# TRI-CITIES AREA MPO PERFORMANCE-BASED PLANNING PROCESS

CRATER PLANNING DISTRICT COMMISSION
CPDC

Prepared for Crater Planning District Commission

AUGUST 2022

# TRI-CITIES AREA MPO PERFORMANCE BASED PLANNING PROCESS


## ACKNOWLEDGMENTS

Ron Svejkovsky, Director of Transportation, Tri Cities Area MPO
Jay Ruffa, Director of Planning & GIS, Crater PDC
Alec Brebner, Former Executive Director, Crater PDC


## ABOUT GAP-TA

The Growth and Accessibility Planning Technical Assistance (GAP-TA) program supports Virginia localities in planning and developing multimodal transportation opportunities. The program has four components, and each component has differences in eligible applicants, eligible activities, expected outcomes, and application evaluation criteria. Component 1 involves conducting multi-modal planning within existing or planned Urban Development Areas or Growth Areas. Component 2 involves developing or evaluating strategies to address emerging planning issues. Component 3 involves developing an accessibility planning process, Finally, Component 4 involves conducting multi-modal planning outside urbanized areas. Visit vtrans.org/about/gap-ta for more information about the GAP-TA program.

## CONTACT INFORMATION


Ron Svejkovsky, Tri-Cities Area MPO Director
804-861-1666 ext. 250
rsvejkovsky@craterpdc.org
1964 Wakefield St.
Petersburg, VA 23805

# CONTENTS

## FIGURES

# TABLES



# APPENDICES

# 1-INTRODUCTION

In 2021, the Tri-Cities Area Metropolitan Planning Organization (TCAMPO) was awarded a grant through the Virginia Office of Intermodal Planning and Investment's (OIPI) Growth and Accessibility Planning (GAP) Technical Assistance program. In its application, the MPO identified that while they already fulfill certain federal performance regulations regarding setting and adopting targets, they expressed a desire for technical assistance in the development of a quality, ongoing, performance-based planning and programming system.

The purpose of this study is the development of a performance-based planning and programming process that can be managed and maintained over time within the constraints of TCAMPO's limited staffing resources. The methodology presented in this document is intended to be transparent, repeatable, and customizable by TCAMPO staff should the need arise.

Through coordination with TCAMPO staff and the TCAMPO Technical Advisory Committee, measures were developed that focus on five factor areas: Safety, Mobility and Congestion, Accessibility and Equity, Environmental, and Economic Development. These five factor areas align with TCAMPO's Plan2045 Vision, Goals, and Objectives while providing sufficient nuance in supportive measures to evaluate a project's competitiveness for a variety of funding opportunities including SMART SCALE, Congestion Mitigation and Air Quality (CMAQ), and the Regional Surface Transportation Program (RSTP).

Included measures support the prioritization of all surface transportation projects. This report is separated into three sections. Chapter 2 provides measures and methodologies for the evaluation and prioritization of highway and roadway projects. These measures are applicable to all manner of roadway projects including segment improvements and intersection improvements. Chapter 3 component of the report provides measures and methodologies for the evaluation and prioritization of active transportation, transportation demand management (TDM), and transit projects. Finally, Chapter 4 presents methodologies for normalizing scores across measures, assessing the benefit/cost of projects, and developing a single project score that can be used to rank projects across project types. These methodologies were tested on a sample set of projects and effectively provided scores across a variety of project types including roadway widening, turn lane construction, roundabout construction, bicycle improvement, pedestrian improvement, park and ride lot, and transit improvement.2 - Highway and Roadway Projects

## 2.1 Safety

Safety is weighted at 25% of the total project score. Safety will be evaluated based on two performance measures weighted as shown in Table 1.

### S1. Crash Frequency

**Table 1: Safety Performance Measure Weights**

| Performance Measure (PM) | PM Weight |
|---|---|
| S.1. Crash Frequency | 50% |
| S.2. Crash Rate | 50% |
| Total | 100% |

**Description**
This measure calculates the reduction, due to project implementation, in Equivalent Property Damage Only (EPDO) of fatal and injury crashes ($EPDO_{F+I}$).

**Explanation of Measure**
This measure looks at the reduction in fatal and injury (F+I) crashes over a five-year period attributable to the proposed improvement, weighted by severity. The measure focuses on the reduction in fatalities and injuries experienced by potential users of highway and roadway projects. The expected change in crashes is calculated using crash modification factors related to the project type (CMF).

EPDO is a scale used to standardize crashes based on severity. Virginia has adopted a statewide weighting for use in the SMART SCALE program. The details of this methodology can be found on page 56 of the Round 5 SMART SCALE Technical Guide. For example, a crash resulting in a fatality or severe injury is weighted at 160 times that of a crash with only property damage. The full crash severity weighting values are listed in Table 2 below.

**Outcome Measured:**

**Table 2: Crash Severity Weights**

| Crash Severity | Rounded Value | Weighting |
|---|---|---|
| Fatal/Severe Injury (K,A) | $2,200,000 | 160 |
| Non-Incapacitating Injury (B) | $260,000 | 20 |
| Non-Visible/Possible Injury (C) | $140,000 | 10 |
| Property Damage Only (O) | - | 1 |

The number of EPDO-weighted fatal and injury crashes ($EPDO_{F+I}$) expected to be reduced due to project implementation.

**Data Requirements (GIS layers and documentation):**

- Project Limits
- Motor Vehicle Crashes:
  Most recent five years of VDOT crash data. Retrieve through ArcGIS by selecting add data from ArcGIS Online, searching 'VDOT Crash' and adding the 'Full Crash' dataset. Then select crashes in and around the project area and export and save the data.
- Six-Year Improvement Program (SYIP):
  Retrieve from http://syip.virginiadot.org/Pages/allProjects.aspx
- Simplified Planning Level Crash Modification Factors (CMF):
  drawn from Virginia Smart Scale Planning Level Crash Modification Factors. Retrieve from https://smartscale.org/documents/cmf-list-smart-scale-rd4_fy2022.pdf

**Methodology:**

1. Add the Project Limits layer to an ArcGIS Desktop project
2. Create a 250 ft Buffer around the project limits layer
3. Add VDOT 'Full Crash' layer from ArcGIS Online (Add Data from ArcGIS Online and search VDOT Crashes and add 'Full Crash')
4. Use the Select by Location tool to select Crashes that intersect the 250 ft buffer
5. Export and Save the selected crash data by right clicking the Full Crash layer in the table of contents and exporting the data (Data > Export)
6. Add the exported crash layer to your project and open the attribute table. Sort by the Crash Date column and delete rows that are not within the 5-year range of your analysis
7. Review the SYIP to determine if any improvements have been made within the project limits that may have impacted safety. If so, shorten the analysis period to the post-improvement period only by deleting those rows.
8. Select the 250 ft buffer for the project you wish to analyze first.
9. Use the Select by Location tool to select crashes that intersect the 250 ft buffer for your selected project. Visually check that none of the selected crashes are within intersections not directly involved in the improvement, parking lots, parallel roadways such as a frontage road, etc., removing any that clearly fall outside of the intended analysis area.
10. Weight the severity of each crash by EPDO using the table above and the Crash Severity column in the crash data. Calculate the average annual EPDO by summing the total weighted score of all crashes in the project area and divide by the number of years included in the analysis.
11. Find the appropriate CMF for the project improvements. Using the identified CMF, calculate the Percent Expected Crash Reduction (PECR) as follows:

    $$PECR = 1 - CMF$$

    Most improvements have been standardized for statewide usage.
12. Multiply the PECR by the annual average EPDO of fatal and injury crashes calculated in Step 10 to determine the expected reduction.

## S2. Crash Rate

**Description:**
Reduction in Equivalent Property Damage Only of Fatal and Injury Crashes ($EPDO_{F+I}$) per Hundred Million Vehicle Miles Traveled (HMVMT) on a roadway segment or per Million Vehicles Entering (MVE) an intersection.

**Explanation of Measure**
This measure builds on the data and expected crash reductions in measure S.1. Whereas measure S.1. is focused on the overall number of fatal and injury crashes, this measure is focused on the annual rate of fatal and injury crashes per hundred million vehicle miles (segments) or million entering vehicles (intersections). This measure allows for better comparison between projects on routes with different traffic volumes.

**Outcome Measured:**
The change in the annual rate of fatal and injury crashes weighted by severity ($EPDO_{F+I}$) per HMVMT (segments) or MVE (intersections).

**Data Requirements (GIS layers and documentation):**

- Project Limits

- Motor Vehicle Crashes:
  Most recent five years of VDOT crash data. Retrieve through ArcGIS by selecting add data from ArcGIS Online, searching 'VDOT Crash' and adding the 'Full Crash' dataset. Then select crashes in and around the project area and export and save the data.

- Annual Average Daily Traffic (AADT):
  Most recent year of VDOT Traffic Volume data. Retrieve through ArcGIS by selecting add data from ARCGIS Online, searching 'VDOT ADT' and selecting the most recent year of traffic volume data. Then select segments in and around the project area and export and save the data.

**Methodology:**

1. Add the project limits as defined in S.1 (project limits with a 250 ft buffer) to an ArcGIS desktop project

2. Add the AADT layer to the ArcGIS Desktop project from ArcGIS Online (Add Data from ArcGIS Online and search VDOT AADT and add the most recent year)

3. Zoom to the project you are analyzing.

4. Calculate the length of the segments that intersect the 250' buffer around the study area. Ignore any segments picked up by the buffer that are on roads not included in the study (e.g., a parallel frontage road, etc.). Segment lengths can be found manually using the measure tool in ArcGIS. If you downloaded or exported the layer, Segment length can be generated by a adding a field and doing a field calculate using the calculate geometry function.

5. Find the AADT for segments that intersect the study area by clicking the segments with the identify tool and locating the value in the AADT field.

6. For segments, calculate the annual traffic volume for the base year in Hundred Million Vehicle Miles Traveled (HMVMT):

$$HMVMT \ = Length \ \times AADT \ \ \times \ 365\frac{days}{year}/1{,}000{,}000$$

   For projects that cross multiple segments, the annual traffic volume is calculated as the weighted average volume for all segments. For intersections, the measure is per Million Vehicles Entering (MVE):

$$MVE \ = \sum \frac{1}{2} AADT_{approach} \ \times \ 365\frac{days}{year}/1{,}000{,}000$$

   where AADT _approach is the AADT of each intersection approach.

7. Calculate annual EPDO of fatal + injury crashes avoided (measure S.1.).

8. Convert that into the reduced crash rate using the appropriate formula:

$$S2 = {}^{EPDO_{K+I}}/_{HMVMT}$$ for segments

or

$$S2 = {}^{EPDO_{K+I}}/_{MVE}$$ for intersections

## 2.2 Mobility and Congestion

Mobility and Congestion is weighted at 20% of the total project score. Mobility and Congestion will be evaluated based on two performance measures weighted as shown in Table 3.

### Table 3: Mobility and Congestion Performance Measure Weights

| Performance Measure (PM) | PM Weight |
|---|---|
| MC1. Demand | 50% |
| MC2. Congestion | 50% |
| Total | 100% |

### MC1. Demand

**Description:**
This measure calculates the demand for the project based on traffic volumes in and around the project area.

**Explanation of Measure**
This measure uses Annual Average Daily Traffic to identify the potential volume of users who are likely to benefit from the project.

**Outcome Measured:**
Weighted average Annual Average Daily Traffic (AADT) of all roads within one quarter mile of the project.

**Data Requirements (GIS layers):**

- Project Limits
- Annual Average Daily Traffic (AADT):
  Most recent year of VDOT Traffic Volume data. Retrieve through ArcGIS by selecting add data from ArcGIS Online, searching 'VDOT ADT' and selecting the most recent year of traffic volume data. Then, select segments in and around the project area and export and save the data.

**Methodology:**

1. Use the buffer tool to create a 0.25-mile buffer (1,320 ft) around the project location/project segment.
2. Select segments in the AADT data that intersect the project location buffer using the 'Select by Location' tool in ArcGIS.
3. Calculate the mileage for all selected AADT segments in the attribute table (if not already calculated) by adding a new field named 'Mileage', right-clicking the field header and using the 'Calculate Geometry' tool.
4. Add a field named "VMT" to the attribute table in which to calculate Vehicle Miles Traveled for each selected segment. Multiply the AADT field by the Mileage Field using the field calculator to calculate Vehicle Miles Traveled.
5. Calculate the weighted-average AADT for the project by dividing the total VMT of all segments by the total length of all segments:

$$\overline{AADT} = \frac{\sum VMT_n}{\sum Length_n}$$

## MC2. Congestion

**Description**
This measure estimates the level of traffic congestion in and around the project area.

**Explanation of Measure**
The Travel Time Index (TTI) is the ratio of the travel time during the peak period to the time required to make the same trip at free-flow speeds. A value of 1.3, for example, indicates a 20-minute free-flow trip requires 26 minutes during the peak period. TTI data, provided by INRIX via the Regional Integrated Transportation Information System (RITIS), can be used to determine the severity of congestion along the project area.

**Outcome Measured**
Congestion measured as a Travel Time Index based on the roads that are within a quarter of a mile of the project (weighted by road segment length).

**Data Requirements (GIS layers):**

- Project Limits
- INRIX XD data, 2019 (Extracted from RITIS ): Retrieve this data using the steps in the methodology below.

**Methodology:**

1. Download INRIX data using the following steps:
    a. Log in at www.ritis.org.
    b. Select the "Data Archive" tab at top of screen.
    c. Select the "Probe Data Analytics" option at top of screen.
    d. Select the "Trend Map" tool.
    e. Enter the following options for Trend Map tool:
        i. "XD" for Segments selection.
        ii. Using the Map function, select the area you wish to analyze.
        iii. Select the dates to include. Typically include the most recent calendar year.
        iv. Select the option to "Create a single time period for this range" then select to only include weekdays (M-F).
        v. Select the "Add Time Period" green box.
        vi. Select data sources as "INRIX" only.
        vii. Select "1 hour" for granularity.
        viii. Click "submit."
    f. Let the report run, which may take about 10-15 minutes.
    g. From the map screen produced from the report run, select "Travel Time Index" in the dropdown box in the upper left corner.
    h. Select the disk icon in the upper right corner of screen and select "Save as" and "XML file (for use in EXCEL)."
    i. Save the file to disk. This file contains a row for every XD segment in the selected area with a travel time index for every hour of day.
2. Create a 0.25-mile buffer (1,320 ft) around the project location/project segment.
3. Obtain the latest INRIX XD "ShapeFile" from VDOT. The XD Shapefile version should correspond to the year of data extracted. Select INRIX XD segments that intersect the project location buffer using the 'Select by Location' tool in ArcGIS.
4. Calculate the mileage for all selected INRIX XD segments in the attribute table (if not already calculated) by adding a 'Mileage' field, right clicking the field header and using the 'Calculate Geometry' tool.
5. Identify the TTI for each selected segment using the TTI data found in the INRIX XD attribute table. Follow the process described below in ESRI ArcMap or another GIS platform to join the shapefile and the Excel file.
    a. Open the XD shapefile obtained from VDOT.
    b. Import the Excel file of travel time index values by XD segment.
    c. Link the two files based on XD segment value.
    d. Find maximum hourly travel time index across all hours for each segment.
6. Score the projects according to the approach in Table 4. The table will have you calculate total mileage in each congestion level which is based on the TTI Thresholds. A corresponding Congestion Value is determined based on the level of congestion according to the TTI value. Segments with No Congestion receive a Congestion Value of 0, Low Congestion receive a value of 1, Medium Congestion receive a value of 2, and High Congestion receive a value of 3. The percent of the project for each level of congestion is then multiplied by the Congestion Value to provide a score for each level of congestion. All of those scores are then added together to determine the congestion score for the project.

**Table 4: Congestion Approach**

| Thresholds | Level/ Description | Enter total XD Segment Miles for each congestion level in the Project Area | Calculate XD Segment Mile Distribution Percentage | Congestion Value on 0-3 scale. User can re-define these if desired (higher the score the more the congestion) | Congestion Value % x Scoring Value |
|---|---|---|---|---|---|
| Max TTI < 1.30 | No Congestion | 1.3 mi | (1.3mi / 2.8 mi) = 46% | **0** | ( 46% x 0) = 0 |
| 1.30 <= Max TTI < 1.5 | Low Congestion | 1.0 mi | (1.0mi / 2.8 mi) = 36% | **1** | ( 36% x 1) = 0.36 |
| 1.5 <= Max TTI < 1.8 | Med Congestion | 0.4 mi | (0.4mi / 2.8 mi) = 14% | **2** | ( 14% x 2) = 0.28 |
| 1.8 <= Max TTI | High Congestion | 0.1 mi | (0.1mi / 2.8 mi) = 04% | **3** | ( 04% x 3) = 0.12 |
| Total | | 2.8 mi Will equal total miles of segments in project area | Always sums to 100% | Total Project Congestion Value | Sum of above 0.76 |

*Threshold values can be modified based on distribution in area. In most cases the value of 1.20-1.30 is indicative for congestion. Values for Med/High may be adjusted but should not vary by project.*

## 2.3 Equity and Accessibility

Equity and Accessibility is weighted at 20% of the total project score. Equity and Accessibility will be evaluated based on four performance measures weighted as shown in Table 5. Fifty percent of the project score for this goal measure is only applicable to Environmental Justice Areas (EJ Areas) to make the project scoring process equitable.

**Table 5: Equity and Accessibility Performance Measure Weights**

| Performance Measure (PM) | PM Weight |
|---|---|
| EA1. Access to Jobs | 25% |
| EA2. Access to Jobs (EJ Areas) | 25% |
| EA3. Access to Non-Work Destinations | 25% |
| EA4.Access to EJ Non-Work Destinations (EJ Areas) | 25% |
| Total | 100% |

## EA1. Access to Jobs

**Description:**
Access to jobs within a specified distance of the project (based on Functional Classification) for all populations.

Note: The following four Accessibility performance measures calculate access to jobs or destinations within a specified distance of project improvements. This distance is an estimate of what can be traveled in 10 minutes on various road types as determined by their Functional Classification.

**Explanation of Measure**
A project's potential for improving access to employment centers can be related to the project's proximity to those employment centers. A project with close proximity to employment centers is likely to serve a higher number of users who will benefit from the project. This measure evaluates access to employment in both the plan year and the horizon year. Note that declining employment estimates in the horizon year may produce negative scores.

**Outcome Measured:**
Access to employment opportunities for all populations within a distance of project implementation.

**Data Requirements (GIS layers):**
- Project Limits
- 2017 Base year and 2045 Horizon Year total employment (RRTPO and TCAMPO Socioeconomic TAZ data)
- VDOT Road Centerline with Functional Classification
  View here
  https://www.virginiaroads.org/maps/VDOT::functional-classification-web-map/explore?location=37.510502%2C-77.555950%2C11.78
  or retrieve through ArcGIS by selecting add data from ArcGIS Online, searching 'VDOT Functional Class' and adding the Functional Classification layer. Then select segments in and around the project area and export and save the data.

**Methodology:**
1. Select TAZs that have their center within the appropriate distance of the project based on the highest functional classification of the roads in the project using Table 6. Selection can be made by:
   - Using the buffer tool to create a buffer of the appropriate distance around the project based on Table 6.
   - Selecting TAZs that have their center in each modal buffer via the 'Select By Location' tool in ArcGIS.

### Table 6: Buffer Distance

| Functional Class | Buffer Size |
|---|---|
| Principal Arterial | 10 |
| Minor Arterial | 7.5 |
| Major Collector | 5 |

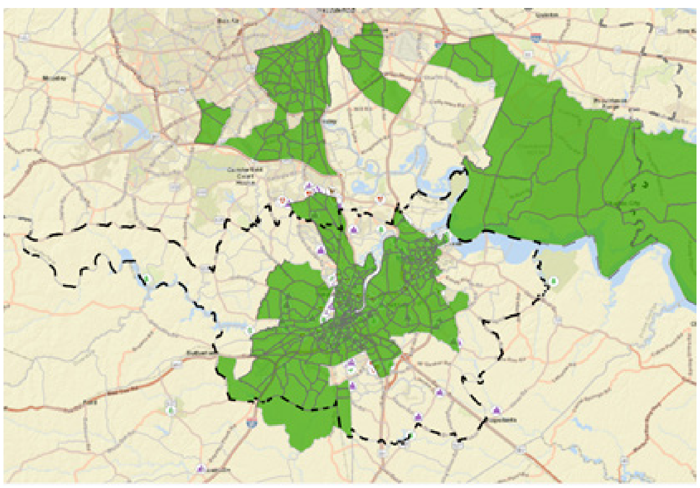
2. Calculate the sum of total employment in selected TAZs using the 'Statistics' option from the right click menu of the 'TotEmp' (Total Employment Field) of the TAZ attribute table for both 2017 and 2045.

## EA2. Access to Jobs (EJ Area)

**Description:**
Access to jobs within a specified distance of the project (based on Functional Classification) for Environmental Justice (EJ) populations.

**Explanation of Measure:**
This measure is similar to the previous Measure (EA1) except that Access to Jobs is calculated only for Environmental Justice Areas within the TCAMPO Metropolitan Planning Area (MPA) boundary (and southern RRTPO MPA) and for the respective EJ Populations residing within the EJ Areas. EJ populations include minority, low income, and limited English proficiency populations. EJ Areas in the Tri-Cities region are identified in Figure 1.

### Figure 1: Environmental Justice Areas in the Tri-Cities Region



**Outcome Measured:**
Access to employment opportunities for EJ Populations within a distance of project implementation for all populations.

**Data Requirements (GIS layers):**

- Project Limits
- 2017 Base year and 2045 Horizon Year total employment (RRTPO and TCAMPO Socioeconomic TAZ data) with EJ areas defined
- VDOT Road Centerline with Functional Classification
  View here
  https://www.virginiaroads.org/maps/VDOT::functional-classification-web-map/explore?location=37.510502%2C-77.555950%2C11.78
  or retrieve through ArcGIS by selecting add data from ArcGIS Online, searching 'VDOT Functional Class' and adding the Functional Classification layer. Then select segments in and around the project area and export and save the data.

**Methodology:**

1. Use a definition query to limit the TAZ data (both 2017 and 2045) to only include TAZs that fall within the EJ areas.
2. Select TAZs that have their center within the appropriate distance of the project based on the highest functional classification of the roads in the project using the Table 6. Selection can be made by selecting TAZs that have their center in the modal buffers (Created in EA1, Step 1) via the 'Select By Location' tool in ArcGIS.
3. Calculate the sum of total employment in selected EJ TAZs using the 'Statistics' option from the right click menu of the 'TotEmp' (Total Employment Field) of the TAZ attribute table for both 2017 and 2045.

## EA3. Access to Non-Work Destinations

**Description:**
Access to non-work destinations within a distance of the project (based on Functional Classification) for all populations.

**Explanation of Measure:**
This measure is similar to EA1 but instead of jobs it measures the access to destinations as a result of planned project improvements. For this analysis - grocery stores, pharmacies, schools, colleges, health care facilities, parks, libraries, and government centers are considered as non-work destinations.

**Outcome Measured:**
Access to non-work destinations within a distance of project implementation for all populations.

**Data Requirements (GIS layers):**

- Project Limits
- 2017 Base year and 2045 Horizon Year total employment (RRTPO and TCAMPO Socioeconomic TAZ data)
- VDOT Road Centerline with Functional Classification
  View here
  https://www.virginiaroads.org/maps/VDOT::functional-classification-web-map/explore?location=37.510502%2C-77.555950%2C11.78
  or retrieve through ArcGIS by selecting add data from ArcGIS Online, searching 'VDOT Functional Class' and adding the Functional Classification layer. Then select segments in and around the project area and export and save the data.
- Non-Work Destinations
  (defined above) layer(s) created by Tri Cities staff

**Methodology:**

1. Select all non-work destinations within the appropriate distance of the project based on the highest functional classification of the roads in the project using Table 6. Selection can be made by selecting Non-Work Destinations that intersect the modal buffers (Created in EA1, Step 1) via the 'Select By Location' tool in ArcGIS.
2. Note the number of destinations selected.
3. Select TAZs that have their center within the appropriate distance of the project based on the highest functional classification of the roads in the project using Table 6. Selection can be made by selecting TAZs that have their center in the modal buffers (Created in EA1, Step 1) via the 'Select By Location' tool in ArcGIS.
4. Calculate the sum of total employment and the sum of total population in selected TAZs using the 'Statistics' option from the right click menu of the header of the 'TotEmp' and 'TotPop' fields of the TAZ attribute table for both 2017 and 2045.
5. Add a 'SqMi' field to the TAZ layer (formatted as 'double' to accommodate decimals). Right click the column header and select 'calculate geometry' and calculate the square mileage into that field.
6. Calculate population density with access to Non-Work Destinations by multiplying the total number of reachable destinations (from step 1) by the total population plus total employment and divide that number by the area.

$$\left(\sum Dest_{Non\text{-}work,n} \times \sum Pop_n + Emp_n\right) / \sum Area_n$$

where

$Dest_{Non\text{-}work,n}$ = the weighted non-work destinations accessible to the $n$ TAZ
$Pop_n$ = the population of the $n$ TAZ
$Emp_n$ = the employment of the $n$ TAZ
$Area_n$ = the area (mi2) of the $n$ TAZ

### EA4. Access to Non-Work Destinations (EJ Areas)

**Description:**
Access to non-work destinations within a distance of the project (based on Functional Classification) for Environmental Justice (EJ) populations.

**Explanation of Measure:**
This measure is similar to (EA3) except that Access to Non-Work Destinations is calculated for only the EJ populations instead of the entire population. EJ Areas for the Tri-Cities region are identified in Figure 1.

**Outcome Measured:**

Access to non-work destinations within a distance of project implementation for EJ populations.

**Data Requirements (GIS layers):**

- Project Limits
- 2017 Base year and 2045 Horizon Year total employment (RRTPO and TCAMPO Socioeconmic TAZ data) with EJ areas defined
- VDOT Road Centerline with Functional Classification
  View here
  https://www.virginiaroads.org/maps/VDOT::functional-classification-web-map/explore?location=37.510502%2C-77.555950%2C11.78
  or retrieve through ArcGIS by selecting add data from ArcGIS Online, searching 'VDOT Functional Class' and adding the Functional Classification layer. Then select segments in and around the project area and export and save the data.
- Non-Work Destinations
  (defined above) layer(s) created by Tri Cities staff

**Methodology:**

1. Select all non-work destinations within the appropriate distance of the project based on the highest functional classification of the roads in the project using Table 6. Selection can be made by selecting Non-Work Destinations that intersect the modal buffers (Created in EA1, Step 1) via the 'Select By Location' tool in ArcGIS.
2. Note the number of destinations selected.
3. Use a definition query to limit the TAZ data (both 2017 and 2045) to only include TAZs that fall within the EJ areas
4. Select TAZs that have their center within the appropriate distance of the project based on the highest functional classification of the roads in the project using Table 6. Selection can be made by selecting TAZs that have their center in the modal buffers (Created in EA1, Step 1) via the 'Select By Location' tool in ArcGIS.
5. Calculate the sum of total EJ employment and the sum of total population of selected EJ TAZs using the 'Statistics' option from the right-click menu of the header of the 'TotEmp' and 'TotPop' fields of the TAZ attribute table for both 2017 and 2045.
6. Add a 'SqMi' field to the TAZ layer (formatted as 'double' to accommodate decimals). Right click the column header and select 'calculate area' and calculate the square mileage into that field.
7. Calculate the population density with access to Non-Work Destinations by multiplying the total number of reachable destinations (from step 1) by the total population plus total employment and divide that number by square miles.

$$\left(\sum Dest_{Non\text{-}work,n} \times \sum EJPop_n + EJEmp_n\right) / \sum Area_n$$

where
$Dest_{Non\text{-}work,n}$ = the weighted non-work destinations accessible to the $n$ EJ TAZ
$EJPop_n$ = the population of the $n$ EJ TAZ
$EJEmp_n$ = the employment of the $n$ EJ TAZ
$Area_n$ = the area (mi2) of the $n$ EJ TAZ

## 2.4 Environment

Environment is weighted at 10% of the total project score. Environment will be evaluated based on one performance measure weighted as shown in Table 7.

### Table 7: Environment Performance Measure Weights

| Performance Measure (PM) | PM Weight |
|---|---|
| E1. Sensitive Features | 100% |
| Total | 100% |

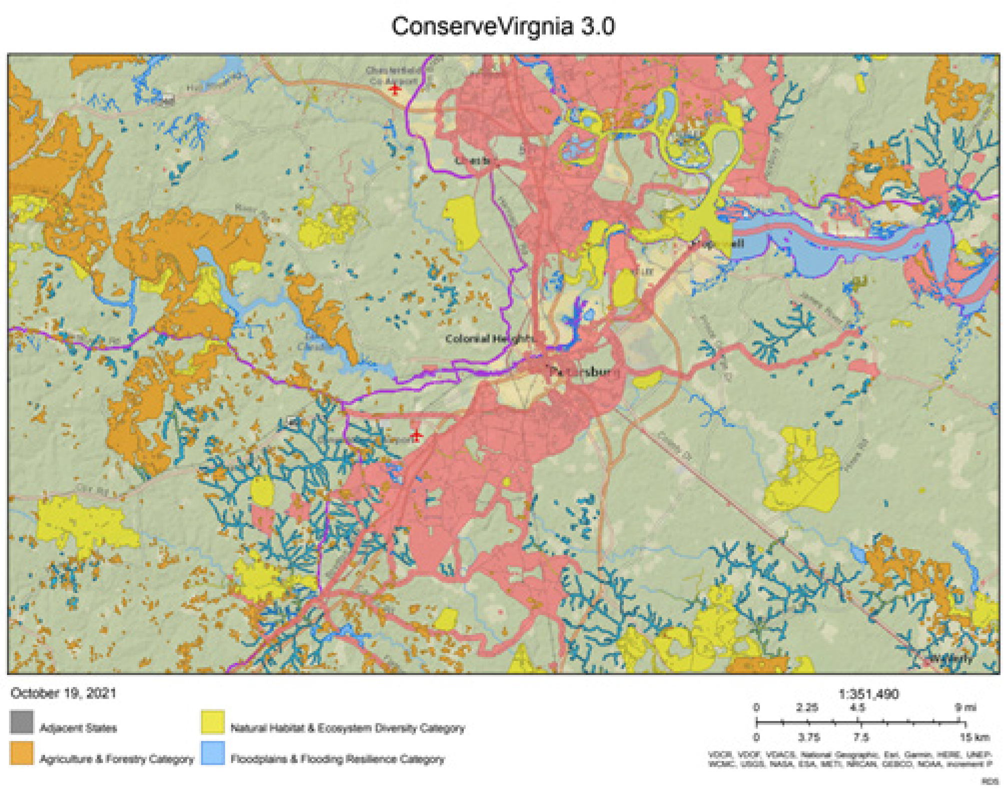
## E1. Sensitive Features

**Description:**
Ratio of scaled number of acres of Wetland, Resiliency Water Hazard Zone, and Conserved Lands within ¼ mile of the project limits to total acreage within ¼ mile of the project limits.

**Explanation of Measure:**
Infrastructure projects have impacts on watersheds, wetlands, and habitats among many other aspects of the natural environment. Additionally, building in environmentally sensitive areas such as floodplains or storm surge areas can result in reduced functionality during storms. Beyond the natural areas, lands are sometimes set aside for public use or conserved from development due to natural, agricultural, or historic value - a value that can be impaired by adjacent development. This measure seeks to weigh the potential for negative impacts of a project on the environment and conserved lands. Figure 2 shows the environmentally sensitive and conservation lands in the Tri-Cities Area from the Virginia Department of Conservation and Recreation (DCR).

**Outcome Measured:**
Ratio of environmentally sensitive and conservation lands within ¼ mile of the project limits to total acreage within ¼ mile of the project limits. This measure is an inverse measure meaning that a project with no impacts will receive the highest score.

### Figure 2: Environmentally Sensitive and Conservation Lands in the Tri-Cities Area



**Data Requirements (GIS layers):**

- Project Limits

- Conservation Lands
  A Department of Conservation and Recreation. Retrieve from https://www.dcr.virginia.gov/natural-heritage/cldownload

- Wetlands
  VA Fish and Wildlife Service. Retrieve from https://fwsprimary.wim.usgs.gov/wetlands/apps/wetlands-mapper/

- Flood Hazards:
  Federal Emergency Management Agency. Retrieve from https://msc.fema.gov/portal/advanceSearch

- Flooding Risk Assessment
  VTrans (Vulnerability – SLR Intermediate, Intermediate-High, and Extreme; an indication of seal level rise risk). Retrieve from https://vtrans.org/interactvtrans/map-explorer

**Methodology:**

1. Limit the FEMA Flood Hazard layer to the 100 year flood plain by setting a Definition Query so that only the 'AE' Zone is selected.

2. Create Intermediate Flooding Risk polygon layers by using the buffer tool to create a 200 ft buffer around the VTrans Flooding Risk Assessment layers at intermediate vulnerability and above.

3. Use the dissolve tool to dissolve all environmentally sensitive and conservation areas into one feature (Flood Hazard Zone AE, DCR Conservation Lands, Wetlands, and Flood Risk level at the Intermediate level and above).

4. Use the buffer tool to create a ¼-mile buffer around the project limits.

5. Run the 'intersect' tool on the buffered project limits and the dissolved environmental and conservation area features to determine the areas of overlap between the two layers.

6. Calculate the total areas of the ¼ mi buffered layer around the project and the intersect layer with environmentally sensitive and conservation areas by adding a field (Double format to allow for decimal places) named "SqMi" to the attribute tables of both layers. Then use the 'Calculate Area' dialogue from the right-click menu of the column header to calculate square mileage for all features of both layers.

7. Reduce the overlap area (intersect layer) based on the project tier adjustment factor shown in Table 8 below and the formula:

$$Impact\ Area = Overlap\ Area\ (mi^2) \times Adjustment\ Factor$$

### Table 8: Sensitive Features Adjustment Factor

| Project Tier | Adjustment Factor |
|---|---|
| Tier I (CE) | 10% |
| Tier 2 (EA) | 30% |
| Tier 3 (EIS) | 50% |

*Note: The Project Tier is determined by the type of environmental document required, a Categorical Exclusion (CE), Environmental Assessment (EA), or Environmental Impact Statement (EIS).*

8. Calculate the impact percentage by dividing the impact area by the total area of the buffer.

## 2.5 Economic Development

Economic Development is weighted at 25% of the total project score. Economic Development will be evaluated based on the performance measures weighted as shown in Table 9.

### Table 9: Economic Development Performance Measure Weights

| Performance Measure (PM) | PM Weight |
|---|---|
| ED1. Job Growth (2017-2045) | 60% |
| ED2. Freight Jobs | 20% |
| ED3. Activity Centers | 20% |
| Total | 100% |

## ED1. Job Growth

**Description:**
This measures the relation between job growth and proposed improvements and evaluates the change in jobs by TAZ from 2017 to 2045 in the project vicinity.

**Explanation of Measure:**
This measure is focused on the relation between job growth and proposed improvements. This measure looks at the change in jobs by TAZ from 2017 to 2045 within a specified distance of the project based off of Functional Classification.

**Outcome Measured:**
Total number of expected new jobs served by the project.

**Data Requirements (GIS layers):**

- Project Limits
- 2017 Base year and 2045 Horizon Year total employment (RRTPO and TCAMPO Socioeconomic TAZ data) with EJ areas defined
- VDOT Road Centerline with Functional Classification
  View here
  https://www.virginiaroads.org/maps/VDOT::functional-classification-web-map/explore?location=37.510502%2C-77.555950%2C11.78
  or retrieve through ArcGIS by selecting add data from ArcGIS Online, searching 'VDOT Functional Class' and adding the Functional Classification layer. Then select segments in and around the project area and export and save the data.

**Methodology:**

1. Use the buffer tool to create a buffer of the appropriate distance around the project based on the highest functional classification of the roads in the project using Table 10.
2. Select TAZs that have their center in each modal buffer via the 'Select By Location' tool in ArcGIS.

### Table 10: Economic Development Buffer Size

| Functional Class | Buffer Size (mi) |
|---|---|
| Principal Arterial | 10 |
| Minor Arterial | 7.5 |
| Major Collector | 5 |

3. Sum the 2017 jobs and sum the 2045 jobs for the selected TAZs. This is done by right clicking the 2017 and 2045 jobs columns in the attribute table and clicking Statistics while the appropriate TAZs (from steps 1 and 2) are selected.
4. Calculate the total job growth for the project area by subtracting the total 2017 jobs from the total 2045 jobs.

## ED2. Access to Freight Jobs

**Description:**
Proximity to freight jobs.

**Explanation of Measure:**
This measure calculates the number of freight jobs within the vicinity of the transportation project. This measure is an indicator of a project's potential to improve the movement of goods.

**Outcome Measured:**
Improvement's proximity to industrial and economic development areas.

**Data Requirements (GIS layers):**

- Project Limits
- MPO Boundary Layer
- Tri Cities Employment Blocks:
  (Census block layer including freight employment), Retrieve via methodology below.
- VDOT Road Centerline with Functional Classification
  View here
  https://www.virginiaroads.org/maps/VDOT::functional-classification-web-map/explore?location=37.510502%2C-77.555950%2C11.78
  or retrieve through ArcGIS by selecting add data from ArcGIS Online, searching 'VDOT Functional Class' and adding the Functional Classification layer. Then select segments in and around the project area and export and save the data.

**Methodology:**

1. Use the buffer tool to create a buffer of the appropriate distance around the project based on the highest functional classification of the roads in the project using Table 10.
2. Retrieve Census Blocks with freight employment by visiting the Census OnTheMap page at https://onthemap.ces.census.gov/
3. Load a KML file of the MPO boundary by clicking the start tab and select Import from KML (KML file can be created by adding an MPO Boundary layer to your GIS project and using the conversion tools to convert layer to KML). Choose the KML of the MPO boundary and click 'Import'.
4. Once the KML is uploaded, click on 'Zoom to imported shapes' and then 'Select all Polygons', and finally 'Continue with Selected Features'. Confirm selection to continue.
5. Select 'Perform Analysis on Selection Area'. Select Analysis Settings and select 'All Jobs', then select 'Go' to run the report. Download the results shapefile.
6. Add the shapefile to your GIS project. The shapefile will be center points of census blocks.
7. Add a field named "FreightEmp" to the block points shapefile. Right click the field and select 'Field Calculator'. To generate freight employment, sum the following fields: cns01 (Agriculture, Forestry, Fishing, and Hunting), cns02 (Mining, Quarrying, and Oil and Gas Extraction), cns05 (Manufacturing), cns06 (Wholesale Trade), and cns08 (Transportation and Warehousing).
8. Select the census block points that intersect each modal buffer via the 'Select By Location' tool in ArcGIS.
9. Calculate the sum of freight employment of the selected blocks using the 'Statistics' option from the right-click menu of the 'FreightEmp' (Freight Employment) field of the block points attribute table.

## ED3. Proximity to Activity Centers

**Description:**
Increase in the Activity Center units adjacent to the project from 2017 to 2045.

**Explanation of Measure:**
This measure calculates the number of VTrans Activity Centers for the Tri-Cities MPO area and Walthall within a specified distance of the project (based on Functional Classification). Figure 3 shows the VTrans Activity Center in the Tri-Cities Area.

**Outcome Measured:**
Number of Activity Center served by the project.

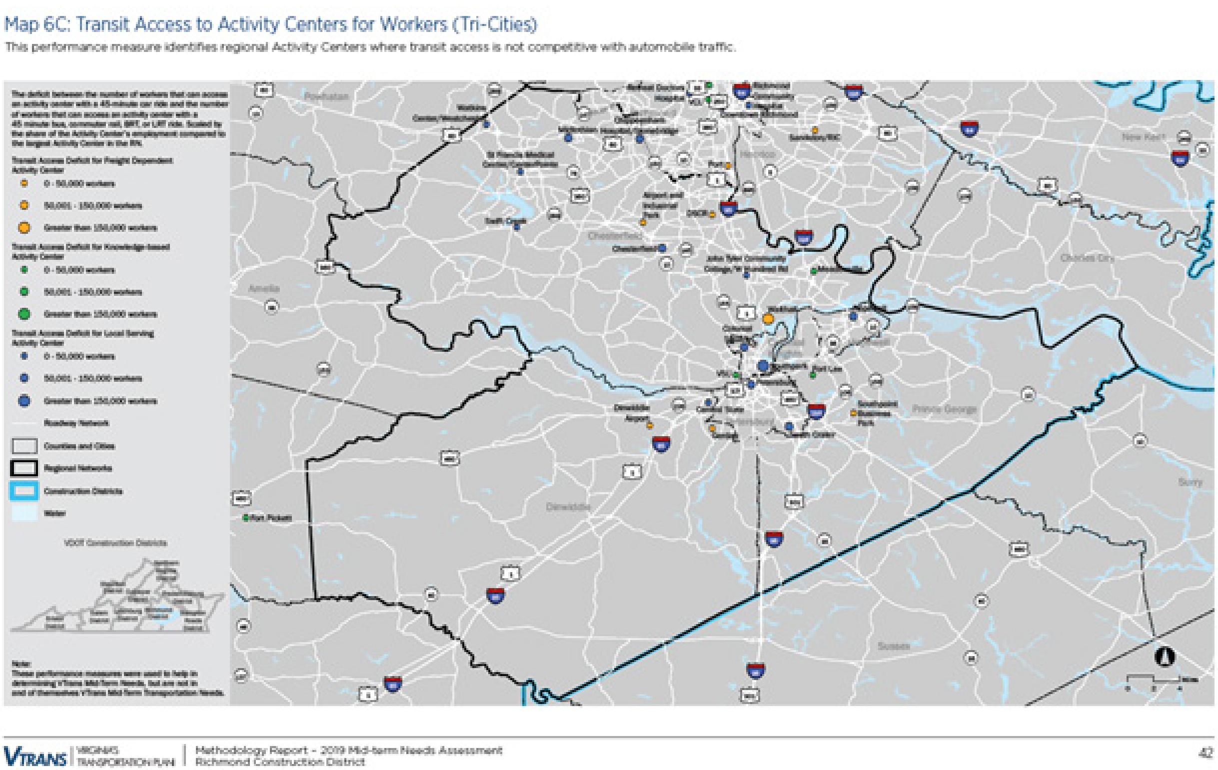
**Data Requirements (GIS layers):**

- Project Limits
- VTrans Activity Centers (plus Walthall)
  Retrieve from:
  https://www.vtrans.org/interactvtrans/map-explorer
- VDOT Road Centerline with Functional Classification
  View here
  https://www.virginiaroads.org/maps/VDOT::functional-classification-web-map/explore?location=37.510502%2C-77.555950%2C11.78
  or retrieve through ArcGIS by selecting add data from ArcGIS Online, searching 'VDOT Functional Class' and adding the Functional Classification layer. Then select segments in and around the project area and export and save the data.

**Methodology:**

1. Use the buffer tool to create a buffer of the appropriate distance around the project based on the highest functional classification of the roads in the project using Table 10.
2. Select activity centers that intersect each modal buffer via the 'Select By Location' tool in ArcGIS.
3. Open the attribute table for the Activity Centers layer and note the number of selected records.

### Figure 3: VTrans Activity Centers in the Tri-Cities Area



# 3-ACTIVE TRANSPORTATION, TDM, AND TRANSIT PROJECTS

## 3.1 Safety

Safety is weighted at 25% of the total project score. Safety will be evaluated based on two performance measures weighted as shown in Table 11.

**Table 11: Safety Performance Measure Weights**

| Performance Measure (PM) | PM Weight |
|---|---|
| S.1. Crash Frequency | 50% |
| S.2. Crash Rate | 50% |
| Total | 100% |

### S.1. Crash Frequency

**Description:**
Reduction in fatal and injury crashes weighted by crash severity due to project implementation.

**Explanation of Measure:**
This measure looks at the reduction in fatal and injury crashes over a five-year period attributable to the proposed improvement, weighted by severity. The measure focuses on the reduction in fatalities and injuries experienced by potential users of the active transportation, travel demand management (TDM), and transit projects. The expected change in crashes is calculated using crash modification factors related to the project type (CMF).

Weights for crash severity are related to Equivalent Property Damage Only (EPDO) values for crash severity. EPDO is a method used to standardize crashes based on severity. Virginia has adopted a statewide weighting for use in the Smart Scale program. For example, a crash resulting in a fatality or severe injury is weighted as heavily as 16 times that of a crash with only property damage. Raw weights listed in Table 12 that are from Smart Scale's safety scoring methodology[1] were converted to final weights by dividing by the sum of the raw weights (190). This conversion ensures that values used to weight crash types sum to 100%. These final weights were applied to crashes of each type to calculate a score for this measure.

**Table 12: Crash Severity Weights**

| Crash Severity | Rounded Value | Raw Weight | Final Weight |
|---|---|---|---|
| Fatality/Severe Injury (K and A) | $2,200,000 | 160 | 84.21% |
| Moderate Injury (B) | $260,000 | 20 | 10.53% |
| Mild Injury (C) | **$140,000** | **10** | 5.26% |

1 Office of Intermodal Planning and Investment (2022). SMART SCALE Technical Guide. Table 6.2: EPDO Crash Value Conversion. Retrieved from https://www.smartscale.org/documents/2022/SMART-SCALE-Technical-Guide-02022022.pdf

**Outcome Measured:**
The change in the annual expected number of fatal and injury crashes over five years is weighted by severity, where weights are derived from dollar amounts associated with crash severity for calculating EPDO values.

**Data Requirements/Analytical Tools (Active Transportation Projects):**

- Population (block group level)
  U.S. Census Bureau (2020). American Community Survey (ACS) 5-year estimates. Table B01003 (Total Population).

- Commute mode share (block group level)
  U.S. Census Bureau (2020). American Community Survey (ACS) 5-year estimates. Table B08134 (Means of Transportation to Work by Travel Time to Work).

- Block group shapefile
  U.S. Census Bureau (2020). Cartographic Boundary Files. Retrieved from https://www.census.gov/geographies/mapping-files/time-series/geo/carto-boundary-file.html

- National commute mode share
  Bureau of Transportation Statistics (2015). Retrieved from https://www.bts.gov/content/commute-mode-share-2015

- Average commute time for pedestrians and bicyclists (national)
  U.S. Census Bureau (2021). Travel Time to Work in the United States: 2019. Figure 4: Average Travel Time to Work by Means of Transportation: 2019. American Community Survey Reports. Retrieved from https://www.census.gov/content/dam/Census/library/publications/2021/acs/acs-47.pdf

- Average commute speed for pedestrians and bicyclists
  Office of Intermodal Planning and Investment (2021). Technical Guide for the Identification and Prioritization of the VTrans Mid-Term Needs. Page 25. Retrieved from https://vtrans.org/resources/VTrans_Mid-term_Technical_Guide.pdf

- Share of total bike/ped mileage in U.S. and share of work trip bike/ped mileage in Virginia
  Federal Highway Administration (2017). National Household Travel Survey. Retrieved from https://nhts.ornl.gov/

- Number of fatalities by bicyclists and pedestrians in one year
  National Highway Traffic Safety Administration (2019). National Statistics. Retrieved from
  https://www-fars.nhtsa.dot.gov/Main/index.aspx

- Crash modification factor (CMF) associated with installing shared-use path for avoiding automobile-vehicle collisions
  Federal Highway Administration. Crash Modification Factor Clearinghouse. Retrieved from
  http://www.cmfclearinghouse.org/detail.cfm?facid=9250#commentanchor

- Reduction in the chance of a location being an automobile-pedestrian crash site due to the presence of a sidewalk
  McMahon, P. J. (2002). An analysis of factors contributing to "walking along roadway" crashes research study and guidelines for sidewalks and walkways (Vol. 1). DIANE Publishing. Retrieved from Google Books.

- Ratio of pedestrian injuries to fatalities and bicyclist injuries to fatalities in Virginia
  Drive Smart Virginia. 2021 Annual Report. Retrieved from
  https://www.drivesmartva.org/about-dsv/annual-report/

- Ratio of A, B, and C pedestrian injuries and bicyclist injuries in Virginia to the total number of pedestrian injuries and bicyclist injuries in Virginia*
  Virginia Department of Transportation (2022). "Full Crash" layer. Updated April 28, 2022. Accessed May 25, 2022. Retrieved from
  https://oipi-stp.maps.arcgis.com/home/item.html?id=101101cecac34f28b38c0846e847bd0b

  - *K-Fatal Injury, A-Suspected Serious Injury, B-Suspected Minor Injury, C-Possible Injury, and O-No Apparent Injury (Source: Model Minimum Uniform Crash Criteria, 5th Edition. Retrieved from https://www.nhtsa.gov/mmucc-1).

**Data Requirements/Analytical Tools (TDM Projects and Transit Projects):**

- Linear Referencing System (LRS)
  VDOT LRS (version 21.1). Retrieved from
  https://vdot.maps.arcgis.com/apps/MapAndAppGallery/index.html?appid=7ad6fb5c1f9148ff986db843e7f7b67c#!

- Point crash locations
  Virginia Department of Transportation (2022). "Full Crash" layer. Updated April 28, 2022. Accessed May 25, 2022. Retrieved from
  https://oipi-stp.maps.arcgis.com/home/item.html?id=101101cecac34f28b38c0846e847bd0b

- Annual average daily traffic (AADT) at the segment level
  Virginia Department of Transportation (2019). Pathways to Planning.

- Vehicle occupancy
  2017 National Household Travel Survey (NHTS). Retrieved from
  https://nhts.ornl.gov/

**Methodology (Active Transportation Projects):**

1. Estimate number of potential project users.
   a. Establish a shed in which potential bike and pedestrian users of the project may be located by creating a half-mile buffer around each project.
   b. Calculate number of pedestrian and cyclist commuters within the buffer based on U.S. Census data, specifically Table B08134 (Means of Transportation to Work by Travel Time to Work) of the American Community Survey (ACS).
   c. ACS includes bicyclist mode share along with taxi and motorcycle. National mode share by the Bureau of Transportation Statistics (https://www.bts.gov/content/commute-mode-share-2015) shows bicyclist commute mode share to be approximately 1/3 of the total of these three modes. Therefore, multiply the number of commuters by bicycle, taxi, and motorcycle within each block group by 1/3 to estimate the number of bicycle commuters.
   d. Intersect the ½-mile buffer with the block groups and calculate the share of the block group area that is within the buffer.
   e. Multiply the share by the number of bicyclist and pedestrian commuters in the block group.
   f. Account for the fact pedestrian and bicycle commuters will only use the project for commuting when it is on their way to work. Without knowing where each pedestrian and bicycle commuter works and therefore which direction they travel to work, it is assumed that commuters' directions of travel are evenly distributed, meaning that only ¼ travel toward or within 45 degrees of the project.

To account for the fact that commuters will only use the project when it is along their route, multiply the number of bicyclist and pedestrian commuters in each block group by ¼.

g. Estimate the number of pedestrian and bicycle commuters using the project by summing the block-group level estimate from the previous bullet.

2. Estimate fatality risk per pedestrian-mile traveled:

$$R_p = \frac{f_p K_{p,2019}}{f_{T,p}\, \overline{S_{T,p}}\, \overline{t_{T,p}}\, P}$$

Where

$R_p$ = Pedestrian Fatality risk per mile
$f_p$ = factor representing pedestrian share of commuter mileage (=0.15)
$K_{p,2019}$ = count of 2019 pedestrian fatalities
$f_{T,p}$ = factor representing the total number of individual pedestrian commute trips (T,p) per year (2 trips per day times 260 working days per year = 520)
$\overline{S_{T,p}}$ = average pedestrian commute trip (T,p) speed (mph)
$\overline{t_{T,p}}$ = average pedestrian commute trip (T,p) time (hours)
$P$ = number of nationwide pedestrian commuters

or fatality risk per bicyclist-mile traveled:

$$R_b = \frac{f_b K_{b,2019}}{f_T\, \overline{S_T}\, \overline{t_T}\, B}$$

Where

$R_b$ = cyclist fatality risk per mile
$f_b$ = factor representing cyclist share of commuter mileage (=0.21)
$K_{b,2019}$ = count of 2019 cyclist fatalities
$f_{T,b}$ = factor representing the total number of individual bicycle commute trips (T,b) per year (2 trips per day times 260 working days per year = 520)
$\overline{S_{T,b}}$ = average bicycle commute trip (T,b) speed (mph)
$\overline{t_{T,b}}$ = average bicycle commute trip (T,b) time (hours)
$B$ = number of nationwide bicycle commuters

Each value for the above formulas are taken from the appropriate data source listed above.

3. Estimate "no build" fatalities around project locations.

$$K_p = 365 \times L \times P_d \times R_p$$

where

$K_p$ = annual pedestrian fatalities
$L$ = project length (miles)
$P_d$ = daily pedestrian users (from step 1)
$R_p$ = pedestrian fatality risk per mile (from step 2)

and

$$K_b = 365 \times L \times B_d \times R_b$$

where

$K_b$ = annual bicycle fatalities
$L$ = project length (miles)
$B_d$ = daily bicycle users (from step 1)
$R_b$ = cyclist fatality risk per mile (from step 2)

4. Estimate reduction in fatality risk due to project types.
   a. These risk reductions are based on relevant research or crash modification factors (CMFs).
      i. Pedestrian risk reduction: According to McMahon (2002), the presence of a sidewalk can reduce the chance of a location being a crash site by 88.2%.
      ii. Pedestrian risk reduction: According to Crash Modification Factors Clearinghouse, installing a share-used path can reduce vehicle-bike collisions by 25%.
   b. If these risk reductions are not relevant to the project type, additional crash modification factors can be obtained from the Crash Modification Factors Clearinghouse[2] or from standard crash modification factors prepared by the Virginia Department of Transportation.
   c. If using CMFs, the risk reduction factor should be calculated as

$$f_R = 1 - CMF$$

5. Estimate reduction in fatalities due to the projects.

$$\Delta K = f_R K$$

where

$\Delta K$ = reduction in fatalities by mode
$f_R$ = risk reduction factor (from Step 4)
$K$ = annual fatalities by mode (from Step 3)

2 FHWA (2022). Crash Modification Factors Clearinghouse. Retrieved from http://www.cmfclearinghouse.org/index.cfm

6. Estimate injury reduction by severity.
    a. Calculate reduction in serious injuries based on ratio of 13 pedestrian injuries to one fatality and 39 cyclist injuries to one fatality.
    b. Split among A, B, and C injuries for pedestrians and cyclists based on ratio of each to total injuries.

7. Calculate reduction in severity weighted crashes.
    a. Multiply the avoided injuries of each type by the severity weights indicated.
    b. Multiply by 5 to account for five-year time period.

**Methodology (TDM Projects and Transit Projects):**

1. Calculate rate of fatalities and injuries on commute routes affected by park-and-ride lot or on transit routes.
    a. Process crash data
        i. Limit crash data to prior 5 years.
        ii. Assign crashes to LRS segments using a 5-foot buffer.
        iii. Summarize number of K, A, B, and C injuries occurring on each segment.
    b. Process AADT
        i. Use overlay route events function in ESRI ArcMap to assign AADT to LRS segments.
    c. Calculate rates of K, A, B, and C injuries per vehicle mile traveled.
2. Reduce VMT on commute routes due to affected by park-and-ride lot or transit routes.
    a. For TDM projects, identify linear referencing system (LRS) roadway segments leading from park-and-ride lot to Richmond CBD. For transit projects, identify LRS segments on the transit route.
    b. For TDM projects, reduce daily VMT on these segments by 90% of the expected lot capacity in each direction to account for use of park-and-ride lot. For transit projects, reduce daily VMT by the expected average daily route ridership divided by average vehicle occupancy (1.65 per 2017 National Household Travel Survey).
        i. Note: The multiplier for TDM projects assumes that 90% of the park-and-ride lot capacity is used each day
3. Estimate fatalities and injuries avoide
    a. Use modified AADT from step 2 to recalculate K, A, B, and C injuries using rates from step 1.
4. Calculate EPDO and Multiply by 5 to Account for Five Years
    a. Calculate EPDO for the number of reduced K, A, B, and C injuries calculated in step 3 using the dollar amounts in Table 12.

## S.2. Crash Rate

**Description:**
Reduction in Equivalent Property Damage Only (EPDO) of Fatal and Injury Crashes per Vehicles Miles Traveled (VMT).

**Explanation of Measure:**
This measure builds on the data and expected crash reductions in Measure S.1. Whereas Measure S.1. is focused on the overall number of fatal and injury crashes, this measure is focused on the rate of fatal and injury crashes per million vehicle miles (segments) or million entering vehicles (intersections). This measure allows for better comparison between projects on routes with different traffic volumes.

**Outcome Measured:**
The change in the annual rate of fatal and injury crashes weighted by severity (equivalent property damage only) per 1 million vehicle miles (segments) or 1 million entering vehicles (intersections)

**Data Requirements/Analytical Tools:**
- Not applicable

**Methodology (Active Transportation, TDM, and Transit Projects):**
1. A score of zero is assigned to active transportation, TDM, and transit projects for this measure. For measure S1, active transportation projects' effects on fatalities and serious injuries depends on pedestrian and bicycling activity rather than a relationship with VMT. Similarly, TDM and transit projects are assumed to change the number of fatalities and serious injuries by changing VMT and keeping crash rates constant.

## 3.2 Mobility/Congestion

Mobility and Congestion is weighted at 20% of the total project score. Safety will be evaluated based on two performance measures weighted as shown in Table 13.

**Table 13: Mobility and Congestion Performance Measure Weights**

| Performance Measure (PM) | PM Weight |
|---|---|
| MC1. Demand | 50% |
| MC2. Congestion | 50% |
| Total | 100% |

## MC1. Walk Score and Bike Score

**Description:**
Walk Score and Bike Score[3]

**Explanation of Measure:**
Walk Score and Bike Score measure the ease of getting around on foot or by bike at a given location. The higher the score, the easier it is to get around locally on foot or by bike. Walk Score considers factors such as population density, block length, intersection density, and proximity to amenities, while the Bike Score considers bike infrastructure, hills, destinations, road connectivity, and the number of bike commuters[4]. Higher scores here indicate that an active transportation project is likely to join a network of highly useable active transportation infrastructure.

**Outcome Measured:**
The ability of potential users to access the project location by bike or on foot, and the potential of the project to integrate into a network of infrastructure and travel by bike or pedestrian modes.

**Data Requirements/Analytical Tools:**
- Walk Score and Bike Score downloadable from OIPI's Interact VTrans portal
  Redfin (n.d.). Walk Score and Bike Score. Revied from https://vtrans.org/interactvtrans/map-explorer?layer=Walk%20Score%C2%AE%2C%20Transit%20Score%C2%AE%2C%20and%20Bike%20Score%C2%AE&field=Walk%20Score%C2%AE&center=-79.42091791156685-%2C38.018031417766714&zoom=8

**Methodology (Active Transportation Projects):**
1. Calculate project length.
2. Intersect project with Walk Score and Bike Score layer.
3. Recalculate length of each segment resulting from the intersection.
4. Calculate the share of each project belonging to each segment.
5. Calculate the length-weighted average Walk Score and Bike Score for each project.
6. Average the Walk Score and the Bike Score.

**Methodology (TDM and Transit Projects):**
1. Assign the project the Walk Score and the Bike Score for a park-and-ride location (if a point project) or the centroid of its location (if a line or polygon). For a transit project, if stops have been designated, assign the average of each of the stop's Walk Scores and Bike Scores to the project. If stops have not been designated yet, average Walk Scores and Bike Scores at regular intervals along the affected transit route.
2. Average the Walk Score and the Bike Score together to create a single score for the projects.

3 Redfin (2022). Walk Score. Retrieved from https://www.walkscore.com/

4 Redfin (2022). Walk Score Methodology. Retrieved from https://www.walkscore.com/methodology.shtml

## MC2. Person Hours of Delay

**Description:**
Congestion score derived from the existing travel time index overlapping with the project.

**Explanation of Measure:**
This measure indicates the extent of the project location that is exposed to congestion and the severity of that congestion using data derived from the travel time index (TTI) that is calculated from INRIX XD data.

**Outcome Measured:**
The existing extent and severity of congestion at the project location.

**Data Requirements/Analytical Tools:**
- Project limit shapefile
- Hourly travel time index for most recent year using XD segments
- The INRIX XD network shapefile

**Methodology (Active Transportation):**
1. Join the XD data with the XD network shapefiles. Take the maximum TTI for any one-hour period for each segment.
2. Assign points to each segment based on the maximum TTI (Table 14).

### Table 14: Points to Assign based on Maximum TTI

| Maximum TTI | Points |
|---|---|
| NA OR < 1.2 | 0 |
| >=1.2 AND <1.3 | 1 |
| >=1.3 AND <1.5 | 2 |
| >= 1.5 | 3 |

3. Create a ¼-mile buffer around the projects.
4. Intersect the buffer with the XD network.
5. Calculate the post-intersection length of each segment and calculate its share out of the length of all segments intersected by the intersecting project buffer.
6. Multiply share by the number of points, and sum for each project to calculate a "congestion value."

**Methodology (TDM Projects and Transit Projects):**
1. Join the XD data with the XD network shapefiles. Take the maximum TTI for any one-hour period for each segment.
2. Assign points to each segment based on the maximum TTI (Table 14).
3. For TDM projects, identify the segments leading to and from the park-and-ride facility to the Richmond central business district (CBD) via freeways. For transit projects, identify the segments affected by the transit route
4. For TDM projects, calculate each segment's share of the length of all segments on the bidirectional path between the park-and-ride facility and the Richmond CBD. For transit projects, calculate each segment's share of the length of all segments affected by the transit route.
5. Multiply share by the number of points, and sum for each project to calculate a "congestion value" for the project.

## 3.3 Equity/Accessibility (to Jobs and Non-Work Destinations)/Multimodal

Equity and Accessibility are weighted at twenty-five percent **(25%)** of the total project score. Equity and Accessibility will be evaluated based on four performance measures weighted as shown in Table 15. Forty percent of the project score for this goal measure is only applicable to Environmental Justice Areas (EJ Areas) to make the project scoring process equitable. Therefore, **Equity** is weighted as ten percent **(10%)** of the total project score, and **Accessibility** accounts for the other fifteen percent **(15%)**.

**Table 15: Equity/Accessibility/Multimodal Performance Measure Weights**

| Performance Measure (PM) | EA Weight | Total Weight |
|---|---|---|
| EA1. Access to Jobs | 20% | 5% |
| EA2. Access to Jobs (EJ Areas) | 20% | 5% |
| EA3. Access to Non-Work Destinations | 20% | 5% |
| EA4.Access to EJ Non-Work Destinations (EJ)Areas) | 20% | 5% |
| EA5. Increase Access to Multimodal | 20% | 5% |
| Total | 100% | 25% |

## EA1. Access to Jobs

**Description:**
Increase in average job access (Distance of ten miles by auto; three miles by bicycle; and one mile by walking or transit) for all populations.

**Explanation of Measure:**
Note: The first four Accessibility performance measures are essentially calculating the access to jobs or destinations as a result of planned project improvements.

Access to jobs is calculated for all areas within the TCAMPO Metropolitan Planning Area (MPA) boundary and if needed for all populations residing within the southern RRTPO MPA boundary.

**Outcome Measured:**
The average access to employment opportunities because of project implementation for all populations.

**Data Requirements/Analytical Tools:**
- Latest historical LEHD LODES employment data for Census Tracts
- Existing and Committed Highway, Transit, Pedestrian, and Bicyclist Networks (E+C)
- Project Limit Shapefile
- Project Conceptual Sketches (for complex projects like interchanges)
- Bicycle or pedestrian system connectivity changes for active transportation projects (as it relates to filling gaps in existing bike/ped network or the last mile connection to transit service).

**Methodology:**
For all Highway, Transit and Active Transportation Projects:

1. Prepare GIS data for the transportation network of interest given the project type, the project extents and how they alter network properties, and the geography for employment data.
2. Run network analysis tools to identify a 15-minute travel shed from the project's intersection point(s) with the existing network or, for new transit stops, the nearest point on the network.
3. Measure the number of jobs in the portion of the employment geographies that intersect the travel shed.
4. Add the project geometry and/or alterations to the network
5. Rerun the travel shed process.
6. Measure employment in the new travel shed.
7. Compare before and after conditions to determine change in access to jobs.

For all other projects:

- The job accessibility is not measured for freight and rail projects.

## EA2. Access to Jobs (EJ Areas)

**Description:**
Increase in average job access (Distance of ten miles by auto, three miles by bicycle; and one mile by walking or transit) for Environmental Justice (EJ) populations.

**Explanation of Measure:**
This measure is similar to the previous measure (EA1) except the fact that Access to Jobs (EJ areas) is calculated only for Environmental Justice Areas (as defined above) within the TCAMPO Metropolitan Planning Area (MPA) boundary (and southern RRTPO MPA) and for the respective EJ population residing within EJ Areas. Figure 1 shows the EJ Areas in the Tri-Cities region.

**Outcome Measured:**
The change in average access to employment opportunities as a result of project implementation for the Environmental Justice (EJ) population.

**Data Requirements/Analytical Tools:**
- All Data/Analytical tools required for EA1.
- EJ areas in the Tri-Cities Region and southern Richmond Region (EJ Flagged TAZs)
- EJ Population (Minority, Low Income, Limited English Proficiency (LEP) population) for 2017 and 2045.

**Methodology:**
For all Highway, Transit and Active Transportation Projects

- The project is scored for what percentage of the extent is within an EJ zone.

For all other projects:

- The job accessibility for Environmental Justice (EJ) populations is not measured for freight and rail projects.

## EA3. Access to Non-Work Destinations

**Description:**
Access to non-work destinations (similar to SMART SCALE's walking distance methodology) for all populations.

**Explanation of Measure:**
This measure is similar to EA2 but instead of jobs it measures the access to destinations as a result of planned project improvements. For this analysis - grocery stores, pharmacies, schools, colleges, health care facilities, parks, libraries, and government centers are considered as non-work destinations.

**Outcome Measured:**
The change in average access to weighted destinations as a result of project implementation for all populations.

**Data Requirements/Analytical Tools:**
- Bicycle or pedestrian system connectivity changes for active transportation projects (as it relates to filling gaps in existing bike/ped network or the last mile connection to transit service).
- Destinations (Grocery Stores, Pharmacies, Schools, Colleges, Health Care Facilities, Parks, Libraries and Government Centers) location by TAZs.
- Number of persons and jobs in 1-mile radius
- Existing and Committed Highway and Transit Networks (E+C)
- Project Limit Shapefile
- Project Conceptual Sketches (for complex projects like interchanges)

**Methodology**
For all Highway, Transit and Active Transportation Projects

- Destinations within 75 feet of the project travel sheds calculated for "Access to Jobs".

For all other projects

- The access to non-work destinations is not measured for freight and rail projects.

## EA4. Access to Non-Work Destinations (EJ Areas)

**Description:**
Access to non-work destinations (similar to SMART SCALE's walking distance methodology) for Environmental Justice (EJ) populations.

**Explanation of Measure:**
This measure is similar to the previous measure (EA3) except the fact that Access to Non-Work Destinations (EJ areas) is calculated only for Environmental Justice Areas (as defined above) within the TCAMPO Metropolitan Planning Area (MPA) boundary (and southern RRTPO MPA) and for the respective EJ population residing within EJ Areas. Figure 1 shows the EJ Areas in the Tri-Cities region.

**Outcome Measured:**
The change in average access to weighted destinations as a result of project implementation for EJ populations.

**Data Requirements/Analytical Tools:**
- Same data sources as EA3
- EJ areas in the Tri-Cities Region and southern Richmond Region (EJ Flagged TAZs)
- EJ Population (Minority, Low Income, Limited English Proficiency (LEP) population) for 2017 and 2045.

**Methodology**
For all Highway, Transit and Active Transportation Projects

- Destinations within 75 feet of the project travel sheds calculated for "Access to Jobs".

For all other projects

- The access to non-work destinations is not measured for freight and rail projects.

## EA5. Access to Multimodal Transportation

**Description:**
Whether a project includes multimodal elements.

**Explanation of Measure:**
This measure assigns points for providing multimodal elements in a project

**Outcome Measured:**
Whether end users of a project have greater access to a variety of transportation modes, including transit, pedestrian, and bicycle facilities.

**Data Requirements/Analytical Tools:**
- Project modality details.

**Methodology:**
For all Highway, Transit and Active Transportation Projects:

- Assign points as follows:
    a. Park and ride or transit improvements = 4 points
    b. Bicycle improvements = 2 points
    c. Pedestrian improvements = 2 points

For all other projects:

- The access to multimodal transportation is not measured for freight and rail projects.

## 3.4 Environment

Environment is weighted at 10% of the total project score. Environment will be evaluated based on two performance measures weighted as shown in Table 16.

**Table 16: Environmental Performance Measure Weights**

| Performance Measure (PM) | PM |
|---|---|
| E1. Sensitive Features | 50% |
| E2. Air Quality Impact | 50% |
| Total | 100% |

### E1. Sensitive Features

**Description:**
Percentage of Wetlands, Resiliency Water Hazard Zones, Conserved Land, Habitat, and Cultural Resources, etc. in ¼ mile of the project limit (as per DCR map of Conservation Lands Database (ConserveVirginia V3.0).

**Explanation of Measure:**
Infrastructure projects have impacts on watersheds, wetlands, and habitats among many other aspects of the natural environment. Additionally, building in environmentally sensitive areas such as floodplains or storm surge areas can result in reduced functionality during storms. Beyond the natural areas, lands are sometimes set aside for public use or conserved from development due to natural, agricultural, or historic value - a value that can be impaired by adjacent development. This measure seeks to weigh the potential for negative impacts on the environment and conserved lands from a project. Figure 2 shows the environmentally sensitive and conservation lands in the Tri-Cities Area.

**Outcome Measured:**
Percentage of environmentally sensitive and conservation lands within ¼ mile of the project. This measure is an inverse measure meaning that a project with no impacts will receive the highest score.

**Data Requirements/Analytical Tools:**
The following geographic features datasets in a spatial format like shapefile:

- Conservation Lands Database (by DCR)
- Project limits shapefile

**Methodology:**
1. Dissolve all environmentally sensitive and conservation areas into one feature.
2. Create a ¼-mile buffer around each project.
3. Run the union tool to determine the areas of overlap between the buffer and the environmental and conservation areas feature.
4. For each project, reduce the overlap area based on the project tier shown in Table 17 and formula: Overlap Area * Adjustment Factor = Impact Area
5. Calculate the impact percentage by dividing the impact area by the total area of the buffer

**Table 17: Adjustment Factor for Projects**

| Project Tier | Adjustment Factor |
|---|---|
| Tier l | 10% |
| Tier 2 | 30% |
| Tier 3 | 50% |

## E2. Air Quality Impact

**Description:**
Reduction of annual VOC and NOx emissions in metric tons attributed to the project.

**Explanation of Measure:**
Environmental Protection Agency (EPA) has set National Ambient Air Quality Standards (NAAQS) for six common air pollutants (also known as "criteria air pollutants"). These pollutants can harm health and the environment, and cause property damage. Some of these pollutants are emitted to the atmosphere through passenger vehicle transportation. The pollutant emissions from passenger vehicle transportation include ozone precursors-volatile organic compounds (VOC) and nitrogen oxides (NOx), and other pollutants particulate matter (PM2.5 and PM10), sulfur oxides (SOx) and carbon monoxide (CO). Since the Richmond/Tri-Cities region historically had issues meeting the ozone standard, the current Air Pollution measure analysis has been streamlined to limit to ozone precursors only (i.e., VOC and NOx). Transportation related SOx, CO, and PM2.5, PM10 are not a concern in the Richmond/Tri-Cities region. These emissions can be calculated at the project scale on the basis of per-mile factors. This measure seeks to weigh the potential emission reduction due to the change in travel characteristics attributed to the project. If there is reduction in pollutant emission attributed to the project, then the project will be given a score.

**Outcome Measured:**
Annual reduction of the pollutant emissions in metric ton.

**Data Requirements/Analytical Tools:**

- Emissions calculations
  Federal Highway Administration (2022). CMAQ Emissions Calculator Toolkit. Retrieved from https://www.fhwa.dot.gov/environment/air_quality/cmaq/toolkit/
- Project length
  Derived from project limit shapefile or geospatial file
- Vehicle occupancy
  Federal Highway Administration (2017). 2017 National Household Travel Survey (NHTS). Retrieved from https://nhts.ornl.gov/

**Methodology (Active Transportation Projects):**

1. Use estimated number of bike or ped users from the safety calculations (regardless of trip purposes). For each project, sum number of bike or ped users. Assume that half these commuters would otherwise drive.
2. Divide by average vehicle occupancy (1.65 per 2017 National Household Travel Survey) to estimate number of avoided vehicles.
3. Calculate project length in miles. Assume an equal length of vehicles removed from road.
4. Use CMAQ tool to estimate NOx and VOC pollution (kg) removed daily.
5. Convert to annual using number of workdays (260) and metric tons by dividing by 1,000.

**Methodology (TDM Projects and Transit Projects):**

1. Use CMAQ tool
   a. Year = current year
   b. Change in VMT = park-and-ride lot size x 90% (Assuming 90% of lot is used) for TDM projects or projected daily ridership divided by average vehicle occupancy for transit projects
   c. Trip Distance Source = Average
   d. Typical Trip Distance = Distance from park-and-ride lot to Richmond central business district for TDM project or the estimated trip length of the average transit rider on this route for transit projects. If estimated trip length cannot be estimated, assume half of the route length.
2. Sum of VOC and NOx emissions.
3. Convert NOx and VOC emissions from kg/day to metric tons per year by multiplying by number of workdays in year (260) and converting to metric tons by dividing by 1,000.

## 3.5 Economic Development

Economic Development is weighted at 25% of the total project score. Economic Development will be evaluated based on four performance measures weighted as shown in Table 18.

**Table 18: Economic Development Performance Measure Weights**

| Performance Measure (PM) | PM Weight |
|---|---|
| ED1. Job Growth (2017-2045) | 60% |
| ED2. Freight Jobs | 20% |
| ED3. Activity Centers | 20% |
| Total | 100% |

## ED1. Job Growth

**Description:**
Increase in the decay weighted quantity of 2017-2045 job growth adjacent to the project.

**Explanation of Measure:**
This measure is focused on the relation between job growth and proposed improvements. The approach is adapted from Smart Scale Project Evaluation Measures following an approach proposed for the Harrisonburg MPO. This measure looks at the change in jobs by TAZ from 2017 to 2045. Projects are given credit based on the percentage of the TAZ within the buffer.

**Outcome Measured:**
Total number of expected new jobs served by the project.

**Data Requirements/Analytical Tools:**
- 2017 Base Year and 2045 Horizon Year employment data by Traffic Analysis Zones (TAZs)
- Tri-Cities Area's TAZs boundary shapefile
- Project limits shapefile

**Methodology:**
1. Add the project to the GIS map. For each project, create a multiple ring buffer at ¼-mile increments up to the influence buffer distance based on the project type. The dissolve option should be left at the default when creating the multiple ring buffer to create distinctive rings.
2. Use the intersect tool to calculate the overlap between each project ring and each TAZ. Filter results to remove features with no overlap.
3. Calculate job increases credited to project for each overlap area using the following formula: Jobs Served = (Future Year Employment - Base Year Employment) * (Overlap Area / Total TAZ Area)
4. Sum jobs served in all overlaps to get the total number of new jobs served by the project.

## ED2. Access to Freight Jobs

**Description:**
Proximity to freight jobs.

**Explanation of Measure:**
This measure calculates the number of freight jobs within proximity of the transportation project.

**Outcome Measured:**
Improvement's proximity to industrial and economic development areas.

**Data Requirements/Analytical Tools:**
- Utilizes same data as "Access to Jobs" with the LEHD LODES data providing the NAICS codes for freight-related employment.

**Methodology**
- Utilizes same methodology as "Access to Jobs" but substitute freight-related employment for total employment.

## ED3. Proximity to Activity Centers

**Description:**
Increase in the Activity Center Units adjacent to the project from 2017 to 2045.

**Explanation of Measure:**
This measure calculates the proximity to VTrans Activity Centers (plus Walthall). Figure 3 shows the VTrans Activity Centers in the Tri-Cities Area.

**Outcome Measured:**
New Activity Center Units from 2017 to 2045 in the Activity Centers served by project.

**Data Requirements/Analytical Tools:**
- VTrans Activity Centers geographical dataset (plus Walthall)
- Project limit shapefile

**Methodology**
- Count the number of activity centers within 1 mile of the project.

# 4-PROJECT SCORING

1. Calculate the raw value for all Performance Measures within the five Goal Categories for each project
2. In order to be able to compare scores for multiple projects and across project types, normalize the scores by Performance Measure by dividing all scores by the maximum score for that measure. This score can then be adjusted to a 100-point scale to produce a score that is comparable across performance measures. See Table 18 below for an example. In the event that a measure both negative and has an absolute value greater than the maximum positive score, the minimum normalized value assigned to that measure shall be -100. For example, if the maximum value of a given measure is 137 and a project scores -243 for that measure, the project with the negative score will be assigned a -100 for that measures normalized value.
3. Multiply the normalized measure scores by their respective measure weights
4. Sum the weighted, normalized performance measure scores within each goal area to produce the Goal Value.
5. Multiply each Goal Value by its respective Goal Weight to produce the Weighted Goal Value. This is repeated for all the goal categories.
6. Sum the Weighted Goal Values to produce the project Benefit Score.
7. Record the total project cost for each product.
8. Divide each project's Benefit Score by its Total Project Cost (per $10 million) to determine the Project Score.

All the projects in the 'Universe of Projects' are then ranked based on the Project Score. The project receiving the highest score will be ranked first, followed by the project ranking second and so on.

Once all projects have been scored for each measure pertinent to the project type, use the following steps to produce project scorecards, normalized scores, and overall project rankings.

Project Scorecard templates are provided in Appendix 1.

### Table 18: Score Normalization Example

| Project Number | Performance Measure Score | Normalize to 0-1 value (Divide all values by Max) | Scale to 0-100 (Multiply by 100) |
|---|---|---|---|
| 1 | 0.76 | 0.76 / 0.80 = 0.95 | (100 x 0.95) = 95 |
| 2 | 0.40 | 0.40 / 0.80 = 0.50 | (100 x 0.50) = 50 |
| 3 | 0.44 | 0.44 / 0.80 = 0.55 | (100 x 0.55) = 55 |
| **4** | 0.80 | 0.80 / 0.80 = 1.0 | (100 x 1.00) = 100 |
| **5** | 0.30 | 0.30 / 0.80 = 0.375 | (100 x 0.375) = 37.5 |
| **3** | 0.44 | 0.44 / 0.80 = 0.55 | (100 x 0.55) = 55 |
| **4** | 0.80 | 0.80 / 0.80 = 1.0 | (100 x 1.00) = 100 |
| **5** | 0.30 | 0.30 / 0.80 = 0.375 | (100 x 0.375) = 37.5 |

# APPENDIX A: SCORECARD TEMPLATE

# Highway and Roadway Projects Scorecard Template

**Project Name:** **Jurisdiction:**

**Facility**
[Enter facility name]
[Enter project description]

**Functional Classification**

**Project Type**

| Goal Areas | Safety | | Mobility / Congestion | | Accessibility | | | | Environmental | Economic Development | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Goal Weight | 25% | | 20% | | 10% | | | | 10% | 25% | | |
| Project Performance Measure (PM) | Crash Frequency | Crash Rate | Demand | Congestion | 2045 Access to Jobs | 2045 EJ Access to Jobs | Access to Non-Work Destinations | EJ Access to Non-Work Destinations | Sensitive Features | 2017-2045 Job Growth | Freight Jobs | Activity Centers |
| PM Weight | 12.5% | 12.5% | 10% | 10% | 5% | 5% | 5% | 5% | 10% | 15% | 5% | 5% |
| Unit of Measurement (PM) | Change in Crashes | Change in Rate of Crashes | Weighted Volumes | Weighted TTI | Number of Jobs | Number of Jobs | Number of Destinations | Number of Destinations | Percentage of Sensitive Areas | Number of Jobs | Number of Freight Jobs | Activity Units |
| PM Value | | | | | | | | | | | | |
| Normalized PM Value Relative to Other Projects | | | | | | | | | | | | |
| Total Benefit Score (MAX 100) | | | | | | | | | | | | |
| Total 2021 Project Cost ($M) | | | | | | | | | | | | |
| Total Benefit Score / Cost | | | | | | | | | | | | |

# Active Transportation, TDM, and Transit Scorecard Template

**Project Name:** **Jurisdiction:**

**Facility** **Functional Classification** **Project Type**

[Enter facility description]

[Enter project description]

| Goal Areas | Safety | | Mobility / Congestion | | Accessibility | | | | | Environmental | | Economic Development | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Goal Weight | 25% | | 20% | | 20% | | | | | 10% | | 25% | | |
| Project Performance Measure (PM) | Crash Frequency | Crash Rate | Demand | Congestion | 2017 Access to Jobs | 2017 EJ Access to Jobs | Access to Non-Work Destinations | EJ Access to Non-Work Destinations | Access to Multimodal Options | Sensitive Features | Air Quality Impact | 2017-2045 Job Growth | Freight Jobs | Activity Centers |
| PM Weight | 12.5% | 12.5% | 10% | 10% | 4% | 4% | 4% | 4% | 4% | 5% | 5% | 15% | 5% | 5% |
| Unit of Measurement (PM) | Change in Crashes | Change in Rate of Crashes | Weighted Volumes | Weighted TTI | Number of Jobs | Number of Jobs | Number of Destinations | Number of Destinations | Points | Percentage of Sensitive Areas | Reduction in Emissions in Metric Tons | Number of Jobs | Number of Freight Jobs | Activity Units |
| PM Value | | | | | | | | | | | | | | |
| Normalized PM Value Relative to Other Projects | | | | | | | | | | | | | | |
| Total Benefit Score (MAX 100) | | | | | | | | | | | | | | |
| Total 2021 Project Cost ($M) | | | | | | | | | | | | | | |
| Total Benefit Score / Cost | | | | | | | | | | | | | | |

# APPENDIX B: TEST SCORES

In order to determine the validity of the methodologies presented in this report, TCAMPO identified a sample set of projects that represented a variety of project types in various locations across the MPO area. The projects fell into four categories: Intersection/Operations; Roadway Improvements; Active Transportation; and Transportation Demand Management (TDM). These projects were then tested and scored using the appropriate methodologies respective to the project type. A list of the projects tested follows accompanied by project scores on subsequent pages of this appendix.

**Intersections/Operations**

- Rt 156 (Prince George Drive) & Middle Road Roundabout
  SMART SCALE application; $5.7M
  - Convert 2-way stop to one-lane roundabout.
  - No sidewalks, transit, or bicycle elements.
  - Construction of a single lane Roundabout at Middle Road (Route 646) and Prince George Drive (Route 156) to eliminate poor sight distance and reduce the number of vehicle conflict points. Sidewalk will be constructed along the northeast and southeast quadrants of the roundabout and the median along Moncol drive.
- Boulevard & Westover Rd
  UPC 100501; $1.085M
  - Add WB left turn lane.
  - No sidewalks, transit, or bicycle elements.
  - Project will add turn lane onto Westover Ave along with other intersection improvements.
- Boulevard & Branders Bridge Rd
  UPC 99194; $629k
  - Add EB right turn lane.
  - Construct right turn lane extension.
- Temple Ave/Route 1 signal replacement
  UPC 109264; $1.6M
  - Replace signal at intersection of Route 1 and Temple Avenue including sidewalks and boulevard improvements.
- Temple Ave/Puddledock Intersection
  UPC 105131; $2.9 M
  - Add turn lanes
  - Intersection capacity improvement with adding an extra WB left turn lane and one extra SB receiving lane. The one NB left turn currently shared with thru lane to be separated into an individual left turn lane.

**Roadway Improvements**

- Lakeview Ave Minor Widening, Boulevard to Brijidan
  UPC 101288; $5.248M
  - Add center turn lane.
  - Add sidewalks.
  - This project would reconstruct and modernize this street segment to provide an urban cross section consisting of two (2) vehicle travel lanes, one (1) continuous two-way turn lanes, two (2) bike lanes, two (2) sidewalks, storm drain system and landscaping.
- Dupuy Ave Widening, Boulevard to MLK
  UPC 101287; $5.308M
  - Add center turn lane.
  - Add sidewalks.
  - This project reconstructs Dupuy Avenue providing an urban cross section with 2 vehicle travel lanes, 1 continuous two-way turn lane, 2 bike lanes, 2 sidewalks, pedestrian crossings, storm drain system and landscaping.

**Active Transportation**

- Fall Line Trail, Patton Park Through VSU to River Rd
  SMART SCALE application; $7.46M (update)
  - Multiuse trail with bike/ped bridges.
  - Fall Line Trail Segment 1A of the Ashland To Petersburg (ATP) Trail Study: River Road through Virginia State University to Patton Park to Appomattox River Trailhead in Petersburg using VSU and City property. Includes 4,900 foot 10' wide multi-use trail with two bike/ped bridges (Fleets Branch, Appomattox River/Canal) and 200 foot 10' wide multi-use trail stub from ATP Trail to east edge of VSU property (to connect to the future CHART Trail extension).
- Petersburg Appomattox River Trail, University Blvd to Squaw Valley
  CMAQ application; $1.3M
  - Multiuse trail.
- Fall Line Trail, River Road/Dupuy Ave to w. Westover Ave
  UPC 118966; $1.416M
  - Multiuse trail.
  - Construct 10' wide multi-use trail (typical section D in ATP Study) from Dupuy Ave to W. Westover Ave (parallel to Meridian Ave) in Chesterfield County; project sheets 2 & 3 of ATP Trail study; mile marker .85-1.3.
- Colonial Heights Appomattox River Trail Phase IV, Boulevard to Appomatuck Park
  UPC 115182; $534k
  - Multiuse trail.
  - Construct approximately 1800 LF of 8' wide hard surface trail along the Appomattox River in the City of Colonial Heights from the Boulevard (Route 1) to Appamatuck Park, completing the trail between the City's Roslyn Park (and Southpark Mall) and Appamatuck Park, a distance of nearly 2 miles.
- Boulevard Sidewalk, Temple Ave to "A" Ave.
  UPC 107534; $35k
  - Sidewalk.
  - (PE/RW) Design of sidewalks on both sides of Boulevard from Temple Avenue to "A" Avenue.

**TDM**

- Walthall Park and Ride Lot
  (new from I-95 Operations and Enhancement); $7.4M
  - Construct new Park and Ride lot.

# Highway and Roadway Projects Summary

| PROJECT | SAFETY | | MOBILITY/CONGESTION | | ACCESSIBILITY | | | | ENVIRONMENTAL | ECONOMIC DEVELOPMENT | | | TOTAL BENEFIT SCORE (MAX 100) | TOTAL 2021 COST ($M) | TOTAL BENEFIT SCORE/ COST | RANK |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 25% | | 20% | | 20% | | | | 10% | 25% | | | | | | |
| | 12.5% | 12.5% | 10% | 10.0% | 5% | 5% | 5% | 5% | 10% | 15% | 5% | 5% | | | | |
| | Crash Frequency | Crash Rate | Demand | Congestion | 2017 Access to Jobs | 2017 EJ Access to Jobs | Access to Non-Work Destinations | EJ Access to Non-Work Destinations | Sensitive Features | 2017-2045 Job Growth | Freight Jobs | Activity Centers | | | | |
| | CALC | CALC | GIS | GIS | GIS | GIS | GIS | GIS | GIS | GIS | GIS | GIS | | | | |
| Rt 156 (Prince George Drive) & Middle Road Roundabout | 100% | 100% | 33% | 100% | 59% | 80% | 54% | 86% | 2% | 14% | 63% | 67% | 60.98 | $5.70 | 10.70 | 5 |
| Boulevard & Westover Avenue Turn Lane | 14% | 7% | 68% | 49% | 99% | 100% | 97% | 100% | 0% | 100% | 88% | 100% | 58.48 | $1.09 | 53.65 | 2 |
| Boulevard & Branders Bridge Road Right Turn Lane | 19% | 10% | 96% | 39% | 99% | 100% | 100% | 99% | 1% | 100% | 100% | 100% | 62.06 | $0.63 | 98.51 | 1 |
| Temple Ave/Route 1 signal replacement | 65% | 25% | 100% | 28% | 100% | 100% | 100% | 99% | 0% | 100% | 100% | 100% | 69.01 | $1.60 | 43.13 | 3 |
| Temple Ave and Puddledock Road Intersection Turn Lanes | 7% | 3% | 87% | 86% | 96% | 98% | 90% | 96% | 73% | 97% | 83% | 100% | 68.43 | $2.90 | 23.60 | 4 |
| Lakeview Ave Minor Widening, Boulevard to Brijidan Lane | 15% | 14% | 77% | 38% | 34% | 55% | 84% | 77% | 100% | -5% | 22% | 58% | 40.90 | $5.25 | 7.79 | 1 |
| Dupuy Avenue Widening, Boulevard to MLK Drive | 29% | 16% | 67% | 28% | 56% | 91% | 89% | 88% | 0% | -13% | 42% | 83% | 35.71 | $5.31 | 6.73 | 2 |

| |
|---|
| Intersection/Operation Projects |
| Highway Improvement Projects |

# Active Transportation, TDM, and Transit Projects Summary

| PROJECT | SAFETY | | MOBILITY/CONGESTION | | EQUITY & ACCESSIBILITY | | | | | ENVIRONMENTAL | | ECONOMIC DEVELOPMENT | | | TOTAL BENEFIT SCORE (MAX 100) | TOTAL 2021 COST ($M) | TOTAL BENEFIT SCORE/ COST | RANK |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 25% | | 20% | | 20% | | | | | 10% | | 25% | | | | | | |
| | 12.5% | 12.5% | 10% | 10% | 4% | 4% | 4% | 4% | 4% | 5% | 5% | 15% | 5% | 5% | | | | |
| | Crash Frequency<br>CALC | Crash Rate<br>CALC | Demand<br>GIS | Congestion<br>GIS | 2017 Access to Jobs<br>GIS | 2017 EJ Access to Jobs<br>GIS | Access to Non-Work Destinations<br>GIS | EJ Access to Non-Work Destinations<br>GIS | Access to Multimodal Options | Sensitive Features<br>GIS | Air Quality Impact | 2017-2045 Job Growth<br>GIS | Freight Jobs<br>GIS | Activity Centers<br>GIS | | | | |
| Boulevard Sidewalk, Temple Ave to "A" Ave | 2% | 0% | 65% | 100% | 5% | 5% | 94% | 94% | 50% | 0% | 6% | -97% | 3% | 75% | 16.36 | $5.70 | 2.87 | 5 |
| CHART Phase IV, Boulevard to Appomatuck Park | 4% | 0% | 20% | 4% | 0% | 0% | 94% | 94% | 50% | 0% | 11% | -100% | 9% | 100% | 3.44 | $1.09 | 3.15 | 4 |
| FLT River Road/Dupuy Ave to w. Westover Ave. | 36% | 0% | 65% | 15% | 100% | 100% | 63% | 63% | 50% | 0% | 15% | -83% | 9% | 75% | 19.99 | $0.63 | 31.73 | 1 |
| FLT (Patton Park Through VSU to River Rd) | 100% | 0% | 80% | 35% | 5% | 5% | 100% | 100% | 50% | 0% | 42% | -100% | 7% | 100% | 26.84 | $1.60 | 16.77 | 2 |
| Petersburg ART, University Blvd to Squaw Valley | 7% | 0% | 100% | 25% | 1% | 1% | 100% | 100% | 50% | 0% | 39% | -100% | 8% | 100% | 15.83 | $2.90 | 5.46 | 3 |
| Walthall Park and Ride Lot (new from I-95 O&E) | 43% | 0% | 9% | 12% | 68% | 0% | 0% | 0% | 100% | 0% | 100% | 100% | 100% | 63% | 42.34 | $5.31 | 7.97 | 1 |

| |
|---|
| Active Transportation Projects |
| Travel Demand Management Projects |

**Project Name:** Rt 156 (Prince George Drive) & Middle Road Roundabout

**Jurisdiction:** Prince George

**Facility**
Rt 156 (Prince George Drive) & Middle Road
Convert 2-way stop to one-lane roundabout

**Functional Classification**
Minor Arterial

**Project Type**
Intersection improvement

| Goal Areas | Safety | | Mobility / Congestion | | Accessibility | | | | Environmental | Economic Development | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Goal Weight | 25% | | 20% | | 20% | | | | 10% | 25% | | |
| Project Performance Measure (PM) | Crash Frequency | Crash Rate | Demand | Congestion | 2045 Access to Jobs | 2045 EJ Access to Jobs | Access to Non-Work Destinations | EJ Access to Non-Work Destinations | Sensitive Features | 2017-2045 Job Growth | Freight Jobs | Activity Centers |
| PM Weight | 12.5% | 12.5% | 10% | 10% | 5% | 5% | 5% | 5% | 10% | 15% | 5% | 5% |
| Unit of Measurement (PM) | Change in Crashes | Change in Rate of Crashes | Weighted Volumes | Weighted TTI | Number of Jobs | Number of Jobs | Number of Destinations | Number of Destinations | Percentage of Sensitive Areas | Number of Jobs | Number of Freight Jobs | Activity Units |
| PM Value | 115.2 | 9481 | 6151 | 3 | 72735 | 50191 | 99780 | 199954 | 0.07% | 2268 | 15906 | 8 |
| Normalized PM Value Relative to Other Projects | 100% | 100% | 33% | 100% | 59% | 80% | 54% | 86% | 2% | 14% | 63% | 67% |
| Total Benefit Score (MAX 100) | 60.98 | | | | | | | | | | | |
| Total 2021 Project Cost ($M) | $5.70 | | | | | | | | | | | |
| Total Benefit Score / Cost | 10.70 | | | | | | | | | | | |

**Project Name:** Boulevard & Westover Avenue Turn Lane

**Jurisdiction:** Colonial Heights

**Facility**
Boulevard & Westover Avenue
Add WB left-turn lane

**Functional Classification**
Principal Arterial

**Project Type**
Turn lane

| Goal Areas | Safety | | Mobility / Congestion | | Accessibility | | | | Environmental | Economic Development | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Goal Weight | 25% | | 20% | | 20% | | | | 10% | 25% | | |
| Project Performance Measure (PM) | Crash Frequency | Crash Rate | Demand | Congestion | 2045 Access to Jobs | 2045 EJ Access to Jobs | Access to Non-Work Destinations | EJ Access to Non-Work Destinations | Sensitive Features | 2017-2045 Job Growth | Freight Jobs | Activity Centers |
| PM Weight | 12.5% | 12.5% | 10% | 10% | 5% | 5% | 5% | 5% | 10% | 15% | 5% | 5% |
| Unit of Measurement (PM) | Change in Crashes | Change in Rate of Crashes | Weighted Volumes | Weighted TTI | Number of Jobs | Number of Jobs | Number of Destinations | Number of Destinations | Percentage of Sensitive Areas | Number of Jobs | Number of Freight Jobs | Activity Units |
| PM Value | 15.6 | 658 | 12765 | 1.48 | 121791 | 62853 | 181354 | 231438 | 0.00% | 16563 | 22149 | 12 |
| Normalized PM Value Relative to Other Projects | 14% | 7% | 68% | 49% | 99% | 100% | 97% | 100% | 0% | 100% | 88% | 100% |
| Total Benefit Score (MAX 100) | 58.48 | | | | | | | | | | | |
| Total 2021 Project Cost ($M) | $1.09 | | | | | | | | | | | |
| Total Benefit Score / Cost | 53.65 | | | | | | | | | | | |

**Project Name:** Boulevard & Branders Bridge Road Right Turn Lane

**Jurisdiction:** Colonial Heights

**Facility**
Boulevard and Branders Bridge Road
Add EB right-turn lane

**Functional Classification**
Principal Arterial

**Project Type**
Turn lane

| Goal Areas | Safety | | Mobility / Congestion | | Accessibility | | | | Environmental | Economic Development | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Goal Weight | 25% | | 20% | | 20% | | | | 10% | 25% | | |
| Project Performance Measure (PM) | Crash Frequency | Crash Rate | Demand | Congestion | 2045 Access to Jobs | 2045 EJ Access to Jobs | Access to Non-Work Destinations | EJ Access to Non-Work Destinations | Sensitive Features | 2017-2045 Job Growth | Freight Jobs | Activity Centers |
| PM Weight | 12.5% | 12.5% | 10% | 10% | 5% | 5% | 5% | 5% | 10% | 15% | 5% | 5% |
| Unit of Measurement (PM) | Change in Crashes | Change in Rate of Crashes | Weighted Volumes | Weighted TTI | Number of Jobs | Number of Jobs | Number of Destinations | Number of Destinations | Percentage of Sensitive Areas | Number of Jobs | Number of Freight Jobs | Activity Units |
| PM Value | 22.2 | 904 | 18093 | 1.17 | 121760 | 62853 | 185424 | 229973 | 0.04% | 16503 | 25187 | 12 |
| Normalized PM Value Relative to Other Projects | 19% | 10% | 96% | 39% | 99% | 100% | 100% | 99% | 1% | 100% | 100% | 100% |
| Total Benefit Score (MAX 100) | 62.06 | | | | | | | | | | | |
| Total 2021 Project Cost ($M) | $0.63 | | | | | | | | | | | |
| Total Benefit Score / Cost | 98.51 | | | | | | | | | | | |

**Project Name:** Temple Ave/Route 1 Signal Replacement

**Jurisdiction:** Colonial Heights

**Facility**
Temple Avenue and Route 1 (Boulevard)
Replace signal including Boulevard improvements

**Functional Classification**
Principal Arterial

**Project Type**
Signal replacement

| Goal Areas | Safety | | Mobility / Congestion | | Accessibility | | | | Environmental | Economic Development | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Goal Weight | 25% | | 20% | | 20% | | | | 10% | 25% | | |
| Project Performance Measure (PM) | Crash Frequency | Crash Rate | Demand | Congestion | 2045 Access to Jobs | 2045 EJ Access to Jobs | Access to Non-Work Destinations | EJ Access to Non-Work Destinations | Sensitive Features | 2017-2045 Job Growth | Freight Jobs | Activity Centers |
| PM Weight | 12.5% | 12.5% | 10% | 10% | 5% | 5% | 5% | 5% | 10% | 15% | 5% | 5% |
| Unit of Measurement (PM) | Change in Crashes | Change in Rate of Crashes | Weighted Volumes | Weighted TTI | Number of Jobs | Number of Jobs | Number of Destinations | Number of Destinations | Percentage of Sensitive Areas | Number of Jobs | Number of Freight Jobs | Activity Units |
| PM Value | 74.8 | 2338 | 18893 | 0.85 | 122635 | 62853 | 186142 | 229973 | 0.01% | 16536 | 25225 | 12 |
| Normalized PM Value Relative to Other Projects | 65% | 25% | 100% | 28% | 100% | 100% | 100% | 99% | 0% | 100% | 100% | 100% |
| Total Benefit Score (MAX 100) | 69.01 | | | | | | | | | | | |
| Total 2021 Project Cost ($M) | $1.60 | | | | | | | | | | | |
| Total Benefit Score / Cost | 43.13 | | | | | | | | | | | |

**Project Name:** Temple Avenue and Puddledock Road Intersection Turn Lanes

**Jurisdiction:** Prince George

**Facility**
Temple Avenue and Puddledock Road

**Functional Classification**
Principal Arterial

**Project Type**
Turn lanes

Add WB left turn lane and SB receiving lane; reconfigure NB shared left turn lane to dedicated left turn lane

| Goal Areas | Safety | | Mobility / Congestion | | Accessibility | | | | Environmental | Economic Development | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Goal Weight | 25% | | 20% | | 20% | | | | 10% | 25% | | |
| Project Performance Measure (PM) | Crash Frequency | Crash Rate | Demand | Congestion | 2045 Access to Jobs | 2045 EJ Access to Jobs | Access to Non-Work Destinations | EJ Access to Non-Work Destinations | Sensitive Features | 2017-2045 Job Growth | Freight Jobs | Activity Centers |
| PM Weight | 12.5% | 12.5% | 10% | 10% | 5% | 5% | 5% | 5% | 10% | 15% | 5% | 5% |
| Unit of Measurement (PM) | Change in Crashes | Change in Rate of Crashes | Weighted Volumes | Weighted TTI | Number of Jobs | Number of Jobs | Number of Destinations | Number of Destinations | Percentage of Sensitive Areas | Number of Jobs | Number of Freight Jobs | Activity Units |
| PM Value | 7.86 | 241 | 16491 | 2.58 | 117238 | 61784 | 166805 | 222367 | 2.22% | 15986 | 21060 | 12 |
| Normalized PM Value Relative to Other Projects | 7% | 3% | 87% | 86% | 96% | 98% | 90% | 96% | 73% | 97% | 83% | 100% |
| Total Benefit Score (MAX 100) | 68.43 | | | | | | | | | | | |
| Total 2021 Project Cost ($M) | $2.90 | | | | | | | | | | | |
| Total Benefit Score / Cost | 23.60 | | | | | | | | | | | |

**Project Name:** Lakeview Ave Minor Widening, Boulevard to Brijidan Lane

**Jurisdiction:** Colonial Heights

**Facility**
Lakeview Avenue

**Functional Classification**
Major Collector

**Project Type**
Reconstruction

Modernize to urban cross section consisting of two (2) vehicle travel lanes, one (1) continuous two-way turn lanes, two (2) bike lanes, two (2) sidewalks, storm drain system and landscaping

| Goal Areas | Safety | | Mobility / Congestion | | Accessibility | | | | Environmental | Economic Development | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Goal Weight | 25% | | 20% | | 20% | | | | 10% | 25% | | |
| Project Performance Measure (PM) | Crash Frequency | Crash Rate | Demand | Congestion | 2045 Access to Jobs | 2045 EJ Access to Jobs | Access to Non-Work Destinations | EJ Access to Non-Work Destinations | Sensitive Features | 2017-2045 Job Growth | Freight Jobs | Activity Centers |
| PM Weight | 12.5% | 12.5% | 10% | 10% | 5% | 5% | 5% | 5% | 10% | 15% | 5% | 5% |
| Unit of Measurement (PM) | Change in Crashes | Change in Rate of Crashes | Weighted Volumes | Weighted TTI | Number of Jobs | Number of Jobs | Number of Destinations | Number of Destinations | Percentage of Sensitive Areas | Number of Jobs | Number of Freight Jobs | Activity Units |
| PM Value | 17 | 1327 | 14549 | 1.15 | 41694 | 34462 | 156298 | 179288 | 3.04% | -865 | 5673 | 7 |
| Normalized PM Value Relative to Other Projects | 15% | 14% | 77% | 38% | 34% | 55% | 84% | 77% | 100% | -5% | 22% | 58% |
| Total Benefit Score (MAX 100) | 40.90 | | | | | | | | | | | |
| Total 2021 Project Cost ($M) | $5.25 | | | | | | | | | | | |
| Total Benefit Score / Cost | 7.79 | | | | | | | | | | | |

**Project Name:** Dupuy Avenue Widening, Boulevard to MLK Drive **Jurisdiction:** Colonial Heights

**Facility**
Dupuy Avenue

**Functional Classification**
Minor Arterial

**Project Type**
Reconstruction

Reconstruct to anurban cross section with 2 vehicle travel lanes, 1 continuous two-way turn lane, 2 bike lanes, 2 sidewalks, Ped X-ings, storm drain system and landscaping

| Goal Areas | Safety | | Mobility / Congestion | | Accessibility | | | | Environmental | Economic Development | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Goal Weight | 25% | | 20% | | 20% | | | | 10% | 25% | | |
| Project Performance Measure (PM) | Crash Frequency | Crash Rate | Demand | Congestion | 2045 Access to Jobs | 2045 EJ Access to Jobs | Access to Non-Work Destinations | EJ Access to Non-Work Destinations | Sensitive Features | 2017-2045 Job Growth | Freight Jobs | Activity Centers |
| PM Weight | 12.5% | 12.5% | 10% | 10% | 5% | 5% | 5% | 5% | 10% | 15% | 5% | 5% |
| Unit of Measurement (PM) | Change in Crashes | Change in Rate of Crashes | Weighted Volumes | Weighted TTI | Number of Jobs | Number of Jobs | Number of Destinations | Number of Destinations | Percentage of Sensitive Areas | Number of Jobs | Number of Freight Jobs | Activity Units |
| PM Value | 33 | 1549 | 12651 | 0.85 | 69245 | 57199 | 166508 | 204125 | 0.00% | -2166 | 10577 | 10 |
| Normalized PM Value Relative to Other Projects | 29% | 16% | 67% | 28% | 56% | 91% | 89% | 88% | 0% | -13% | 42% | 83% |
| Total Benefit Score (MAX 100) | 35.71 | | | | | | | | | | | |
| Total 2021 Project Cost ($M) | $5.31 | | | | | | | | | | | |
| Total Benefit Score / Cost | 6.73 | | | | | | | | | | | |

**Project Name:** Boulevard Sidewalk, Temple Ave to "A" Ave

**Jurisdiction:** Colonial Heights

**Facility**
Boulevard Sidewalk
Sidewalk on both sides of Boulevard

**Functional Classification**
Principal Arterial

**Project Type**
Sidewalk

| Goal Areas | Safety | | Mobility / Congestion | | Accessibility | | | | | Environmental | | Economic Development | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Goal Weight | 25% | | 20% | | 20% | | | | | 10% | | 25% | | |
| Project Performance Measure (PM) | Crash Frequency | Crash Rate | Demand | Congestion | 2017 Access to Jobs | 2017 EJ Access to Jobs | Access to Non-Work Destinations | EJ Access to Non-Work Destinations | Access to Multimodal Options | Sensitive Features | Air Quality Impact | 2017-2045 Job Growth | Freight Jobs | Activity Centers |
| PM Weight | 12.5% | 12.5% | 10% | 10% | 4% | 4% | 4% | 4% | 4% | 5% | 5% | 15% | 5% | 5% |
| Unit of Measurement (PM) | Change in Crashes | Change in Rate of Crashes | Weighted Volumes | Weighted TTI | Number of Jobs | Number of Jobs | Number of Destinations | Number of Destinations | Points | Percentage of Sensitive Areas | Reduction in Emissions in Metric Tons | Number of Jobs | Number of Freight Jobs | Activity Units |
| PM Value | 0.032 | 0 | 30 | 1.01 | 648 | 648 | 15 | 15 | 2 | 0 | 0.011 | -1408 | 41 | 6 |
| Normalized PM Value Relative to Other Projects | 2% | 0% | 65% | 100% | 5% | 5% | 94% | 94% | 50% | 0% | 6% | -97% | 3% | 75% |
| Total Benefit Score (MAX 100) | 16.357 | | | | | | | | | | | | | |
| Total 2021 Project Cost ($M) | 5.70 | | | | | | | | | | | | | |
| Total Benefit Score / Cost | 2.870 | | | | | | | | | | | | | |

**Project Name:** CHART Phase IV, Boulevard to Appomatuck Park

**Jurisdiction:** Colonial Heights

**Facility**
Appomattox River Trail
Construct 8' wide hard surface trail

**Functional Classification**
N/A

**Project Type**
Multi-Use Trail

| Goal Areas | Safety | | Mobility / Congestion | | Accessibility | | | | | Environmental | | Economic Development | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Goal Weight | 25% | | 20% | | 20% | | | | | 10% | | 25% | | |
| Project Performance Measure (PM) | Crash Frequency | Crash Rate | Demand | Congestion | 2017 Access to Jobs | 2017 EJ Access to Jobs | Access to Non-Work Destinations | EJ Access to Non-Work Destinations | Access to Multimodal Options | Sensitive Features | Air Quality Impact | 2017-2045 Job Growth | Freight Jobs | Activity Centers |
| PM Weight | 12.5% | 12.5% | 10% | 10% | 4% | 4% | 4% | 4% | 4% | 5% | 5% | 15% | 5% | 5% |
| Unit of Measurement (PM) | Change in Crashes | Change in Rate of Crashes | Weighted Volumes | Weighted TTI | Number of Jobs | Number of Jobs | Number of Destinations | Number of Destinations | Points | Percentage of Sensitive Areas | Reduction in Emissions in Metric Tons | Number of Jobs | Number of Freight Jobs | Activity Units |
| PM Value | 0.083 | 0 | 9 | 0.04 | 38 | 38 | 15 | 15 | 2 | 0 | 0.019 | -3762 | 148 | 8 |
| Normalized PM Value Relative to Other Projects | 4% | 0% | 20% | 4% | 0% | 0% | 94% | 94% | 50% | 0% | 11% | -100% | 9% | 100% |
| Total Benefit Score (MAX 100) | 3.437 | | | | | | | | | | | | | |
| Total 2021 Project Cost ($M) | 1.09 | | | | | | | | | | | | | |
| Total Benefit Score / Cost | 3.153 | | | | | | | | | | | | | |

**Project Name:** FLT River Road/Dupuy Ave to w. Westover Ave.

**Jurisdiction:** Colonial Heights

**Facility**
Fall Line Trail
Construct 10' wide multi-use trail

**Functional Classification**
N/A

**Project Type**
Multi-Use Trail

| Goal Areas | Safety | | Mobility / Congestion | | Accessibility | | | | | Environmental | | Economic Development | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Goal Weight | 25% | | 20% | | 20% | | | | | 10% | | 25% | | |
| Project Performance Measure (PM) | Crash Frequency | Crash Rate | Demand | Congestion | 2017 Access to Jobs | 2017 EJ Access to Jobs | Access to Non-Work Destinations | EJ Access to Non-Work Destinations | Access to Multimodal Options | Sensitive Features | Air Quality Impact | 2017-2045 Job Growth | Freight Jobs | Activity Centers |
| PM Weight | 12.5% | 12.5% | 10% | 10% | 4% | 4% | 4% | 4% | 4% | 5% | 5% | 15% | 5% | 5% |
| Unit of Measurement (PM) | Change in Crashes | Change in Rate of Crashes | Weighted Volumes | Weighted TTI | Number of Jobs | Number of Jobs | Number of Destinations | Number of Destinations | Points | Percentage of Sensitive Areas | Reduction in Emissions in Metric Tons | Number of Jobs | Number of Freight Jobs | Activity Units |
| PM Value | 0.7 | 0 | 30 | 0.15 | 12892 | 12892 | 10 | 10 | 2 | 0 | 0.026 | -1211 | 142 | 6 |
| Normalized PM Value Relative to Other Projects | 36% | 0% | 65% | 15% | 100% | 100% | 63% | 63% | 50% | 0% | 15% | -83% | 9% | 75% |
| Total Benefit Score (MAX 100) | 19.987 | | | | | | | | | | | | | |
| Total 2021 Project Cost ($M) | 0.63 | | | | | | | | | | | | | |
| Total Benefit Score / Cost | 31.726 | | | | | | | | | | | | | |

**Project Name:** FLT (Patton Park Through VSU to River Rd)

**Jurisdiction:** Petersburg

**Facility**
Fall Line Trail
Construct 10' wide multi-use trail

**Functional Classification**
N/A

**Project Type**
Multi-Use Trail

| Goal Areas | Safety | | Mobility / Congestion | | Accessibility | | | | | Environmental | | Economic Development | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Goal Weight | 25% | | 20% | | 20% | | | | | 10% | | 25% | | |
| Project Performance Measure (PM) | Crash Frequency | Crash Rate | Demand | Congestion | 2017 Access to Jobs | 2017 EJ Access to Jobs | Access to Non-Work Destinations | EJ Access to Non-Work Destinations | Access to Multimodal Options | Sensitive Features | Air Quality Impact | 2017-2045 Job Growth | Freight Jobs | Activity Centers |
| PM Weight | 12.5% | 12.5% | 10% | 10% | 4% | 4% | 4% | 4% | 4% | 5% | 5% | 15% | 5% | 5% |
| Unit of Measurement (PM) | Change in Crashes | Change in Rate of Crashes | Weighted Volumes | Weighted TTI | Number of Jobs | Number of Jobs | Number of Destinations | Number of Destinations | Points | Percentage of Sensitive Areas | Reduction in Emissions in Metric Tons | Number of Jobs | Number of Freight Jobs | Activity Units |
| PM Value | 1.961 | 0 | 37 | 0.35 | 649 | 649 | 16 | 16 | 2 | 0 | 0.071 | -2290 | 105 | 8 |
| Normalized PM Value Relative to Other Projects | 100% | 0% | 80% | 35% | 5% | 5% | 100% | 100% | 50% | 0% | 42% | -100% | 7% | 100% |
| Total Benefit Score (MAX 100) | 26.835 | | | | | | | | | | | | | |
| Total 2021 Project Cost ($M) | 1.60 | | | | | | | | | | | | | |
| Total Benefit Score / Cost | 16.772 | | | | | | | | | | | | | |

**Project Name:** Petersburg ART, University Blvd to Squaw Valley

**Jurisdiction:** Petersburg

**Facility**
Appomattox River Trail
Construct multi-use trail

**Functional Classification**
N/A

**Project Type**
Multi-Use Trail

| Goal Areas | Safety | | Mobility / Congestion | | Accessibility | | | | | Environmental | | Economic Development | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Goal Weight | 25% | | 20% | | 20% | | | | | 10% | | 25% | | |
| Project Performance Measure (PM) | Crash Frequency | Crash Rate | Demand | Congestion | 2017 Access to Jobs | 2017 EJ Access to Jobs | Access to Non-Work Destinations | EJ Access to Non-Work Destinations | Access to Multimodal Options | Sensitive Features | Air Quality Impact | 2017-2045 Job Growth | Freight Jobs | Activity Centers |
| PM Weight | 12.5% | 12.5% | 10% | 10% | 4% | 4% | 4% | 4% | 4% | 5% | 5% | 15% | 5% | 5% |
| Unit of Measurement (PM) | Change in Crashes | Change in Rate of Crashes | Weighted Volumes | Weighted TTI | Number of Jobs | Number of Jobs | Number of Destinations | Number of Destinations | Points | Percentage of Sensitive Areas | Reduction in Emissions in Metric Tons | Number of Jobs | Number of Freight Jobs | Activity Units |
| PM Value | 0.145 | 0 | 46 | 0.25 | 68 | 68 | 16 | 16 | 2 | 0 | 0.067 | -2051 | 132 | 8 |
| Normalized PM Value Relative to Other Projects | 7% | 0% | 100% | 25% | 1% | 1% | 100% | 100% | 50% | 0% | 39% | -100% | 8% | 100% |
| Total Benefit Score (MAX 100) | 15.834 | | | | | | | | | | | | | |
| Total 2021 Project Cost ($M) | 2.90 | | | | | | | | | | | | | |
| Total Benefit Score / Cost | 5.460 | | | | | | | | | | | | | |

**Project Name:** Walthall Park and Ride Lot (new from I-95 O&E)

**Jurisdiction:** Chesterfield

**Facility**
Walthall Park and Ride
Construct park and ride

**Functional Classification**
N/A

**Project Type**
Park and Ride

| Goal Areas | Safety | | Mobility / Congestion | | Accessibility | | | | | Environmental | | Economic Development | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Goal Weight | 25% | | 20% | | 20% | | | | | 10% | | 25% | | |
| Project Performance Measure (PM) | Crash Frequency | Crash Rate | Demand | Congestion | 2017 Access to Jobs | 2017 EJ Access to Jobs | Access to Non-Work Destinations | EJ Access to Non-Work Destinations | Access to Multimodal Options | Sensitive Features | Air Quality Impact | 2017-2045 Job Growth | Freight Jobs | Activity Centers |
| PM Weight | 12.5% | 12.5% | 10% | 10% | 4% | 4% | 4% | 4% | 4% | 5% | 5% | 15% | 5% | 5% |
| Unit of Measurement (PM) | Change in Crashes | Change in Rate of Crashes | Weighted Volumes | Weighted TTI | Number of Jobs | Number of Jobs | Number of Destinations | Number of Destinations | Points | Percentage of Sensitive Areas | Reduction in Emissions in Metric Tons | Number of Jobs | Number of Freight Jobs | Activity Units |
| PM Value | 0.851 | 0 | 4 | 0.12 | 8805 | 0 | 0 | 0 | 4 | 0 | 0.17 | 1459 | 1564 | 5 |
| Normalized PM Value Relative to Other Projects | 43% | 0% | 9% | 12% | 68% | 0% | 0% | 0% | 100% | 0% | 100% | 100% | 100% | 63% |
| Total Benefit Score (MAX 100) | 42.339 | | | | | | | | | | | | | |
| Total 2021 Project Cost ($M) | 5.31 | | | | | | | | | | | | | |
| Total Benefit Score / Cost | 7.973 | | | | | | | | | | | | | |

CRATER PLANNING DISTRICT COMMISSION

CPDC