use experiences from other similar areas to estimate the impacts in their own area. This analysis method was suggested in *A Manual of Transportation-Air Quality Modeling for Metropolitan Planning Organizations* (Harvey et al., 1992).

This is the simplest approach for estimating travel and emission impacts of mobile source emission reduction strategy–type projects. Project scopes and their results might be proportionately scaled up or down to fit a region's planned project. Extreme care must be given to the appropriate application of this approach to extremely similar cases and areas so that comparable results can be expected.

The empirical data must be stringently evaluated for accuracy and reliability. Mobile source emission reduction strategy impacts are difficult or impossible to measure directly and require other ways to collect or estimate the data. A good understanding of how a project's results were calculated is required so that the results may be correctly applied to a new region.

Generally, there is a lack of available before and after data to evaluate mobile source emission reduction strategy impacts. Though regions may validate their mobile source emission reduction strategy impacts, this information is difficult to find and obtain because it is not widely available through technical information services.

Considerable staff time can be invested to investigate the results of similar projects under consideration. Although information on reasons for a project's success or failure is invaluable and can be applied across geographic boundaries, the results of the projects themselves are less applicable, unless many of the characteristics between the regions are similar.

Interagency consultation partners are least likely to accept benefits from this approach. The success or failure of a mobile source emission reduction strategy is dependent on many local factors: area size, demographics, available infrastructure, and land use patterns. Therefore, rigorous approaches are more likely to be required for acceptance by federal and state reviewing agencies.

7.7 Additional Resources

California Air Resources Board and CalTrans. *Methods to Find the Cost Effectiveness of Funding Air Quality Projects: For Evaluating Motor Vehicle Registration Fee Projects and Congestion Mitigation and Air Quality Improvement (CMAQ) Projects*. March 2018 Ed. Available at: http://www.arb.ca.gov/planning/tsaq/eval/evaltables.pdf

Federal Highway Administration. Congestion Mitigation and Air Quality Program, *FHWA - Cost Effectiveness Tables Summary*. Available at: http://www.fhwa.dot.gov/environment/air_quality/cmaq/reference/cost_effectiveness_tables/costeffectiveness.pdf

Transportation Demand Management Institute of the Association for Commerce Transportation. *TDM Case Studies and Commuter Testimonials*. Washington, DC, August 1997

Appendix A. Criteria for Including a TCM in SIP

EPA's policy establishes a set of criteria that a TCM must meet before it can be considered for approval in the SIP. The criteria include all of the following:

1. A complete description of the measure and its estimated emissions reduction benefits
2. Evidence that the measure was properly adopted by a jurisdiction with legal authority to commit to and execute the measure
3. Evidence that funding has been (or will be) obligated to implement the measure
4. Evidence that all necessary approvals have been obtained from all appropriate government agencies (including MPOs and state transportation departments, if applicable)
5. Evidence that a complete schedule to plan, implement, and enforce the measure has been adopted by the implementing agency or agencies
6. A description of the monitoring program to assess the measures' effectiveness and to allow for necessary in-place corrections or alterations
7. Governor's approval of the SIP
8. Public hearing (as part of the SIP approval process)

The documentation of the above criteria is found in the following reference:

Eisinger, Douglas S., et al. *Transportation Control Measure: State Implementation Plan Guidance, Revised Final Report.* No. PB-92-182013/XAB; SYSAPP—90/084. Systems Applications, Inc., San Rafael, CA (United States), 1990.

Appendix B. MPO and Implementing Agency Responsibilities

The Texas Administrative Code (TAC) defines the responsibilities for both the MPO and implementing agencies (the full section of the code is provided in the CD-ROM companion) on matters for TCM reporting (the TAC language uses TCM and is reflected here). These reports cover annual estimates of emissions credits, a five-year rolling inventory, and assurances that funding is committed to these projects.

As stated in the TAC, the MPO shall be responsible for the following:

- Ensure that all responsibilities required by an annual estimate of the emission reductions achieved from implementation of the TCM and a comparison of the actual and projected reductions are fulfilled.
- Maintain, on a rolling basis, complete and accurate records of all TCMs for at least five years. TCM records shall be sufficient to accurately reflect the effectiveness of the TCM program and shall include all of the following:
    - The annual status of the implementation of the TCM, including quantification of progress
    - An annual estimate of the funding and other resources expended toward implementing the TCM and a comparison of the actual and projected expenditures
    - An annual estimate of the emission reductions achieved from implementation of the TCM and a comparison of the actual and projected reductions
    - Any modifications to the TCM since the last annual report and/or projected modifications for the next reporting period to compensate for a shortfall in the implementation of the TCM or in the associated emissions reductions
- Make such records are available to the representatives of TCEQ, EPA, FHWA, FTA, TxDOT, local air pollution agencies having jurisdiction in the area, and the public, upon request.

According to the TAC, the implementing agency shall have responsibility for the following tasks:

- Ensure that all responsibilities required by providing evidence that funding has been, or will be, obligated to implement the TCMs are fulfilled.
- Provide the following items to the MPO upon request:
    - A complete description of the TCMs and their associated estimated emission reduction benefits
    - Evidence that the TCMs were properly adopted by a jurisdiction with legal authority to commit to and execute the program
    - Evidence that funding has been, or will be, obligated to implement the TCMs
    - A description of the monitoring program to assess the TCM effectiveness

Timely Implementation of TCMs in SIP

Those mobile source emission reduction strategies that are included in an EPA-approved SIP and that are eligible for federal funding are designated TCMs and are subject to the timely implementation requirement. TCMs included within the SIP must have funding priority consistent with the SIP schedule for implementation in a timely manner. Because the MPO or state is required to ensure timely implementation of TCMs, it ensures that they are not postponed due to lack of a funding commitment.

- Transportation projects with demonstrated air quality benefits are to receive priority allocation of funds regardless of funding source. Therefore, TCMs included in the SIP must receive maximum priority for approval.

Transportation planners should be aware of the relationship between timely implementation of TCMs and conformity determinations and TIPs. It is clear from the criteria presented below that funding and implementation of TCMs in an approved SIP receive high priority. Transportation projects used to attain NAAQS in a nonattainment area that are lacking in funding or implementation will negatively affect conformity determinations and TIPs in the area.

The FHWA's *Transportation Conformity Guide* provides the relevant sections regarding timely implementation of mobile source emission reduction strategies, both as TCMs within SIPs and those adopted that are not in the implementation plan.

CAA §176(c)(2)(B), 42 U.S.C. §7502(c)(2)(B):

> *No metropolitan planning organization or other recipient of funds under title 23, United States Code, or the Urban Mass Transportation Act shall adopt or approve a transportation improvement program of projects until it determined that such program provides for timely implementation of transportation control measures consistent with schedule included in the application implementation plan (SIP).*

58 FR 62197, November 24, 1993:

> *EPA believes that the determination of "timely implementation" should focus on the prospective schedule for TCM implementation, and all past delays should be irrelevant. Therefore, it is permissible for the plan/TIP to project completion of a TCM implementation milestone which is later than the SIP schedule if the lateness is due to delays which have already occurred, or due to the time reasonably required to complete remaining essential steps (such as preparation of a NEPA document, design, work right-of-way acquisition, Federal permits, construction, etc.). It is also*

> *permissible to allow time for obtaining State or local permits if the project has not yet advanced to the point where a permit could have been applied.*
>
> *However, where implementation milestones have been missed or are projected to be missed, agencies must demonstrate that maximum priority is being given to TCM implementation. All possible actions must be taken to shorten the time periods necessary to complete essential steps in TCM implementation—for example, by increasing the funding rate—even though the timing of other projects may be affected. It is not permissible to have prospective discrepancies with the SIP's TCM implementation schedule due to lack of programming funding in the TIP, lack of commitment to the project by sponsoring agency, unreasonably long periods to complete future work due to lack of staff or other agency resources, lack of approval or consent by local government bodies, or failure to have applied for a permit where necessary work preliminary to such application has been completed.*
>
> *However, where statewide and metropolitan funding resources and planning and management capabilities are fully consumed with responding to damage from natural disasters, civil unrest, or terrorist acts, TCM implementation can be determined to be timely without regard to the above, provided reasonable efforts are being made. The burden of proof will be on the agencies making conformity determinations to demonstrate that the amount of time to complete remaining implementation steps will not exceed that specified in the SIP without good cause, and that where possible, steps will be completed more rapidly than assumed in the SIP in order to make up lost time.*

As part of the interagency consultation process when TCMs included in an approved SIP have been delayed in the past or are currently behind schedule, a determination must be made that all obstacles to implementation have been identified and are being overcome. In addition, the U.S. Department of Transportation must, in approving a conformity determination, find that priority is being given to TCMs included in approved SIPs.

Criteria for Demonstrating Timely Implementation of TCMs in TIPs

To demonstrate timely implementation of TCMs for TIPs, states must meet the following criteria:

Code of Federal Regulations (CFR), 40 CFR §93.113(c)(1–3), as amended by 62 FR 43780, 43809-10, August 15, 1997:

> *(1) An examination of the specific steps and funding source(s) needed to fully implement each TCM indicates that TCMs which are eligible for funding under title 23 U.S.C. or the Federal Transit Laws are on or ahead of the schedule established in the applicable implementation plan, or if such TCMs are behind the schedule established in the applicable implementation plan, the MPO and DOT have determined that past obstacles to implementation of the TCMs have been identified and have been or are being overcome, and that all State and local agencies with influence over approvals or funding for TCMs are giving maximum priority to approval or funding of TCMs over other projects within their control, including projects in locations outside the nonattainment or maintenance area.*
>
> *(2) If TCMs in the applicable implementation plan have previously been programmed for Federal funding but the funds have not been obligated and the TCMs are behind the schedule in the implementation plan, then the TIP cannot be found to conform if the funds intended for those TCMs are reallocated to projects in the TIP other than TCMs, or if there are no other TCMs in the TIP, if the funds are reallocated to projects in the TIP other than projects which are eligible for Federal funding intended for air quality improvement projects, e.g. the Congestion Mitigation and Air Quality Improvement Program.*
>
> *(3) Nothing in the TIP may interfere with the implementation of any TCM in the applicable implementation plan.*

TCM Substitution Process

SAFETEA-LU streamlined the TCM substitution process. SAFETEA-LU amends the CAA to provide a process for replacing TCMs in approved SIPs with alternate TCMs or for adding TCMs to approved SIPs.

SAFETEA-LU provides that substitute TCMs can replace or be added to existing TCMs in approved SIPs if:

- the substitute TCM achieves equal or greater emissions reductions;
- the schedule is consistent with the existing TCM or, if the implementation date has passed, as soon as practicable but no later than the date reductions are needed;
- adequate personnel, funding, and enforcement are demonstrated; and
- the substitute TCM is developed through a collaborative process that includes public comment and concurrence by the MPO, the air agency, and EPA.

No substitution mechanism in the SIP is needed, and substitution does not require a new conformity determination or SIP revision.

Appendix C. Expected MOSERS Documentation Elements

Project TIP ID:

Project name:

Description (objective):____

____

Project limits or scope (specific location or locations):___________________

Funding Category:

Implementation agency: _____________________

Letting date: _______________________________

Implementation date: _______________________

Project Benefits Methodology:

Analysis tool:

Is the methodology national or locally derived?

Inputs and sources/assumptions and their basis:

Procedures for obtaining and maintaining data (brief description):

Equations or processes used to estimate benefits (travel, emissions):

Sample calculations for one inventoried like project:

Other documentation and references (include or attach documentation of spreadsheet equations, if used):

Expected Benefits:

Travel (vehicle trips removed, VMT removed/reduced, speed improvements, delay reduction):

Emissions (rate source, assumptions, trip end emissions, running emissions):

Cost-effectiveness (life cycle or effective period, implementation and operating):

Major Summary:

Emission reduction (lb./day or tons/day) (kg/day — CMAQ):

Total cost:

Annual cost per unit reduced ($/ton):

Appendix D. Examples of Off-Model Documentation

Example 1: Off-Model Documentation

Traffic Signal Coordination ❶

The city's master traffic signal controller was replaced with a new controller with expanded capacity. This allowed 26 more intersections to be coordinated.

Inputs to Calculated Cost-Effectiveness

Funding dollars (funding): $90,000 ❷
Effectiveness period life): 5 years
Days of use/year (D): 250
Length of congested roadway segment (L): 8.07 miles
Traffic volume during congested period (congested traffic): 88,643 trips per day

Before speed: 28 mph ❸
After speed: 33 mph

Emissions Factor Inputs (from Table 4):

	Before Speed Factor	After Speed Factor
ROG Factor	0.51 grams per mile	0.43 grams per mile
NO_X Factor	1.14	1.13
PM_{10} Factor	0	0

Calculations: ❹

Annual Project VMT (VMT) = (D) * (L) * (Congested Traffic)
=250 * 8.07 * 88,643 =
178,837,253 annual miles

Annual Emission Reductions (ROG, NO_X, and PM_{10}) in lb. per year

= [(0.50) * (VMT) * (Bef Speed Fctr – Alt Speed Fctr)]/454 grams per lb.

Note: Initial speed improvements decline to zero improvement by the effectiveness period, In order to account for this, the emission reduction equation reduces initial emission reduction benefits by one half.

ROG: [(0.50) * (178,837,253) * (0.51 – 0.43)]/454 = **15,757 lb. per year**
NO_X: [(0.50) * (178,837,253) * (1.14 – 1.13)/454 = **1,970 lb. per year**
PM_{10}: [(0.50) * (178,837,253) * (0 – 0)/454 = **0 lb. per year**

Capital Recovery Factor (CRF)

= $[(1 + i)^n (i)/[(1 + i)^n] – 1 = 0.23$,
Where n = project life (5 years) and i = discount rate (5 percent)

Cost Effectiveness of Funding Dollars ❺

= (CRF * Funding)/(ROG + NO_X + PM_{10})
= (0.23 * 90,000) / 17,727
= **$1 per lb.**

FOR CMAQ PROJECTS ONLY:

Once emissions reductions have been calculated, add them together (15,727 + 1,970 = 17,727) and convert emissions reductions to kg/day:
= lb. reduced per year / (2.2 lb./kg * 365 days/year)
= 17,727 / (2.2 * 365)
= 22 kg/day

❶ No dates

❷ No funding category

❸ No sources for volume or speed

❹ Good use of equations and data below

❺ O&M costs not included

Example 2: Off-Model Documentation

DESCRIPTION: 41 intersections with fiber optic cable installed. ❶

❷

Project will reduce the travel time for trips within the district and also help reduce delays during diversion route strategies. This project is for arterials in the city of Birmingham. Emissions reductions for air quality include project (5) City Center Congestion Management Plan.

Vehicle miles traveled along those routes are 415,340 vehicle miles per day.

❸

Average delay reductions per mile are 46 seconds/vehicle for en route drive information, respectively, during peak hour periods.

(Source: Phase I report, Congestion Management System/VHS Program Study for Birmingham, Alabama, by Parsons Brinkerhoff Quade and Douglas, Inc., APRIL 1995)

❹

Idling emission rate for delay is based on Mobile 5.0 in year 1998.

HC & NO_X Worksheet for (12):

❺

Criteria & Assumptions* ❻

Description	Assumption	Note
Total vehicle miles in locations	415,340	No
Peak hours period	2.0	hours
Avg. delay reductions per veh-mile for en route drive in form	46.0	seconds/veh
HC idling emission rate	62.81	grams/hour (1998)
NO_X idling emission rate at	11.26	grams/hour (1998)

Methodology ❼

E = D * VMT * ERi where

E = HC or NO_X emissions reductions in grams per day

*VMT = VT * L*

D = delay reductions per vehicle mile during peak hours

ERi = idling emissions rate

Result

Item	Reduction	Note
HC reduction = Delay * ERi	66,672	grams
= (46)/3600 * 415340 * (0.1 * 2) * 62,814		
NO_X reduction = (E by Bike) + (E by Ped)	10,393	grams/d
= (46)/3600 * 415340 * (0.1 * 2) * 11.26		
VMT Reductions =	0	vehicle miles/year

❶ No dates

❷ Good description, but no funding given

❸ No source

❹ Good source

❺ No project life

❻ No days/year

❼ Lack of proper unit conversion

Appendix E. Summary Documentation

There are currently no standard guidelines for summary documentation. A variety of tables can be generated to display project listings and the travel and emission benefits of those projects. A sampling of summary documentation is described below.

One area chose to summarize their TIP projects for conformity following the format in Figure E1. Using this format, on-model and off-model projects are clearly separated for the reviewing agencies. Separating out how the analyses were conducted will allow the reviewing agency to check that modeled projects are ones that can actually be modeled. It also enables the reviewing agency to identify and verify that off-model analyses were performed correctly and that their benefits are accurately represented.

FY 2xxx TIP PROJECTS

2xxx MODEL

County	TIP#	Project/Facility	Limits	Improvement
Projects listed here				

2xxx OFF-MODEL

County	TIP#	Project/Facility	Limits	Improvement
Projects listed here				

Figure E1. Sample Documentation Format.

Cost-effectiveness summaries are also valuable. When used, these tables provide a broad overview of strategy benefits and costs. Many of the mobile source emission reduction strategy projects may be toward the top of the table and can vary in expense. Only a few projects will yield high emission benefits toward the bottom of Table E1.

Table E1. MOSERS Cost-Effectiveness Summary Table.

Emissions Reduction	Revenue Producing	\$0 – \$49K per Ton	\$50K – \$99K per Ton	\$100K – \$249K per Ton	\$250K – \$499K per Ton	> \$500K per Ton
< 0.5						
0.5 – 0.99						
1.0 – 1.49						
1.5 – 1.99						
2.0 – 2.49						
2.5 – 2.99						
3.0 – 3.49						
3.5 – 3.99						
4.0 – 4.49						
4.5 – 4.99						
5.0 – 5.49						
5.5 – 5.99						
≥ 6.0						