
8.0 Air Quality Implications

8.1 INTRODUCTION

This chapter discusses the potential air quality benefits of Operation Green Light. The object of this evaluation is to predict the reduction in automobile emissions including Carbon Monoxide (CO), Hydrocarbons (HC), and Oxides of Nitrogen (NO_x). The first section describes the Congestion Mitigation and Air Quality Improvement (CMAQ) program, the second section describes the MARC program and the need for evaluation of air quality. Then, the following section presents the methodology for estimation of automobile emissions reduction.

8.2 THE CMAQ PROGRAM

The United States Congress initiated the Congestion Mitigation and Air Quality Improvement (CMAQ) program to fund transportation projects or programs that will contribute to attainment or maintenance of the National Ambient Air Quality Standards (NAAQS) for Ozone and CO. The recently enacted TEA-21 legislation also allows CMAQ funding to be expanded in particulate matter (PM) non-attainment and maintenance areas.

CMAQ has authorized \$1,345,415,000 nationally for the current fiscal year. It should be noted that CMAQ is not the only source of funds to reduce congestion and improve air quality. Funds under the Surface Transportation Program (STP) and the Federal Transit Administration (FTA) capital assistance programs may be used for this purpose as well.

The CMAQ funds are apportioned annually according to factors largely based on air quality need, which are calculated in the following manner: the population of each area in a state (based on Census bureau data by county), that, at the time of apportionment, is a non-attainment or maintenance area for ozone and/or CO and meets the classification contained in the Clean Air Act (CAA), is multiplied by the apportionment factor presented in Table 7. Two key changes are included in the apportionment factors under TEA-21. Areas that are designated and classified as submarginal and maintenance areas for Ozone are now explicitly included in the apportionment formula, and there are new weighting factors for CO non-attainment areas. Furthermore, each state is guaranteed at least $\frac{1}{2}$ of 1 percent of each year's CMAQ authorized funding regardless of whether the State has any non-attainment or maintenance areas.

Table 7. TEA-21 CMAQ Apportionment Factors

Pollutant	Classification At The Time Of Annual Apportionment	Weighting Factor
Ozone or CO	Maintenance	0.8
	Submarginal	0.8
	Marginal	1.0
	Moderate	1.1
	Serious	1.2
	Severe	1.3
	Ozone	Extreme
CO	Non-attainment	1.0
Ozone and CO	Ozone non-attainment or maintenance and CO maintenance	1.1 x Ozone factor
	Ozone non-attainment or maintenance and CO non-attainment	1.2 x Ozone factor
All States - minimum apportionment	2 of 1 percent total annual apportionment of CMAQ funds	N/A

Source: CMAQ Program Under the TEA-21 Program Guidance, April 1999

MARC, being a maintenance area for ozone, is eligible for CMAQ funding. A non-attainment area by definition is an area where the air quality does not comply with the NAAQS set by Environmental Protection Agency (EPA). A maintenance area by definition is an area where the air quality complies with NAAQS but has been a non-attainment area in the past. The CMAQ program was started by Congress to fund transportation projects or programs that will contribute to attainment of the NAAQS. The Federal Highway Administration (FHWA) and the Federal Transit Administration (FTA) strongly encourage state and local governments to use CMAQ funds for

transportation projects that result in reduction of automobile emissions and attainment of NAAQS. To obtain CMAQ funding, the transportation projects have to demonstrate that a tangible reduction in emissions could be achieved by their implementation. Therefore, Operation Green Light must demonstrate automobile emissions reduction in order to obtain CMAQ funding.

8.3 OPERATION GREEN LIGHT PROGRAM (PHASE 1)

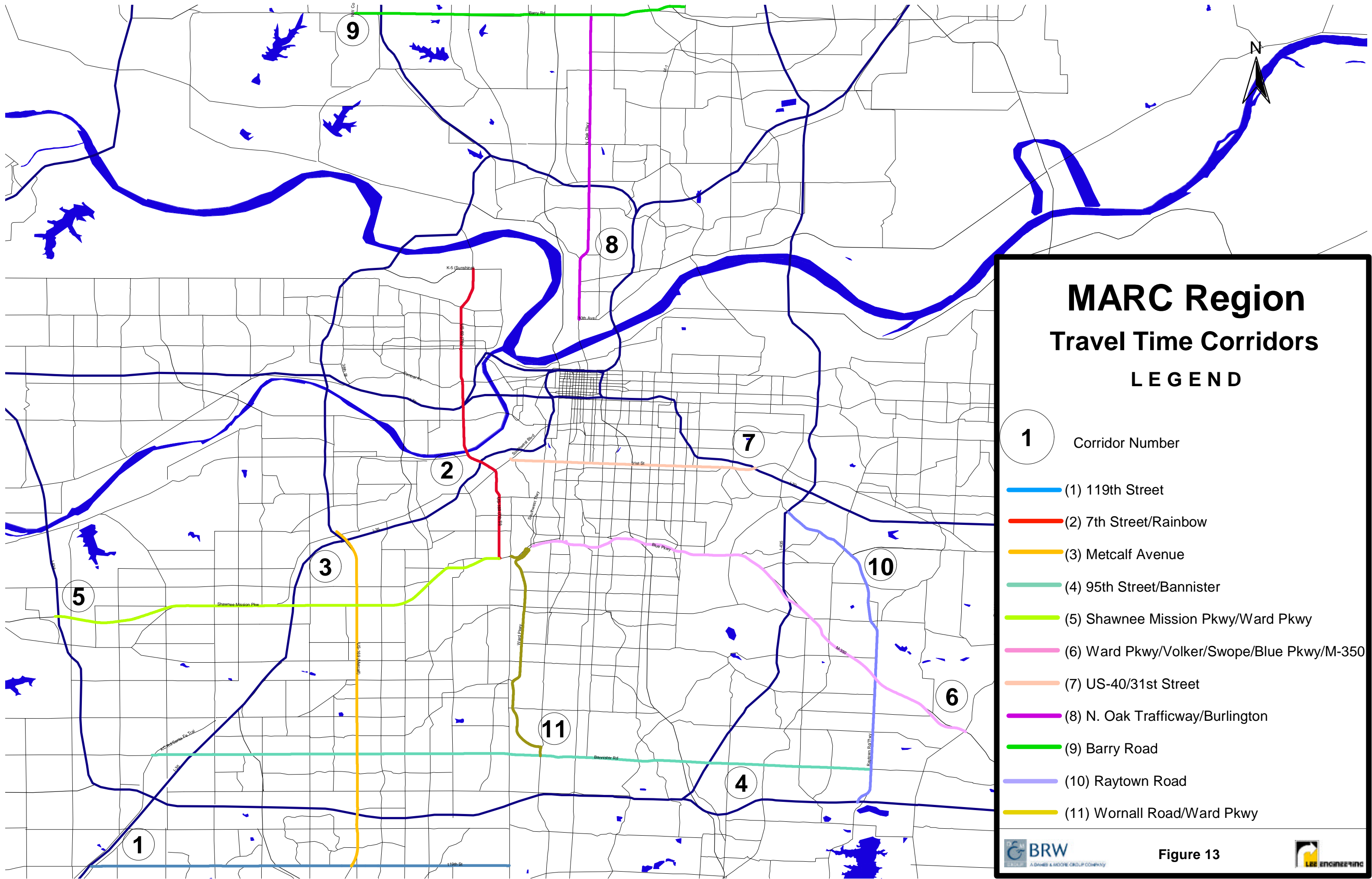
The Phase 1 Application of the Operation Green Light program includes the 583 traffic signals represented in Table 1 of Chapter 7 (where Phase 1 consists of Phases I, IIA, IIB, and IIC). These corridors, shown in Figures 10, 11 and 12 in Chapter 7, receive approximately 8.0 percent of the total vehicle-miles of travel (VMT) in the Kansas City region. They are the highest priority based on the process discussed in Chapter 7. Phase V of the Implementation Plan contains those signals on the MARC corridors which were not included in the Phase 1 application. Phase VI of the Implementation Plan contains the remaining signals which were part of this study which were not on the original MARC study corridors. This chapter presents an analysis of the air quality impacts estimated to result from deployment of Phase 1 of Operation Green Light (Phases I, IIA, IIB, and IIC of the Implementation Plan) as well as the impacts resulting from Phase V and VI of the Implementation Plan.

8.4 TRAVEL TIME STUDY

In order to determine the average speed of the arterials that are part of Operation Green Light, travel time studies were conducted on selected corridors. These travel time corridors are shown in Figure 13. Travel time data was collected using a global positioning system (GPS). A vehicle with a GPS device interfaced with a laptop computer with appropriate travel time software was driven along the corridors. Six runs in each direction in three time periods (AM peak, off-peak, and PM peak) were conducted. The AM peak hours sampled were 6:30 AM to 9 AM. The PM peak hours were 3:30 PM to 6 PM. The off-peak hours represented all other times of the day. The travel time data for these runs is shown in the Appendix.

The average speed for these corridors was determined by using a weighted average of the speed in the AM peak, off-peak and PM peak hours. This was done by estimating the percent of the traffic volume in each of these three periods. Generally, approximately eight percent of the 24-hour volume occurs during the AM peak hour, and nine percent of the 24-hour volume occurs during PM peak hour. Using these numbers it was estimated that 19 percent of the 24-hour volume occurred.

FIGURE 13 – TRAVEL TIME CORRIDORS



MARC Region Travel Time Corridors LEGEND

- 1** Corridor Number
- (1) 119th Street
- (2) 7th Street/Rainbow
- (3) Metcalf Avenue
- (4) 95th Street/Bannister
- (5) Shawnee Mission Pkwy/Ward Pkwy
- (6) Ward Pkwy/Volker/Swope/Blue Pkwy/M-350
- (7) US-40/31st Street
- (8) N. Oak Trafficway/Burlington
- (9) Barry Road
- (10) Raytown Road
- (11) Wornall Road/Ward Pkwy



Table 8. Travel Time Corridor Data

	Corridor Number										
	1	2	3	4	5	6	7	8	9	10	11
AM Speed (mph)	29.75	26.25	35.05	28	34.35	29.7	20	27.75	36.8	31.2	28.25
Off Peak Speed (mph)	30.15	25.75	36.6	29.45	33.6	33.9	21.35	29.25	28.6	32.05	33.8
PM Speed (mph)	27	24.3	30.75	24.25	31.3	30.9	18.5	28.95	30.1	28.35	30.15
AM Volume*	3842	3034	7301	3617	6293	5137	2192	4057	2796	2216	6007
Off Peak Volume*	12131	9580	23054	11422	19873	16221	6923	12812	8830	6998	18969
PM Volume*	4246	3353	8069	3998	6956	5677	2423	4484	3090	2449	6639
ADT	20219	15966	38424	19037	33122	27035	11539	21353	14716	11663	31615
Length (mi)	8.9	8.2	9.25	15.1	9.9	11.6	5.2	8.2	7	8.7	5.7
VMT	179949	130921	355422	287459	327908	313606	60003	175095	103012	101468	180206
Weighted Average Speed	29.41	25.54	35.08	28.08	33.26	32.47	20.50	28.90	30.47	31.11	31.98

* Calculated based on the assumption of 19% of ADT for AM period (6:30-9), 60% of ADT for Off Period (9a-3:30p, 6p-6:30a), and 21% of ADT for PM Period (3:30-6)

during the AM period of 6:30 AM to 9 AM. Furthermore it was assumed that 21 percent of the 24-hour volume occurred during PM Peak period of 3:30 PM to 6 PM. The remaining 60 percent of the volume represents the off-peak period.

Table 8 shows the average daily speed on each of the 11 corridors determined by this process.

8.5 REDUCTION IN EMISSIONS

Currently, there are many computer modeling software packages available (e.g., MOBILE, EMFAC, Urban Airshed Model (UAM), SAI program, SANDAG program, TCM Analyst, etc.) for estimation of automobile emissions reduction. Various state and local governments rely on various computer models. However, EPA approves and requires use of the MOBILE model for estimation of automobile emissions reduction.

For the purpose of this study, the MOBILE 5a model will be used. This model calculates automobile emissions reduction as a function of average speed and vehicle miles of travel (VMT). The model produces automobile emission factors for Hydrocarbons, Carbon Monoxide, and Oxides of Nitrogen based upon the vehicle fleet information, vehicle fuel information, vehicle operating conditions, temperature data, and vehicle inspection data specified by the user. The automobile emission factors for various emissions and speeds were obtained by MARC using the MOBILE 5a model. Based on these automobile emission factors, the reduction in automobile emissions (for CO, HC, and NO_x) were calculated in the following manner:

$$E_t = [F(S_1) - F(S_2)] * VMT_{a,t} * K * P_t$$

where:

E_t	=	Reduction in automobile emissions
$F(S_1)$	=	Emission factor for speed S_1
$F(S_2)$	=	Emission factor for speed S_2
S_1	=	Speed before signal coordination program
S_2	=	Speed after signal coordination program
$VMT_{a,t}$	=	Regional VMT for year t, adjusted for the design year
K	=	Percent of regional VMT affected by the proposed program
P_t	=	Percent of program implemented in year t

The speed before signal coordination (S_1) for the entire MARC region was estimated in the following manner and is shown in Table 8:

- 1) The average operating speed of vehicles in the AM, PM, and Off-peak (representing the rest of the day) on the 11 corridors on which travel time data was collected was determined.
- 2) The average operating speed by corridor on an average weekday was estimated using the weighted average of the AM, PM, and Off-peak speeds as shown below.

$$S_{\text{corr}} = S_{\text{am}} (\text{Vol}_{\text{am}}/\text{ADT}) + S_{\text{off}} (\text{Vol}_{\text{off}}/\text{ADT}) + S_{\text{pm}} (\text{Vol}_{\text{pm}}/\text{ADT})$$

- 3) The speed before signal coordination (S_1) for the Operation Green Light project was estimated by taking a weighted average of S_{corr} for the 11 corridors (as shown in Table 8) based upon corridor VMTs. That speed (S_1) was calculated to be 30.97 mph.

National data is available for estimating the improvements in average speed due to signal coordination (*Source: Transportation Control Measure Information Documents, U.S. Environmental Protection Agency, Office of Mobile Sources, March 1992*). This data was used for estimating the speed after signal coordination program (S_2) from S_1 in the following manner:

$$S_2 = S_1 \text{ raised by the \% improvement in speed}$$

Table 9 presents the percent improvement in speed data used for estimating S_2 . The percentage of the various categories currently existing on the Phase 1 corridors was estimated using the traffic signal inventory data discussed in Chapter 3. Some jurisdictions currently have interconnected signal systems using their own timing plans, while other areas do not have interconnected signal systems. Thus, the improvement in travel speed along the Phase 1 corridors after deployment of Operation Green Light Phase 1 was predicted to be 17 % since this was the average between the two Before Conditions in Table 9 that are predominant in the region.

Table 9. Traffic Signal Improvements

Before Conditions	After Conditions	Improvement in Speed or Time
Non-Interconnected, Pre-Timed Signals with Old Timing Plan	Computer Based Control	25%
Interconnected, Pre-Timed Signals with Old Timing Plan	Computer Based Control	18%
Non-Interconnected Signals with Traffic-Actuation	Computer Based Control	16%
Interconnected, Pre-Timed Signals with Actively Managed Timing	Computer Based Control	8%
Interconnected, Pre-Timed Signals with Various Types of Master Control and Timing Plans	Optimization of Signal Timing Plans	12%

Source: Urban and Suburban Highway Congestion, Working Paper No. 10, Washington D.C., FHWA, December 1987.

The regional total of 48,500,000 vehicle-miles of travel was obtained from MARC. The VMT on the Phase 1 implementation project was estimated by multiplying the length of each Phase 1 corridor by the estimated average daily traffic (worksheet included in Appendix). The percent of regional VMT affected by the proposed program (K) was be estimated in the following manner:

$$K = \text{VMT on Phase 1 Corridors} / \text{Total Regional VMT}$$

It should be noted that the present MOBILE 5 version is not capable of estimating emission factors for time periods less than a full day (such as for peak periods). Therefore, the reduction in automobile emissions was estimated for an average day.

8.6 RESULTS

After deployment of Phase 1 of Operation Green Light, a significant reduction in Hydrocarbon and Carbon Monoxide emissions along the project corridors should result. Table 10 summarizes the expected results for full system implementation which includes Phase I, IIA, IIB, IIC, V and VI as described in the Implementation Plan. Table 11 summarizes the predicted change in emission after the implementation of the Phase 1 of Operation Green Light (Phases I, IIA, IIB, and IIC of the Implementation Plan).

Table 10. Reduction in Emissions at Full System Implementation

Emission Type	Emissions Without Any System	Emissions After System Implemented	Change
	(Grams)	(Grams)	(Grams)
Hydrocarbons	17,688,961	16,074,867	-1,614,094
Carbon Monoxide	133,073,094	114,336,388	-18,736,706
Nitrous Oxides	21,379,668	21,568,451	+188,783

Table 11. Reduction in Emissions After Implementation of Phase 1

Emission Type	Emissions Without Any System	Emissions After System Implemented	Change
	(Grams)	(Grams)	(Grams)
Hydrocarbons	7,259,550	6,597,126	-662,424
Carbon Monoxide	54,613,198	46,923,653	-7,689,545
Nitrous Oxides	8,774,216	8,851,692	+77,476