Transportation Improvement Program Greenhouse Gas Assessment and Reporting Guidance

GUIDELINES TO ASSIST METROPOLITAN PLANNING ORGANIZATIONS IN COMPLYING WITH 310 CMR 60.05: GLOBAL WARMING SOLUTIONS ACT REQUIREMENTS FOR TRANSPORTATION

PREPARED BY:

Office of Transportation Planning
Sustainable Transportation

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INTRODUCTION

MassDOT and the Commonwealth's Metropolitan Planning Organizations (MPOs) have been assessing and publishing Transportation Improvement Plans'/State Transportation Improvement Programs' (TIP/STIP) greenhouse gas (GHG) impacts since the 2013-2016 STIP process in an effort to better understand how project programming and funding decisions increase or decrease transportation sector GHG emissions.

In August 2017, the Massachusetts Department of Environmental Protection amended 310 CMR 60.05: Global Warming Solutions Act Requirements for Transportation, a legal reinforcement of the GHG assessment and reporting work that MassDOT and the MPOs have been doing since 2012.

The purpose of this guidance document is to assist MPOs in meeting their regulatory requirements under 310 CMR 60.05 around the assessment and reporting of TIP project GHG impacts. Assessment and reporting outputs will help satisfy two Regulation requirements:

- Assist MPOs in using GHG impacts as an evaluation criterion for project prioritization and assist MPOs in annually evaluating the aggregate GHG impacts of their TIPs.
- Allow MassDOT to annually evaluate the aggregate GHG impact of the STIP.

There are two sections to this guidance document: GHG assessment guidance and reporting guidance. The GHG assessment section will assist MPOs in determining whether a project's GHG impacts should be assessed qualitatively or quantitatively as well as data requirements for different categories of TIP projects. The reporting section presents specific guidelines for formatting and relaying impact data annually through the e-STIP application and the GHG Impact Template.

APPLICATION

This update addresses the transition to the e-STIP application for highway project selection implemented during the 2020-2024 STIP development process and will be used going forward until new updates are necessary. **CMAQ spreadsheets, a GHG Impact Template (modified from the former TIP Template), and a spreadsheet of emissions factors will be sent to MPOs each January for use in that year's development process.** For assistance using the CMAQ spreadsheets and with emissions factors, please contact Derek Krevat, MPO Activities, at Derek.Krevat@dot.state.ma.us, and please copy your MPO liaison as well. For questions about reporting, please contact Shannon Greenwell, Sustainable Transportation, at Shannon.greenwell@dot.state.ma.us.

GHG ASSESSMENT GUIDANCE

This section presents the guidelines MPOs should follow when conducting TIP project GHG assessments as part of their TIP development processes.

1.) All TIP projects are subject to GHG assessment

A GHG assessment should be conducted for each TIP project. Depending on the project type, this will either be a quantitative or qualitative assessment.

2.) All TIP projects should assess impact direction and cause

The direction of the GHG impact (increase, decrease or no impact) for all TIP projects should be determined, as well as the project characteristic that caused the impact (i.e. bicycle and pedestrian improvements, bus replacement, Complete Streets project).

3.) All TIP projects should be considered for a quantitative evaluation

The following guidelines should be used to determine whether or not the GHG impacts of a project should be quantified. Note that this process is not necessary for RTP projects that are included in the statewide model. Each of the project types below corresponds with a CMAQ spreadsheet that can be used to estimate the impacts for quantifiable projects.

- Bicycle and pedestrian infrastructure projects should be quantified when any shared use path is constructed or improved as part of a project.
- Bus replacement projects should be quantified any time a bus is replaced with a model that differs in efficiency.
- New/additional transit service projects should always be quantified as they expand transit options for customers.
- Park and Ride lot projects should be quantified any time the number of parking spaces changes or a new lot is built.
- Traffic operational improvement projects should be quantified any time the improvement is expected to reduce intersection delay.
- Complete Streets projects should be quantified any time bicycle or pedestrian facility construction improvements (or both) are included in the project.
- Alternative fuel vehicle procurements should be quantified when alternative fuel/advanced technology vehicles replace traditional gas or diesel vehicles. This spreadsheet can be used for vehicle types that are not appropriate for the bus replacement spreadsheet.
- Anti-idling strategies spreadsheet should be used when GHG emissions reductions are expected from policies such as limiting idling allowed, incorporating anti-idling

technology into fleets and using LED lights on trucks for the purpose of illuminating worksites.

- Bike sharing projects should be quantified anytime a new project is implemented or capacity is changed on an existing system.
- Induced travel projects should be quantified when roadway capacity is changed through the reduction or addition of lanes.
- Speed reduction programs should be quantified when road speeds are reduced to no less than 55 miles per hour.
- Transit signal priority projects should be quantified anytime this technology is applied at a signal intersection or along a corridor that impacts bus service. It cannot be used for rail technologies.
- Truck stop electrification projects should be quantified anytime a new project is implemented or capacity is added to an existing project.

4.) Quantitative assessments should use methodologies provided by MassDOT

After determining a project should be quantified, the CMAQ spreadsheets provided by MassDOT should be used to estimate the impact number using inputs from the project's functional design report.[1] These projects fall under the following categories, each with its own spreadsheet:

- Bicycle and pedestrian infrastructure
- Bus replacement
- New/additional transit service
- Park and Ride lot
- Traffic operational improvement
- Complete Streets projects
- Alternative fuel vehicles
- Anti-idling strategies
- Bike sharing projects
- Induced travel
- Speed reduction programs
- Transit signal priority
- Truck stop electrification

Images of these spreadsheets are shown in the Appendix. For the purpose of this reporting, only the CO_2 figure generated by the CMAQ spreadsheets must be included in the e-STIP or GHG Impact Template.

[1] If there is difficulty obtaining the functional design report, MPOs should contact the project sponsor and alert him/her that under this regulation the functional design report is required for quantification before a project is programmed into the TIP.

An example of a project that should be quantified with a CMAQ spreadsheet is the construction of a new rail trail using the bicycle and pedestrian infrastructure CMAQ spreadsheet.

There may be cases where it is appropriate to use more than one spreadsheet for a particular project. For example, if a travel lane is taken away and an on-road bicycle lane is put in its place, it is appropriate to use both the induced travel and Complete Streets spreadsheets. The GHG estimates from both sheets should be added together to represent the total estimated impact of the project. This total estimated impact is entered into the e-STIP or GHG Impact Template.

For projects that appear in the out years of the TIP and do not yet have the inputs for the CMAQ spreadsheets, MPOs should make note of this in the e-STIP or GHG Impact Template and quantify the project in a later TIP when more data is available. Until the data is available for the CMAQ spreadsheets and an estimate can be produced, the project should be considered qualitative.

RTP projects that are included in the statewide travel demand model do not need to be quantified separately. However, if an RTP project is not included in the statewide model, its impact should be assessed and reported using these guidelines. Examples of RTP projects include an interstate ramp construction or a major transit project, such as the Green Line Extension in Somerville.

<u>5.) Where MPOs may have the option to quantify projects using alternative methodologies when appropriate</u>

If MPOs have alternative methodologies for quantifying projects, including methodologies for quantifying types of projects not addressed by the MassDOT CMAQ spreadsheets, they may use those methodologies provided that they produce the CO_2 impact data required under the Regulation.

<u>6.) Qualitative assessments should use the following methodology for determining impact direction</u>

If a project does not fall into the categories above, the direction of the impact should still be estimated as an increase, decrease or no impact. The table below provides examples of the types of projects that might have a qualitative increase, decrease, or no GHG impact.

Increase	Decrease	No/Negligible Impact
Procuring less efficient buses than those they replace	Pavement improvement	Bridge maintenance that does not change the roadway
	Transit marketing or customer experience improvement	Utility relocation
	ITS improvement	Median barrier replacement
	Bicycle rack installation	Visitor center improvement
	Safe Routes to School project	Retaining wall replacement
		Culvert repair
		Bridge replacement
		Highway lighting improvement

REPORTING GUIDANCE

Greenhouse gas impact estimates will be reported to MassDOT during each TIP/STIP development cycle through the e-STIP or GHG Impact Template and should be included in both the draft and the final versions of the TIP documents. Both reporting methods include a number of fields related to a project's GHG impact, some of which are drop downs with specific response options. This section will provide guidance on where TIP project GHG impact data should be included in the e-STIP or GHG Impact Template. Completed GHG Impact Templates should be sent to your MassDOT MPO Liaison.

GHG impact reporting method	
e-STIP application (general info tab)	GHG impacts (qualitative or quantitative) for all TIP highway projects
GHG Impact Template	GHG impacts for all quantifiable transit projects

Regardless of the reporting method, there are two data fields required for all projects: "GHG Analysis Type" and "GHG Impact Description."

1.) MPOs should specify analysis type for every project

All projects should be designated as qualitative or quantitative in the "GHG Analysis Type" field.

2.) MPOs should specify impact direction and cause for every project

The impact direction of all projects (increase, decrease, or no impact) and the project characteristic that causes the impact (i.e. bicycle and pedestrian improvements, bus replacement, Complete Streets project) should be designated in the "GHG Impact Description" field. If a project calls for the use of more than one CMAQ spreadsheet, the analysis should include the impact direction/cause for the greatest impact.

3.) Projects with a quantitative impact

The following guidelines apply to all projects determined to have a quantitative impact and should be followed when entering impact information:

- All GHG reduction numbers should be positive and GHG increase numbers should be negative and reported as kg/year (as generated in the CMAQ spreadsheets).[2] Direction of impact will also be captured in the "GHG Impact Description" field. GHG impact numbers should be entered in the "GHG Impact by the Numbers" field.
- Where a project spans more than one STIP year, a note listing all the STIP years in which the project is programmed should be inserted in the "Additional Description" field.
- Where a project falls under one of the CMAQ spreadsheet categories, but there is not yet enough information to generate an estimate, a note should be included in the "Additional Description" field and the project should be listed as qualitative until an estimate can be produced.

4.) Projects with a qualitative impact

These guidelines should be followed when reporting on projects with a qualitative impact:

- A project should be labeled as qualitative any time a GHG number is not provided, even if the project might be quantified in the future.
- The "GHG CO_2 Impact (kg/yr)" field should be left blank for qualitative projects.

[2] For example, a project that would increase emissions by 3,000 kg/year would be reported as -3,000, while a project that would decrease emissions by 3,000 kg/year would be reported as 3,000.

5.) GHG impacts of transit TIP projects should be reported through the transit tables of the GHG Impact Template

All projects listed in the transit TIP will be assessed for GHG impacts during the CIP scoring process. MassDOT will provide the relevant CMAQ spreadsheets and emissions factors with the Rail and Transit Division CIP scoring guidance. While the assessment will happen during the CIP process, the impacts of the relevant projects should be reported using the transit tables of the GHG Impact Template.

6.) TIPs should contain a GHG impact estimate appendix

All TIPs should contain GHG impact estimates as an appendix.

7.) GHG impacts of all projects added to the TIP via amendments should be evaluated and reported

Any new project, highway or transit, added to the TIP via an amendment should be evaluated for GHG impact and reported MassDOT.[3] Projects for which the GHG impacts have already been evaluated and reported in a different year of the TIP do not need to be resubmitted.

[3] Projects awarded under the Community Transit Grant Program will be evaluated and reported in aggregate by MassDOT.

Appendix: CMAQ Spreadsheet Images

BUS REPLACEMENT

CMAQ Bus Replacement Air Quality Analysis Worksheet

FILL IN SHADED BOXES ONLY

TIP YEAR:		**Bus Replacements**
MPO:		
RTA:		

Project 1 - Replace # (model year) Buses with # (model year) Buses

Emission Rates in grams/mile at assumed operating speed of : 18 MPH

Scenario Comparison			**Summer VOC** (grams/mile)	**Summer NOx** (grams/mile)	**Winter CO** (grams/mile)	**Summer CO2** (grams/mile)
		Model Year				
Existing Model*	=					
New Bus Purchase*	=	2016	0.195	0.776	0.383	872.900

HDDV 3 — Enter vehicle type used for New Bus emission factors (For example, HDGV 6 or HDDV 2b)

*Please refer to the 'Emission Factors' tab to determine the most appropriate 'New Bus' factors based on fuel type and gross vehicle weight. If you require factors for an operating speed other that 18MPH, or for the 'Existing Model' being replaced, please contact Ethan Britland at 857-368-8840 or at Ethan.Britland@state.ma.us

	Summer VOC	Summer NOx	Winter CO	Summer CO2
Change (Buy-Base)	0.195	0.776	0.383	872.900

Calculate fleet vehicle miles per day:

Revenue miles per year	X Deadhead factor	= fleet miles per year	/ operating days per year	= fleet miles per day
1,623,050	1.15	1,866,508	301	6,201

Calculate emissions change in kilograms per summer day

Change	rate change grams/mile	/ 1000 g/kg	X fleet miles per day	X seasonal adj factor	= change/day in kg
Change in Summer VO	0.195	1,000	6,201	1.0188	**1.232**
Change in Summer NO	0.776	1,000	6,201	1.0188	**4.902**
Change in Winter CO	0.383	1,000	6,201	0.9812	**2.330**
Change in Summer CO	872.900	1,000	6,201	1.0000	**5412.872**

Calculate emissions change in kilograms per year

Pollutant	= change/day in kg	X op. days per year	= change per year in kg
Summer VOC	1.232	301	370.812
Summer NOx	4.902	301	1475.640
Winter CO	2.330	301	701.433
Summer CO2	5412.872	301	##########

Calculate cost effectiveness (cost per kg of emissions reduced)

Pollutant	Total Project Cost	/ Project Life in years	/ reduction per year in kg	= annual cost per kg
Summer VOC		**12**	-370.812	**$0**
Summer NOx		**12**	-1475.640	**$0**
Winter CO		**12**	-701.433	**$0**
Summer CO2		**12**	-1629274.397	**$0**

A	B	C	D	E	F	G	H
	CMAQ New Bus Service Air Quality Analysis Worksheet						
FILL IN SHADED BOXES ONLY							
FILL IN SHADED BOXES ONLY							
TIP YEAR:	2013						
MPO:							
RTA:							
Project:							
Summary of Vehicle Emission Rates:							
Emission Rates by Vehicle Type	Milestone Year for Rates	Oper. Speed (mph)	Summer VOC (grams/mile)	Summer NOx (grams/mile)	Winter CO (grams/mile)	Summer CO2 (grams/mile)	
Auto	2016	20	0.280	0.215	11.340	368.1	
Bus*	2016	18	0.195	0.776	0.383	872.9	
HDDV 3	Vehicle type used for Bus emission factors (For example, HDGV 6 or HDDV 2b)						
*Please refer to the 'Emission Factors' tab to determine the most appropriate 'Bus' factors based on fuel type and gross vehicle weight. If you require 'Bus' factors for an operating speed other that 18MPH, or for 'Auto' factors other than 20 MPH, please contact Ethan Britland at 857-368-8840 or at Ethan.Britland@state.ma.us							
Calculate VMT and emissions savings from private vehicles:							
Convert daily bus ridership into private auto VMT savings:							
Daily one way person trips (reduced)	/ average veh. occupancy	= daily one-way auto trips	x avg. auto trip length (miles)	= daily savings auto VMT			
169	1.18	143	7.8	1,117			
Calculate emissions change from auto VMT savings:			Daily Auto VMT change (net)	X Emission factor (auto)	/ 1000g per kg	= change/day in kg	
Pollutant							
Summer VOC			-1,117	0.280	1000	-0.313	
Summer NOx			-1,117	0.215	1000	-0.240	
Winter CO			-1,117	11.340	1000	-12.668	
Summer CO2			-1,117	368.100	1000	-411.211	
Calculate bus route mileage and emissions per day:							
Pollutant	Total Route distance (miles)	X # of round trips per day	= fleet miles per day	X Emission factor (bus)	/ 1000g per kg	= change/day in kg	
Summer VOC	12	10	120	0.195	1000	0.023	
Summer NOx	12	10	120	0.776	1000	0.093	
Winter CO	12	10	120	0.383	1000	0.046	
Summer CO2	12	10	120	872.900	1000	104.748	
Add impact of bus emissions to emission savings from private vehicles							
Pollutant				change/day auto (kg)	+ change/day bus or van (kg)	= change/day (NET) in kg	
Summer VOC				-0.313	0.023	-0.289	
Summer NOx				-0.240	0.093	-0.147	
Winter CO				-12.668	0.046	-12.622	
Summer CO2				-411.211	104.748	-306.463	
Calculate net emissions change in kilograms per year (seasonally adjusted)							
Pollutant			change/day (NET) in kg	X operating days per year	X seasonal adj factor	= change per year in kg	
Summer VOC			-0.289	250	1.0188	-73.708	
Summer NOx			-0.147	250	1.0188	-37.456	
Winter CO			-12.622	250	0.9812	-3096.217	
Summer CO2			-306.463	250	1.0000	-76615.843	

PARK AND RIDE LOT

CMAQ Air Quality Analysis Worksheet for Park and Ride Lots

TIP YEAR:

MPO: **Municipality:**

Project:

Details of Project

Number of Parking Spaces		Average Utilization of lots in the area =		(default: 85%)
Total Number of Spaces Utilized	**0**			

Prior Mode Split of Future Users

Drive alone	
Carpool/Vanpool	
Walk/Bicycle/Transit/Other	

Future Mode Split of those leaving the lot

Carpool/Vanpool		Number of new buses added		buses
Transit		Total one-way distance of bus route		miles
Walk/BicycleTransit/Other				

Average Vehicle Occupancy

Arrivals to the lot	1.1
Carpools from the lot	2.6
Transit Bus from the lot	55

Distance to Primary Employment Center		miles
Average Peak Hour Travel Speed	35	mph

Calculated Existing Conditions

Existing Drive Alone Vehicle Trips	(Spaces Utilized * % Drive Alone)	0
Existing Car/Vanpool Vehicle Trips	(Spaces Util. * % Car/Vanpool) * (Avg. Arrival Occ. / Avg. Carpool Occ.)	0
Total Existing Vehicle Trips		0
Total Existing VMT	(Total Existing Veh. Trips * Distance to Primary Employment Center) * 2 trips/day	**0**

Calculated Future Conditions

Future Carpooling Vehicle Trips	(Spaces Util. * % Future Car/Vanpool) * (Avg. Arrival Occ. / Avg. Carpool Occ.)	0
Future Carpooling VMT	(Future Carpooling Veh. Trips * Distance to Primary Employment Center) * 2 trips/day	**0**
Future Transit Vehicle Trips	(Spaces Util. * % Future Transit) * (Avg. Arrival Occ. / Avg. Transit Bus Occ.)	0
Future Transit VMT	(Number of new buses added * One-way distance of bus route) * 2 trips/day	**0**

Mobile 6 Emission Factors for estimated average travel spee(35 mph:

	2016	2016	2016	2016
Auto (LDGV)*	Summer VOC Factor	Summer NOx Factor	Winter CO Factor	Summer CO2 Factor
	grams/hour	grams/hour	grams/hour	grams/hour
	0.232	**0.178**	**11.060**	**####**
	2016	2016	2016	2016
Bus*	Summer VOC Factor	Summer NOx Factor	Winter CO Factor	Summer CO2 Factor
	grams/hour	grams/hour	grams/hour	grams/hour
	0.115	**###**	**0.196**	**####**

HDDV 3 Enter vehicle type used for Bus emission factors (For example, HDGV 6 or HDDV 2b)

*If you require 'Auto' or 'Bus' factors for an operating speed other that 35 MPH, please contact Ethan Britland at 857-368-8840. or at Ethan.Britland@state.ma.us.

If the park and ride lot is being served by an existing bus service with no new service proposed, please enter 0.0 for the 'Bus' emission factors.

Calculate net emissions change in kilograms per day:

	VMT	VOC Emissions kilograms/day	NOx Emissions kilograms/day	Winter CO Emissions kilograms/day	CO2 Emissions kilograms/day
Existing Conditions	0.0	0.000	0.000	0.000	0.000
With Improvements	0.0	0.000	0.000	0.000	0.000
Net Change		**0.000**	**0.000**	**0.000**	**0.000**

Calculate net emissions change in kilograms per year (seasonally adjusted)

	Net change per day (kg)	X	Avg. weekdays per year	X	Seasonal adj. factor	=	Adj. net change in kg per year
VOC Emissions	0.000	X	250	X	1.0188	=	**0.000**
NOx Emissions	0.000	X	250	X	1.0188	=	**0.000**
Winter CO Emissions	0.000	X	250	X	0.9812	=	**0.000**
CO2 Emissions	0.000	X	250	X	1.0000	=	**0.000**

Calculate cost effectiveness (first year cost per kg of emissions reduced)

Emission	Project Cost	/	Adj. net change in kg per year	=	First year cost per kilogram
VOC Emissions		/	0.000	=	**#DIV/0!**
NOx Emissions		/	0.000	=	**#DIV/0!**
Winter CO Emiss		/	0.000	=	**#DIV/0!**
CO2 Emissions		/	0.000		**#DIV/0!**

COMPLETE STREETS PROJECTS

CMAQ Air Quality Analysis Worksheet for Complete Streets Project — rev. 12/31/2014

FILL IN SHADED BOXES ONLY

TIP YEAR:

MPO: | **Municipality:**

Project:

Step 1: Calculate New Walk and Bike Miles Traveled:

If VMT reduction per year is known then go to Step 2B, if not proceed with Step 1 :

	Value	Units	User Input (blank for default)	Default
A. Facility Length **(L)**:	1.0	Miles		
B Types of Improvements Implemented:	Both	(select Pedestrian, Bicycle, or Both from list)		
B. Service Area Radius for Bicycling **(RB)**:	0.5	Miles		0.5
C. Service Area Radius for Walking **(RW)**:	0.25	Miles		0.25
D. Service Area of Community(ies) **for Bicycling (SAB)**: L * 2RB = SAB	1	Sq. Miles		
E. Service Area of Community(ies) **for Walking (SAW)**: L * 2RW = SAW	0.5	Sq. Miles		
F. Land Area of Neighborhoods Served **(AN)**:	1.0	Sq. Miles		
G. Population of Neighborhoods Served **(PN)**:	10,000	Persons		
H. Population Density of Neighborhoods Served **(PD)**:	10,000	Persons/Sq. Mile		
I. Population Served by Facility for Bicycling **(PB)**: PD * SAB = PB	10,000	Persons		
J. Population Served by Facility for Walking **(PW)**: PD * SAW = PW	5,000	Persons		
K. Trips per Person per Day in Service Area **(T)**:	4.7	Trips		4.7
L. Baseline Bicycle Mode Share in Service Area **(MSB)**:	1.7%	Percent		
M. Baseline Walk Mode Share in Service Area **(MSW)**:	30.2%	Percent		
N. Relative Increase in Service Area Bicycle Mode Share from Improvements **(BI)**:	30.0%	Percent		30.0%
O. Relative Increase in Service Area Walk Mode Share from Improvements **(WI)**:	7.5%	Percent		7.5%
P. New Bike Trips **(BT)**: PB * T * MSB * BI = BT	240	1-Way Trips/Day		
Q. New Walk Trips **(WT)**: PW * T * MSW * WI = WT	532	1-Way Trips/Day		
R. Average Bike Trip Length **(LB)**:	2.3	Miles		2.3
S. Average Walk Trip Length **(LW)**:	0.7	Miles		0.7
T. New Bike and Walk Miles of Travel **(BWM)**:	935	Miles per Day		

Default Mode Shares by Population Density

	>7,500	1,000-7,500	<1,000
Bicycle	1.7%	0.6%	0.6%
Walk	30.2%	7.2%	4.7%

Step 2: Calculate the VMT Reduction:

		Value	Units	User Input
U. Prior Drive Mode Share of New Bike and Walk Trips **(MSD)**:		59.0%	Percent	59%
V. VMT Reduced per Day **(VMTR)**: BWM * MSD = VMTR		551	Miles per Day	
W. VMTR * Operating Days Per Year	551 * 365 =	201,255	VMTR Per Year	
If the Vehicle Miles Traveled Reduction is known enter in the box to the right.			VMTR Per Year	

Note: A manual entry of the VMTR will override the calculated cell.

Step 3: Emission Factors for Average Commuter Travel Speed:

Note: Use 35 MPH as a default if average speed is not known. Speed Used: 35 MPH

2016 Auto Summer VOC Factor grams/mile	2016 Auto Summer NOx Factor grams/mile	2016 Auto Summer CO Factor grams/mile	2016 Auto Summer CO2 Factor grams/mile
0.232	0.178	3.540	368.100

Step 4: Calculate emissions reductions in kilograms per year (Seasonally Adjusted):

Summer VOC	Summer NOx	Summer CO	Summer CO2
47.6	36.5	725.8	74,081.9

Step 5: Calculate cost effectiveness (first year cost per kg of emissions reduced)

Emission	Project Cost		Emission Reduction in kg per year	First year cost per kilogram
Summer VOC		/	47.6 =	$0
Summer NOx	$0	/	36.5 =	$0
Summer CO	$0	/	725.8 =	$0

BICYCLE AND PEDESTRIAN INFRASTRUCTURE

CMAQ Air Quality Analysis Worksheet for Bicycle and Pedestrian Project

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TIP YEAR:

MPO: **Municipality:**

Project:

Step 1: Calculate Estimated Reduction in Vehicle Miles Traveled (VMT):

If VMT reduction per year is known then go to Step 2B, if not proceed with Step 1 :

A.	Facility Length **(L)**:	1.8	Miles	
B.	Service Area Radius **(R)**:	1.0	Miles	(Default = 1 Mile)
C.	Service Area of Community(ies) **(SA)**: L * 2R = SA	3.6	Sq. Miles	
D.	Total Land Area of Community(ies) **(T)**:	25	Sq. Miles	
E.	Service Area % of Community(ies) Land Area **(LA)**: SA / T = LA	14.4%		
F.	Total Population of Community(ies) **(TP)**:	50,000	Persons	
G.	Population Served by Facility **(P)**: LA * TP = P	7,200	Persons	
H.	Total Number of Households in Community(ies) **(HH)**:	20,000	HH	
I.	Number of Households Served by Facility **(HS)**: LA * HH = HS	2,880	HH	
J.	Total Number of Workers Residing in Community(ies) **(W)**:	25,000	Persons	
K.	Workers Per household **(WPHH)**: W / HH = WPHH	1.25	Persons	
L.	Workers in Service Area **(WSA)**: HS * WPHH = WSA	3,600	Persons	
M.	Population Density of the Service area **(PD)**: P / SA = PD	2,000	Persons Per Sq. Mile	

N. If the bicycle and pedestrian commuter mode share is known, enter the percentage at the right. **(BMS)** 2.5%

If not, use US Census - American Community Survey data to determine the mode share and enter the percentage.

http://www.census.gov/programs-surveys/acs/guidance/estimates.html

O.	Bike and Ped. Work Utilitarian Trips **(BWT)**: WSA * BMS = BWT	90	One-Way Trips
P.	Bike and Ped. Non-Work Utilitarian Trips **(BNWT)**: BWT * 1.7 = BNWT	153	One-Way Trips

(Latest planning assumptions estimate non-work utilitarian trips to be 1.7 times the work utilitarian.)

Step 2: Calculate the VMT Reduction Per Day:

A. ((2 * BWT) + (2 * BNWT)) * (0.5* L) = VMTR — 437.4 VMTR Per Day

B. VMTR * Operating Days Per Year — 437.4 * 200 = 87,480 VMTR Per Year

If the Vehicle Miles Traveled Reduction is known enter in the box to the right. VMTR Per Year

Note: A manual entry of the VMTR will override the calculated cell.

Step 3: MOVES 2014 Emission Factors for Urban Unrestricted PM:

Note: Use 35 MPH as a default if average speed is not known. Speed Used: 35 MPH

2016 Passenger Summer VOC Factor grams/mile	2016 Passenger Summer NOx Factor grams/mile	2016 Passenger Summer CO Factor grams/mile	2016 Passenger Summer CO2 Factor grams/mile
0.047	**0.163**	**2.460**	**378.555**

Step 4: Calculate emissions reductions in kilograms per year (Seasonally Adjusted):

Summer VOC	Summer NOx	Summer CO	Summer CO2
4.2	**14.5**	**219.3**	**33,116.0**

Step 5: Calculate cost effectiveness (first year cost per kg of emissions reduced)

Emission	Project Cost		Emission Reduction in kg per year		First year cost per kilogram
Summer VOC		/	4.2	=	**$0**
Summer NOx		/	14.5	=	**$0**
Summer CO		/	219.3	=	**$0**
Summer CO2		/	33,116.0	=	**$0**

TRAFFIC OPERATIONAL IMPROVEMENT

CMAQ Air Quality Analysis Worksheet for Traffic Flow and Intersection Improvements

FILL IN SHADED BOXES ONLY

TIP YEAR:			
MPO:		Municipality:	
Project:			

Step 1: Calculate Existing AM Peak Hour Total Intersection Delay in Seconds:

Street Name	Dir	Left-Turns (Vol /	PHF)	X delay per veh	=	Total move. delay	+	Thru (Vol /	PHF)	X delay per veh	=	Total move. delay	+	Right-Turns (Vol /	PHF)	X delay per veh	=	Total move. delay	=	Total approach delay
Main St.	NB	6	###	22.9	=	145	+	338	###	22.9	=	8,148	+	401	###	22.9	=	9,666	=	17,958
Main St.	SB	72	###	12.8	=	970	+	205	###	12.8	=	2,762	+	6	###	12.8	=	81	=	3,813
Plain St	EB	352	###	54.8	=	20,305	+	205	###	54.8	=	11,825	+	107	###	10.4	=	1,171	=	33,301
Keith Ave	WB		###	0.1	=	0	+		###	0.1	=	0	+		###	0.1	=	0	=	0
														Total Intersection Delay/Seconds					=	**55,073**

Step 2: Calculate Existing PM Peak Hour Total Intersection Delay in Seconds:

Street Name	Dir	Left-Turns (Vol /	PHF)	X delay per veh	=	Total move. delay	+	Thru (Vol /	PHF)	X delay per veh	=	Total move. delay	+	Right-Turns (Vol /	PHF)	X delay per veh	=	Total move. delay	=	Total approach delay
Main St.	NB	5	###	11.9	=	63	+	351	###	11.9	=	4,397	+	272	###	11.9	=	3,407	=	7,867
Main St.	SB	195	###	180.0	=	36,947	+	397	###	180.0	=	75,221	+	13	###	180.0	=	2,463	=	114,632
Plain St	EB	427	###	57.4	=	25,800	+	114	###	57.4	=	6,888	+	60	###	10.0	=	632	=	33,319
Keith Ave	WB		###	0.1	=	0	+		###	0.1	=	0	+		###	0.1	=	0	=	0
														Total Intersection Delay/Seconds					=	**155,817**

Step 3: The spreadsheet automatically chooses the peak hour with the longer total intersection delay for the next step in the analysis.

Peak Hour (AM/PM	PM	Total Intersection Delay	155,817

Step 4: Calculate the exi: PM Peak Hour Total Intersection Delay with Improvements:

Street Name	Dir	Left-Turns (Vol /	PHF)	X delay per veh	=	Total move. delay	+	Thru (Vol /	PHF)	X delay per veh	=	Total move. delay	+	Right-Turns (Vol /	PHF)	X delay per veh	=	Total move. delay	=	Total approach delay
Main St.	NB	5	###	6.0	=	32	+	351	###	6.0	=	2,232	+	272	###	6.0	=	1,729	=	3,993
Main St.	SB	185	###	4.2	=	810	+	397	###	4.2	=	1,738	+	13	###	4.2	=	57	=	2,605
Plain St	EB	427	###	13.6	=	6,090	+	114	###	13.6	=	1,626	+	51	###	13.6	=	727	=	8,444
Keith Ave	WB	8	###	13.8	=	117	+	38	###	13.8	=	554	+	53	###	13.8	=	772	=	1,442
														Total Intersection Delay/Seconds					=	**16,484**

Step 5: Calculate vehicle delay in hours per day:

	(	Delay in seconds	X	Hours per day)	/	Seconds per hour	=	Delay in hours / day
Existing peak hour intersection delay	(	155,817	X	10)	/	3600	=	432.8
Peak hour intersection delay w/	(	16,484	X	10)	/	3600	=	45.8

Step 6: MOVES 2014 emission factors for Urban Unrestricted idling speed:

2016 Summer VOC Factor grams/hour	2016 Summer NOx Factor grams/hour	2016 Winter CO Factor grams/hour	2016 Summer CO2 Factor grams/hour
0.519	**###**	**6.363**	**#####**

Step 7: Calculate net emissions change in kilograms per day:

	Delay in Hours per Day	Summer VOC Emissions kilograms/day	Summer NOx Emissions kilograms/day	Winter CO Emissions kilograms/day	Summer CO2 Emissions kilograms/day
Existing Conditions	432.8	0.225	0.598	2.754	1,707.569
With Improvements	45.8	0.024	0.063	0.291	180.648
Net Change		**-0.201**	**-0.535**	**-2.463**	**#######**

Step 8: Calculate net emissions change in kilograms per year (seasonally adjusted)

	Net change per day (kg)	X	Avg. weekdays per year	X	Seasonal adj. factor	=	Adj. net change in kg per year
Summer VOC Emissions	-0.201	X	250	X	1.0188	=	**-51.155**
Summer NOx Emissions	-0.535	X	250	X	1.0188	=	**-136.300**
Winter CO Emissions	-2.463	X	250	X	0.9812	=	**-604.066**
Summer CO2 Emissions	-1,526.921	X	250	X	1.0000	=	**-381,730.336**

Calculate cost effectiveness (first year cost per kg of emissions reduced)

Emission	Project Cost	/	Adj. net change in kg per year	=	First year cost per kilogram
Summer VOC		/	-51.155	=	**$0**
Summer NOx		/	-136.300	=	**$0**
Winter CO		/	-604.066	=	**$0**
Summer CO2		/	-381,730.336	=	**$0**

ALTERNATIVE FUELS VEHICLES

CMAQ Air Quality Analysis Worksheet for Alternative Fuel Vehicles

FILL IN SHADED BOXES ONLY

TIP YEAR:

MPO: **Municipality:**

Project:

Step 1: Details of Project:

A.	Existing Fuel Type Vehicle:	Gasoline Car	
B.	Alternative Fuel Type/Technology Vehicle:	Propane Car	
C.	Number of Vehicles:	10	Vehicles
D.	Annual Miles Traveled per Vehicle:	10,000	Miles

Step 2: Emission Factors for Average Commuter Travel Speed:

Note: Use 35 MPH as a default if average speed is not known. Speed Used: 35 MPH

	Summer VOC Factor grams/mile	Summer NOx Factor grams/mile	Summer CO Factor grams/mile	Summer CO2 Factor grams/mile
Existing Fuel Type Vehicle	**0.153**	**0.221**	**2.524**	**334.689**
Alt. Fuel Type/Tech. Vehicle	**0.135**	**0.196**	**2.231**	**295.865**

Step 3: Calculate emissions reductions in kilograms per year (Seasonally Adjusted):

Summer VOC	Summer NOx	Summer CO	Summer CO2
1.8	**2.6**	**29.8**	**3,955.4**

Step 4: Calculate cost effectiveness (first year cost per kg of emissions reduced)

Emission	Project Cost		Emission Reduction in kg per year		First year cost per kilogram
Summer VOC	$1,000,000	/	1.8	=	**$552,938**
Summer NOx	$1,000,000	/	2.6	=	**$382,076**
Summer CO	$1,000,000	/	29.8	=	**33527.66441**
Summer CO2	$1,000,000	/	3,955.4	=	**$253**

ANTI-IDLING STRATEGIES

CMAQ Air Quality Analysis Worksheet for Anti-Idling Strategies

FILL IN SHADED BOXES ONLY

TIP YEAR:

MPO: **Municipality:**

Project:

Step 1: Details of Project:

Note: This tool estimates emission reductions from anti-idling policies which include limiting idling allowed, incorporating anti-idling technology into fleets, and using LED lights on trucks used to illuminate worksites.

			User Input (blank for default)	Default
A. Daily Hours of Idling Reduced per Vehicle:	1.0	Hours/Day		
B. Number of Vehicles Affected:	100	Vehicles		
C. Idling Vehicle Fuel Type:	Gasoline			
D. Days per Year of Strategy in Place:	365	Days/Yr		365
E. Idling Fuel Consumption Rate:	1.0	Gal/Hr		1.0

Step 2: Emission Factors for Idling Vehicles:

VOC Factor grams/gallon (grams/MCF of CNG)	NOx Factor grams/gallon (grams/MCF of CNG)	CO Factor grams/gallon (grams/MCF of CNG)	CO2 Factor grams/gallon (grams/MCF of CNG)
3.012	**2.475**	**11.259**	**2584.230**

Step 3: Calculate emissions reductions in kilograms per year:

VOC	NOx	CO	CO2
109.9	**90.4**	**411.0**	**94,324.4**

Step 4: Calculate cost effectiveness (first year cost per kg of emissions reduced)

Emission	Project Cost		Emission Reduction in kg per year		First year cost per kilogram
VOC	$1,000,000	/	109.9	=	**$9,097**
NOx	$1,000,000	/	90.4	=	**$11,068**
CO	$1,000,000	/	411.0	=	**$2,433**
CO2	$1,000,000	/	94,324.4	=	**$11**

BIKE SHARE PROJECT

CMAQ Air Quality Analysis Worksheet for Bike Sharing Project

FILL IN SHADED BOXES ONLY

TIP YEAR:

MPO: **Municipality:**

Project:

Step 1: Details of Project:

				User Input (blank for default)	Default
A.	Number of Bikes in Project:	603	Bikes		
B.	Average Bike Trip Length:	1.1	Miles		1.1
C.	Average Number of Trips per Bike per Day:	3.7	Trips		3.7
D.	Bike Sharing Operating Days per Year:	251	Days		251

Step 2: Mode Substitution by Bike Sharing Project:

Note: A bike sharing project would attract new riders from different modes. Actual surveys can determine the extent of the transition from different modes to such program. If site specific data is unavailable, use the defaults provided below.

				User Input	Default
E.	Percentage of Bikes Used Shifted from Walking:	25%	Percent		25%
F.	Percentage of Bikes Used Shifted from Public Transit:	41%	Percent		41%
G.	Percentage of Bikes Used Shifted from Taxis:	5%	Percent		5%
H.	Percentage of Bikes Used Shifted from Cars:	12%	Percent		12%
I.	Percentage of Bikes Used Shifted from Private Bikes:	8%	Percent		8%
J.	Percentage of Bikes Used Shifted from Motorcycles:	4%	Percent		4%
K.	Percentage of Bikes Used Shifted from Other/New Trips:	5%	Percent		5%
L.	Total Percentage of Bikes Used Shifted from Other Modes **(Must be 100%)**:	100%	Percent		
M.	Public Transit Vehicle Occupancy:	40	Persons		40
N.	Taxi Vehicle Occupancy:	1.18	Persons		1.18
O.	Car Vehicle Occupancy:	1.18	Persons		1.18
P.	Motorcycle Vehicle Occupancy:	1.16	Persons		1.16

Step 3: Emission Factors for Average Commuter Travel Speed:

Note: Use 25 MPH as a default if average speed is not known. Speed Used: 25 MPH

	Summer VOC Factor grams/mile	Summer NOx Factor grams/mile	Summer CO Factor grams/mile	Summer CO2 Factor grams/mile
2016 Bus	0.014	0.023	0.150	22.645
2016 Auto	0.169	0.252	2.879	398.914
2016 Motorcycle	1.362	0.466	13.331	342.739

Step 4: Calculate emissions reductions in kilograms per year (Seasonally Adjusted):

Summer VOC	Summer NOx	Summer CO	Summer CO2
44.8	33.0	549.8	43,630.7

Step 5: Calculate cost effectiveness (first year cost per kg of emissions reduced)

Emission	Project Cost		Emission Reduction in kg per year		First year cost per kilogram
Summer VOC	$1,000,000	/	44.8	=	$22,303
Summer NOx	$1,000,000	/	33.0	=	$30,312
Summer CO	$1,000,000	/	549.8	=	$1,819
Summer CO2	$1,000,000	/	43,630.7	=	$23

INDUCED TRAVEL

CMAQ Air Quality Analysis Worksheet for Induced Travel

FILL IN SHADED BOXES ONLY

TIP YEAR:

MPO: **Municipality:**

Project:

Step 1: Lane Miles Reduced by Project:

Note: Enter the reduction in capacity in lane-miles by road type that will result from the project. Conversely, this tool could be used to estimate the increase in emissions associated with an increase in capacity in lane-miles.

A.	Reduction of Local Roads **(L)**:	20	Lane-Miles
B.	Reduction of Minor & Major Collector Roads **(C)**:	40	Lane-Miles
C.	Reduction of Minor Arterial Roads **(A)**:	0	Lane-Miles

Step 2: Lane Mile Elasticity for VMT:

Note: Regression modeing of data on vehicle travel and changes in road capacity can result in induced travel elasticities. If site specific data is unavailable, use the defaults provided below.

				(blank for default)	Default
D.	Lane Miles Elasticity for Local Roads **(EL)**:	0.255	1/Year		0.255
E.	Lane Miles Elasticity for Minor & Major Collector Roads **(EC)**:	0.759	1/Year		0.759
F.	Lane Miles Elasticity for Minor Arterial Roads **(EA)**:	0.538	1/Year		0.538

Step 3: Estimated Change in VMT:

G.	Total Decreased Traffic **(VMT)**: (L*EL) + (C*EC) + (A*EA) = VMT	35.5	VMT

Step 4: Emission Factors for Average Commuter Travel Speed:

Note: Use 35 MPH as a default if average speed is not known. Speed Used: 35 MPH

2016 Auto Summer VOC Factor grams/mile	2016 Auto Summer NOx Factor grams/mile	2016 Auto Summer CO Factor grams/mile	2016 Auto Summer CO2 Factor grams/mile
0.173	**0.255**	**2.973**	**352.030**

Step 4: Calculate emissions reductions in kilograms per year (Seasonally Adjusted):

Summer VOC	Summer NOx	Summer CO	Summer CO2
0.0	**0.0**	**0.1**	**12.7**

Step 5: Calculate cost effectiveness (first year cost per kg of emissions reduced)

Emission	Project Cost		Emission Reduction in kg per year		First year cost per kilogram
Summer VOC	$1,000,000	/	0.0	=	**$159,913,970**
Summer NOx	$1,000,000	/	0.0	=	**$108,695,334**
Summer CO	$1,000,000	/	0.1	=	**$9,309,787**
Summer CO2	$1,000,000	/	12.7	=	**$78,632**

SPEED REDUCTION PROJECTS

CMAQ Air Quality Analysis Worksheet for Speed Reduction Project

FILL IN SHADED BOXES ONLY

TIP YEAR:

MPO: **Municipality:**

Project:

Step 1: Details of Project:

Note: This tool estimates emission reductions from reducing highway speeds to no less than 55 MPH, below which emissions rise dramatically. This tool is not applicable to any speeds less than 55 MPH.

A.	Daily Vehicle Miles Traveled for Enforecment Region:	10,000	Miles
B.	Current Average Speed:	65	MPH
C.	Target Average Speed - No Less than 55 MPH:	60	MPH

Step 2: Emission Factors at 55 MPH and 65 MPH:

	Summer VOC Factor grams/mile	Summer NOx Factor grams/mile	Summer CO Factor grams/mile	Summer CO2 Factor grams/mile
55 MPH	**0.152**	**0.278**	**2.732**	**318.880**
65 MPH	**0.152**	**0.302**	**3.001**	**321.274**

Step 3: Estimated Emission Factors at Current and Target Speed:

	Summer VOC Factor grams/mile	Summer NOx Factor grams/mile	Summer CO Factor grams/mile	Summer CO2 Factor grams/mile
Current Speed: 65 MPH	**0.152**	**0.302**	**3.001**	**321.274**
Target Speed: 60 MPH	**0.152**	**0.290**	**2.866**	**320.077**

Step 4: Calculate emissions reductions in kilograms per year (Seasonally Adjusted):

Summer VOC	Summer NOx	Summer CO	Summer CO2
-0.1	**45.0**	**500.1**	**4,451.2**

Step 5: Calculate cost effectiveness (first year cost per kg of emissions reduced)

Emission	Project Cost		Emission Reduction in kg per year		First year cost per kilogram
Summer VOC	$1,000,000	/	-0.1	=	**$8,537,046**
Summer NOx	$1,000,000	/	45.0	=	**$22,201**
Summer CO	$1,000,000	/	500.1	=	**$2,000**
Summer CO2	$1,000,000	/	4,451.2	=	**$225**

TRANSIT SIGNAL PRIORITY

CMAQ Air Quality Analysis Worksheet for Transit Signal Priority

FILL IN SHADED BOXES ONLY

TIP YEAR:

MPO: **Municipality:**

Project:

Step 1: Project Details:

Note: This tool estimates emission reductions from providing Transit Signal Priortiy (TSP) along a signal intersection or corridor to bus vehicles; rail technologies cannot be used in this analysis.

	Street 1:		Street 2:	
A. Capacity at Intersection:	1,200	Vehicles/Lane	1,000	Vehicles/Lane
B. Number of Lanes:	5.5	Lanes	3.0	Lanes
C. Average Peak Hour Volume:	4,500	Vehicle/Hour	2,500	Vehicle/Hour
D. Percent Trucks:	10%	Trucks	9%	Trucks

Step 2: Traffic Signal Information:

Note: Detailed traffic signal information is required to estimate the effects of transit signal priority.

	Value	Units	User Input (blank for default)	Default
E. Average Existing Intersection Cycle Length:	100	Seconds		
F. Transit Average Daily Headways:	15	Minutes		
G. Transit Signal Priority Hours of Service per Day:	18	Hours/Day		
H. Average Daily Transit Ridership:	100	Riders/Day		
I. Number of Intersections with TSP in Corridor:	5	Intersections		
J. Average Corridor Travel Time for Buses in One Direction:	30	Minutes		
K. Average Existing Intersection Cycle Length:	100	Seconds		
L. Auto Occupancy:	1.18	Persons		1.18
M. Peak Hour to Daily Conversion:	10			10
N. Number of Weekdays per year:	250	Days/Yr		250
O. Effective Green to Cycle Length Ratio:	0.5			0.5
P. Green to Cycle Length Ratio with TSP - Street 1:	0.6			
Q. Green to Cycle Length Ratio with TSP - Street 2:	0.4			
R. Travel Time Elasticity with Respect to Ridership:	-0.4			-0.4
S. Number of Transit Trips in Both Directions:	144	Trips/Day		
T. Average Trip Length:	16	Miles		

Step 3: Emission Factors for Idling Vehicles:

	VOC Factor grams/hour	NOx Factor grams/hour	CO Factor grams/hour	CO2 Factor grams/hour
2016 Light Duty	0.723	0.949	13.262	3962.370
2016 Trucks	7.694	36.143	14.489	6216.290
2016 Transit	6.399	60.982	16.562	7700.820

Step 4: Emission Factors for Average Commuter Travel Speed:

Note: Use 35 MPH as a default if average speed is not known. Speed Used: 35 MPH

	Summer VOC Factor grams/mile	Summer NOx Factor grams/mile	Summer CO Factor grams/mile	Summer CO2 Factor grams/mile
2016 Light Duty	0.109	0.209	2.418	385.049

Step 5: Calculate emissions reductions in kilograms per year (Seasonally Adjusted):

Summer VOC	Summer NOx	Summer CO	Summer CO2
46.6	429.4	149.8	60,485.2

Step 6: Calculate cost effectiveness (first year cost per kg of emissions reduced)

Emission	Project Cost		Emission Reduction in kg per year		First year cost per kilogram
Summer VOC	$1,000,000	/	46.6	=	**$21,451**
Summer NOx	$1,000,000	/	429.4	=	**$2,329**
Summer CO	$1,000,000	/	149.8	=	**$6,677**
Summer CO2	$1,000,000	/	60,485.2	=	**$17**

Tool Outputs - Not To Be Changed by User:

Weighted Truck Percentage:	9.6%
Street 1 V/C Ratio:	0.68
Street 2 V/C Ratio:	0.83
Current Peak Hour Street 1 & Transit Delay (s/veh):	19
Current Peak Hour Street 2 Delay (s/veh):	21
Peak Hour Street 1 & Transit Delay with TSP Granted (s/veh):	12
Peak Hour Street 2 Delay with TSP Granted (s/veh):	31
Probability of Bus Arriving during a Cycle:	17%
Current Average Intersection Delay to Buses (mins per trip):	6.32
Improved Average Intersection Delay to Buses due to TSP (mins per trip):	4.05
Intersection Peak Hour Delay with no TSP (Veh-hr):	38.6
Intersection Peak Hour Delay with TSP (Veh-hr):	38.3
Total Travel Time Change due to TSP:	-8%
Ridership Change due to TSP Travel Time Improvements:	25,759

	VOC	NOx	CO	CO2
Passenger Vehicle Emissions without TSP Activation (g/day):	538	1,676	5,163	1,612,861
Passenger Vehicle Emissions with TSP Activation (g/day):	534	1,662	5,119	1,599,020
Existing Total Daily Emissions (g/day):	485	4,626	1,256	584,200
Improved Daily Emissions (g/day):	311	2,961	804	373,888

Delay/VMT Impact:

Reduction in Annual Transit Vehicle Hours of Delay:	1,366
Reduction in Annual Vehicle Hours of Delay for Other Vehicles on TSP Corridor:	3,556
Addition of Annual Vehicle Hour of Delay on Cross Streets (Street 2):	-2,728
Net Change in Annual Vehicle Hours of Delay for All Vehicles:	2,193
Eliminated Annual Auto VMT due to Improved Transit Service:	10,286

Non-Transit Change (added Street 2 delay + reduced Street 1 delay) (g/yr):

VOC	NOx	CO	CO2
962	2,996	9,231	2,883,513

TRUCK STOP ELECTRIFICATION

CMAQ Air Quality Analysis Worksheet for Truck Stop Electrification

FILL IN SHADED BOXES ONLY

TIP YEAR:

MPO: **Municipality:**

Project:

Step 1: Details of Project:

			User Input (blank for default)	Default
A. Average Daily Hours of Elecitrification Utilization per Bay:	2.0	Hours/Day		
B. Number of Electrification Bays:	10	Bays		
C. Days per Year Electrification Bays Available:	365	Days/Yr		365
D. Diesel Truck Idling Fuel Consumption Rate:	1.0	Gal/Hr		1.0
E. Use of Electricity by Each Electrification Bay:	7.5	kWh/hr		7.5

Step 2: Emission Factors for Electricity Usage:

VOC Factor pounds/MWh	NOx Factor pounds/MWh	CO Factor pounds/MWh	CO2 Factor pounds/MWh
0.012	**0.408**	**0.105**	**637.900**

Step 3: Emission Factors for Idling Vehicles:

VOC Factor grams/gallon	NOx Factor grams/gallon	CO Factor grams/gallon	CO2 Factor grams/gallon
7.694	**36.143**	**14.489**	**6216.290**

Step 3: Calculate emissions reductions in kilograms per year:

VOC	NOx	CO	CO2
55.9	**253.7**	**103.2**	**29,536.9**

Step 4: Calculate cost effectiveness (first year cost per kg of emissions reduced)

Emission	Project Cost		Emission Reduction in kg per year		First year cost per kilogram
VOC	$1,000,000	/	55.9	=	**$17,902**
NOx	$1,000,000	/	253.7	=	**$3,942**
CO	$1,000,000	/	103.2	=	**$9,693**
CO2	$1,000,000	/	29,536.9	=	**$34**