Introduction to

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

Reza Farzaneh, Ph.D., P.E.
Robert Huch, P.G., CPESC
Madhusudhan Venugopal, P.E.

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Introduction to

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

MOSERS Training – Part 1

INTRODUCTION

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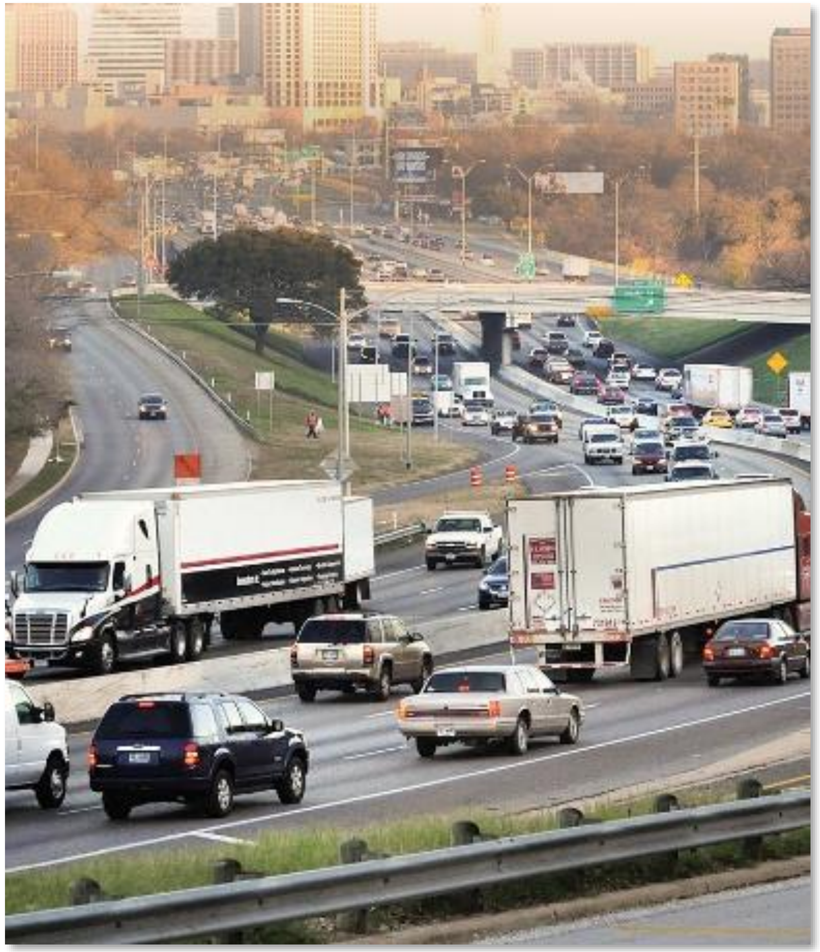
Outline



1. Introduction
2. What is MOSERS?
3. Application of MOSERS
4. Analytical Approaches to MOSERS
5. Overview of the MOSERS Guide Module 2
6. MOSERS Spreadsheet Tool

Stakeholders

Technical Working Group for Mobile Source Emissions

Federal

EPA

U.S. Department of Transportation Federal Highway Administration

State

Texas Department of Transportation

Texas Commission on Environmental Quality

Local

AACOG Alamo Area Council Of Governments

Capital Area Council of Governments CAPCOG 50th Anniversary

North Central Texas Council of Governments

CAMPO Capital Area Metropolitan Planning Organization

H-GAC Houston-Galveston Area Council

El Paso Metropolitan Planning Organization

Heart of Texas Council of Governments

East Texas Council of Governments

Northeast Texas Air Care It's Your Air, Take Care!

NET RMA North East Texas Regional Mobility Authority

AAMPO

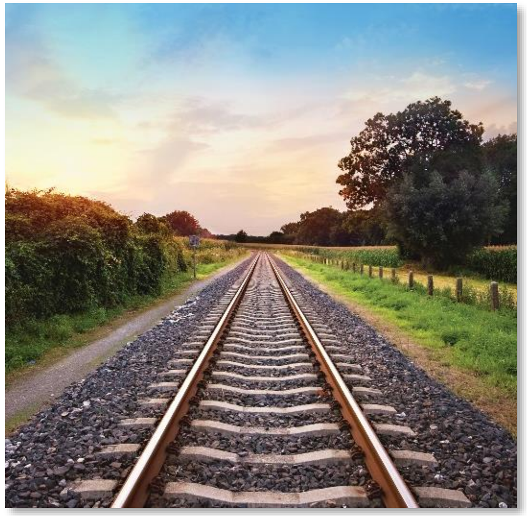
SETRPC South East Texas Regional Planning Commission

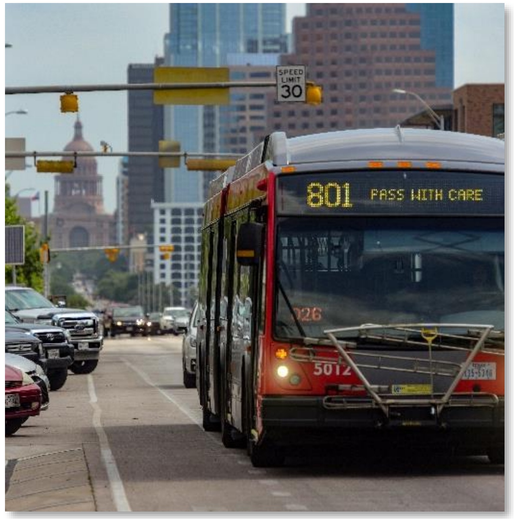
Victoria MPO Metropolitan Planning Organization

Goal

- Participants will develop an understanding of:

- MOSERS methodologies basics
- Types of emission reduction strategies
- Basics on activities & emission rates
- Difference of benefits in SIP, conformity, & CMAQ
- Hands-on exercise on a few strategies





MOSERS Training – Part 2

WHAT IS MOSERS?

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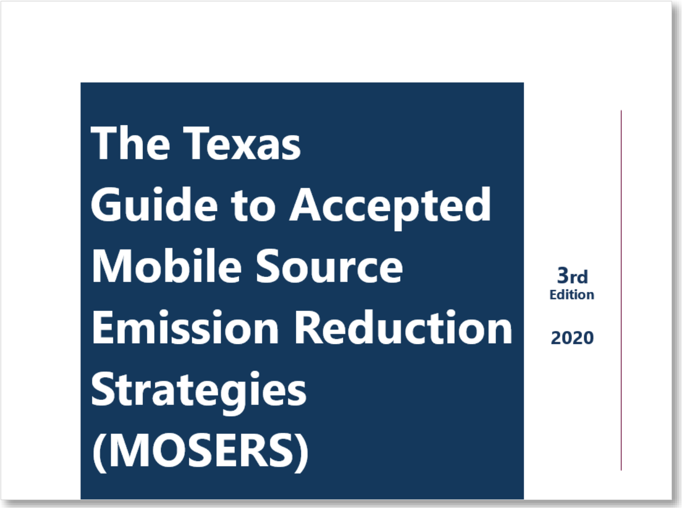
What is MOSERS?

MOSERS = Mobile Source Emission Reduction Strategies

- A set of project types known to reduce mobile source emissions and assist in meeting the NAAQS
- MOSERS Guide is a set of methodologies, equations, and tools to estimate emission reduction benefits



MOSERS Guide provides

- Uniformity
- Consistency
- Modeling that is not travel demand model (TDMs)

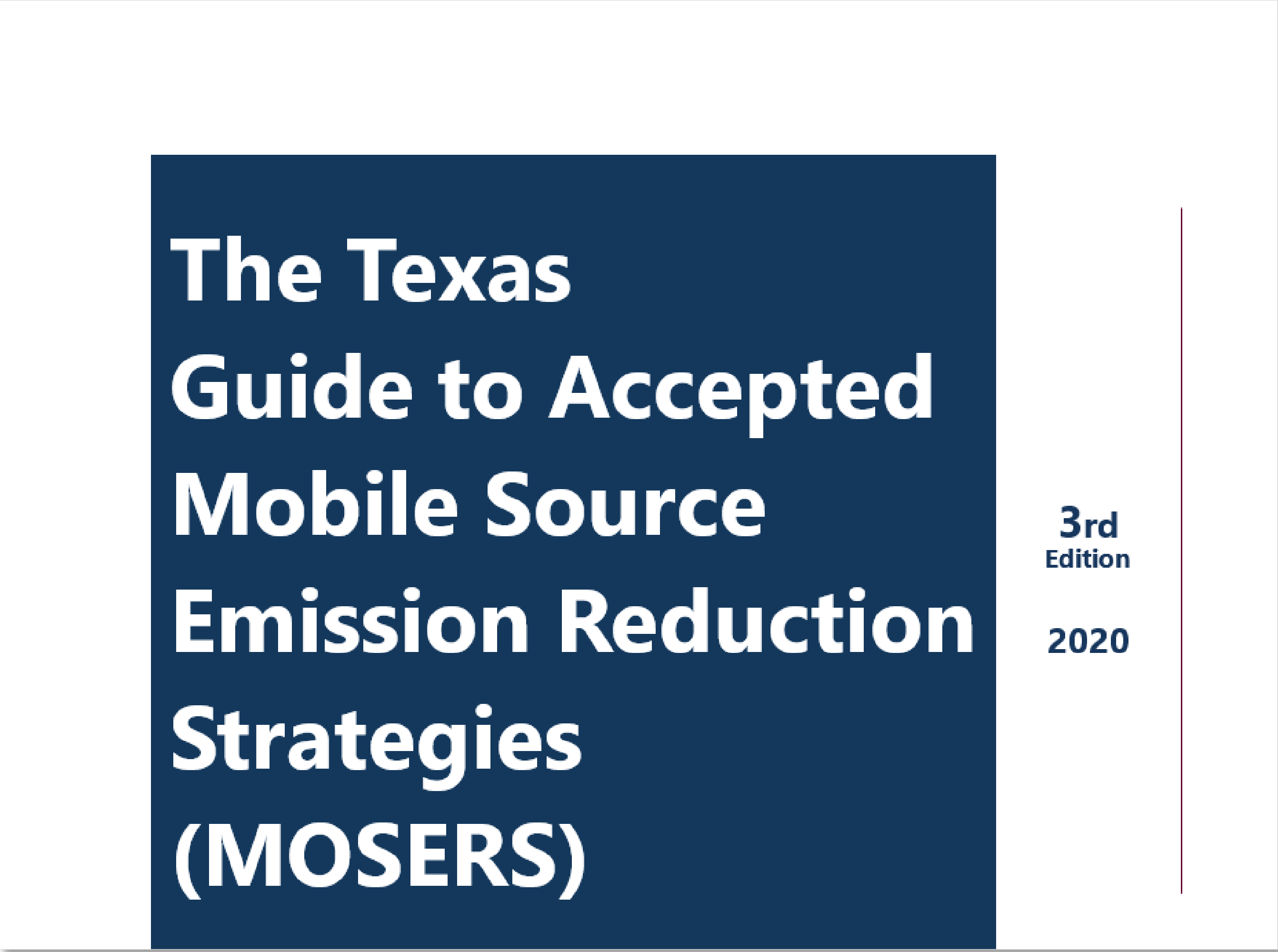
Emissions Benefits Estimations

Sketch Planning Methods

- Simple equations
- Requires assumptions
- Less time and data needed

Models

- More accurate
- Complex and data intensive
- Requires skills such as software programs



Laws and Regulations

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

Continues the CMAQ Program and amends the eligible uses of CMAQ funds set aside for PM2.5

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

Places an emphasis on projects that reduce PM emissions

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

Reauthorizes the CMAQ program

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

Reauthorizes CMAQ and expanded provisions to improve bicycle and pedestrian facilities

1993 – **The Conformity Rule**

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

1991 – **Intermodal Surface Transportation Efficiency Act (ISTEA)**

Authorizes the CMAQ Program to provide funding for projects that contribute to AQ improvements and congestion mitigation.

1990 – **CCA Amendment**

Sixteen categories of TCMs are identified (Section 108)

1981 – CCA Amendment

Regulations require transportation plans, programs, and projects to conform to approved SIPs, giving priority to transportation control measures

1977 – CCA Amendment

SIPs are required to contain transportation control plans that included programs to reduce mobile source emissions

1970 – **Clean Air Act (CCA)**

Establishes the National Ambient Air Quality Standards (NAAQS) and SIP requirements.

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Criteria Pollutants

EPA established the National Ambient Air Quality Standards (NAAQS) for six Criteria Pollutants

1. Carbon monoxide (CO)
2. Particulate matter (PM)
3. Ground-level ozone (O_3)
4. Nitrogen dioxide (NO_2)
5. Lead (Pb)
6. Sulfur dioxide (SO_2)

Transportation is a major contributor to these four

State Implementation Plan (SIP)

- A plan for cleaning the air in those areas of the state that do not meet the levels of air pollutions set in the NAAQS
- Demonstrates how and when Texas will attain air quality standards established under the federal Clean Air Act
- Areas not conforming to NAAQS within the state may be designated nonattainment and are then subject to additional planning and control requirements
- An emissions inventory of the pollutants in the nonattainment area is required

Transportation Conformity

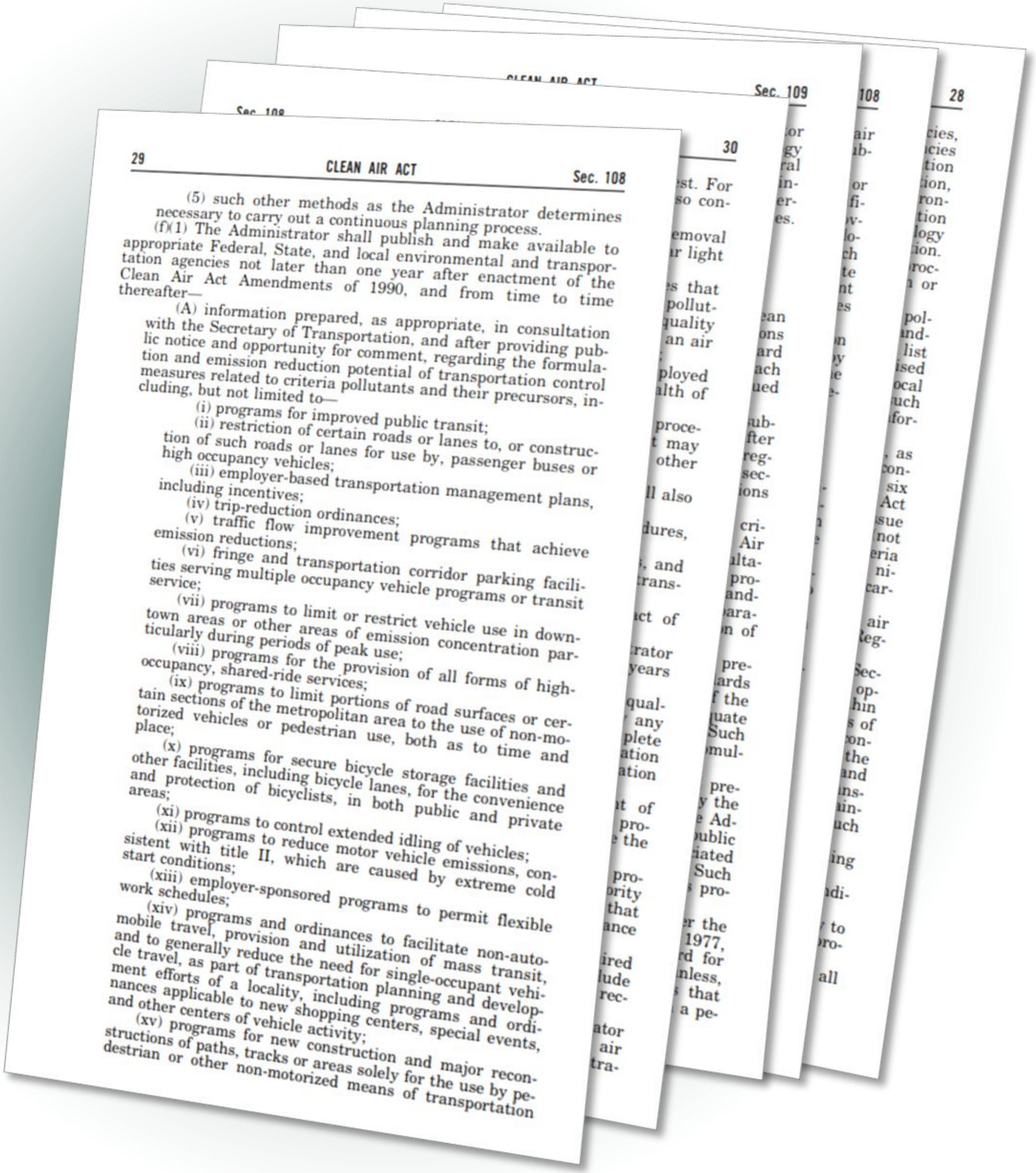
Transportation conformity links transportation planning and air quality planning for the purpose of ensuring that changing transportation plans continue to meet established emissions budgets in the SIP

The CAA requires transportation conformity for non-attainment and maintenance areas

MOSERS Background

Transportation Control Measures are defined as:

- Emissions control measures listed in CAA Section 108(f)(1)(a)
- Any measure that reduces emissions by reducing vehicle use or improving traffic flow (i.e., reducing congestion)



29 CLEAN AIR ACT Sec. 108

(5) such other methods as the Administrator determines necessary to carry out a continuous planning process.

(f)(1) The Administrator shall publish and make available to appropriate Federal, State, and local environmental and transportation agencies not later than one year after enactment of the Clean Air Act Amendments of 1990, and from time to time thereafter—

(A) information prepared, as appropriate, in consultation with the Secretary of Transportation, and after providing public notice and opportunity for comment, regarding the formulation and emission reduction potential of transportation control measures related to criteria pollutants and their precursors, including, but not limited to—

(i) programs for improved public transit;

(ii) restriction of certain roads or lanes to, or construction of such roads or lanes for use by, passenger buses or high occupancy vehicles;

(iii) employer-based transportation management plans, including incentives;

(iv) trip-reduction ordinances;

(v) traffic flow improvement programs that achieve emission reductions;

(vi) fringe and transportation corridor parking facilities serving multiple occupancy vehicle programs or transit service;

(vii) programs to limit or restrict vehicle use in downtown areas or other areas of emission concentration particularly during periods of peak use;

(viii) programs for the provision of all forms of high-occupancy, shared-ride services;

(ix) programs to limit portions of road surfaces or certain sections of the metropolitan area to the use of non-motorized vehicles or pedestrian use, both as to time and place;

(x) programs for secure bicycle storage facilities and other facilities, including bicycle lanes, for the convenience and protection of bicyclists, in both public and private areas;

(xi) programs to control extended idling of vehicles;

(xii) programs to reduce motor vehicle emissions, consistent with title II, which are caused by extreme cold start conditions;

(xiii) employer-sponsored programs to permit flexible work schedules;

(xiv) programs and ordinances to facilitate non-automobile travel, provision and utilization of mass transit, and to generally reduce the need for single-occupant vehicle travel, as part of transportation planning and development efforts of a locality, including programs and ordinances applicable to new shopping centers, special events, and other centers of vehicle activity;

(xv) programs for new construction and major reconstructions of paths, tracks or areas solely for the use by pedestrian or other non-motorized means of transportation

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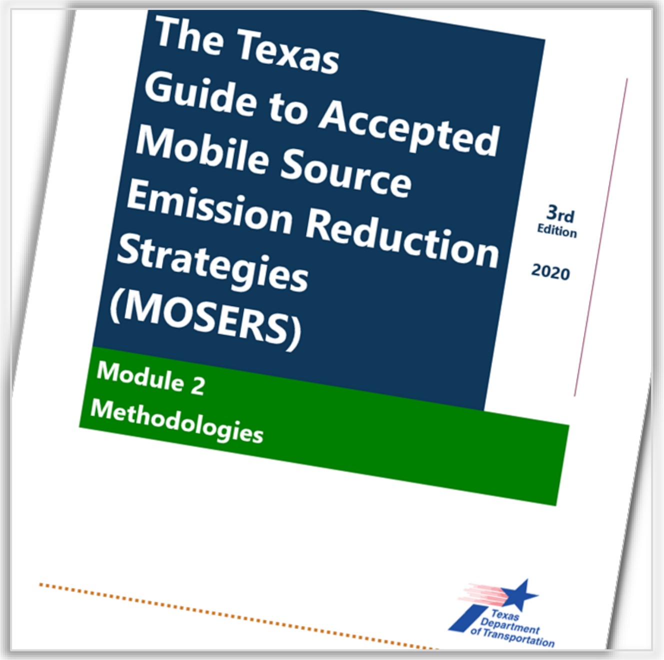
Examples of MOSERS

- Intersection improvements
- Bicycle/pedestrian facilities
- HOV lanes
- Rail
- Grade separations
- Park-and-ride
- Vanpools

- Intelligent transportation systems
- Traffic signal improvements

- Employee trip reduction program
- Clean vehicle program
- Locally-enforced idling restrictions
- Diesel idling reduction program

Questions and Comments



Introduction to the MOSERS Guide

History of the MOSERS Guide

First Edition — **2003**

- Reviewing agencies needed consistencies
- Uniformity in emission reduction strategies

Second Edition — **2007**

- Modifications to the equations
- Added new strategies

Draft Third Edition — **2017**

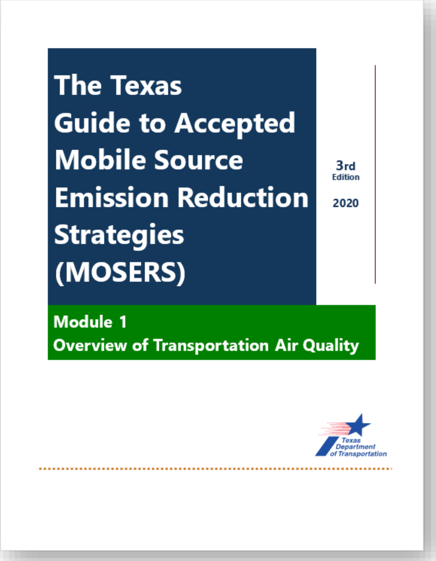
- Uniformity in activity estimation
- Refinement of equations

Final Third Edition — **2020**

- Refinement of equations
- Added new strategies
- Added spreadsheet tool
- Added web portal

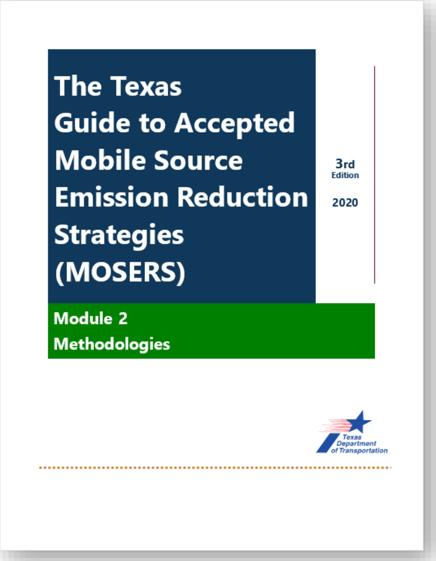
Final MOSERS Guide Format

Module 1



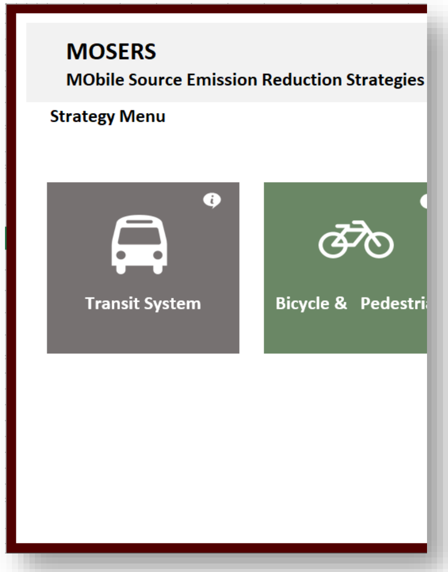
Online
PDF Document

Module 2



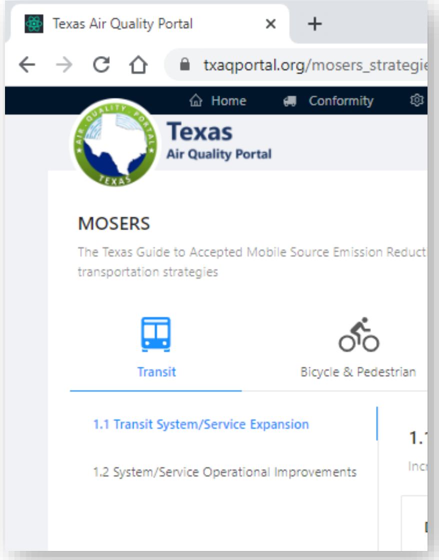
Online
PDF Document

Tool



Excel®
Spreadsheet Tool

Web Edition



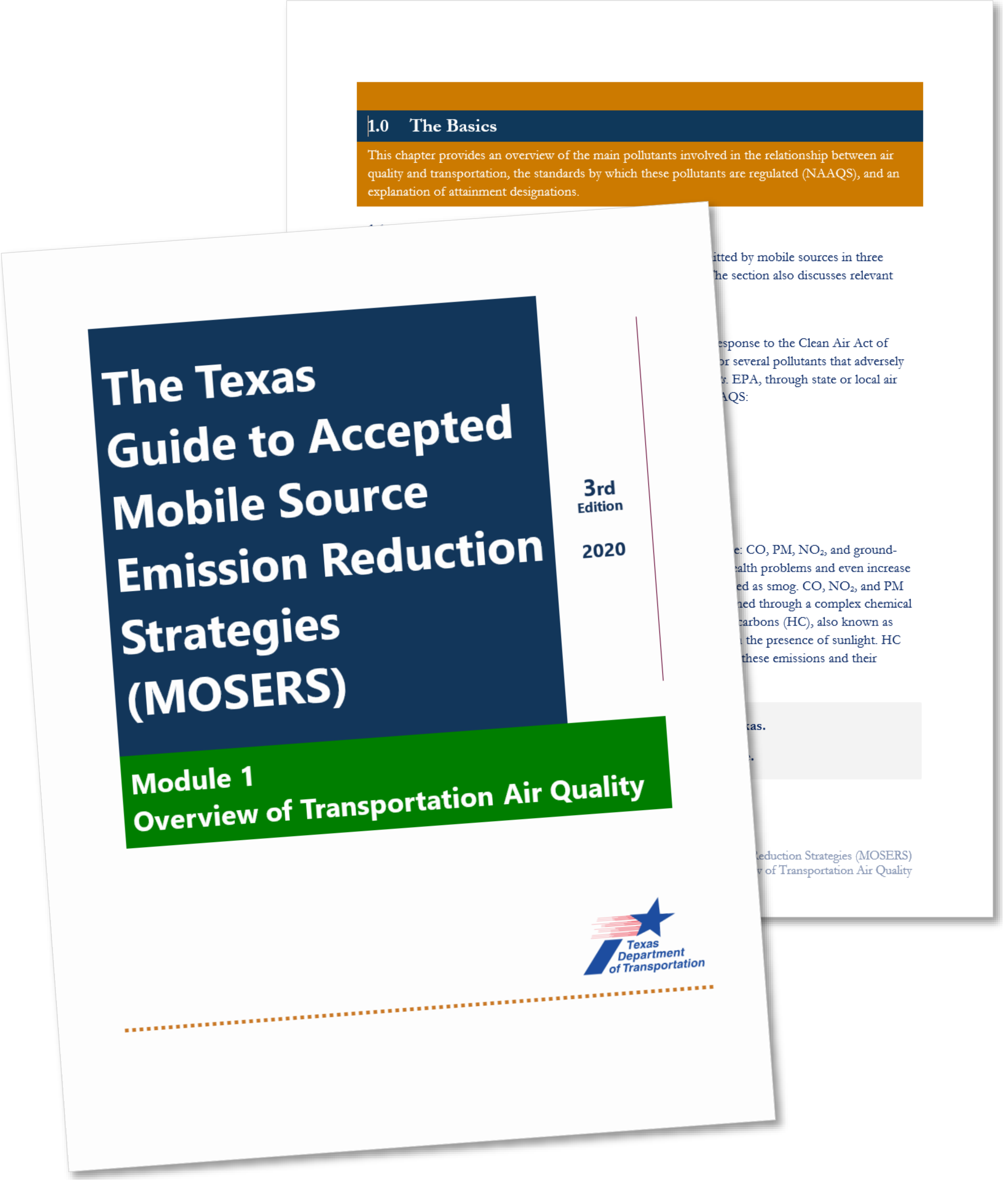
Online
Documentation
and Data

MOSERS Guide – Module 1

Overview for air quality practitioners

The document provides

- The basics of air quality
- Overview of transportation conformity
- Air quality modeling
- Mobile source emission reduction strategies
- Application of MOSERS
- Methodologies & information sources
- Analytical approaches and tools

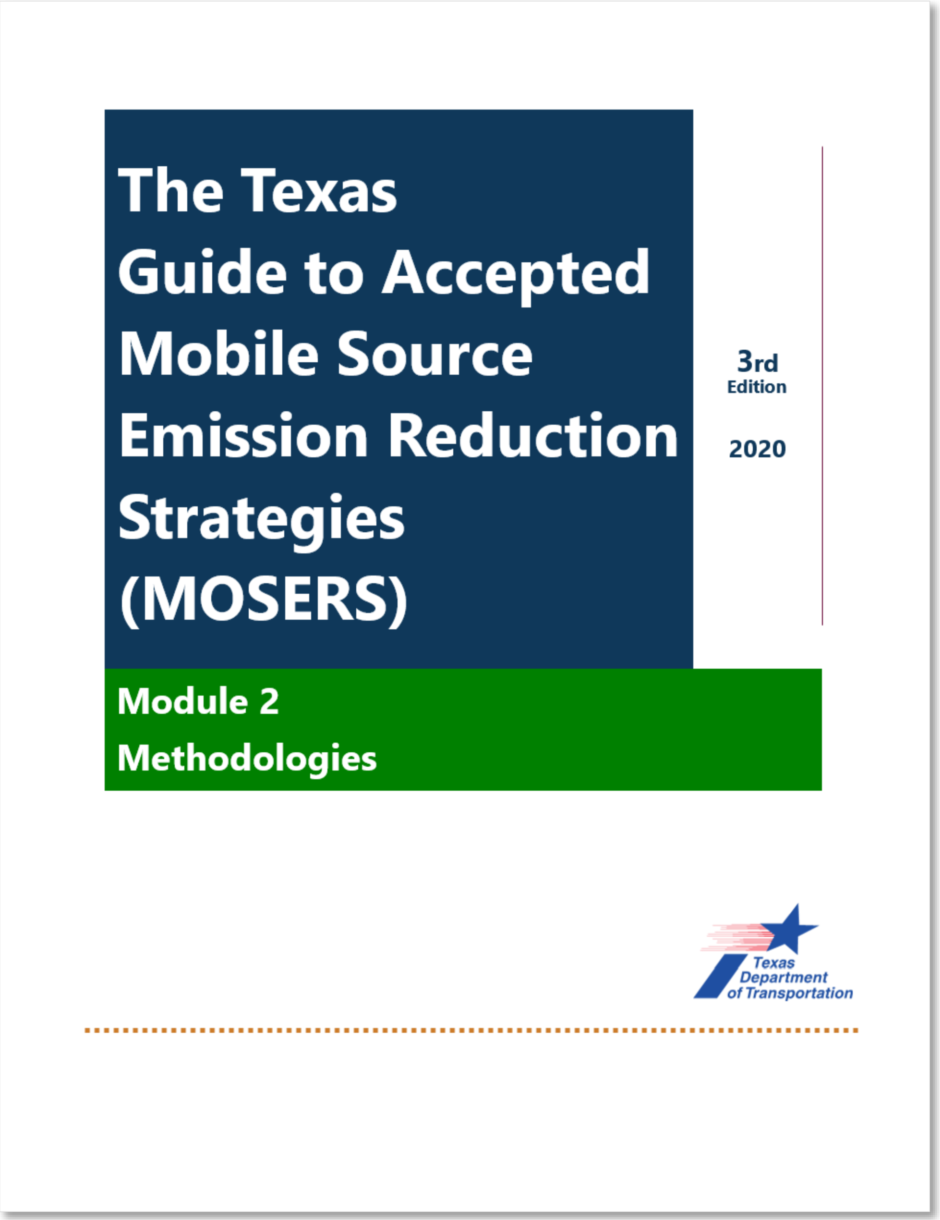


MOSERS Guide – Module 2

**Analysis methods
for emission reduction estimation**

The document provides

- Analysis methods for each strategy
- Provides descriptions of required inputs and variables
- Data sources
- Does not include calculation for activity data


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

3rd Edition

2020

Module 2

Methodologies

Texas Department of Transportation

MOSERS Guide – Spreadsheet Tool

Automates activity and emission calculations

The tool provides

- Estimates of vehicle activity and emission benefits
- Emission rates for seven Texas metropolitan areas
- Default input values
- Documentation in a convenient format

MOSERS

MObile Source Emission Reduction Strategies

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Strategy 2.1 - HOV Facilities

Main Menu | Save Report as PDF | View Report | Project Information | Open Strategy Documentation

Input Data	Press here to clear input values	Variable	Value	Units
Region	Metropolitan area	Select ▾	**Dallas/ Fort Worth**	-
Year	Analysis year	Select ▾	**2018**	-
Road Type	Urban or rural with restricted or unrestricted access	Select ▾	**Urban-Freeway**	-
Facility Geographic Information	Area type	Select ▾	**Urban**	-
	Corridor length	L	**10.0**	mile
	Facility type	Select ▾	**Freeway**	-
	Peak time of the day	Select ▾	**Morning Peak Only**	-
Facility Existing Traffic Information	Annual average daily traffic along the facility	-	**100,000**	vehicles / day
General Purpose Lane	Number of general purpose lanes	N_{GP}	**3**	lane
HOV Lane	Number of additional HOV lanes	N_{HOV}	**1**	lane

Default Data			Default	Variable	Value	Units
Default Ocuupancy		General purpose lane auto occupancy	1.13	O_{GP}	**1.13**	person
		HOV lane auto occupancy	2.31	O_{H}	**2.31**	person
Existing Facility Traffic Information		Volumes of peak hours	2,256 **	V_{lane}	**2,256**	vehicles / lane / hour
		Peak-hour hourly traffic volume	6,769 **	V_{peak}	**6,769**	vehicles / hour
Default Service Hours		Peak service hours per day	3 **	N_{PH}	**3**	hour
Default Traffic Constant	**Capacity**	Facility capacity	2,231 **	C	**2,231**	vehicles / lane / hour
	Free Flow Speed	Facility free flow speed	60 **	$V_{free\ flow}$	**60**	mph
	High-Occupancy Vehicles	Percent of high-occupancy vehicles along the facility	20	$P_{HOV,GP}$	**20**	percent
	V/C Ratio	Projected HOV lanes volume/capacity ratio	0.90	V/C_{H}	**0.90**	-
	Volume Reduction Term	General purpose Lane volume reduction compared to additional HOV capacity	0.95	F_{R}	**0.95**	-
Default Delay Function Terms		Delay calculation term A	0.015 **	A	**0.015**	minutes / mile
		Delay calculation term B	3.5 **	B	**3.5**	minutes / mile
		Delay calculation term M - maximum minutes of delay per mile	1 **	M	**1**	minutes / mile

** Double asterisk indicates that the *Default* value is dependent on *Input Data Value(s)* and can vary based on user input data selections.

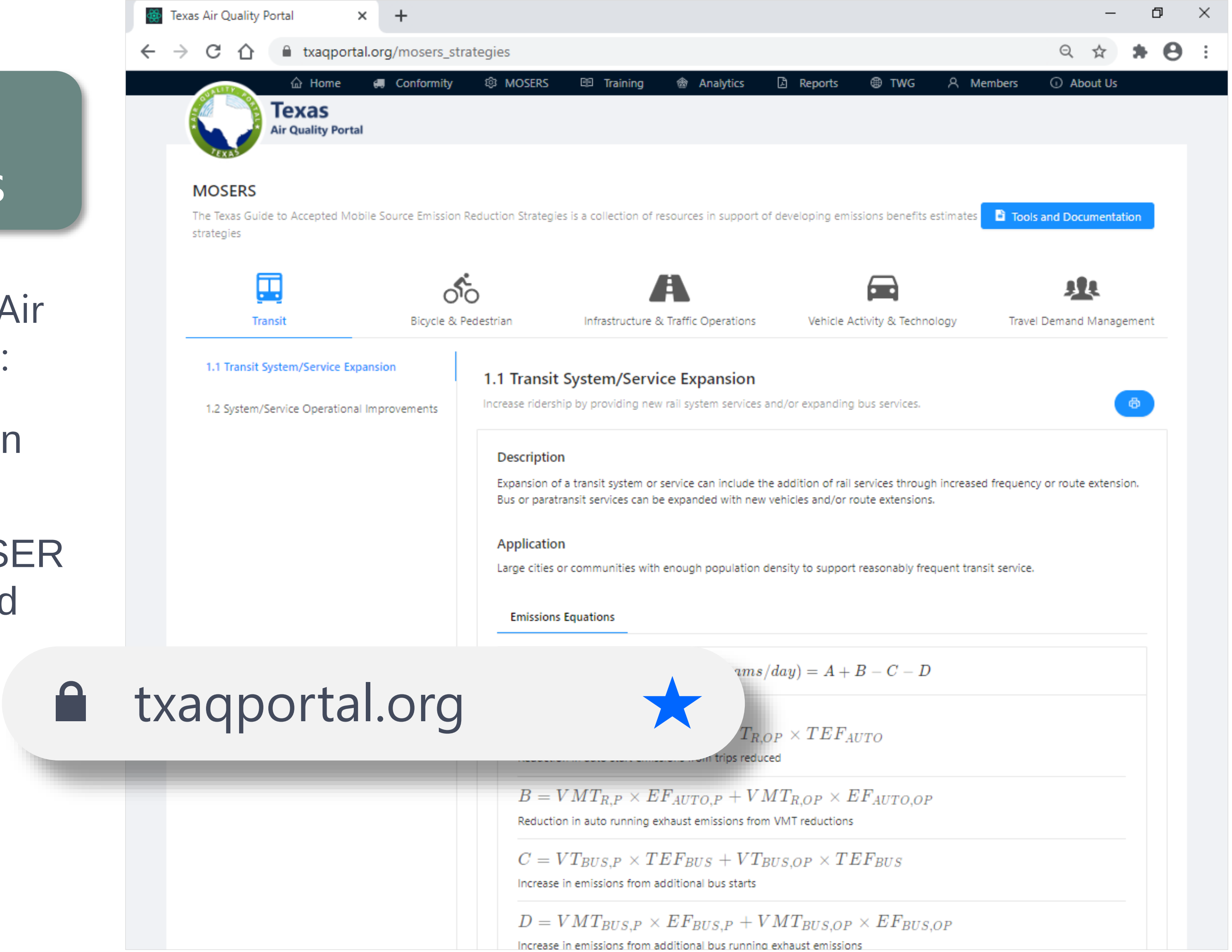
Calculated Data			Variable	Value	Units
General Purpose Lane Calculation	**Volume**	General purpose lane vehicle volume - before	$V_{GP,B}$	6,769	vehicles / hour
		General purpose lane vehicle volume - after	$V_{GP,A}$	5,483	vehicles / hour
	V/C Ratio	General purpose lane V/C ratio - before	$V/C_{GP,B}$	1.01	-
		General purpose lane V/C ratio - after	$V/C_{GP,A}$	0.82	-
	Delay	General purpose lane delay - before	$D_{GP,B}$	5.17	minute / vehicle
		General purpose lane delay - after	$D_{GP,A}$	2.64	minute / vehicle
	Speed	General purpose lane speed - before	$v_{GP,B}$	39.55	mph
		General purpose lane speed - after	$v_{GP,A}$	47.47	mph
	Travel Time	Travel time under free-flow conditions	$TT_{free\ flow}$	10.00	minute
		General purpose lane travel time - before	$TT_{GP,B}$	15.17	minute
		General purpose lane travel time - after	$TT_{GP,A}$	12.64	minute
	VMT	Daily peak hour general purpose lane VMT - before	VMT_{B}	203,084	-
		Daily peak hour general purpose lane VMT - after	VMT_{A}	164,498	-
HOV Lane	**Volume**	Additional HOV lane volume	$V_{H,A}$	1,354	vehicles / hour
	VMT	Daily peak hour HOV lane VMT	VMT_{HOV}	40,617	-
	Delay	HOV lane delay - after	D_{H}	3.50	minute / vehicle
	Speed	HOV lane speed - after	[illegible]	44.44	mph

MOSERS Guide – Web Edition

Provides MOSERS documentation and tools

The MOSERS section of the TxDOT Air Quality Portal web edition provides:

- MOSERS Guide documentation
- Strategy equations
- Download versions of the MOSER Module 1 and 2 documents and the current MOSERS Spreadsheet Tool
- Emission factors used in the MOSERS Spreadsheet Tool.



$B = VMT_{R,P} \times EF_{AUTO,P} + VMT_{R,OP} \times EF_{AUTO,OP}$

$C = VT_{BUS,P} \times TEF_{BUS} + VT_{BUS,OP} \times TEF_{BUS}$

$D = VMT_{BUS,P} \times EF_{BUS,P} + VMT_{BUS,OP} \times EF_{BUS,OP}$

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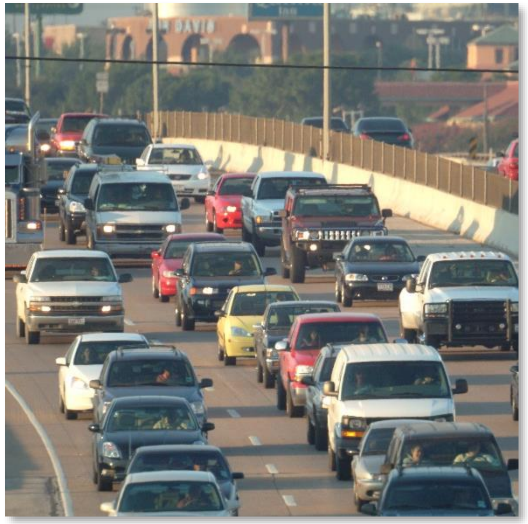
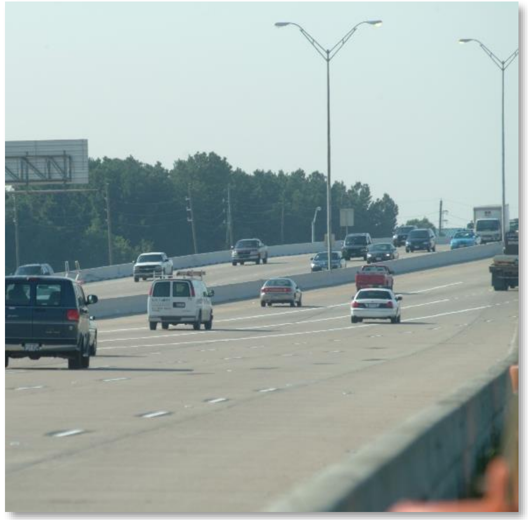
Questions and Comments





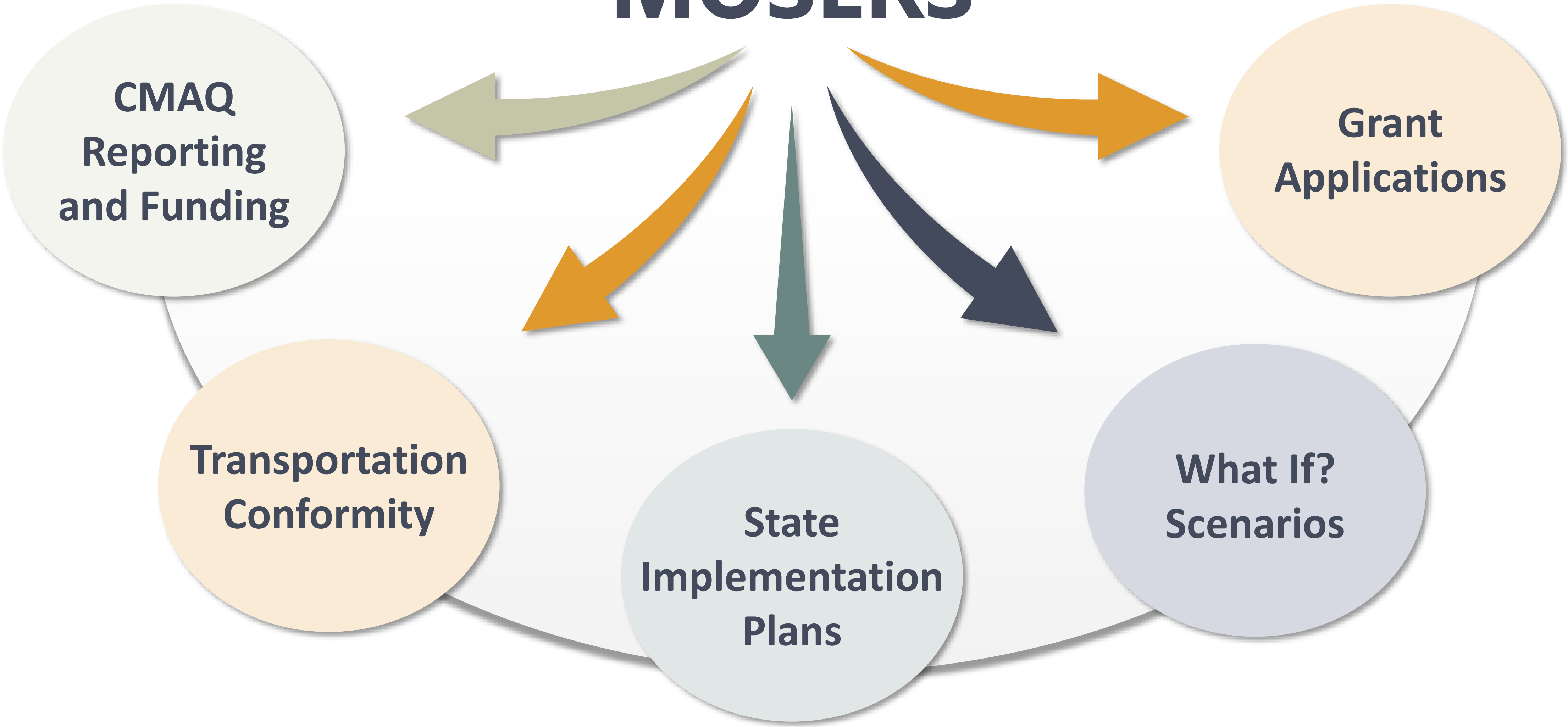
MOSERS Training – Part 3

APPLICATION OF MOSERS GUIDE

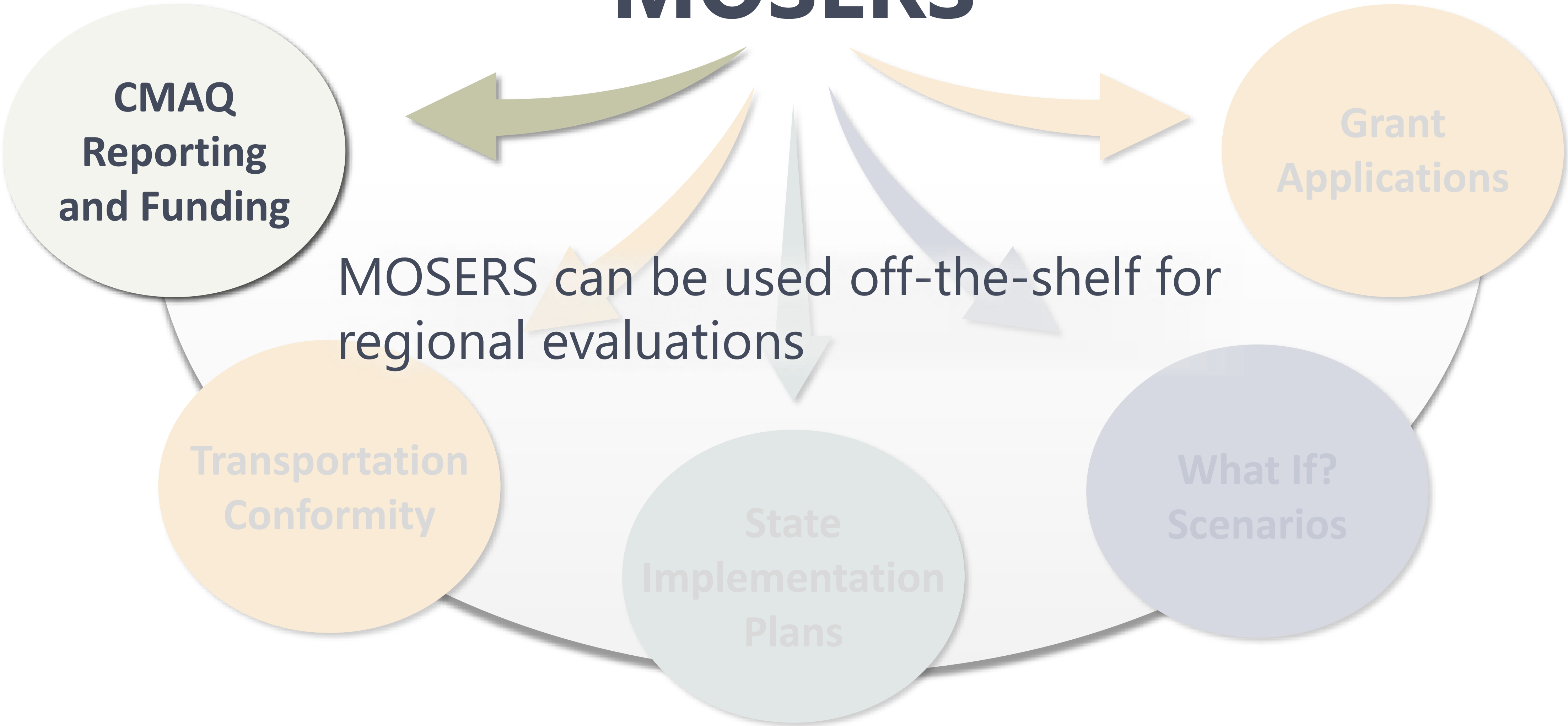
Prior to MOSERS Guide, there was a wide variety of methods and equations that were used to estimate emission benefits for transportation projects

MOSERS was developed to provide Texas practitioners with consistent emission estimation methods

Applications of MOSERS

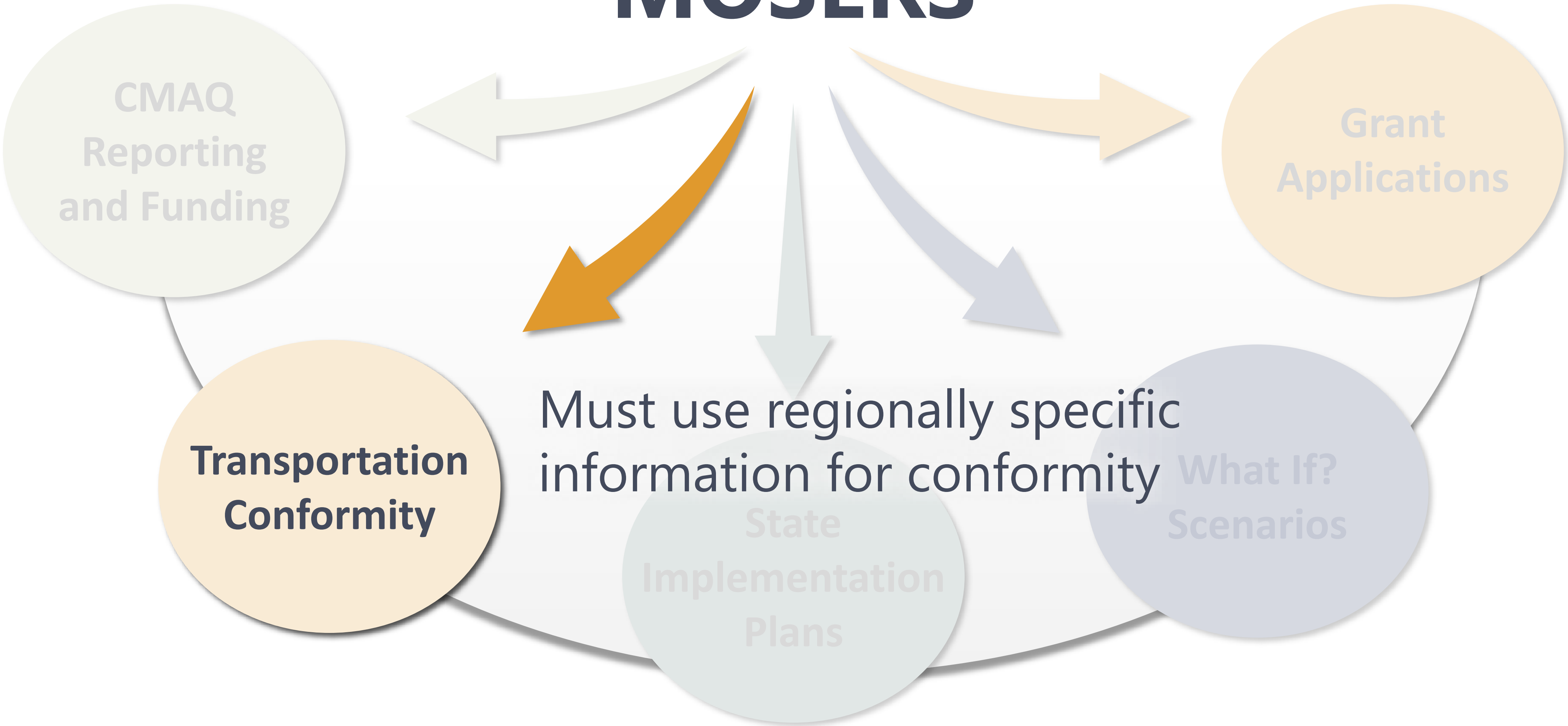


Applications of MOSERS



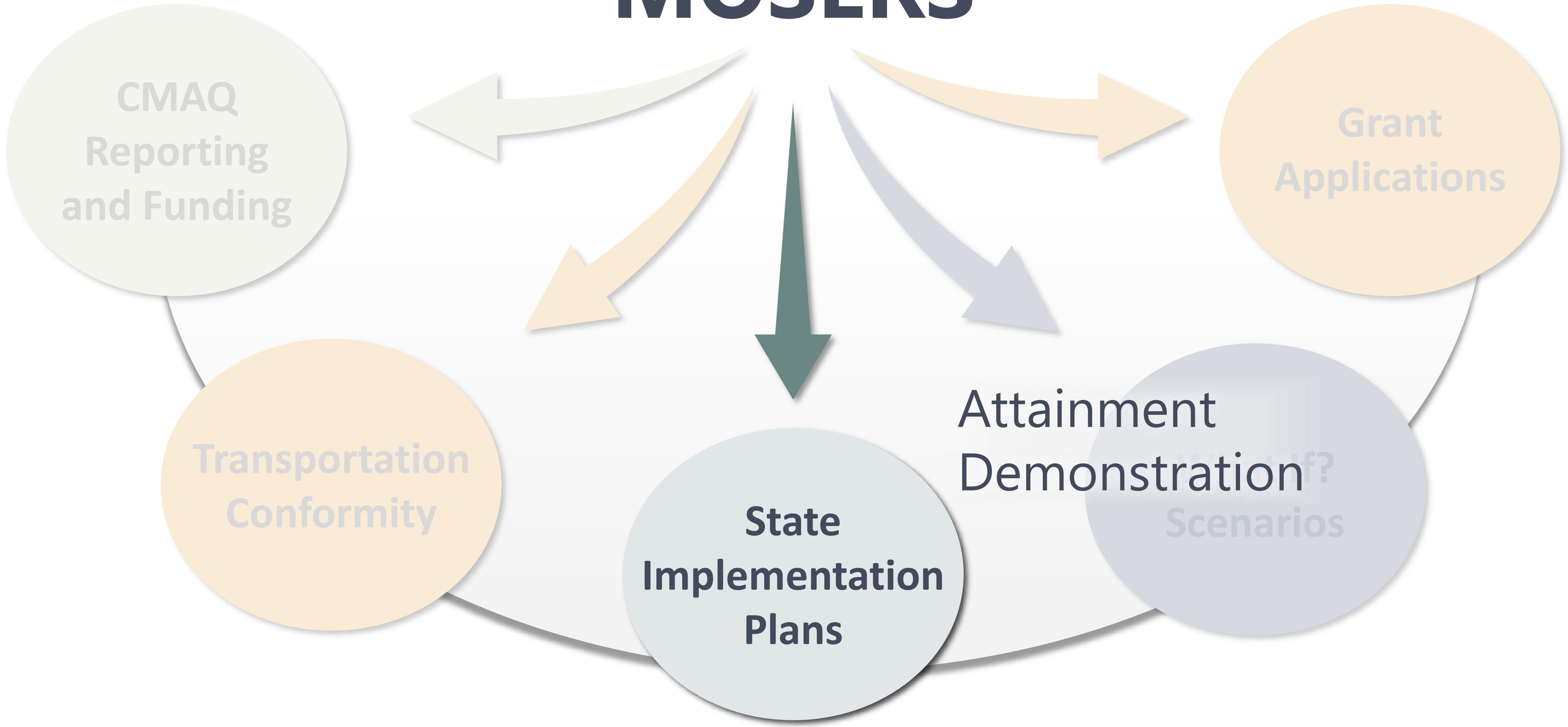
MOSERS can be used off-the-shelf for regional evaluations

Applications of MOSERS

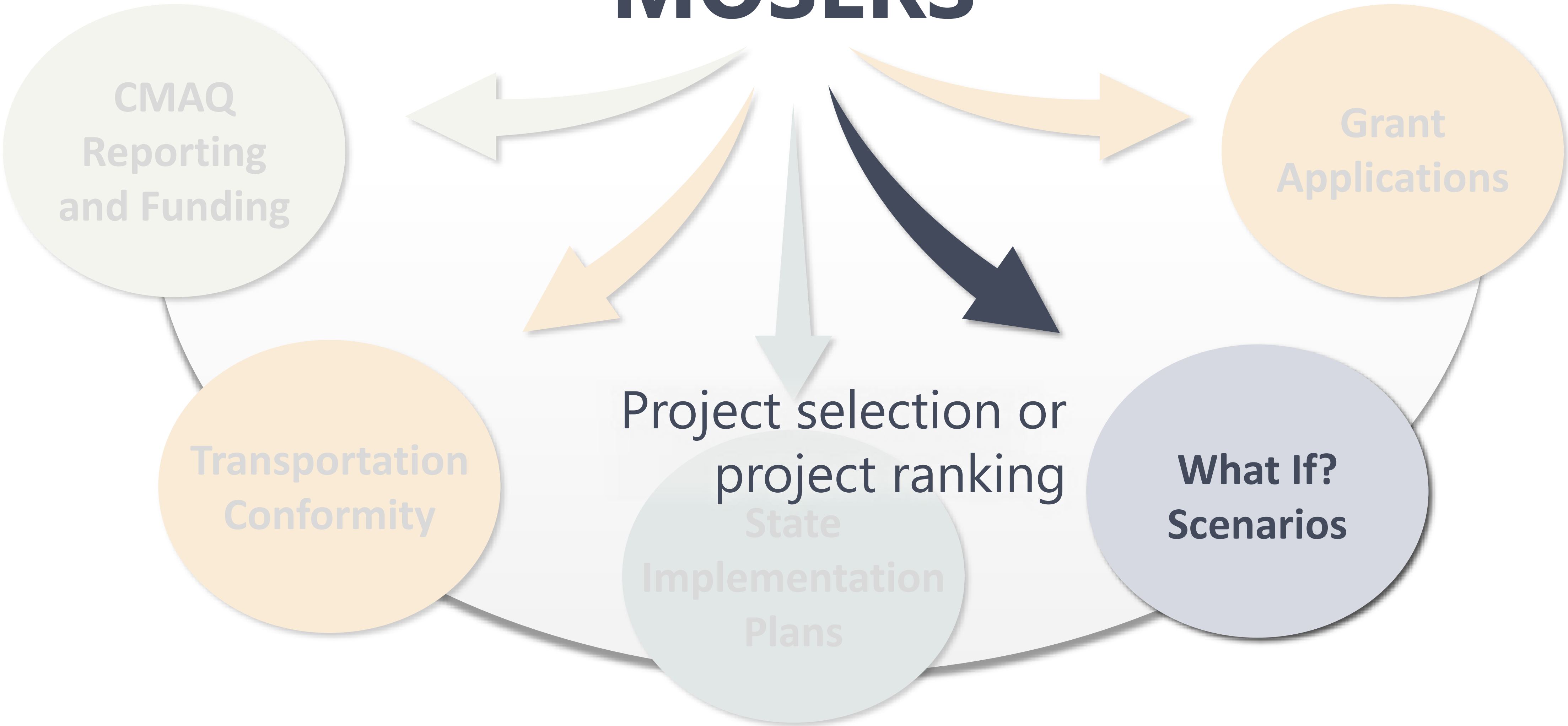


Must use regionally specific information for conformity

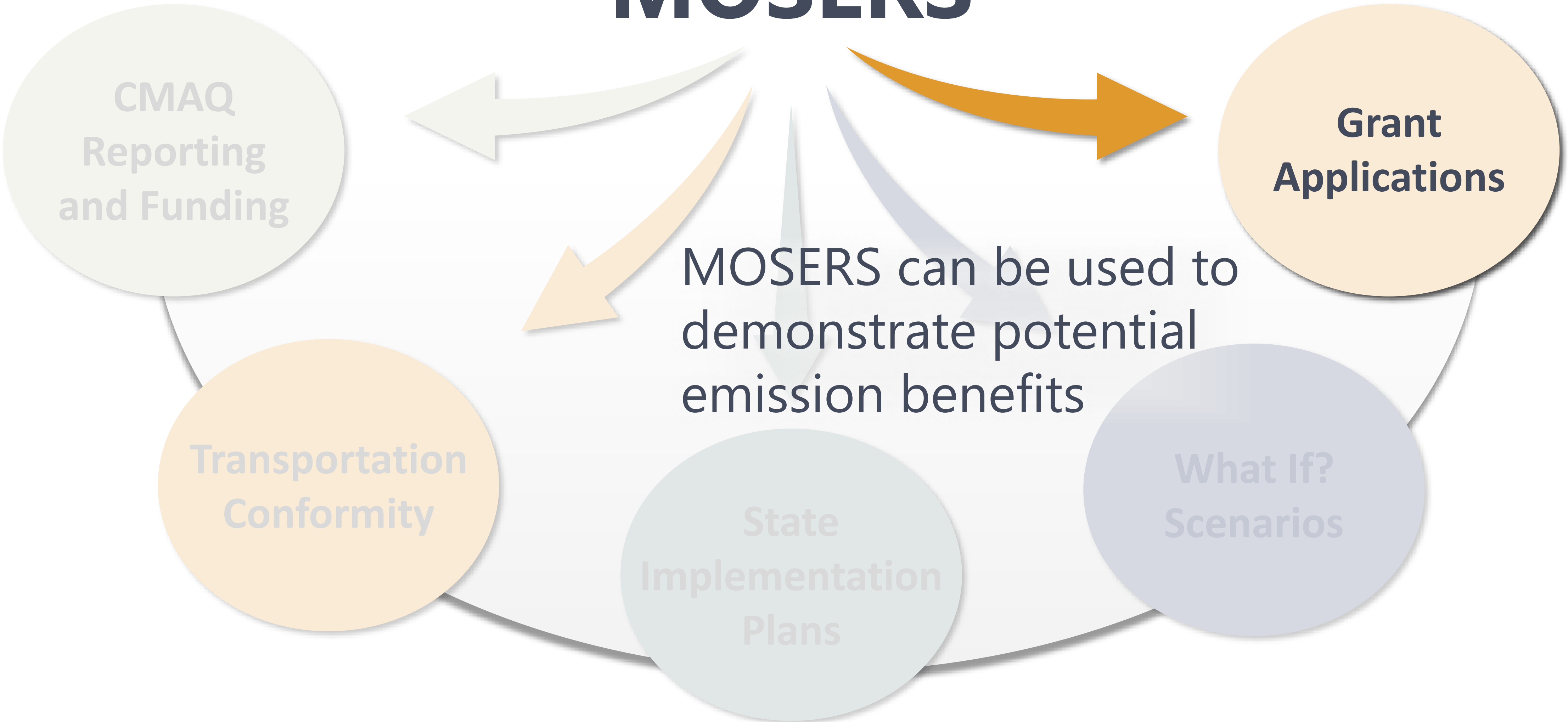
Applications of MOSERS



Applications of MOSERS



Applications of
MOSERS



MOSERS can be used to demonstrate potential emission benefits

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MOSERS Applied in SIP, Conformity and CMAQ

Different assumptions and inputs

- Affected by start date of the analysis

SIP	Conformity	CMAQ
Emission benefits estimated for future years (attainment demonstration)	Emission benefits estimated for current, future, and past years (depends of MVEB year)	Reports submitted for year in which projects are completed

Documentation of MOSERS

Elements of Good MOSERS Documentation

- Accurate Description of Units
- Consistency of Emissions
- Conservative Assumptions
- Completeness of Documentation
- Quality Control

Documentation of MOSERS - Examples

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):

Off-Model Documentation Elements

Traffic Signal Coordination

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
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
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:

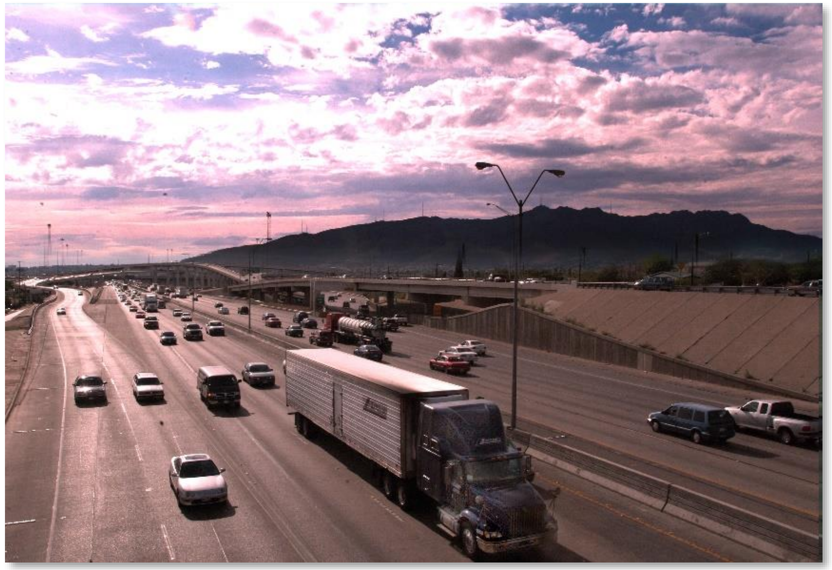
Annual Project VMT (VMT) = (D) * (L) * (Congested Traffic)
=250 * 8.07 * 88,643 =
178,837,253 annual miles

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

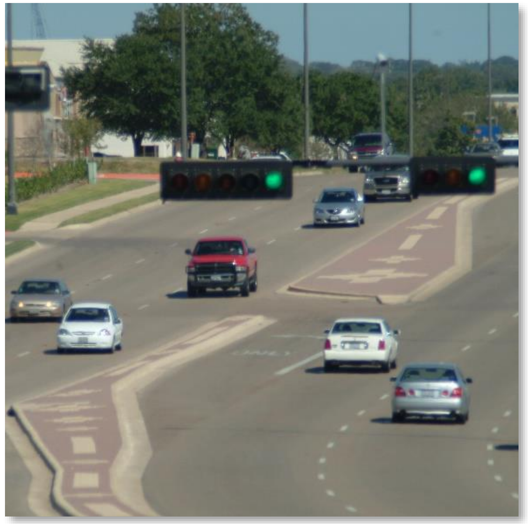
= [(0.50) * (VMT) * (Bef Speed Fctr – Alt Speed Fctr)]/454 grams per lb.

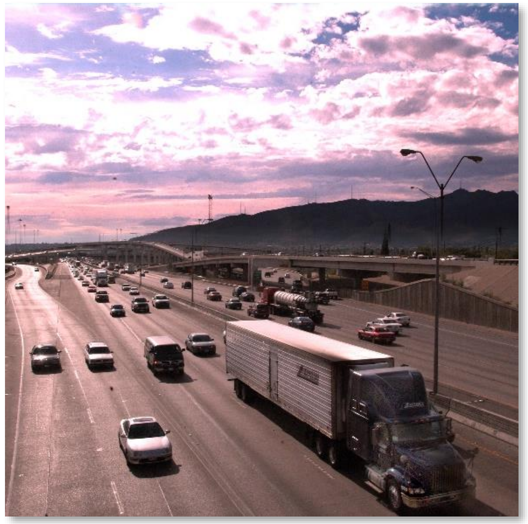
Note: Initial speed improvements decline to zero improvement by the effectiveness period. In order to account for this, the emission reduction equation reduces initial emission reduction benefits by one half.

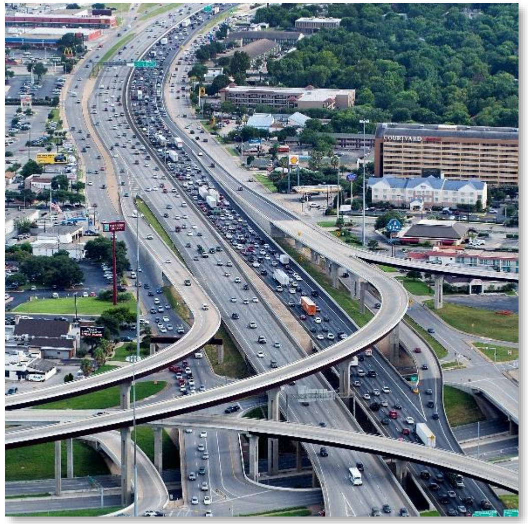
ROG: [(0.50) * (178,837,253) * (0.51 – 0.43)]/454 = **15,757 lb. per year**
NO_x: [(0.50) * (178,837,253) * (1.14 – 1.13)/454 = **1,970 lb. per year**
PM_{10}: [(0.50) * (178,837,253) * (0 – 0)/454 = **0 lb. per year**



Questions and Comments







MOSERS Training – Part 4

ESTIMATION OF EMISSION BENEFITS

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Methods

- On-model (TDM)
- Off-model
  - Trip Behavior Modification
  - Transportation System Improvements
  - Vehicle and Fuel Technology

Modeled vs Non-Modeled

Modeled

- High occupancy vehicle (HOV) lanes
- Grade separations
- Transit

Non-Modeled

- Bike-Ped
- Signal improvements
- Intersection improvements

Emissions Estimation

Calculated as **Mass / Time**

(pounds/day, kilograms/day, tons/year, etc.)

Activity X **Emission Rates** = **Emissions**

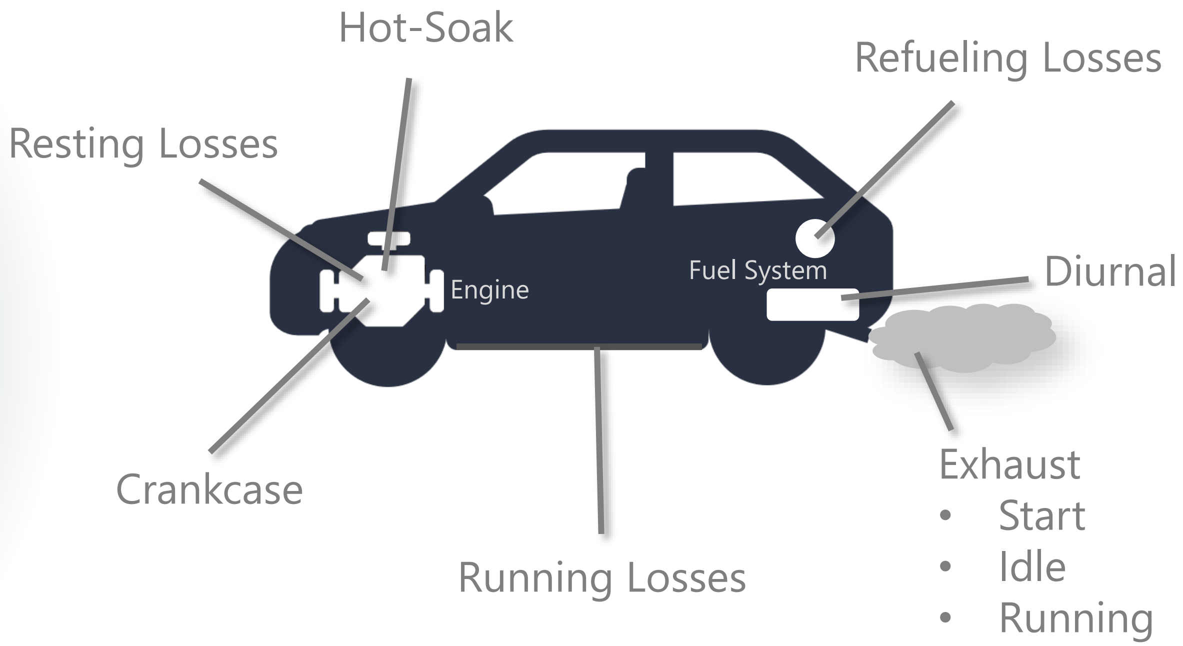
Where:

- Activity can be VMT, number of starts, idling hours, fuel consumed, etc.
- Emission rates can be function of fuel consumed, distance, duration, etc.

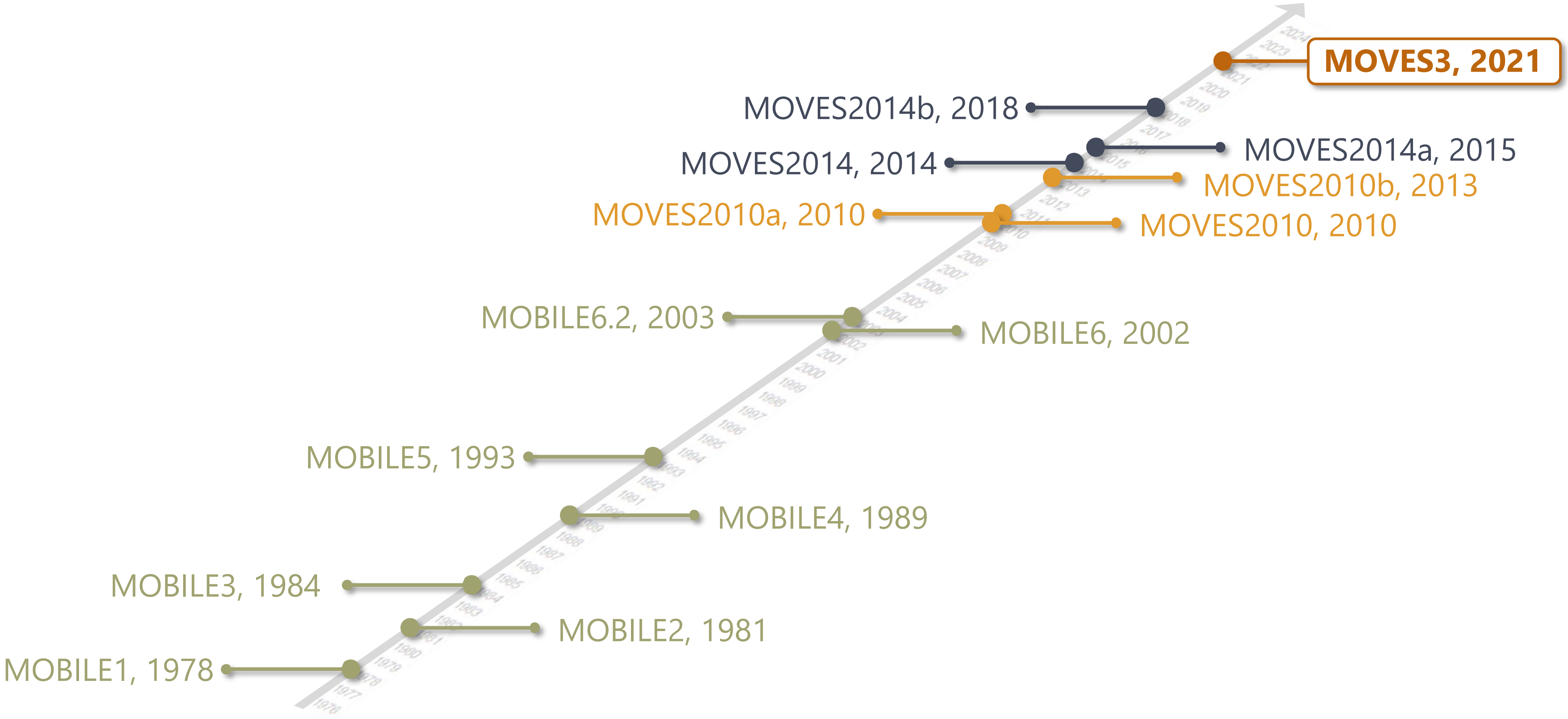
Vehicular Emissions Sources

Vehicles emission occur during:
- Starts
- Idling
- Running
- When parked

Emission vary due to:
- Fuel type
- Vehicle type and age
- Operating speed



Emission Rates Estimation Models



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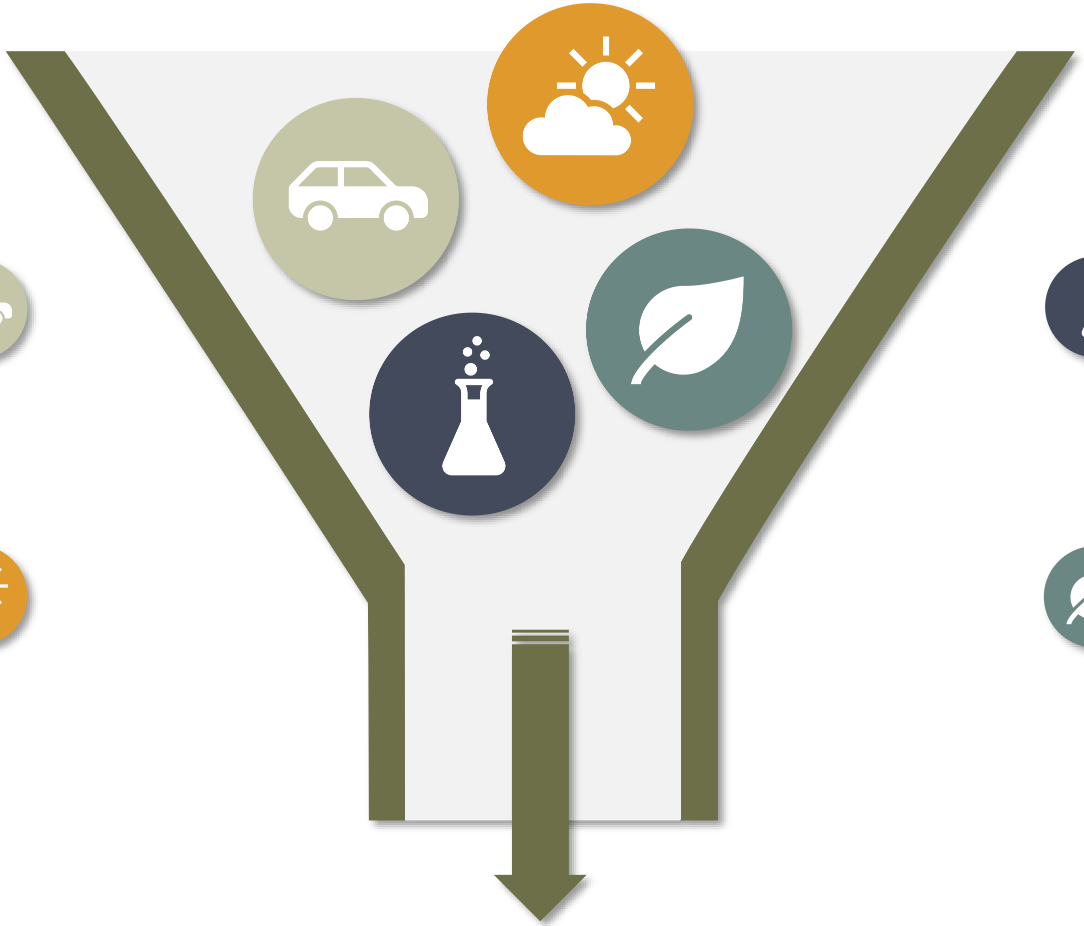
Factors Affecting Emission Rates

Fleet Characteristics

External Conditions



Fuel Characteristics

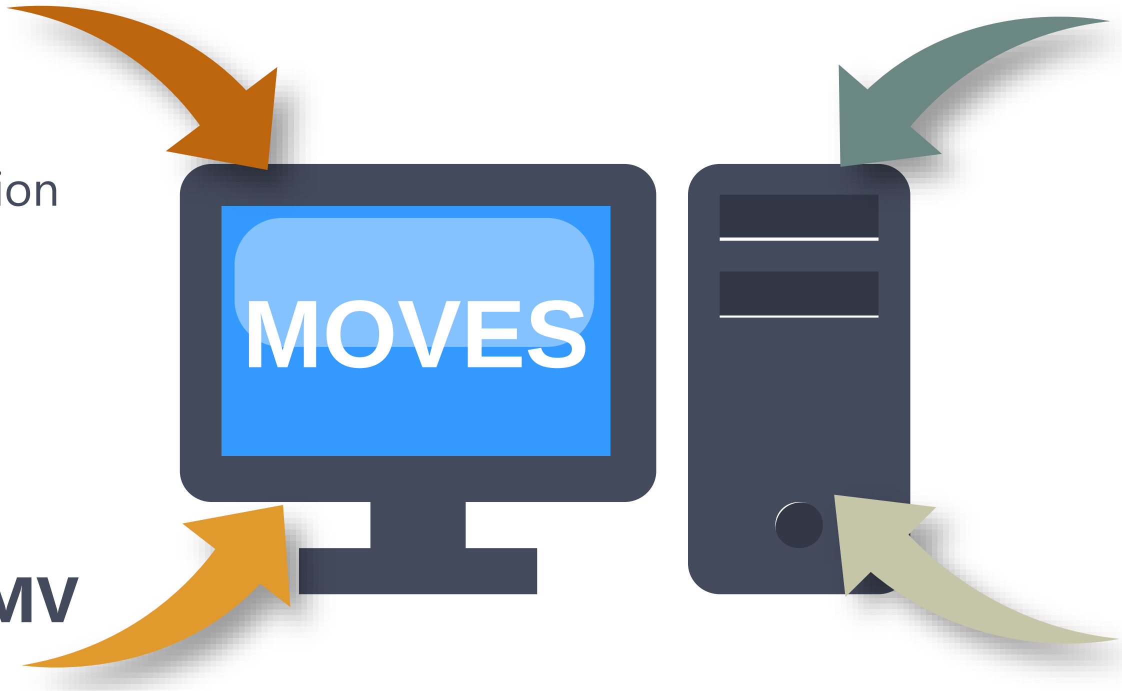
Control Programs

EMISSION RATES

Major Sources of Key Input Data

State Air Agency
Fuel properties
State programs
Meteorological information

MPOs
Vehicle activity (VMT and speed)
Hourly distribution of VMT and speed



State DOT and DMV
Vehicle type and age distribution
Fuel/engine fraction

EPA & MOVES defaults
VMT distribution by age
Starts per vehicle
Etc.

MOVES Emission Process

Process ID	Emission Process	Rates/Distance	Rates/Vehicle	Rate/Profile
1	Running Exhaust	X		
2	Start Exhaust		X	
9	Brakewear	X		
10	Tirewear	X		
11	Evap Permeation	X	X	X
12	Evap Fuel Vapor Venting	X		X
13	Evap Fuel Leaks	X	X	X
15	Crankcase Running Exhaust	X		
16	Crankcase Start Exhaust		X	
17	Crankcase Extended Idle Exhaust		X	
18	Refueling Displacement Vapor Loss	X	X	
19	Refueling Spillage Loss	X	X	
90	Extended Idle Exhaust		X	
91	Auxiliary Power Unit		X	

MOVES Roadway Type

Rural & Urban Restricted Access

- Freeways/interstate highways
- Toll-ways
- Managed/HOV lanes

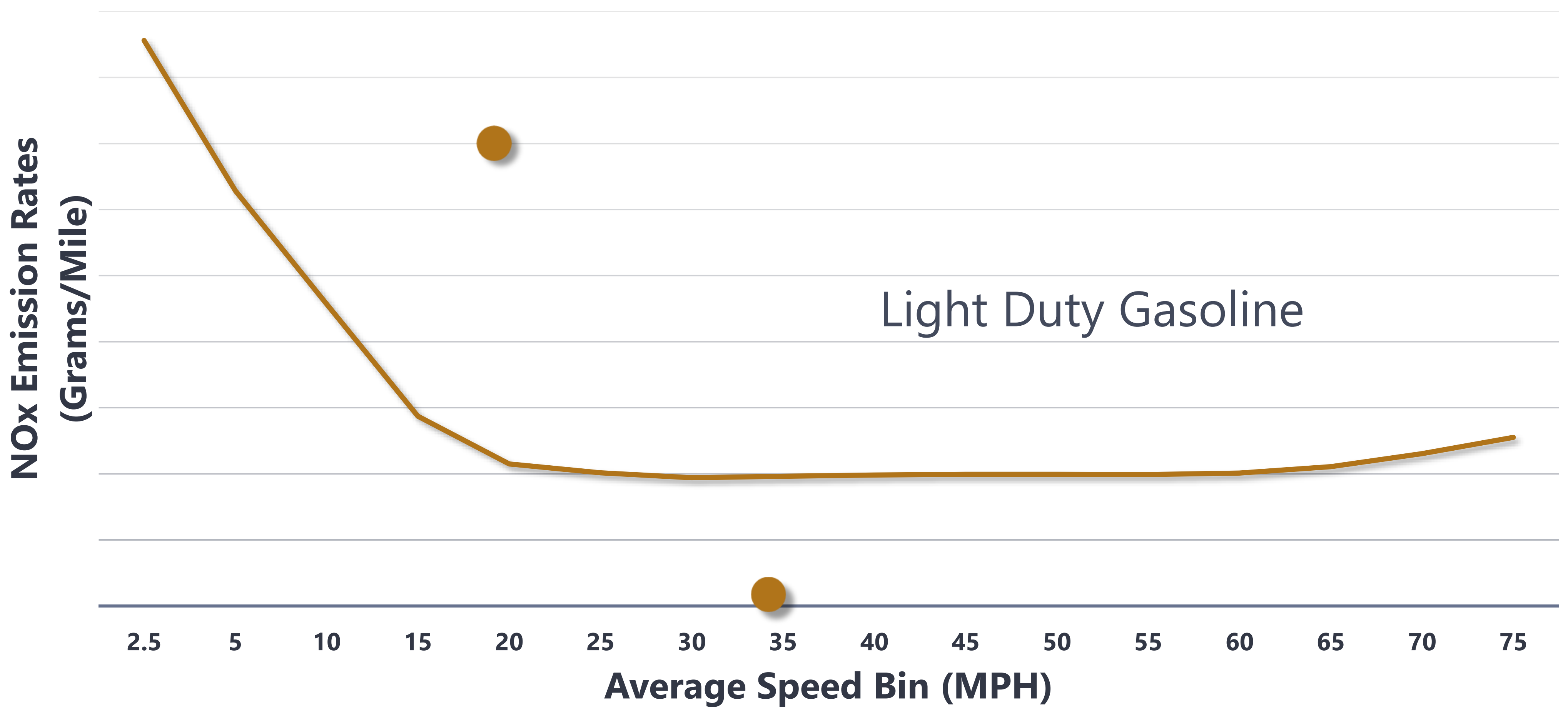
Rural & Urban Unrestricted Access

- Arterials
- Collectors
- Locals
- Ramps

MOVES Vehicle Types

Vehicle Class	Source Type ID	Description
Light Duty	11	MotorCycle
	21	Passenger Car
	31	Passenger Truck: SUV, Pickup Truck, Minivans - Two-Axle/Four-Tire Single Unit
	32	Light Commercial Trucks - Two-Axle/Four-Tire Single Unit
Buses & Medium-Duty	41	Intercity Buses
	42	Transit Buses
	43	School Buses
	52	Single-Unit Short-Haul Trucks
	53	Single-Unit Long-Haul Trucks
	54	Single- Unit Motor Homes
Heavy Duty	51	Refuse Trucks
	61	Combination Short-Haul Trucks
	62	Combination Long-Haul Trucks

Emission Rates by Speed



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How Are The Rates Used?

Emission Outputs

Rates per Distance

- Running exhaust
- Evaporative permeation
- Evaporative fuel vapor venting
- Evaporative leaks
- Crankcase running

Rate per Activity

- Start Exhaust
- Evaporative permeation
- Evaporative fuel leaks
- Crankcase start
- Extended idle exhaust
- Evaporative fuel vapor venting

Activity Information

- Link-based speed and VMT
- Number of starts in each zone
- Number of ends in each zone
- Hours of trucks idling in each zone

Vehicle Activity

X

Emission Rates

Link, Zone, and Regional Emissions

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Questions and Comments

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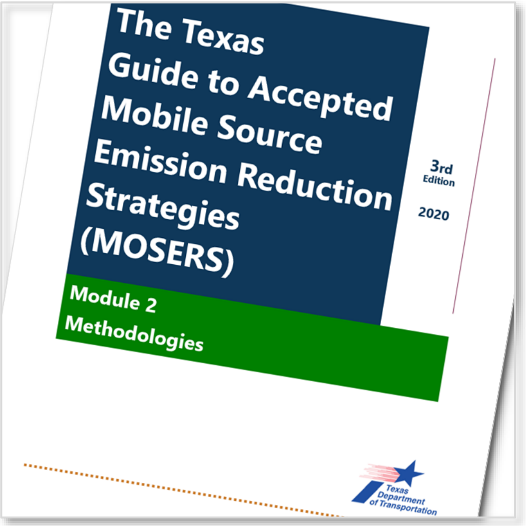
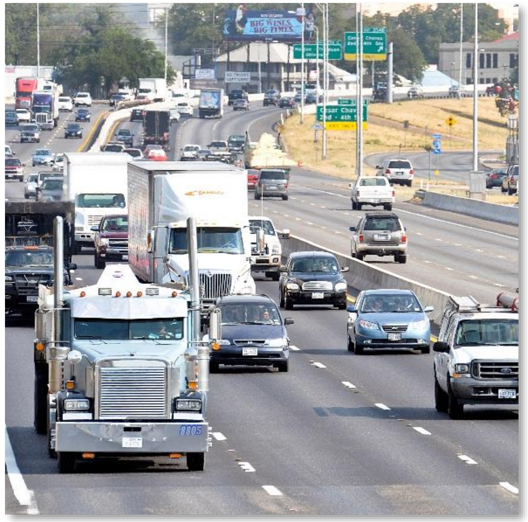
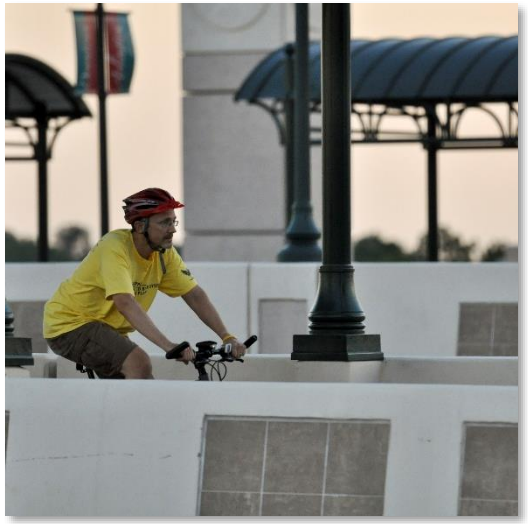
Break



MOSERS Training – Part 5

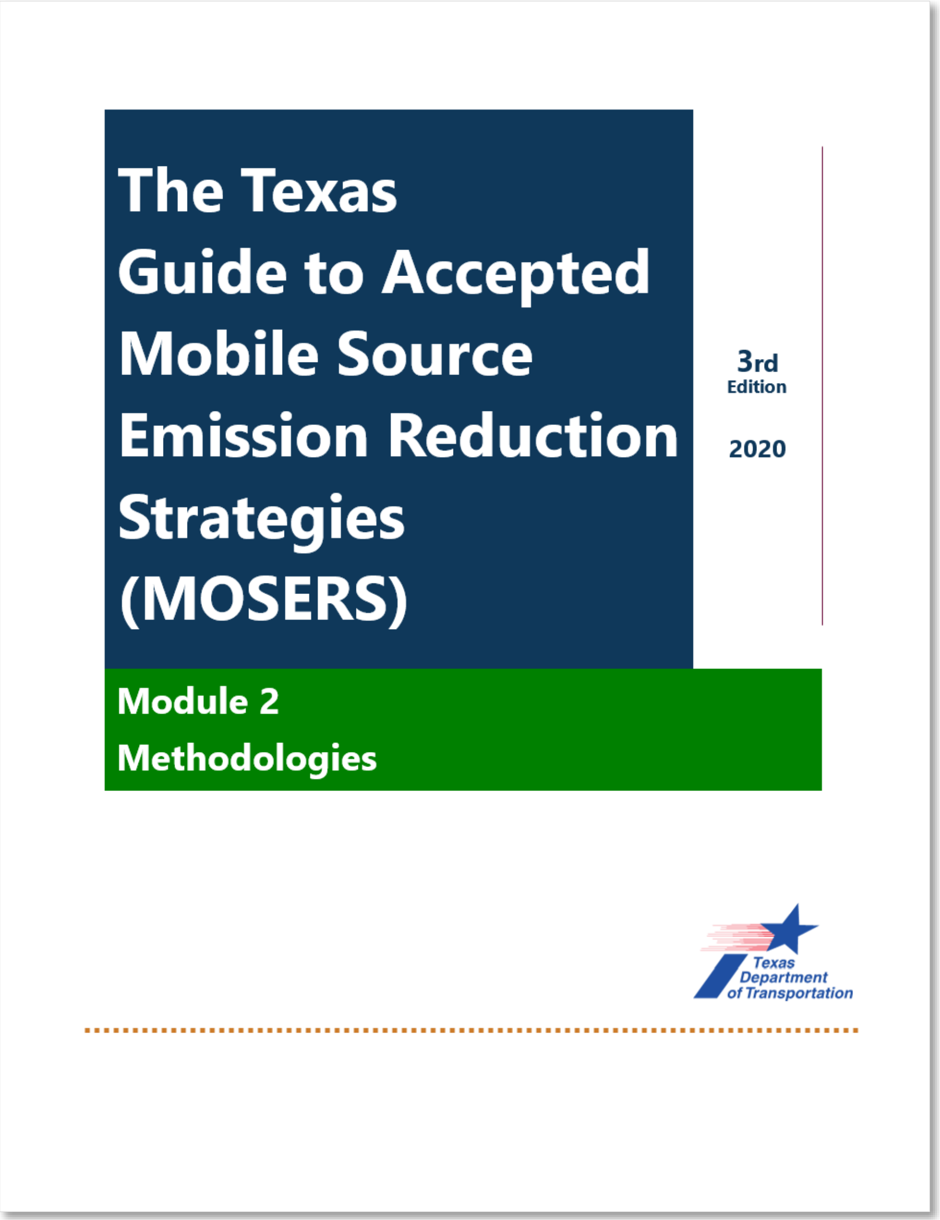
OVERVIEW OF THE MOSERS GUIDE MODULE 2

MOSERS Guide – Module 2

Analysis methods for emission reduction estimation

The document provides:

- Analysis methods for each strategy
- Provides descriptions of required inputs and variables
- Data sources
- Does not include calculation for activity data


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

3rd Edition

2020

Module 2

Methodologies

Texas Department of Transportation

MOSERS Guide – Module 2

17 broad types of strategies

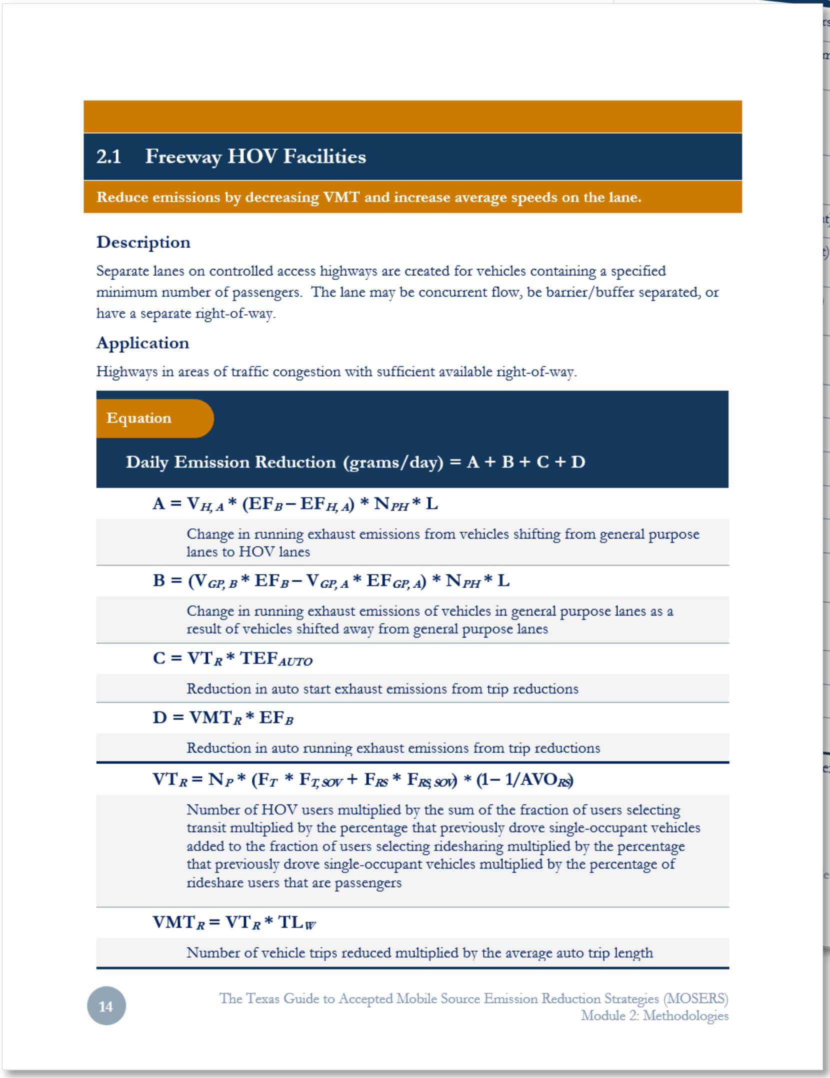
Table of Contents

Contents

MOSERS Guide – Module 2

Individual Strategies

- Description
- Application
- Equation
- Variables



2.1 Freeway HOV Facilities

Reduce emissions by decreasing VMT and increase average speeds on the lane.

Description

Separate lanes on controlled access highways are created for vehicles containing a specified minimum number of passengers. The lane may be concurrent flow, be barrier/buffer separated, or have a separate right-of-way.

Application

Highways in areas of traffic congestion with sufficient available right-of-way.

Equation

Daily Emission Reduction (grams/day) = A + B + C + D

$A = V_{H,A} * (EF_B - EF_{H,A}) * N_{PH} * L$

Change in running exhaust emissions from vehicles shifting from general purpose lanes to HOV lanes

$B = (V_{GP,B} * EF_B - V_{GP,A} * EF_{GP,A}) * N_{PH} * L$

Change in running exhaust emissions of vehicles in general purpose lanes as a result of vehicles shifted away from general purpose lanes

$C = VT_R * TEF_{AUTO}$

Reduction in auto start exhaust emissions from trip reductions

$D = VMT_R * EF_B$

Reduction in auto running exhaust emissions from trip reductions

$VT_R = N_P * (F_T * F_{T,SOV} + F_{RS} * F_{RS,SOV}) * (1 - 1/AVO_{RS})$

Number of HOV users multiplied by the sum of the fraction of users selecting transit multiplied by the percentage that previously drove single-occupant vehicles added to the fraction of users selecting ridesharing multiplied by the percentage that previously drove single-occupant vehicles multiplied by the percentage of rideshare users that are passengers

$VMT_R = VT_R * TL_W$

Number of vehicle trips reduced multiplied by the average auto trip length

14 The Texas Guide to Accepted Mobile Source Emission Reduction Strategies (MOSERS)
Module 2: Methodologies

Variables (unit)	Definitions
rsons/vehicle)	Average vehicle occupancy of rideshare
ms/mile)	Speed-based running exhaust emission factor for affected roadway before implementation (NOx, VOC, PM, or CO)
	Speed-based running exhaust emission factor on general purpose lanes after implementation of HOV facility (NOx, VOC, PM, or CO) (estimate)
	Speed-based running exhaust emission factor on HOV facility (NOx, VOC, PM, or CO) (estimate)
t)	Percentage of people attracted to the HOV facility using rideshare
)	Percentage of people attracted to the HOV facility using rideshare that previously were vehicle drivers
	Percentage of people attracted to the HOV facility using a transit vehicle
	Percentage of people using a transit vehicle that previously were vehicle drivers
	Length of HOV facility
	Total number of expected people using the HOV lanes per day
	Number of peak hours (AM and/or PM)
	Auto trip-end emission factor (NOx, VOC, PM, or CO)
	Average auto trip length
	Average hourly volumes on general purpose lanes during peak hours after implementation of HOV facility
	Average hourly volumes on general purpose lanes during peak hours before implementation of HOV facility
	Average hourly volumes on HOV lanes during peak hours
	Reduction in daily automobile VMT
	Reduction in number of daily automobile vehicle trips (estimate)

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Source Emission Reduction Strategies (MOSERS) 15

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Activity Information Needed for MOSERS

Depends on the strategy

Most common

- VMT (Volume * Length of the Roadway)
- Average hourly speed
- Fuel consumed
- No. of starts
- Idling hours
- Trip length
- Vehicle population

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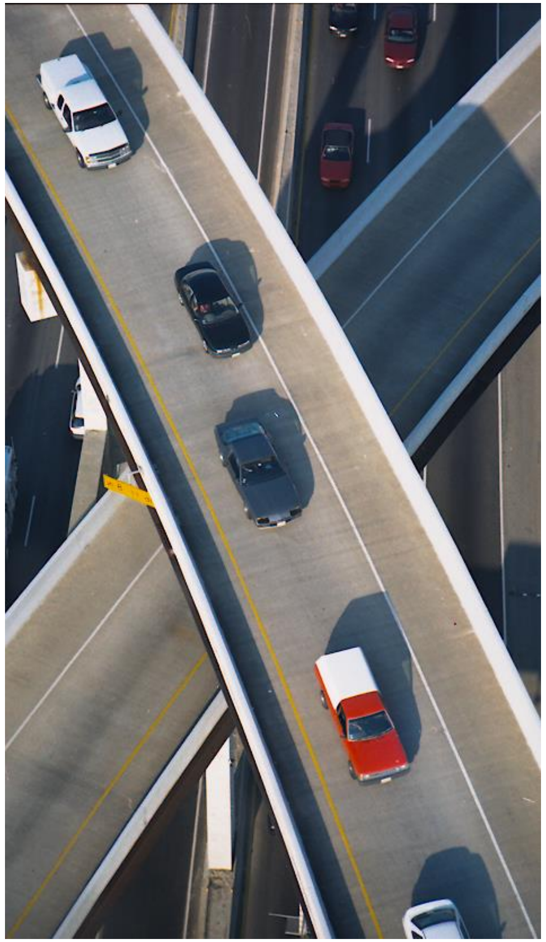
Activity Data Sources

Activity Type	Data Sources
Vehicle Miles of Travel (VMT)	Travel demand & micro-simulation model, HPMS
Volume	Travel demand & micro-simulation model, traffic counts, traffic studies
Speed	Travel demand & micro-simulation model, NPMRDS, other data sources
Trip Length	Travel model (regional specific- trip purpose), NHTS
Vehicle Population	TxDOT DMV, other proprietary data sources
Starts	EPA models, other peer reviewed studies and models
Idling Hours	EPA models, fleet management databases, other peer reviewed studies and models
Fuel Consumed	EPA models, fleet management databases, other peer reviewed studies and models

Additional Notes for Emission Rates



- Emission models are time consuming & data intensive
- Not necessary to run models to calculate emissions for all strategies
- Preference for local data where available
- Emission rates requires post processing depending on the strategy
- Can obtain emission rates from MPOs, TCEQ, TxDOT/TTI*

* Emission rates are available for seven metropolitan areas in Texas from the MOSERS web edition (TxAQ Portal)

CLASS EXERCISE

Using the MOSERS Guide Module 2 Emission Equations
Instructor Demonstration

Class Exercise 1: Transit System Service Expansion

Increase ridership by providing new rail system services and/or expanding bus services

- Expansion of rail services through increased frequency or route extension
- Expansion bus or paratransit services with new vehicles and/or route extensions

Application

- Large cities or communities with enough population density to support reasonably frequent transit service

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Class Exercise 1

A city wants to explore replacing a portion of their bus fleet with newer, more fuel efficient and lower emission buses. If the project were to move forward, the replacement buses would be purchased in 2024 to replace buses ten years old or older. Both replacement and new buses will be diesel powered.

Calculate NOx emission benefits using following information.

Traffic Information		
Average model year of buses to be replaced	=	2014
Anticipated average model year of new bus	=	2024
Average Bus Speed	=	22 mph
Total vehicle miles traveled (VMT) of buses to be replaced	=	6,336

Class Exercise 1: Clean Vehicle Program

Strategy 16.1 Equation

Daily Emission Reduction =

Daily miles X Change in running emission rates (i.e., old rates – new rates)

plus

Daily trips X Change in start emission rates (i.e., old rates – new rates)

Equation

Daily Emission Reduction (grams/day) =

$$VMT_{REP} * (EF_B - EF_A) + VT_{REP} * (TEF_B - TEF_A)$$

Average daily VMT of the replaced vehicle multiplied by the change in pre-replacement and post-replacement composite emission factors

Variables (unit)		Definitions
EF_A	(grams/mile)	Speed-based running exhaust emission factor after replacement (NO_X, VOC, PM, or CO)
EF_B	(grams/mile)	Speed-based running exhaust emission factor before replacement (NO_X, VOC, PM, or CO)
TEF_A	(grams/trip)	Trip end emission factor after replacement (NO_X, VOC, PM, or CO)
TEF_B	(grams/trip)	Trip end emission factor before replacement (NO_X, VOC, PM, or CO)
VMT_{REP}		Average Daily VMT of the vehicle to be replaced
VT_{REP}		Average Daily Trips of the vehicle to be replaced

Source: CalTrans/ CARB

Class Exercise 1: Step 1 Equation

Equation

Daily Emission Reduction (grams/day) =

$$VMT_{REP} * (EF_B - EF_A) + VT_{REP} * (TEF_B - TEF_A)$$

Average daily VMT of the replaced vehicle multiplied by the change in pre-replacement and post-replacement composite emission factors

Running Emissions — $VMT_{REP} * (EF_B - EF_A)$

Start Emissions — $VT_{REP} * (TEF_B - TEF_A)$

Revised Equation

$$\text{Daily Emission Reduction} = VMT_{REP} * (EF_B - EF_A)$$

Class Exercise 1: Step 2

Look-up NOx emission rates

$$\text{Daily Emission Reduction} = VMT_{REP} * (EF_B - EF_A)$$

NO_X Emissions Rates for 22 mph	
2014	$EF_B = 8.6230$
2024	$EF_A = 2.9531$

2014				2024			
Average Speed	NOx (grams/mile)	Average Speed	NOx (grams/mile)	Average Speed	NOx (grams/mile)	Average Speed	NOx (grams/mile)
2.5	67.61180252	39	7.277778527	2.5	22.74472302	39	2.480097625
3	55.93208247	40	7.224916447	3	18.87541259	40	2.46065858
4	41.33243242	41	7.174630341	4	14.03877454	41	2.442166972
5	32.57264239	42	7.126738811	5	11.13679171	42	2.424555917
6	27.58011221	43	7.081074795	6	9.421119584	43	2.40776398
7	24.01401923	44	7.037486415	7	8.195639492	44	2.391735313
8	21.33944949	45	6.995835297	8	7.276529423	45	2.376419032
9	19.25922859	46	7.206000843	9	6.561666036	46	2.444424939
10	17.59505186	47	7.407223175	10	5.989775326	47	2.509536977
11	15.48740927	48	7.600061243	11	5.275996039	48	2.571936014
12	13.73104045	49	7.78502837	12	4.681179966	49	2.631788152
13	12.24488221	50	7.962596811	13	4.177874058	50	2.689246204
14	10.9710323	51	8.133202143	14	3.746468994	51	2.744451611
15	9.867029037	52	8.297245731	15	3.372584606	52	2.797533734
16	9.622665965	53	8.455098995	16	3.29018274	53	2.848612757
17	9.407051489	54	8.607105842	17	3.217475212	54	2.897799965
18	9.215394178	55	8.753585167	18	3.152846298	55	2.945198547
19	9.04391132	56	8.731095059	19	3.095020428	56	2.935624897
20	8.889576748	57	8.709394077	20	3.042977145	57	2.926387165
21	8.749938689	58	8.688441404	21	2.995889676	58	2.917467975
22	8.622995	59	8.668198992	22	2.953082887	59	2.908851131
23	8.507089892	60	8.648631327	23	2.913998427	60	2.900521515
24	8.400843543	61	8.792909359	24	2.878171005	61	2.946401453
25	8.303096902	62	8.932533261	25	2.845209777	62	2.990801392
26	8.21287253	63	9.067724658	26	2.814784467	63	3.03379181
27	8.129331444	64	9.198691325	27	2.786612883	64	3.075438778
28	8.051757579	65	9.325628247	28	2.760453555	65	3.1158043
29	7.979533636	66	9.462888792	29	2.736098319	66	3.159636241
30	7.912124623	67	9.596052008	30	2.713366766	67	3.202159765
31	7.82345249	68	9.725298659	31	2.6807592	68	3.243432598
32	7.740322365	69	9.850799029	32	2.650189607	69	3.283509117
33	7.66223043	70	9.972713675	33	2.621472717	70	3.322440593
34	7.588732138	71	10.15130263	34	2.594445055	71	3.38078222
35	7.519433748	72	10.32493078	35	2.568961832	72	3.437503246
36	7.453985459	73	10.49380199	36	2.544894442	73	3.492670272
37	7.392074915	74	10.65810911	37	2.522127993	74	3.546346296
38	7.333422821	75	10.81803472	38	2.500559778	75	3.598590961

Class Exercise 1: Step 3

Calculate the emission reduction

$$\text{Daily Emission Reduction} = VMT_{REP} * (EF_B - EF_A)$$

$= VMT_{REP} * (8.6230 - 2.9531)$

$= 6{,}336 * 5.6699$

$= 35{,}924$ grams / day

VMT and NO_X Emission Rates
VMT_{REP} = 6,336 miles
EF_B = 8.6230
EF_A = 2.9531

Emission Reduction = 35.9 kg / day

CLASS EXERCISE

Using the MOSERS Guide Module 2 Emission Equations

Class Participation

Class Exercise 2: Traffic Signalization for Corridors

Improved traffic flow

- Can improve interconnection and coordination of signals
- Reduce travel times, delays, and stops.

Application

- Implemented on major arterials and large capacity roadways

Class Exercise 2

A city is planning on retiming signals on one of their principal arterial corridors. The project will be completed in June 2024.

Calculate NOx emission benefits using following information.

Traffic Information			
	AADT	=	30,000
	Corridor Length	=	4 miles
	Number of Signals	=	4
	Peak hourly travel mix	=	6.77%
	Hours in peak period	=	6
Speed **before** implementation	Peak hour	=	17 mph
	Off-peak hour	=	39 mph
Speed **after** implementation	Peak hour	=	18 mph
	Off-peak hour	=	43 mph

Class Exercise 2: Traffic Signalization for Corridors

Strategy 5.1 Equation

Daily Emission Reduction (grams/day) = A + B

Equation

Daily Emission Reduction (grams/day) = A + B

For corridors

$$A = V_{D,P} * (EF_{B,P} - EF_{A,P}) * L$$

Change in running exhaust emissions from improved traffic flow during the peak period

$$B = V_{D,OP} * (EF_{B,OP} - EF_{A,OP}) * L$$

Change in running exhaust emissions from improved traffic flow during the off-peak period

Class Exercise 2: Coordinated Signals Variables

Strategy 5.1 Variables

Variables (unit)		Definitions
$EF_{A, OP}$	(grams/mile)	Speed-based running exhaust emission factor during off-peak hours in affected corridor after implementation (NO_X, VOC, PM, or CO)
$EF_{A, P}$	(grams/mile)	Speed-based running exhaust emission factor during peak hours in affected corridor after implementation (NO_X, VOC, PM, or CO)
$EF_{B, OP}$	(grams/mile)	Speed-based running exhaust emission factor during off-peak hours in affected corridor before implementation (NO_X, VOC, PM, or CO)
$EF_{B, P}$	(grams/trip)	Speed-based running exhaust emission factor during peak hours in affected corridor before implementation (NO_X, VOC, PM, or CO)
EF_I	(grams/hour)	Idling emission factor (NO_X, VOC, PM, or CO)
L	(mile)	Length of corridor affected by signalization project
$V_{D, OP}$		Average daily volume for the corridor during off-peak hours
$V_{D, P}$		Average daily volume for the corridor during peak hours

Source: Federal Highway Administration Southern Resource Center & Texas A&M Transportation Institute

Class Exercise 2: Step 1 Equation

Equation

Daily Emission Reduction (grams/day) = A + B

For corridors

$$A = V_{D,P} * (EF_{B,P} - EF_{A,P}) * L$$

Change in running exhaust emissions from improved traffic flow during the peak period

$$B = V_{D,OP} * (EF_{B,OP} - EF_{A,OP}) * L$$

Change in running exhaust emissions from improved traffic flow during the off-peak period

Class Exercise 2: Step 1

Calculate peak hour volume

$$A = V_{D,P} * (EF_{B,P} - EF_{A,P}) * L$$

$V_{D,P}$ = AADT * Peak Hour Mix * Hours in Peak Period

= 30,000 * 0.0677 * 6

= 12,186 vehicles per day

Traffic Information			
	Average Daily Traffic (AADT)	=	30,000
	Corridor Length	=	4 miles
	Number of Signals	=	4
	Peak hourly travel mix	=	6.77%
	Hours in peak period	=	6
Speed before	Peak hour speed	=	17 mph
	Off-peak hour speed	=	39 mph
Speed after	Peak hour speed	=	18 mph
	Off-peak hour speed	=	43 mph

Class Exercise 2: Step 2 Equation

Equation

Daily Emission Reduction (grams/day) = A + B

For corridors

$$A = V_{D,\,P} * (EF_{B,\,P} - EF_{A,\,P}) * L$$

Change in running exhaust emissions from improved traffic flow during the peak period

$$B = V_{D,\,OP} * (EF_{B,\,OP} - EF_{A,\,OP}) * L$$

Change in running exhaust emissions from improved traffic flow during the off-peak period

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Class Exercise 2: Step 3

Calculate off-peak hour volume

$$B = V_{D,OP} * (EF_{B,OP} - EF_{A,OP}) * L$$

$$V_{D,OP} = AADT - \text{Peak Hour Volume}$$

$$= 30{,}000 - 12{,}186$$

$$= 17{,}814 \text{ vehicles per day}$$

Traffic Information			
	AADT	=	30,000
	Corridor Length	=	4 miles
	Number of Signals	=	4
	Peak hourly travel mix	=	6.77%
	Hours in peak period	=	6
Speed before	Peak hour speed	=	17 mph
	Off-peak hour speed	=	39 mph
Speed after	Peak hour speed	=	18 mph
	Off-peak hour speed	=	43 mph

Class Exercise 2: Step 4

Look-up NOx emission rates

Emission Factors		
Speed before	Peak hour = 17 mph	$EF_{B,P}$ = **0.0832**
	Off-peak hour = 39 mph	$EF_{B,OP}$ = **0.0702**
Speed after	Peak hour = 18 mph	$EF_{A,P}$ = **0.0822**
	Off-peak hour = 43 mph	$EF_{A,OP}$ = **0.0707**

Average Speed	NOx (grams/mile)
2.5	0.1695
3	0.1527
4	0.1317
5	0.1191
6	0.1107
7	0.1047
8	0.1002
9	0.0967
10	0.0939
11	0.0916
12	0.0897
13	0.0881
14	0.0867
15	0.0855
16	0.0843
17	0.0832
18	0.0822
19	0.0813
20	0.0806
21	0.0795
22	0.0785
23	0.0776
24	0.0768
25	0.0760
26	0.0749
27	0.0738
28	0.0728
29	0.0718
30	0.0709
31	0.0708
32	0.0706
33	0.0704
34	0.0703
35	0.0701
36	0.0701
37	0.0701
38	0.0701

Average Speed	NOx (grams/mile)
39	0.0702
40	0.0702
41	0.0704
42	0.0706
43	0.0707
44	0.0709
45	0.0711
46	0.0716
47	0.0720
48	0.0725
49	0.0729
50	0.0733
51	0.0739
52	0.0746
53	0.0752
54	0.0758
55	0.0763
56	0.0772
57	0.0780
58	0.0788
59	0.0796
60	0.0804
61	0.0818
62	0.0832
63	0.0846
64	0.0859
65	0.0872
66	0.0902
67	0.0931
68	0.0960
69	0.0988
70	0.1015
71	0.1057
72	0.1098
73	0.1137
74	0.1176
75	0.1214

Class Exercise 2: Step 5

Calculate total NOx emission benefits

$$A = V_{D,P} * (EF_{B,P} - EF_{A,P}) * L$$

$$A = 12{,}186 * (0.0832 - 0.0822) * 4$$

$$A = 48.744$$

$$B = V_{D,OP} * (EF_{B,OP} - EF_{A,OP}) * L$$

$$B = 17{,}814 * (0.0702 - 0.0707) * 4$$

$$B = -35.628$$

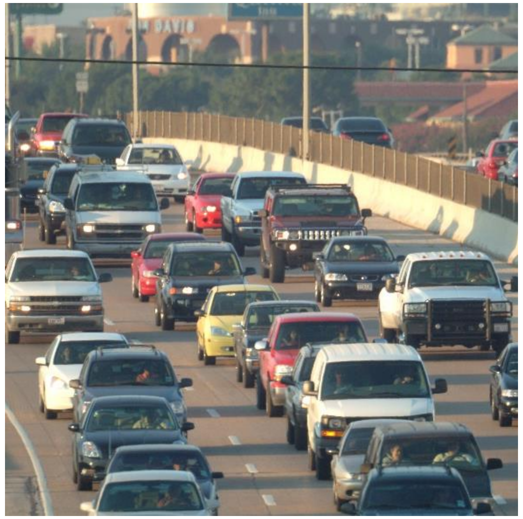
Emission Factors				
Speed before	Peak hour	=	17 mph	**$EF_{B,P}$ = 0.0832**
	Off-peak hour	=	39 mph	**$EF_{B,OP}$ = 0.0702**
Speed after	Peak hour	=	18 mph	**$EF_{A,P}$ = 0.0822**
	Off-peak hour	=	43 mph	**$EF_{A,OP}$ = 0.0707**

$$A + B = 48.744 - 35.628$$

$$A + B = 13.1 \text{ grams / day}$$

Emission Reduction = 0.0131 kg / day

Questions and Comments



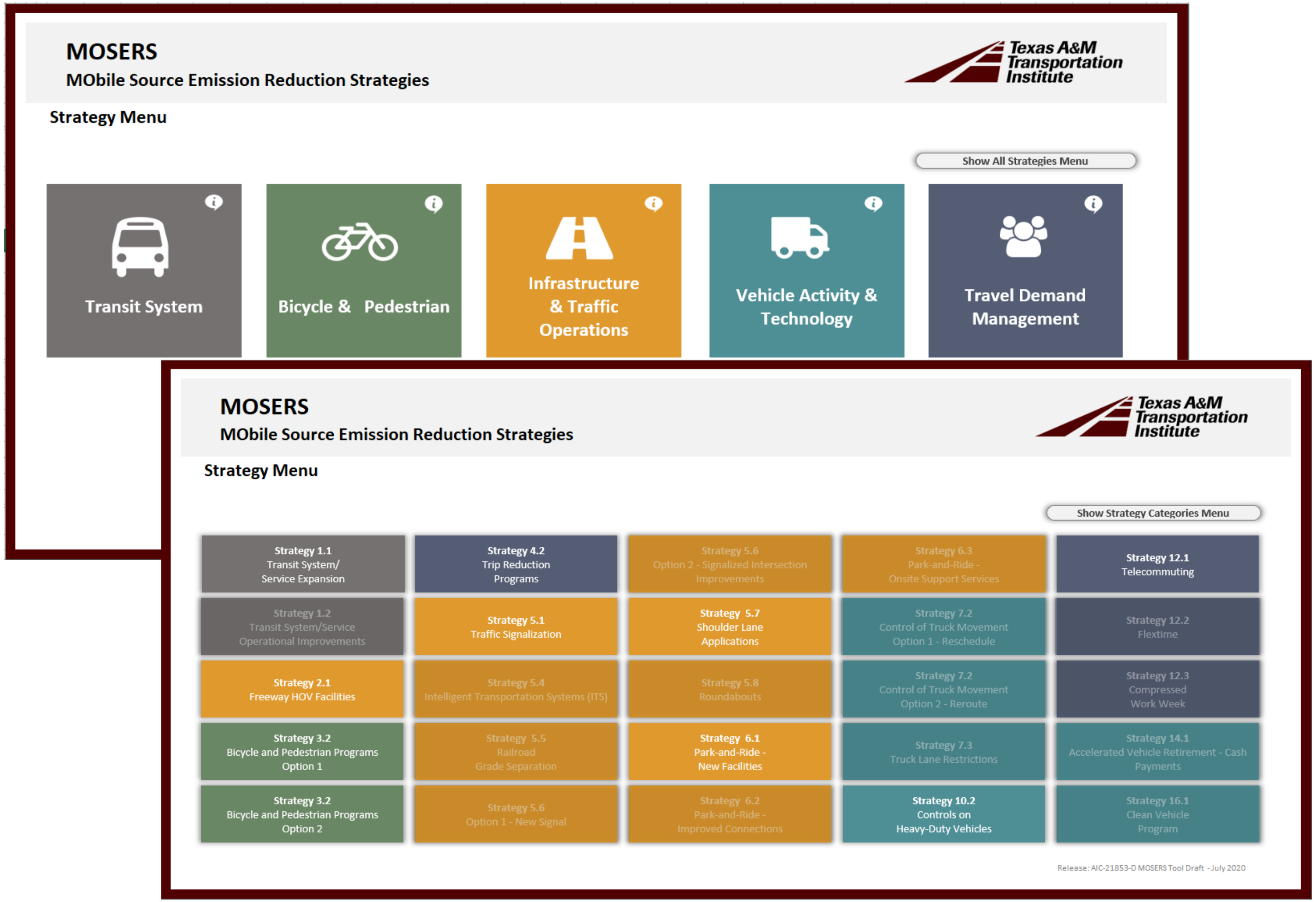
MOSERS Training – Part 6

MOSERS SPREADSHEET TOOL AND WEB EDITION

Texas A&M Transportation Institute

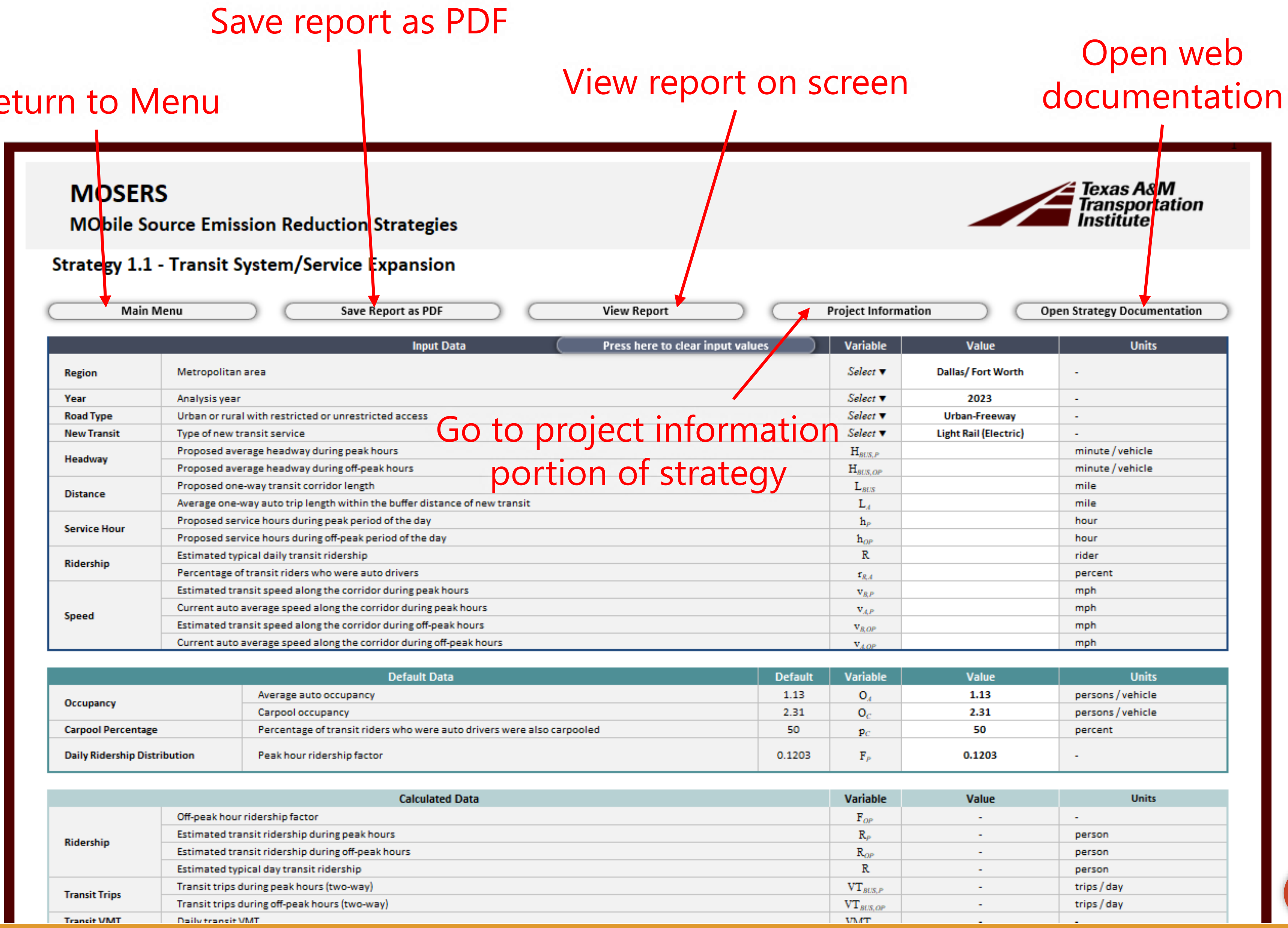
MOSERS Guide - Spreadsheet Tool

- Macro-enabled and Excel-based
- Automated
- Estimates changes in vehicles activity
- Two menu types
- Grouped by strategy type
- Navigation buttons
- Ten active strategies



MOSERS Guide - Spreadsheet Tool

- Navigation and action buttons
- User input is limited to white cells
- Drop-down lists
- Average Texas state-wide default values are available for some inputs
- FHWA's Highway Capacity Manual Equations



Input Data		Variable	Value	Units
Region	Metropolitan area	Select ▾	Dallas/ Fort Worth	-
Year	Analysis year	Select ▾	2023	-
Road Type	Urban or rural with restricted or unrestricted access	Select ▾	Urban-Freeway	-
New Transit	Type of new transit service	Select ▾	Light Rail (Electric)	-
Headway	Proposed average headway during peak hours	$H_{BUS,P}$		minute / vehicle
	Proposed average headway during off-peak hours	$H_{BUS,OP}$		minute / vehicle
Distance	Proposed one-way transit corridor length	L_{BUS}		mile
	Average one-way auto trip length within the buffer distance of new transit	L_A		mile
Service Hour	Proposed service hours during peak period of the day	h_P		hour
	Proposed service hours during off-peak period of the day	h_{OP}		hour
Ridership	Estimated typical daily transit ridership	R		rider
	Percentage of transit riders who were auto drivers	$r_{R,A}$		percent
Speed	Estimated transit speed along the corridor during peak hours	$v_{R,P}$		mph
	Current auto average speed along the corridor during peak hours	$v_{A,P}$		mph
	Estimated transit speed along the corridor during off-peak hours	$v_{R,OP}$		mph
	Current auto average speed along the corridor during off-peak hours	$v_{A,OP}$		mph

Default Data		Default	Variable	Value	Units
Occupancy	Average auto occupancy	1.13	O_A	1.13	persons / vehicle
	Carpool occupancy	2.31	O_C	2.31	persons / vehicle
Carpool Percentage	Percentage of transit riders who were auto drivers were also carpooled	50	p_C	50	percent
Daily Ridership Distribution	Peak hour ridership factor	0.1203	F_P	0.1203	-

Calculated Data		Variable	Value	Units
Ridership	Off-peak hour ridership factor	F_{OP}	-	-
	Estimated transit ridership during peak hours	R_P	-	person
	Estimated transit ridership during off-peak hours	R_{OP}	-	person
	Estimated typical day transit ridership	R	-	person
Transit Trips	Transit trips during peak hours (two-way)	$VT_{BUS,P}$	-	trips / day
	Transit trips during off-peak hours (two-way)	$VT_{BUS,OP}$	-	trips / day
Transit VMT	Daily transit VMT	VMT	-	-

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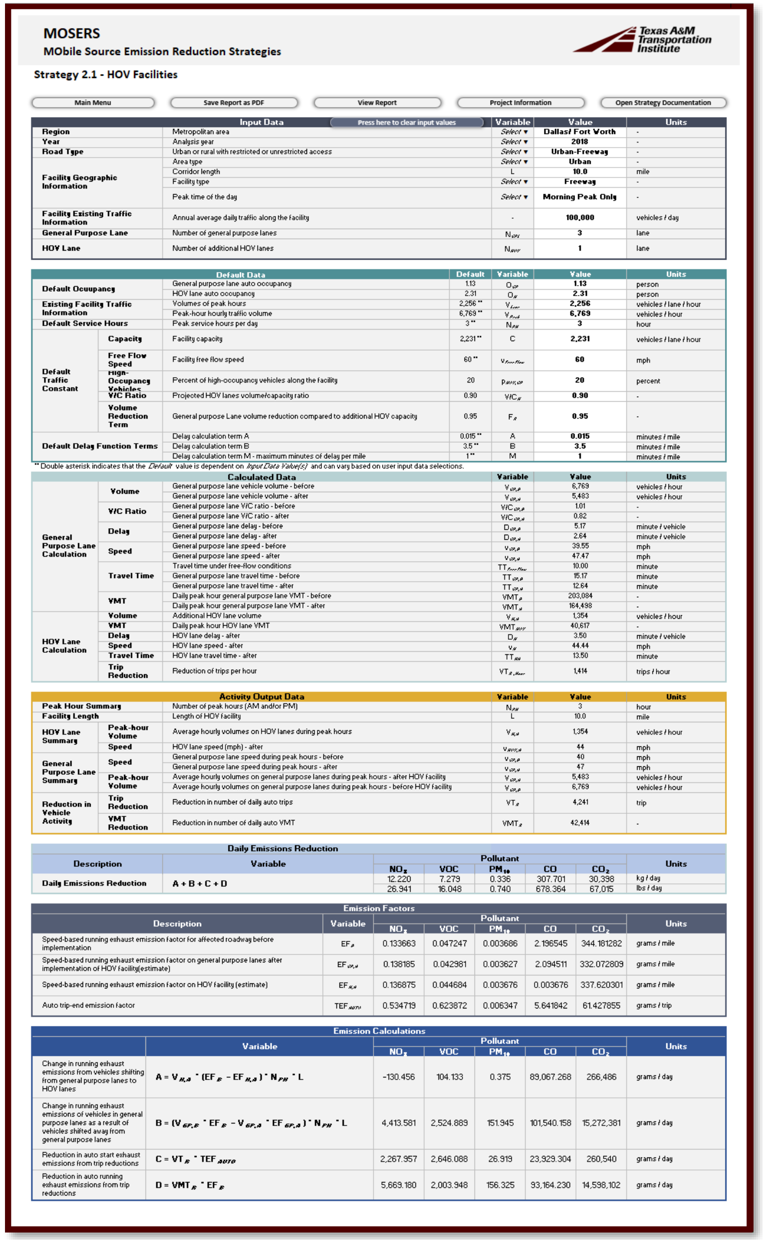
- Seven sections in each strategy

1. Input data
2. Default data
3. Calculated Data
4. Activity output data
5. Daily emission reductions
6. Emission factors
7. Emission calculations



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Input Data section

Press to clear all input values

Select indicates drop-down list for cell

Input Data	Press here to clear input values	Variable	Value	Units
Region	Metropolitan area	Select ▾	Dallas/ Fort Worth	-
Year	Analysis year	Select ▾	2018	-
Road Type	Urban or rural with restricted or unrestricted access	Select ▾	Urban-Freeway	-
Facility Geographic Information	Area type	Select ▾	Urban	-
	Corridor length	L	10.0	mile
	Facility type	Select ▾	Freeway	-
	Peak time of the day	Select ▾	Morning Peak Only	-
Facility Existing Traffic Information	Annual average daily traffic along the facility	-	100,000	vehicles / day
General Purpose Lane	Number of general purpose lanes	N_{GP}	3	lane
HOV Lane	Number of additional HOV lanes	N_{HOV}	1	lane

White cells for require user input

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Default Data section

Default value restores to this value

Restore default value buttons

Default Data			Default	Variable	Value	Units
Default Occupancy		General purpose lane auto occupancy	1.13	O_{GP}	**1.13**	person
		HOV lane auto occupancy	2.31	O_{H}	**2.31**	person
Existing Facility Traffic Information		Volumes of peak hours	2,256 **	V_{lane}	**2,256**	vehicles / lane / hour
		Peak-hour hourly traffic volume	6,769 **	V_{peak}	**6,769**	vehicles / hour
Default Service Hours		Peak service hours per day	3 **	N_{pk}	**3**	hour
Default Traffic Constant	Capacity	Facility capacity	2,231 **	C	**2,231**	vehicles / lane / hour
	Free Flow Speed	Facility free flow speed	60 **	$v_{free\text{-}flow}$	**60**	mph
	High-Occupancy Vehicles	Percent of high-occupancy vehicles along the facility	20	$p_{HOV,GP}$	**20**	percent
	V/C Ratio	Projected HOV lanes volume/capacity ratio	0.90	V/C_{H}	**0.90**	-
	Volume Reduction Term	General purpose Lane volume reduction compared to additional HOV capacity	0.95	F_{H}	**0.95**	-
Default Delay Function Terms		Delay calculation term A	0.015 **	A	**0.015**	minutes / mile
		Delay calculation term B	3.5 **	B	**3.5**	minutes / mile
		Delay calculation term M - maximum minutes of delay per mile	1 **	M	**1**	minutes / mile

** Double asterisk indicates that the *Default* value is dependent on *Input Data Value(s)* and can vary based on user input data selections.

Restore All
Restore
Restore

Double asterisk (**) indicate that the default value is dependent on other selections.

White cells in this section are populated with Texas default values. Project-specific input is optional.

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Calculated Data Section

No data entry required

Calculated Data			Variable	Value	Units
General Purpose Lane Calculation	Volume	General purpose lane vehicle volume - before	$V_{GP,B}$	6,769	vehicles / hour
		General purpose lane vehicle volume - after	$V_{GP,A}$	5,483	vehicles / hour
	V/C Ratio	General purpose lane V/C ratio - before	$V/C_{GP,B}$	1.01	-
		General purpose lane V/C ratio - after	$V/C_{GP,A}$	0.82	-
	Delay	General purpose lane delay - before	$D_{GP,B}$	5.17	minute / vehicle
		General purpose lane delay - after	$D_{GP,A}$	2.64	minute / vehicle
	Speed	General purpose lane speed - before	$v_{GP,B}$	39.55	mph
		General purpose lane speed - after	$v_{GP,A}$	47.47	mph
	Travel Time	Travel time under free-flow conditions	$TT_{free-flow}$	10.00	minute
		General purpose lane travel time - before	$TT_{GP,B}$	15.17	minute
		General purpose lane travel time - after	$TT_{GP,A}$	12.64	minute
	VMT	Daily peak hour general purpose lane VMT - before	VMT_{B}	203,084	-
		Daily peak hour general purpose lane VMT - after	VMT_{A}	164,498	-
HOV Lane Calculation	Volume	Additional HOV lane volume	$V_{H,A}$	1,354	vehicles / hour
	VMT	Daily peak hour HOV lane VMT	VMT_{HOV}	40,617	-
	Delay	HOV lane delay - after	D_{H}	3.50	minute / vehicle
	Speed	HOV lane speed - after	v_{H}	44.44	mph
	Travel Time	HOV lane travel time - after	TT_{HOV}	13.50	minute
	Trip Reduction	Reduction of trips per hour	$VT_{R,Hour}$	1,414	trips / hour

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Activity Output Data Section

No data entry required

Activity Output Data			Variable	Value	Units
Peak Hour Summary		Number of peak hours (AM and/or PM)	N_{PH}	3	hour
Facility Length		Length of HOV facility	L	10.0	mile
HOV Lane Summary	**Peak-hour Volume**	Average hourly volumes on HOV lanes during peak hours	$V_{H,A}$	1,354	vehicles / hour
	Speed	HOV lane speed (mph) - after	$v_{HOV,A}$	44	mph
General Purpose Lane Summary	**Speed**	General purpose lane speed during peak hours - before	$v_{GP,B}$	40	mph
		General purpose lane speed during peak hours - after	$v_{GP,A}$	47	mph
	Peak-hour Volume	Average hourly volumes on general purpose lanes during peak hours - after HOV facility	$V_{GP,A}$	5,483	vehicles / hour
		Average hourly volumes on general purpose lanes during peak hours - before HOV facility	$V_{GP,B}$	6,769	vehicles / hour
Reduction in Vehicle Activity	**Trip Reduction**	Reduction in number of daily auto trips	VT_R	4,241	trip
	VMT Reduction	Reduction in number of daily auto VMT	VMT_R	42,414	-

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Daily Emissions Reduction Section

Daily Emissions Reduction								
Description	Variable	Pollutant					Units
		NO_x	VOC	PM_{10}	CO	CO_2	
Daily Emissions Reduction	A + B + C + D	12.220	7.279	0.336	307.701	30,398	kg / day
		26.941	16.048	0.740	678.364	67,015	lbs / day

Emission Factors							
Description	Variable	Pollutant					Units
		NO_x	VOC	PM_{10}	CO	CO_2	
Speed-based running exhaust emission factor for affected roadway before implementation	EF_B	0.133663	0.047247	0.003686	2.196545	344.181282	grams / mile
Speed-based running exhaust emission factor on general purpose lanes after implementation of HOV facility(estimate)	$EF_{GP,A}$	0.138185	0.042981	0.003627	2.094511	332.072809	grams / mile
Speed-based running exhaust emission factor on HOV facility (estimate)	$EF_{H,A}$	0.136875	0.044684	0.003676	0.003676	337.620301	grams / mile
Auto trip-end emission factor	TEF_{auto}	0.534719	0.623872	0.006347	5.641842	61.427855	grams / trip

Section with emission factors loaded

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Daily Emissions Reduction Section

Flag

Load button

Press Here to Load Emission Factors

Daily Emissions Reduction							
Description	Variable	Pollutant					Units
		NO_x	VOC	PM_{10}	CO	CO_2	
Daily Emissions Reduction	A + B + C + D	-	-	-	-	-	kg / day
		-	-	-	-	-	lbs / day

Load Emission Factors

Emission Factors							
Description	Variable	Pollutant					Units
		NO_x	VOC	PM_{10}	CO	CO_2	
Speed-based running exhaust emission factor for affected roadway before implementation	EF_{p}	-	-	-	-	-	grams / mile
Speed-based running exhaust emission factor on general purpose lanes after implementation of HOV facility(estimate)	$EF_{gp,a}$	-	-	-	-	-	grams / mile
Speed-based running exhaust emission factor on HOV facility (estimate)	$EF_{H,a}$	-	-	-	-	-	grams / mile
Auto trip-end emission factor	TEF_{auto}	-	-	-	-	-	grams / trip

Section with emission factors NOT loaded

MOSERS Guide - Spreadsheet Tool

Emission Calculations Section

No data entry required

Emission Calculations							
	Variable	Pollutant					Units
		NO_x	VOC	PM_{10}	CO	CO_2	
Change in running exhaust emissions from vehicles shifting from general purpose lanes to HOV lanes	$A = V_{H,A} \cdot (EF_B - EF_{H,A}) \cdot N_{PH} \cdot L$	-130.456	104.133	0.375	89,067.268	266,486	grams / day
Change in running exhaust emissions of vehicles in general purpose lanes as a result of vehicles shifted away from general purpose lanes	$B = (V_{GP,B} \cdot EF_B - V_{GP,A} \cdot EF_{GP,A}) \cdot N_{PH} \cdot L$	4,413.581	2,524.889	151.945	101,540.158	15,272,381	grams / day
Reduction in auto start exhaust emissions from trip reductions	$C = VT_B \cdot TEF_{AUTO}$	2,267.957	2,646.088	26.919	23,929.304	260,540	grams / day
Reduction in auto running exhaust emissions from trip reductions	$D = VMT_B \cdot EF_B$	5,669.180	2,003.948	156.325	93,164.230	14,598,102	grams / day

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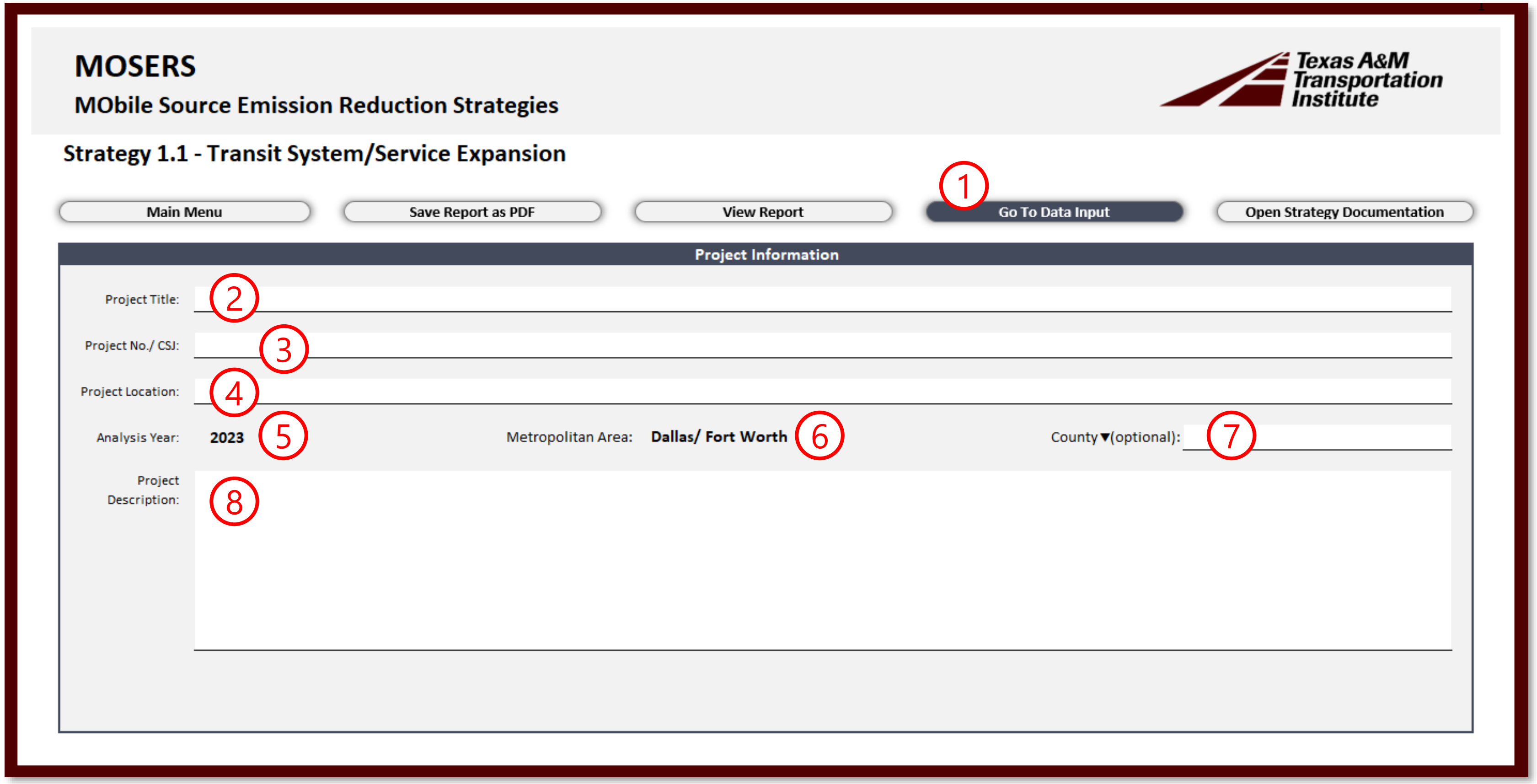
Project Information

1. Return to input section
2. Project Title
3. Project Location
4. Project Location
5. Analysis Year
6. Metro Area
7. County
8. Project Description



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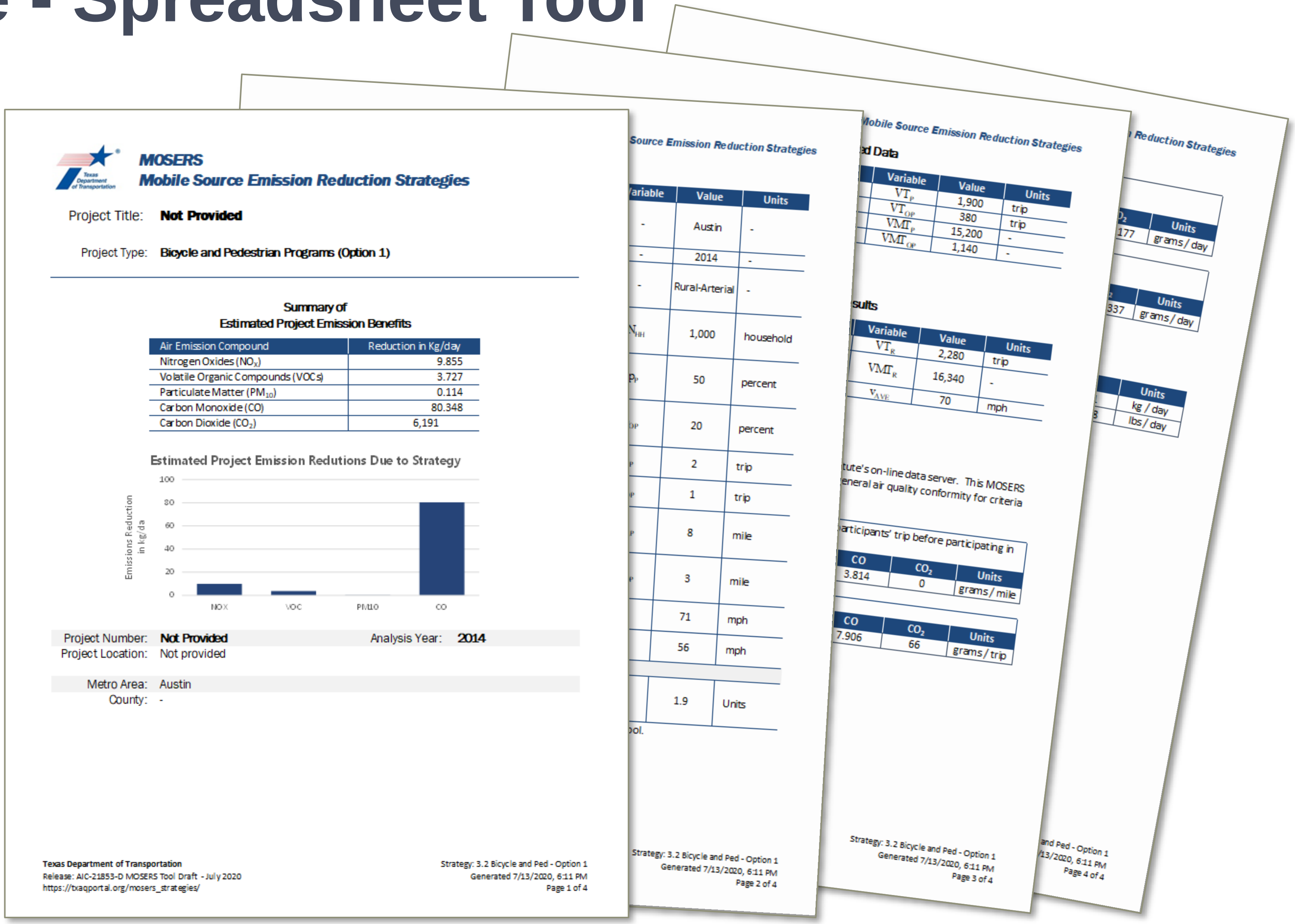
Pre-formatted PDF

The MOSERS spreadsheet tool version/date of release

Strategy number and name

Strategy report creation date and time. This date and time coincides with the default naming used in the *Save Report as PDF* button function

Strategy report page number



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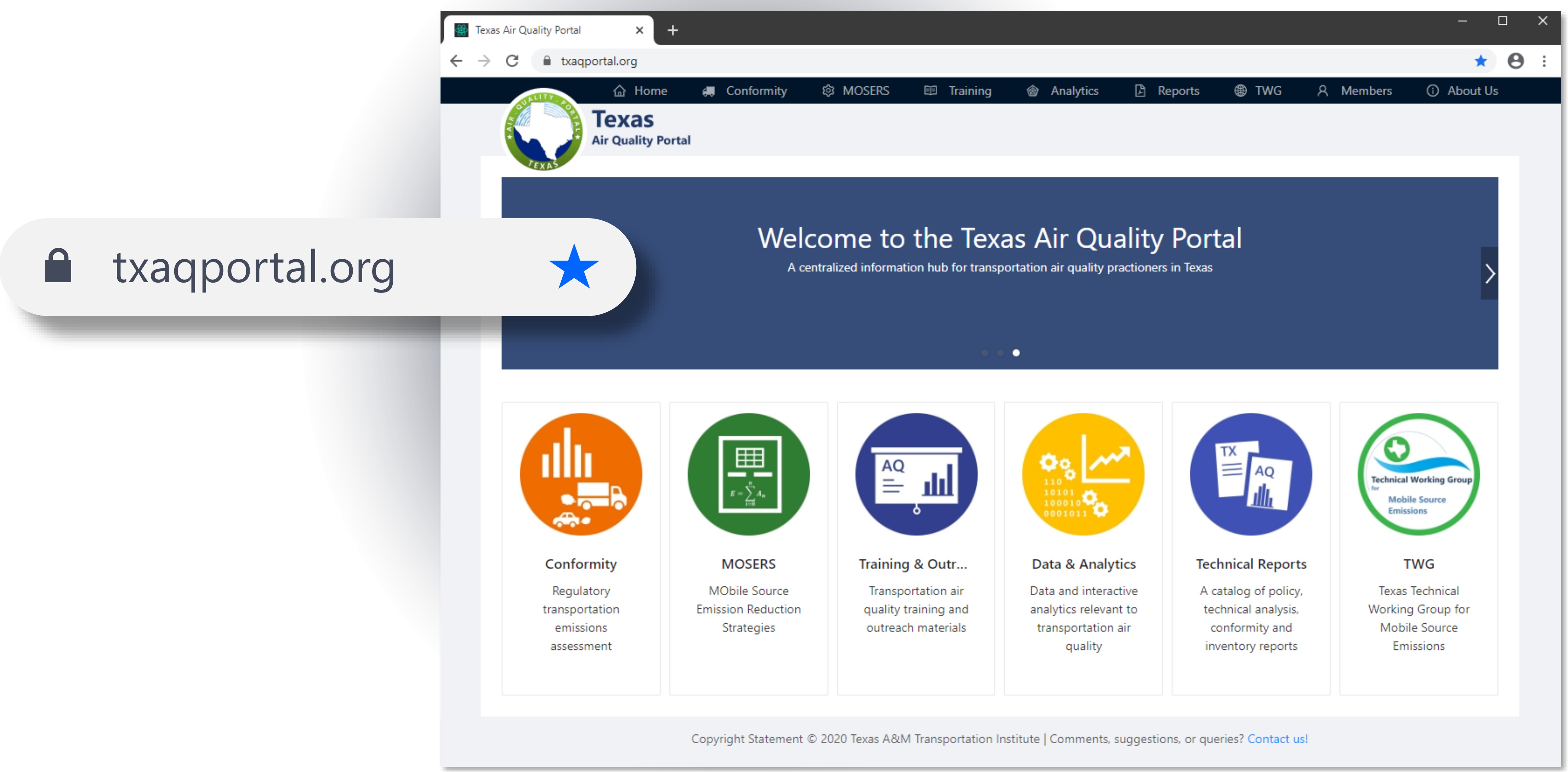

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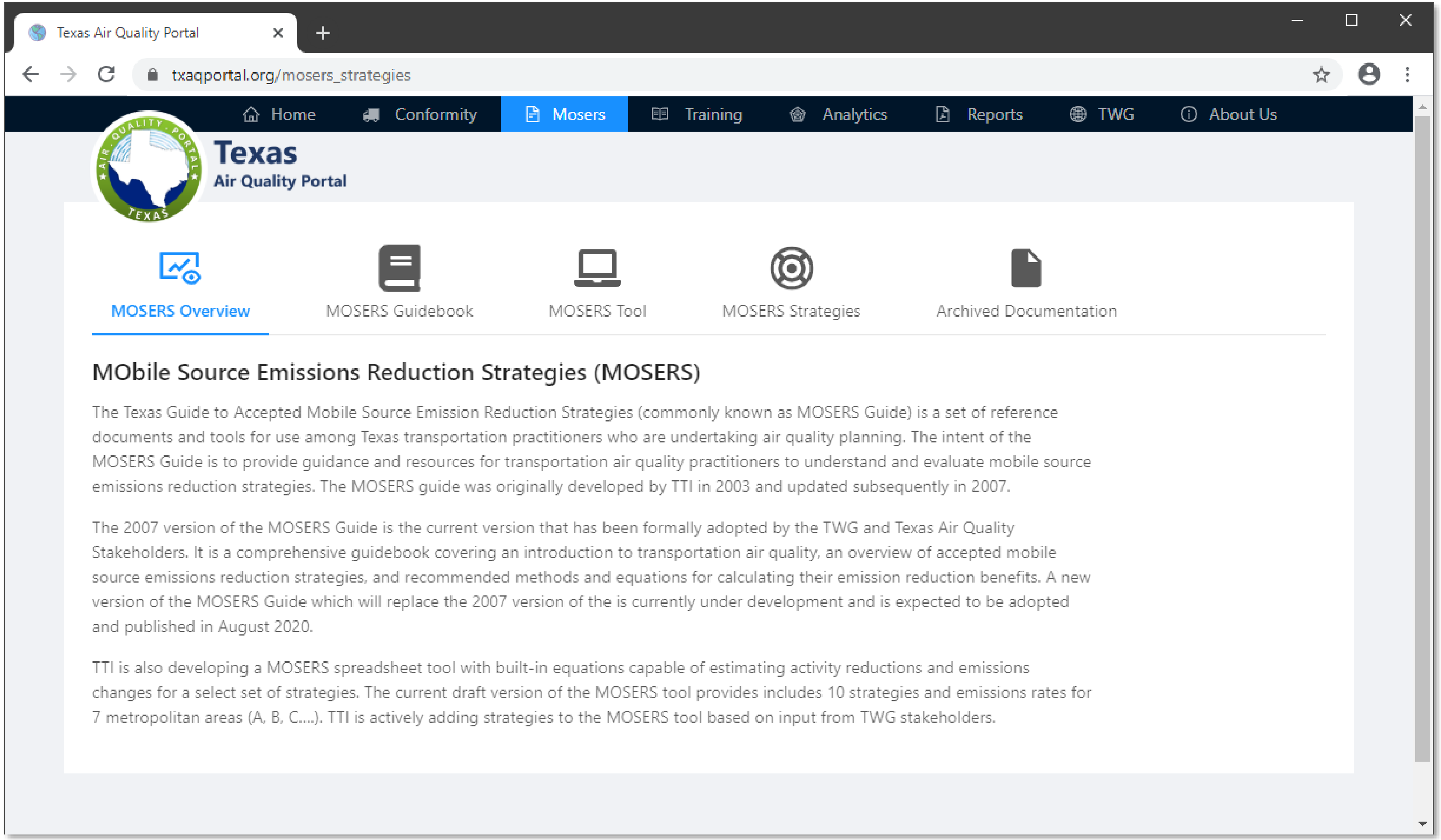

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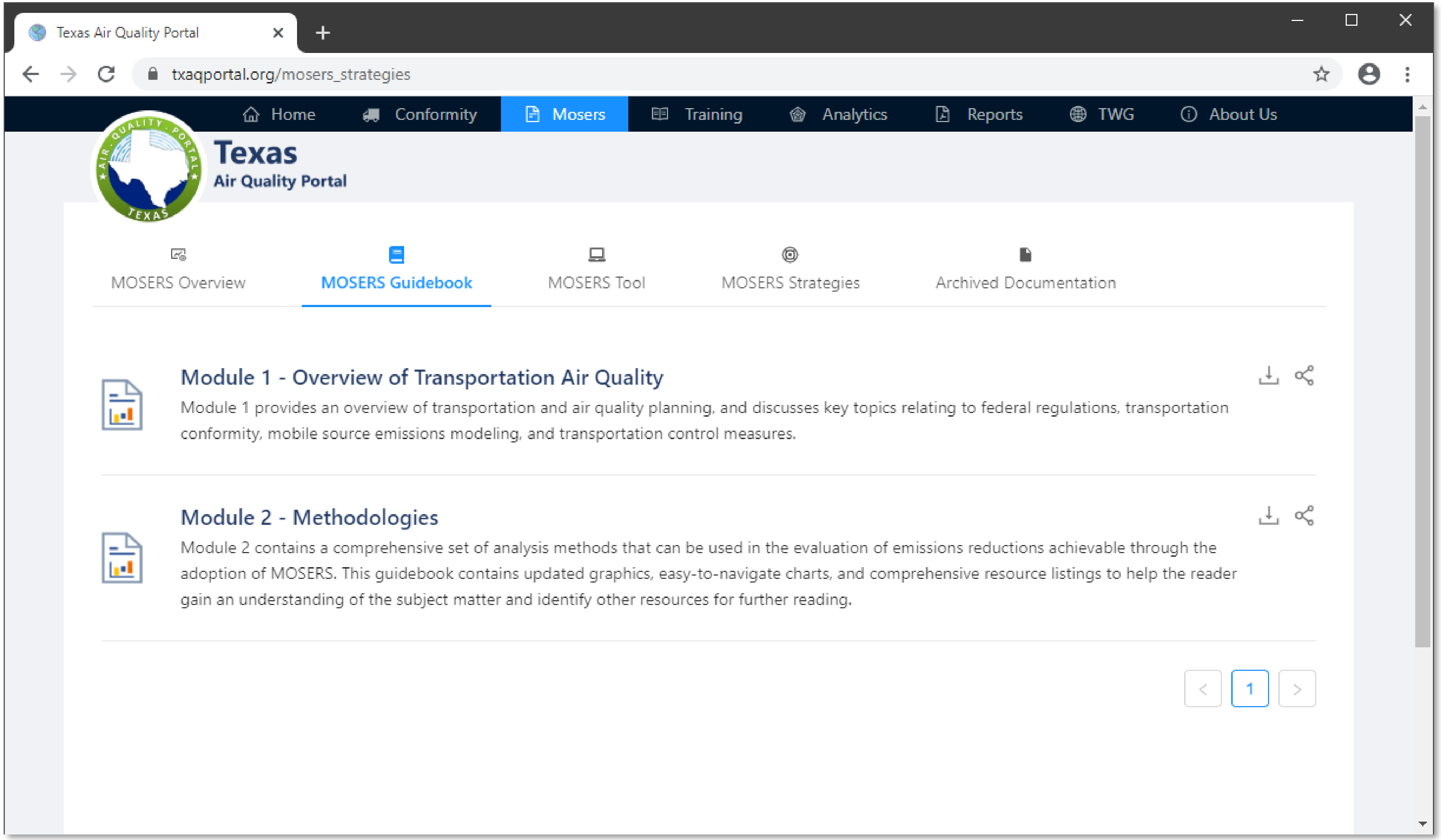

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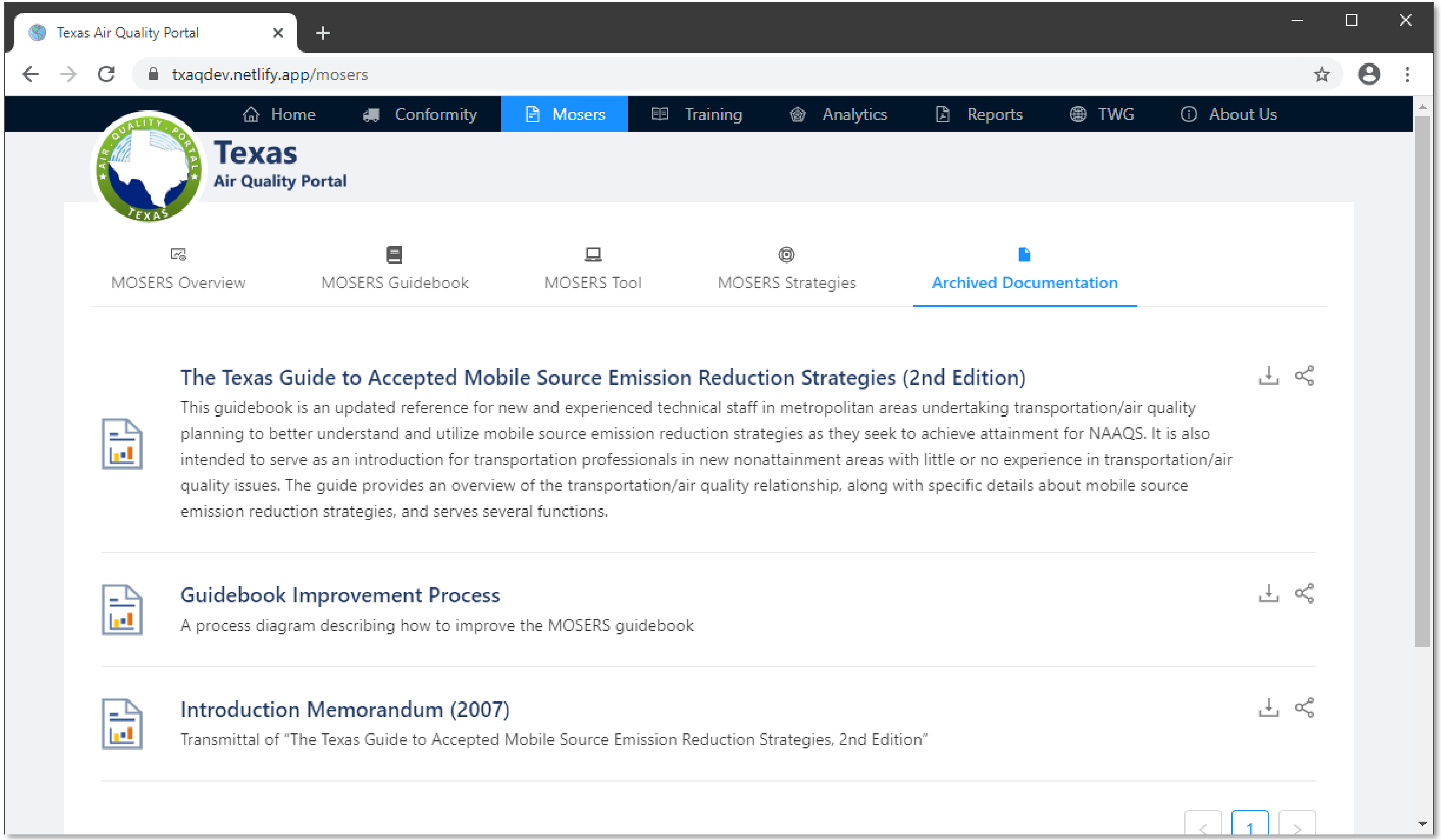

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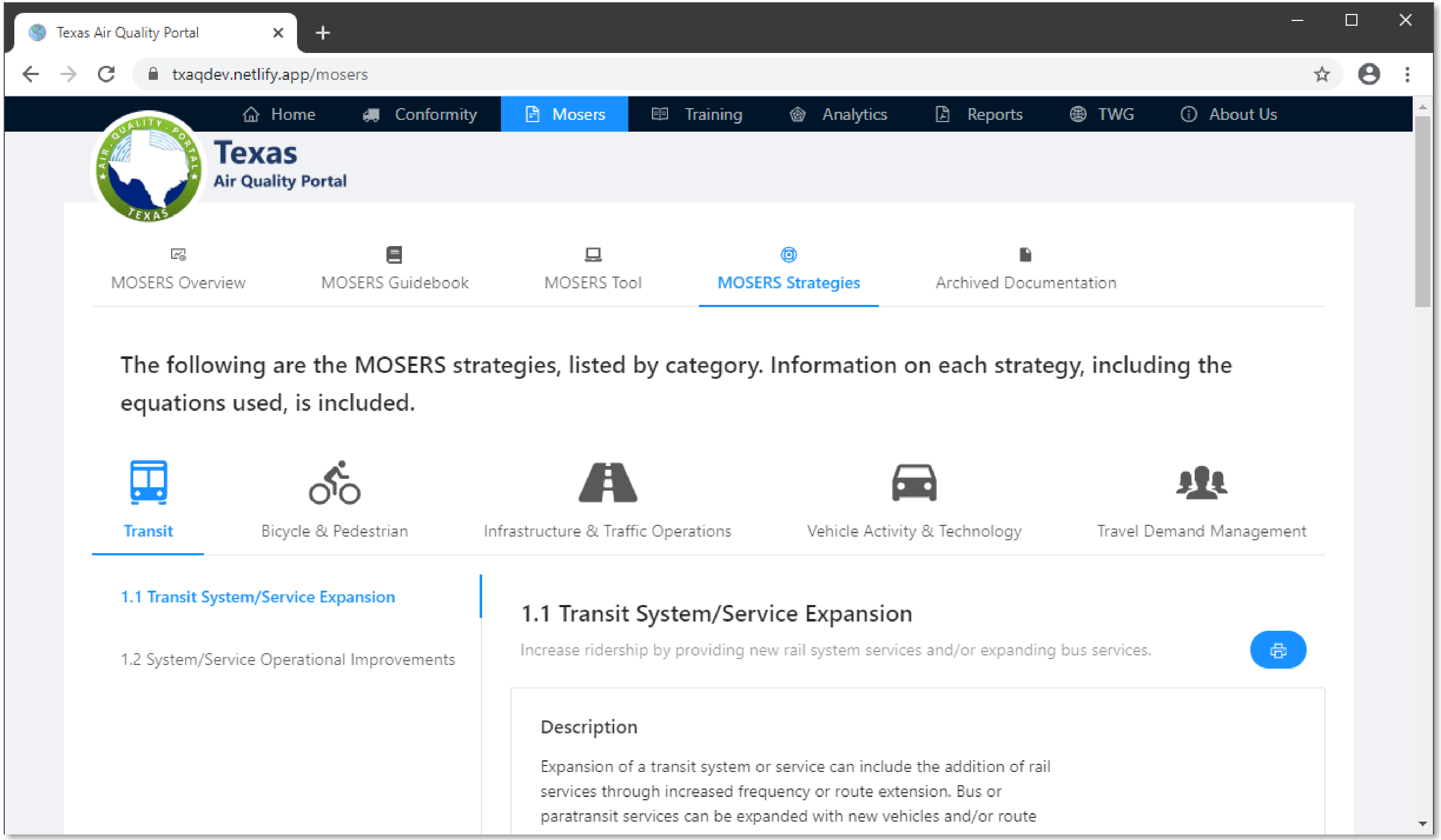

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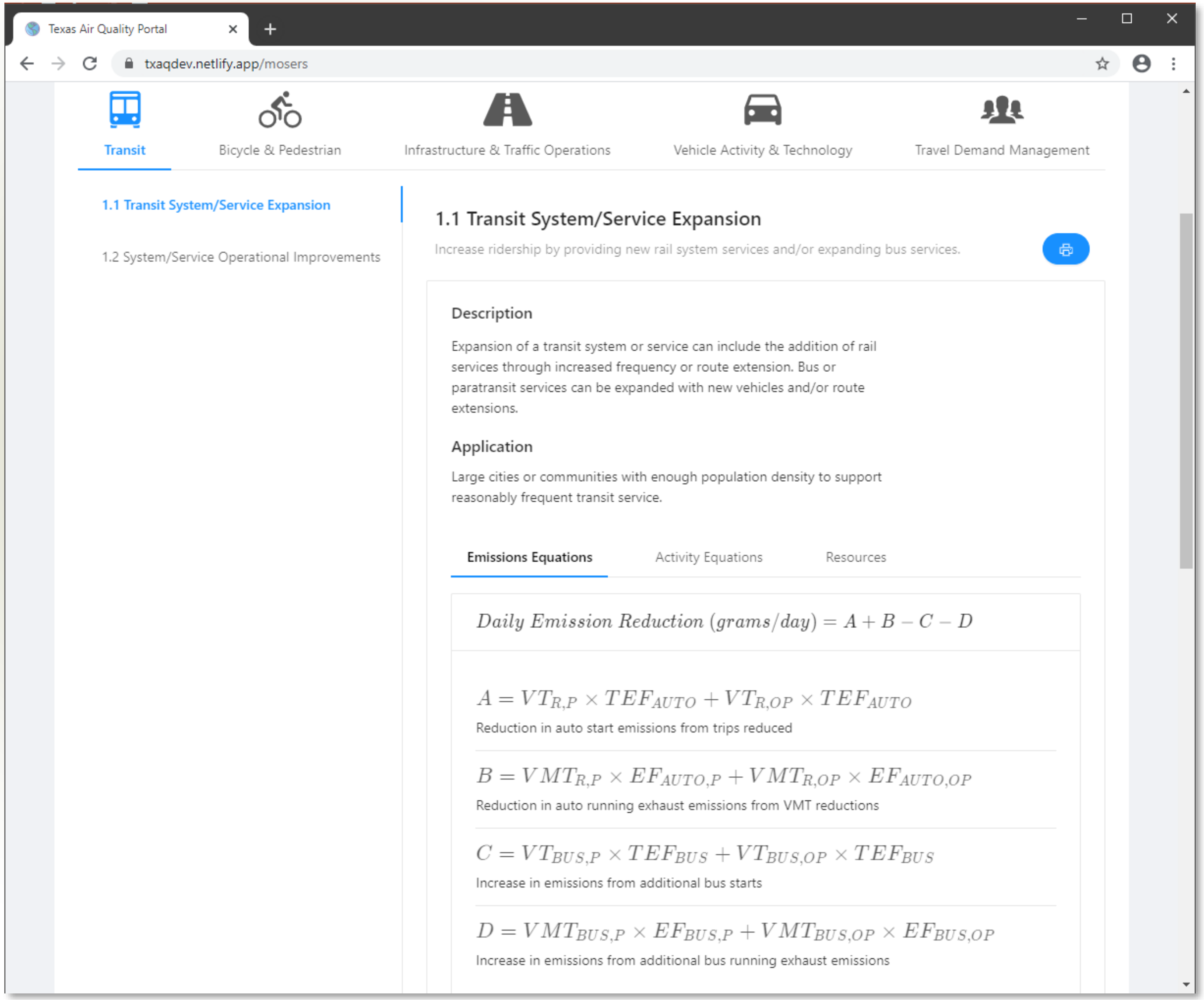

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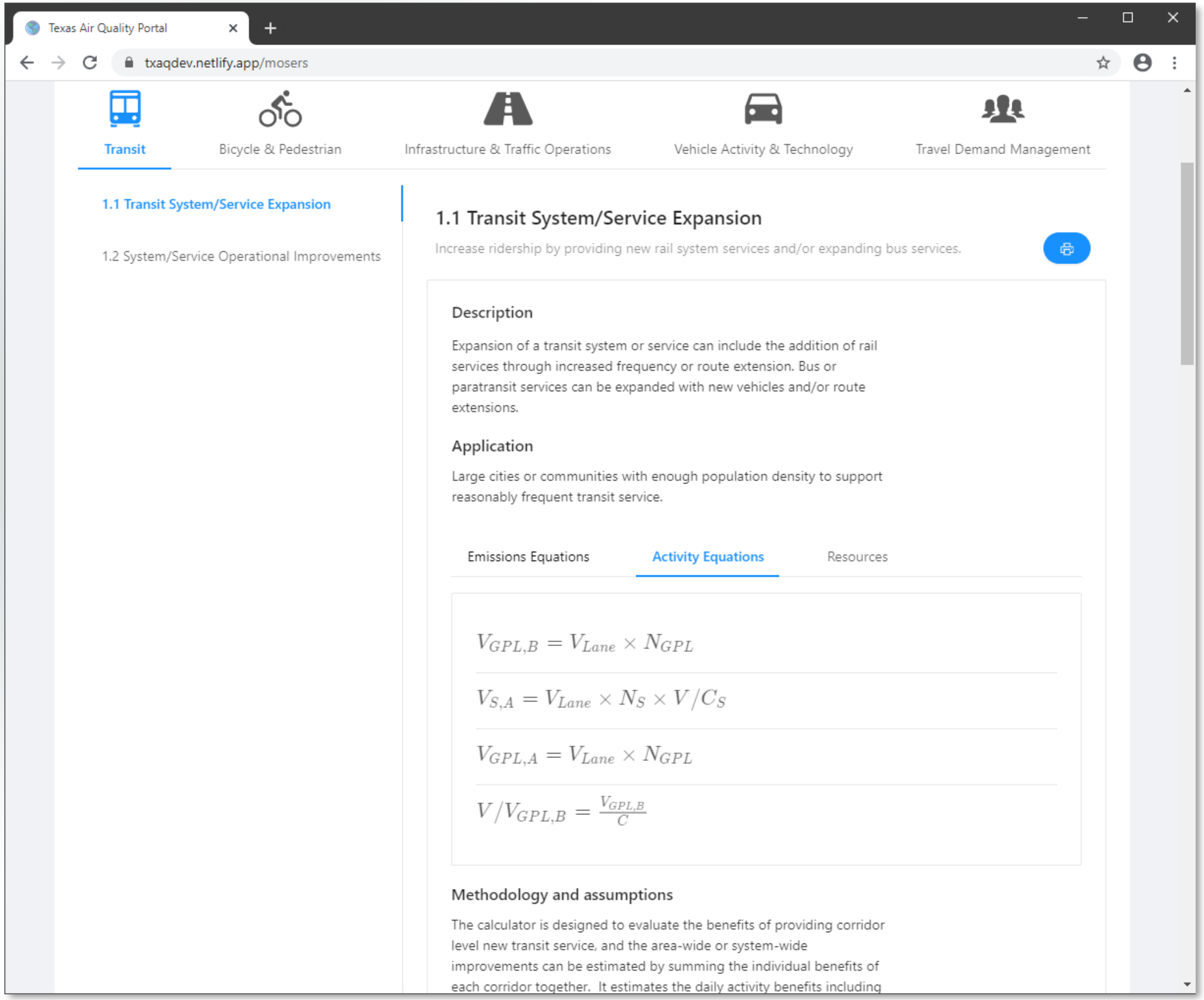

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CLASS EXERCISE

Using the MOSERS Guide Spreadsheet Tool
Instructor Demonstration

Class Exercise 3: Idling Controls on H-D Vehicles

Idling Restrictions

- Reduced vehicle emissions
- Reduced fuel cost
- Implemented manually or through vehicle modifications

Application

- Medium-sized and large urban areas with a significant number of heavy-duty vehicles operating in the area

Class Exercise 3

Austin is planning to implement extended vehicle idling restrictions for hotelling of heavy-duty trucks within the metropolitan area. The restrictions will be implemented area beginning in the 2023.

Calculate the emission benefits using following information.

Project Information		
Number of facilities in the plan	=	8 facilities
Existing number of heavy-duty vehicles per facility	=	200 vehicles
Existing average idle time per vehicle per day	=	480 minutes
Maximum idling time per vehicle per day allowed by restriction	=	240 minutes
Compliance factor (percent of vehicles that do not idle)	=	60 percent

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Class Exercise 3

Strategy 10.2 Extended Vehicle Idling Controls on Heavy-Duty Vehicles

Project Information		
Number of facilities in the plan	=	8 facilities
Existing number of heavy duty vehicles per facility	=	200 vehicles
Existing average idle time per vehicle per day	=	480 minutes
Maximum idling time per vehicle per day allowed by restriction	=	240 minutes
Compliance factor (percent of vehicles that do not idle)	=	60 percent

Input Data		Press here to clear input values	Variable	Value	Units
Region		Metropolitan area	*Select* ▼	**Austin**	-
Year		Analysis year	*Select* ▼	**2023**	-
Facility Description		Facility type	*Select* ▼	**Rest Area**	-
Extended Vehicle Idling Facility	Number of Vehicles	Existing daily number of heavy-duty vehicles per facility	N_{avg}	**200**	heavy-duty vehicle
	Existing Idling	Existing average idle time per vehicle per day	t	**480**	minute
	Number of Facilities	Number of existing facilities in plan to reduce idling time	N	**8**	facility
Idling Control	Idling Control	Maximum idling time expected to be allowed per vehicle by the control	t'	**240**	minute
	Compliance Factor	Compliance factor (percentage of vehicles that park instead of idling)	F_{PARK}	**60**	percent

Class Exercise 3

Calculated Data		Variable	Value	Units
Number of Vehicle Calculation	Existing daily number of heavy-duty vehicles per facility	-	200	heavy-duty vehicle

Activity Output			Variable	Value	Units
Idling Summary	**Idling Before Implementation**	Total idling time spent before implementation of control per vehicle per day	t_B	8.00	hour
	Idling After Implementation	Total idling time spent after implementation of control per vehicle per day	t_A	4.00	hour
Number of Vehicles		Total number of vehicles	N_T	1,600	vehicle

Daily Emissions Reduction							
Description	Variable	Pollutant					Units
		NO_X	VOC	PM_{10}	CO	CO_2	
Daily Emissions Reduction	$A * B$	17,246.612	2,964.669	102.137	8,227.661	834,722	kg / day
		38,022.226	6,535.968	225.173	18,138.867	1,840,244	lbs / day

Emission Factors							
Description	Variable	Pollutant					Units
		NO_X	VOC	PM_{10}	CO	CO_2	
Idling emission factor for trucks	EF_I	187.137719	32.168714	1.108257	89.275839	9,057.309570	grams / hour

Emission Calculations							
	Variable	Pollutant					Units
		NO_X	VOC	PM_{10}	CO	CO_2	
The number of vehicles in compliance with idling restrictions	$A = N_V * F_{PARK}$	960.000	960.000	960.000	960.000	960	vehicles / day
The reduction in idling exhaust emissions from reduced time spent in idling	$B = EF_I * (t_B - t_A)$	17,965.221	3,088.197	106.393	8,570.481	869,502	grams / vehicle

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CLASS EXERCISE

Using the MOSERS Guide Spreadsheet Tool

Class Participation

Class Exercise 4

Corpus Christi is planning to implement trip reduction program within the metropolitan area. The programs will be implemented area beginning in the 2022.

Calculate the emission benefits using following information.

Project Information		
Road type	=	Urban-Freeway
Total employment (site-wide or area-wide)	=	10,000 employees
Average home-based vehicle work trip distance	=	9 miles
Current trip mode shares of home-based work trip - SOV	=	60 percent
Expected percent of SOV drivers to participate bike/ped program	=	10 percent
Expected percent of SOV drivers to participate transit program	=	20 percent
Expected percent of SOV drivers to participate rideshare program	=	10 percent

Class Exercise 4

Strategy 4.2 Trip Reduction Programs

Project Information		
Road type	=	Urban-Freeway
Total employment (site-wide or area-wide)	=	10,000 employees
Average home-based vehicle work trip distance	=	9 miles
Current trip mode shares of home-based work trip - SOV	=	60 percent
Expected percent of SOV drivers to participate bike/ped program	=	10 percent
Expected percent of SOV drivers to participate transit program	=	20 percent
Expected percent of SOV drivers to participate rideshare program	=	10 percent

Input Data		Press here to clear input values	Variable	Value	Units
Region		Metropolitan area	Select ▼	Corpus Christi	-
Year		Analysis year	Select ▼	2021	-
Road Type		Urban or rural with restricted or unrestricted access	Select ▼	Urban-Freeway	-
Employment		Total employment (site-wide or area-wide)	N	10,000	employee
Trip Information	Distance	Average home-based vehicle work trip distance per employee	L	5	mile
	Mode Share	Current trip mode shares of home based work trip - single occupant vehicle	p_{SOV}	40	percent
	Speed	Average speed of home-based work trips	v	35	mph
Trip Reduction Program Information	Bike/Ped Participants	Expected percentage of SOV drivers to be participants in the bike/pedestrian program	$p_{B/P}$	10	percent
	Transit	Expected percentage of SOV frivers to be participants in the public transit program	$p_{Transit}$	20	percent
	Rideshare	Expected percentage of SOV drivers to be participants in the rideshare program	$p_{Rideshare}$	10	percent

Default Data		Default	Variable	Value	Units
Occupancy	Rideshare auto occupancy	2.31	$O_{Rideshare}$	2.31	rider

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Class Exercise 4

Calculated Data			Variable	Value	Units
Participants Calculation	Bike/Ped Participants	Number of bike/pedestrian program participants	$N_{B/P}$	600	participant
	Transit	Number of public transit program participants	$N_{Transit}$	1,200	participant
	Rideshare	Number of rideshare program participants	$N_{Rideshare}$	600	participant
		Number of single occupancy vehicle trips of rideshare program participants	$VT_{Ridershare}$	681	trip
		Number of rideshare trips of rideshare program participants	$VT_{Transit}$	2,400	trip
		Number of rideshare trips of rideshare program participants	$VT_{B/P}$	1,200	trip

Activity Output Data		Variable	Value	Units
Trip Summary	Reduction in number of daily auto vehicle trips	VT_R	4,281	less vehicle trip
VMT Summary	Reduction in number of daily auto vehicle miles traveled	VMT_R	38,525	less
Participants Summary	Number of participants	N_P	2,400	participant
Speed Summary	Average speed of home-based work trips	v	35	mph

Daily Emissions Reduction							
Description	Variable	Pollutant					Units
		NO_x	VOC	PM_{10}	CO	CO_2	
Daily Emissions Reduction	A + B	5.568	4.242	0.164	125.574	12,875	kg / day
		12.275	9.352	0.361	276.842	28,385	lbs / day

Emission Factors							
Description	Variable	Pollutant					Units
		NO_x	VOC	PM_{10}	CO	CO_2	
Speed-based running exhaust emission factor for affected roadway before implementation during peak hours	EF_B	0.093447	0.042201	0.003518	2.642612	327.8307	grams / mile
Auto trip-end emission factor	TEF_{AUTO}	0.459742	0.611215	0.006546	5.552591	57.4129	grams / trip

Emission Calculations							
	Variable	Pollutant					Units
		NO_x	VOC	PM_{10}	CO	CO_2	
Reduction in auto start emissions from trips reduced	$A = VT_R * TEF_{AUTO}$ (trips * grams / trip)	1,967.933	2,616.319	28.018	23,767.975	245,757	grams / day
Reduction in auto running exhaust emissions from VMT reductions	$B = VMT_R * EF_{AUTO}$ (vehicle miles * grams / mile)	3,600.024	1,625.795	135.523	101,805.759	12,629,570	grams / day

Questions and Comments

Final Thoughts

- Encourage Texas practitioners to use MOSERS
- Welcome suggestions and recommendations to improve
- New information will be included when available
- New methodologies will be added
- Continual improvement of content and user experience

Contact Information

Reza Farzaneh, Ph.D., P.E.
Program Manager
Air Quality Program
Texas A&M Transportation Institute
Email: R-Farzaneh@tti.tamu.edu
Office: (512) 407-1118 |
Fax: (512) 467-8971

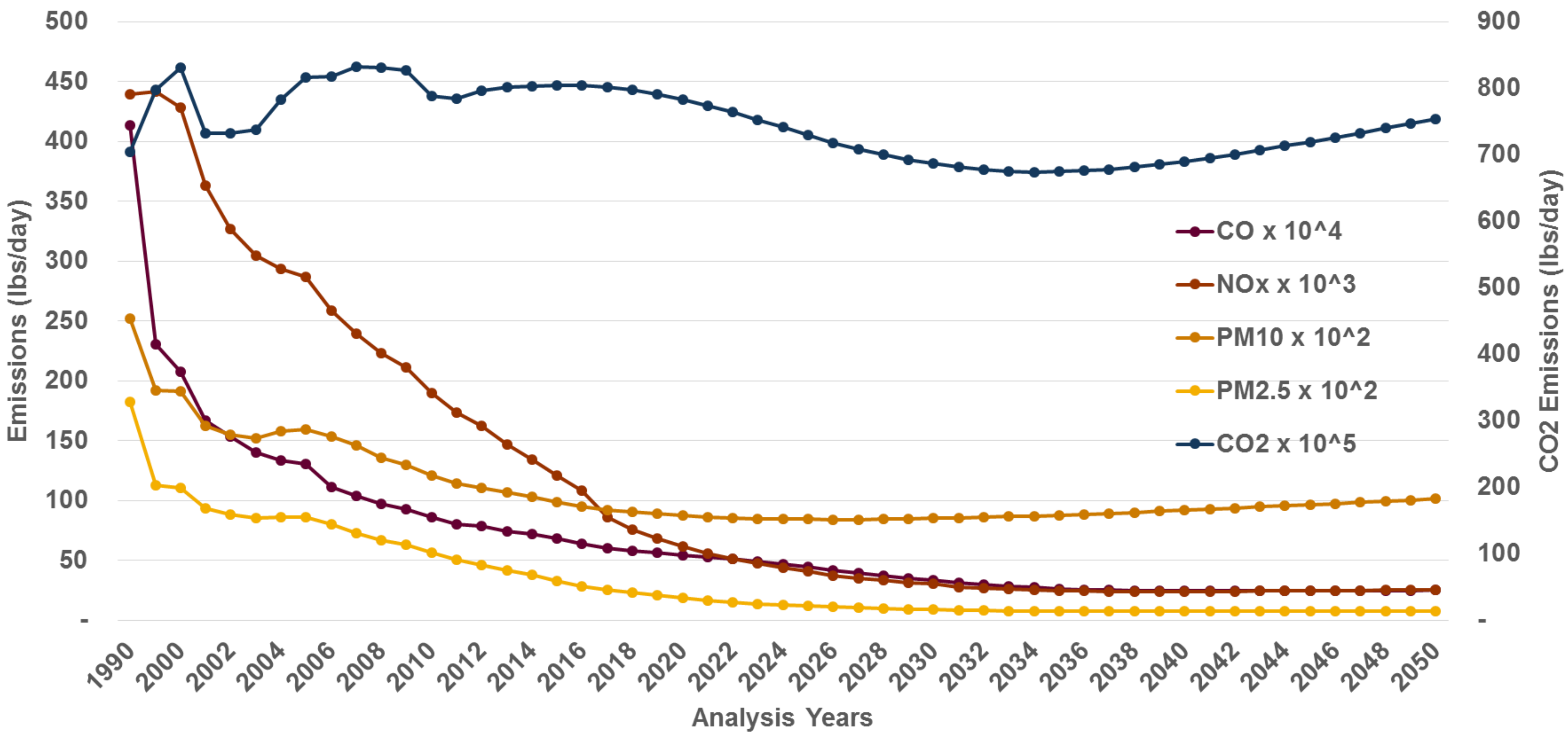
Robert Huch, P.G., CPESC
Research Specialist
Air Quality Program
Texas A&M Transportation Institute
Email: R-Huch@tti.tamu.edu
Office: (512) 407-1133
Fax: (512) 467-8971

Madhusudhan Venugopal, P.E.
Associate Research Scientist
Transportation Modeling Program
Texas A&M Transportation Institute
Email: M-Venugopal@tti.tamu.edu
Office: (817) 462-0523
Fax: (817) 461-1239

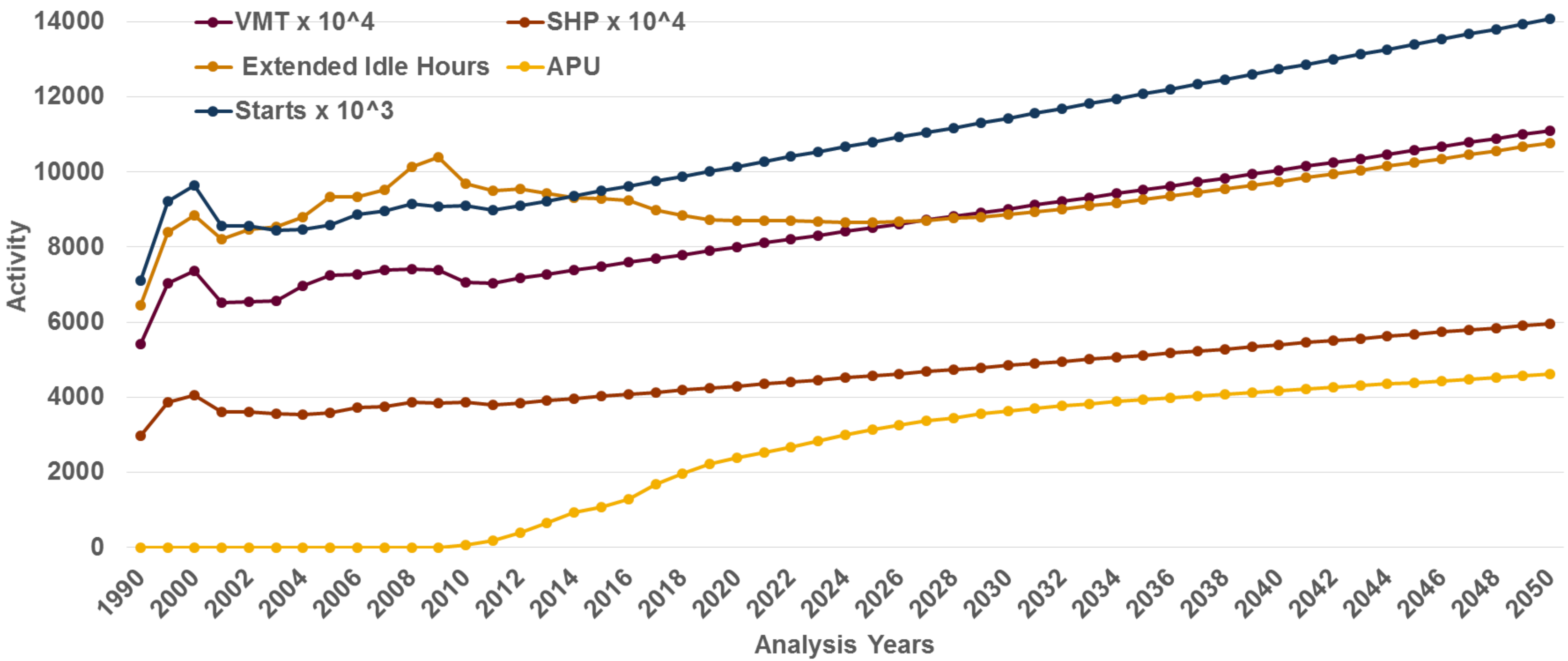
http://tti.tamu.edu/group/airquality/

Thank you

Emission Trends



Activity Trends



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Resources

FHWA

https://www.fhwa.dot.gov/environment/air_quality/cmaq/toolkit/index.cfm,

http://www.fhwa.dot.gov/environment/air_quality/conformity/research/mpe_benefits/ ,

http://www.fhwa.dot.gov/environment/air_quality/conformity/research/transportation_control_measures/tcm3.cfm

https://www.fhwa.dot.gov/environment/air_quality/cmaq/training/

https://www.fhwa.dot.gov/environment/air_quality/cmaq/research/cmaq_cost.cfm

https://www.fhwa.dot.gov/environment/air_quality/cmaq/reference/cost_effectiveness_tables/

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Resources

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TCEQ

https://www.tceq.texas.gov/airquality/sip/