



CIVIL ENGINEERING STUDIES
Illinois Center for Transportation Series No. 13-020
UIIU-ENG-2013-2016
ISSN: 0197-9191

CARBON MONOXIDE SCREEN FOR SIGNALIZED INTERSECTIONS COSIM, VERSION 4.0: TECHNICAL DOCUMENTATION

Prepared By
Scott Peters
University of Illinois at Urbana-Champaign

Research Report No. FHWA-ICT-13-020

A report of the findings of
ICT-R27-SP21
**Illinois Carbon Monoxide Screening for
Intersection Modeling (COSIM) 2012 Update**

Illinois Center for Transportation

June 2013

1. Report No. FHWA-ICT-13-020		2. Government Accession No.		3. Recipient's Catalog No.	
4. Title and Subtitle Carbon Monoxide Screen for Signalized Intersections: COSIM, Version 4.0—Technical Documentation				5. Report Date June 2013	
				6. Performing Organization Code	
7. Author(s) Scott Peters				8. Performing Organization Report No. ICT-13-020 UILU-ENG-2013-2016	
9. Performing Organization Name and Address Illinois Center for Transportation Department of Civil and Environmental Engineering University of Illinois at Urbana-Champaign 205 N. Mathews, MC 250 Urbana, IL 61801				10. Work Unit No. (TRAIS) N/A	
				11. Contract or Grant No. R27-SP21	
12. Sponsoring Agency Name and Address Illinois Department of Transportation Bureau of Materials and Physical Research 126 E. Ash St. Springfield, IL 62704				13. Type of Report and Period Covered	
				14. Sponsoring Agency Code	
15. Supplementary Notes					
16. Abstract Illinois Carbon Monoxide Screen for Intersection Modeling (COSIM) Version 3.0 is a Windows-based computer program currently used by the Illinois Department of Transportation (IDOT) to estimate worst-case carbon monoxide (CO) concentrations near signalized intersections in Illinois. Modeled results from COSIM are based on the U.S. Environmental Protection Agency's (EPA's) mobile source emission model, MOBILE6.2, and roadway dispersion model, CAL3QHC v 2.0. Emission factor (EF) tables derived from MOBILE6.2 are incorporated directly into COSIM's program coding. Recent regulatory changes in mobile source emissions modeling have prompted IDOT to update the EFs used in COSIM with EFs estimated using EPA's Motor Vehicle Emission Simulator (MOVES) mobile source emission model. This report documents the changes made to COSIM, Version 3.0, that allow IDOT to continue to use COSIM (Version 4.0) to estimate worst-case CO concentrations for proposed roadway projects with signalized intersections in 2013 and beyond.					
17. Key Words COSIM, carbon monoxide, microscale air-quality assessment			18. Distribution Statement No restrictions. This document is available to the public through the National Technical Information Service, Springfield, Virginia 22161		
19. Security Classif. (of this report) Unclassified		20. Security Classif. (of this page) Unclassified		21. No. of Pages 14	22. Price

ACKNOWLEDGMENT, DISCLAIMER, MANUFACTURERS' NAMES

This publication is based on the results of ICT-R27-SP21 Illinois Carbon Monoxide Screening for Intersection Modeling (COSIM) 2012 Update. ICT-R27-SP21 was conducted in cooperation with the Illinois Center for Transportation; the Illinois Department of Transportation, Division of Highways; and the U.S. Department of Transportation, Federal Highway Administration.

Members of the Technical Review Panel were the following:

Walt Zyznieuski, Illinois Department of Transportation (Chair)

Matt Fuller, Federal Highway Administration

Chuck Gebhardt, Illinois Environmental Protection Agency

Michael Rogers, Illinois Environmental Protection Agency

The contents of this report reflect the view of the author, who is responsible for the facts and the accuracy of the data presented herein. The contents do not necessarily reflect the official views or policies of the Illinois Center for Transportation, the Illinois Department of Transportation, or the Federal Highway Administration. This report does not constitute a standard, specification, or regulation.

Trademark or manufacturers' names appear in this report only because they are considered essential to the object of this document and do not constitute an endorsement of product by the Federal Highway Administration, the Illinois Department of Transportation, or the Illinois Center for Transportation.

EXECUTIVE SUMMARY

The Illinois Department of Transportation (IDOT) currently uses the computer screening model Illinois CO Screen for Intersection Modeling (COSIM) Version 3.0 to estimate worst-case carbon monoxide (CO) concentrations for proposed roadway projects affecting signalized intersections. The original model was developed as part of Illinois Transportation Research Center (ITRC) research project IIIA-H1, FY 97, completed in October 1999. Modeled results from Version 1.0 and 1.1 of COSIM are based on the U.S. Environmental Protection Agency's (USEPA) mobile source emission factor (EF) model, MOBILE5b, and roadway dispersion model, CAL3QHC v 2.0.

The second version of COSIM was released in 2003. Version 2.0 incorporated new EF tables developed using USEPA's updated version of the MOBILE model, called MOBILE6. In addition to updating the EFs used in COSIM, pre-screen criteria for determining when COSIM needs to be used for a roadway project were developed and incorporated into COSIM as a pre-screen feature.

Regulatory changes in the Illinois vehicle Inspection and Maintenance (I/M) program in 2007 prompted a COSIM Version 3.0 update. Carbon monoxide EF tables were revised using MOBILE6.2, and improvements were made to the pre-screen feature in the Version 3.0 release.

In March 2010, USEPA announced the release of a new mobile source emission model named Motor Vehicle Emission Simulator (MOVES). To allow continued use of the COSIM model, the Illinois-specific CO EF tables were replaced with EFs developed using MOVES. Additionally, the pre-screen feature was updated using the MOVES-based EFs. This report documents the updates and revisions in COSIM Version 4.0.

CONTENTS

CHAPTER 1: UPDATING ILLINOIS COSIM EMISSION FACTORS	1
1.1 Emission Factor Updates	1
CHAPTER 2: ILLINOIS COSIM VERSION 4.0	9
2.1 Revising the Pre-Screen Feature	9
2.2 Other Revisions in Version 4.0	11
2.2.1 Visible Revisions.....	11
2.2.2 Non-Visible Revisions.....	11
2.3 COSIM Version Compatibility.....	11
CHAPTER 3: CONCLUSIONS	13
REFERENCES.....	14

CHAPTER 1 UPDATING ILLINOIS COSIM EMISSION FACTORS

Illinois Carbon Monoxide Screen for Intersection Modeling (COSIM), Version 3.0, is a Windows-based screening model used by Illinois Department of Transportation (IDOT) staff to estimate worst-case carbon monoxide (CO) concentrations that could result from proposed roadway projects with signalized intersections. If the results from COSIM are within the National Ambient Air Quality Standards (NAAQS) for CO, no further CO modeling is required for the intersection. If the results from COSIM indicate that the project may cause a NAAQS violation, a detailed analysis is required to evaluate potential CO levels more accurately.

Modeled results from COSIM, Version 3.0, are based on the U.S. Environmental Protection Agency's (USEPA) mobile source emission factor model, MOBILE6.2, and roadway dispersion model, CAL3QHC v 2.0. In March 2010, USEPA announced the release of a new mobile source emission model named Motor Vehicle Emission Simulator (MOVES). IDOT was required to begin using MOVES for hot-spot transportation conformity determinations after December 20, 2012 (USEPA 2012). To allow continued use of the COSIM model, the CO emission factor (EF) tables in COSIM 3.0 were updated with EFs developed using MOVES. This chapter details the updates made to the specific EFs used in Version 4.0 of the COSIM model.

1.1 EMISSION FACTOR UPDATES

Emission factors in COSIM, Version 3.0, were based on the results of six different MOBILE6.2 input files (Peters 2008). The files were developed to capture six different default vehicle-fleet characteristics defined by the Illinois Environmental Protection Agency (Illinois EPA). The six areas are defined as follows:

1. Vehicles in counties north of the 40° north latitude line that are in attainment of the ozone NAAQS *without* a vehicle inspection and maintenance (I/M) program.
2. Vehicles in counties north of the 40° north latitude line that are in non-attainment of the ozone NAAQS *with* a vehicle I/M program.
3. Vehicles in counties north of the 40° north latitude line that are in non-attainment of the ozone NAAQS *without* a vehicle I/M program.
4. Vehicles in counties south of the 40° north latitude line that are in attainment of the ozone NAAQS *without* a vehicle I/M program.
5. Vehicles in counties south of the 40° north latitude line that are in non-attainment of the ozone NAAQS *with* a vehicle I/M program.
6. Vehicles in counties south of the 40° north latitude line that are in non-attainment of the ozone NAAQS *without* a vehicle I/M program.

Emission rates for the same six areas were modeled by Chuck Gebhardt of the Illinois EPA using MOVES, Version 2010b (MOVES2010b). Each area was modeled for the month of January for the years 2012 through 2025 (note; only results from 2013 through 2024 were used in COSIM). Output data from MOVES were post-processed by the Illinois EPA using Microsoft's MySQL and six new EF lookup tables were developed for use in

COSIM, Version 4.0. Tables 1.1 through 1.3 were created by Chuck Gebhardt and provided to describe the MOVES input data, the Illinois I/M program, and the MOVES2010b run-specification settings (Gebhardt 2013).

Table 1.1 describes the input data and their sources used to build the nine tables required to run MOVES at the project level. The Illinois EPA obtained 2010 registration data from the Illinois Secretary of State and vehicle miles traveled (VMT) data from the IDOT. Average January meteorological data for Chicago and the areas north of 40° north latitude were obtained for O'Hare International Airport from the National Weather Service (NWS). Similar NWS data for Metro-East St. Louis and the area south of 40° north latitude were obtained for Lambert–St. Louis International Airport.

Table 1.1. MOVES Input Tables with Descriptions and Data-Source Information

MOVES Table	Description	Data Source
Off-Network	Provides information about vehicles which are not driving on the project links, but still contribute to the project emissions.	Off-network emissions were not considered in the COSIM project.
Link	Defines the precise speed and grade as a function of time on a particular roadway link.	Unit data for a flat road was used in the link table where the linkLength = 1, linkVolume = 100,000 and linkAvgGrade = 0.
LinkSourceTypeHour	Provides the fraction of link traffic volume driven by each source type.	Source type fractions are estimated using the Secretary of State's (SOS) vehicle registration data.
OpModeDistribution	Provides fractional data for source types, hour/day combinations, roadway links and pollutant/process combinations.	No data needed for COSIM project.
AgeDistribution	Provides data about the distribution of vehicle counts by age for each calendar year and vehicle type.	Registration data, obtained from the Illinois Secretary of State (SOS), was used to estimate the age distribution where data about a vehicle type is available. Registration data for 2010 was used for LDV, LDT1 and LDT2 source types. MOVES default age distributions are used for all other source types.
FuelSupply	Provides data about the associated market share for existing fuels.	Market shares are as follows: Cook County fuel supply for counties North of 40 degrees north latitude and St. Clair fuel supply for counties South of 40 degrees north latitude.
fuelformulation	Provides data about the fuel formulation for each fuel type listed in the fuel supply table.	MOVES default fuel formulations were used assuming the use of reformulated gasoline in the non-attainment counties and conventional gasoline in the attainment counties.
MeteorologyData	Provides temperature and humidity data for months, zones, counties, and hours.	Used average meteorological data obtained from the National Weather Service (NWS) O'Hare Airport for counties North of 40 degrees north latitude and St. Louis' Lambert Airport for counties South of 40 degrees north latitude.
I/M Coverage	Provides information describing inspection and maintenance(I/M) programs.	Refer to table 2 which lists the different I/M scenarios.

Table 1.2 describes the I/M program in the northeastern Illinois and Metro-East St. Louis non-attainment areas. Beginning February 1, 2012, Illinois discontinued testing 1996 through 2006 heavy-duty vehicles with idle and gas-cap tests in accordance with the provisions of the amended Vehicle Emissions Inspection Law of 2005. The current I/M program is for model year (MY) vehicles 1996 through 4 model-years-old vehicles that are equipped with second-generation onboard diagnostic (OBD-II) equipment and have a gross vehicle weight rating (GVWR) of 14,000 lb or less.

Table 1.2. Illinois I/M Program Description

Item		I/M Program Description
Network type		Centralized (98%) / Test and Repair (2%)
Start date		1987
Test frequency		Biennial
Model year coverage		1996 through model year (MY) – 4 years
Vehicle type coverage		Non-electric and non-diesel vehicles
Exhaust emission test type	Light-duty vehicles and light-duty trucks (<8,501 lbs. GVWR) between 1996 and older than 4 MYs	OBD-II Test
	Heavy-duty trucks (GVWR between 8,501 and 14,000 lb) between MY 1996 and 2006	Exempt
	Heavy-duty trucks (GVWR between 8,501 and 14,000 lb) between MY 2007 and older than 4 MYs	OBD-II Test
	Heavy-duty trucks (GVWR > 14,001 lb) between 1996 and older than 4 MYs	Exempt
Emission standards		Vehicle Emission Inspection Law of 2005.
Emission control device inspections		None
Evaporative system function checks		None
Pre-1981 MY Stringency		N/A (Pre-1996 MY vehicles are exempt)
Waiver rate		2.2%
Compliance rate		96%

Table 1.3 describes the MOVES run specifications used to generate the CO emissions factors for COSIM. Data items in the Manage Input Data Sets, Strategies, and Advanced Performance Features in the MOVES navigation panel were not required for the COSIM run.

Table 1.3. Description of the Run Specification

Navigation Panel Item	Detail Panel Item	Detail Panel Sub Item	Selections
Description	Description		Varies by region and year
Scale	Domain / Scale		Project
	Calculation Type		Emission Rates
Time Spans	Time Aggregation Level		Hour (default)
	Years		2012 through 2025
	Months		January
	Days		Weekdays
	Hours		8:00 AM to 8:59 AM
Geographic Bounds	Region		Zone & Link
	States		Illinois
	Counties		Cook for Northern Illinois St. Clair for Southern Illinois
	Server		localhost
	Database		Varies by region and year
Vehicles / Equipment			
On Road Vehicle Equipment	Fuels		Diesel and Gasoline
	Source Use Types		All valid source types
Road Type	Selected Road Types		Off-Network Urban Unrestricted Access
Pollutant and Processes		Carbon Monoxide	Running Exhaust Start Exhaust Crankcase Running Exhaust Crankcase Start Exhaust
Output			
General Output	Output Database		Varies by region and year
	Units	Mass	Grams
		Energy	MMBTU
		Distance	Miles
	Activity		Distance Traveled (Default) Population (Default)
Output Emissions Detail	Always	Time (Default)	
		Location (Default)	
		Pollutant (Default)	
		Hour (Default)	
		Link (Default)	
	On Road / Off Road		On Road / Off Road (Default)
		On Road	Road Type (Default)
		Number of Iterations	2 (Default)
	For All Vehicle / Equipment Categories	Emissions Process	

The values in the six EF lookup tables in the COSIM, Version 3.0, computer code were replaced with the 2013 through 2024 results from MOVES. The new lookup tables are provided in Tables 1.4 through 1.9. COSIM, Version 4.0, uses the MOVES EFs, following the same methodology as previous versions of COSIM, as described below.

When a user selects a county in COSIM, a number is assigned to the selected county. Based on the county number, at least one region index is assigned to the current project. The region index references one of the six EF tables arranged by model year versus average speed. The year index ranges from 0 to 11, covering the years 2013 through 2024. EFs for years after 2024 in COSIM are equal to the 2024 EFs. This maintains a worst-case scenario as MOVES2010b EFs after 2024 decrease (or remain the same) as model year increases through 2050. See Table 1.6 for MOVES2010b EFs for model years 2025 through 2050.

The speed index ranges from 0 to 11, covering speeds from 0 miles per hour (mph) (idle) to 55 mph, in increments of 5 mph. EFs, in grams per hour (g/hr) or grams per mile (gpm) for speeds between the 5-mph intervals are obtained by linear interpolation. The feasibility of linear interpolation was tested in the first phase of the project and determined to be acceptable (Larson et al. 1999).

In counties where I/M and non-I/M regions adjoin, EFs from both the I/M and non-I/M regions are weighted, based on county vehicle-fleet information provided by IDOT, and added together to determine an average EF for the county (Larson et al. 1999).

After the idle and free-flow EFs are determined, the COSIM model inserts them into the CAL3QHC input file and runs CAL3QHC to determine the worst-case CO concentrations.

Table 1.4. EFs in Region Index 0: Counties North of the 40° North Latitude Line That Are in Attainment of the Ozone NAAQS without a Vehicle I/M Program

Emission Factors for Northern Illinois												
Year	Idle	Speed (mph)										
		5	10	15	20	25	30	35	40	45	50	55
	g/hr	gpm										
2013	31.13	11.90	8.31	7.14	6.33	5.40	5.05	4.63	4.32	4.12	4.05	4.05
2014	27.70	10.95	7.72	6.67	5.93	5.07	4.75	4.36	4.06	3.87	3.80	3.81
2015	24.81	10.14	7.22	6.27	5.60	4.78	4.49	4.13	3.84	3.66	3.60	3.61
2016	21.75	9.30	6.70	5.86	5.24	4.47	4.22	3.88	3.61	3.44	3.39	3.41
2017	19.84	8.75	6.37	5.59	5.01	4.27	4.04	3.72	3.46	3.30	3.25	3.27
2018	18.26	8.29	6.08	5.36	4.82	4.10	3.89	3.58	3.33	3.18	3.13	3.15
2019	16.94	7.91	5.84	5.17	4.65	3.96	3.76	3.47	3.22	3.07	3.03	3.06
2020	15.65	7.55	5.62	4.99	4.50	3.82	3.64	3.35	3.12	2.98	2.94	2.97
2021	14.78	7.29	5.46	4.86	4.39	3.72	3.55	3.28	3.05	2.91	2.88	2.90
2022	14.14	7.10	5.34	4.77	4.30	3.65	3.49	3.22	2.99	2.86	2.83	2.86
2023	13.66	6.96	5.25	4.70	4.24	3.60	3.44	3.18	2.95	2.82	2.79	2.82
2024+	13.15	6.81	5.16	4.62	4.18	3.55	3.40	3.14	2.91	2.79	2.76	2.79

Table 1.5. EFs in Region Index 1: Counties North of the 40° North Latitude Line That Are in Non-Attainment of the Ozone NAAQS with a Vehicle I/M Program

Emission Factors for Chicago Nonattainment Area (with I/M program)												
Year	Idle g/hr	Speed (mph)										
		5	10	15	20	25	30	35	40	45	50	55
		gpm										
2013	25.08	9.57	6.63	5.68	5.03	4.30	4.01	3.68	3.43	3.27	3.21	3.22
2014	22.16	8.74	6.11	5.26	4.67	4.00	3.74	3.43	3.20	3.05	3.00	3.00
2015	19.72	8.03	5.68	4.91	4.38	3.74	3.51	3.23	3.00	2.87	2.82	2.82
2016	17.07	7.28	5.21	4.54	4.06	3.47	3.27	3.00	2.80	2.67	2.63	2.64
2017	15.43	6.80	4.91	4.30	3.85	3.29	3.11	2.86	2.66	2.54	2.50	2.51
2018	14.09	6.40	4.66	4.10	3.68	3.14	2.97	2.74	2.55	2.43	2.40	2.41
2019	12.99	6.07	4.46	3.93	3.54	3.02	2.86	2.64	2.46	2.35	2.31	2.33
2020	11.89	5.76	4.26	3.78	3.40	2.90	2.76	2.54	2.37	2.26	2.23	2.25
2021	11.20	5.55	4.13	3.67	3.31	2.82	2.69	2.48	2.31	2.21	2.18	2.20
2022	10.69	5.39	4.04	3.60	3.25	2.76	2.63	2.43	2.26	2.16	2.14	2.16
2023	10.32	5.27	3.96	3.54	3.20	2.72	2.59	2.40	2.23	2.13	2.11	2.13
2024+	9.91	5.16	3.89	3.48	3.15	2.68	2.56	2.36	2.20	2.10	2.08	2.10

Table 1.6. EFs in Region Index 2: Counties North of the 40° North Latitude Line That Are in Non-Attainment of the Ozone NAAQS without a Vehicle I/M Program

Emission Factors for Chicago Nonattainment Area (No I/M program)												
Year	Idle g/hr	Speed (mph)										
		5	10	15	20	25	30	35	40	45	50	55
		gpm										
2013	27.38	10.41	7.23	6.19	5.48	4.68	4.37	4.01	3.73	3.56	3.50	3.50
2014	24.26	9.52	6.68	5.76	5.11	4.37	4.09	3.75	3.49	3.33	3.27	3.28
2015	21.64	8.77	6.22	5.39	4.80	4.10	3.85	3.53	3.29	3.13	3.08	3.09
2016	18.86	8.00	5.74	5.01	4.48	3.82	3.60	3.31	3.08	2.93	2.89	2.90
2017	17.14	7.50	5.43	4.76	4.26	3.63	3.43	3.16	2.94	2.80	2.76	2.77
2018	15.71	7.08	5.17	4.55	4.08	3.48	3.29	3.03	2.82	2.69	2.65	2.67
2019	14.52	6.73	4.95	4.37	3.93	3.34	3.18	2.93	2.72	2.60	2.56	2.58
2020	13.35	6.40	4.75	4.21	3.79	3.22	3.06	2.82	2.62	2.51	2.48	2.49
2021	12.56	6.16	4.60	4.09	3.69	3.13	2.99	2.75	2.56	2.44	2.42	2.44
2022	11.99	5.99	4.49	4.01	3.61	3.07	2.93	2.70	2.51	2.40	2.37	2.39
2023	11.56	5.86	4.41	3.94	3.56	3.02	2.88	2.66	2.47	2.36	2.34	2.36
2024+	11.10	5.72	4.33	3.87	3.50	2.97	2.84	2.63	2.44	2.33	2.31	2.33
2025	10.82	5.64	4.28	3.83	3.46	2.94	2.82	2.6	2.42	2.31	2.28	2.31
2030	10.11	5.42	4.14	3.72	3.37	2.86	2.74	2.53	2.35	2.25	2.23	2.25
2035	9.84	5.36	4.1	3.69	3.34	2.83	2.72	2.51	2.33	2.23	2.21	2.24
2040	9.83	5.35	4.1	3.69	3.34	2.83	2.72	2.51	2.33	2.23	2.21	2.23
2045	9.83	5.35	4.1	3.69	3.34	2.83	2.72	2.51	2.33	2.23	2.21	2.23
2050	9.83	5.35	4.1	3.69	3.34	2.83	2.72	2.51	2.33	2.23	2.21	2.23

Table 1.7. EFs in Region Index 3: Counties South of the 40° North Latitude Line That Are in Attainment of the Ozone NAAQS without a Vehicle I/M Program

Emission Factors for Southern Illinois												
Year	Idle g/hr	Speed (mph)										
		5	10	15	20	25	30	35	40	45	50	55
		gpm										
2013	31.13	11.90	8.31	7.14	6.33	5.40	5.05	4.63	4.32	4.12	4.05	4.05
2014	27.70	10.95	7.72	6.67	5.93	4.07	4.75	4.36	4.06	3.87	3.80	3.81
2015	24.81	10.14	7.22	6.27	5.60	4.78	4.49	4.13	3.84	3.66	3.60	3.61
2016	21.75	9.30	6.70	5.86	5.24	4.47	4.22	3.88	3.61	3.44	3.39	3.41
2017	19.84	8.75	6.37	5.59	5.01	4.27	4.04	3.72	3.46	3.30	3.25	3.27
2018	18.26	8.29	6.08	5.36	4.82	4.10	3.89	3.58	3.33	3.18	3.13	3.15
2019	16.94	7.91	5.84	5.17	4.65	3.96	3.76	3.47	3.22	3.07	3.03	3.06
2020	15.65	7.55	5.62	4.99	4.50	3.82	3.64	3.35	3.12	2.98	2.94	2.97
2021	14.78	7.29	5.46	4.86	4.39	3.72	3.55	3.28	3.05	2.91	2.88	2.90
2022	14.14	7.10	5.34	4.77	4.30	3.65	3.49	3.22	2.99	2.86	2.83	2.86
2023	13.66	6.96	5.25	4.70	4.24	3.60	3.44	3.18	2.95	2.82	2.79	2.82
2024+	13.15	6.81	5.16	4.62	4.18	3.55	3.40	3.14	2.91	2.79	2.76	2.79

Table 1.8. EFs in Region Index 4: Counties South of the 40° North Latitude Line That Are in Non-Attainment of the Ozone NAAQS with a Vehicle I/M Program

Emission Factors for Metro-East Nonattainment Area (with I/M Program)												
Year	Idle g/hr	Speed (mph)										
		5	10	15	20	25	30	35	40	45	50	55
		gpm										
2013	30.38	11.70	8.17	7.01	6.22	5.32	4.97	4.57	4.25	4.06	3.99	4.00
2014	27.00	10.75	7.58	6.55	5.83	4.98	4.67	4.29	3.99	3.81	3.75	3.75
2015	24.15	9.95	7.09	6.15	5.49	4.70	4.41	4.06	3.77	3.60	3.54	3.55
2016	21.07	9.09	6.56	5.73	5.13	4.38	4.13	3.80	3.54	3.38	3.33	3.34
2017	19.16	8.54	6.21	5.46	4.90	4.18	3.95	3.64	3.39	3.23	3.19	3.20
2018	17.59	8.09	5.93	5.23	4.70	4.01	3.80	3.50	3.26	3.11	3.07	3.09
2019	16.29	7.71	5.69	5.04	4.53	3.87	3.67	3.39	3.15	3.01	2.97	2.99
2020	15.01	7.35	5.47	4.86	4.38	3.73	3.55	3.27	3.05	2.91	2.88	2.90
2021	14.19	7.11	5.32	4.74	4.28	3.64	3.47	3.20	2.98	2.85	2.81	2.84
2022	13.60	6.93	5.21	4.65	4.20	3.57	3.41	3.15	2.93	2.80	2.77	2.79
2023	13.15	6.79	5.12	4.58	4.14	3.52	3.36	3.11	2.89	2.76	2.73	2.76
2024+	12.67	6.65	5.03	4.51	4.08	3.47	3.32	3.07	2.85	2.73	2.70	2.73

Table 1.9. EFs in Region Index 5: Counties South of the 40° North Latitude Line That Are in Non-Attainment of the Ozone NAAQS without a Vehicle I/M Program

Emission Factors for Metro-East Nonattainment Area (No I/M Program)												
Year	Idle	Speed (mph)										
		5	10	15	20	25	30	35	40	45	50	55
	g/hr	gpm										
2013	33.00	12.66	8.85	7.61	6.75	5.76	5.38	4.95	4.61	4.40	4.32	4.33
2014	29.42	11.67	8.24	7.13	6.34	5.42	5.08	4.66	4.34	4.14	4.07	4.08
2015	26.38	10.82	7.72	6.71	5.99	5.12	4.81	4.42	4.11	3.92	3.86	3.87
2016	23.18	9.94	7.18	6.28	5.63	4.80	4.53	4.17	3.87	3.69	3.64	3.66
2017	21.18	9.37	6.83	6.00	5.38	4.59	4.34	4.00	3.71	3.55	3.49	3.52
2018	19.52	8.90	6.53	5.76	5.18	4.41	4.18	3.85	3.58	3.42	3.37	3.39
2019	18.14	8.50	6.29	5.56	5.01	4.26	4.05	3.73	3.47	3.31	3.27	3.29
2020	16.78	8.12	6.05	5.38	4.85	4.12	3.92	3.62	3.36	3.21	3.17	3.20
2021	15.87	7.85	5.89	4.25	4.73	4.02	3.83	3.54	3.29	3.14	3.10	3.13
2022	15.20	7.65	5.76	5.15	4.65	3.94	3.77	3.48	3.23	3.09	3.05	3.08
2023	14.70	7.50	5.67	5.07	4.58	3.89	3.72	3.43	3.19	3.05	3.02	3.05
2024+	14.16	7.35	5.57	5.00	4.52	3.83	3.67	3.39	3.15	3.01	2.98	3.01

CHAPTER 2 ILLINOIS COSIM, VERSION 4.0

Several changes have been made to COSIM, Version 3.0, in developing Version 4.0. Aside from updating the CO EF lookup tables, as discussed in Chapter 1 of this report, revisions to the pre-screen feature were the most significant changes made in the COSIM, Version 4.0, program. This chapter documents the other revisions made to the COSIM model.

2.1 REVISING THE PRE-SCREEN FEATURE

The pre-screen feature in COSIM, Version 3.0, allows the user to determine whether a full COSIM run is needed by entering only three variables: project location (county), largest approach volume traveling on any leg of the intersection (vehicles per hour (vph) or Average Daily Traffic), and receptor distance from roadway. The pre-screen criteria were developed using a worst-case COSIM scenario to determine traffic-approach volumes that produced 8-hour average CO concentrations of 8.5 ppm. (NAAQS for an 8-hour CO average concentration is 9 ppm. The lower 8.5 ppm cutoff was used to ensure that the pre-screen criteria were conservative.) These “failing approach volumes” were then plotted against receptor distance for four regions in Illinois: north attainment, south attainment, Chicago, and Metro-East. A line was drawn beneath the data points from each modeled region to represent the pre-screen criterion for the region. Points lying below the line meet the pre-screen criterion and do not require additional CO modeling. Points lying above the line fail the pre-screen criterion and require a COSIM analysis to better estimate conditions at the intersection (Peters 2008).

The original plan for the COSIM 4.0 update was to use this same approach and to update the pre-screen criteria once the EFs in COSIM were updated with the values obtained using MOVES 2010b. Holding all other input variables the same as in previous work, except for model year, a series of COSIM model runs was performed to develop new pre-screen criteria. Model year was set to 2013, to use the highest CO EFs available in the updated COSIM model. Worst-case model run inputs are presented in Table 2.1.

Table 2.1. COSIM Input Variables Used to Develop Pre-Screen Criteria

COSIM VARIABLE	VALUE
Year of Analysis	2013
Background Concentration	3.0 ppm
Intersection Location	Varies
Intersection Surroundings	Corn
Intersection Type	6 x 6 T-Type
Peak Hour Approach Speed	10 mph on each leg
Total Cycle Time	150 seconds
Red Cycle Times	Quick-and-Easy Option

After performing a series of COSIM model runs with the MOVES EFs, it was determined for the county with the highest CO EFs (i.e., Monroe County) to produce a failing run at a receptor distance of 10 ft, each leg of the intersection would need to have an approach volume of 5,000 vph (62,500 ADT). In COSIM, Version 3.0, at a receptor distance of 10 ft, the worst-case county failed at 1,350 vph (16,875 ADT). This drastic increase in failing approach volumes is attributed to the significantly lower MOVES CO EFs. For the same model year, MOVES CO Running EFs are approximately two times lower than those calculated using MOBILE6.2. CO Idle EFs are approximately three times lower.

To produce a failing run at a receptor distance of 20 ft, approach volumes on each leg of the intersection were 6,300 vph. Traffic flow through the modeled intersection completely breaks down at these approach volumes. At 5,000 vph, V/C ratios range from 2.5 to 5.5; queues range from 300 to 600 vehicles, with lengths exceeding 2.5 miles, making it unrealistic to add even greater approach volumes to the model run.

Instead of continuing to develop new pre-screen criteria to update the COSIM, Version 3.0, pre-screen equations, the existing criteria were replaced by one threshold value of 5,000 vph (62,500 ADT), representing the worst-case failing run in Monroe County at a receptor distance of 10 ft. In other words, if the highest approach volume is below 5,000 vph or 62,500 ADT, CO modeling would not be required for the NEPA analysis. If the volume is above this threshold, a full COSIM 4.0 run would need to be performed to determine whether additional project-level CO modeling is required. As a result, IDOT will no longer require the COSIM pre-screen feature to be run for project-level analysis. Instead, documentation that the highest approach volume for the project's design year is less than 5,000 vph or 62,500 ADT will need to be provided. All members of the Technical Review Panel agreed with this revised approach to the pre-screen.

Although IDOT will no longer require the use of pre-screen, the feature is included in COSIM 4.0 for IDOT Districts who may want additional documentation for their project file. Inputs to the pre-screen are the same as those in COSIM Version 3.0; however, the highest design-year traffic-approach volume on the busiest leg of the intersection is now the only input used to determine whether a complete COSIM run is required. The value entered by

the user will be compared with the new threshold value of 5,000 vph or 62,500 ADT for the pass/fail determination.

2.2 OTHER REVISIONS IN VERSION 4.0

Other minor changes were made to the COSIM program to create Version 4.0. Some of the additions and revisions are apparent to the user, that is, a user could run Versions 3.0 and 4.0 and see many of the differences. Other changes made do not affect the appearance of the program but rather the program's operating algorithms.

2.2.1 Visible Revisions

The following is a list and brief discussion of revisions made to Version 3.0 that are visible to someone using Version 4.0.

- The "Welcome to Illinois" COSIM title screen and "About COSIM" dialog box: The version number and release date have been updated to Version 4.0—April 2013. Copyright information has been updated to 1999–2013.
- COSIM logo in the main view has been updated to Version 4.0.
- Program title bar: The program title bar has been updated to display the name of the open COSIM project file, followed by COSIM 4.0.
- Help file updates: Minor changes were made to the help sections, based on comments received from the Technical Review Panel.
- Year of analysis, on page 1 of the "General Inputs" screen, has been updated to include model years 2013 through 2050. Spin buttons and error messages associated with entering a valid model year have also been updated.
- Final Report heading: The final report heading has been updated to COSIM 4.0.
- Pre-Screen Report heading: The Pre-Screen Report heading has been updated to COSIM 4.0.

2.2.2 Non-Visible Revisions

The majority of non-visible revisions were made to code pertaining to the EF lookup tables. Additional code revisions were made to address compatibility of input files created with previous versions of COSIM.

2.3 COSIM VERSION COMPATIBILITY

COSIM Version 4.0 has the ability to open project files saved using Version 1.0 (this includes Versions 1.0 and 1.1), Version 2.0, or Version 3.0. If a file created with a previous version of COSIM is opened, all the saved input variables will appear; but the user will have to run through the entire series of input screens before CO concentrations can be calculated. If the previously saved model year was 1999 through 2012, a new valid model year (2013 through 2050) will have to be entered. If a Version 1.0, 2.0, or 3.0 file is opened and calculations were made before the file was saved, the final report in Version 1.0, 2.0, or 3.0 formats (with the exception of the year being shown as two digits in Version 1.0 and 2.0) will be displayed in the main view. The user is able to print the old report; however, to rerun the calculations, the user will have to step through all of the input screens. The variables

saved to the old file will appear in the input boxes as the user steps through the screens. When the calculate button is selected, CO concentrations will be recalculated using the latest MOVES EFs. Once the calculate button is pressed, the previously saved CO concentrations that were calculated using the emission factors in Version 1.0, 2.0, or 3.0 will be lost. COSIM, Version 4.0, is not able to recalculate CO concentrations determined using prior versions of COSIM.

CHAPTER 3 CONCLUSIONS

IDOT, Illinois EPA, and FHWA reviewed this report and the revised COSIM, Version 4.0, program. Their comments have been addressed and are reflected in the final release of this report and Version 4.0 of the COSIM model. The Technical Review Panel approved the use of COSIM, Version 4.0, for IDOT project-level CO analysis at signalized intersections on April 10, 2013. The COSIM user's manual has been updated to reflect changes made to the model and is now titled *Illinois COSIM Carbon Monoxide Screen for Intersection Modeling Air Quality Manual Version 4.0*. Electronic pdf versions of this report and the revised *Air Quality Manual* were provided to IDOT, along with CDs containing the COSIM 4.0 installation program. An electronic copy of the C++ source code was also provided to IDOT.

REFERENCES

- Gebhardt, Chuck. 2013. Personal correspondence via email, February 13, 2013.
- Larson, S.M., F. Coleman, S. Peters, and P.K. Gollapalli. 1999. Carbon Monoxide Analysis for Highway Projects, University of Illinois, Department of Civil and Environmental Engineering, October 1999.
- Peters, Scott. 2008. Carbon Monoxide Screen for Signalized Intersections COSIM, Version 3.0: Technical Documentation, Illinois Center for Transportation, Research Report FHWA-ICT-08-019, July 2008.
- U.S. Environmental Protection Agency. 2012. Policy Guidance on the Use of MOVES2010 and Subsequent Minor Revisions for State Implementation Plan Development, Transportation Conformity, and Other Purposes, EPA-420-B-12-010, April 2012.

