

Electric Vehicle Infrastructure Location Identification Tool and Visualization Maps



User Guide

Version 3.0 (release date October 31, 2019)

1 INTRODUCTION

The Infrastructure Location Identification Tool (“Tool”) and Visualization Maps (“Maps”) represent the outputs of a project conducted by M.J. Bradley & Associates and the Georgetown Climate Center to support the Transportation & Climate Initiative (TCI)¹ of the northeast and mid-Atlantic states. This project used a Geographic Information Systems (GIS)-based analysis to evaluate the existing plug-in electric vehicle (PEV) public fast charging network across the TCI region and used transportation network, commercial, and demographic data to identify possible suitable locations for future fast charging PEV infrastructure development.

1.1 BASIC ANALYSIS METHODOLOGY

MJB&A utilized a GIS platform to collect data on over 12,500 miles of freeway, highways, and other key roads across 13 states: the 12-state (and District of Columbia) TCI region and North Carolina. Focusing on roadway exits and other key intersections (called “exits” throughout this guide for convenience) as possible nodes for future infrastructure development, the analysis developed a detailed database with data including:

- Proximity Metrics: distance from each exit to nearest existing (public, non-Tesla) direct current fast charging (DCFC) station (or a subset of those stations based on DCFC connector type) and density of DCFC ports around each exit;
- Nearby Activity: number of points of interest and commercial establishments (restaurants, shops/stores, gas stations, etc.) within a mile of each exit; and
- Demand Metrics: population density by census tract and various traffic volume measurements on the roadway around each exit.

Using metrics drawn from this database, each potential location for additional PEV charging infrastructure can then be assigned one cumulative “score” from 1 to 100 that reflects the potential relative suitability of that location for infrastructure development. This analysis was limited to areas in close proximity to freeway exits.

For additional details on the methodology, please see <http://www.mjbradley.com/analytical-resources>.

¹ The Transportation and Climate Initiative (TCI) is a regional collaboration of 11 Northeast and Mid-Atlantic states and the District of Columbia that seeks to develop the clean energy economy and reduce oil dependence and greenhouse gas emissions from the transportation sector. The participating states are: Connecticut, Delaware, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, Vermont, and Virginia. For more information, see <http://www.transportationandclimate.org/>.

1.2 PRODUCTS: TOOL AND VISUALIZATION MAPS

There are three primary outputs from this analysis:

The **Infrastructure Location Identification Tool** is an Excel-based tool that allows users to identify possible suitable locations for DCFC infrastructure given specific inputs. Because users of this database may have differing priorities for new infrastructure (e.g., some may want to focus infrastructure in “gaps” in the existing DCFC network, while others may prefer to identify locations with high traffic volume and commercial activity), the Tool allows a user to adjust the weighting of different metrics and view updated exit rankings.

The **Visualization Map: Data Viewer** provides users a way to display both the underlying characteristics of the region—traffic volume, existing DCFC stations, exit information, etc.—and preloaded potential location rankings. The Data Viewer offers the ability to filter exits by metric data and comes preloaded with region-specific outputs of the Identification Tool for certain weighting methodologies.

The **Visualization Map: Results Viewer** enables users to replicate the ranking analysis of the Excel tool and simultaneously view interactive results. By extending the functionality and customizability of the Excel tool to a web-based mapping tool, results are easier to visualize and formatted perfectly for discussions with policymakers, local decisionmakers, and other stakeholders.

1.3 USE AND TERMS

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MJB&A assumes no responsibility for errors or omissions in the Identification Tool or Visualization Maps or any documentation available from www.mjbradley.com

The use of the Identification Tool or Visualization Maps is done at your own discretion and risk. In no event shall MJB&A be liable to you or any third parties for any special, punitive, incidental, indirect or consequential damages of any kind, or any damages whatsoever, including, without limitation, those resulting from loss of use, data or profits, whether or not MJB&A has been advised of the possibility of such damages, and on any theory of liability, arising out of or in connection with the use of the Identification Tool or Visualization Maps.

1.4 QUESTIONS AND CONTACT

For questions on use of the Tool or Map, or for inquiries regarding expansion or further use of these products, please contact Grace Van Horn at [gvanhorn \[at\] mjbradley.com](mailto:gvanhorn@mjbradley.com).

2 INFRASTRUCTURE LOCATION IDENTIFICATION TOOL USER GUIDE

The Infrastructure Location Identification Tool is an Excel-based tool that allows users to identify possible locations for DCFC infrastructure given individual inputs. This User Guide will explain how to modify inputs and use the results.

2.1 USING THE TOOL: SETTING INPUTS

The Tool can be downloaded with a free registration at <http://www.mjbradley.com/analytical-resources>. Using a Microsoft Windows operating system is recommended to ensure full functionality of the tool, as some macros may not be recognized or are severely limited in other operating systems. In addition, be sure to save the Tool in a known location; this is important for using the data export functions described below. Upon opening the Tool, a user must first read and agree to basic user terms. The Tool will then open to a page with ranking tool inputs along the left bar. The following image of the Tool can be used as a visual guide as the inputs and outputs are discussed:

Infrastructure Location Identification Tool

Geography

Select State/Region: Massachusetts ← 2.1.1
 Filter by County: Yes
 Select County: Middlesex

Exit Group

Select Exit Type: Corridor (all exits) ← 2.1.2 # Exits Ranked: 52
 Select Corridor: Interstate 95

DCFC Connector Type Proximity

Select Connector Type(s): All (SAE & CHAdeMO) ← 2.1.3
Calculates proximity metrics based on locations of all DCFC connector types

Applicable Traffic Demand

Select Traffic Metric: Annual Average Daily Traffic ← 2.1.4
Average daily traffic (AADT; default)

Weighting Method

Pre-Weighted Method: Through Traffic ← 2.1.5 Metric Priority: Demand
 Custom Weighting: OFF

Metric Weights

Pre-Weighted Method Priorities:	Weights:	
	Method	Custom
Through Traffic: Traffic volume & commercial activity	Proximity	
	Closest DCFC	15%
	Port Density	15%
Fill Gaps: Proximity metrics	Demand	
	Annual Average Daily Traffic	30%
High Traffic Gaps: Traffic volume & proximity	Population Density	10%
	Total	40%
Traveler Use: Traffic volume & commercial activity	Convenience	
	Nearby Commercial Activity	30%
Resident Use: Population density & commercial activity	Total	25%
	Total	100%

Calculate Rankings → Go

Rankings: Interstate 95 in Middlesex, Massachusetts: 'Through Traffic' Weighting Method

2.2.1

Final Rank	Exit ID	Weights					Final Score
		Proximity Closest DCFC	Port Density	Demand Traffic	Population	Convenience Nearby Activity	
1	I-95_Middlesex_MA_Service_1	7	5	10	5	10	82.5
2	I-95_Middlesex_MA_Exit_9	2	7	10	3	10	76.5
3	I-95_Middlesex_MA_Exit_48	10	6	5	10	7	69.5
T-4	I-95_Middlesex_MA_Exit_35	1	6	9	2	10	69.0
T-4	I-95_Middlesex_MA_Exit_36	1	6	9	2	10	69.0
6	I-95_Middlesex_MA_Exit_34	1	5	9	2	10	67.5
T-7	I-95_Middlesex_MA_Exit_32	3	4	7	7	9	65.0
T-7	I-95_Middlesex_MA_Exit_33	3	4	8	7	8	65.0
T-9	I-95_Middlesex_MA_Exit_6	10	6	4	10	6	63.5
T-9	I-95_Middlesex_MA_Exit_31	4	4	7	7	8	63.5
11	I-95_Middlesex_MA_Exit_42	8	4	10	5	3	61.5
12	I-95_Middlesex_MA_Exit_10	2	4	8	2	9	61.5
13	I-95_Middlesex_MA_Exit_15	2	3	8	2	9	61.0
14	I-95_Middlesex_MA_Exit_47	10	6	5	2	6	59.5
T-15	I-95_Middlesex_MA_Exit_7	5	4	6	6	7	59.0
T-15	I-95_Middlesex_MA_Exit_28	1	4	7	6	8	59.0
17	I-95_Middlesex_MA_Exit_41	8	4	10	5	2	58.5
18	I-95_Middlesex_MA_Exit_3	10	7	5	2	5	58.0
19	I-95_Middlesex_MA_Exit_37	4	6	10	3	3	57.5
20	I-95_Middlesex_MA_Exit_21	5	5	1	8	10	56.5
21	I-95_Middlesex_MA_Exit_8	5	6	8	3	4	56.0
T-22	I-95_Middlesex_MA_Exit_1	8	5	3	9	6	56.0
T-22	I-95_Middlesex_MA_Exit_29	3	4	6	6	7	56.0
T-22	I-95_Middlesex_MA_Exit_30	5	4	6	7	6	56.0
25	I-95_Middlesex_MA_Exit_27	1	4	7	6	7	55.5
T-28	I-95_Middlesex_MA_Exit_14	6	4	10	5	2	55.5
T-28	I-95_Middlesex_MA_Exit_16	7	5	10	5	1	55.5
T-28	I-95_Middlesex_MA_Exit_17	9	5	6	10	2	55.5
T-26	I-95_Middlesex_MA_Exit_18	6	4	10	5	2	55.5
T-26	I-95_Middlesex_MA_Exit_40	6	4	10	5	2	55.5
T-26	I-95_Middlesex_MA_Exit_44	9	5	6	10	2	55.5
T-26	I-95_Middlesex_MA_Exit_45	10	6	4	7	4	55.5
33	I-95_Middlesex_MA_Exit_46	10	7	5	2	4	55.0
34	I-95_Middlesex_MA_Exit_22	4	4	1	10	10	55.0
35	I-95_Middlesex_MA_Exit_39	4	4	6	8	3	54.5
36	I-95_Middlesex_MA_Exit_12	7	5	3	9	6	54.5
37	I-95_Middlesex_MA_Exit_5	5	5	1	8	9	53.5
38	I-95_Middlesex_MA_Exit_38	3	6	10	3	2	53.0
39	I-95_Middlesex_MA_Exit_24	1	5	3	9	8	51.5
40	I-95_Middlesex_MA_Exit_4	9	6	4	7	3	50.0
41	I-95_Middlesex_MA_Exit_43	8	4	6	5	3	49.5
42	I-95_Middlesex_MA_Exit_19	4	4	1	6	9	48.0
43	I-95_Middlesex_MA_Exit_26	2	3	3	9	7	46.0
44	I-95_Middlesex_MA_Exit_20	6	5	2	8	5	46.0

Here, peach-colored cells denote inputs that can be changed by the user. Blue cells update to reflect user selections. Other cells may be red or green—red cells indicate that the user must update cells before running the Tool, while green indicates that the applicable function of the Tool is ready to be run. When inputs are set appropriately, a user may press the “Go” button to calculate rankings among the subset of exits selected.

These basic inputs are described in more detail below.

2.1.1 Area, State, or County

Select the region of interest. This could be either the entire analysis region or one of the states (or District of Columbia) included in the analysis region. If a user selects a state, the user may also then select a specific county located within that state. Note that the number of exits ranked will adjust to reflect the selected region (as subsequent criteria are changed, the number of exits ranked will continue to adjust).

2.1.2 Exit Group

Select a “group,” or subset of exits within the selected region. These groups allow a user to focus in on specific areas or types of exits for further analysis.

- *All Exits (with service plazas):* this group can be used to identify exits across the entire selected region.
- *All Exits (no service plazas):* this exit group excludes service plazas from the locations analyzed. Service plazas are those exits that are open to commercial development (unlike rest areas, which are legally barred from commercial development), but are isolated from other commercial areas and typically do not connect with the surrounding region (i.e., a driver may only enter and exit the freeway but does not have an ability to travel elsewhere within the region without utilizing a different freeway exit). Some users of these Tools may therefore wish to exclude these regions
- *Service Plazas Only:* for those users interested in service plaza development, this group includes only those exits.

- *Specific Corridor (all exits, service plazas excluded, and service plaza only)*: these three options will limit the ranking and analysis to a specific freeway within the selected region. The three options available here mirror the “All Exits” options discussed above regarding the treatment of service plazas. If one of these three options is selected, the “Select Corridor” input box will activate to the right; select the appropriate highway from the drop-down menu.

Again, the number of exits ranked will adjust to reflect the selected region.

2.1.3 DCFC Connector Type

Select the existing DCFC stations that will be included in the proximity metrics (i.e., the closest existing DCFC station to and the density of ports surrounding an exit). This allows the user to identify potential gaps in the network based on all in-scope DCFC stations or just a subset based on connector type. As a reminder, in-scope DCFC stations are publicly accessible, non-Tesla stations located within 5 miles of a corridor included in the analysis.

- *All (SAE & CHAdeMO)*: all in-scope DCFC stations
- *SAE Combo*: only DCFC stations with SAE Combo connectors are included in the proximity metrics
- *CHAdeMO*: only DCFC stations with CHAdeMO connectors are included in the proximity metrics

2.1.4 Traffic Demand Metric

Select the traffic data that will be used for the traffic demand metric.

- *Annual Average Daily Traffic (AADT)*: this is the default measure, reflecting average number of vehicles on a roadway (taking total annual traffic and distributing it evenly across all days of the year)
- *Peak Traffic Volume*: this measure uses AADT multiplied by a peak measurement called a “K-factor.” K-factor is defined as the proportion of annual average daily traffic occurring in an hour, typically the 30th-highest hour of traffic density from the year's-worth of data. These data therefore measure traffic at peak times across all roadways.
- *Peak Hourly Factor*: this measure is the K-factor, or the indicator of peak traffic of a corridor. Corridors with higher K-factors have a larger range between low traffic and high traffic times. K-factors are typically highest areas along corridors that experience substantial seasonal, holiday-, or event-induced traffic increases.

2.1.5 Weighting Method

The weighting method is used to emphasize specific metrics/characteristics of exits when ranking within the selected region and group. The Tool has five pre-loaded methods, described in more detail below. In addition, a user may turn on a “Custom Weighting” option that allows additional control in emphasizing attributes of exits in the weighting process. These options help a user adjust the weighting to reflect his or her own priorities for infrastructure development in the ranking process.

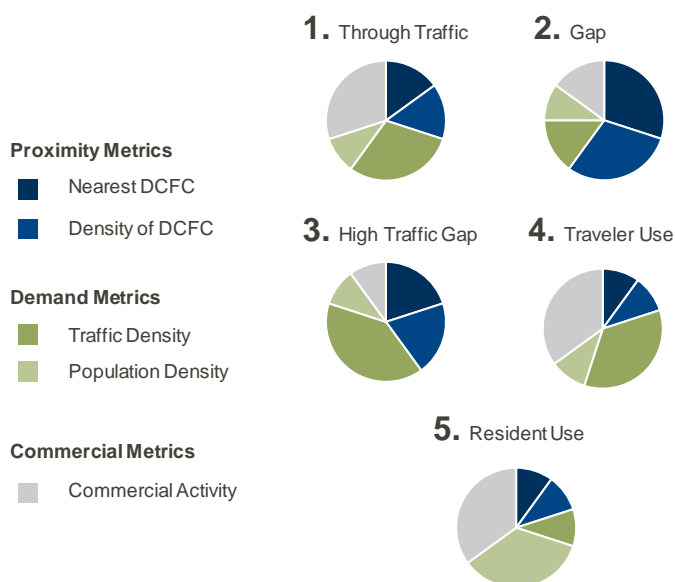
To select a built-in weighting method, use the drop-down menu. This will populate the table with the weights associated with this option. It will also update the “metric priority” box to show at quick glance which of the three groups of characteristics is most heavily emphasized. The built-in options are:

- *Through Traffic*: This is MJB&A’s default method (for display on map and in analysis results). This equally emphasizes proximity to existing DCFC stations (split among the two proximity metrics), traffic volume, and convenience, and places low emphasis on local population density. The mix of metrics is meant to prioritize areas that are likely to have high amounts of through traffic, due to traffic and commercial activity, but also are somewhat likely to be in gaps.
- *Fill Gaps*: This method strongly weights proximity metrics, emphasizing those exits with low levels of nearby charging infrastructure (note that as opposed to the Gaps Group, exits that are not in gaps will still be included in this analysis if a region-wide Group is selected, they will just likely be ranked lower than they would be under a methodology that less heavily weighted the proximity metrics).

- *High Traffic Gaps*: This method weights proximity metrics somewhat highly, and also highly weights traffic volume. The exits emphasized under this method are those that are more likely to be in gaps and receive high amounts of vehicle traffic.
- *Traveler Use*: This method is focused on those metrics related to the potential utilization of a certain freeway exit: traffic volume, which approximates the number of cars passing by, and commercial activity, which indicates possible reasons for a driver to use a specific exit when traveling.
- *Resident Use*: In contrast to *Traveler Use*, the resident use methodology is focused on those metrics that indicate locations that are likely to be used by local area residents, with population density and commercial activity most heavily weighted.

Note that all pre-loaded methodologies were initially designed to utilize average traffic and all DCFC stations for proximity metrics. Accordingly, the ranking results shown in the Data Viewer reflect those default inputs. However, selecting a pre-loaded methodology will **not** reset any changes to DCFC connector type or traffic demand metrics if the user has changed them for prior weighting methodologies. A user should check these inputs before comparing results within the Tool to visualized results within the Data Viewer, as rankings will change with different connector type or traffic demand inputs.

The figure below displays graphically the relative weighting of each metric in these methodologies.



In addition to these options, a user may enter custom weightings to adjust based off of one of these methods or create a new personalized option. To use this option, select “ON” from Custom Weighting. This will highlight an additional five cells in orange. Enter custom weightings here, ensuring that when finished, the total reads 100 percent (it will show in green). While in custom weighting, a user may move between built-in weighting methods which will show in grey to the left of the custom field; these can serve as a reference to building a new custom methodology. However, when Custom Weighting is turned on, only those values in the Custom weights column will be referenced for ranking.

2.2 USING THE TOOL: OUTPUTS

After selecting input criteria, exit rankings can be generated by clicking the “Go” button and waiting a few seconds while rankings are calculated.

2.2.1 Final Ranks and Final Scores

The primary outputs shown on the main page (“Identification Tool” tab) is a ranking of all exits in the select group, listed from high to low. The values shown on the left of the table reflect the relative position/rank of each exit as compared to others within the analysis selection. Note that there may be numerous ties.² Along the right, in bold, is listed the Final Total Score for each exit. In between are the metric-specific values and weights that determine this score.

It is important to not compare rankings, metric values, or final scores across exit groups (i.e., subsets of exists within a selected region). Because the analysis is based on a distribution of exit data within each metric, the group of exits included can dramatically change a metric value. For example, when comparing across Gap Group exits in New Hampshire, an exit may be relatively high-valued for traffic volume. However, when analyzing this exit in the context of all exits in the region, which includes very highly trafficked exits in major metropolitan areas like New York City, Boston, and Washington D.C., this exit would likely receive a lower overall traffic volume value. Therefore, Final Scores and Rankings should not be compared across Groups and are specific to the specified criteria.

2.3 DATA AND RESULTS VISUALIZATION

Results and Data Viewer Interactive Maps

2.3.1

Results Viewer (click to link)

1. Select the above link to the interactive Tableau tool and map
2. Use filters and metric weights to generate and view real-time results

2.3.2

Data Viewer (click to link)

1. Select the above link to the interactive ArcGIS tool and map
2. Copy/paste the desired "Exit ID" into the search bar (top left corner of map) to view location
3. View data layers (existing DCFC, traffic, corridors, etc.) used to generate ranking inputs
4. Use filters to simulate general analysis used in this tool

2.3.3

Data Export (.csv; can be uploaded to ArcGIS)

Top 10 Exits	
Top 1000 Exits	(maximum size for ArcGIS upload)
All Exits	(all exits in current scenario)

2.3.1 Results Viewer

Click this link to access the Results Viewer. This tool enables users to replicate the ranking analysis of the Excel tool and simultaneously view interactive results. By extending the functionality and customizability of the Excel tool to a web-based mapping tool, results are easier to visualize and formatted perfectly for discussions with policymakers, local decisionmakers, and other stakeholders.

² This is in part because an “exit” is typically noted as a directional off or on ramp at a specific freeway exchange. This means that there may be four (or more) “exits” clustered closely around a single intersection (e.g., off ramp northbound, on ramp northbound, off ramp southbound, on ramp southbound). Mapping these results can be useful for identifying where these overlaps exist.

2.3.2 Data Viewer

Click this link to access the Data Viewer. This tool provides users a way to display both the underlying characteristics of the region—traffic volume, existing DCFC stations, exit information, etc.—and preloaded potential location rankings. The Data Viewer offers the ability to filter exits by metric data and comes preloaded with region-specific outputs of the Identification Tool for certain weighting methodologies

2.3.3 Exporting Results to Data Viewer Map

In addition, the Tool has a function to export a file for further analysis or use in the Visualization Map: Data Viewer. Once a user has ranked a subset of exits per a chosen methodology, the user can use buttons to export data on all exits, the top 1,000 exits, or the top 10 exits.³ This will produce a .csv file that can be uploaded into the Data Viewer as a new layer (see additional details below in Visualization Map: Data Viewer User Guide).

After clicking on the appropriate button, the file will automatically save into the same folder in which the Identification Tool is located; note that it is important to save the tool in a known location (rather than a default download location) to be able to locate the exported results file. A message box will notify the user when this export has been executed. The default file name is listed directly above the applicable export button within the Tool.

Note also that without additional GIS experience or access, a user cannot format these results in the map (i.e., they will display simply as exits, without differentiation between high and low suitability). For formatted results, we recommend that the user utilize the Visualization Map: Results Viewer (see Section 2.3.1 above and Section 4 below).

3 VISUALIZATION MAP: DATA VIEWER USER GUIDE

A link to the Visualization Map: Data Viewer (“Data Viewer”) can be found after registering at https://mjbradley.com/mjb_form/EV-tools. This Data Viewer was developed to display three primary data layers:

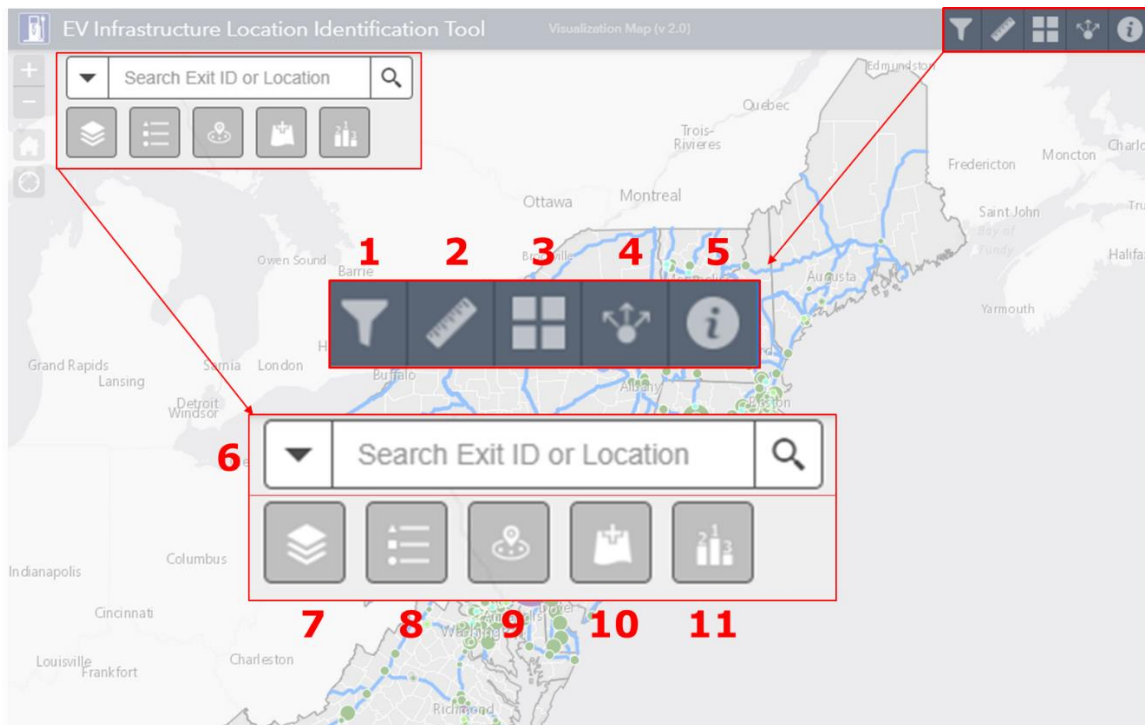
1. Existing public DCFC infrastructure;
2. Potential metrics that may guide or assist DCFC infrastructure development planning; and
3. Results from the Infrastructure Location Identification Tool, especially pre-loaded weighting methodologies.

This mapping application projects the data used by the Identification Tool and offers interactive resources to further the user’s understanding of how areas can be prioritized for future charging infrastructure development.

3.1 USING THE MAP: ORIENTATION





The Data Viewer uses several functions, or “widgets,” that allow the user to customize the view of the map. Before learning how to configure the widgets, it is useful to understand how to navigate the mapping application. The following image and table display where these widgets are located on the map and provide a brief description of the functionalities.

³ Again, note that there is likely to be location overlap, per footnote 2.



Orientation of Map Functions

Map Location	Icon	Description
1		<p><i>Filter Exits and DCFC by Metrics</i></p> <ul style="list-style-type: none"> All Exits: Filter “All Exits Along Selected Corridors” by various criteria, such as state, county, corridor, and evaluation metrics (distance to nearest existing infrastructure, traffic volume, etc.) EV Network of Public DCFC: view only those DCFC stations that belong to one or more provider network (e.g., EVgo or Greenlots) DCFC Connector Type(s): view only those DCFC stations that have a certain connector type (e.g., CHAdeMO or SAE) Utility Service Territories: view a specific electric utility distribution company service territory
2		<p><i>Manual Measurements</i></p> <ul style="list-style-type: none"> Area, length, and coordinate measurements made by user
3		<p><i>Basemap Options</i></p> <ul style="list-style-type: none"> Underlying map layer options
4		<p><i>Share this Map</i></p> <ul style="list-style-type: none"> Get a shareable link for the map (Tool and User Guide available through www.mjbradley.com)
5		<p><i>About This Map</i></p> <ul style="list-style-type: none"> Basic information of map and link to User Guide
6		<p><i>Search Exit ID or location</i></p> <ul style="list-style-type: none"> Search for exits or specific locations within the analysis region
7		<p><i>Layers</i></p> <ul style="list-style-type: none"> Turn visibility of selected layers on/off

8		<p><i>Legend</i></p> <ul style="list-style-type: none"> View how each visible layer is displayed
9		<p><i>Nearby Public DCFC and Exits</i></p> <ul style="list-style-type: none"> Find DCFC/exits that are within a selected radius of a location
10		<p><i>Add Exit Rankings Data</i></p> <ul style="list-style-type: none"> Upload exported exit rankings generated by Identification Tool
11		<p><i>Exit Rankings Layers</i></p> <ul style="list-style-type: none"> View location and data of pre-loaded/uploaded exit rankings

3.2 USING THE MAP: VISIBLE LAYERS

After agreeing to terms and conditions to continue to the map, the default extent and layers of the mapping application are visible. The default layers that are visible include:

- State and county boundaries of TCI region and North Carolina
- Corridors within the scope of this analysis
- Public DCFC stations along corridor (as defined in scope)

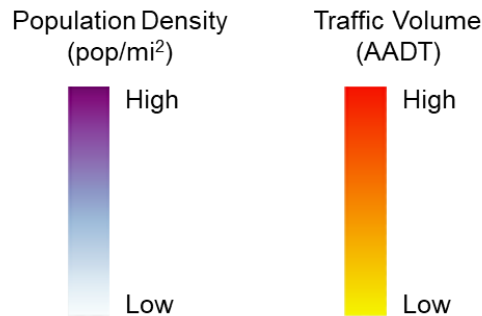
Along with the default layers, additional layers that contain supplementary data and analytical inputs used in the Identification Tool can be turned on/off by using the “Layers” widget and marking the check box next to each operational layer. To view how each layer is/will be displayed, either select the layer anywhere outside of the check box or select the “Legend” widget, which will show currently visible layers. Although all layers can be visible simultaneously, displaying too many data at one time can limit visibility and slow map navigation.

Additional data layers that can be turned on using the “Layers” widget:

- Tesla DCFC Stations (along selected corridors)*: Existing Tesla charging network within analysis region as defined by project scope
- Public DCFC Stations (outside region, w/in scope)*: public DCFC stations included in analysis that are relevant to the analysis but outside the region (i.e., in bordering states or Canada)
- Public DCFC Stations (w/in region, outside scope)*: public DCFC stations that are within the region but are not included in the analysis (because they are more than 5 miles from an analyzed roadway)
- All Exits Along Selected Corridors*: all exits included in analysis within analysis region
- Commercial Activity*: gas stations, restaurants, etc. within a 1-mile radius of all exits; note that this layer can only be turned on when zoomed in past a certain extent
- Utility Service Territories*: all electric utility distribution company service territories shown. Note that there is some overlap.
- Traffic Volume*: corridors within the scope of this analysis displayed by average traffic volume
- Population Density (census tracts)*: population density (population per square mile) of census tracts within the analysis region
- Pop-up layers (see 3.3 Viewing Data, below for examples):⁴
 - Corridor and Traffic Data (turn on/off data pop-up)*: data relevant to the corridor layers are visible when features are selected
 - County Data (turn on/off data pop-up)*: data relevant to counties within the analysis region are visible when features are selected

⁴ These are pop-up data layers associated with visual layers. For example, to enable “pop-ups” displaying detailed county data that will activate upon clicking on a county, turn on the *TCI County Data (turn on/off data pop-up)* layer. Note that all data associated with the layers is always accessible through the attribute table widget, regardless of whether the pop-up layer is enabled.

Note that two of the layers, *Traffic Volume* and *Population Density (census tracts)*, do not display in the legend on the Visualization Tool. While we believe the display of these layers are intuitive, below are their specific legend data:



Lastly, exit rankings layers generated using the Identification Tool can be made visible. In the Data Viewer, five layers representing the Identification Tool weighting methodologies discussed above (see 2.1.3 Weighting Method) have been pre-loaded and can be accessed through the “Exit Rankings Layer” widget (using the same method when using the "Layers" widget).

In addition to the five weighting methodologies described above, the Data Viewer also contains two additional exit ranking layers that can be generated with the Identification Tool using different traffic data. These are variations on the “Through Traffic” method using alternate measures of peak traffic (peak traffic volume and peak hourly factor) instead of average traffic.

3.3 VIEWING DATA

A user can access and explore data within the Visualization Map: Data Viewer using the "pop-up" tabs. When a feature is selected on the map, a small pop-up table will appear and display information specific to the selected feature.

The data displayed in pop-ups for the following layers include:

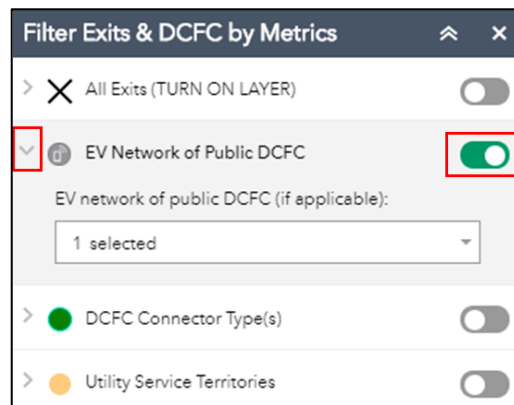
- **County layers**
 - Corridor summary information: names of corridors included in county, as well as exits and miles of each
 - Total exits or “nodes” analyzed in the county
 - Miles of analyzed corridor(s) in county
 - Average AADT of analyzed corridor(s) in county
 - Population density
 - Number of DCFC stations and ports in county
- **Corridor layers**
 - Roadway name
 - AADT of segment
 - Miles of roadway in state
 - Average AADT of roadway in state
 - Total exits or “nodes” analyzed along the roadway in the state
- **DCFC layers**
 - Station name
 - County and state of station
 - Station status (existing or planned)
 - Number of DCFC ports and connector type(s) at station
 - EV network (if applicable)
 - Name (or ID) of closest exit or “node”
 - Distance to closest roadway exit
 - AADT of closest roadway

- Count of commercial activity within 1 mile
- Nearby population density (census tract level)
- **All Exits Along Selected Corridors**
 - Exit ID (format: roadway_county_state_node_type_numberidentifier)
 - Distance to nearest DCFC
 - Number of DCFC ports within 5, 10, and 20 miles
 - AADT near exit
 - Nearby population density (census tract level)
 - POI and commercial activity within 1 mile
- **Points of Interest and Commercial Activity**
 - Name of business/entity
 - Category of POI/commercial activity (restaurant, shop/store, gas station, etc.)
 - Additional information (if applicable)
- **Ranked exit layers** (pre-loaded and user-uploaded)
 - Rank of exit applicable to weighting method
 - Exit ID
 - Final Score
 - Ranking methodology criteria

3.4 INTERACTIVE CAPABILITIES AND UPLOADING DATA

In addition to displaying and viewing data, the Visualization Map: Data Viewer has a few interactive functions (introduced in Section 3.1) to enable data analysis. These are:

- *Filter Exits & DCFC by Metrics*: This tool includes four filtering options that can be opened by clicking on the arrow next to the corresponding title and ensuring that the toggle to the right is clicked on (and showing green). See example below. In addition, each filter will require that certain layers in the “Layer” widget are turned on (see Section 3.2 for more detail on how to use these layers).



The four options are:

1. All Exits: Filter “All Exits Along Selected Corridors” by various criteria, such as state, county, corridor, and evaluation metrics (distance to nearest existing infrastructure, traffic volume, etc.)
 - This tool allows the “All Exits Along Selected Corridors” layer to be filtered to show only a select range of exits. This can be used as an additional screening tool to determine suitable exits based on ranking metrics and user priorities. After turning on the All Exits layer, a user can filter exits by defining:
 - Geographic extent (state, county, or corridor)
 - Exit node type (exits/intersections and/or service plazas)

- Analysis metrics (distance to closest DCFC, traffic volume, population density, and nearby commercial activity)
 - Note that all of these filters are optional, but also dependent on previous conditions. For instance, only counties specific to the selected state will be shown in the filter drop-down menu; likewise, only exits that meet all criteria defined in the filter will be displayed. Users are also able to record exits that result from their filter by clicking on a resulting exit to open a pop-up, clicking the button with three dots (bottom right corner of pop-up), and selecting “Add a marker” (second option). This will drop a marker on to the map to keep track of the user-screened exit node(s). To remove the dropped marker, click the marker and follow the same directions to produce the option “Remove marker.”
- 2. EV Network of Public DCFC: filter all in-scope DCFC stations that belong to one or more provider network (e.g., EVgo or Greenlots). A user may select one or more EV network to view. To use this filter, the “Public DCFC Stations” layer must be turned on. Note that the following filter (DCFC Connector Type(s)) must be turned off for this filter to function correctly.
- 3. DCFC Connector Type(s): filter all in-scope DCFC stations by connector type (e.g., CHAdeMO or SAE). To use this filter, the “Public DCFC Stations” layer must be turned on. Note that the preceding filter (EV Network of Public DCFC) must be turned off for this filter to function correctly.
- 4. Utility Service Territories: a user may select a utility distribution company service territory. The map will zoom to this region and show the relevant service territory. To use this filter, the “Utility Service Territories” layer must be turned on.
- *Search Exit ID or location:* Enter an exit ID (from the Identification Tool) into the search bar to see suggested exits under “Exit ID” and view the location of an exit. This tool allows for quick visualization of top-rated exits found using the Identification Tool. Note that it is not necessary to upload results from the tool to find and display the exit location. Any location within the analysis region can also be searched using the search bar; suggested results appear under “Region.” Using the “down” arrow on the left side of the search bar filters the search to focus on only exit IDs, locations within the analysis region, or both.
- *Add Exported Exit Rankings Data:* This tool allows data that was exported from the Identification Tool to be uploaded into the Visualization Map: Data Viewer. Although *Search by Exit ID* quickly displays the location of searched exits, this tool allows exit rankings data generated by the Identification Tool to be uploaded to and visualized on the mapping application. After opening this widget:
 - Browse and select the exported data file you wish to upload; selected files can be opened or dragged into the widget configuration to upload
 - Unformatted data points will be projected on to the mapping application; data values can be viewed by clicking a point or opening the attribute table
 - A new layer (same name as uploaded file) will appear in both the *Layers* and *Exit Rankings Layers* widgets; its visibility can be turned on or off within these widgets
 - To view uploaded layer files, select the “LAYERS” text located at the bottom-right of the *Add Exit Rankings Data* widget pop-up; delete uploaded layers by clicking the “Remove Layer” icon (designated as a trash can) to the right of the layer name
- *Nearby Public DCFC and Exits:* This tool can be used to identify public DCFC stations and exits within a specified distance from a point (such as a business of interest to the user). After opening this widget:
 - Search for a point or location within the analysis region by entering an address in the search bar or selecting the "pin" (located to the right of the search bar) and "Set location" by clicking on any point on the map
 - Specify the distance/radius from the selected point within which DCFC station and exit data will appear using the slider bar.
 - DCFC stations and exits within specified radius will appear with corresponding data

4 VISUALIZATION MAP: RESULTS VIEWER USER GUIDE

The Visualization Map: Results Viewer (“Results Viewer”) can be found after registering at https://mjbradley.com/mjb_form/EV-tools. This Results Viewer was developed to replicate the Excel-based tool and display real-time results of a user’s personalized weighting methodology. Unlike the data upload functionality in the Data Viewer, the Results Viewer provides a one-step user experience and creates visualizations of suitability rankings that are formatted for easy assessment and sharing with additional stakeholders. It also includes various functionalities for users to drill down on certain exits by location or suitability rank.

4.1 USING THE MAP: ORIENTATION

The Results Viewer includes several functions to build and refine displays of exit suitability results. Along the left of the Results Viewer is the inputs dashboard, which mirrors the dashboard of the Tool (see Section 2.1). Once a user inputs a weighting methodology and produces a set of exit suitability rankings, various functions on the right allow a user to refine which exits are displayed on the map.

The following image and table display where these functions are located on the map and provide a brief description of the functionalities.

Results Viewer: Infrastructure Location Identification Tool (v3.0)

Use icons in bottom-right corner for full-screen mode and image/result downloads

1. Exit Filters & Inputs

- Select State(s): (All)
- Select County(ies): (All)
- Select Corridor(s): (All)
- Select Node Type(s): (All)
- DCFC Connector Type (for proximity): All (SAE & CHAdeMO)
- Traffic Type (for traffic volume): Average Traffic (AADT, default)

2. Metric Weighting (%)

- Proximity: Closest DCFC: 15
- Proximity: Port Density: 15
- Traffic Volume: 30
- Population Density: 10
- Nearby Activity: 30
- Total (must equal 100): 100

3. Results

Exit Score: 17.0 to 94.0

4. Filter by Exit Rank

1 to 9,412

5. Highlight Ranked Exits

Node ID	Rank
I-81_Onondaga_NY_E...	1
I-81_Onondaga_NY_E...	1
I-81_Onondaga_NY_E...	1
I-81_Onondaga_NY_E...	1

Highlight County: [input]
 Highlight Corridor: [input]
 Highlight Node ID: [input]



Note: Final exit scores and ranks are relative to the exits defined in "Exit Filters & Inputs" and specific to the metric weighting scenario

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Map navigation controls: + a b | e a u [Full Screen] [Download]

Orientation of Map Functions

Map Location	Section Title / Symbol	Description
1	Exit Filters & Inputs	<ul style="list-style-type: none"> • Selections to identify the analysis area (state, county, roadway, and node type) • Options for which in-scope existing DCFC should be included in proximity metrics (all or only certain plug types) • Options for which traffic data should be used (average, peak, or peak to average ratio)
2	Metric Weighting	<ul style="list-style-type: none"> • Mirrors the option in the Tool dashboard for a user to input personalized metric weightings
3	Exit Score	<ul style="list-style-type: none"> • Key showing color convention for exit rankings as well as minimum and maximum ranking values for included exits
4	Filter by Exit Rank	<ul style="list-style-type: none"> • Limit exits shown on map to only those within a certain range of ranks (highest exit score corresponds with rank of 1)
5	Highlight Ranked Exits	<ul style="list-style-type: none"> • Select an exit from a list to highlight this location on the map • Of all exits included in the analysis (based on the Exit Filters), show only a subset without re-running the rankings.
6	 (Download)	<ul style="list-style-type: none"> • Download an image of the map results
7	 (Full Screen)	<ul style="list-style-type: none"> • Make Results Viewer full-screen (good for increasing the size of the map)

4.2 USING THE MAP: INPUTS

The inputs panels of the Results Viewer will be very familiar to users of the Tool: these filters and metrics are the same as those used in the Tool in order to allow a user to create a visualization of identical scenarios as created in the Tool with an associated list of exits or other nodes. We encourage a user to review Section 2.1 of this User Guide if unfamiliar with the options here. A relatively brief summary is provided below.

4.2.1 Exit Filters & Inputs

The user may select among four filters to limit the scope of exits that the Results Viewer will analyze and display. These filters are:

- State: limit the analysis to one or more states by checking the appropriate boxes. To unselect all states to start, uncheck “(All)” at the top of the list
- County: within the selected state(s) limit the analysis to one or more counties by checking the appropriate boxes. The user may also search at the top of the drop-down list to quickly find a specific county to include or exclude. To unselect all counties to start, uncheck “(All)” at the top of the list.
- Corridor(s): within the selected geographic region, limit the analysis to one or more corridors by checking the appropriate boxes. The user may also search at the top of the drop-down list to quickly find a specific corridor to include or exclude. To unselect all corridors to start, uncheck “(All)” at the top of the list.
- Node Types(s): a user may include all nodes (i.e., exits, service plazas, and other intersections), only service plazas, or only exits and intersections (excluding service plazas).

Like the Tool, the user must also select two data inputs that will determine how the metrics are calculated. These are:

- *DCFC Connector Type*: select the existing DCFC stations that will be included in the proximity metrics (i.e., the closest existing DCFC station to and the density of ports surrounding a location). This allows a user to select all DCFC stations, only stations with SAE Combo connectors, or only stations with CHAdeMO connectors.
- *Traffic Demand Metric*: select the traffic data that will be used for the traffic demand metric. A user can select: Annual Average Daily Traffic (AADT), reflecting average number of vehicles on a roadway; Peak Traffic Volume, measuring traffic at peak times across all roadways; or Peak Hourly Factor, an indicator of peak traffic relative to average traffic on a corridor.

4.2.2 Metric Weighting

The weighting method is used to emphasize specific metrics/characteristics of exits when ranking within the selected region and group. A user selects the values across five metrics, totaling 100, to create a scenario that reflects his or her own priorities for infrastructure development in the ranking process. To change the values, click within a box and replace the number, pressing enter when finished. The Results Viewer will automatically update after each change. If the values entered across all metrics do not equal 100, the Results Viewer will return no rankings, scoring all exits at “0.”

The Proximity and Traffic Volume metrics will calculate using the data selected in the Exit Filters & Inputs dashboard (e.g., average traffic and all DCFC connectors).

4.3 USING THE MAP: RESULTS AND RESULT FILTERS

The Dashboard to the right of the map within the Results Viewer contains various functions that allow a user to refine which exits are displayed on the map.

4.3.1 Exit Score

This key shows the range of exit scores, which may be from 1 – 100. It also shows the color scheme of exit markers on the map.

4.3.2 Filter by Exit Rank

A user may choose to only show a subset of exits included in the analysis by dragging the half-circles on either end of the slide bar. The numbers above the slider will update to reflect the exit ranks that are included. A user may also click on these numbers and directly enter a value here, pressing enter when finished. The map will update automatically to display only these selected exits after any change. To reset, drag the sliders to the far end of each end of the scale.

4.3.3 Highlight Ranked Exits


This section allows a user to highlight a subset of exits included in the analysis based on geographic characteristics or by specific exit. Unlike changing the geographic filters in the “Exit Filters and Inputs” section, this will not re-run the analysis for only those exits, simply create a visual emphasizing this group of exits.

- *List of Exits/Nodes*: view the exits (sorted by rank) of the current scenario and hover over the ID to highlight the location on the map. The scrollable list will include only those exits that are located with the state(s) and county(ies) selected in the “Exit Filters and Inputs Section” This function works best in Full Screen mode (see Section 4.3.5 below).
- *Highlight County*: type or select from the list a county. The map will highlight those exits located in the county. The list will only include those counties that are located within the state(s) selected in the “Exit Filters and Inputs” section and are within the range defined in the “Filter by Exit Rank”.
- *Highlight Corridor*: type or select from the list a corridor. The map will highlight those exits located on that corridor. The list will only include those corridors that are located within the state(s) and county(ies) selected in the “Exit Filters and Inputs” section and are within the range defined in the “Filter by Exit Rank”.
- *Highlight Node ID*: type or select from the list a node ID. This can be a useful way to locate a specific exit or intersection identified in a user’s use of the Identification Tool. The list will only include those nodes that are located within the state(s), county(ies), and corridors selected in the “Exit Filters and Inputs” section and are within the range defined in the “Filter by Exit Rank”.

4.3.4 Download

Select the download function to create an output—essentially screenshot—of the full Results Viewer screen at a given point. This will include the map and the dashboards. Select between file formats. The download should automatically start.

4.3.5 Full Screen

Select full screen by clicking the appropriate icon to increase the width of the Results Viewer. This may take a few moments to load. Depending on screen size, this may significantly increase the view area of the map. To exit full screen, click the  image at the bottom right corner of the screen or by pressing Esc.