

BMC Pedestrian Infrastructure Assessment Toolkit Manual

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SECTION I: INTRODUCTION

Welcome to the Baltimore Metropolitan Council (BMC) Pedestrian Infrastructure Assessment Toolkit (PIAT) Manual. The PIAT Manual provides concise, step-by-step instructions for using the PIAT.

A. Purpose and Overview

The PIAT includes three toolboxes designed to help BMC member jurisdictions identify pedestrian infrastructure needs and prioritize potential pedestrian infrastructure projects.

- *Data Management Toolbox*— Use this toolbox to create your own geodatabases structured to work with the PIAT, import your own layers, and update existing layers. Note that the PIAT comes with the geodatabases you need already included as well as most of the datasets, so your use of this toolbox is likely to be limited.
- *Needs Assessment Toolbox*— Use this toolbox to identify sidewalk and pedestrian crossing gaps, and to evaluate pedestrian travelsheds.
- *Prioritization Toolbox*—Use this toolbox to develop a ranked priority list of pedestrian infrastructure improvement locations. The locations can be identified through the *Needs Assessment Toolbox* or through another process.

The manual is organized around the three toolboxes, with a separate section for each. It also includes three appendices.

- **Appendix A: Data Requirements and Sources by Toolbox** provides critical details about the datasets needed for the *Needs Assessment Toolbox* and *Prioritization Toolbox*, including which tool or factor the dataset is needed for, the expected layer type, the required columns, and the data source.
- **Appendix B: Variable Measurement Details** provides details on how the PIAT measures the variables used in the *Prioritization Toolbox*.
- **Appendix C: Troubleshooting** provides troubleshooting tips.

B. Technical Requirements

To use the PIAT, you will need:

- ArcGIS Pro--The tool has been developed and tested in ArcGIS Pro 2.9.0.
- ArcGIS Pro Advanced license—This is needed for the *Needs Assessment Toolbox* to function fully. Basic and Standard license levels will work with limited functionality. See **Section III.B: Technical Requirements** for additional information.
- Spatial Analyst extension—This is needed for the *Travelshed Analysis Tool*.
- GIS experience related to data formatting.

C. Connecting to the PIAT Resources Folder

Creating a map project for your PIAT analysis and adding a connection to the *BMC_PAT_Resources* folder is a necessary first step for using the toolboxes provided with the PIAT. The *BMC_PAT_Resources* folder includes:

- *BMC-Pedestrian-Infrastructure-Assessment-Toolkit*—Contains the scripts and files necessary to run the PIAT. This is where you will find the three PIAT toolboxes: the *Data Management Toolbox*, the *Needs Assessment Toolbox*, and the *Prioritization Toolbox*.
- *PIAT_Data_Layers.gdb*— This geodatabase includes the spatial layers provided with the PIAT. If you decide to create your own geodatabases instead of using the pre-populated databases but wish to import some or all of the spatial layers provided with the PIAT, you can find them here.
- *PIAT_Pre_Populated_GDBs*— This geodatabase includes the standardized and scratch geodatabases provided with the PIAT. These databases are pre-populated with most of the datasets needed for the PIAT, except variables related to the *Opportunities*, *Constraints*, and *Stakeholder Engagement* factors, which must be supplied by the user in Excel tables.
- *sample_excel_table_format.xlsx*—This is a sample Excel table showing how variables that must be supplied by the user in an Excel table must be formatted. This file is provided as a sample for reference only and is not to be used with the PIAT tools.
- *PIAT Manual*—This manual.

Follow these steps to add a connection to the *BMC_PAT_Resources* folder in ArcGIS Pro:

Step 1. Open ArcGIS Pro.

Step 2. Create a *New Map* project.

Step 3. Open the *Catalog* window. (If not already open, click *View*, then select *Catalog* pane.)

Step 4. Click on the *Folders* tab in the *Catalog* window, then right click and select *add a folder connection*.

Step 5. Browse to the folder where the *BMC_PAT_Resources* folder is saved and add it as a folder connection in *Catalog*. The PIAT tools are located within this folder inside the *BMC-Pedestrian-Infrastructure-Assessment* folder (**Figure 1**).

Note: **Steps 1-5** only need to be done once, since added folder connections will remain saved if the ArcGIS Pro project is saved.

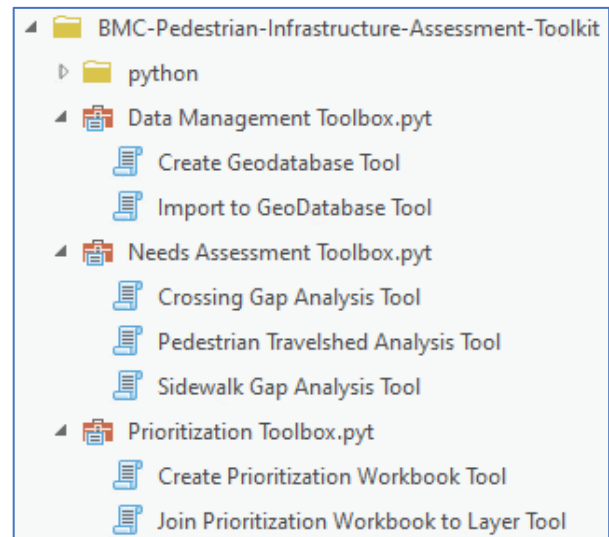


Figure 1: Screenshot of newly added folder connection with three toolboxes.

SECTION II: DATA MANAGEMENT TOOLBOX

If you haven't previously created a map project for your PIAT analysis and added a connection to the [BMC_PAT_Resources](#) folder, you'll need to do so now. This is a necessary step for using the toolboxes provided with the PIAT. See **Section I.C: Connecting to the PIAT Resources Folder** for instructions.

A. What It Does

The Data Management Toolbox includes two tools, the [Create Geodatabase Tool](#) and the [Import to Geodatabase Tool](#). **Section II is only required if you intend to create a new geodatabase or import new data instead of using the existing geodatabase provided with the PIAT.** See the paragraphs below for more information on these cases. If you do not want to do these things, skip to **Section III: Needs Assessment Toolbox** to start using the analysis tools.

Create Geodatabase Tool

This tool creates new standardized and scratch geodatabases structured to work with the PIAT. The standardized geodatabase houses all the layers and inputs used by the PIAT, while the scratch geodatabase houses intermediate layers and other temporary data that are needed for the PIAT tools to run. Note that these new geodatabases will be empty. Data can be imported into them by using the [Import to Geodatabase Tool](#).

Since the PIAT comes with built-in standardized and scratch geodatabases, you will only need to use this tool if you want to create additional databases. Examples of why you might want to create additional databases include:

- To do analysis for different datasets and keep them separate instead of overwriting them.
- To work with a copy of the PIAT geodatabases while leaving the original PIAT databases as is.
- To address a case where the PIAT has become corrupted.

Import to Geodatabase Tool

This tool enables you to import data into the standardized and scratch geodatabases. Before importing the data, it checks to make sure it is in the right format. You'll need to use the [Import to Geodatabase Tool](#) if one or more of the following are true.

- *You want to prioritize pedestrian infrastructure improvement locations by certain factors, specifically: Opportunities, Constraints, and Stakeholder Input.* The variables associated with these factors rely on local and/or project-specific data that you must format in an Excel table and import into the PIAT. The Excel tables must be formatted as indicated in **Appendix A: Data Requirements and Sources by Toolbox**.
- *You'd prefer to use your own data layer instead of a layer provided with the PIAT.* Note that data layers must be formatted as indicated in **Appendix A: Data Requirements and Sources by Toolbox**.
- *You'd like to replace a layer provided with the PIAT with a more up-to-date version of the layer from the same source.* Again, the layer must be formatted as indicated in **Appendix A: Data Requirements and Sources by Toolbox**.

B. How to Use the Create Geodatabase Tool

- Step 1.** Click on the *Folders* tab in the *Catalog* window.
- Step 2.** Double click on the *BMC_PIAT_Resources* folder and then double click on the *BMC-Pedestrian-Infrastructure-Assessment-Toolkit* folder.
- Step 3.** There will be three toolboxes with a *.pyt* extension, as shown in **Figure 1** on the previous page. Double click to expand the *Data Management Toolbox*.
- Step 4.** Double click to open the *Create Geodatabase Tool*.
- Step 5.** You will be prompted to select where you want the geodatabases to be created. Choose any location on your local drive that is convenient. To keep the PIAT files cleaner, we suggest not selecting the same folder as the folder housing the PIAT. In some cases, certain special characters in the folder path can prevent the tool from running properly. In such cases, try renaming the folder to something else; a folder path without spaces or non-alphanumeric characters works well. The underscore character “_” can be included in the folder name.
- Step 6.** After the folder has been selected, click *Run*. If the tool runs successfully, the box at the bottom right of your ArcGIS window will turn green and have a check mark next to *Standardize Data – Create Geodatabase Completed*.
- Step 7.** Navigate to the folder you just selected or created. There will be a new folder inside (**Figure 3**). The numbers populated in the folder name are based on the date (in YYYYMMDD format) the geodatabase was created. In the figure, the tool was run on June 8, 2022, thus generating a folder name with the numbers *20220608*.
- Step 8.** Within this folder there will be two geodatabases, the scratch geodatabase and the standardized geodatabase (**Figure 2**).

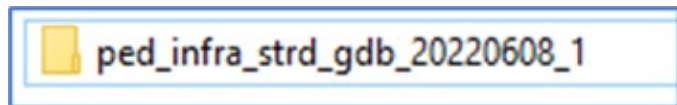


Figure 3

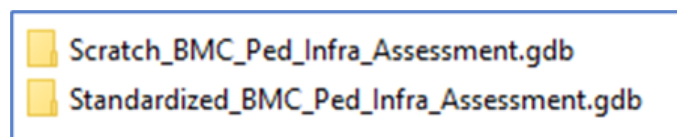


Figure 2

C. How to Use the Import to Geodatabase Tool

Step 1. Click on the *Folders* tab in the *Catalog* window.

Step 2. Double click to expand the *BMC_PIAT_Resources* folder.

Step 3. Double click to expand the *Data Management Toolbox*.

Step 4. Double click the *Import to Geodatabase Tool*. The tool dialog box will open as shown in **Figure 4**.

Step 5. *Folder with Standardized and Scratch Geodatabases*—Select the folder where the standard and scratch geodatabases are located. If you are using the geodatabases provided with the PIAT, they will be located inside the

BMC_PIAT_Resources folder. If you created your own standardized and scratch geodatabases using the *Create Geodatabase Tool*, they will be located where you saved them.

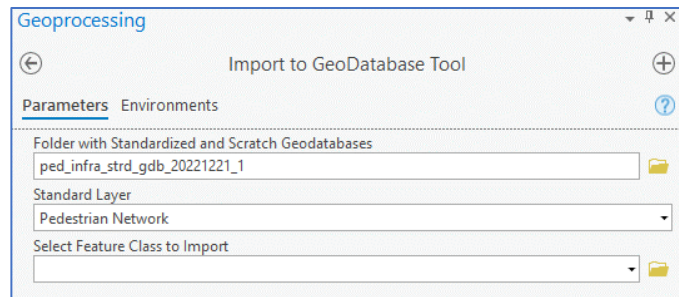


Figure 4: Screenshot of the Import to Geodatabase Tool dialog box.

Step 6. *Standard Layer*—Identify which standard layer you want to import. Click the arrow to show a drop-down box. See **Table 1** on the next page for a list of standard layers and corresponding names in the standardized geodatabase. You will have to go through this same process for each standard layer. Note that if you intend to replace a current standard layer, you will first need to delete that layer from the standardized geodatabase.

Step 7. For spatial datasets: *Select Feature Class to Import*— Navigate to the location where the data to import is stored. If you are importing from the original datasets provided with the tool, these are in the PIAT_Data_Layers.gdb in the BMC_PIAT_Resources folder. Select the feature class or shapefile corresponding to the *Standard Layer* from the previous step. This parameter only appears if the *Standard Layer* selected is a spatial dataset and not an Excel file.

Step 8. For Excel tables: *Excel Workbook* and *Worksheet with Location Information*—These parameters appear if the selected *Standard Layer* requires you to provide an Excel table. Select the location of the Excel workbook and the worksheet within the workbook where the data is located.

Table 1: List of Standard Layers and Corresponding Dataset Name in Standardized Geodatabase

Standard Layer Name	Dataset Name in Standardized Geodatabase
Plan / Approved List	PlannedAppvList
Recommended by Advisory Committee	AdvisoryCommitteeRecs
Cost	CostList
Grant Funding Candidate	GrantFundingCandidateList
Coincides with Planned Roadway Improvement / Maint	CoincidesPlannedRoadwayImprovement
Pedestrian Network	PedestrianNetwork
Population Counts	PopulationCounts
Employment Counts	EmploymentCounts
Vulnerable Population Index	VulnerablePopulationsIndex
Traffic Signals	Traffic_Signals
All Pedestrian Crashes	AllPedestrianCrashes
Pedestrian Fatalities and Severe Injuries	FatalandSeverePedCrshs
Multi-Jurisdictional or Multi-Agency Coordination	Jurisdictions
Schools, Public K-12	SchoolsK12
Higher Education, College and Universities	HigherEducation
Retail Locations	RetailLocations
Intersections	Intersections
Minor Transit Stops	MinorTransitStops
Major Transit Stops	MajorTransitStops
Functional Classification	FunctionalClassification

Step 9. Select [Run](#). If the layer or table was imported properly, the box at the bottom right of your screen will turn green and produce a checkmark next to [Import to Geodatabase Tool completed](#). (**Figure 5**) If the validation checks are unsuccessful, you will receive an error message. See **Section II.D: Validation Checks** below for a description of what the tool looks for when it runs validation checks. See **Section II.E: Common Error Messages** for a description of common error if your dataset fails the validation checks.

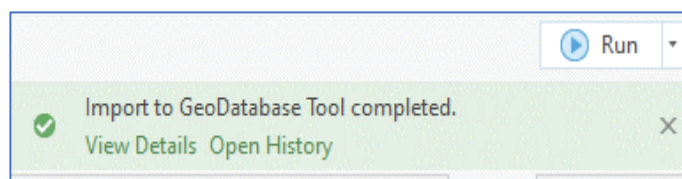


Figure 5: Screenshot of message that appears if validation checks are successful and the layer imported properly.

Step 10. Navigate back to the Catalog Pane. Expand the [Standardized_BMC_Ped_Infra_Assessment.gdb](#). The imported data layer or table should now be in the standardized geodatabase. Depending on the feature type, it will either be a geodatabase feature class or geodatabase table. This data can be added to your map. To spot check that the data came through properly, see if the desired data type (point, geometries) populates on your map.

D. Validation Checks

The following is a description of the validation checks the *Import to Geodatabase Tool* performs when importing data.

For Excel workbooks, the tool will verify that the worksheet:

- Doesn't already exist in the geodatabase.
- Is not empty.
- Includes only two columns of data.
- Includes the expected columns.
- Includes the expected column headers.
- Includes values for each attribute that meet certain basic criteria. See **Appendix A: Data Requirements and Sources by Toolbox** for specific values and ranges.

For GIS layers requiring geometry only, the tool will verify that the layer:

- Doesn't already exist in the geodatabase.
- The feature class contains data.
- Geometry type (polyline, point, polygon, etc.) is correct.

For GIS Layers Requiring Geometry and Specific Fields, the tool will verify that the layer:

- Doesn't already exist in the geodatabase.
- Contains data.
- Includes the expected attribute table fields.
- Includes attribute table fields that have the expected field properties (integer, decimals, text, etc.).
- Doesn't include unexpected values.
- Geometry type (polyline, point, polygon, etc.) is correct.

E. Common Error Messages

The *Import to Geodatabase Tool* will display an error message if the data you are attempting to import fails the validation checks or if the tool encounters other issues in the import process. Common error messages include.

- *Geodatabase names are not valid.* – This error occurs when there are too many geodatabases in the folder with the standardized and scratch geodatabases. It can also occur if modifications have been made to the standardized or scratch geodatabases that could cause the tool to fail. Creating a fresh geodatabase using the *Create Geodatabase Tool* should resolve this error.
- *This table already exists. Delete it or select another layer.* – This error occurs when the table you are trying to import is already in the standardized geodatabase. To resolve this error, delete the existing table and rerun the *Import to Geodatabase Tool*.
- *The shapefile you imported is the incorrect geometry type.* – This error occurs when the geometry type of the shapefile you are attempting to import is different from what the tool expects, e.g., point shapefile instead of polygon shapefile. Refer to **Appendix A: Data Requirements and Sources by Toolbox** for geometry type details.
- *Expected attributes do not all exist in the shapefile you provided.* – This error occurs when required attributes are missing from a shapefile selected for import. Refer to **Appendix A: Data Requirements and Sources by Toolbox** for attribute details.
- *The 'p_id' column is not unique.* – This error occurs when the values in the primary id column are not unique for each feature or row in the table. To resolve this error, recalculate the primary id column with unique values for each feature or row.
- *Excel table errors* – This error occurs when a column is missing, or the column headers differ from what is expected.
- *999999: Something unexpected caused the tool to fail.* – This is a generic error message that sometimes occurs in ArcGIS Pro. To resolve this error, try restarting the application or the computer. In some cases, a folder path or name being too long might also create this error. Please try shorter names and avoid using special characters in the names. More details on this error can be found here <https://pro.arcgis.com/en/pro-app/2.9/tool-reference/tool-errors-and-warnings/999001-999999/tool-errors-and-warnings-999998-999999-999999.htm>

SECTION III: NEEDS ASSESSMENT TOOLBOX

A. What It Does

There are three tools in the *Needs Assessment Toolbox*: the *Sidewalk Gap Analysis Tool*, the *Crossing Gap Analysis Tool*, and the *Pedestrian Travelshed Analysis Tool*.

Sidewalk Gap Analysis Tool

This tool uses the street network layer as an input, generates a buffer based on a user-defined buffer size, and measures sidewalk length within the street segment buffer on each side of the street. The tool uses sidewalks (CateTitle=sidewalk) from the *PedestrianNetwork* layer from the standardized geodatabase. If the measured sidewalk length is shorter than the street length by a value you specify, then the street is flagged as having a sidewalk gap.

Crossing Gap Analysis Tool

This tool compares the distance between low-stress crossings to a threshold you specify and identifies segments that exceed the threshold. The tool uses the street network layer with street name and functional class attributes as an input. The tool identifies continuous street corridors, which it accomplishes by dissolving adjacent street segments based on street name and functional class. These corridors are then overlaid with low-stress crossing locations, which by default are defined as locations where there is a traffic signal. However, you can also define your own low-stress crossing locations by inputting your own layer into the tool. The tool uses a 30-foot buffer distance to select crossing locations along a street corridor, so it is important that any features intended to represent low-stress crossings be within this distance of the street centerlines. Finally, the distance between low-stress crossings is compared against the crossing gap threshold you specify to identify street segments where the distance between low-stress crossings exceeds the threshold. Optionally, you can also supply a high-stress crossings layer. If a high-stress crossings layer is given, the tool removes any low-stress crossing locations within 30 feet of these high-stress locations before generating the crossing gaps.

Pedestrian Travelshed Analysis Tool

This tool computes travelsheds around user-defined locations and outputs the following travelshed layers based on a travel distance you specify.

- **Euclidean Travelshed**—This travelshed is calculated based on a straight-line or “as the crow flies” distance. It is the theoretical maximum possible travelshed.
- **Sidewalk Network Travelshed**—This travelshed is calculated using the sidewalk network from the *PedestrianNetwork* layer from the standardized geodatabase. Unmarked crosswalks (CateTitle=crosswalk_unmarked) are excluded from this analysis. The output is a polygon layer with a 100-foot buffer applied around the sidewalk network within the user-defined travel distance.
- **Optional Network Travelshed**—This travelshed is calculated with a user-supplied network layer, e.g., a street network layer. The user also has the option to choose whether to combine this layer with the sidewalk network layer or to use it separately for travelshed analysis.

B. Technical Requirements

The [Sidewalk Gap Analysis Tool](#) and the Pedestrian [Travelshed Analysis Tool](#) require an ArcGIS Pro Advanced License to run with full functionality. Running the [Sidewalk Gap Analysis Tool](#) without the Advanced License will result in skewed calculations due to rounded buffer ends and buffers not being separated by left and right sides. Running the [Pedestrian Travelshed Analysis Tool](#) without the Advanced License will also prevent running the tool on an optional network that is different from the [Pedestrian Network](#) in the standardized geodatabase.

The Pedestrian [Travelshed Analysis Tool](#) requires the Spatial Analyst extension to run.

If you don't have these licenses/extensions, contact your GIS admin to activate them.

In addition, the layers listed in **Table 2** are required for the [Needs Assessment Toolbox](#). If you are using the data provided with the PIAT, these layers will already be in the standardized and scratch geodatabases. If you have decided not to use the provided layers, you will need to import them using the [Import to Geodatabase Tool](#). See **Section II.C: How to Use the Import to Geodatabase Tool** for details. See **Appendix A: Data Requirements and Sources by Toolbox** for more information about required data formats.

Table 2: Standard Layers Required for Needs Assessment Toolbox

Tool	Standard Layer Name	Dataset Name in Standardized Geodatabase
Sidewalk Gap Analysis Tool	Pedestrian Network	PedestrianNetwork
Crossing Gap Analysis Tool	Traffic Signals	Traffic_Signals
Pedestrian Travelshed Analysis Tool	Pedestrian Network	PedestrianNetwork

Finally, if you plan to use a street centerline layer that is different from the street centerline layer provided with the PIAT, it is recommended that the layer be broken at intersections, so sidewalk breaks at intersections are not counted as gaps.

C. How to Use the Sidewalk Gap Analysis Tool

Step 1. Open the *Sidewalk Gap Analysis Tool* within the *Needs Assessment Toolbox* by double clicking it. See **Figure 6** for a screenshot of the tool dialog box that appears when you do this.

Step 2. *Street Centerline Layer*—Select the street centerline layer. If you are using the data provided with the PIAT, this layer will be called *FunctionalClassification*. This layer is provided by the Maryland Department of Transportation State Highway Administration (MDOT SHA) with some processing done by BMC. If you wish to run this tool for a smaller area or a selected subset of roadways, you can do so by applying a definition query or a selection on this layer before running the tool.

Figure 6: Screenshot of Sidewalk Gap Analysis Tool dialog box.

Step 3. *Primary Key*—Choose a primary key field. The primary key field may be any field type, provided it contains a unique value for each feature. If you are using the data provided with the PIAT, this field is **pkey_field**.

Step 4. *Buffer Value Type*—Select the buffer value type. The buffer value determines the size of the buffer around the street centerline. The buffer is used for determining whether a sidewalk is present. This can be a single value for all features or a field in the attribute table of the street centerline if the user wishes to have different buffer sizes for different segments. Selecting *Value* enables you to compute the buffer based on a value you specify in the tool. (We recommend 50 feet as a starting point.) Selecting *Field* enables you to compute the buffer based on the values in a *Buffer Distance field* in a street centerline layer you provide. This option allows you to customize the buffer distance for specific streets or street types, e.g., based on characteristics like street functional classification.

Step 5. (Optional) *Query to identify each side of a divided road*— This is an optional input to specify which segments represent one side of a divided roadway. If you are using the data provided with the PIAT, the query to identify these segments is **Divided_Centerline = 'Y'**. Since each side of a divided roadway roadways and calculates sidewalk gaps by looking at both sides of the segment. will only need sidewalk on one side, the tool calculates sidewalk gaps for these segments differently than other segments. If this input is not provided, the tool assumes all streets are undivided

- Step 6.** *Folder with Standardized and Scratch Geodatabases*—Select the folder where the standardized and scratch geodatabases are located. If you are using the standardized and scratch geodatabases provided with the PIAT, you will select the *PIAT_Pre_Populated_GDBs* folder inside the *BMC_PIAT_Resources* folder.
- Step 7.** *Output Feature Class with Scores*—Indicate where the output feature class with scores should be saved. *Output Feature Class* should automatically populate with a default location in your Pro project geodatabase; however, you can choose a different location if you prefer. It is recommended that the output not be saved in the same folder as the standardized geodatabases to avoid potential errors.
- Step 8.** (Optional) *Sidewalks Layer*—Provide an optional sidewalk layer. The tool will default to the *PedestrianNetwork* layer in the standardized geodatabase, but you can select another sidewalk layer (polyline geometry type) if you prefer. Note that this layer should only contain lines corresponding to sidewalk features. Any other features, e.g., crosswalks, can skew the results.
- Step 9.** *Sidewalk deficit length in feet*—Sidewalk deficit length is used to determine whether a gap exists. If the difference between the length of the street segment and the length of the sidewalk exceeds this value, the street segment is flagged as having a sidewalk gap. Enter the sidewalk deficit length in feet. The default value is 100 feet, but you can choose a different value based on local conditions. Having a smaller value for this input will flag more segments as having sidewalk gaps in the output and vice versa.
- Step 10.** Click *Run*. If you do not have an ArcGIS Advanced license, you will receive a message saying, *Needs Assessment – Identify Sidewalk Gaps completed with warnings*. The results are still valid. This message indicates that the tool was not able to calculate sidewalk lengths for the left and right sides of the street separately. In this case, the tool will determine the presence of a sidewalk gap based on the combined length of sidewalk on both sides of the street.

Outputs

- The output layer from this tool varies based on whether you have an ArcGIS Advanced license.
- Without an Advanced license, the output layer has the following attributes related to sidewalk gaps:
 - *sw_length_both_sides*— This attribute indicates the total length, in feet, of sidewalk features within the buffer specified for both sides of the street.
 - *sw_gap_length_both_sides*— This attribute is the difference between the length of the centerline feature and the *sw_length_both_sides* value described above.
 - *sw_gap_both_sides*— This attribute has a value of “True” or “False” based on the sidewalk gap length and whether the street is divided or not.
- With an Advanced license, the output layer has the following attributes related to sidewalk gaps:
 - *divided*— If the optional divided road input is provided in Step 5 above, this attribute has a value of 1 if the road input was divided and a value of 0 if it was not divided.
 - *sw_length_LEFT, sw_length_RIGHT*— These attributes indicate the total length of the sidewalk lines within the specified buffer distance on each side of the street.
 - *sw_gap_length_LEFT, sw_gap_length_RIGHT*— These attributes indicate the difference in feet between the centerline feature and sidewalk length fields described above.

- *sw_gap_LEFT, sw_gap_RIGHT* – These attributes have a value of ‘True’ or ‘False’ to indicate whether a centerline has a sidewalk gap on each side based on the parameters provided.
- *sw_gap_type* – This attribute indicates where the gap(s) occur: No Gap, Gap on Both Sides, Gap on One Side, or Gap on Divided Roadway (if the option in Step 5 is used).
- The output layer is automatically symbolized using the **sw_gap_type** field into No Gap and Gap Present classifications. The Gap Present classification combines the Gap on Both Sides, Gap on One Side, or Gap on Divided Roadway values. The symbology palette can be used to display these categories separately, if desired.
- The primary key field titled *uid* in the output layer can be used to join the results back to the original input for further analysis, if needed.

D. How to Use the Crossing Gap Analysis Tool

Step 1. Open the *Crossing Gap Analysis Tool* within the *Needs Assessment Toolbox* by double clicking it. The tool dialog box will open as shown in **Figure 7** above.

Step 2. *Streets Layer*— Select the street centerline layer. If you are using the data provided with the PIAT, this layer will be called *FunctionalClassification*. This layer is provided by MDOT SHA with some processing done by BMC. If you wish to run this tool for a smaller area or for selected roadways, you can do so by applying a definition query or a selection on this layer before running the tool. You can also import your own street layer. The street centerline layer must include the street name and functional class fields. Note that there should not be any NULL values in these fields. Please format your data layer to remove any NULL values before running the tool.

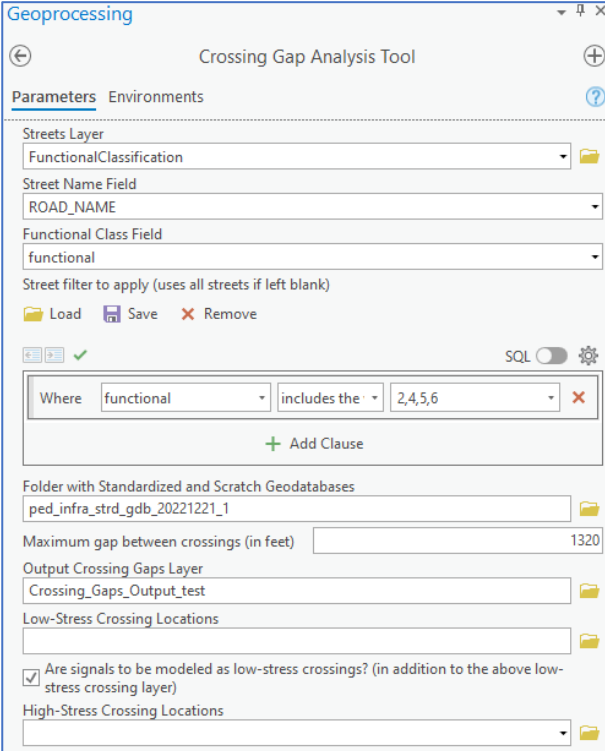


Figure 7: Screenshot of Crossing Gap Analysis Tool dialog box.

Step 3. *Street Name Field*—Select *ROAD_NAME* (or equivalent field in your layer). This must be a text field.

Step 4. *Functional Class Field*—Select *functional* (or equivalent field in your layer). You can use either the numeric functional classifications or the descriptive text functional classifications. This field must be a text or integer type.

Step 5. (Optional) *Street filter to apply* layer query—If desired, set up a query to specify which subset of streets to analyze. In **Figure 7**, functional class is used to limit the analysis to arterials and collectors.

Step 6. *Folder with Standardized and Scratch Geodatabase*—Select the folder where the standardized and scratch geodatabases are located. If you are using the standardized and scratch geodatabases provided with the PIAT, you will select the *PIAT_Pre_Populated_GDBs* folder inside the *BMC_PAT_Resources* folder.

Step 7. *Maximum gap between crossings*—Fill in a maximum gap between low-stress crossings in feet that you feel is appropriate. We suggest starting with 1320 feet (0.25 miles), which is the default, but you may want to adjust that figure based on the context.

Step 8. *Output Crossing Gaps Layer*—Choose where to save the *Output Crossing Gaps Layer*. The output layer saves to the project workspace by default, but you can choose another location.

Step 9. (Optional) *Low-Stress Crossing Locations*— Select a point layer with low-stress crossing locations. The points must be within 30 feet of the linear street network for the tool to recognize them. If you do not input *Low-Stress Crossing Locations*, the tool will use the *Traffic Signals* layer in the standardized geodatabase as low-stress crossing locations.

If you input your own *Low-Stress Crossing Locations* layer, you can also specify whether to combine traffic signals with these low-stress crossing locations by checking the box next to *Are signals to be modeled as low-stress crossings?*

Step 10. (Optional) *High-Stress Crossing Locations*— Select a point layer with high-stress crossing locations. The points must be within 30 feet of the linear street network for the tool to recognize them. If you input High-Stress Crossing Locations, the tool will ignore any low-stress crossing locations or traffic signals within 30 feet of a high-stress crossing location.

Step 11. Click *Run*.

Outputs

- The output layer has an attribute *crossing_gap* which has the values “TRUE” or “FALSE” indicating whether the segment is part of a corridor whose length is greater than the maximum gap length provided as a tool input.

E. How to Use the Pedestrian Travelshed Analysis Tool

Step 1. Open the *Pedestrian Travelshed Analysis Tool* within the *Needs Assessment Toolbox* by double clicking it. The tool dialog box will open as shown in **Figure 8**.

Step 2. *Destination Layer*—Select the destination layer. In the example shown in **Figure 8** we used a layer called *points_testing_bmc* for testing purposes, but you can use any layer, e.g., transit stops, schools, parks, etc. This parameter can accept any geometry type (points, lines, or polygons).

Step 3. *Buffer Distance*—Input an appropriate buffer distance to address cases in which the destination feature is not directly on the pedestrian network. The tool's default buffer distance is 50 feet, but you may wish to change this based on the *Destination Layer* you have selected. *Destination Layer* features should be within the specified buffer distance to the nearest pedestrian facility. If no features are within the buffer distance, the tool will give an error message.

Step 4. *Travel Distance*—Input an appropriate travel distance based on the maximum distance most pedestrians are likely to travel to the type of destination selected, e.g., 1 mile for a *Destination Layer* with elementary schools. The default value is 0.5 miles.

Step 5. *Folder with Standardized and Scratch Geodatabases*—Select the folder where the standardized and scratch geodatabases are located. If you are using the standardized and scratch geodatabases provided with the PIAT, you will select the *PIAT_Pre_Populated_GDBs* folder inside the *BMC_PAT_Resources* folder.

Step 6. (Optional) *Optional layer to run routing for travelshed analysis*—The *Pedestrian Travelshed Analysis Tool* automatically runs a travelshed analysis using the *Pedestrian Network* layer in the standardized geodatabase. This analysis excludes all unmarked crosswalks (CateTitle=crosswalk_unmarked). Optionally, you may also input an additional layer to run the routing for the travelshed analysis. All features in the optional layer will be included in the analysis, regardless of their attributes. The optional layer can be a street network, a pedestrian network with new planned connections, or another type of network, and can be any geometry type (points, lines, or polygons). You can choose to run the analysis on this optional layer by itself, or you can check the box next to *Should the "Pedestrian Network" Layer...* for the tool to add this optional layer to the *Pedestrian Network* layer in the standardized geodatabase and run the analysis on that combined layer. Note that optional layer routing is only possible with an ArcGIS Advanced license.

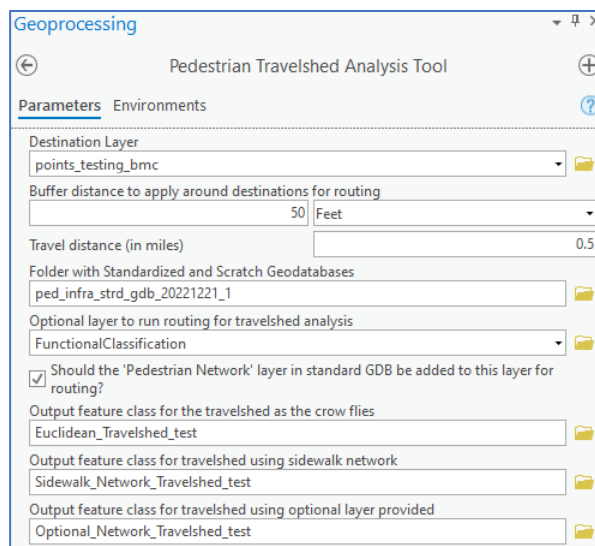


Figure 8: Screenshot of Pedestrian Travelshed Analysis Tool dialog box.

Step 7. *Output feature class*—Use the final three fields in this dialog to indicate where you want to save the outputs from the travelshed analysis. The default location is the project's workspace, but you can choose another location if you prefer. The three travelshed output feature classes are as follows

- a. Euclidean Travelshed (as the crow flies distance)
- b. Sidewalk Network Travelshed
- c. Optional Network Travelshed

Step 8. Click *Run*.

Outputs

- The following travelshed layers are created as outputs by the tool:
 - *Euclidean Travelshed*— This layer shows an as the crow flies travelshed from the destination locations. This can be seen as a theoretical maximum area one can cover within a given distance without regard to any network routing.
 - *Sidewalk Network Travelshed*— This is the travelshed from the destination locations using the Pedestrian Network layer that is in the standardized geodatabase. Routing and travelsheds are first calculated along a rasterized network. The tool outputs a line feature class of the pedestrian travelshed. It also buffers this by 100 feet and outputs a polygon feature class of the buffered travelshed (same feature name with "_buffer" appended at the end).
 - *Optional Network Travelshed*— This travelshed is only created if an optional network is provided for routing and if an advanced license is present. This travelshed is calculated in the same manner as the sidewalk network travelshed above, but using the optional network provided. If the box is checked in the tool to combine the Pedestrian Network layer with this layer, then routing is done on a rasterized network combining both these layers. The tool outputs a polygon feature class of the pedestrian travelshed. If the input optional network was line geometry, you can extract the linear version of the output by clipping the original input optional network layer with this output polygon. The tool also buffers the output by 100 feet and outputs a polygon feature class of the buffered travelshed (same feature name with "_buffer" appended at the end).

SECTION IV: PRIORITIZATION TOOLBOX

A. What It Does

The *Prioritization Toolbox* enables you to prioritize improvement locations based on weighted factors and variables. Improvement locations can be identified through the *Needs Assessment Toolbox* or through another process. Three tools are included in this toolbox: the *Create Prioritization Workbook Tool*, the *Prioritization Workbook*, and the *Join Prioritization Workbook to Layer Tool*. These tools must be used in sequence.

Create Prioritization Workbook Tool

This tool enables selection of the factors and variables that will be used to prioritize the improvement locations layer, which can be any point or polyline layer. Based on these selections, the tool calculates unweighted data values for each improvement location for each selected variable. Information about how these calculations are performed is provided in **Appendix B: Variable Measure Details**.

Prioritization Workbook

This tool is an Excel workbook. It computes prioritization scores based on weights, rescaling methodologies, and minimum and maximum scores specified by the user. The computed scores include factor, variable, and total scores for each improvement location. You can adjust and calibrate weights and rescaling methods on the fly without having to run additional spatial processes in ArcGIS Pro.

Join Prioritization Workbook to Layer Tool

This tool joins the scores generated by the Prioritization Workbook back to the improvement locations layer. The output is a GIS layer that includes those scores.

B. Technical Requirements

The formulas used in the Prioritization Workbook are tested in Microsoft Excel 2016 and higher and may not work in older versions of Excel. The number of improvement locations that can be prioritized at one time is limited to 999.

C. Key Terms

Improvement Locations: Locations that have been identified for potential improvements, such as new sidewalks or improved pedestrian crossings. Improvement locations are represented in GIS as either points or polylines.

Factors: Factors are categories of variables that may contribute to a specific community or agency goal. For example, the *Pedestrian Potential* factor considers variables such as proximity to colleges and universities, retail, transit stops, and other characteristics related to the potential for pedestrian activity.

Variables: Variables are characteristics of roadways, households, neighborhood areas, and other features that can be measured. Variables are the core elements of the prioritization process. For example, *Population Counts* and *Major Transit Stops* are variables.

Data Values: Data values are the numerical outcome when measures are applied to specific locations. For example, if the variable is *Major transit Stops* and the measure is *Number of major transit stops within ¼ mile*, then the data values would be the number major transit stops within ¼ mile for each improvement location included in the prioritization.

Weights: Weights are applied to indicate the relative importance of different factors and variables based on community or agency values. For example, if you decide that the *Safety* factor is more important than the *Constraints* factor, you will give the *Safety* factor a higher weight. Unweighted factor and variable scores are multiplied by the weight to determine weighted variable and factor scores.

Rescaling: Rescaling involves identifying a common numeric scale, e.g., 0 to 100, for all variables and adjusting the data value for each variable to fit this scale. The purpose of rescaling is to make variables with different data value ranges comparable to one another. Otherwise, variables with higher data value ranges, e.g., *Population Counts*, might far outweigh variables with low numerical ranges, e.g., *All Pedestrian Crashes*, when the prioritization score is calculated. The user can also select different mathematical methods for rescaling.

Prioritization Scores: Prioritization scores are the final scores for each discrete improvement location considered in the prioritization process. They are the result of multiplying the scaled data values by specific weights and summing these values across all factor categories. These prioritization scores are ranked from highest to lowest score to create the final prioritized list.

D. How to Use the Create Prioritization Workbook Tool

Step 1. Expand the *Prioritization Toolbox* in the *Catalog* window and double click on *Create Prioritization Workbook Tool*. The tool dialog box will open as shown in **Figure 9**.

Step 2. *Prioritization Feature Layer*—Select the dataset with the improvement locations you want to prioritize. This can be any point or polyline layer.

These features do not have to coincide with any existing roadway or other real-life features. However, if features are greater than 150 feet away from the nearest roadway centerline in the FunctionalClass layer (excluding interstates with functional class = 1), they will not be given a relative weight for the Functional Class variable in the Safety factor. See **Appendix B: Variable Measurement Details** for additional details.

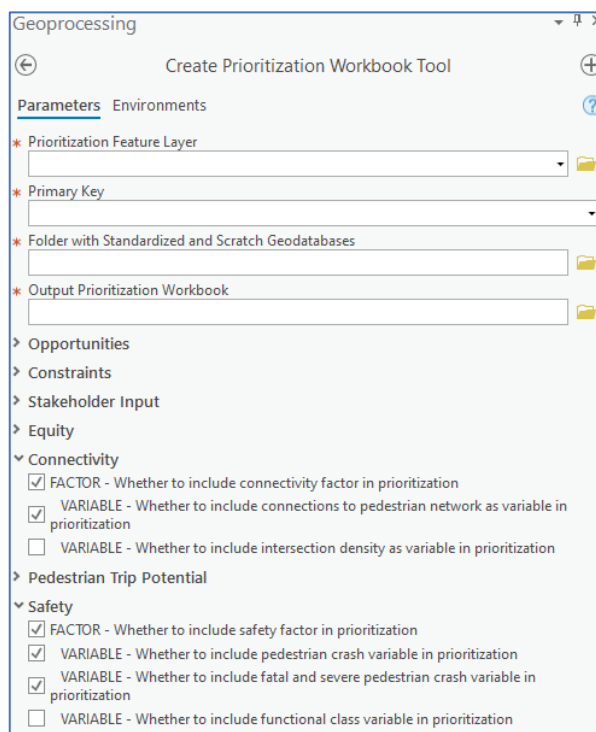


Figure 9: Screenshot of Create Prioritization Workbook Tool dialog box.

Step 3. *Primary Key*—Select the primary key field in the *Prioritization Feature Layer*. This field must be a unique identifier. If using variables within the Opportunities, Constraints, and Stakeholder Input factors, the values in this primary key field must match the *p_id* value in the corresponding user-provided tables in the standardized geodatabase: GrantFundingCandidateList, CoincidesPlannedRoadwayImprovement, CostList, AdvisoryCommitteeRecs, and PlannedAppvList. Note that the default OBJECTID field cannot be used as a primary key field.

Step 4. *Folder with Standardized and Scratch Geodatabases*—Select the folder where the standardized and scratch geodatabases are located. If you are using the standardized and scratch geodatabases provided with the PIAT, you will select the *PIAT_Pre_Populated_GDBs* folder inside the *BMC_PIAT_Resources* folder.

Step 5. *Output Prioritization Workbook*—Select where you want the Prioritization Workbook to be saved and provide a name for the file that will be created. The *Prioritization Workbook* is an Excel workbook where the unweighted data values from the prioritization spatial processes will be saved for use with the next tool.

Step 6. *Factors and Variables*—Select the factors and variables you want to include in your prioritization calculations. Selecting a factor enables selection of variables under that factor grouping. You

can select any combination of variables, provided the needed inputs are in the standardized geodatabase. See **Appendix A: Data Requirements and Sources by Toolbox** for details on which data layer is needed for each prioritization variable. See **Appendix B: Variable Measurement Details** for details on how the tool measures each variable. If you do not select any variables under a factor, neither the factor nor any of the variables within it will be included in the prioritization analysis and cannot be added later without rerunning the [Create Prioritization Workbook Tool](#). If the selected variables require layers or tables that are missing from the standardized geodatabase, the tool will give an error message in the form of "Data corresponding to [Layer Name] is not present in standard GDB."

- Step 7.** Click [Run](#). This will write the unweighted data values from the prioritization spatial process to the Prioritization Workbook.

E. How to Use the Prioritization Workbook

Step 1. Open the *Prioritization Workbook*— This is the Excel workbook that is the output from the *Create Prioritization Workbook Tool* named in Step 5 of the Create Prioritization Workbook Tool. All the user inputs that are used to calculate prioritization scores are in the worksheet titled *Inputs – Weights*. (Figure 10)

Step 2. *Relative Weight of Variables*— Modify the relative variable weights in cells C2-C28 where there is green fill. Green fill indicates the variables you selected when using the *Create Prioritization Workbook Tool*. Entering weights for variables not formatted with green fill will cause the tool process Prioritization Workbook to fail.

By default, variable weights are set to 10 but can be adjusted as desired. If you selected only one variable within a factor, then the relative weight is irrelevant and can be left at the default value. At least one included variable (green fill) for each factor must have a value greater than zero for the workbook to work properly.

Note that relative weights do not need to total to any particular number. The workbook automatically calculates adjusted weights, which appear as percentages in column D.

Step 3. *Relative Weight of Factors*— Modify the relative factor weights in cells B32-B28 where there is green fill. The relative weight of at least one included factor (green fill) must have a value greater than zero for the workbook to work properly.

	A	B	C	D	E	F	G
1	Factor	Variable	Relative Wt	Adjusted Wt	Rescaling Method	Include	Score Range
2	Opportunity	GrantFunding	10	100.0%	NONE	TRUE	1-100
3		CoincidesRoadwayImprovement	10	0.0%	NONE	FALSE	1-100
4	Constraints	MultiJurisdictional	10	50.0%	NONE	TRUE	1-100
5		Cost	10	50.0%	CATEGORICAL	TRUE	1-100
6	Stakeholder	AdvisoryCommittee	10	0.0%	NONE	FALSE	1-100
7		AdoptedPlan	10	0.0%	NONE	FALSE	1-100
8	Equity	Disabilities	10	50.0%	PERCENTILE	TRUE	1-100
9		Income	10	50.0%	PERCENTILE	TRUE	1-100
10		LimitedEnglishProficiency	10	0.0%	PERCENTILE	FALSE	1-100
11		VehicleAccess	10	0.0%	PERCENTILE	FALSE	1-100
12		OlderPopulation	10	0.0%	PERCENTILE	FALSE	1-100
13		HispanicPopulation	10	0.0%	PERCENTILE	FALSE	1-100
14		NonWhitePopulation	10	0.0%	PERCENTILE	FALSE	1-100
15		YoungerPopulation	10	0.0%	PERCENTILE	FALSE	1-100
16		VPI	10	0.0%	PERCENTILE	FALSE	1-100
17	Connectivity	PedestrianNetwork	10	0.0%	NONE	FALSE	1-100
18		IntersectionDensity	10	0.0%	PERCENTILE	FALSE	1-100
19	PedTripPotential	PopulationDensity	10	0.0%	PERCENTILE	FALSE	1-100
20		EmploymentDensity	10	0.0%	PERCENTILE	FALSE	1-100
21		Schools	10	0.0%	PERCENTILE	FALSE	1-100
22		HigherEducation	10	0.0%	PERCENTILE	FALSE	1-100
23		Retail	10	0.0%	PERCENTILE	FALSE	1-100
24		MinorTransit	10	0.0%	PERCENTILE	FALSE	1-100
25		MajorTransit	10	0.0%	PERCENTILE	FALSE	1-100
26	Safety	Crashes	10	0.0%	PERCENTILE	FALSE	1-100
27		SevereFatalCrashes	10	0.0%	PERCENTILE	FALSE	1-100
28		FunctionalClass	10	0.0%	CATEGORICAL	FALSE	1-100
29							
30					Rescale Type		
31	Factor	Factor Wt	Adjusted Wt	Include	LINEAR		
32	Opportunity	10	33.3%	TRUE	PERCENTILE		
33	Constraints	10	33.3%	TRUE	QUANTILES		
34	Stakeholder	10	0.0%	FALSE	DECILES		
35	Equity	10	33.3%	TRUE	NONE		
36	Connectivity	10	0.0%	FALSE	CATEGORICAL		
37	PedTripPotential	10	0.0%	FALSE			
38	Safety	10	0.0%	FALSE			

Figure 10: Screenshot of Inputs – Weights sheet in Prioritization Workbook

You should only edit the cells with green fill. These are the cells corresponding to the factors and variables you selected when you ran the *Create Prioritization Workbook Tool*. Editing other cells or renaming any of the sheet titles will cause the tool process *Prioritization Workbook* to fail.

Step 4. *Relative Score of Categories*— The Cost and FunctionalClass variables are categorical variables, meaning that each variable value is treated as a category rather than as a number. If you included these variables, you will need to indicate how each value category should be scored. When thinking about what scores to use, it is helpful to have a better understanding of how the variable is used. See **Cost and FunctionalClass Variables box** below.

Cost and FunctionalClass Variables

Cost

- *Cost* is a variable in the *Constraints* factor.
- The tool uses the Cost table in the standardized geodatabase
- The *Cost* table can have values of “High”, “Medium” and “Low”.
- Cells J3-L3 in the workbook allow you to assign numeric scores for each of these values.

FunctionalClass

- *FunctionalClass* is a variable in the *Safety* factor.
- The tool uses roadway functional classification as a proxy for traffic volume.
- The tool uses the FunctionalClassification layer in the standardized geodatabase. It excludes interstates (functional class = 1) and selects the highest volume roadway (lowest functional class numeric code) within 150 feet of the input project location. The *functional* field is an integer field with numeric codes between 0-7, with 1 = interstates and 7 = local roads. Lower functional class numeric codes represent higher roadway functional classes. Functional class value 0 represents any feature without classification and is considered local (functional class = 7) for purposes of prioritization.
- Cells J5-O5 in the *Prioritization Workbook* allow you to assign scores to each of the functional class numeric codes. Lower functional class numeric codes should generally be given a higher score since pedestrian exposure is higher on higher volume roadways.

Step 5. (Optional) *Rescaling Method*—Determine which scaling methodology should be used for each variable. Rescaling is the process of putting the values for each variable on a common numeric scale, so values for different variables are comparable. Otherwise, variables with higher raw values, e.g., *Population Density*, would far outweigh variables with lower raw values, e.g., *Proximity to Education (K - 12)*. The rescaling methodologies available for each variable can be selected using a dropdown menu provided in cells E2-E28. See **Rescaling Terms box** at right for an explanation of rescaling methodology terms.

Step 6. (Optional) *Score range*—Adjust the score range for specific variables. The score range dictates the lowest and highest possible values for the rescaled scores. The score range can be adjusted by changing the values in cells G2-G28. Score ranges must be formatted “LowestScore-HighestScore” with no spaces. For example, a score range of 0 to 100 would be entered as 0-100. By default, the Prioritization Workbook is populated with a score range of 1-100, but it could be changed to something like 25-75 or 50-100.

Step 7. *Calculate Formulas*—Click on the *Calculate Now* button in the Calculation group in the *Formulas* tab of the Excel ribbon menu. Afterward, check that the prioritization scores have been calculated. The scores should appear in the worksheets titled *WeightedScores – Variables* and *WeightedScores – Factors* in the columns corresponding to selected variables and factors. Columns for variables and factors not selected will remain blank.

Step 8. Save and close workbook—Once the scores are calculated, save the Excel file and close it. **This step is critical for the *Join Workbook to Layer Tool* to work as intended.**

Rescaling Terms

LINEAR: The lowest raw score for the variable gets the lowest rescaled score and the highest raw score gets the highest rescaled score with everything in between getting rescaled values based on where the raw score falls on a linear scale between the lowest and highest raw scores.

PERCENTILE: The lowest raw score for the variable gets the lowest rescaled score and the highest raw score gets the highest rescaled score with everything in between getting rescaled values based on their percentile within the raw scores for that variable. The default value in the Excel workbook is populated with percentile rescaling for the relevant variables.

QUARTILES: This is like percentile, but with the rescaled scores being one of four based on which quartile the raw score falls into.

DECILES: This is like quartiles, but instead the rescaled scores are based on deciles of the raw scores.

CATEGORICAL: This is only available for *Cost* and *FunctionalClass* variables. The rescaled value is dependent on how the user decides to value each raw score. This can be adjusted in green formatted cells in the range I2-P5 in the sheet.

NONE: Some variable raw scores are binary in nature with a value of 0 or 1. For these variables, rescaling is not required.

F. How to Use the Join Workbook to Layer Tool

Step 1. Open the *Join Workbook to Layer Tool* within the *Prioritization Toolbox*. The tool dialog box will open as shown in **Figure 11**.

Step 2. *Prioritization Feature Layer* and *Primary Key*—Select the same feature layer and the corresponding primary key field that you used when you ran the *Create Prioritization Workbook Tool*. The primary key values will be used to join the scores in the *Prioritization Workbook* to the features in the prioritization layer.

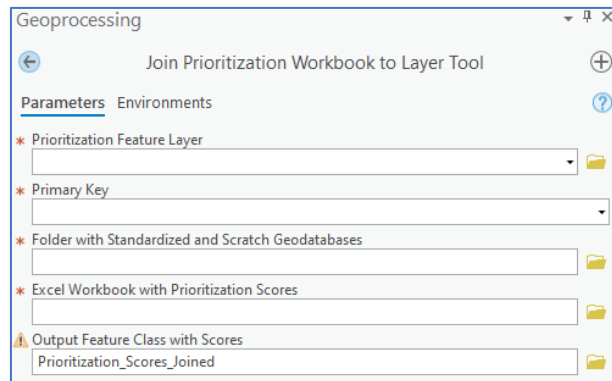


Figure 11: Screenshot of Join Workbook to Layer dialog box.

Step 3. *Folder with Standardized and Scratch Geodatabases*—Select the folder where the standardized and scratch geodatabases are located. If you are using the standardized and scratch geodatabases provided with the PIAT, you will select the *PIAT_Pre_Populated_GDBs* folder inside the *BMC_PAT_Resources* folder.

Step 4. *Excel Workbook with Prioritization Scores*—Select the *Prioritization Workbook*. This is the Excel workbook you created with the *Create Prioritization Workbook Tool* and then modified to include your custom weights, rescaling methods, etc.

Step 5. *Output Feature Class with Scores*— Select where you want the output to be saved and provide a name for the feature class that will be created with the joined prioritization scores. By default, this layer will be saved to the project's default workspace, but you can specify any other location for the output. The output layer will have the variable, factor, and total prioritization scores in the attribute table. The **Total_Score** field has the total prioritization score; the highest scores have the highest priority. The primary key field can be used to join the attributes of the original input layer for any further analysis.

APPENDICES

Appendix A: Data Requirements and Sources by Toolbox

Table 3: Needs Assessment Toolbox—Data Requirements and Sources

Tool	Dataset	Expected Layer Type	Required Columns	Data Source Notes	Data Pre-Processing Notes
Sidewalk Gap Analysis Tool	Pedestrian Network - includes sidewalks, crosswalks, and any pedestrian paths. This tool uses only sidewalks (CateTitle=sidewalk) in this analysis. Dataset name in standardized geodatabase – “PedestrianNetwork”	Requires line geometry and special fields	“p_id” <ul style="list-style-type: none">type: Noneattribute values: must be unique “CateTitle” <ul style="list-style-type: none">type: text formatattribute values: "crosswalk_continental", "crosswalk_standard", "crosswalk_other", "crosswalk_ladder", "crosswalk_unmarked", "pedestrian_bridge", "sidewalk"	Ecopia through BMC. Data acquired: 01/2023 Data extracted from imagery dated: May/June 2021	New column “p_id” was added to represent the unique id of each feature in the layer.
	Street Centerlines – This dataset is part of the standardized geodatabase, but users can use their own layer for this tool if it has the correct fields. Dataset name in standardized geodatabase – FunctionalClassification	Requires line geometry and special fields	“pkey_column” (or equivalent) <ul style="list-style-type: none">type: Noneattribute values: must be unique	MDOT SHA Roadway Functional Classification (OMOC): https://data.imap.maryland.gov/datasets/maryland::mdot-sha-roadway-functional-classification Data date: 10/06/2022 MDOT SHA Roadway Centerline: https://data.imap.maryland.gov/datasets/maryland::mdot-sha-roadway-functional-classification Data date: 10/18/2022	BMC acquired a roadway centerline datasets from MDOT SHA similar to those listed in the Data Source Notes, but with additional attribute fields. BMC geoprocessed these datasets to: (1) Clip to a two-mile buffer of the BMC region. (2) Combine into a single dataset that included all roadway centerline geometries. (Some dual roadway centerlines are not currently included in the OMOC dataset.) (3) Apply attributes where missing as much as possible on dual roadway centerlines. Some roadways with unknown Functional Class are coded as zero. (4) Split roadway centerlines at intersections to optimize for use in the PIAT. (5) Add attribute to identify divided centerlines (Divided_Centerline = Y) for use in the Identify Sidewalk Gaps tool. (6) Replace null road names with an empty string (‘ ’) to conform to requirements of PIAT. (7) Add a long integer primary key field “pkey_field” to store unique ID. Add a short integer field “functional” to store functional classification. MDOT SHA anticipates that all dual roadway centerlines will be included in OMOC by Fall 2023. Contact BMC for additional information on geoprocessing if needed.
Crossing Gap Analysis Tool	Traffic Signals Dataset name in standardized geodatabase – “Traffic_Signals”	Requires point geometry	None	https://data-maryland.opendata.arcgis.com/datasets/maryland-traffic-signals-1 and https://gisdata.baltimorecity.gov/egis/restservices/CAD911/traffic_signal/FeatureServer/0 Acquired: 09/2022	The signals datasets in were downloaded in Sep-2022 and merged into one layer.

Tool	Dataset	Expected Layer Type	Required Columns	Data Source Notes	Data Pre-Processing Notes
	<p>Street Centerlines – This dataset is part of the standardized geodatabase, but users can use their own layer for this tool if it has the correct fields.</p> <p>Dataset name in standardized geodatabase – FunctionalClassification</p>	Requires line geometry and special fields	<p>“pkey_column” (or equivalent)</p> <ul style="list-style-type: none">type: Noneattribute values: must be unique <p>“ROAD_NAME” (or equivalent)</p> <ul style="list-style-type: none">type: text formatattribute values: non-Null values <p>“functional” (or equivalent)</p> <ul style="list-style-type: none">type: any formatattribute values: non-Null values	<p>MDOT SHA Roadway Functional Classification (OMOC): https://data.imap.maryland.gov/datasets/maryland::mdot-sha-roadway-functional-classification Data date: 10/06/2022</p> <p>MDOT SHA Roadway Centerline: https://data.imap.maryland.gov/datasets/maryland::mdot-sha-roadway-functional-classification Data date: 10/18/2022</p>	<p>BMC acquired a roadway centerline datasets from MDOT SHA similar to those listed in the Data Source Notes, but with additional attribute fields.</p> <p>BMC geoprocessed these datasets to:</p> <ol style="list-style-type: none">(1) Clip to a two-mile buffer of the BMC region.(2) Combine into a single dataset that included all roadway centerline geometries. (Some dual roadway centerlines are not currently included in the OMOC dataset.)(3) Apply attributes where missing as much as possible on dual roadway centerlines. Some roadways with unknown Functional Class are coded as zero.(4) Split roadway centerlines at intersections to optimize for use in the PIAT.(5) Add attribute to identify divided centerlines (Divided_Centerline = Y) for use in the Identify Sidewalk Gaps tool.(6) Replace null road names with an empty string (' ') to conform to requirements of PIAT.(7) Add a long integer primary key field “pkey_field” to store unique ID. Add a short integer field “functional” to store functional classification. <p>MDOT SHA anticipates that all dual roadway centerlines will be included in OMOC by Fall 2023. Contact BMC for additional information on geoprocessing if needed.</p>
Pedestrian Travelshed Analysis Tool	<p>Pedestrian Network - includes sidewalks, crosswalks, and any pedestrian paths. Unmarked crosswalks (CateTitle=crosswalk_unmarked) are excluded from this analysis.</p> <p>Dataset name in standardized geodatabase – “PedestrianNetwork”</p>	Requires line geometry and special fields	<p>“p_id”</p> <ul style="list-style-type: none">type: Noneattribute values: must be unique <p>“CateTitle”</p> <ul style="list-style-type: none">type: text formatattribute values: "crosswalk_continental", "crosswalk_standard", "crosswalk_other", "crosswalk_ladder", "crosswalk_unmarked", "pedestrian_bridge", "sidewalk"	<p>Ecopia through BMC. Data acquired: 01/2023 Data extracted from imagery dated: May/June 2021</p>	<p>New column “p_id” was added to represent the unique id of each feature in the layer.</p>

Table 4: Prioritization Toolbox—Data Requirements and Sources

Factor	Variable/Dataset Name	Expected Layer Type	Required Columns	Data Source	Data Pre-Processing Notes
Opportunities	Coincides with Planned Roadway Improvement / Maintenance Dataset name in standardized geodatabase – “CoincidesPlannedRoadwayImprovement”	Will be imported from an Excel table	“p_id” <ul style="list-style-type: none">type: Noneattribute values: must be unique	This is a user provided table	
			“coincides” <ul style="list-style-type: none">type: Booleanattribute value: “TRUE”, “FALSE”		
Opportunities	Grant Funding Candidate Dataset name in standardized geodatabase – “GrantFundingCandidateList”	Will be imported from an Excel table	“p_id” <ul style="list-style-type: none">type: Noneattribute values: must be unique	This is a user provided table	
			“candidate” <ul style="list-style-type: none">type: Booleanattribute value: “TRUE”, “FALSE”		
Constraints	Cost Dataset name in standardized geodatabase – “CostList”	Will be imported from an Excel table	“p_id” <ul style="list-style-type: none">type: Noneattribute values: must be unique	This is a user provided table	
			“cost” <ul style="list-style-type: none">type: text formatattribute values: “High”, “Medium”, “Low”		
Constraints	Multi-Jurisdictional or Multi-Agency Coordination (Polygon of Jurisdiction Boundaries) Dataset name in standardized geodatabase – “Jurisdictions”	Requires polygon geometry	None	2020 Census TIGER boundaries Counties: https://www2.census.gov/geo/tiger/TIGER2020PL/STATE/24_MARYLAND/24/tl_2020_24_county20.zip Places: https://www2.census.gov/geo/tiger/TIGER2020PL/STATE/24_MARYLAND/24/tl_2020_24_place20.zip Data date: 2020 Acquired: 02/2022	Selected BMC jurisdictions from County dataset. Combined (union) with Annapolis from TIGER Place 20 dataset.
Stakeholder Input	Plan / Approved List Dataset name in standardized geodatabase – “PlannedAppvList”	Will be imported from an Excel table	“p_id” <ul style="list-style-type: none">type: Noneattribute values: must be unique	This is a user provided table	
			“approved” <ul style="list-style-type: none">type: Booleanattribute value: “TRUE”, “FALSE”		
Stakeholder Input	Recommended by Advisory Committee	Will be imported from an Excel table	“p_id” <ul style="list-style-type: none">type: Noneattribute values: must be unique	This is a user provided table	

Factor	Variable/Dataset Name	Expected Layer Type	Required Columns	Data Source	Data Pre-Processing Notes
	Dataset name in standardized geodatabase – “AdvisoryCommitteeRecs”		“approved” <ul style="list-style-type: none"> type: Boolean attribute value: “TRUE”, “FALSE” 		
Equity	Vulnerable Population Index Dataset name in standardized geodatabase – “VulnerablePopulationsIndex”	Requires polygon geometry and special fields	“p_id” <ul style="list-style-type: none"> type: None attribute values: must be unique 	Census socio-demographic counts at the block group level. VPI scores at the tract level were applied to their component block groups. See BMC’s Vulnerable Population Index 2020 app for further documentation: https://bmc.maps.arcgis.com/home/item.html?id=b1e22c0caa7644ccb58484b00610712f Data date: 2020	BMC compiled the Census Bureau 2016-2020 5-year American Community Survey data at the Census block group level for specific socio-demographic characteristics. This information is joined to block group geometries using the GEOID column. Vulnerable Population Index score at the Census tract level was also added to block group geometries using GEOID column.
			“GEOID” <ul style="list-style-type: none"> type: text format attribute values: unique geometry id description: used to join different census datasets 		
			“cnt_hh_pvr” <ul style="list-style-type: none"> type: integer, real attribute values: Non negative description: Count of households in poverty 		
			“cnt_hh_noc” <ul style="list-style-type: none"> type: integer, real attribute values: Non negative description: Count of zero car households 		
			“cnt_not_wh” <ul style="list-style-type: none"> type: integer, real attribute values: Non negative description: Count of nonwhite population 		
			“cnt_lep” <ul style="list-style-type: none"> type: integer, real attribute values: Non negative description: Count of population that speaks little or no English 		
			“cnt_hisp” <ul style="list-style-type: none"> type: integer, real attribute values: Non negative description: count of Hispanic population 		
			“cnt_age75” <ul style="list-style-type: none"> type: integer, real attribute values: Non negative description: count of population 75 years or older 		

Factor	Variable/Dataset Name	Expected Layer Type	Required Columns	Data Source	Data Pre-Processing Notes
			<div> <div> “cnt_disab” <ul style="list-style-type: none"> type: integer, real attribute values: Non negative description: Count of disabled population </div> <div> “cnt_age17” <ul style="list-style-type: none"> type: integer, real attribute values: Non negative description: Count of population younger than 17 </div> <div> “vpi_score” <ul style="list-style-type: none"> type: integer, real attribute value: Non negative description: Score calculated from the above attributes and represented as a single value </div> </div>		
Connectivity	Intersections Dataset name in standardized geodatabase – “Intersections”	Requires point geometry	None	Intersections created from Functional Classification dataset by BMC. Data date: 10/06/2022	BMC created a point dataset for Intersections derived from the FunctionalClassification dataset by dissolving, intersecting, and removing duplicate points. Some roadway segments were excluded to avoid creating false intersections: interstates and limited-access roads were excluded, but their ramps were included to capture intersections of ramps with other roadways.
Connectivity	Pedestrian Network - includes sidewalks, crosswalks, and any pedestrian paths. Unmarked crosswalks (CateTitle=crosswalk_unmarked) are excluded from this analysis. Dataset name in standardized geodatabase – “PedestrianNetwork”	Requires line geometry and special fields	<div> <div> “p_id” <ul style="list-style-type: none"> type: None attribute values: must be unique </div> <div> “CateTitle” <ul style="list-style-type: none"> type: text format attribute values: "crosswalk_continental", "crosswalk_standard", "crosswalk_other", "crosswalk_ladder", "crosswalk_unmarked", "pedestrian_bridge", "sidewalk" </div> </div>	Ecopia through BMC. Data acquired: 01/2023 Data extracted from imagery dated: May/June 2021	New column “p_id” was added to represent the unique id of each feature in the layer.
Pedestrian Potential	Employment Counts Dataset name in standardized geodatabase – “EmploymentCounts”	Requires polygon geometry and special fields	<div> <div> “p_id” <ul style="list-style-type: none"> type: None attribute values: must be unique </div> <div> “tot_emp” <ul style="list-style-type: none"> type: integer attribute value: Non negative </div> </div>	Census LEHD 2019 work area characteristics downloaded from Census https://lehd.ces.census.gov/data/lodes/LODES7/md/wac/md_wac_S000_JT00_2019.csv.gz	The total number of jobs from LEHD is aggregated to block group geometries (2010 Census geometries) using GEOID. LEHD releases in 2020 and beyond are likely going to use GEOID corresponding to block group geometries from 2020 census.
Pedestrian Potential	Higher Education, Colleges, and Universities Dataset name in standardized geodatabase – “HigherEducation”	Requires point geometry	None	Open Street Map (OSM) data downloaded as shapefiles from http://download.geofabrik.de/north-america/us/maryland.html Data acquired: 02/2022	Selected from OSM points of interest layer that have their “fclass” value equal to “university” or “college”. See following documentation for more details http://download.geofabrik.de/osm-data-in-gis-formats-free.pdf

Factor	Variable/Dataset Name	Expected Layer Type	Required Columns	Data Source	Data Pre-Processing Notes
Pedestrian Potential	Major Transit Stops Dataset name in standardized geodatabase – “MajorTransitStops”	Requires point geometry	None	BMC Baltimore Region Public Transit stops https://gisdata.baltometro.org/datasets/baltimore-region-public-transit-stops Data date: 02/25/2022	Any stop with “Mode_Of_Trans” value one of the following is classified as a major transit stop – “MARC”, “Metro”, and “Light Rail”
Pedestrian Potential	Minor Transit Stops Dataset name in standardized geodatabase – “MinorTransitStops”	Requires point geometry	None	BMC Baltimore Region Public Transit stops https://gisdata.baltometro.org/datasets/baltimore-region-public-transit-stops Data date: 02/25/2022	Any stop that is not classified as a major transit stop above is classified as minor transit stop
Pedestrian Potential	Population Counts Dataset name in standardized geodatabase – “PopulationCounts”	Requires polygon geometry and special fields	“p_id” • type: None • attribute values: must be unique	Census Bureau 2016-2020 5-year American Community Survey data at the Census block group level	Census ACS data is joined to block group geometries using GEOID columns.
			“tot_pop” • type: integer • attribute values: Non negative		
Pedestrian Potential	Retail Locations Dataset name in standardized geodatabase – “RetailLocations”	Requires point geometry	None	Open Street Map (OSM) data downloaded as shapefiles from http://download.geofabrik.de/north-america/us/maryland.html Data acquired: 02/2022	Selected from OSM points of interest layer that have their “fclass” value in one of the following: (beverages, toy_shop, jeweller, museum, stadium, gift_shop, shoe_shop, greengrocer, recycling_clothes, kiosk, mobile_phone_shop, market_place, stationery, car_rental, bicycle_rental, mall, furniture_shop, bakery, artwork, newsagent, supermarket, department_store, butcher, car_dealership, sports_shop, chemist, garden_centre, bicycle_shop, pharmacy, cafe, computer_shop, beauty_shop, florist, convenience, clothes, bookshop) See following documentation for more details http://download.geofabrik.de/osm-data-in-gis-formats-free.pdf
Pedestrian Potential	Schools, Public K – 12 Dataset name in standardized geodatabase – “SchoolsK12”	Requires point geometry	None	BMC Regional Schools https://gisdata.baltometro.org/datasets/schools/explore Data acquired: 02/2022	Only schools designated as public and level between kindergarten and high school are selected

Factor	Variable/Dataset Name	Expected Layer Type	Required Columns	Data Source	Data Pre-Processing Notes
Safety	All Pedestrian Crashes Dataset name in standardized geodatabase – “AllPedestrianCrashes”	Requires point geometry	None	Maryland vehicle crashes data https://opendata.maryland.gov/Public-Safety/Maryland-Statewide-Vehicle-Crashes/65du-s3qu and Maryland crashes - person level https://opendata.maryland.gov/Public-Safety/Maryland-Statewide-Vehicle-Crashes-Person-Details-/py4c-dicf Data acquired: 02/2022	Crash data from Jan 2015 to Dec 2021 were processed to select crashes within a mile of BMC boundary. The person and vehicle crash datasets are joined using the crash report number and any crashes involving a pedestrian are selected is they meet one of the below criteria. 1. HARM_EVENT_CODE = 3 (Pedestrian) in vehicle crash table 2. PED_TYPE_CODE = 1 (Pedestrian) in person table 2. PERSON_TYPE = P (Pedestrian) in person table See data dictionary for more details https://opendata.maryland.gov/Public-Safety/Maryland-Statewide-Vehicle-Crash-Data-Dictionary/7xpx-5fte
Safety	Pedestrian Fatalities and Severe Injuries Dataset name in standardized geodatabase – “FatalandSeverePedCrshs”	Requires point geometry	None	Maryland Statewide Vehicle Crashes https://opendata.maryland.gov/Public-Safety/Maryland-Statewide-Vehicle-Crashes/65du-s3qu and Maryland Statewide Vehicle Crashes - Person Details (Anonymized) https://opendata.maryland.gov/Public-Safety/Maryland-Statewide-Vehicle-Crashes-Person-Details-/py4c-dicf Data acquired: 02/2022	From all pedestrian crashes, fatal and severe injury crashes are selected where INJ_SEVER_CODE is 4 or 5. See data dictionary for more details https://opendata.maryland.gov/Public-Safety/Maryland-Statewide-Vehicle-Crash-Data-Dictionary/7xpx-5fte

Factor	Variable/Dataset Name	Expected Layer Type	Required Columns	Data Source	Data Pre-Processing Notes
Safety	Street Centerlines with Functional Class Dataset name in standardized geodatabase – “FunctionalClassification”	Requires line geometry and special fields	“functional” <ul style="list-style-type: none">type: integerattribute values: between 0 and 7	MDOT SHA Roadway Functional Classification (OMOC): https://data.imap.maryland.gov/datasets/maryland::mdot-sha-roadway-functional-classification Data date: 10/06/2022 MDOT SHA Roadway Centerline: https://data.imap.maryland.gov/datasets/maryland::mdot-sha-roadway-functional-classification Data date: 10/18/2022	BMC acquired a roadway centerline datasets from MDOT SHA similar to those listed in the Data Source Notes, but with additional attribute fields. BMC geoprocessed these datasets to: (1) Clip to a two-mile buffer of the BMC region. (2) Combine into a single dataset that included all roadway centerline geometries. (Some dual roadway centerlines are not currently included in the OMOC dataset.) (3) Apply attributes where missing as much as possible on dual roadway centerlines. Some roadways with unknown Functional Class are coded as zero. (4) Split roadway centerlines at intersections to optimize for use in the PIAT. (5) Add attribute to identify divided centerlines (Divided_Centerline = Y) for use in the Identify Sidewalk Gaps tool. (6) Replace null road names with an empty string (‘ ’) to conform to requirements of PIAT. (7) Add a long integer primary key field “pkey_field” to store unique ID. Add a short integer field “functional” to store functional classification. MDOT SHA anticipates that all dual roadway centerlines will be included in OMOC by Fall 2023. Contact BMC for additional information on geoprocessing if needed.

Appendix B: Variable Measurement Details

Factor	Variables	How variable is measured in tool
Opportunities	Grant Funding Candidate	Boolean—Tool will build a new variable and assign the value to 1 if location is eligible for grant funding.
Opportunities	Coincides with Planned Roadway Improvement/Maint	Boolean—Tool will build a new variable and assign the value to 1 if location is part of a planned roadway improvement or maintenance plan.
Constraints	Requires Multi-Jurisdictional or Multi-Agency Coordination	Boolean—Tool will build a new variable and assign the value to 1 if a location is in a single administrative area or assign the value to 0 if a location is in multiple administrative areas.
Constraints	Cost	Categorical—Tool will build a new variable and lifecycle cost from the .xlsx file. Three categories are expected, “High”, “Medium”, and “Low”.
Stakeholder Input	Recommended by Advisory Committee	Boolean—Tool will build a new variable and assign the value to 1 if addressing the location is recommended by an advisory group.
Stakeholder Input	Included in Adopted Plan or Approved List	Boolean—Tool will build a new variable and assign the value to 1 if location is included in an adopted plan or approved list.
Equity	Adults with Disabilities (adjusted from people with disabilities due to data limitations)	Float—The tool will proportionally allocate the measure of population with disabilities within 1/2 mile of the location, then calculate density by dividing by area of the 0.5-mile buffer.
Equity	Households Below Poverty	Float—The tool will proportionally allocate the measure of households with income below 200% of the poverty line within 1/2 mile of the location, then calculate density by dividing by area of the 1/2-mile buffer.

Factor	Variables	How variable is measured in tool
Equity	Limited English Proficiency	Float—The tool will proportionally allocate the measure of population with limited English proficiency within 1/2 mile of the location, then calculate density by dividing by area of the 1/2-mile buffer.
Equity	No car households	Float—The tool will proportionally allocate the measure of no car households within 1/2 mile of the location, then calculate density by dividing by area of the 1/2-mile buffer.
Equity	Elderly (age 75 and up)	Float—The tool will proportionally allocate the measure of elderly population within 1/2 mile of the location, then calculate density by dividing by area of the 1/2-mile buffer.
Equity	Hispanic	Float—The tool will proportionally allocate the measure of Hispanic population within 1/2 mile of the location, then calculate density by dividing by area of the 1/2-mile buffer.
Equity	Minority (non-White, non-Hispanic)	Float—The tool will proportionally allocate the measure of minority population within 1/2 mile of the location, then calculate density by dividing by area of the 1/2-mile buffer.
Equity	People younger than Age 18	Float—The tool will proportionally allocate younger population within 1/2 mile of the location, then calculate density by dividing by area of the 1/2-mile buffer.
Equity	Vulnerable Population Index	Integer—The tool will calculate the location's VPI as the maximum of VPI score of block groups intersecting the location.
Connectivity	Connects to Existing Facility	Boolean—Tool will assign a value of 1 if location is within 25 feet of an existing sidewalk or crosswalk and 0 otherwise. Unmarked crosswalks (CateTitle=crosswalk_unmarked) are excluded from this analysis.
Connectivity	Street Connectivity (Intersection Density)	Float—The tool will count the number of intersections within 1/2 mile of the location, then calculate density by dividing by area of the 1/2-mile buffer.

Factor	Variables	How variable is measured in tool
Pedestrian Potential	Population Density	Float—The tool will proportionally allocation the population within 1/2-mile buffer of the location, then calculate density by dividing by area of the 1/2-mile buffer.
Pedestrian Potential	Employment Density	Float—The tool will proportionally allocation the jobs within 1/2-mile buffer of the location, then calculate density by dividing by area of the 1/2-mile buffer.
Pedestrian Potential	Proximity to Education (K - 12)	Integer—The tool will count the number of schools within 1/2 mile of the location.
Pedestrian Potential	Proximity to Education (Colleges, Universities)	Integer—The tool will count the number of universities/colleges within 1 mile of the location.
Pedestrian Potential	Proximity to Retail	Integer—The tool will count the number of retail locations within 1/4 mile of the location.
Pedestrian Potential	Proximity to Minor Transit Stop	Integer—The tool will count the number of minor transit stops within a threshold distance (1/8 mile for lines and 1/4 mile for points).
Pedestrian Potential	Proximity to Major Transit Stops	Integer—The tool will count the number of major transit stops within a threshold distance (1/4 mile for lines and 1/2 mile for points).
Safety	Total Ped Crash Density	Float—Tool will create a new variable of total number of pedestrian crashes within 250 ft of location and calculate density by dividing by length of location. For point projects, it will count number of crashes within 500 feet.
Safety	Fatal & Severe Ped Crash Density	Float—Tool will create a new variable of total number of pedestrian crashes that resulted in a fatality or serious injury within 250 ft of the project and calculate density by dividing by length of location. For point projects, it will count number of crashes within 500 feet.

Factor	Variables	How variable is measured in tool
Safety	Functional Classification	<p>Categorical—Tool uses functional classification as a proxy for traffic volume of a roadway. Higher volume roadways are prioritized over lower volume roadways to address safety concerns associated with higher traffic volumes.</p> <p>The tool excludes interstates (functional class = 1) and selects the highest volume roadway (lowest functional class numeric code) within 150 feet of the input project location. The "functional" field is an integer field with numeric codes between 1-7, with 1 = interstates and 7 = local roads. Lower functional class numeric codes represent higher roadway functional classes. A value of functional = 0 indicates roads without functional classification and these are modeled as local streets (functional = 7).</p> <p>Each location will be weighted based on the functional class of that location's selected roadway. The weighting values for functional classes are input by the user in the Excel Prioritization Workbook (cells J5:O5).</p>

Appendix C: Troubleshooting

- Spatial Analyst Extension
 - To better understand what the Spatial Analyst Extension is and how to enable it, please review this information provided by ESRI:
<https://pro.arcgis.com/en/pro-app/2.9/help/analysis/spatial-analyst/>
- Updating data
 - Some of the data used within the PIAT will be updated from time to time. Use the data source and pre-processing notes information in **Appendix A** to refer to where updated data may be downloaded from. Be cautious when downloading new data because it may need to be reformatted to follow the required columns as also described in **Appendix A**.
- Create P_ID Field
 - Follow these instructions provided by ESRI: <https://support.esri.com/en/technical-article/000011137>