# GRANT APPLICATION SUMMARY SHEET

| | |
|---|---|
| **Grant Name:** | Intelligent Transportation Systems CMAQ Improvement 21-24 |
| **Department:** | PUBLIC WORKS |
| **Grantor:** | U.S. DEPARTMENT OF TRANSPORTATION |
| **Pass-Through Grantor (If applicable):** | TENN. DEPT. OF TRANS. |
| **Total Applied For:** | $3,655,000.00 |
| **Metro Cash Match:** | $0.00 |
| **Department Contact:** | Devin Doyle<br>862-8704 |
| **Status:** | NEW |

**Program Description:**
Implementation of a modern fully-functional Transportation Management Center (TMC) which will be housed in the Metro Howard Office Building (HOB) located at 700 2nd Avenue S, Nashville, TN 37210. Metro Nashville is requesting enough funding to cover three years of active operational staff for the management, operation, and maintenance of the TMC. The operational funding is expected to cover nine full time positions in the TMC consisting of engineers, operators, and technicians.

**Plan for continuation of services upon grant expiration:**
The Metro Nashville Transportation Plan recognizes and acknowledges the need to increase both operational and capital funding for the enhancement, management and maintenance of the City's transportation infrastructure. Metro Nashville is committed to the future sustainability of positions and functions created through this grant and anticipates increased operating and capital funding in future departmental budgets to accomplish this goal.

**APPROVED AS TO AVAILABILITY OF FUNDS:**

DocuSigned by: Kevin Crumbo/mjw 7/10/2021
Director of Finance — Date

DS TE

**APPROVED AS TO FORM AND LEGALITY:**

DocuSigned by: Nicki Ebe 7/12/2021
Metropolitan Attorney — Date

**APPROVED AS TO RISK AND INSURANCE:**

DocuSigned by: Balogun Cobb 7/12/2021
Director of Risk Management Services — Date

DocuSigned by: John Cooper 7/12/2021
Metropolitan Mayor — Date

DS KW

*(This application is contingent upon approval of the application by the Metropolitan Council.)*

5282

Budget Analyst Initials

DS KW

# Grants Tracking Form

## Part One

Pre-Application ○ Application ◉ Award Acceptance ○ Contract Amendment ○

| Department | Dept. No. | Contact | Phone | Fax |
|---|---|---|---|---|
| PUBLIC WORKS | 042 | Devin Doyle | 862-8704 | |

| | | | |
|---|---|---|---|
| Grant Name: | Intelligent Transportation Systems CMAQ Improvement 21-24 | | |
| Grantor: | U.S. DEPARTMENT OF TRANSPORTATION | Other: | |
| Grant Period From: | 11/01/21 | (applications only) Anticipated Application Date: | 07/12/21 |
| Grant Period To: | 11/01/24 | (applications only) Application Deadline: | 07/12/21 |
| Funding Type: | FED PASS THRU | Multi-Department Grant ☐ → If yes, list below. | |
| Pass-Thru: | TENN. DEPT. OF TRANS. | Outside Consultant Project: ☐ | |
| Award Type: | COMPETITIVE | Total Award: | $3,655,000.00 |
| Status: | NEW | Metro Cash Match: | $0.00 |
| Metro Category: | Est. Prior. | Metro In-Kind Match: | $0.00 |
| CFDA # | 20.205 | Is Council approval required? ☑ | |
| Project Description: | | Applic. Submitted Electronically? ☑ | |

Implementation of a modern fully-functional Transportation Management Center (TMC) which will be housed in the Metro Howard Office Building (HOB) located at 700 2nd Avenue S, Nashville, TN 37210. Metro Nashville is requesting enough funding to cover three years of active operational staff for the management, operation, and maintenance of the TMC. The operational funding is expected to cover nine full time positions in the TMC consisting of engineers, operators, and technicians.

**Plan for continuation of service after expiration of grant/Budgetary Impact:**

The Metro Nashville Transportation Plan recognizes and acknowledges the need to increase both operational and capital funding for the enhancement, management and maintenance of the City's transportation infrastructure. Metro Nashville is committed to the future sustainability of positions and functions created through this grant and anticipates increased operating and capital funding in future departmental budgets to accomplish this goal.

**How is Match Determined?**

| | | | | | |
|---|---|---|---|---|---|
| Fixed Amount of $ | | or | 0.0% | % of Grant | Other: ☐ |

Explanation for "Other" means of determining match:

**For this Metro FY, how much of the required local Metro cash match:**

| | | | | | |
|---|---|---|---|---|---|
| Is already in department budget? | N/A | | Fund | | Business Unit |
| Is not budgeted? | | | Proposed Source of Match: | | |
| (Indicate Match Amount & Source for Remaining Grant Years in Budget Below) | | | | | |

**Other:**

| | | | | | |
|---|---|---|---|---|---|
| Number of FTEs the grant will fund: | 9.00 | | Actual number of positions added: | 9.00 | |
| Departmental Indirect Cost Rate | 33.91% | | Indirect Cost of Grant to Metro: | $1,239,410.50 | |
| *Indirect Costs allowed? ◉ Yes ○ No | % Allow. | 0.00% | Ind. Cost Requested from Grantor: | $0.00 | in budget |

*(If "No", please attach documentation from the grantor that indirect costs are not allowable. See Instructions)

Draw down allowable? ☐

Metro or Community-based Partners:

## Part Two

### Grant Budget

| Budget Year | Metro Fiscal Year | Federal Grantor | State Grantor | Other Grantor | Local Match Cash | Match Source (Fund, BU) | Local Match In-Kind | Total Grant Each Year | Indirect Cost to Metro | Ind. Cost Neg. from Grantor |
|---|---|---|---|---|---|---|---|---|---|---|
| Yr 1 | FY22 | $1,810,000.00 | | | | | | $1,810,000.00 | $613,771.00 | |
| Yr 2 | FY23 | $915,000.00 | | | | | | $915,000.00 | $310,276.50 | |
| Yr 3 | FY24 | $930,000.00 | | | | | | $930,000.00 | $315,363.00 | |
| Yr 4 | FY__ | | | | | | | | | |
| Yr 5 | FY__ | | | | | | | | | |
| Total | | $3,655,000.00 | | | | | | $3,655,000.00 | $1,239,410.50 | |

| | | | | | |
|---|---|---|---|---|---|
| Date Awarded: | | Tot. Awarded: | | Contract#: | |
| (or) Date Denied: | | Reason: | | | |
| (or) Date Withdrawn: | | Reason: | | | |

Contact: trinity.weathersby@nashville.gov
vaughn.wilson@nashville.gov

Rev. 5/13/13
5282

GCP Rec'd 07/09/21

GCP Approved 07/09/21

VW

21-004-037

**Project Title**

**The Tennessee Department of Transportation (TDOT) is accepting project proposals for funding under the federal CMAQ program. Applications must be completed and submitted online.**

**This online application must be submitted no later than .**

**Project Title:**

Metro Nashville Traffic Management Center

**Applicant**

| | |
|---|---|
| Organization Name | Nashville |
| Primary Contact | Devin Doyle |
| Street Address 1 | 720 South 5th Street |
| Street Address 2 | |
| City | Nashville |
| County | |
| State | Tennessee |
| Zip | 37204 |
| Phone | (615) 862-8704 |
| Fax | |
| Email | devin.doyle@nashville.gov |
| Type of Legal Organization | Municipality |
| If Other, please specify: | |

**Employer Identification Number/Tax Identification Number (EIN/TIN):**

62-0694743

**Organization's DUNS Code:**

078217668

**Organization's Edison ID:**

4

Applicants selected for funding must register as a vendor/contractor in the state of Tennessee Edison system before signing a grant contract for funding. For more information on contractor registration, visit http://www.tn.gov/generalservices/topic/vendor-information. From this page, go to the online registration site (https://supplier.edison.tn.gov/). Contact the Edison Help Desk at 615.741. HELP or 1.866.376.0104 with ALL questions about Contractor Registration.

## Project Type

**Select Eligible CMAQ Project Type for this Application**

[ ] New or Expanded Transit Service

[ ] New or Expanded Park and Ride Projects

[ ] Diesel Emission Reduction Projects (purchase of cleaner vehicles and equipment)

[ ✔ ] Intelligent Transportation Systems

[ ] Traffic Flow Improvements

[ ] Bicycle Pedestrian Projects

[ ] Transportation Demand Management

[ ] Education and Outreach

[ ] Other vehicle replacement projects

[ ] Freight

[ ] Fuel Infrastructure

[ ] Other

All CMAQ funded projects shall be developed to comply with TDOT roadway design standards. Additional work required to address accessibility deficiencies within the limits of project and any ADA upgrades if required may not be eligible for 100% federal funding, addressing such features will require 20% local match. All projects seeking for CMAQ funding shall scope addressing accessibility related issues when putting together project estimates. Refer to roadway design guidelines for additional guidance.
Projects developed by locals and let by locals are also under obligation to follow the same guidance since local agencies are obligated to comply with the FHWA ADA Transition plan requirements by end of 2021. For more guidance, refer to the TDOT Roadway Design Division's ADA Office.

[ ✔ ] Please select this checkbox stating you have read and understand the statement above.

**Does this project involve construction?** ( ) Yes ( ✔ ) No

**Will this project incorporate iron and/or steel?** ( ) Yes ( ✔ ) No

## MPO Area

Counties eligible to receive CMAQ funding are designated by the U.S. Environmental Protection Agency (EPA) as federal air quality nonattainment or maintenance areas. Eligible counties are listed below for each Metropolitan Planning Organization (MPO)/Transportation Planning Organization (TPO) area. Projects in counties outside of designated air quality nonattainment or maintenance areas may be eligible for funding if the project applicant can demonstrate that the project will result in air quality benefits in a nonattainment or maintenance county. Tennessee nonattainment and maintenance counties are listed below:

**Clarksville Area Metropolitan Planning Organization**

Montgomery County

**Chattanooga-Hamilton County Transportation Planning Organization**

Hamilton County

**Knoxville Regional Transportation Planning Organization**

Anderson, Blount, Cocke (partial), Knox, Loudon, Roane (partial), Sevier Counties

**Lakeway Area Metropolitan Transportation Planning Organization**

Jefferson County

**Memphis Area Metropolitan Planning Organization**

Shelby County

**Nashville Area Metropolitan Planning Organization**

Davidson, Rutherford, Sumner, Williamson, Wilson

**MPO Area:**

- Chattanooga
- Clarksville
- Knoxville
- Lakeway
- Memphis
- ✔ Nashville

## Project Partners (if applicable)

**Private Partner (if applicable)**

Organization Name
Primary Contact
Street Address 1
Street Address 2
City
State
Zip
Phone
Fax
Email
Type of Legal Organization
If Other, please specify:
Project Partner Edison ID

*For-profit and nonprofit applicants selected for funding will be required to provide documentation that their business is a viable, ongoing concern (e.g., audited financial statement or past income tax returns).*

21-004-037

## Contact Information

**Secondary Contact Person**

| | |
|---|---|
| Contact Name | Derek Hagerty |
| Title | Engineer 1 |
| Organization | Metro Nashville Public Works |
| Phone Number | (615) 862-8748 |
| Fax Number | (615) 880-3257 |
| Email Address | derek.hagerty@nashville.gov |

**Authorized Representative for Project (Person who will sign the contract)**

| | |
|---|---|
| Contact Name | Faye DiMassimo |
| Title | Sr Advisor for Transportation and Infrastructure |
| Organization | Nashville Mayor's Office |
| Phone Number | (615) 862-6000 |
| Fax Number | |
| Email Address | faye.dimassimo@nashville.gov |

21-004-037

## Project Location

**Primary Project Location**

| | | |
|---|---|---|
| Street Address 1 | 700 2nd Avenue South | Location Map |
| Street Address 2 | | |
| City | Nashville | |
| County | Davidson County | |
| State | Tennessee | |
| Zip | 37210 | |

**The project must benefit air quality in one or more of the counties listed below. Please select the CMAQ-eligible counties covered by your project here:**

| | |
|---|---|
| Anderson | Montgomery |
| Blount | Roane |
| Cocke | Rutherford |
| ✔ Davidson | Sevier |
| Hamilton | Shelby |
| Jefferson | Sumner |
| Knox | Williamson |
| Loudon | Wilson |

**If any of the project is located/conducted outside of a CMAQ-eligible county, please select the counties below:**

| | | | |
|---|---|---|---|
| Bedford | Franklin | Lawrence | Robertson |
| Benton | Gibson | Lewis | Scott |
| Bledsoe | Giles | Lincoln | Sequatchie |
| Bradley | Grainger | Macon | Smith |
| Campbell | Greene | Madison | Stewart |
| Cannon | Grundy | Marion | Sullivan |
| Carroll | Hamblen | Marshall | Tipton |
| Carter | Hancock | Maury | Trousdale |
| Cheatham | Hardeman | McMinn | Unicoi |
| Chester | Hardin | McNairy | Union |
| Claiborne | Hawkins | Meigs | Van Buren |
| Clay | Haywood | Monroe | Warren |
| Coffee | Henderson | Moore | Washington |
| Crockett | Henry | Morgan | Wayne |
| Cumberland | Hickman | Obion | Weakley |
| Decatur | Houston | Overton | White |
| DeKalb | Humphreys | Perry | |
| Dickson | Jackson | Pickett | |
| Dyer | Johnson | Polk | |
| Fayette | Lake | Putnam | |
| Fentress | Lauderdale | Rhea | |

**General Competition - Project Description**

Provide a detailed description of the project or program so that individuals unfamiliar with your organization will understand the project or program scope and location. For projects selected for funding, this information will be used to develop the contract scope of services.

The City of Nashville's traffic management infrastructure is aging and cannot meet the demands of a modern multimodal mobility network in a growing metropolitan area. As such, the Nashville Department of Transportation and Multimodal Infrastructure (NDOT) is requesting CMAQ funding for two primary project phases:

Phase 1: Implement a modern fully-functional Transportation Management Center (TMC). The TMC will be located in the Metro Howard Office Building (HOB) located at 700 2nd Ave. S. in Nashville.

Phase 2: Augment staff to cover 3 years of managing, operating, & maintaining the TMC. Funding will accommodate several full-time positions in the TMC composed of engineers, operators, and technicians.

Phase 1: TMC

With this project NDOT will establish its official countywide TMC. It will become the foundation to Metro Nashville's smart mobility initiative and will act as the nerve center for the future of automated and responsive multi-modal transportation systems. For the TMC itself, NDOT will modify existing underutilized space in the HOB that Metro General Services currently uses as a remote management & monitoring center for various Metro facilities. It houses an outdated video wall, six workstation consoles, a network/IT room, an adjacent conference room, and staff office space.

Using 100% local funding, NDOT has already procured services of Kimley-Horn & Associates (KHA) to develop design plans for the upgrade and conversion of the 2nd Ave. space into a fully-functional TMC. KHA is inventorying all components of the existing HOB management center. They will be evaluating the existing communication and center assets with a specific focus on determining what infrastructure is salvable and what infrastructure must be replaced in order to successfully integrate planned and proposed TMC operations.
KHA is also completing corridor design plans for two major corridors: (1) Gallatin Pike (SR6/US31E) and (2) Nolensville Pike (SR11/US41A/US31A). These corridor improvements will be constructed using 100% local funding as well, and will include the following:

- fiber optic communications
- CCTV Cameras
- system detection
- upgraded traffic signal detection and infrastructure

If awarded, this phase of the CMAQ grant will be used to implement/build-out NDOT's TMC. It is anticipated that the primary components of that plan will include:

- video wall display monitors and ancillary hardware
- upgraded workstation consoles
- upgraded workstation computers and servers
- upgraded fiber optic cable components
- installation of new communications and networking equipment

Phase 2: Staffing

The remaining funds will be used to address the staffing requirements for operating and maintaining the TMC. Those staffing needs were identified in 2020 when a Metro-commissioned consultant team assessed the current transportation management operations of NDOT and conducted a peer review of operations in similar sized cities. The assessment provided functional recommendations addressing short and long term staffing needs.

It noted that NDOT has one traffic engineer responsible for all 865 traffic and no full-time operators. As such, the Department is severely understaffed in all roles including signal engineers, system operators, and signal technicians. The conclusion was that for a

city the size of Nashville, a total of 8 additional traffic engineers, 4-9 TMC operators, and 4 additional signal technicians are needed to match the average levels of the peer agencies. NDOT cannot presently hire all of the additional staff needed to meet those levels. However, introduction of any additional staff will have a tremendous positive impact on the Department's ability to manage traffic and maintain related assets.

Because of this, NDOT is requesting enough funding through this CMAQ application to cover three (3) years of operational staff for the management, operation, & maintenance of the TMC. The operational funding is expected to cover several full-time engineering and operator/technician level positions. This will enable the implementation of the following operational and safety management strategies:

- operating smart traffic signals
- managing reversible lanes
- regularly updating time-based coordination signal timing plans
- implementing & maintaining traffic responsive signal timing plans
- developing adaptive signal control technology systems
- managing/coordinating Nashville's expanding transit priority control system
- monitoring & enhancing pedestrian signal infrastructure
- coordinating with TDOT's TMC during planned and unplanned freeway incident/events
- coordinating with EOC & MNPD during traffic incidents & special events

| | | |
|---|---|---|
| Is the proposed project a continuation of an existing project? | Yes ✔ No | |
| Federal project number of the existing project | | |
| State project number of existing project | | |
| Previous CMAQ funding amounts obligated by year | FY | Amount: |
| Previous CMAQ funding amounts obligated by year | FY | Amount: |
| Total funding (all funds) dedicated to the project by funding source(s) | Source: | Amount: |
| Total funding (all funds) dedicated to the project by funding source(s) | Source: | Amount: |

Provide a description of the relationship between the proposed project and the existing project, and how the proposed project will augment or strengthen the existing project

If applicable, describe plans to continue program operations after the CMAQ grant period has ended.

In December 2020, Mayor John Cooper and the Metro Council of Nashville approved the Metro Nashville Transportation Plan. That plan prioritizes the implementation of a local TMC. It also recognizes and acknowledges the need to continue investing in technology as the City's portfolio grows, over time expanding the fiber and transportation infrastructure. The City is committed to the future sustainability of the positions and functions created through this grant and will build more permanent staff into the annual operating budget as the benefits of the TMC are recognized. This project provides a bridge to that outcome and ensures that NDOT will have necessary staff to serve as a foundation for the implementation of the TMC.

## General Competition Emissions

Please provide the following information:

1. Describe what the project will do (i.e., project activities).
2. Describe the impact of those activities and show how that will reduce emissions.
3. List the estimated emission reductions of the project in **kg/day**.
4. Regardless of methodology used, **please still detail any logic and assumptions used. Please ensure that emissions reductions and associated information are updated and current and build on local or programmatic data whenever possible.**

This project will build out the Metro Nashville Traffic Management Center and staff it for a period of three years. Implementing and staffing a fully functional traffic management center will allow NDOT to actively manage traffic through real-time monitoring of traffic conditions, signal timings, emergency response, and traffic signal priority (TSP) for bus rapid transit (BRT) among other actions along five of the city's major corridors (Charlotte Pk, Gallatin Pk, Nolensville Pk, Murfreesboro Pk, and West End Ave) that are currently undergoing signal, communications, and detection upgrades. Without a TMC the advantages gained through the corridor projects will go largely unrealized as current staffing and workspace does not allow for full utilization of new technologies.

To estimate emission reductions, the Traffic Signal Synchronization Module of the Federal Highway Administration's (FHWA) CMAQ Toolkit was used. This toolkit is designed to calculate the emissions benefits from coordinating traffic signals along a corridor which will be a primary responsibility of the Nashville TMC once staffed and operational. Currently signals along major corridors are only retimed every three-to-five years. By improving signal synchronization on a more frequent basis in response to real-time changes in traffic patterns and road conditions, NDOT will be able to considerably reduce congestion which limits stop-and-go traffic and the amount of time vehicles spend operating on the roadway resulting in lower levels of emissions. The scope of this project will directly impact nearly 45 miles of roadway and ancillary benefits can be expected on connecting streets, such as reducing the volume of "cut-through" traffic that is typical near congested corridors & intersections.

To calculate estimated emissions reductions a few assumptions were made to fit the FHWA Traffic Signal Synchronization Model. The posted speed limit used for calculations, 45 MPH, represents an average of the speed limits across the corridors as they vary based on land use from 30 MPH in the more urban areas to 55 MPH further from the downtown core. Similarly, the average cycle length was taken to be 130 seconds and the truck percentage to be 2%. The existing corridor travel time 178 minutes.

The emissions calculator produces results assuming a corridor is uncoordinated. This is a valid assumption for the five corridors in questions as none have undergone a thorough synchronization in over two years and the combination of growth in the Middle Tennessee area and the impacts of the COVID pandemic have almost certainly shifted traffic patterns in that time. Traffic volumes were pulled from TDOT's Tennessee Traffic Information Management and Evaluation System (TN-TIMES). To provide an accurate snapshot of existing volumes, counts were used from January through March 14, 2020, all prior to the impacts of COVID. One count from each of the five corridors was utilized to determine an average volume of 40,007 vehicles per day and a peak volume of 2,928 vehicles per hour across the corridors. Existing corridor travel time was determined by combining the travel times of the five corridors to correspond with the combined corridor length of 44.55 miles.

Estimated Emissions Reduction:

CO = 370.756 kg/day
PM2.5 = 4.213 kg/day
PM10 = 19.884 kg/day
NOx = 23.915 kg/day
VOC = 5.849 kg/day

These reductions represent a carbon dioxide equivalent of over 26M kilograms per year.

| | |
|---|---|
| Please attach your emissions methodology | https://tdot.intelligrants.com/_Upload/11130_1112367-EmissionsMethodology.pdf |
| Additional emissions methodology documents (if applicable)<br>(to upload additional documents, click the SAVE button) | https://tdot.intelligrants.com/_Upload/11130_1112368-EmissionsModel.pdf |

## General Competition Emissions

**Indicate cost effectiveness of emission reduction**

If a project will reduce emissions of more than one pollutant, add the estimated emission reductions of all pollutants together (except CO2) and use the total to calculate the project's cost per Kilogram of emission reduction.

Calculate and describe the proposed project's cost per Kilogram of emission reduction that the project will achieve in a **year** after the project is fully implemented. Please indicate the following in Cost per Kilogram for CMAQ dollars requested.

| | |
|---|---|
| Cost per Kilogram of all criteria pollutants ($/Kg) | $23.58 |
| Cost per Kilogram of PM 2.5 reductions ($/Kg) | $2,376.86 |
| Cost per Kilogram of NOx reductions ($/Kg) | $418.72 |

Calculate and describe the proposed project's cost per Kilogram of emissions reduction the project will achieve over the **lifetime** of the project. Please indicate the following in Cost per Kilogram for CMAQ dollars requested.

| | |
|---|---|
| Cost per Kilogram of all criteria pollutants ($/Kg) | $7.86 |
| Cost per Kilogram of PM 2.5 reductions ($/Kg) | $792.29 |
| Cost per Kilogram of NOx reductions ($/Kg) | $139.57 |

# CMAQ EMISSIONS CALCULATOR TOOLKIT

The purpose of the Congestion Mitigation and Air Quality Improvement Program Emissions Calculator Toolkit (CMAQ Toolkit) is to provide users a standardized approach to estimating emission reductions from the implementation of a CMAQ-funded project. The CMAQ Toolkit uses emission rates for highway vehicles based on a series of project-scale and national-scale runs of the Motor Vehicle Emission Simulator (MOVES) as well as other data sources. For each tool in the toolkit, the inputs and methodology are described in user guides along with some example cases. Emission estimates from the CMAQ Toolkit are not intended to meet specific requirements for State Implementation Plans (SIPs) or transportation conformity analyses. Information regarding the development of default emission rates and guidance on incorporating user-supplied emission rates can be found in the accompanying documentation of the emissions data.

## Traffic Signal Synchronization Module

The signal synchronization project emission reductions calculator estimates the emissions benefits from coordinating traffic signal timing along a corridor.[1]

This tool is not intended for the addition of new signals, only for the synchronization of existing unsynchronized signals. Although this project does not examine the effect of signal coordination throughout a system or area, system-wide or area-wide emission reductions can be reasonably determined by combining the reductions estimated for corridors individually. Emission reductions are calculated for peak- and off-peak hours on a typical weekday.

Emission reductions are estimated by calculating the change in running emissions from an improved travel time along the corridor. The improved travel time is calculated by estimating the change in delay at each signal along the corridor, or travel time savings, and multiplying by a factor to account for the effect of traffic volume on travel time and speed.[2] Running emissions for the average speed associated with the existing and the improved travel time are compared to estimate emissions benefits.

This document is organized into three sections – User Guide, Tool Methodology, and Examples – to aid the user in understanding and interpreting results from the calculator. The User Guide directs the user on how to properly input values into the tool, and provides definitions of both user inputs and tool outputs. The Tool Methodology section outlines the steps taken by the tool to calculate emission reductions, as well as any assumptions incorporated into the tool. This section also describes the equations used within the tool to calculate emission benefits. The Examples section provides instructive examples of how to use the tool for project analysis.

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[1] The most current version of the tool is dated July 2019. To verify the version, check the date on the Introduction page of the tool. Release notes are included in the Change Log tab, which can be viewed by right-clicking on any tab in the tool, selecting “Unhide”, and revealing the tab.

[2] Roadway performance calculations rely on the Highway Capacity Manual, Transportation Research Board National Academy of Sciences, Washington DC, 2010.

# Contents

# USER GUIDE

This section lists the units and description for each user input and tool output, as well as a description of emission reductions reporting and error messages.

## User Inputs

The Traffic Signal Synchronization Module contains a series of questions to guide the user in properly inputting information for emission reductions calculations in a step-by-step process. The inputs for this tool should be specific to the vehicles and road types involved in the project.

***Table 1. User Inputs***

| User Input | Units | Description |
|---|---|---|
| Evaluation year | ----- | Use the drop-down menu to choose a year between 2019 and 2030. |
| Road type | ----- | Use the drop-down menu to choose the appropriate road type for the coordinated signalized corridor. Available road types are: rural and urban, indicating rural and urban unrestricted road types. |
| Corridor Length | miles | Input the length of the project corridor along which the lights will be synchronized. The default value is 1 mile. |
| Number of signalized intersections | ----- | Input the number of traffic signals along the project corridor. The default value is 2 signals. Traffic signal synchronization projects can only be implemented in corridors with at least 2 intersections |
| Number of lanes, one direction | ----- | Input the average number of through lanes along the length of the project corridor for one approach direction. The default value is 1 lane. |
| Posted speed limit | mph | Input the average speed limit posted along the length of the project corridor. This is used as the mid-segment (between signals) free-flow speed. The tool's upper limit is 75 mph. |
| Average cycle length | seconds | Input the average cycle length of the traffic signals included in the signal synchronization project. The default value is 90 seconds, per the Highway Capacity Manual. |
| Truck Percentage | | Input the percent of traffic along the corridor that is heavy-duty truck vehicles. The default value is 6%, based on default MOVES activity rates. |
| Annual Average Daily Traffic (AADT), both directions | vehicles/day | Input the AADT volume of traffic across all lanes of travel, in both approach directions along the length of the corridor. |
| Peak-hour volume, both directions | vehicles/hour | Input the average volume of traffic across all lanes, in both approach directions along the length of the corridor during typical weekday peak travel hours |
| Existing corridor travel time | minutes | Input the average time in minutes that it takes for a vehicle to travel the length of the corridor. |

| User Input | Units | Description |
|---|---|---|
| Total peak hours per day (AM+PM) | hours | Input the total number of peak hours the project corridor experiences on a typical weekday. The default value is 4 hours.[3] |

## Tool Outputs

Once the input parameters are entered, click the 'Calculate Output' button to generate results. Emission results will not automatically update: if any changes are made to the input parameters, this button must be clicked again to calculate updated emission reductions. If you would like to return to default settings and clear input values, click on the 'Reset to Default Values' button.

Emission reductions are calculated for five pollutants – carbon monoxide (CO), particulate matter < 2.5 µm ($PM_{2.5}$), particulate matter < 10 µm ($PM_{10}$), nitrogen oxides (NOx), and volatile organic compounds (VOC) – in kilograms per day. Reductions in carbon dioxide equivalents ($CO_2e$) and total energy consumption (million BTU) are also provided. These parameters are outputs from MOVES related to greenhouse gas reporting.

Note that a '0' value for an emission reduction indicates no change in emissions associated with the project. A negative emissions reduction indicates a disbenefit (i.e., the project increases emissions for a particular pollutant).

***Table 2. Proposed Conditions***

| Output | Units | Description |
|---|---|---|
| Peak-hour volume (both directions) | vehicles/hour | The average hourly volume of traffic for both approach directions and across all lanes, as input by the user. |
| Off-peak hourly volume (both directions) | vehicles/hour | The calculated off-peak hourly volume found by subtracting total peak traffic from the annual average daily traffic in approach both directions and across all lanes. |
| Peak-hour existing average speed | miles per hour | The existing corridor average traveling speed as calculated from existing corridor travel time and length of the project corridor. |
| Off-peak existing average speed | miles per hour | Using the methodology explained below, the calculated corridor average traveling speed calculated from free-flow speed and a calculated delay at each signal along the corridor, based on off-peak volume and road capacity. |
| Peak-hour travel time savings | minutes | Using the methodology explained below, the calculated travel time savings (reduction in delay from coordinated signals) during peak-hour conditions. |

[3] https://nacto.org/publication/urban-street-design-guide/design-controls/design-hour/

| Output | Units | Description |
|---|---|---|
| Off-peak travel time savings | minutes | Using the methodology explained below, the calculated travel time savings (reduction in delay from coordinated signals) during off-peak hours, based on off-peak hourly volume. |
| Peak-hour improved average speed | miles per hour | The calculated new travel speed along the corridor length from travel time savings during peak-hour conditions |
| Off-peak improved average speed | miles per hour | The calculated new travel speed along the corridor length from travel time savings during off-peak hour conditions |

## Error Messages

Table 3 below lists error messages the user may encounter in this tool, the reason for the error message, and the solution. Once you correct any errors, please press 'Calculate Output' to recalculate the results.

***Table 3. Error Messages***

| Error Message | Reason for Error | Solution |
|---|---|---|
| Truck percentage cannot be greater than 100% | Traffic volume is composed of more than 100% trucks | Reduce truck volume |
| Roadway is over capacity. | Volume-to-capacity ratio is greater than one | Adjust number of lanes, posted speed-limit or traffic volume to remedy volume-to-capacity ratio. The tool assumes no emission reductions for volume-to-capacity ratio greater than one. |
| Conditions indicate corridor is operating above the posted speed limit. | The travel time and corridor length conditions input by the user indicate that the average speed on the roadway exceeds the posted speed limit | Adjust the travel time or roadway length. |
| Corridor already operating at speed limit. No improvement made | Traffic is moving along corridor at free-flow speed | No adjustment necessary if these are operating conditions; if this is not correct, please adjust travel time along corridor. |
| AADT cannot be less than total volume of all peak hours | Peak-hour volume times the number of peak hours is greater than the reported total daily traffic | Adjust peak-hour volume, number of peak hours, or AADT. |
| Under input conditions, there is no improvement in speed along corridor | Traffic already operating at maximum speed for volume and capacity for length of corridor | No adjustment necessary if these are operating conditions; if this is not correct, please adjust inputs. |

# TOOL METHODOLOGY

## Delay Reduction Calculation Methodology

The methodology for calculating emission reductions as a result of signal synchronization relies on the calculation of time savings for travel along the project corridor by reducing delay at each intersection. The Highway Capacity Manual (2010) provides the following equation for calculating uniform delay, $d_1$, at a signalized intersection[4]:

$$d_1 = \frac{0.5C(1-\frac{g}{C})^2}{1-\left[\min(1,X)\frac{g}{C}\right]} \quad (1)$$

Where

C = cycle length (seconds),

g/C = green light duration to total cycle duration ratio;

min(1, X ) is function to limit the volume to capacity ratio to a maximum of 1.0 by choosing the smallest value of 1 or X; and

X, defined as the highest volume to capacity ratio of any turning movement or lane group at intersection, is expressed in the following equation[5]:

$$X = \frac{v}{c} = \frac{v}{Ns\frac{g}{C}} \quad (2)$$

where

v = volume (vehicles/hour) (one direction),

c = capacity

N = number of lanes (one direction), and

s = saturation flow rate/lane (vehicles/lane/hour).

Saturation flow rate is calculated using an adjustment of a base saturation flow rate. The base saturation flow rate uses a default value of 1900 passenger vehicles per lane per hour in urban areas, and 1750 passenger vehicles per lane per hour for rural areas[6]. This base rate is adjusted to account for heavy duty vehicle percent distributions on the roadway to obtain the saturation flow rate in vehicles per lane

[4] Equation 18-20 in Chapter 18: Signalized Intersection, Highway Capacity Manual, Transportation Research Board National Academy of Sciences, Washington DC, 2010.
[5] Equations 18-17 and 18-19, Chapter 18: Signalized Intersections, Highway Capacity Manual, Transportation Research Board National Academy of Sciences, Washington DC, 2010.
[6] Exhibit 18-28 in Chapter 18: Signalized Intersection, Highway Capacity Manual, Transportation Research Board National Academy of Sciences, Washington DC, 2010.

per hour in the specific scenario. The other default used in the tool is the green-time-to-cycle-time ratio, set at 0.5 for this tool.

Aside from the saturation flow rate and green-time-to-cycle-time ratio, the other variables in the delay calculation are user inputs. This delay is multiplied by a progression factor (PF) in order to account for coordinated and uncoordinated signals. Uncoordinated signals throughout a corridor correspond to an Arrival Type 3 and a progression factor, PF, of 1.00, while traffic subject to coordinated signals is characterized as an Arrival Type 4 with a PF of 0.67.[7] The delay then, for newly coordinated signals, $d_2$, is given as:

$$d_2 = 0.67 d_1 \quad (1)$$

In other words, delay is reduced along a corridor by a factor of 0.67. The delay reduction for the project corridor is calculated by multiplying the delay reduction for one signal by the number of signals along the corridor.

This total delay reduction is subtracted from the existing travel time and a new travel speed along the corridor is calculated. The existing travel time is provided by the user for peak-hours and the new travel speed is calculated using the methodology described below. To account for volume of traffic and the effect of traffic volume on travel speed along a corridor, a volume factor, $f_v$, is applied to the travel time savings calculation, given as[8]:

$$f_v = \frac{2}{1 + \left(1 - \frac{v}{52.8 N S_{PL}}\right)^{0.21}} \quad (2)$$

Where:

v = volume (vehicles/hour) (one direction),

N = number of lanes (one direction), and

$S_{PL}$ = posted speed limit (which is our estimate of the free flow speed).

For higher traffic volumes, travel time savings are reduced. When the traffic volume is critically over capacity, travel time savings are negligible. In this tool, when critical overcapacity occurs, denoted when the term:

$$\left(1 - \frac{v}{52.8 N S}\right)$$

is less than zero, the travel time savings is reported as zero and an error message is displayed.

The final adjusted travel time savings is calculated as:

[7] Progression factor, PF, is calculated by the equation: PF = (1- [1.33g/C])/(1- g/C). Exhibit 31-46, Chapter 31: Signalized Intersections: Supplemental, Highway Capacity Manual, Transportation Research Board National Academy of Sciences, Washington DC, 2014.

[8] Equation 17-5, Chapter 17: Urban Street Segments, Highway Capacity Manual, Transportation Research Board National Academy of Sciences, Washington DC, 2010.

$$\frac{d_1 - d_2}{f_v} \quad (5)$$

Once a new travel speed is calculated, multiplying emissions rates by the vehicle miles traveled during peak-hours in both directions of travel yields peak-hour emission reductions. Following this same procedure for the new travel speed for conditions during off-peak hours results in off-peak hour emission reductions. The peak-hour and off-peak emission reductions are added to give total emission reductions for a weekday along the project corridor, reported in kilograms/day.

## Off-Peak Existing Average Speed Calculation Methodology

Assuming that the mid-segment (roadway between signals) travel speed is the free-flow speed along the corridor, the corridor travel time, $t_R$, in seconds, is expressed in the following equation from the Highway Capacity Manual, 2010[9]:

$$t_R = N_s \frac{6.0 - l_1}{(0.0025L)5280} f_x + \frac{3600L}{S_{PL}} f_v + N_s d_1 \quad (6)$$

where:

$l_1$ = start-up lost time = 2.0 for signalized intersections,

L = corridor length (miles),

$f_x$ = 1.00 for signalized through movement,

$S_{PL}$ = posted speed limit (miles per hour),

$f_v$ = traffic volume proximity factor, defined previously,

$N_s$ = number of signals along project corridor,

$d_1$ = calculated delay (seconds), defined previously.

The existing travel speed along the corridor, $S_1$, is then given by the equation:

$$S_1 = \frac{3600L}{t_R} \quad (7)$$

where:

L = corridor length (miles).

[9] Equation 17-6, 17-7, Chapter 17: Urban Street Segments, Highway Capacity Manual, Transportation Research Board National Academy of Sciences, Washington DC, 2010.

# EXAMPLE

## Urban Signal Synchronization

A municipality is considering synchronizing a two-mile corridor with three signalized intersections, which could improve traffic flow by smoothing the drive cycle and raising the average speed through the corridor.

Using this information, the user would enter the following inputs into the tool to analyze the scenario, as shown below:

**INPUT** User Guide

| | | |
|---|---|---|
| Evaluation Year | 2030 | |
| Area Type | Urban | |
| Corridor Length | 2 | miles |
| Number of Signalized Intersections | 3 | |
| Number of Lanes (one direction) | 2 | |
| Posted Speed Limit | 45 | miles per hour (1 - 75 MPH) |
| Average Cycle Length | 90 | seconds |
| Truck Percentage | 6% | |
| Annual Average Daily Traffic (AADT) (both directions) | 50,000 | veh/day |
| Peak-hour Volume (both directions) | 4,500 | veh/hr |
| Existing Corridor Travel Time | 3 | minutes |
| Total peak hours per day (AM+PM) | 4 | |

Project evaluation year: 2030
Area type: Urban
Corridor length: 2 miles
Number of signalized intersections: 3
Number of lanes: 2
Posted speed limit: 45
Average cycle length: 90 seconds
Truck percentage: 6%
AADT: 50,000
Peak hour volume: 4,500
Existing corridor travel time: 3 minutes
Total peak hours per day: 4 hours

Pressing the "Calculate Output" button produces the following results:

**PERFORMANCE**

| | PEAK-HOUR | OFF-PEAK | |
|---|---|---|---|
| Volume (both directions) | 4,500 | 1600 | veh/hr |
| Existing Average Speed | 40 | 35 | miles per hour |
| Travel Time Savings | 21 | 14 | minutes |
| Proposed Average Speed | 45 | 37 | miles per hour |

**EMISSION REDUCTIONS**

| Pollutant | Peak-hour Kilograms/day | Off-Peak Kilograms/day | Total Kilograms/day |
|---|---|---|---|
| Carbon Monoxide (CO) | 2.178 | 2.150 | 4.327 |
| Particulate Matter <2.5 µm ($PM_{2.5}$) | 0.056 | 0.057 | 0.113 |
| Particulate Matter <10 µm ($PM_{10}$) | 0.338 | 0.347 | 0.685 |
| Nitrogen Oxide (NOx) | 0.079 | 0.077 | 0.156 |
| Volatile Organic Compounds (VOC) | 0.041 | 0.041 | 0.082 |
| Carbon Dioxide Equivalent (CO2e) | 274.596 | 270.372 | 544.968 |
| Total Energy Consumption (MMBTU) | 3.588 | 3.533 | 7.121 |

The total daily emission reductions in kg/day and TEC reductions in millions of British Thermal Units (MMBTU) are:

Carbon Monoxide (CO): 4.327
Particulate Matter (PM2.5): 0.113
Particulate Matter (PM10): 0.685
Nitrogen Oxide (NOx): 0.156
Volatile Organic Compounds (VOC): 0.082

Carbon Dioxide Equivalent ($CO_2e$): 544.968
Total Energy Consumption (TEC): 7.121

Note that some signal synchronization projects may show a disbenefit for certain pollutants, indicating that the project increases emissions for this pollutant. There are known trade-offs between PM and NOx, including for speed.[10]

[10] Mark, Jason, and Candace Morey. "Diesel Passenger Vehicles and the Environment." Union of Concerned Scientists, April 1999. https://www.ucsusa.org/sites/default/files/legacy/assets/documents/clean_vehicles/diesel-toc.pdf.; Feibig, Michael, Andreas Wiartalla, Bastian Holderbaum, and Sebastian Kiesow. "Particulate Emissions from Diesel Engines: Correlation between Engine Technology and Emissions." Journal of Occupational Medicine and Toxicology 9, no. 6 (March 7, 2014). https://doi.org/10.1186/1745-6673-9-6.

CMAQ Emissions Calculator Toolkit

# Traffic Signal Synchronization

This calculator will estimate the emission reductions resulting from synchronizing the traffic signals along a previously unsynchronized corridor.

Navigator

Intersection Improvements

Traffic Signal Synchronization

Roundabouts

## INPUT

| | | |
|---|---|---|
| Evaluation Year | 2025 | |
| Area Type | Urban | |
| Corridor Length | 44.55 | miles |
| Number of Signalized Intersections | 216 | |
| Number of Lanes (one direction) | 3 | |
| Posted Speed Limit | 45 | miles per hour (1 - 75 MPH) |
| Average Cycle Length | 130 | seconds |
| Truck Percentage | 2% | |
| Annual Average Daily Traffic (AADT) (both directions) | 40,007 | veh/day |
| Peak-hour Volume (both directions) | 2,928 | veh/hr |
| Existing Corridor Travel Time | 178 | minutes |
| Total peak hours per day (AM+PM) | 6 | |

## OUTPUT

### PERFORMANCE

| | PEAK-HOUR | OFF-PEAK | |
|---|---|---|---|
| Volume (both directions) | 2,928 | 1246.544444 | veh/hr |
| Existing Average Speed | 15 | 21 | miles per hour |
| Travel Time Savings | 1,533 | 1291 | minutes |
| Proposed Average Speed | 18 | 26 | miles per hour |

### EMISSION REDUCTIONS

| Pollutant | Peak-hour Kilograms/day | Off-Peak Kilograms/day | Total Kilograms/day |
|---|---|---|---|
| Carbon Monoxide (CO) | 73.689 | 297.067 | 370.756 |
| Particulate Matter <2.5 µm ($PM_{2.5}$) | 1.661 | 2.552 | 4.213 |
| Particulate Matter <10 µm ($PM_{10}$) | 8.538 | 11.346 | 19.884 |
| Nitrogen Oxide (NOx) | 10.120 | 13.796 | 23.915 |
| Volatile Organic Compounds (VOC) | 2.385 | 3.464 | 5.849 |
| Carbon Dioxide Equivalent (CO2e) | 32,324.619 | 39,941.039 | 72,265.657 |
| Total Energy Consumption (MMBTU) | 425.311 | 525.676 | 950.987 |

**General Competition Project Information**



**Project Purpose**

- Describe why the project sponsor is proposing to deliver the project.
- Describe how the project is going to be consistent with the NEPA Purpose and Need statement.

Metro Nashville and Davidson County serves as a major employment & population center for Middle Tennessee. With the explosion of development over the past two decades and anticipated development growth in the future, the City's transportation needs have grown immensely. Metro's arterials are often congested during peak & off-peak hours and special events. To effectively manage transportation assets across Davidson County, the City must improve its ability to use remote monitoring and control to maximize limited resources and enhance response times. When Metro is compared to peer cities, it falls well short of where it needs to be. It is clear that if the City is to achieve the desired active operation and management of its multimodal transportation infrastructure, the implementation of a dedicated TMC with appropriate staffing positions, reliable communication infrastructure, and signal system upgrades are essential. Metro's 2020 assessment of current operations & staffing provides clear recommendations related to this and this project supports those recommendations. As such, the TMC will be the cornerstone of a technology-based solution for coordinating and improving multi-modal activities and generating significant air quality benefits.

Background

NDOT's existing ITS/signal system activities are currently housed in the signal shop on the NDOT campus at 730 South Fifth Street. This system runs on a single desktop PC communicating with many of the 865 signalized intersections in Davidson County. It is used for monitoring the status of the signal controllers and acts as a resource for trouble shooting signal equipment malfunctions and investigating citizen complaints. Other than storing the predeveloped timing plans and maintaining system clocks, the system has limited capability due to insufficient staff and lack of physical space. Thus, the existing facilities cannot accommodate the level of activities needed to manage other currently programmed ITS projects and planned functions of Metro's ITS program.

The condition of much of NDOT's existing signal infrastructure is in a state of disrepair. The signal system is connected to the field controllers using a combination of outdated twisted pair copper interconnect, cell modems, DSLs, and some fiber optic trunk lines. Due to its age, much of the twisted pair copper network has degraded and become increasingly unreliable. Vehicle detection in Nashville is generally relegated to local detection for turning movements on the mainline and for side street movements. It primarily consists of unreliable inductive loops and a limited number of non-intrusive detection installations that include video and radar detection. The City does not utilize any arterial system detection on the surface streets other than a handful of Bluetooth data collection devices installed with TDOT's recent I-440 widening project. Finally, NDOT has no functioning closed-circuit television (CCTV) cameras capable of monitoring traffic operations along the corridors it manages.

In response, the City has begun the process of upgrading the transportation infrastructure on five (5) high-volume congested corridors in Nashville through programmed design and construction activities. The TMC project anticipated to be funded through this grant is critical to coordinating these projects so that effective management functions and air quality goals can be achieved.

The existing corridor project list includes:

- Murfreesboro Pike/SR1/US41/US70S Bus Rapid Transit project (COMPLETE). Project installed transit priority infrastructure, including fiber optic communications, non-intrusive signal detection, and upgraded signal components along 11.5 miles of roadway (57 signalized intersections).

**General Competition Project Information**

- Gallatin Pike/SR6/US31E Local ITS Project (UNDER DESIGN 100% local funds). Project includes the design and implementation of fiber optic communications, non-intrusive signal detection, CCTV, Bluetooth system detection, and upgraded signal components along 12.6 miles of roadway (55 signalized intersections).

- Nolensville Pike/SR11/US41A/US31A Local ITS Project (UNDER DESIGN 100% local funds). Project includes the design and implementation of fiber optic communications, non-intrusive signal detection, CCTV, Bluetooth system detection, and upgraded signal components along 12.4 miles of roadway (46 signalized intersections).

- West End Ave./Broadway/SR1/US70S CMAQ Project (PIN 130753.00). Project includes the design and implementation of fiber optic communications, non-intrusive signal detection, and upgraded signal components along 3.25 miles from I-440 to 1 st Ave. (29 signalized intersections).

- Charlotte Ave./SR24/US70 ATCMTD Project (PIN 131476.00). Project includes the design and implementation of fiber optic communications, non-intrusive signal detection, Bluetooth system detection, and upgraded signal components along 4.8 miles of roadway (29 signalized intersections).

**Innovation Regional Diversity and Complementary Projects**

- Describe the innovative nature and characteristics of the project. In what way is the project innovative? Does it fill gaps in regional efforts to improve air quality and reduce congestion? In what ways will it interact with existing programs to increase their mutual effectiveness? Will the project address emerging air quality/ transportation issues that have become more important in recent years

- Describe whether and how this project initiates new and complementary efforts in a region, adds a new program capability or enhances an existing one that a region wants to establish or maintain as part of their regional suite of programs.

- Describe how the project will relate to existing programs and capabilities in the MPO/TPO region, and how the proposed project will expand, extend or enhance regional efforts. Opportunities for achieving greater results through project coordination should be identified and described.

Traffic management centers and systems are specifically identified as HIGH PRIORITY projects in the Nashville Area Regional ITS Architecture (prepared by the Nashville Area MPO and TDOT in 2010): Regional ITS Deployment Plan. Implementing this proposed TMC project meets the following ITS Architecture goals of accommodating: network surveillance (ATMS01), surface street control (ATMS03), regional traffic management (ATMS07), traffic incident management systems (ATMS08), roadway service patrols (EM04), and transit signal priority (APTS09).

As such, this project directly compliments various on-going innovative TDOT managed ITS projects that are either in design or under construction in the Nashville area. These include TDOT's I-24 SMART Corridor Project, the integration of Bluetooth travel time data collection devices, and TDOT's Advanced Traffic System Performance Monitoring (ATSPM) software implementation.

TDOT is currently working on the I-24 SMART Corridor Project, which takes a comprehensive approach to managing the existing infrastructure and improving travel time reliability between Rutherford and Davidson Counties. NDOT staff has been actively involved in the development of this project because I-24 is an integral part of the

**General Competition Project Information**

Nashville-Davidson County transportation network and a major route for commuters and freight. A primary component of the project is to integrate freeway and arterial roadway management systems, along with physical, technological, and operational improvements, to provide drivers accurate, real-time information. It will allow TMC operators for both TDOT & NDOT to actively manage traffic during typical day-to-day operations as well as during responses to major incidents that occur along this stretch of the I-24 corridor. Approximately 11.5 miles of the 28.5 mile project along Murfreesboro Pike/SR1 fall within the operational boundaries of Metro Nashville & Davidson County. If awarded, this CMAQ project will implement NDOT's TMC and allow direct communication between it and TDOT's Region 3 TMC. Without the TMC and proposed operations staff, Metro's ability to coordinate enhanced responses to incidents in this corridor will be significantly limited.

The proposed TMC project will allow NDOT staff to utilize enhanced communication and Bluetooth detection devices being installed along several of the region's most heavily traveled arterials including the I-24/Murfreesboro Pike corridor. These devices will allow TMC staff to utilize real time and historical speed/travel time tracking data to provide both immediate and planned adjustments to traffic signal operations along these corridors. They will also provide immediate feedback on the effects of signal retiming and allow staff to make further real time changes to signal timing plans. By basing signal plans off congestion, speeds & travel times below a certain level can trigger a message to city staff and assist in developing additional more comprehensive responsive timing plans. The Bluetooth data collection devices will allow the TMC to account not only for peak hour volumes but also crashes, special events, and weather when managing traffic.

As part of the I-24 SMART Corridor project, TDOT is purchasing for Metro Nashville the Advanced Traffic System Performance Monitoring (ATSPM) module for the City's Centracs signal system. ATSPM is a cloud-based high-resolution traffic data collection and analytics software system designed to provide Metro Nashville with new capabilities to proactively optimize traffic signal timings. ATSPM includes a background plan generator that automatically adjusts timing signal plans according to traffic conditions. It works hand-in-hand with the Bluetooth data collection systems being installed on select corridors. NDOT does not currently have physical workstations or dedicated staff to effectively utilize this innovative software. This CMAQ project will create the workspace and provide the staff to apply this traffic management tool to reduce congestion, improve travel times, and thus improve the safety for all modes of transportation along the affected corridors. This will result in shorter commute times, less fuel consumption, and improved air quality for the Nashville community.

**Regional Priorities**

- Describe how the project benefits the region where it is located.
- As applicable, document any local or regional plans that include the proposed project - such as local or community plans, comprehensive plans, corridor studies, major thoroughfare plans, MPO plans, TDOT Long Range Plan, TDOT Bicycle and Pedestrian Plan, etc.
- As applicable, document any existing local or regional support for the proposed project.
- If relevant, describe how the project will expand and enhance multimodal infrastructure in the region. Such projects could include regional transit projects, projects that expand or improve bicycle and pedestrian infrastructure that reduces vehicle miles traveled, projects designed to increase the use of transportation alternatives, and projects to reduce emissions and fuel use associated with hauling, transferring and distributing freight.

The proposed traffic management center aligns with the regional priorities of the Greater Nashville region involving congestion /travel demand management, traffic signalization upgrades and innovative technologies.

Specifically, traffic management center meets the following regional policy priorities as identified in the 2045 Regional Transportation Plan (RTP), adopted in February 2021:

1) Updating traffic signalization: The TMC would help advance the regional priority of upgrading outdated traffic signal devices and investing resources in ongoing staff and equipment to properly maintain traffic control devices

2) Making operational improvements: The TMC would help maximize the performance of the existing transportation system by enabling real-time changes in the operation of the Nashville region's transportation system.

3) Removing capacity bottlenecks: Real-time operations management would help eliminate capacity constraints throughout the transportation system to reduce daily delay for travelers in personal or transit vehicles.

4) Implement managed lanes: The TMC would be critical in the region's pursuit of easing congestion in Nashville's downtown interstate loop.

5) Implement incident management technology: The TMC would be a point to detect crashes, disabled vehicles or other incidents that impede travel and resolve those obstructions.

6) Share traveler information and alerts: A TMC would help disseminate real-time information on where, when and why congestion is occurring to smart phone applications, in-dash displays or electronic message boards.
In order to implement ITS projects in the Nashville region, the Nashville Area MPO/GNRC created a Regional Transit and Technology Program in the 2045 RTP.

**Project Delivery and Management Plan**

**It is essential that funded projects be able to demonstrate substantial progress on all phases of project implementation, including the TIP process, environmental clearance, funds obligation and timely expenditure of CMAQ funds.**

- Provide a detailed, realistic expected timeline for completion of the proposed project.
    - Identify and describe project milestones.
    - Describe the major tasks and activities that must be done for the project to be completed successfully. Include all phases the proposed project will require, such as environmental clearance, design, right-of-way, etc.
    - Provide the federal fiscal year in which each phase will begin. If a phase of the project has already been started or completed, provide the year in which the phase was started. For non-construction projects, describe the work to be completed in each federal fiscal year.

Describe in detail the steps you will take to make sure that milestones are achieved and the project is delivered on time. Include enough detail in your proposal to explain how the project will be managed and tracked so that it can be implemented quickly and efficiently while avoiding major complications or delays.

**General Competition Project Information**

Project proposals that do not contain project milestones, descriptions of major tasks and project management plans are unlikely to be funded.

It is anticipated that this project will be completed within forty-nine (49) months and work is expected to be started in Federal FY2022. The project will not require the purchase of right-of-way (ROW), nor will it require utility relocations or conflict resolutions, thereby reducing the time needed to achieve a construction notice to proceed (NTP). Metro Nashville is funding all NEPA & Systems Engineering Analysis (SEA) work tasks along with the design phase (preliminary design, final design, and construction documents design phase) separately using 100% local funds. Below are the milestones for this project with the scheduled month of completion:

NEPA and SEA Documentation Phase – underway now (will be complete by the time CMAQ funds are awarded – Month 0

Design Phase – underway now (will be complete by the time CMAQ funds are awarded – Month 0
Bid Phase Services (3-4 Months) - Month 4

TMC Construction/Implementation Phase Services (6 Months) - Month 10

TMC System Integration/Testing/Close-out (2-3 Months) - Month 13

TMC Management/Operation Services (36 Months) - Month 49

This project will consist of five (5) primary tasks: (a) Project Management (b) Bid Phase, (c) Construction Phase, (d) Testing & Burn-In Phase and (e) Management/Operation Phase.

Project Management:

Project management activities will consist of general project management, administrative, and accounting tasks for the project. Additional coordination will consist of project status / review meetings throughout the duration of the project, preparing and distributing project correspondence, scheduling meetings and other activities, monthly progress reports, and discussion of any project obstacles that may arise.

Bid Phase:

The Bid Phase will include coordination with the TDOT Local Programs Development Office Region 3 Planner to ensure that all of the necessary items required for a construction notice to proceed are completed (e.g. design approval, bid book approval, estimate approval, DBE goal setting / approval, ROW certification, utility certification, environmental certification). Metro Nashville and their TDOT prequalified ITS Consultant will perform bid phase services in accordance with TDOT Local Government Guideline Standards including bid advertisement, pre-bid meeting, responding to requests for information ( RFI's), bid addendum (if necessary), bid opening, bid review, bid approval, and bid award (in accordance with TDOT Policy No. 355-02, Awards of Construction Contracts). A three (3) – four (4) month schedule is allotted for the Bid Phase.

Construction:

The Construction Phase will be performed in accordance with Appendix C: Roadway and Bridge Field Construction Procedures, in the TDOT Local Government Guideline for the Management of Federal and State Funded Transportation Projects. However, this phase is less construction-oriented and more closely defined as installation/integration

efforts. All of the work will be focused on the installation and integration of technology equipment within an existing Metro building (no outside infrastructure construction will be needed with this project). Sub-tasks to be carried out during the Construction Phase consist of:

• Pre-Construction Conference
• Construction Engineering and Inspection (CEI) Services (with focus on installation / integration oversight and inspection)
• Periodic Construction Progress Meetings
• Overseeing Supplemental Agreements / Construction Change Orders
• Show Drawing / Submittal Review
• Quality Assurance, Testing for Acceptance, and Training Oversight
• Overseeing, processing, and coordinating all required construction (installation / integration) documentation
• Final Records and Project Close-out

Phases of the project along with a brief description of tasks to be performed and expected federal Fiscal Year are below .

CONSTRUCTION PHASE (2023-2024)

• Obtain Contractor and CEI
• Construction

INTEGRATION/TESTING/ACCEPTANCE (2024)

OPERATION PHASE (2024-2027)

• Year 1 - TMC Management/Operation Services
• Year 2 - TMC Management/Operation Services
• Year 3 - TMC Management/Operation Services

- Identify potential obstacles so that a more reliable assessment can be made of the project viability before federal funds are committed. Projects with major implementation challenges (e.g., vaguely defined scopes, right-of-way issues, lack of committed funding match) are less likely to be funded.

NDOT does not anticipate any major potential obstacles for this project as this is clearly identified and prioritized as an immediate need in the Metro Nashville Transportation Plan. Additionally, the project will utilize an existing control room and office space that is currently located in the Metro Howard Office Building . The modifications are expected to be minor and will involve updating outdated devices, workstation consoles, and conference room/ office space.

- Where applicable, highlight the project readiness or the ability to implement the project, or specific tasks, quickly. Projects that appear as if they can be more easily implemented, and that appear more likely to be completed on schedule will receive higher scores.

- Include a description of the project applicant's recent experience in successfully implementing CMAQ projects . This description should include the project or projects that were implemented and sufficient detail to demonstrate whether the

project was successfully completed on time and within budget. These details should include the project schedule and any delays associated with the project, as well as how the project budget was managed and whether the project was completed without cost overruns.

Metro Nashville recently modified and rebranded the Public Works Department into NDOT. This was done in part to streamline the delivery of projects of this nature. NDOT has dedicated specific staff members to administer this project in accordance with the Local Government Guidelines for the Management of Federal and State Funded Projects via coordination with the TDOT Local Programs Development Office. NDOT staff has successfully managed and completed a variety of federally funded, locally-managed, transportation projects, most relevant being the Murfreesboro Rd TIGER project which installed signal upgrades and fiber for 41 intersection along with adjusting signal timings for bus queue jumps in conjunction with the local transit agency, WeGo.

Currently, the City is managing 11 TDOT related projects including Jefferson St Improvements (PIN 103409.00), Lebanon Pike Sidewalks (PIN 121729.00), and SR6/Gallatin Pk BRT (PIN 123838.00) all of which include traffic signal components.

From a project management standpoint, the City has demonstrated its ability to complete a project on time and within budget.

## Tasks/Activities

**CMAQ related Tasks/Activities**

Preliminary Engineering - NEPA
Preliminary Engineering - Design

**NON-CMAQ related Tasks/Activities**

**Goals and Objectives Timeline**

1.Provide specific, measurable, and achievable actions that outline the "who, what, when, where, and how" of the project.
2.Describe the broad long-term vison of this project.
3.Provide the project objectives that would define strategies or implementation steps to attain the identified goals.
4.Also indicate any potential obstacles, as well as the readiness to implement this project.

1.NDOT has contracted with KHA to complete the environmental documentation, the Systems Engineering Analysis, and the Final design & specifications for the TMC using 100% local funds. The targeted completion dates for designing & completing the TMC are:

a. Environmental Documentation – October 1, 2021 (KHA)
b. Systems Engineering Analysis – January 1, 2022 (KHA)
c. Final Design – May 1, 2022 (KHA & NDOT)
d. TDOT Design Approval and NTP – February 1, 2023 (TDOT)
d. Contractor to Begin Implementation of TMC – August 1, 2023 (NDOT)

For the operation component of this request, upon completion of the TMC, staff will begin the active management of the signalized corridors being monitored by the TMC. There are two targeted measurable goals for this project. The first of these relates to targeted travel time reductions and the second relates to the overall benefit to cost ratio of managing the system. The target goals are:

- 5% travel time reduction along the 5 corridors identified earlier
- annual benefit/cost ratio of 2

2. The overarching vision of the TMC project is to build the foundation for Metro Nashville's smart mobility initiative thus improving the efficiency of our system which result in improved air quality. The TMC will serve as the active technology-based nerve center for the future of automated and responsive multi-modal transportation systems. While it is not expected to house all of the technical supporting staff and functions of a smart mobility community, it will act as the central core for connecting NDOT's Traffic Management Operations to TDOT and other local jurisdictions to ensure that a real-time and coordinated system is in place to improve the overall efficiency and safety of our transportation network.

3. The primary objective of this project is to get the facility and related technology in place and organize the staff necessary to achieve the vision described above. The goals and strategies that will achieve this objective include the design, installation, implementation, and integration of core infrastructure and software applications necessary to manage mobility in the Nashville area. This will include the construction of our fiber communication network along the most critical corridors. It will also include the implementation of advanced system detection and monitoring devices along with upgrades to signalized intersections. As described earlier, these activities are already underway and are being accomplished through federally projects and through Metro funded projects. These collective activities will provide the resources needed to effectively manage our network.

4. NDOT does not anticipate any major potential obstacles for implementing this project. It will utilize an existing Metro facility for the implementation of the TMC itself and builds upon a mix of both Federally, State, and locally funded ITS projects that have either already been constructed or are under design.

**Tasks/Activities**

Please attach Goals and Objective Timeline

**Non-Construction Budget**

Failure to submit a complete Project Budget will result in application not being considered for funding.

1. Indicate the federal CMAQ portion of the cost of the phase for which CMAQ funds are being requested.
2. Indicate the local match being provided for this phase. Indicate $0 if the project is eligible for 100% federal funding and no local match is proposed.
3. Include total costs for each phase required for this project. This includes phases that have been started or completed. Not every phase listed may be applicable to your project.
4. Include other funding sources (separately) and amounts that will contribute to this project. For continuing CMAQ projects, show previous CMAQ funds obligated for this project. Add rows if needed.

5. Provide the sources, status and amounts of the local match, i.e., has the local match been identified in an agency budget, capital program, municipal resolution or similar document.

6. Costs incurred before CMAQ funds are approved are not eligible for reimbursement.

*Complete budget worksheet for each project proposed for CMAQ funding. See instructions.
*Show amounts and sources of all match funding committed to this project.

**Applicant/Project Sponsor:** Nashville
**Name of Project:** Metro Nashville Traffic Management Center
**Type of Project:** Intelligent Transportation Systems

## Non-Construction Budget

| Non-Construction Projects | Year One | TIP Year: 2021 | | |
|---|---|---|---|---|
| | CMAQ Funds Requested | Local Match Funds | Other Non-Federal Match Funds | Total Costs |
| Preliminary Engineering - NEPA | | | | $0 |
| Preliminary Engineering - Design | | | | $0 |
| Implementation (show Major Tasks/Activities below and funding requested by activity) | | | | |
| | | | | |
| Salaries, Benefits, and Taxes | $820,000.00 | | | $820,000.00 |
| Professional Fee, Grant and Awards | | | | $0 |
| Supplies, Printing, etc., (direct costs of the grant) | $87,000.00 | | | $87,000.00 |
| Travel, conferences, meetings | $3,000.00 | | | $3,000.00 |
| Other (non-personnel) | | | | $0 |
| Capital Purchase (e.g., equipment) | $900,000.00 | | | $900,000.00 |
| List Non-CMAQ Activities involved and funding source: | | | | |
| | | | | |
| **Total Project Costs** | $1,810,000.00 | $0 | $0 | $1,810,000.00 |

## Non-Construction Budget

| Non-Construction Projects | Year Two | TIP Year: 2022 | | |
|---|---|---|---|---|
| | CMAQ Funds Requested | Local Match Funds | Other Non-Federal Match Funds | Total Costs |
| Preliminary Engineering - NEPA | | | | $0 |
| Preliminary Engineering - Design | | | | $0 |
| Implementation (show Major Tasks/Activities below and funding requested by activity) | | | | |
| | | | | |
| Salaries, Benefits, and Taxes | $835,000.00 | | | $835,000.00 |
| Professional Fee, Grant and Awards | | | | $0 |
| Supplies, Printing, etc., (direct costs of the grant) | $77,000.00 | | | $77,000.00 |
| Travel, conferences, meetings | $3,000.00 | | | $3,000.00 |
| Other (non-personnel) | | | | $0 |
| Capital Purchase (e.g., equipment) | | | | $0 |
| List Non-CMAQ Activities involved and funding source: | | | | |
| | | | | |
| **Total Project Costs** | $915,000.00 | $0 | $0 | $915,000.00 |

## Non-Construction Budget

| Non-Construction Projects | Year Three | TIP Year: 2023 | | |
|---|---|---|---|---|
| | CMAQ Funds Requested | Local Match Funds | Other Non-Federal Match Funds | Total Costs |
| Preliminary Engineering - NEPA | | | | $0 |
| Preliminary Engineering - Design | | | | $0 |
| Implementation (show Major Tasks/Activities below and funding requested by activity) | | | | |
| | | | | |
| Salaries, Benefits, and Taxes | $850,000.00 | | | $850,000.00 |
| Professional Fee, Grant and Awards | | | | $0 |
| Supplies, Printing, etc., (direct costs of the grant) | $77,000.00 | | | $77,000.00 |
| Travel, conferences, meetings | $3,000.00 | | | $3,000.00 |
| Other (non-personnel) | | | | $0 |
| Capital Purchase (e.g., equipment) | | | | $0 |
| List Non-CMAQ Activities involved and funding source: | | | | |
| | | | | |
| **Total Project Costs** | $930,000.00 | $0 | $0 | $930,000.00 |

| | |
|---|---|
| **Total Proposed Project Cost** | $3,655,000.00 |
| **Total CMAQ Funds Requested** | $3,655,000.00 |
| **Total Proposed Local Match Funds** | $0 |

21-004-037

**Budget Summary**

| | Year 1 | Year 2 | Year 3 |
|---|---|---|---|
| **Annual Federal CMAQ Funds Requested** | $1,810,000.00 | $915,000.00 | $930,000.00 |
| **Annual Local Match** | $0 | $0 | $0 |
| **Annual Other Non-Federal Match** | $0 | $0 | $0 |
| **Annual Total Budget** | $1,810,000.00 | $915,000.00 | $930,000.00 |

Please attach commitment of matching funds

Have other Federal funds been requested or awarded for this project? Yes ✔ No

Please explain the source and amount of ALL funds used in this project.

Design for the project is currently underway using local funds. As a Traffic Flow Improvements/Intelligent Transportation Systems, NDOT anticipates 100% federal funding for implementation and staffing.

# APPLICATION FOR CONGESTION MITIGATION AND AIR QUALITY (CMAQ) PROGRAM GRANT

## METROPOLITAN GOVERNMENT OF NASHVILLE AND DAVIDSON COUNTY

Faye DiMassimo /scw
Interim Director
Department of Nashville Department
of Transportation & Multimodal
Infrastructure

07/07/2021
Date