

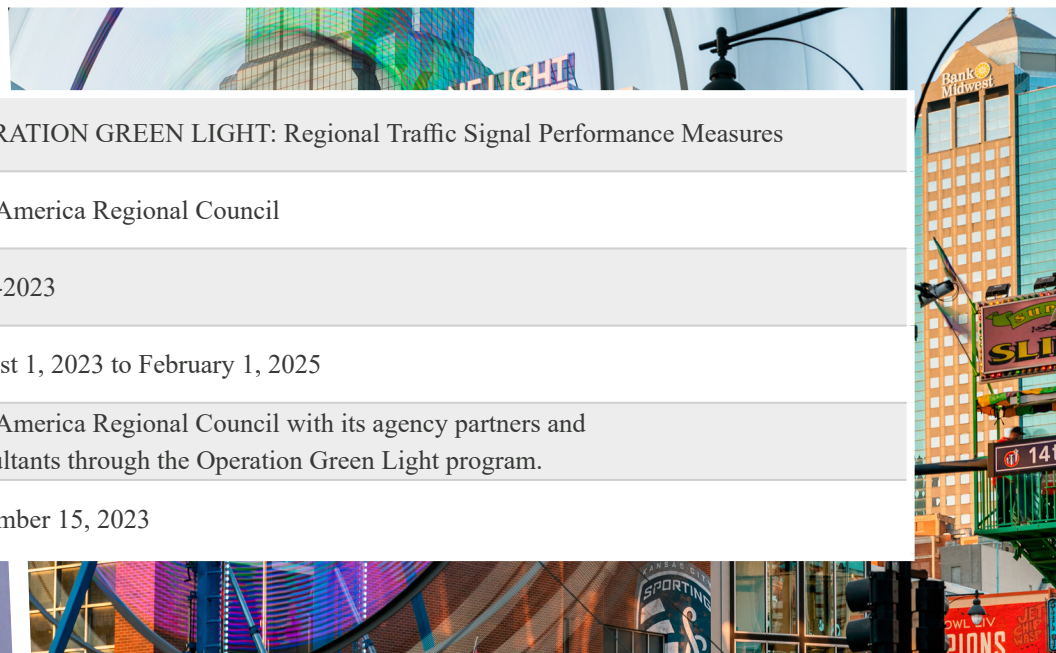


## SMART Grants Program

### OPERATION GREEN LIGHT: *Regional Traffic Signal Performance Measures*

### EVALUATION PLAN

December 15, 2023



<b>Project Title</b>	OPERATION GREEN LIGHT: Regional Traffic Signal Performance Measures
<b>Recipient Name</b>	Mid-America Regional Council
<b>Fiscal Year of Award</b>	2022-2023
<b>Period of Performance</b>	August 1, 2023 to February 1, 2025
<b>Organization(s) preparing the evaluation plan</b>	Mid-America Regional Council with its agency partners and consultants through the Operation Green Light program.
<b>Date Submitted</b>	December 15, 2023

# EVALUATION PLAN NARRATIVE

## PART 1: INTRODUCTION AND PROJECT OVERVIEW

The Mid-America Regional Council (MARC) serves as the Kansas City Area's association of local governments and metropolitan planning organization with the mission of advancing progress toward a stronger Kansas City region through leadership, planning and action. One aspect of MARC's work is to improve transportation access and reliability to benefit disadvantaged users, area businesses, and the traveling public at large. MARC coordinates traffic signal operations at over 700 intersections in 28 regional jurisdictions through the Operation Green Light (OGL) program. One of the main tasks of OGL is to time and coordinate traffic signals along cross-jurisdictional corridors. OGL currently completes retiming projects along these corridors whenever they become aware that the timing could be improved. Because of the lack of consistent data throughout the area, OGL must often rely on engineering judgement and anecdotal feedback to determine which corridors to re-time next. Without good data to inform these decisions, this can result in some corridors that need to be retimed remaining untouched for long periods of time, and other corridors adjusted more frequently than needed.

With the ever-tightening fiscal constraints for infrastructure investment along with evolution and anticipation of new technologies, many agencies like those in the Kansas City region are looking to technology to help optimize operations on existing facilities rather than relying on capital improvements. Advanced traffic signal performance measures (ATSPMs) are used to support performance-based objectives of agencies to improve operations. The data needed for arterial network signal performance measures (SPM) has historically been costly to collect without a significant investment in detection equipment.

However, recent advancements in sensor technology, mobile data, wireless and wired communications networks, arterial performance measures research, and computing power have combined to create many new opportunities for monitoring and understanding arterial network performance. The primary goals of collecting the data needed for regional traffic signal performance measures is to provide OGL and all regional agencies information needed to improve operations at individual signals, to prioritize corridors for retiming, and identify real-time system problems that need immediate attention. Improving the operations of key corridors will positively impact the traveling public by improving flow, increasing safety, saving fuel and money, lowering emissions, and providing more reliable transit.

In Stage one, several vendors will be selected to provide a regional traffic signal performance monitoring system through a formal request for proposal (RFP) and evaluation process. This effort is led by an evaluation team consisting of OGL staff, partner agency staff, and an outside team of consultants from Olsson, Merge Midwest Engineering, and the University of Kansas Transportation Center. Stakeholders completed a needs survey and provided input on key requirements. The consultant team, in coordination with OGL and a task force consisting of agency representatives of the OGL steering committee, have reviewed the survey results and are incorporating evaluation criteria into the RFP requirements. Up to four vendors will be selected from the RFP responses to move into a 12-month trial period where they will implement, demonstrate, test, and adjust their solutions. Vendors will provide as much current and historical data on as many roadways as they can within the eight county MARC region.



*However, data along the following corridors will be required:*

1. Kaw Drive/K-32 and Kansas Avenue/K-132 in Kansas City, Kansas
2. Burlington Avenue and North Oak Trafficway connecting Kansas City, North Kansas City, and Gladstone, Missouri
3. Independence Avenue/US-24 in Kansas City and Independence, Missouri
4. Shawnee Mission Parkway connecting multiple cities in Johnson County, Kansas
5. US Highway 71 in Kansas City, Missouri
6. Santa Fe/135th Street in Olathe and Overland Park, Kansas

The evaluation team will meet regularly with each vendor separately to discuss their product through the evaluation period. After the 12-month evaluation period, either one or more preferred vendors will be chosen based on the previously identified evaluation criteria, or a refined RFP will be developed and issued. Once the evaluation is complete, an implementation plan will be developed. With this plan, it is anticipated that MARC will apply for Stage two funding.

The Stage two deployment would implement the selected system(s) regionally and provide the entire MARC area with access to real-time and historical traffic operations data. Using this data to prioritize efforts, significant benefits will be recognized along OGL corridors and at other non-OGL signalized intersections within the Kansas City metro area.

Stage one is anticipated to last approximately 18 months with initial project activities including RFP development, advertising, and vendor selection and contracting. Once these activities are complete, the 12-month vendor evaluation period will begin. At the conclusion of the evaluation activities, a final report will be developed including final recommendations for the at-scale (Stage two) implementation. This information will also inform the Stage two grant application.

## **PART 2: PROJECT GOALS FOR AT-SCALE IMPLEMENTATION**

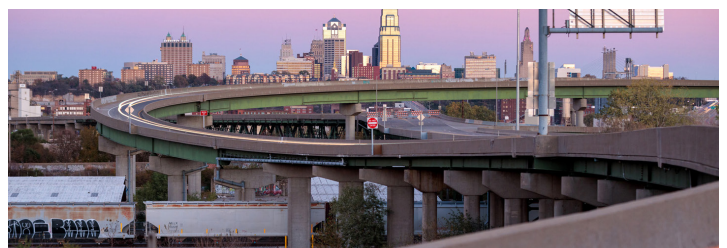
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***Safety and reliability:*** Fewer stops result in improved safety by reducing intersection crashes. Studies show that all crashes, specifically rear-end crashes, can be reduced with proper signal timing along corridors. Fewer stops also reduce aggressive driving between traffic signals. An additional benefit is the ability to react to unexpected congestion. When the street network becomes congested, for example due to a crash on a freeway, unsafe conditions develop for all users. Having an immediate notification of these unexpected conditions would allow for an adjustment of timings to reduce the impact. In high pedestrian locations like central business districts or dense commercial areas, SPMs can assist in justifying improved pedestrian signal timing.

***Resiliency:*** All transportation system users will realize lower travel times due to better progression and fewer stops, improving system reliability. In addition, transit reliability can be achieved through improved transit signal priority operations.

***Equity and access:*** Having this data along corridors in underserved communities will provide the opportunity to efficiently re-time these traffic signals as well. This will provide them with efficient traffic flow along arterials and decrease the delay for all travel modes, among other benefits.



**Climate:** Minimizing the changes in vehicle speeds reduces the amount of CO2 and other harmful emissions emitted from a vehicle. Additionally, reducing idle time due to congestion and unnecessary stops will also reduce emissions and improve air quality.

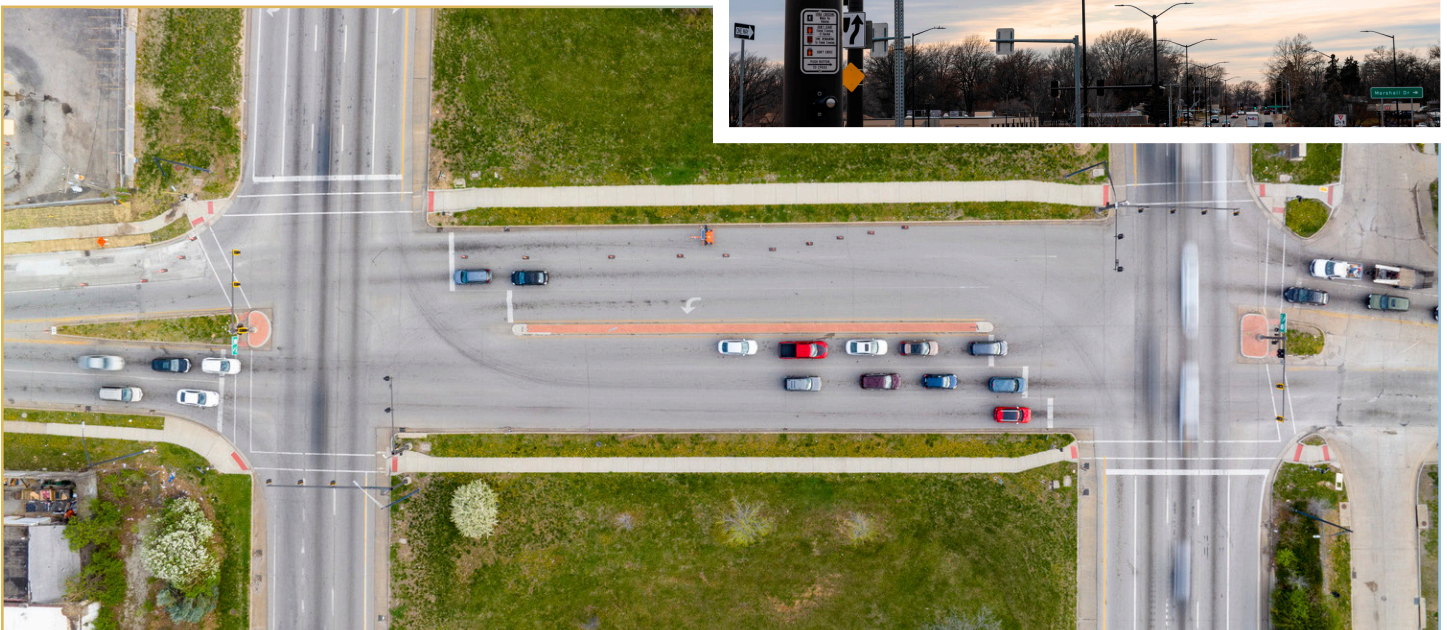
**Partnerships:** The project is not anticipated to have direct impacts to this area; however, it is expected to have some indirect economic benefits within the community by providing more efficient travel and safer roads. In addition, the system will provide consistent measurements across the region and strengthen the partnerships that currently exist.

**Integration:** Provide the 28 OGL partnering agencies with the opportunity to utilize the data along their corridors to improve system operations and efficiency.

The estimated costs of the proof-of-concept/prototype for Stage one is \$734,653. This includes the direct labor, consultant and vendor costs, and fringe and indirect fees. The anticipated cost for at-scale implementation for Stage two is expected to be between \$1,500,000 and \$2,500,000, depending on the findings from Stage one.

Some historical data is available throughout the MARC region. MARC, OGL, and the partner agencies have previously collected similar data for other types of projects. However, the data sets are not comprehensive and do not represent the entire region as they were provided for a specific agency. Furthermore, OGL has previously completed multiple studies assessing various systems and tools in an effort to monitor performance measures to help prioritize decisions for signal re-timing efforts. The findings from these previous assessments will be used as a comparison to the proposed systems.

OGL staff and agency members have had the opportunity for some hands-on experience with multiple systems on a trial basis. Based on this experience, they developed a general use case document. This document helped to identify a list of requirements based on how the system will be used in practice, which can be used to help evaluate each system objectively. In addition, the proposed system can be compared against the previous systems.



### PART 3: PERFORMANCE MEASURES FOR STAGE ONE

Table 1 identifies various evaluation questions the system will seek to answer along with associated performance measures and targets. At this stage, some of the performance measure targets simply consist of assessing if the system can provide the requested data.

**TABLE 1: PROJECT EVALUATION CRITERIA**

<i>Evaluation Question</i>	<i>Performance Measure</i>	<i>Performance Measure Target</i>
<b>How well does the data evaluate corridor performance?</b>	Average travel time/speed, travel time index, planning time index, delay, delay per signal, delay per vehicle, Level of Service, progression quality/platoon ratio, volumes with classification, etc.	Can the system provide this data? Y/N Data accuracy within 95%
<b>How well does the data evaluate intersection-level performance?</b>	Control delay per vehicle, fuel consumption, stops, Level of Service, average speed, turning volumes, volume/capacity, queue lengths, phase utilization, split failures, phase splits, vehicle classification, etc.	Can the system provide this data? Y/N Data accuracy within 95%
<b>How well does the data evaluate multimodal performance?</b>	Pedestrian and bicyclists delay, transit delay, transit stops, preemption response time, pedestrian phase duration, etc.	Can the system provide this data? Y/N Data accuracy within 95%
<b>Can the system report adaptive signal control changes?</b>	Ability to report adaptive signal changes	Can the system provide this data? Y/N
<b>How well does the system capture safety performance?</b>	Near-miss and crash identification	Detect events with at least 75% accuracy
<b>How well does the system work with existing infrastructure?</b>	Use of existing data from sensors, controllers, or the central traffic signal control system	Use of existing infrastructure of at least 90% good quality data



<i>Evaluation Question</i>	<i>Performance Measure</i>	<i>Performance Measure Target</i>
<b>What is the coverage of the system?</b>	Data availability in the study corridors	All intersections and corridors
<b>How user-friendly is the platform?</b>	Data resolution and aggregation level, ease-of-use of interface for selecting intersections/corridors, etc., ease-of-use of data extraction, mapping/GIS capability	Y/N
<b>What types of reports and data does the system provide to evaluate operations and identify system irregularities/failures?</b>	Summary graphs/statistics of performance measures, travel time reliability, coordination diagrams, logging event data for signals, custom reports  Signal malfunctions diagrams (e.g., Purdue phase termination diagram, split failures) and alerts	Y/N for reports  Alert lag time for signal malfunction diagrams < 5 min, false positives (erroneous identification of malfunction) < 3%, false negatives (malfunction is not identified) < 3%
<b>What are the reporting capabilities and customizability of the evaluated systems?</b>	Flexibility in creating monthly/quarterly summary reports, flexibility and responsiveness in creating customizable dashboards and reports ability to create reports by intersection/corridor/mode	Y/N
<b>What are the data requirements of the evaluated systems?</b>	Ability to synthesize different types of historical and real-time data sources, ability to access all data	Y/N
<b>How well can the evaluated system assist in decision-making?</b>	Ranking of corridors based on performance measures (static, and through time), suggestions for retiming, optimization algorithms, visualization tools for communication purposes	Y/N

## **PART 4: EVALUATION METHODOLOGY FOR STAGE ONE**

Vendors will provide a system that includes current and historical data on as many roadways as they can provide in the eight county MARC region. The five corridors listed above in Part 1 must be included.

*The evaluation team will then review and determine how well each vendor's system meets the evaluation criteria of the following categories:*

**Data:** The system will be evaluated on whether it can accommodate not only vendor data, but also local data and third-party data, both of which will be provided. Also, different data types (e.g., traffic flow, safety, vehicle type, etc.) and the ability to download the data will be reviewed. The accuracy of selected data will be reviewed and compared with baseline data, where available.

**User Interface:** The system user interface will be evaluated on its ease of use, the ability to select specific regions within the system for evaluation and reporting, the usefulness of existing system dashboards, the ability to create and modify custom dashboards, and how well the system highlights problem areas.

**Reporting:** The reporting functionality of the system should include a performance measures list. It will be evaluated on the different reporting features, report types available, and ability to create custom reports.

**Support:** Technical support will need to be provided for the system and will be evaluated on the development team's availability to answer questions and anticipated response times, offer training, when needed, work with the project team to improve the system.

**Requirements Compliance:** The system will be evaluated on how well it meets the requirements defined in the RFP.

The team will perform monthly evaluations considering the categories listed above for each of the implemented systems and prepare a summary report of the performance measures evaluation. Our report and evaluations will be discussed with the vendors at scheduled monthly meetings. The evaluation reports will be sent to the vendors ahead of time. The purpose of these meetings will be to obtain feedback on our understanding of their system through reviewing of the data, user interface, and reporting as well as discuss observed issues and potential solutions. The system will also be assessed to determine how many evaluation questions it can answer. This will provide an understanding of the types of performance measures that can be used to compare the data to baseline conditions.

In addition, for each of the intersection or corridor performance measures related to operations or safety, the evaluation team will use available existing data that can be used as a baseline to compare with the data obtained from all vendors. This will be done for selected days/ time periods, rather than continuously throughout the evaluation period. Other considerations, such as time of day, day of the week, peak vs. non-peak period, weather, or special events, will also be included when sampling for the baseline comparison. This comparison will inform the percent accuracy of the selected performance measures against the baseline. To ensure fair comparison between the vendors, the evaluation team will obtain accurate definitions of the selected performance measures from each vendor. Systematic differences that could be attributed to differences in underlying definitions of the obtained performance measure values will be indicated in these reports.

In addition to the monthly reports, the evaluation team will collect qualitative information pertaining to the system's ease of use and technical support quality (e.g., response times, offered training, customized responses, etc.) by logging all interactions with the vendors.

This information along with the monthly reports will be shared with the stakeholders during bi-monthly meetings that will be held to provide updates on the project's status. The final decision for selecting the vendor(s) for Stage two will be made by considering the combination of the four major categories of evaluation criteria listed above. The evaluation team is also considering assigning specific weights (e.g., high, medium, low) to each of these categories to facilitate decision-making.

A list of best practices from OGL, partner agencies, and the consultant team will be collected over the duration of the project. This list will be managed by the consultant team and kept on a project SharePoint site for everyone to access. This list will be shared with US DOT at the conclusion of the project.

Some anticipated benefits of at-scale implementation that will occur in Stage two include a reduction in vehicle emissions (Volatile Organic Compounds, Carbon Monoxide, and Nitric Oxide) and fuel consumption. The savings in annual operating costs will be estimated using guidelines published by FHWA. The calculations are based on average travel times, travel speeds, corridor length, and daily traffic volumes. The cost savings can then be calculated from the estimated fuel savings. Another benefit of implementing the system includes a reduction in crashes. The crash savings will be estimated using current crash costs from the Kansas and Missouri departments of transportation. An overall benefit/cost ratio will be calculated using the total cost savings and the system cost.

**TABLE 2 PROVIDES SEVERAL TECHNICAL TERMS AND ACRONYMS WITH THEIR ASSOCIATED DEFINITIONS THAT ARE RELEVANT TO THIS PROJECT.**

<i>Term</i>	<i>Definition</i>
<b>Advanced traffic signal performance measures (ATSPMs)</b>	Reports and performance measures generated through automatic collection of high-resolution traffic detection data. They are used to support performance-based objectives of agencies to improve operations.
<b>Carbon Monoxide</b>	Is an odorless, colorless gas that can be deadly. It is found in fumes produced any time fuel is burned in cars, trucks, or small engines.
<b>Nitric Oxide</b>	These gases are formed when fuel is burned at high temperatures. It is an ozone depleting gas with global warming potential.
<b>Planning time index</b>	Ratio of the 95th-percent peak period travel time to the free flow travel time
<b>Platoon ratio</b>	A measure of individual phase progression performance derived from the percentage arrivals on green.
<b>Purdue phase termination diagram</b>	a graphic that displays the trigger event (Force-Off, Gap-Out, or Max-Out) for each traffic signal phase at an intersection, typically over a 24-hour period.
<b>Travel time index</b>	Ratio of the travel time during the peak period to the time required to make the same trip at free-flow speeds.
<b>Travel time reliability</b>	The consistency or dependability in travel times, as measured from day-to-day and/or across different times of the day.
<b>Volatile Organic Compounds (VOCs)</b>	Are emitted as gases from certain solids or liquids. They include a variety of chemicals, some of which have short- and long-term adverse health effects.