



HCS™
Network Module



USER GUIDE

Contents

Introduction	1
License Agreement	1
Acknowledgements	5
Trademarks and Copyrights	6
Getting Started	7
System Requirements	7
Getting Started	7
General Controls	8
Menu Items.....	8
Network Analysis	10
HCM Chapter 38	10
Operational Data	10
Network Analysis Report.....	11
How To	12
Create a New File.....	12
Open an Existing File	14
Save a File	18
Close a File	19
Exit the Program.....	20
Edit the Default Settings.....	21
View Results of the Analysis	23
Print a Report	28
Steps for Starting a Network Analysis.....	31
Glossary of Terms	33
Index	49

Introduction

License Agreement

HIGHWAY CAPACITY SOFTWARE™ (HCS™)
END-USER LICENSE AGREEMENT (EULA)

Effective Date: 10/15/2024

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Acknowledgements

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We acknowledge the Transportation Research Board (TRB), the USDOT's Federal Highway Administration (FHWA), the American Traffic Safety Services Association (ATSSA), the Institute of Transportation Engineers (ITE), and the American Association of State Highway and Transportation Officials (AASHTO) for all text, figures, and references included in HCS and express our sincere appreciation for permission to include this information.

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Getting Started

System Requirements

HCS is designed for standard Windows installations. For optimal performance, the system should be Windows 10 or newer. While HCS may be compatible with older versions of Windows, any installation and operational issues arising from using these older versions will be the sole responsibility of the end user.

Getting Started

To begin, click on File then New (or the "New File..." button on the Start page).

Normal Windows keyboard and mouse functions are available. Tabbing, clicking to a new field, or pressing the Enter key will trigger a recalculation and update the report.

Network Analysis

Network analyses will evaluate the interactions between freeways and urban streets and the effects of spillback from one facility to another. This type of analysis can be applied to a network of interconnected freeways and to freeway-to-arterial connections. It can also be applied when the freeway-arterial interchange consists of signalized intersections, stop-controlled intersections, and roundabouts. These analyses will estimate travel times and speeds for networks and for origin-destination pairs (O-D) within these facilities. The methodology and procedures of application use the HCM Chapter 38 procedures.

General Controls

Menu Items

New – Creates a new Network file (*.xnw) and starts a new analysis project; shortcut is Ctrl+N

Open – Opens an existing Network file (*.xnw); shortcut is Ctrl+O

Save – Saves an open Network file (*.xnw) using the current file name; shortcut is Ctrl+S

Save As... – Saves an open Network file (*.xnw) using a specified file name; shortcut is F12

Close – Closes an existing Network file (*.xnw); shortcut is Ctrl+W

Print – Brings up printer selection and prints a Network report to the printer or specified file type; shortcut is Ctrl+P

Print Preview – Displays preview of current report before printing; shortcut is Ctrl+F2

Report

Formatted Report – Displays formatted report including the most important values; shortcut is F4

Text Report – Displays text report with input, intermediary, and final results; shortcut is F6

Default Settings – Opens a dialog box for the user to input defaults for Analyst, Agency, and Jurisdiction, which will be applied to all new files; also allows selection of USC or SI units, which will be applied to all new files; shortcut is Alt+F

Help

Contents – Provides access to glossary, acknowledgements, copyrights, and information on the HCM procedures; shortcut is Ctrl+F1

Index – Allows user to search keywords within the glossary

Search – Allows user to search for any word within the glossary

User Guide – Opens a comprehensive user guide in PDF format; shortcut is Ctrl+G

HCM Reference Guide – Opens a reference guide for the HCM in PDF format

HCS Updates – Sends the HCS version number anonymously without any personally identifiable information to McTrans to check for a newer version

HCM/HCS Training – Opens the McTrans Training Page in the default web browser to view the latest training opportunities

HCQS Web Page – Opens the TRB Highway Capacity and Quality of Service Committee page in the default web browser

Support

Frequently Asked Questions – Opens the McTrans support page for HCS in the default web browser

HCS Overview – Opens the McTrans HCS Overview page in the default web browser

McTrans Website – Opens the McTrans home page in the default web browser

E-mail McTrans – Composes a new e-mail addressed to McTrans in the default e-mail client with registration number, serial key, module, and version number already populated in the Subject field

About HCS – Opens an about window with software version information, EULA, general acknowledgements, and other relevant links

Exit – Exits the *HCS* Network module; shortcut is Alt+F4

Network Analysis

HCM Chapter 38

The Highway Capacity Software (*HCS*) faithfully implements the methodology prescribed in the Highway Capacity Manual (HCM) for analyzing the interactions between freeways and urban streets and the effects of spillback from one facility to another. The methodology of this chapter can be applied to a network of interconnected freeways and to freeway-to-arterial connections. It can also be applied when the freeway-arterial interchange consists of signalized intersections, stop-controlled intersection, and roundabouts. The analysis tools of this chapter provide travel times and speeds for networks and for origin-destination pairs (O-D) within these facilities.

The methodology builds on the analysis methods of individual points, and segments and points, and extends them in several ways in order to consider spillback effects from the downstream facility. First, because spillback affects each lane differently, the analysis is conducted on a lane-by-lane basis. Second, supplemental performance measures are provided at the network level and at the O-D level for undersaturated and oversaturated conditions. Travel time measures are also provided for segments and facilities, and their values are consistent with the analysis methods described in other parts of the manual.

Operational Data

NETWORK

On the Network page, the user first enters the General Information into the respective fields: Analyst, Agency, Date, and Time Analyzed. Then, the user enters the Site Information into the respective fields: Jurisdiction, Analysis Year, and Project Description.

To run a network analysis, the user is required to load a freeway facility file. There are two options when using a freeway facility file: *Load Freeway Facility* and *Create Freeway Facility*. The program requires the HCS Freeways module for both these options. The *Load Freeway Facility* button opens a dialog that allows users to open an existing HCS Freeways (*.xuf) file. The *Create Freeway Facility* button launches the Freeways module where a user can create a new HCS Freeways (*.xuf) file. If HCS is already installed on the computer, then the Freeways module should open when this button is clicked. If HCS is not installed, an error will pop up and HCS will need to be installed on the computer to continue with the Network analysis.

Once a freeway facility is loaded, the Freeway Facility Information box will be displayed with the File Name, Number of Segments, Number of Analysis Periods, and the Start Time. The data grid on the Network page will also populate and a Network Segments graphic will display.

For the data grid, only on-ramp, off-ramp, weaving on-ramp, and weaving off-ramps from the loaded freeway facility will display. For the graphic, the entire freeway facility will be illustrated along with nodes. Other relevant segment information will be displayed. Columns in the data grid include the following: Segment, External File, Segment Type, Ramp Terminal Type, Ramp Terminal Facility Name, Connected Intersection/Segment ID, Connected Intersection/Segment Name, Approach, Ramp Roadway Length, and Details. Segment and Segment Type will automatically populate based on the freeway facility loaded. Under External File, hyperlinks are provided to select an external Streets (*.xuf) or Freeways (*.xuf) file to add as a node. Once selected, Ramp Terminal, Ramp Terminal Facility Name, Connected Intersection/Segment ID, Connected Intersection/Segment Name, and Approach will populate based on the file selected. Ramp Roadway Length can be edited with or without an external file selected. Clicking on any of the Details hyperlinks will open the Details page for the corresponding ramp terminal.

Above the data grid, two buttons and a checkbox are provided. If changes were made to any of the external files, the row(s) of those external files can be selected, and then the 'Refresh Selected Files' button can be clicked. This will reload the selected external file(s) so the most up-to-date information will be used. If the user desires to remove any of the already loaded external files, the row(s) of those external files can be selected, and then the 'Remove Selected Files' button can be clicked. This will remove the external file(s) so it is no longer a connection to the network. When the checkbox 'Assign Ramp Terminal Volumes to all Freeway Ramp' is checked, all checkboxes for 'Assign Ramp Terminal Volume to Freeway' for individual ramp terminals on the Details page will be checked.

DETAILS

On the Details page, all ramp terminals will have the following sections: Ramp Terminal Data, Ramp Details, Volume Balancing, and Freeway Inputs. Ramp Terminals that are either Off-Ramp or Weaving Off-Ramp will also have an additional section of Off-Ramp Lane Assignment.

Under the Ramp Terminal Data section, drop-down selections are provided for Ramp Terminal and Analysis Period. These selections will determine what inputs are displayed on the page. This section also displays the Ramp Terminal Type, Ramp Terminal Facility Name, Connected Intersection/Segment Name, Connected Approach, and a Network Segments graphic.

Under the Ramp Details section, inputs required for Off-Ramp and Weaving Off-Ramp are the Ramp Roadway Length and Shoulder Queue Storage Lengths. Inputs required for On-Ramp and Weaving On-Ramp are the Ramp Roadway Length, indication if Ramp Metering is present, and the Ramp Metering Rate if applicable.

Under the Volume Balancing section, the Ramp Terminal Approach Volume and Ramp Demand values are displayed. When the checkbox 'Assign Ramp Terminal Volume to Freeway' is checked, the Ramp Demand will automatically update to use the Ramp Terminal Approach Volume instead. This checkbox is only available when there is an external file loaded for the ramp terminal.

Under the Off-Ramp Lane Assignment section, the Connected Intersection/Segment Name and Connected Approach information is displayed. The off-ramp lane assignment can be specified through a drop-down selection. This available based on the external file loaded for the ramp terminal and the number of lanes.

The Freeways Inputs section is in a collapsible menu. What is included is dependent on the corresponding segment from the freeway facility originally loaded. All inputs are directly taken from the Freeways file, but are editable within Network

Network Analysis Report

The report page shows a formatted version of the analysis in a dynamic form, reacting to changes in the Network page. All or a portion can be copied to the Windows clipboard for insertion into other files by right-clicking into the report and selecting Copy.

Both formatted and text reports are available for viewing and printing. The formatted report provides data and results that are most important to the user, and are displayed in a clean and more presentable fashion. The text report provides more details to the user, rather than a summary.

The user can switch between reports by clicking on the button found at the bottom of the Report page.

How To

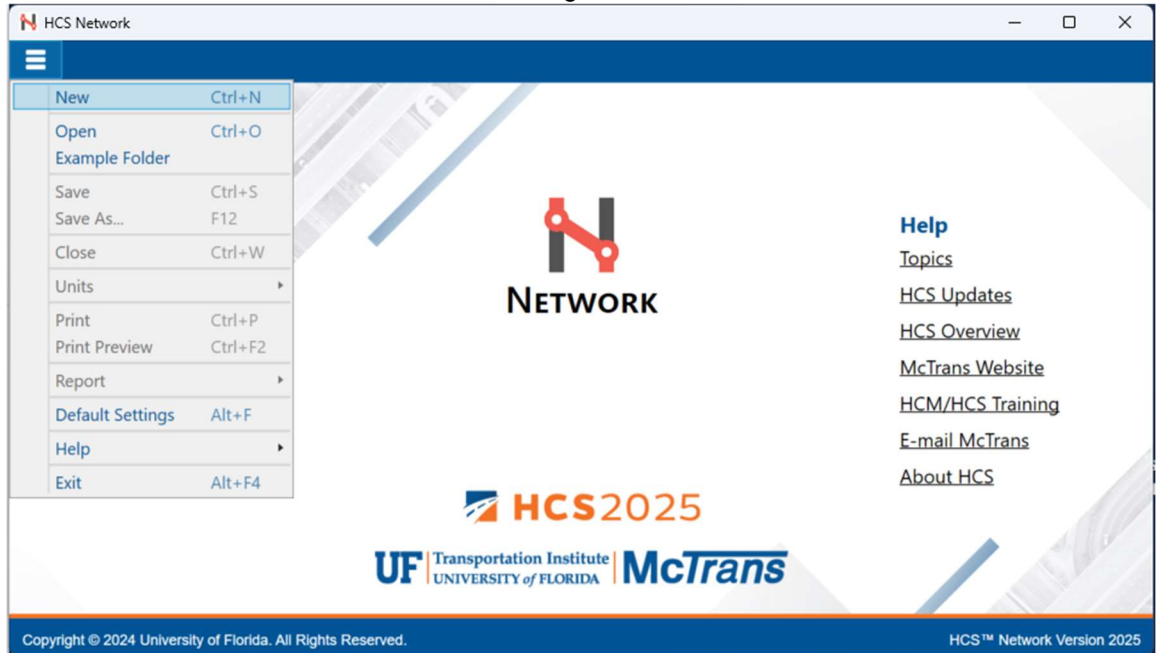
Create a New File

1. From the Start screen, there are three options for creating a new file:



Note: A new file can be created if an existing file is already open; you do not need to start from the Start screen.

- a. Selecting *File > New* from the main menu; this can be found by selecting the three lines in the top left-hand corner of the screen and then selecting “New”

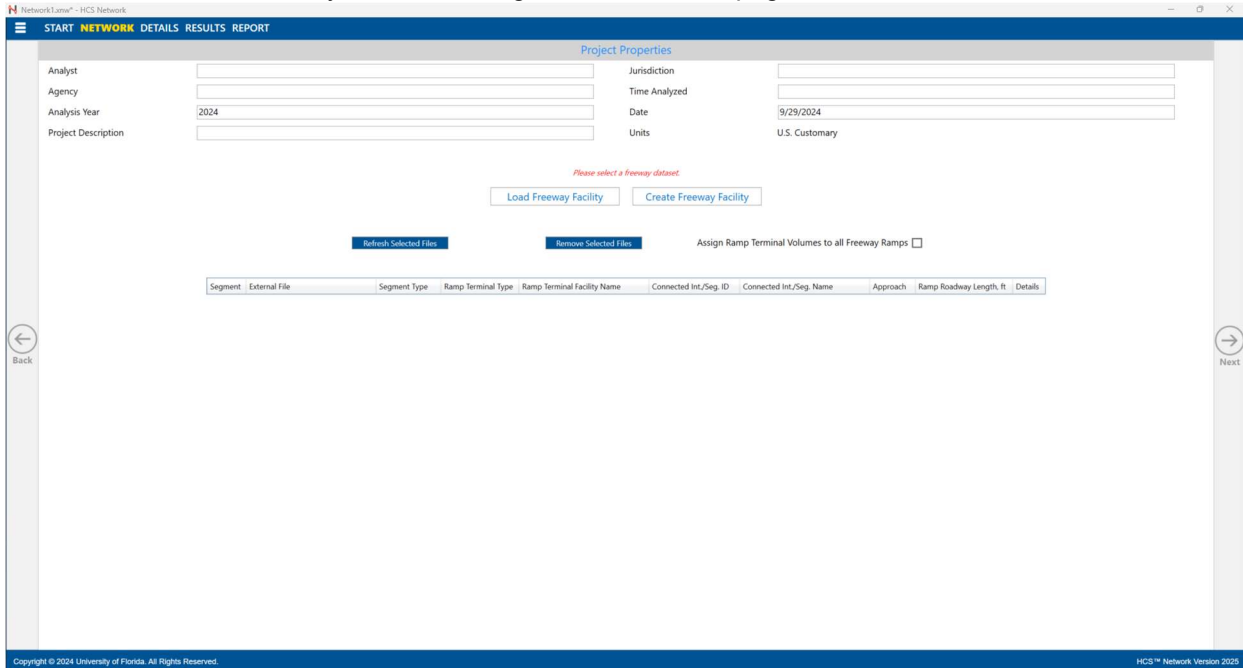


- b. Selecting “New File...” from the Start screen; this can be found below in the red box



- c. Using the keyboard shortcut “Ctrl+N”

2. Once a new file is created, you will be brought to the Network page



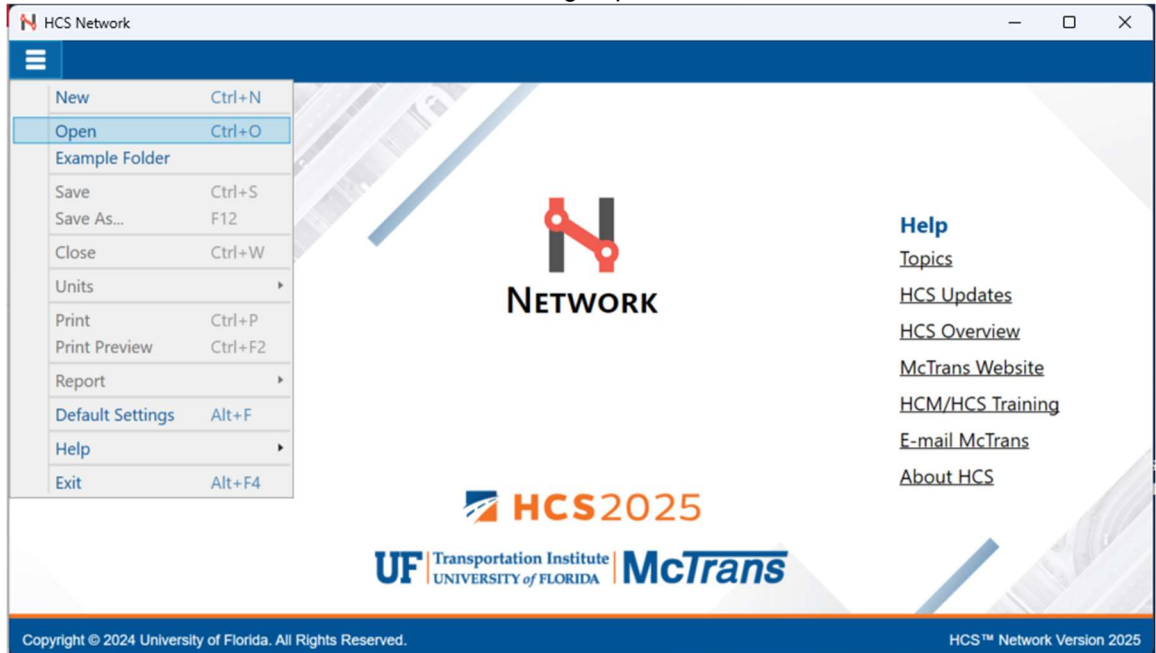
Open an Existing File

1. From the Start screen, there are six options for opening an existing file:

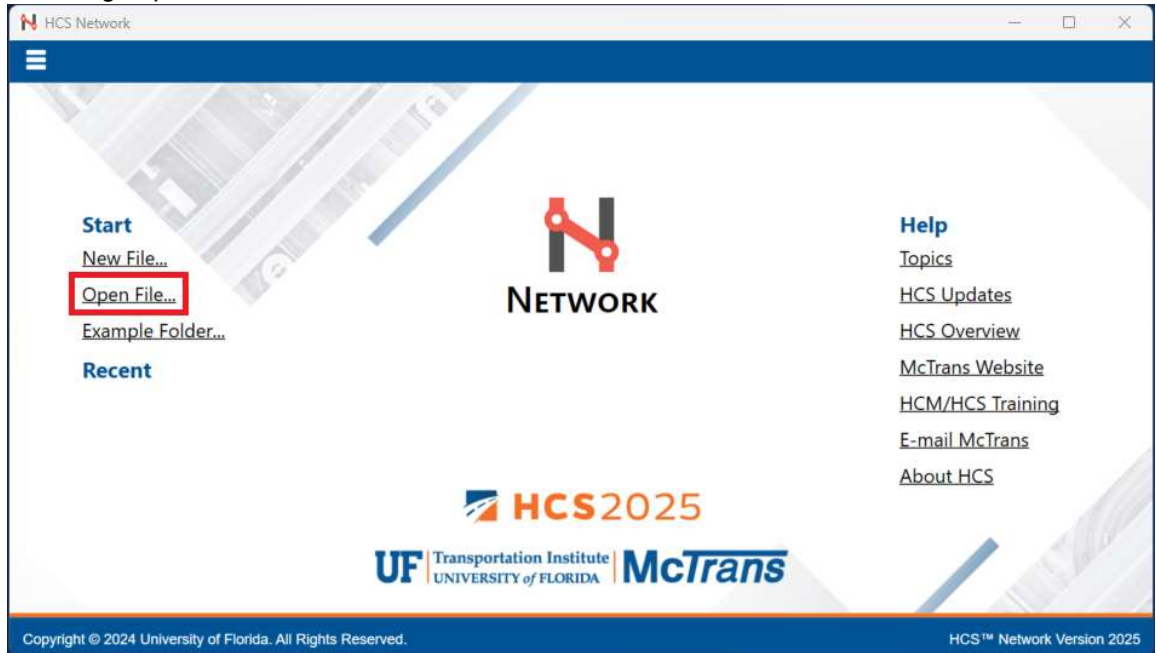


Note: A file can be opened even if another file is currently open; you do not need to start from the Start screen.

- a. Selecting *File > Open* from the main menu; this can be found by selecting the three lines in the top left-hand corner of the screen and then selecting “Open”

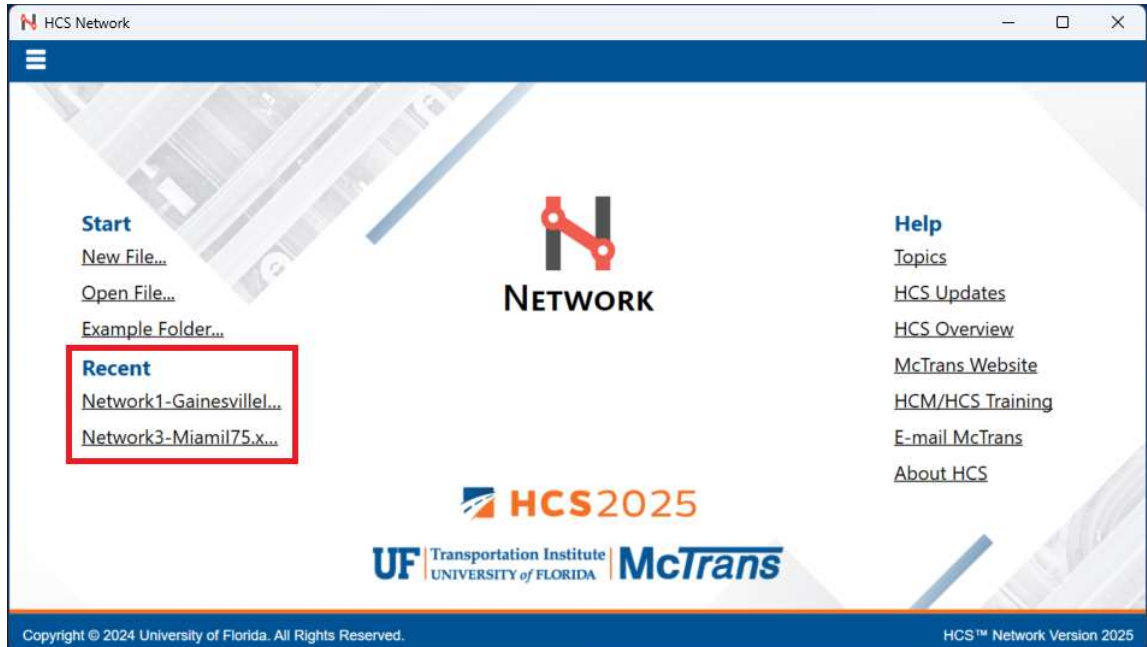


- b. Selecting “Open File...” from the Start screen; this can be found below in the red box

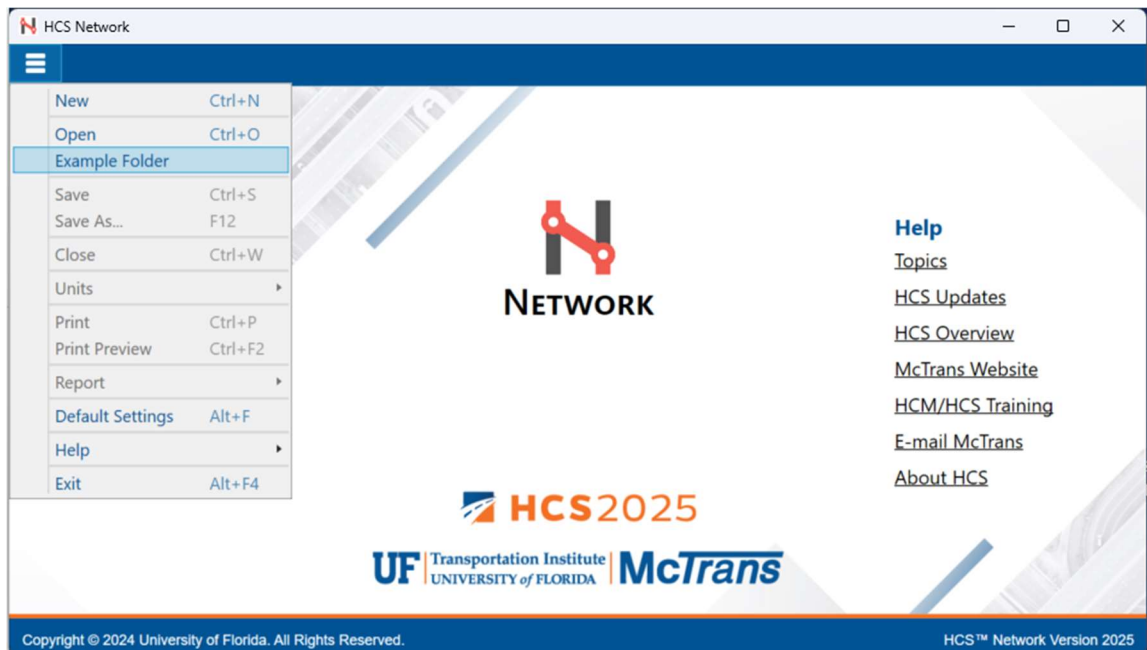


- c. Using the keyboard shortcut “Ctrl+O”

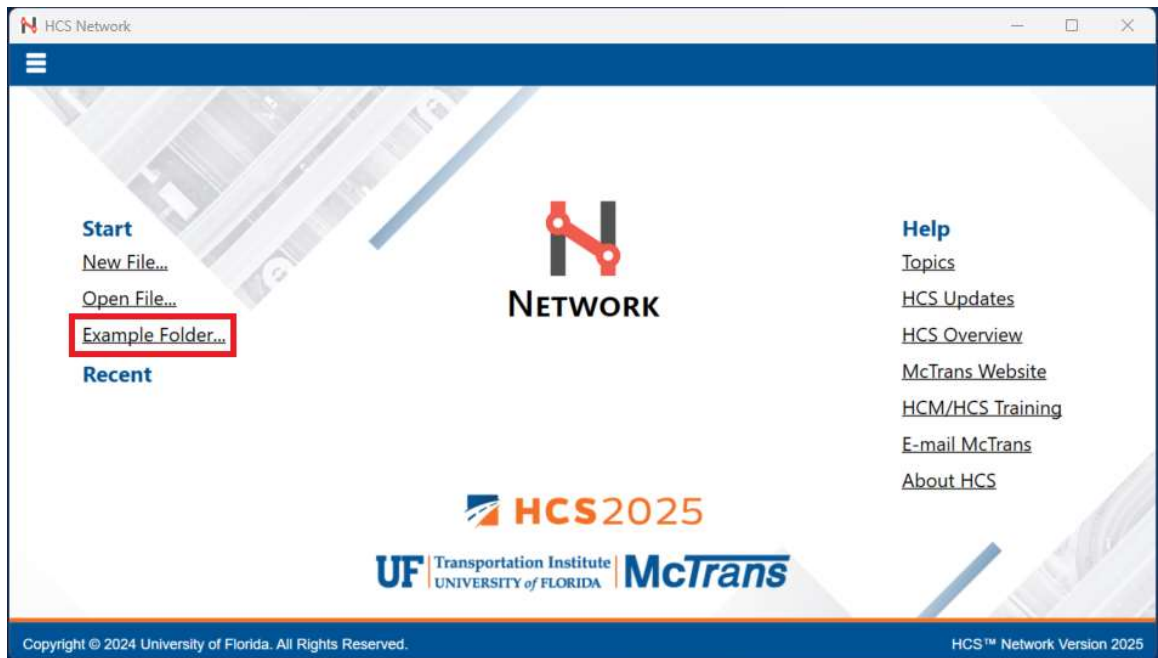
- d. Selecting a file under the Recent files list from the Start screen; this can be found below in the red box



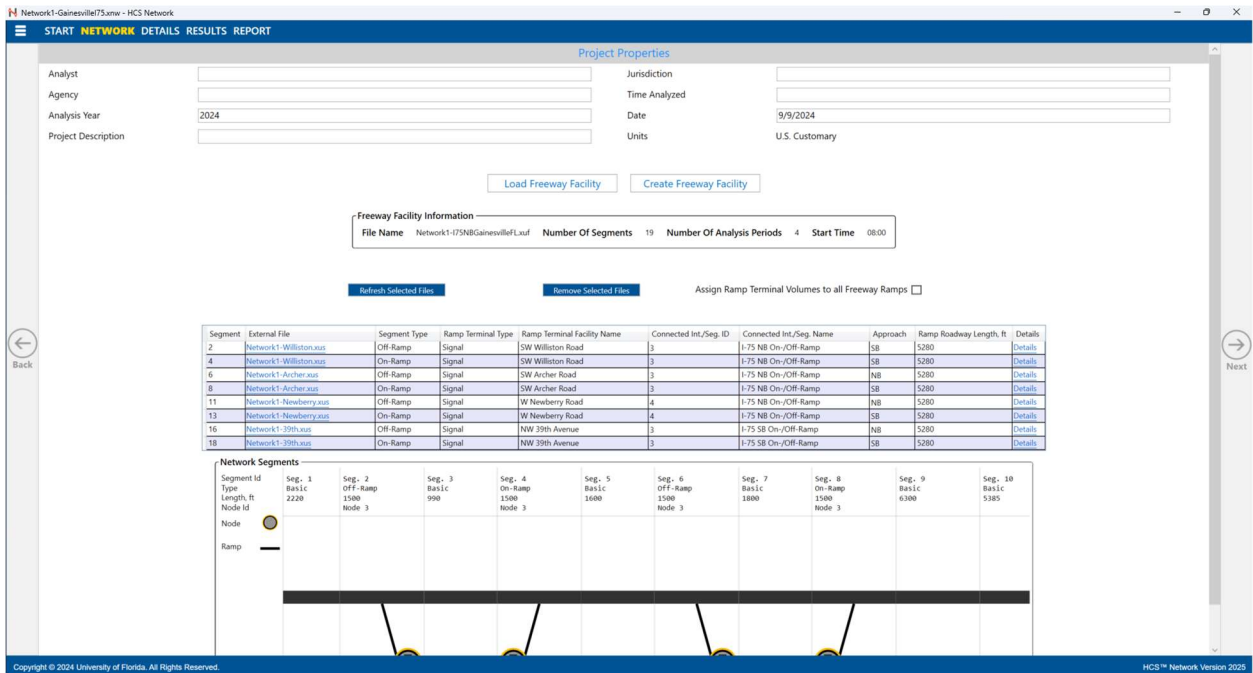
- e. Selecting *File > Example Folder* from the main menu; this can be found by selecting the three lines in the top left-hand corner of the screen and then selecting “Example Folder”. Opening the example folder will open the path of the HCS example files in File Explorer. The desired example file can be double-clicked or right-clicked and selecting ‘Open’, which will open the example file in the Network program.



- f. Selecting “Example Folder...” from the Start screen; this can be found below in the red box. Opening the example folder will open the path of the HCS example files in File Explorer. The desired example file can be double-clicked or right-clicked and selecting ‘Open’, which will open the example file in the Network program.



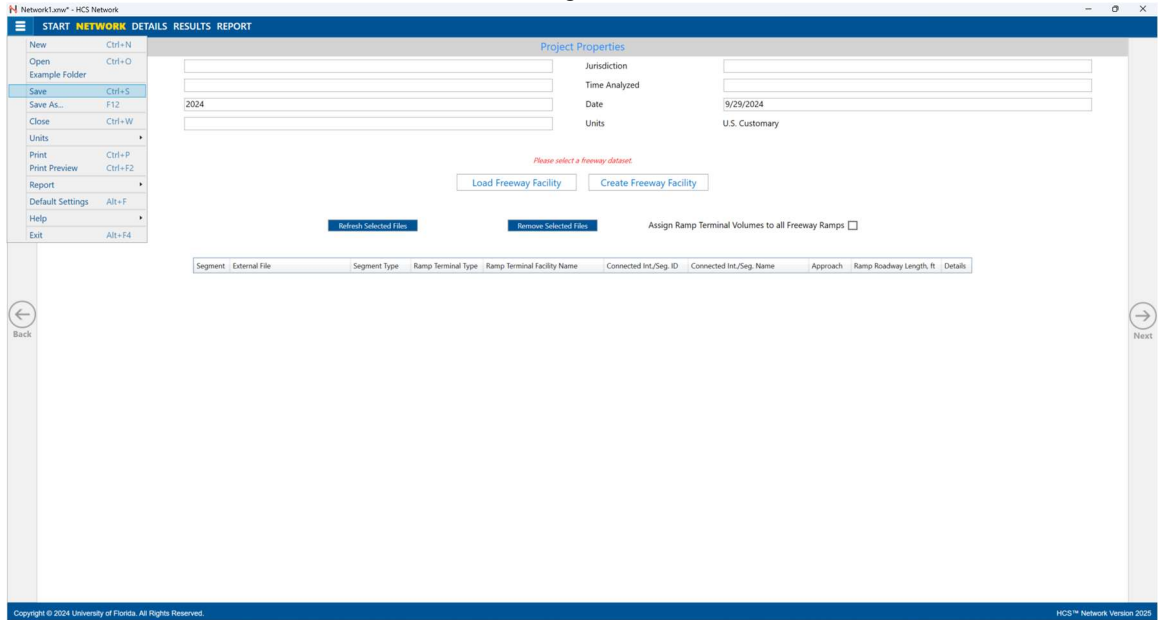
2. Once an existing file is opened, you will be brought to the Network page



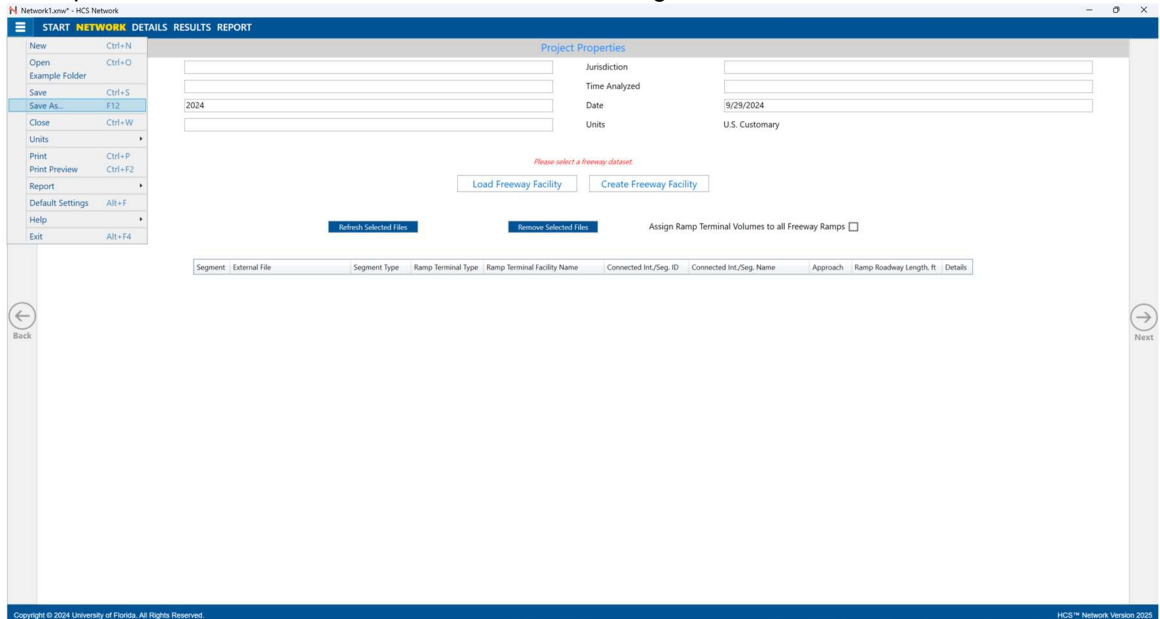
Save a File

1. There are five options for saving an open file:

a. Selecting *File* > *Save* from the main menu; this can be found by selecting the three lines in the top left-hand corner of the screen and then selecting “Save”



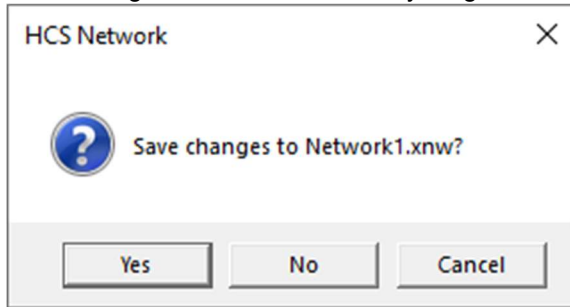
b. Selecting *File* > *Save As...* from the main menu; this can be found by selecting the three lines in the top left-hand corner of the screen and then selecting “Save As...”



c. Using the keyboard shortcut “Ctrl+S” for Save

d. Using the keyboard shortcut “F12” for Save As

- e. Exiting the program or closing the file without saving changes beforehand; this will prompt you to save changes to the file before anything is closed

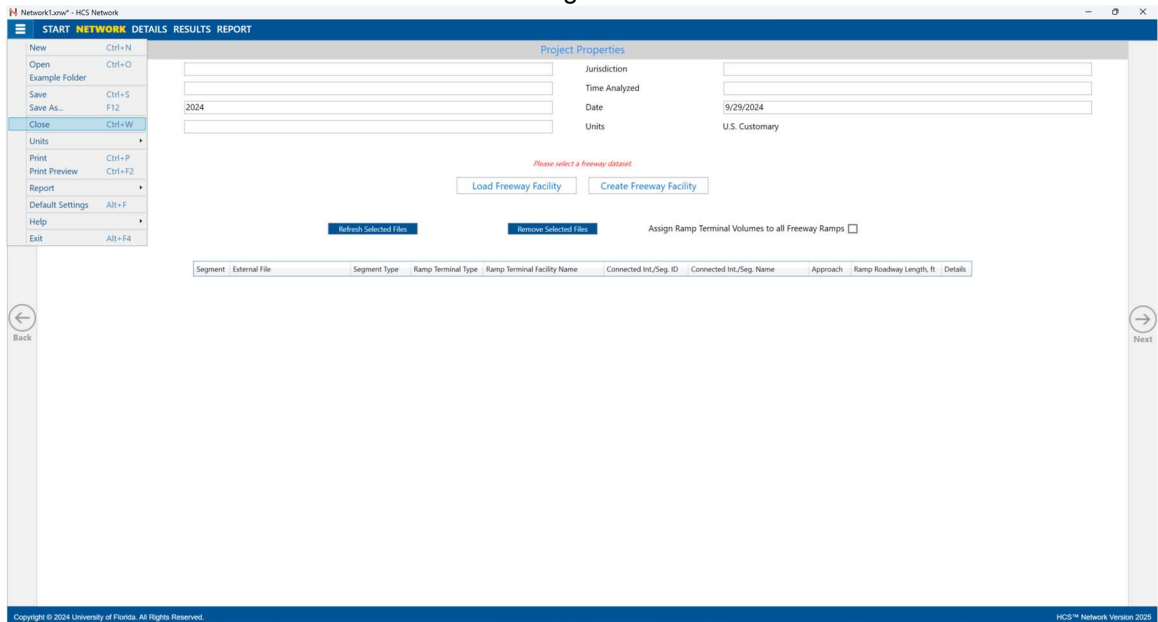


- i. Selecting “Yes” will save the file if it is an existing file. If the file has not been previously saved, the Save As dialog box will pop up allowing you to change the file name and save it.
- ii. Selecting “No” will exit the program or close the file without saving the file
- iii. Selecting “Cancel” will prevent the file from closing

Note: Using Save with an existing file will save a file without prompting you to specify a file name. Using Save with a new file will bring up the Save As dialog box for you to specify a file name for saving. Using Save As will always bring up the Save As dialog box for you to specify a file name for saving.

Close a File

- 1. There are three options for closing an open file:
 - a. Selecting *File > Close* from the main menu; this can be found by selecting the three lines in the top left-hand corner of the screen and then selecting “Close”



- b. Using the keyboard shortcut “Ctrl+W”
- c. Exiting the program itself; please see *How To: Exit the Program*

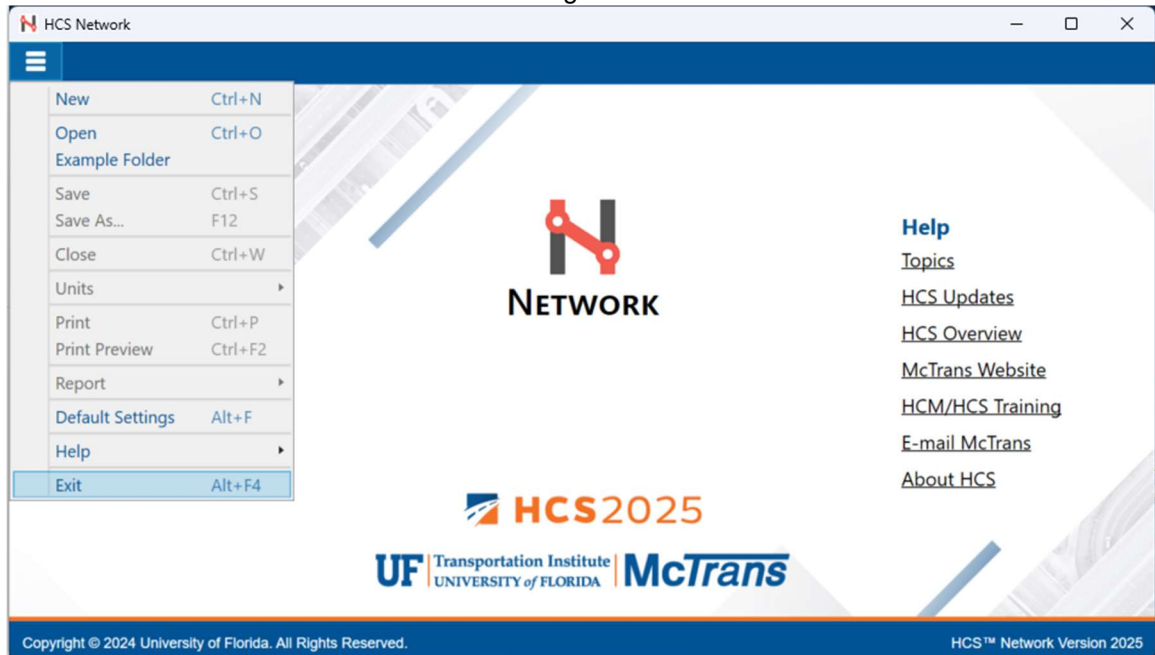
Exit the Program

1. From the Start screen, there are three options for exiting the program:



Note: The program can be exited even if a file is still open; you do not need to start from the Start screen.

- a. Selecting *File > Exit* from the main menu; this can be found by selecting the three lines in the top left-hand corner of the screen and then selecting "Exit"



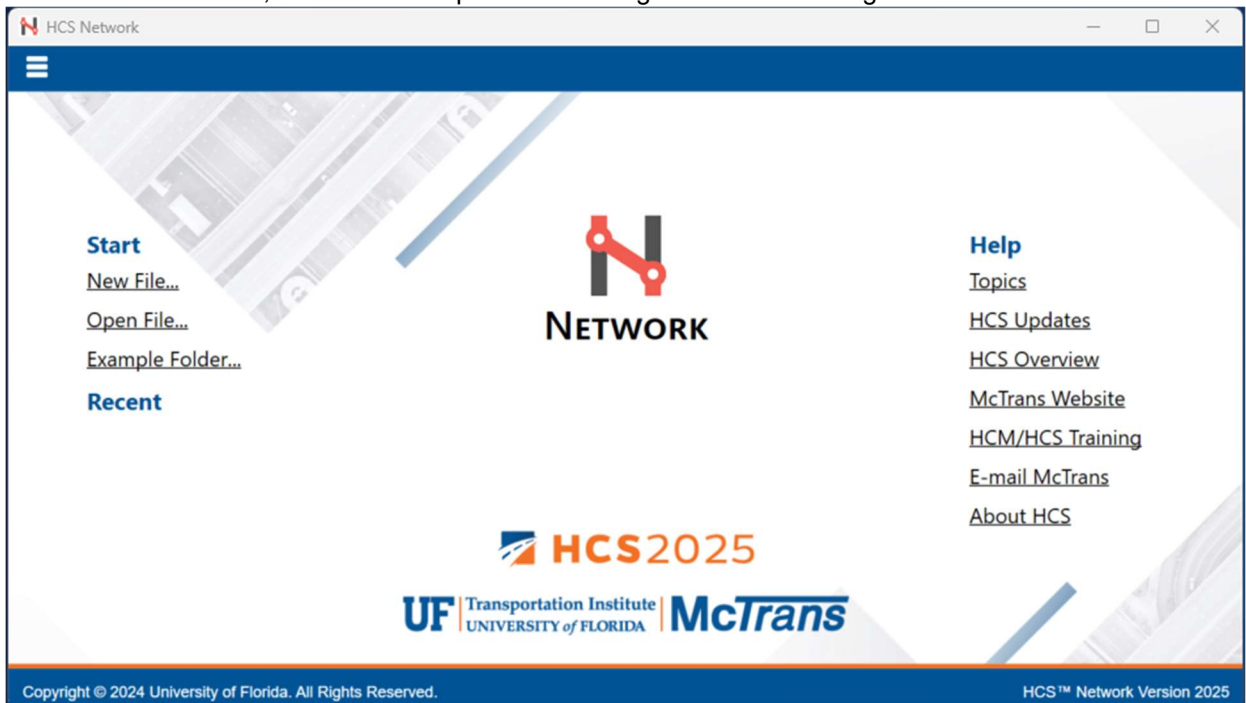
- b. Using the keyboard shortcut "Alt+F4"

- c. Selecting “X” in the top right-hand corner of the screen; this can be found below in the red box



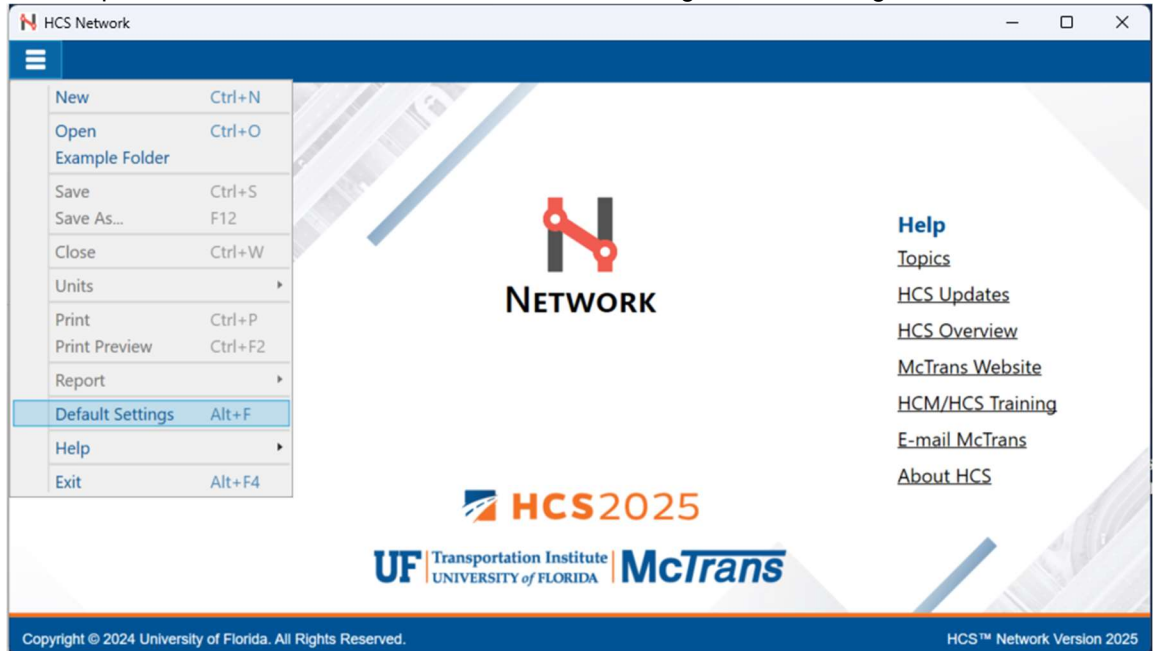
Edit the Default Settings

1. From the Start screen, there are two options for editing the Default Settings:



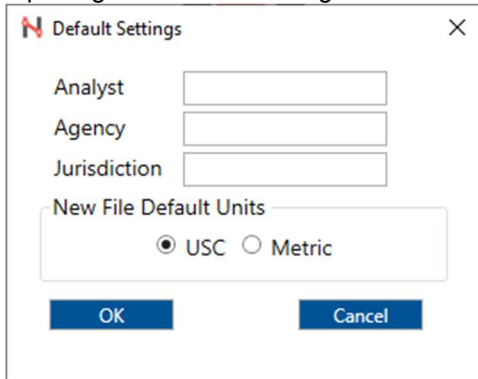
Note: The Default Settings can be changed even if an existing file is already open; you do not need to start from the Start screen.

- a. Selecting *File > Default Settings* from the main menu; this can be found by selecting the three lines in the top left-hand corner of the screen and then selecting “Default Settings”



- b. Using the keyboard shortcut “Alt+F”

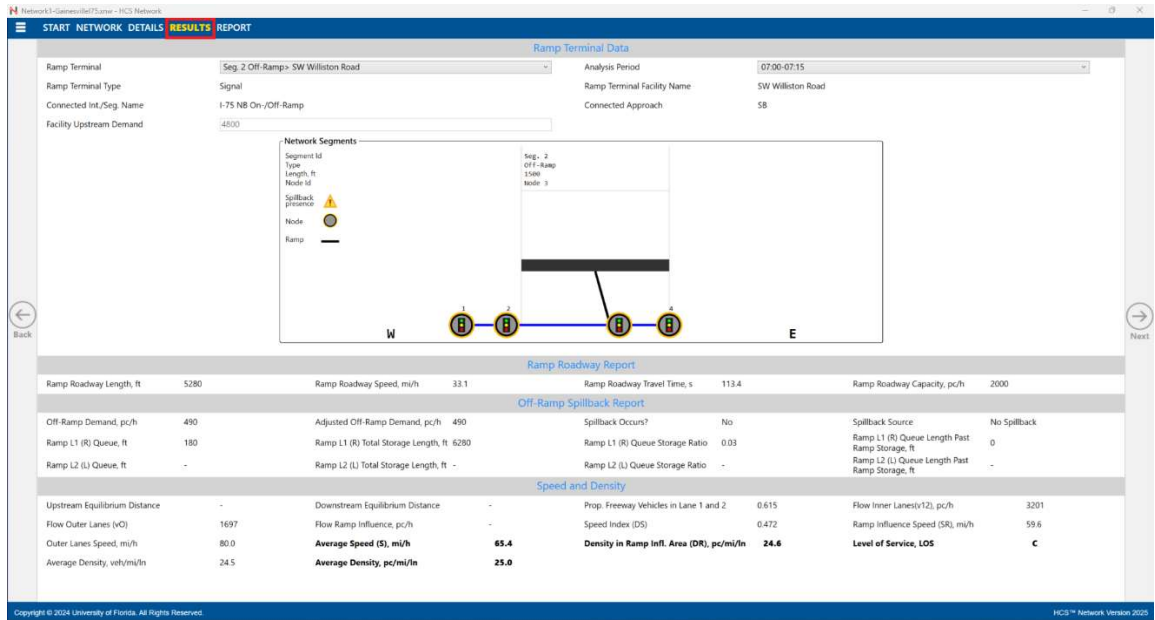
2. Opening the Default Settings will cause a Default Settings window to pop up:



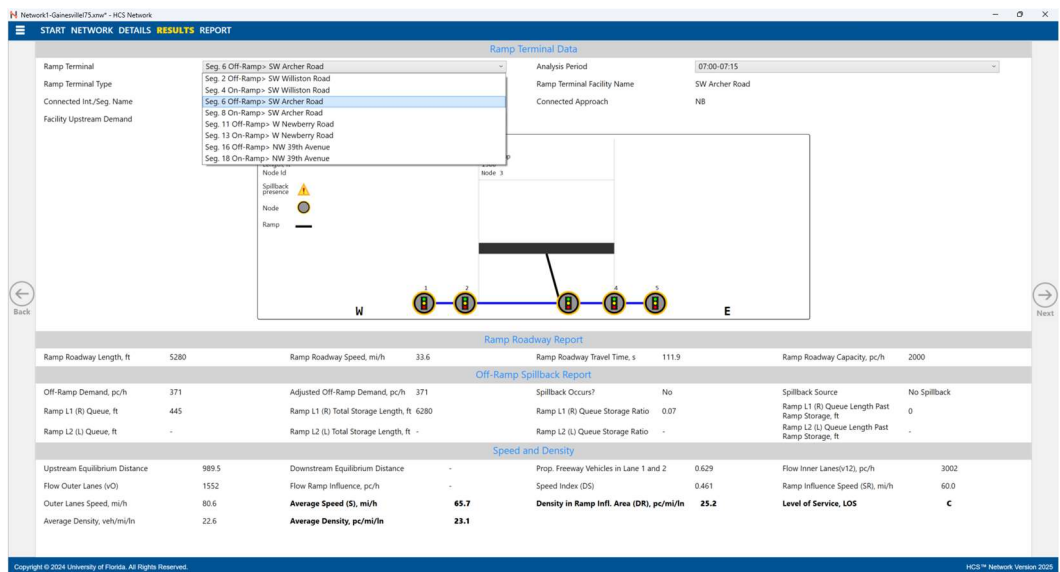
3. You can specify Analyst, Agency, and Jurisdiction by clicking in the corresponding text boxes and typing the desired text. You are also given the option of running the analysis in either *U.S. Customary (USC)* or *SI (Metric)* units.
4. Clicking “OK” will save the changes made and close the Default Settings window; clicking “Cancel” will close the Default Settings window without saving any changes.
5. When a new file is created, the Analyst, Agency, and Jurisdiction fields will automatically be populated with the text specified in the Default Settings.
6. Whether starting a new file or opening an existing file, the inputs and results will display according to the units specified in the Default Settings.

View Results of the Analysis

1. After editing all the necessary inputs, results of the analysis can be found in the form of pages and reports. Reports can be found on the Report page.
2. There are two options for pages: Results and Report
 - a. On the Results page, Ramp Terminal Data, Ramp Roadway Report, On-/Off-Ramp Spillback Report, and Speed and Density sections are provided for each individual segment.



- i. Under the Ramp Terminal Data section, you can specify which ramp terminal within the facility to display by selecting the specific ramp terminal in the drop-down menu. Similarly, the analysis period can be specified by selecting it in the corresponding drop-down menu.



- b. The Report page can display the Network formatted report, Network text report, or O-D formatted report.

HCS Network Report										
Project Information										
Analyst		Date	9/9/2024							
Agency		Analysis Year	2024							
Jurisdiction		Time Analyzed								
Facility Name	I-75 NB - Gainesville, FL	Units	U.S. Customary							
Project Description										
Geometry										
Segment Number	Ramp Type	Ramp Terminal Type	Facility Name	Connected Node/Segment	Connected Approach					
2	Off-ramp	Signal	SW Williston Road	I-75 NB On-/Off-Ramp	SB					
4	On-ramp	Signal	SW Williston Road	I-75 NB On-/Off-Ramp	SB					
6	Off-ramp	Signal	SW Archer Road	I-75 NB On-/Off-Ramp	NB					
8	On-ramp	Signal	SW Archer Road	I-75 NB On-/Off-Ramp	SB					
11	Off-ramp	Signal	W Newberry Road	I-75 NB On-/Off-Ramp	NB					
13	On-ramp	Signal	W Newberry Road	I-75 NB On-/Off-Ramp	SB					
16	Off-ramp	Signal	NW 39th Avenue	I-75 SB On-/Off-Ramp	NB					
18	On-ramp	Signal	NW 39th Avenue	I-75 SB On-/Off-Ramp	SB					
Spillback Analysis and Queues										
Analysis Period 1 (07:00-07:15)										
Ramp Number	1	2	3	4	5	6	7	8	9	10
Segment Number	2	4	6	8	11	13	16	18	-	-
Ramp Terminal	OFR	ONR	OFR	ONR	OFR	ONR	OFR	ONR	-	-
Ramp Terminal Type	SIG	SIG	SIG	SIG	SIG	SIG	SIG	SIG	-	-
Number of Ramp Lanes	1	1	1	1	1	1	2	1	-	-
Ramp Roadway Capacity (pc/h)	2000	2000	2000	2000	2000	2000	4000	2000	-	-
Ramp Demand, vR (pc/h)	490	146	371	1132	955	665	880	160	-	-
Adjusted Ramp Demand, vRadj (pc/h)	490	146	371	1132	955	665	880	160	-	-
Ramp Metering?	No	No	No	No	No	No	No	No	-	-
Ramp Metering Rate (pc/h)	-	-	-	-	-	-	-	-	-	-
Spillback Occurs?	No	No	No	No	No	No	No	No	-	-
Ramp L1 (R) Queue (veh)	7.1	0.0	17.5	0.0	23.1	0.0	0.0	0.0	-	-
Ramp L2 (L) Queue (veh)	-	-	-	-	-	0.0	-	-	-	-
Ramp L1 (R) Queue (ft)	180	0	445	0	587	0	0	0	-	-
Ramp L2 (L) Queue (ft)	-	-	-	-	-	0	-	-	-	-

3. There are three options for reports: Network Formatted, Network Text, and O-D Formatted

a. Formatted reports show the most important results in a presentable format

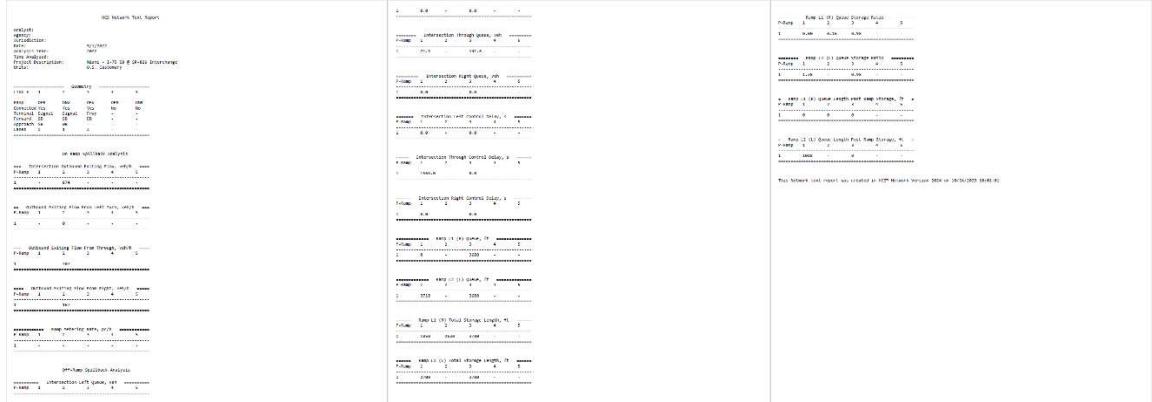
HCS Network Report										
Project Information										
Analyst		Date	9/1/2022							
Agency		Analysis Year	2022							
Jurisdiction		Time Analyzed								
Facility Name	I-75 SB - Miami, FL	Units	U.S. Customary							
Project Description										
Miami - I-75 SB @ SR-826 Interchange										
Geometry										
Segment Number	Ramp Type	Ramp Terminal Type	Facility Name	Connected Node/Segment	Connected Approach					
2	Off-ramp	Signal	Hialeah Gardens Blvd	138th St @ Hialeah Gardens Blvd.	SB					
4	Weaving On-ramp	Signal	Hialeah Gardens Blvd	138th St @ Hialeah Gardens Blvd.	WB					
4	Weaving Off-ramp	Freeway	SR-826 SB	SR-826 SB - Seg 2 - Merge	-					
5	Off-ramp	-	-	-	-					
7	On-ramp	-	-	-	-					
Spillback Analysis and Queues										
Analysis Period 1 (07:00-07:15)										
Ramp Number	1	2	3	4	5	6	7	8	9	10
Segment Number	2	4	4	5	7	-	-	-	-	-
Ramp Terminal	OFR	WONR	WOFR	OFR	ONR	-	-	-	-	-
Ramp Terminal Type	SIG	SIG	FRWY	-	-	-	-	-	-	-
Number of Ramp Lanes	2	1	2	1	1	-	-	-	-	-
Ramp Roadway Capacity (pc/h)	4200	2100	4200	2100	2100	-	-	-	-	-
Ramp Demand, vR (pc/h)	1008	651	2626	420	368	-	-	-	-	-
Adjusted Ramp Demand, vRadj (pc/h)	1008	651	2626	420	368	-	-	-	-	-
Ramp Metering?	No	No	No	No	No	-	-	-	-	-
Ramp Metering Rate (pc/h)	-	-	-	-	-	-	-	-	-	-
Spillback Occurs?	Yes	No	No	No	No	-	-	-	-	-
Ramp L1 (R) Queue (veh)	0.0	15.7	141.8	-	-	-	-	-	-	-
Ramp L2 (L) Queue (veh)	143.0	-	141.8	-	-	-	-	-	-	-
Ramp L1 (R) Queue (ft)	0	408	3688	-	-	-	-	-	-	-
Ramp L2 (L) Queue (ft)	3718	-	3698	-	-	-	-	-	-	-
Average Vehicle Spacing (ft)	26.0	26.0	26.0	-	-	-	-	-	-	-
Ramp L1 (R) Total Storage Length (ft)	1850	2630	3780	-	-	-	-	-	-	-
Ramp L2 (L) Total Storage Length (ft)	2700	-	3780	-	-	-	-	-	-	-
Ramp L1 (R) Queue Storage Ratio	0.00	0.16	0.98	-	-	-	-	-	-	-
Ramp L2 (L) Queue Storage Ratio	1.38	-	0.98	-	-	-	-	-	-	-
Ramp L1 (R) Queue Length Past Ramp Storage (ft)	0	0	0	-	-	-	-	-	-	-
Ramp L2 (L) Queue Length Past Ramp Storage (ft)	1018	-	0	-	-	-	-	-	-	-
Origin-Destination Pairs Travel Time (Min) - Analysis Period 1 (07:00-07:15)										
Origin Node	Destination Node									
2 N	2 S	4	4	5	-	-	-	-	-	-

Upstr:	27.7	28.2	14.4	-	4.6	-	5.8	-	-	-	-	-	-
4 N	-	-	11.8	-	1.9	-	3.1	-	-	-	-	-	-
4 S	-	-	12.8	-	2.9	-	4.1	-	-	-	-	-	-
7	-	-	-	-	-	-	0.7	-	-	-	-	-	-
7	-	-	-	-	-	-	-	-	-	-	-	-	-

Origin		Destination	
Fwy. Upstream			
Freeway Segment 1			
Seg. 4 N	[Hialeah Gardens Blvd] 138th St @ Hialeah Gardens Blvd.	Seg. 2 N	[Hialeah Gardens Blvd] 138th St @ Hialeah Gardens Blvd.
Seg. 4 S	[Hialeah Gardens Blvd] W 84th St	Seg. 2 S	[Hialeah Gardens Blvd] W 84th St
Seg. 7	No Ramp Terminal	Seg. 4	[SR-826 SB] Seg. 4 SR-826 SB - Seg 4 - Basic
-	-	Seg. 5	No Ramp Terminal
-	-	Fwy. Downstream	Freeway Segment 8

Messages	
Warning 1	Queue spillback occurs in at least one ramp in at least one analysis period. Therefore, reported O-D travel times may not be reliable

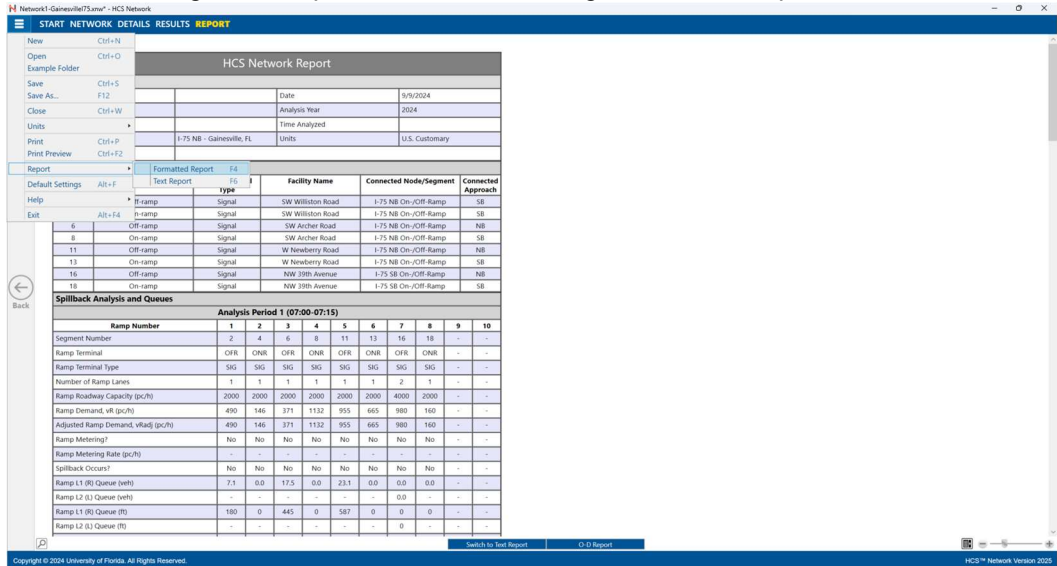
b. Text reports show a more detailed analysis in plain text



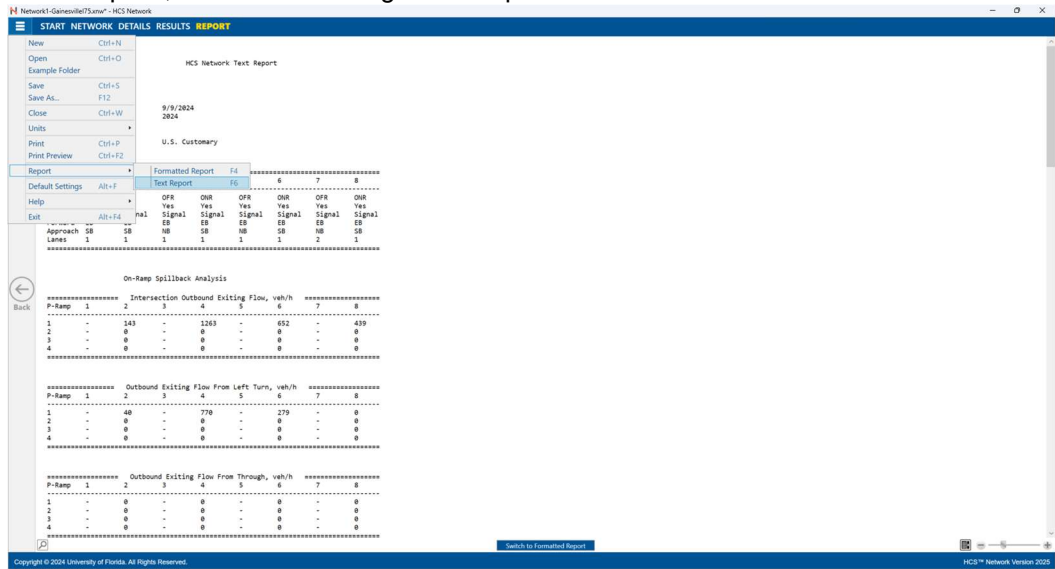
4. The type of report displayed can be changed by using the main menu items, keyboard shortcuts, or toggle buttons found under the report

a. Main Menu Items

- i. To switch to the Formatted Report, select *File > Report > Formatted Report* from the main menu; this can be found by selecting the three lines in the top left-hand corner of the screen, hovering over “Report”, and then selecting “Formatted Report”.



- ii. To switch to the Text Report, select *File > Report > Text Report* from the main menu; this can be found by selecting the three lines in the top left-hand corner of the screen, hovering over “Report”, and then selecting “Text Report”.

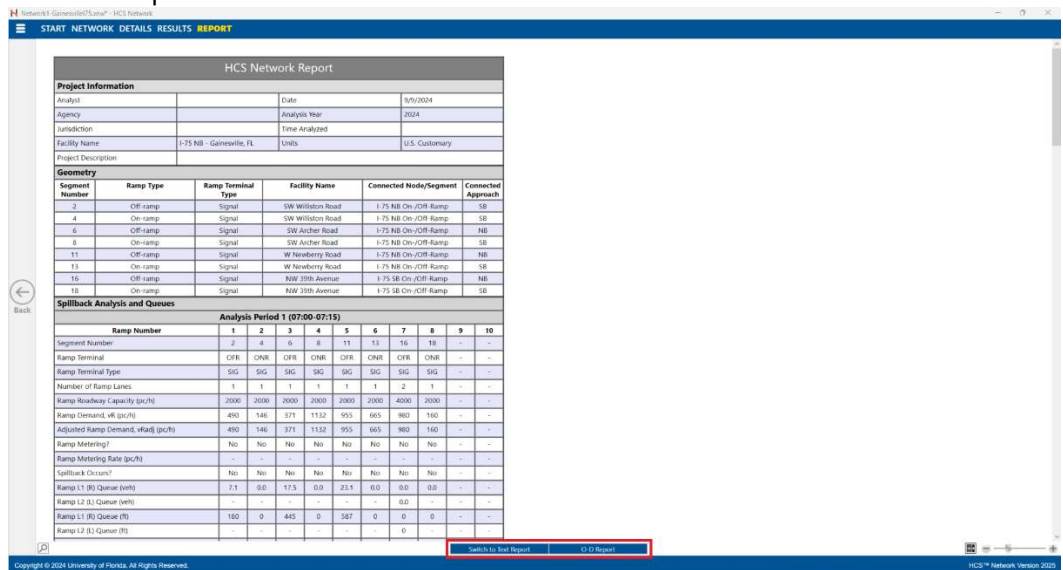


b. Keyboard Shortcuts

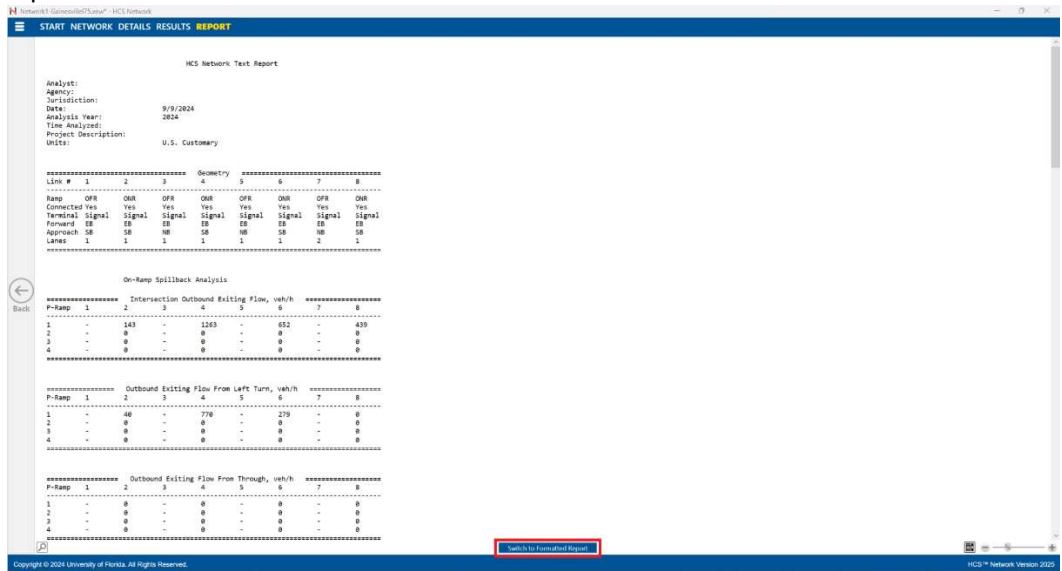
- i. Formatted Report: keyboard shortcut is “F4”
- ii. Text Report: keyboard shortcut is “F6”

c. Report Toggle Buttons

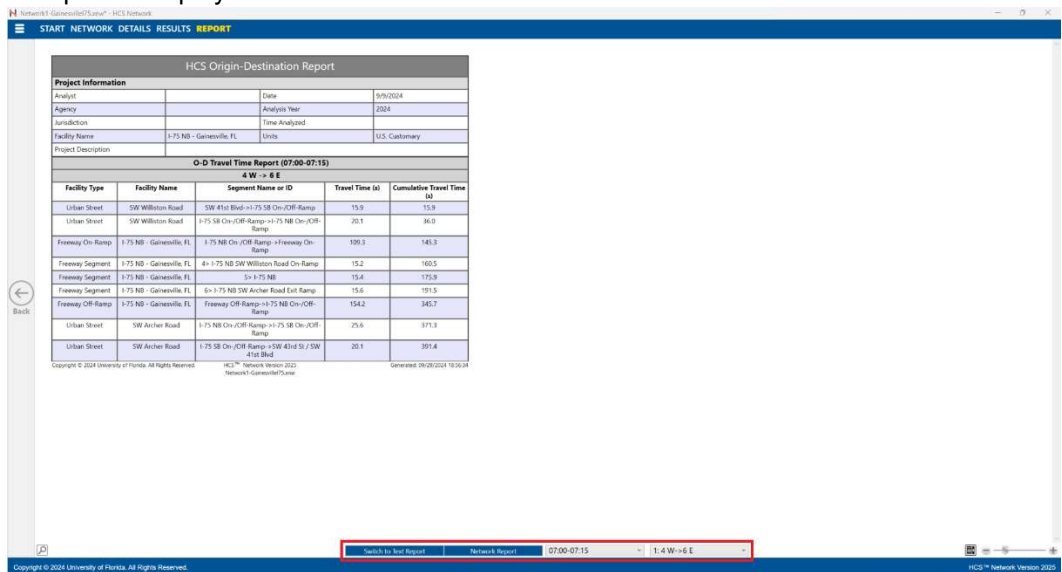
- i. Toggle buttons are available at the bottom of the screen underneath the report.
- ii. If the Network formatted report is currently being displayed, the first toggle button will say “Switch to Text Report” which will allow you to display the Network text report if clicked. The second toggle button will say “O-D Report” which will allow you to display O-D formatted report if clicked.



- iii. If the Network text report is currently being displayed, there will be one toggle button which will say "Switch to Formatted Report". This will allow you to display the Network formatted report if clicked.



- iv. If the O-D formatted report is currently being displayed, the first toggle button will say "Switch to Text Report" which will allow you to display the Network text report if clicked. The second toggle button will say "Network Report" which will allow you to display the Network formatted report if clicked. There are also two drop down menus. The first allows the selection of which analysis period to display. The second allows the selection of which O-D pair to display.



5. The magnification of the report currently being displayed can be changed using the zoom slider found at the bottom right-hand corner of the screen.

The screenshot shows the 'HCS Network Report' window. The report content includes:

Project Information

Analyst		Date	9/9/2024
Agency		Analysis Year	2024
Jurisdiction		Time Analyzed	
Facility Name	I-75 NB - Gainesville, FL	Units	U.S. Customary

Geometry

Segment Number	Ramp Type	Ramp Terminal Type	Facility Name	Connected Node/Segment	Connected Approach
2	Off-ramp	Signal	SW Williston Road	I-75 NB On-/Off-Ramp	SB
4	On-ramp	Signal	SW Williston Road	I-75 NB On-/Off-Ramp	SB
6	Off-ramp	Signal	SW Archer Road	I-75 NB On-/Off-Ramp	NB
8	On-ramp	Signal	SW Archer Road	I-75 NB On-/Off-Ramp	SB
11	Off-ramp	Signal	W Newberry Road	I-75 NB On-/Off-Ramp	NB
13	On-ramp	Signal	W Newberry Road	I-75 NB On-/Off-Ramp	SB
16	Off-ramp	Signal	NW 39th Avenue	I-75 SB On-/Off-Ramp	NB
18	On-ramp	Signal	NW 39th Avenue	I-75 SB On-/Off-Ramp	SB

Spillback Analysis and Queues

Analysis Period 1 (07:00-07:15)

Ramp Number	1	2	3	4	5	6	7	8	9	10
Segment Number	2	4	6	8	11	13	16	18	-	-
Ramp Terminal	OFR	ONR	OFR	ONR	OFR	ONR	OFR	ONR	-	-
Ramp Terminal Type	SG	SG	SG	SG	SG	SG	SG	SG	-	-
Number of Ramp Lanes	1	1	1	1	1	1	2	1	-	-
Ramp Roadway Capacity (pc/h)	2000	2000	2000	2000	2000	2000	4000	2000	-	-
Ramp Demand, vR (pc/h)	490	146	371	1132	955	665	980	160	-	-
Adjusted Ramp Demand, vRadj (pc/h)	490	146	371	1132	955	665	980	160	-	-
Ramp Metering?	No	No	No	No	No	No	No	No	-	-
Ramp Metering Rate (pc/h)	-	-	-	-	-	-	-	-	-	-
Spillback Occurs?	No	No	No	No	No	No	No	No	-	-
Ramp L1 (R) Queue (veh)	7.1	0.0	17.5	0.0	23.1	0.0	0.0	0.0	-	-
Ramp L2 (L) Queue (veh)	-	-	-	-	-	-	0.0	-	-	-
Ramp L1 (R) Queue (ft)	180	0	445	0	587	0	0	0	-	-
Ramp L2 (L) Queue (ft)	-	-	-	-	-	-	0	-	-	-

At the bottom right, there is a zoom slider and buttons for '+', '-', and a magnifying glass icon.

- a. To zoom in, drag the slider to the right; to zoom out, drag the slider to the left
- b. Clicking the plus (+) button will zoom in; clicking the minus (-) button will zoom out
- c. Holding down “Ctrl” on the keyboard and scrolling up on the mouse wheel will zoom in; holding down “Ctrl” on the keyboard and scrolling down on the mouse wheel will zoom out

Print a Report

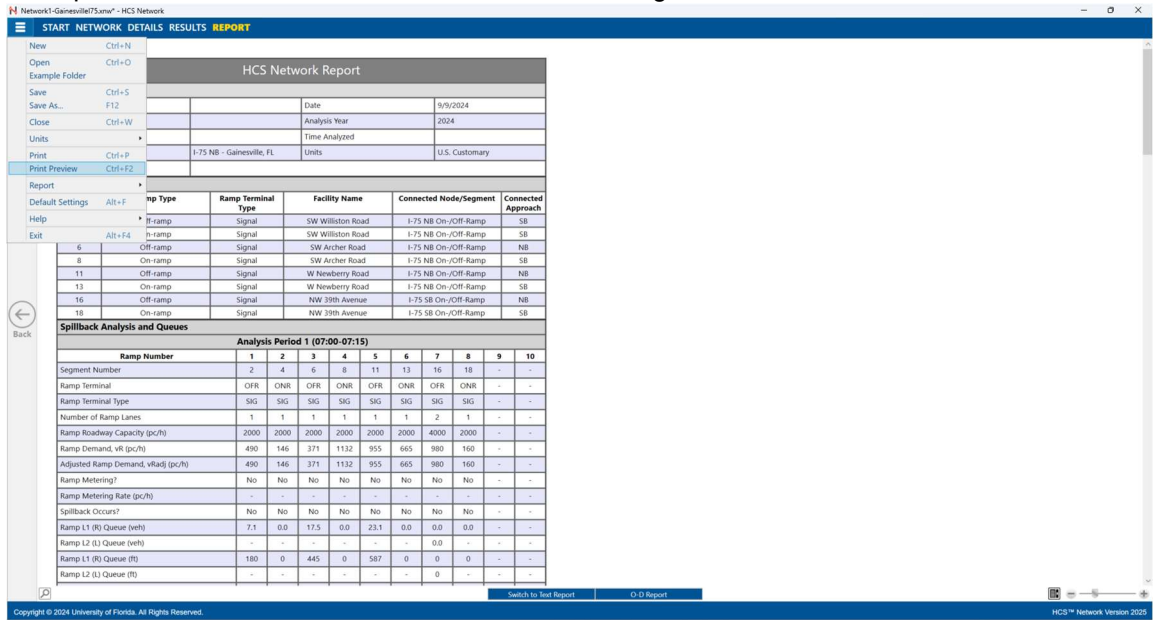
1. There are four options for printing a report:
 - a. Selecting *File > Print* from the main menu; this can be found by selecting the three lines in the top left-hand corner of the screen and then selecting “Print”

The screenshot shows the 'HCS Network Report' window with the 'File' menu open. The menu items are:

- New (Ctrl+N)
- Open (Ctrl+O)
- Example Folder
- Save (Ctrl+S)
- Save As... (F12)
- Close (Ctrl+W)
- Units
- Print (Ctrl+P)**
- Print Preview (Ctrl+F2)
- Report
- Default Settings (Alt+F)
- Help
- Exit

The report content is visible in the background, showing the same tables as in the previous screenshot.

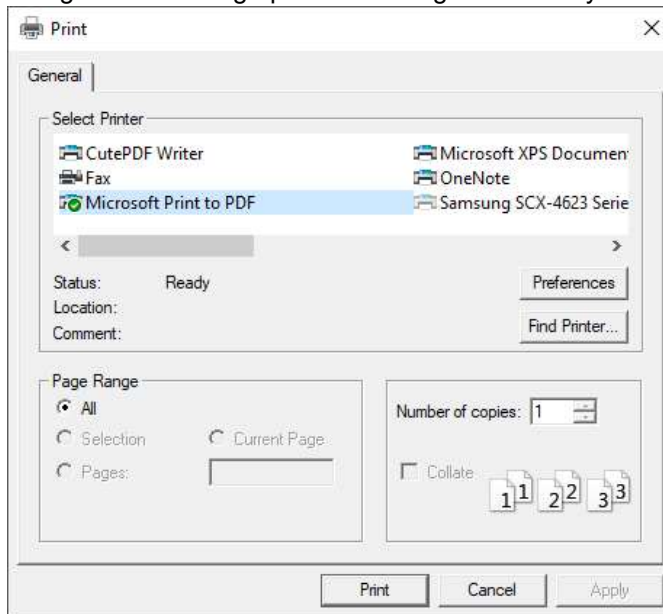
- b. Selecting *File > Print Preview* from the main menu; this can be found by selecting the three lines in the top left-hand corner of the screen and then selecting “Print Preview”



- c. Using keyboard shortcut “Ctrl+P” for Print
- d. Using keyboard shortcut “Ctrl+F2” for Print Preview

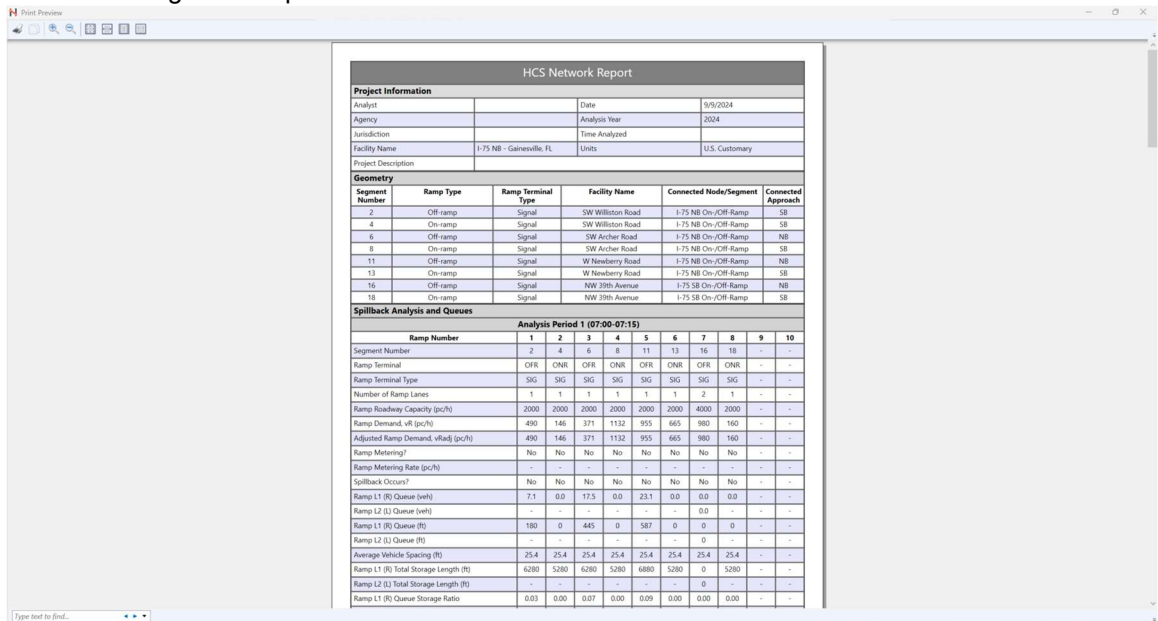
2. Print

- a. Using Print will bring up a Print dialog box where you can select which printer to print to



3. Print Preview

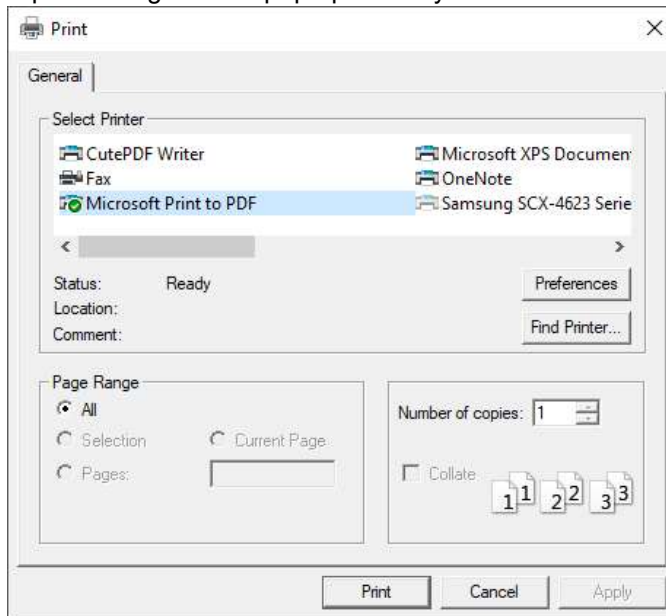
- a. Using Print Preview will bring up a window where you can view how the report will look on paper before sending it to the printer



- b. The print icon in the toolbar found in the top left-hand corner can then be selected



- c. A print dialog box will pop up where you can select which printer to print to



Steps for Starting Network Analysis

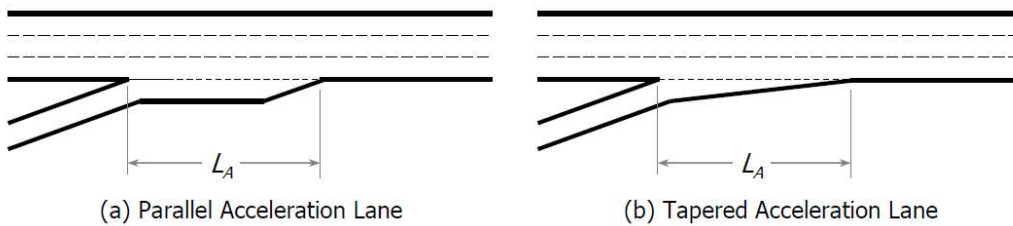
1. To load a facility, create a new file. This can be done by selecting 'New...' on the start page, selecting 'New' from the main menu, or using the keyboard shortcut 'Ctrl+N'.
2. A new analysis will begin, and the user has the option of loading an existing Freeways facility analysis or creating a new one.
 - a. Selecting the button 'Load Freeway Facility' will cause an 'Open' dialog box to appear. Select an existing Freeways facility (*.xuf) file to load the facility.
 - b. Selecting the button 'Create Freeway Facility' will cause the *HCS Freeways* module to open for the user to create a new freeways facility analysis. Once created, the file will need to be loaded in the Network tool.
3. Once a Freeways facility file is loaded, the data grid on the Network page will populate:
 - a. The Segment Number and Segment Type of the loaded facility file will display. Only on-ramp, off-ramp, weaving on-ramp, and weaving off-ramp segments will display.
 - b. Other fields within the table will populate after external files are loaded.
4. Within the data grid is an 'External File' column. An external file (Streets or Freeways) will need to be loaded for each segment to specify the corresponding intersection/segment connected to the ramp.
 - a. Clicking 'Select' will cause an 'Open' dialog box to appear. Select an existing external file:
 - i. HCS Streets File (*.xus)
 - ii. HCS Freeways File (*.xuf)
 - b. Once selected, the rest of the row in the data grid will populate with defaults.
 - c. The Connected Intersection/Segment and Approach from the selected external file can be changed to view and include in the analysis. The corresponding columns will update based on which Connected Intersection/Segment and Approach are selected.
 - d. The Ramp Terminal Facility Name and Connected Intersection/Segment Name are both pulled from the loaded external file. However, they can be edited within the data grid.
 - e. The Ramp Roadway Length starts with a default value and can be edited within the data grid.
5. On the Network page, there is also a checkbox for 'Assign Ramp Terminal Volumes to all Freeway Ramps'. When this checkbox is checked, all checkboxes for 'Assign Ramp Terminal Volume to Freeway' for individual ramp terminals on the Details page will be checked.
6. On the Details page, there are inputs for individual ramp terminals and their corresponding analysis periods. The ramp terminal displayed can be changed by selecting the desired ramp terminal from the drop-down menu at the top left corner of the window. Similarly, the desired analysis period can be changed by selecting the desired analysis period from the drop-down menu at the top right corner of the window. There are four or five sections, depending on what Ramp Terminal is displayed. They include the following:
 - a. Ramp Terminal Data
 - b. Ramp Details
 - c. Volume Balancing
 - d. Off-Ramp Lane Assignment (*Note: This is only available for Off-Ramps and Weaving Off-Ramps.*)
 - e. Freeway Inputs (*Note: These inputs are pulled directly from the loaded Freeway facility file, but can be edited within Network.*)
7. When finished with editing inputs, the Results and Report pages are available to view results of the analysis.
 - a. Sections available on Results page
 - i. Ramp Terminal Data
 - ii. Ramp Roadway Report

- iii. Off-/On-Ramp Spillback Report
 - iv. Speed and Density
 - b. Reports available on Report page
 - i. Network Formatted Report
 - ii. Network Text Report
 - iii. O-D Report

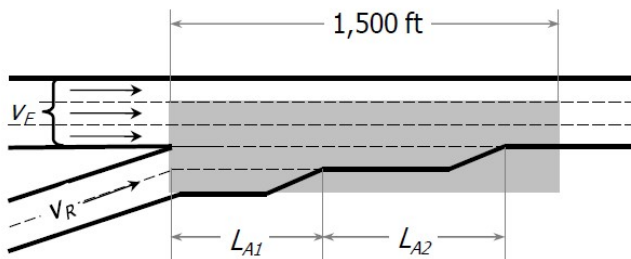
Glossary of Terms

Acceleration Lane Length

This value defines the length for on-ramp acceleration lanes. The typical length of acceleration lanes for ramps should be obtained from the design standards used by the highway operation agency. It is measured from the intersection of the edge of the travel way for the freeway and the ramp (the first point) and the downstream merge point of the freeway and ramp edges of the travel way (the second point). The default value is 800 feet (or 243.8 meters in metric).



The exhibit below illustrates the geometry of a typical two-lane ramp-freeway junction. It is characterized by two separate acceleration lanes, each successively forcing merging maneuvers to the left.



For two-lane ramps, the effective acceleration length must be calculated by the user based on the lengths of the two lanes. In all equations using the length of the acceleration lane L_A , this value is replaced by the effective length of both acceleration lanes L_{Aeff} . The formula for calculating effective acceleration length is:

$$L_{Aeff} = 2 * L_{A1} + L_{A2}$$

where

- L_{Aeff} = Effective acceleration length,
- L_{A1} = Length of the shorter acceleration lane, and
- L_{A2} = Difference in length between the longer acceleration lane and the shorter acceleration lane

In merge and diverge areas, the capacity of the two outer lanes is reduced by 100 and 200 veh/h/ln, respectively. When the user sets the acceleration lanes to 1500 feet (or 457.2 meters in metric), only the outer lane of the merge experiences a capacity reduction, as opposed to normally both of the outer two lanes.

Agency

This field is provided to document the agency or company associated with this analysis or project

Analysis Period

The time frame for which the traffic demand on the freeway is being studied

Analysis Year

This field is provided to document the year for which the analysis is being performed

Analyst

This field is provided to document the name of the analyst

Approach

A set of lanes at an intersection that accommodates all left-turn, through, and right-turn movements from a given direction (i.e., NB, EB, SB, and WB).

Assign Ramp Terminal Volume to Freeway

When this checkbox is checked, the Ramp Demand will automatically update to use the Ramp Terminal Approach Volume instead.

Assign Ramp Terminal Volumes to All Freeway Ramps

When this checkbox is checked, all checkboxes for 'Assign Ramp Terminal Volume to Freeway' for individual ramp terminals on the Details page will be checked.

Base Free Flow Speed

The methodology covers basic freeway segments with a FFS in the range of 55 to 75 mi/h (or 88.5 to 120.7 km/h in metric). The predictive algorithm for free flow speed therefore starts with a value greater than 75 mi/h (or 120.7 km/h in metric), specifically a default base FFS of 75.4 mi/h (121.3 km/h in metric), which resulted in the most accurate predictions in the underlying research. The adjusted free-flow speed is determined by subtracting each speed adjustment from the base free-flow speed.

Capacity Adjustment Factor

Capacity Adjustment Factor, or CAF, is a factor used to allow the user to adjust the capacity for reduced-capacity situations or to match field measurements. The capacity in any cell of the time-space domain can be reduced to represent incident situations such as construction and maintenance activities, adverse weather, traffic accidents, and vehicle breakdowns.

Connected Approach

The connected approach is the subject approach of the connected intersection in the ramp terminal

Connected Intersection

The intersection connected to the ramp of the freeway; available choices of intersections are based on the external file selected

Connected Intersection / Segment ID

When the external file selected is a Streets file, available choices for the connected intersection will be based on how many intersections are available in that file. The Connected Intersection ID would be the intersection number in the corresponding external file.

When the external file selected is a Freeways file, available choices will be based on the ramps available in that file. The Segment ID would be the ramp number and type in the corresponding external file. If the Segment Type in the Network Freeway Facility loaded is an off-ramp, then the available choices for Segment ID in the Freeways External File will be on-ramps. Likewise, if the Segment Type in the Network Freeway Facility loaded is an on-ramp, then the available choices for Segment ID in the Freeways External File will be off-ramps.

Connected Intersection / Segment Name

When the external file selected is a Streets file, the connected intersection name will be pulled from the selected file. This name corresponds to the 'Intersection' input for the selected intersection in the 'General' box under 'PRIMARY INPUT DATA'

When the external file selected is a Freeways file, the segment name will be pulled from the Freeways file. This name corresponds to the 'Segment Name' input for the selected segment within the facility in the Segments data grid.

All names can be edited in the external files themselves and reloaded/refreshed in Network, or the names can be edited in the Network data grid directly

Create Freeway Facility

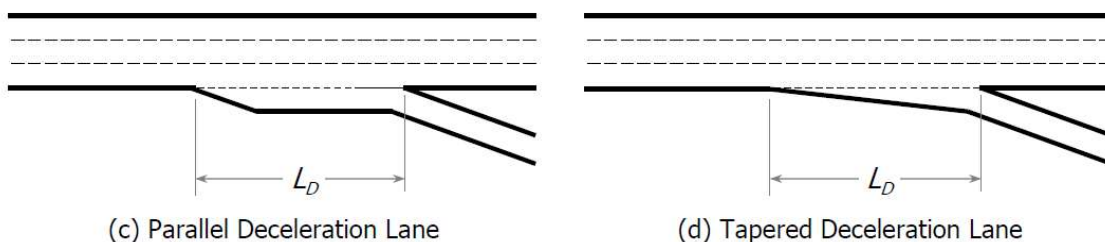
A 'Create Freeway Facility' button is provided to open the HCS Freeways program and to allow creating of a new Freeways facility file that can later be loaded into the Network program.

Date

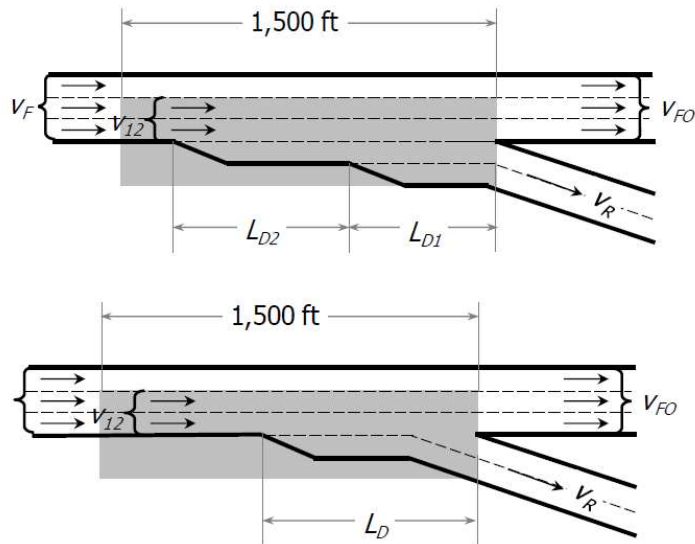
This field is provided to document the date when the analysis is performed

Deceleration Lane Length

This value defines the length for off-ramp deceleration lanes. The typical length of deceleration lanes for ramps should be obtained from the design standards used by the highway operation agency. It is measured from the departing point between the edge of the travel way for the freeway and outer edge of the ramp (the first point) and the downstream intersection point of the freeway and inner ramp edge of the travel way (the second point). The default value is 400 feet (or 121.9 meters in metric).



Two common types of diverge geometries are in use with two-lane off-ramps, as shown in the exhibit below. In the first, two successive deceleration lanes are introduced. In the second, a single deceleration lane is used. The left-hand ramp lane splits from Lane 1 of the freeway at the gore area, without a deceleration lane.



Where a single deceleration lane is used, there is no modification to the length of the deceleration lane L_D ; where two deceleration lanes exist, the length is replaced by the effective length L_{Deff} in all equations.

For two-lane ramps in the Freeways module, the effective deceleration length must be calculated by the user based on the lengths of the two lanes. Where two deceleration lanes exist, the length of the deceleration lane L_D is replaced by the effective length L_{Deff} in all equations. The formula for calculating effective deceleration length is:

$$L_{Deff} = 2 * L_{D1} + L_{D2}$$

where

L_{Deff} = Effective deceleration length,

L_{D1} = Length of the shorter deceleration lane, and

L_{D2} = Difference in length between the longer deceleration lane and the shorter deceleration lane

In merge and diverge areas, the capacity of the two outer lanes is reduced by 100 and 200 veh/h/ln, respectively. When the user sets the deceleration lanes to 1500 feet (or 457.2 meters in metric), only the outer lane of the diverge experiences a capacity reduction, as opposed to normally both of the outer two lanes.

Demand

The number of vehicles or other roadway users desiring to use a given system element during a specific analysis period, typically 1 h or 15 min.

Demand flow rates must be specified for the entering freeway mainline flow and for each merge and diverge segment. For Merge and Diverge analyses, the demand for adjacent ramps must also be specified if one exists

For weaving segments, demand flow rates must be identified by component movement: freeway to freeway, ramp to freeway, freeway to ramp, and ramp to ramp. Where this level of detail is not available, the following procedure may be used to estimate the component flows. It is not recommended, however, as weaving segment performance is sensitive to the split of demand flows.

- *Ramp-weave segments:* Assume that the ramp-to-ramp flow is 0. The ramp-to-freeway flow is then equal to the on-ramp flow; the freeway-to-ramp flow is then equal to the off-ramp flow.
- *Major weave segments:* On-ramp flow is apportioned to the two exit legs (freeway and ramp) in the same proportion as the total flow on the exit legs (freeway and ramp).

Demand Adjustment Factor

Demand Adjustment Factor, or DAF, is a factor used to allow the user to adjust the demand for the purpose of calibration, or to reflect the impacts of weather, incidents, and work zones.

Driver Population

Driver population describes the level of driver familiarity in the traffic stream and is used in adjustments for speed and capacity. The base traffic stream characteristics for basic freeway segments are representative of traffic streams composed primarily of commuters or drivers who are familiar with the facility.

The driver population adjustment factor f_p had previously been used in the HCM to reflect the effects of unfamiliar drivers in the traffic stream and was applied as an increase in demand volume. With the addition of a unified speed flow equation in Chapter 12 of the HCM and the ability to adjust both the base FFS and capacity in all freeway segment chapters (12-14) to account for incidents and weather events, the driver population factor is no longer used. Instead, FFS and capacity adjustment factors SAF_{pop} and CAF_{pop} are applied in combination with other applicable SAFs and CAFs.

Analyst judgment is still required when applying recommended adjustments. However, should there be expectations of significant presence of unfamiliar drivers, the values shown in the exhibit below can serve as a guide for the analysis.

Level of Driver Familiarity	CAF_{pop}	SAF_{pop}
All familiar drivers, regular commuters	1.000	1.000
Mostly familiar drivers	0.968	0.975
Balanced mix of familiar and unfamiliar drivers	0.939	0.950
Mostly unfamiliar drivers	0.898	0.913
All or overwhelmingly unfamiliar drivers	0.852	0.863

External File

External files refer to the ramp terminal files selected for each segment. Once a freeway facility is loaded on the Network page, the data grid on the page will update with however many segments are available based on the freeway facility loaded. An external file can be selected for each segment. Under the 'External File' column of the data grid, the 'Select' hyperlink can be clicked, which will cause an Open dialog box to appear. An HCS Streets (*.xus) or Freeways (*.xuf) file can be selected. Once selected, the file name will appear in the data grid. If the file needs to be changed, the current file name can be selected in the data grid and the Open dialog box will appear again to allow for the new selection.

Free Flow Speed

1. The average speed of vehicles on a given segment, measured under low-volume conditions, when drivers are free to drive at their desired speed and are not constrained by the presence of other vehicles or downstream traffic control devices.
2. The theoretical speed when both density and flow rate are zero.

The adjusted free-flow speed is determined by the HCM equation found below.

$$FFS = BFFS - f_{LW} - f_{RLC} - 3.22 \times TRD^{0.84}$$

where

FFS = free-flow speed of the basic freeway segment (mi/h),

$BFFS$ = base FFS for the basic freeway segment (mi/h),

f_{LW} = adjustment for lane width (mi/h),

f_{RLC} = adjustment for right-side lateral clearance (mi/h), and

TRD = total ramp density (ramps/mi).

If a field measured free-flow speed is entered, no subsequent adjustments are made, and the adjusted free-flow speed will simply be the field-measured free-flow speed. Freeway Merge, Diverge, and Weaving segments require direct speed measurements, estimated from design speed or speed limit.

For metric units, Free-Flow Speed, along with all the corresponding adjustments, are measured in kilometers per hour.

Grade Length

The length of the segment, in miles (or kilometers in metric), to represent the percent grade

Incident Type

The following exhibit shows the default CAFs associated with each incident severity:

Directional Lanes	No Incident	Shoulder Closed	1 Lane Closed	2 Lanes Closed	3 Lanes Closed	4 Lanes Closed
2	1.00	0.81	0.70	N/A	N/A	N/A
3	1.00	0.83	0.74	0.51	N/A	N/A
4	1.00	0.85	0.77	0.50	0.52	N/A
5	1.00	0.87	0.81	0.67	0.50	0.50
6	1.00	0.89	0.85	<u>0.75</u>	0.52	0.52
7	1.00	0.91	0.88	0.80	0.63	0.63
8	1.00	0.93	0.89	0.84	0.66	0.66

Source: Zegeer et al. (1).

Notes: N/A: not applicable, the number of lanes closed equals or exceeds the number of directional lanes.

The methodology does not permit all directional lanes of a facility to be closed.

The values shown in the exhibit reflect the *remaining relative capacity per open lane*. For example, a two-lane closure incident on a six-lane directional facility (underscored) results in a loss of two full-lane capacities, in addition to maintaining only 75% of the remaining four open lanes' capacities. The result is that only three lanes worth (50%) of the facility's original six-lane capacity is maintained. No information is currently available on the effect of incidents on free-flow speed, so this effect is not accounted for at this time.

Interchange Density

The average number of interchanges per mile, measured over 3 miles upstream and 3 miles downstream from the midpoint of the weaving segment.

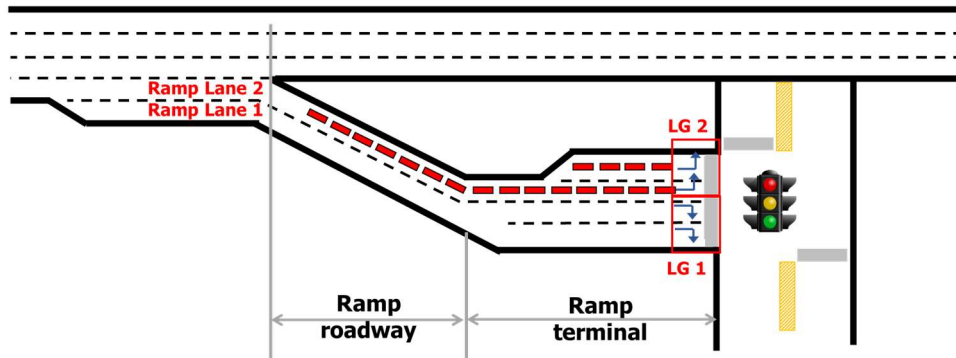
For metric units, it is the average number of interchanges per kilometer, measured over 4.8 kilometers upstream and 4.8 kilometers downstream from the midpoint of the weaving segment.

Jurisdiction

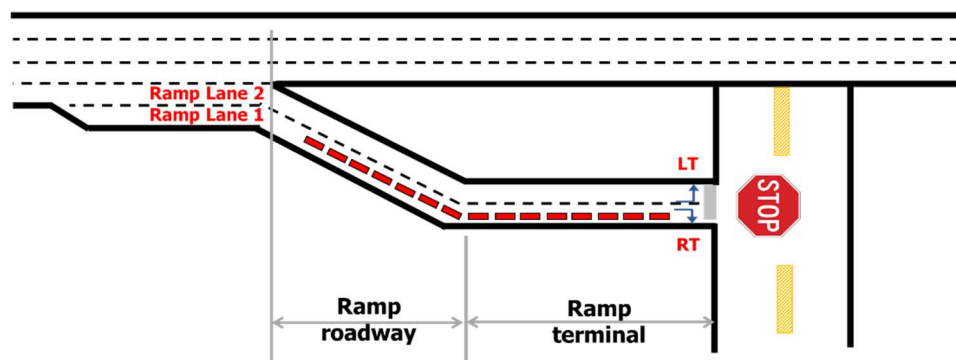
This field is provided to document any jurisdiction convention or project related information

Lane Assignment

When off-ramps have multiple lanes, queues from the downstream ramp terminal may not develop uniformly across ramp roadway lanes. The lane assignment process allows the user to assign queues from the ramp terminal intersection to specific ramp roadway lanes to better match field conditions.



Example 1 – Queues developing from the left-turn movement in the signalized ramp terminal



Example 2 – Queues developing from the right-turn movement in the unsignalized ramp terminal

Lane Width

The lateral distance between stripes for a given lane; measured in feet (or meters in metric)

Load Freeway Facility

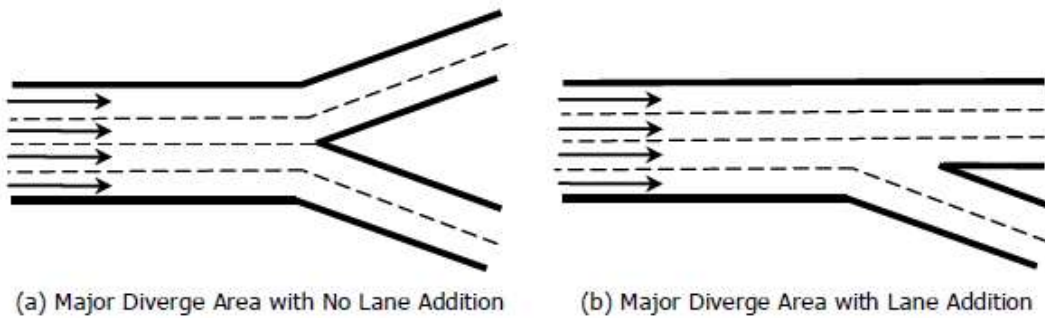
A 'Load Freeway Facility' button is provided to select an existing Freeways facility file (*.xuf) to open and load into the Network program. Once loaded, the Network table will automatically display the segment ramps (on-ramp, off-ramp, weaving on-ramp, and weaving off-ramp) and their corresponding information.

Major Diverge

A Major Diverge checkbox will appear when the number of Ramp Lanes is 2. The checkbox will be hidden when the number of Ramp Lanes is 1.

A major diverge area is one in which two primary roadways, each having multiple lanes, diverge from a single freeway segment. Such junctions occur when a freeway splits to become two separate freeways or when a major multilane high-speed ramp diverge from the freeway. Major diverges are different from one- and two-lane off-ramps in that each of the diverging roadways is generally at or near freeway design standards and no clear ramp or deceleration lane is involved in the diverge.

The two common geometries for major diverge areas are illustrated in the exhibit below. In the first case, the number of lanes leaving the diverge area is the same as the number entering it. In the second, the number of lanes leaving the diverge area is one or more than the number entering it.



The principal analysis of a major diverge area involves checking the capacity of entering and departing roadways, all of which are generally built to mainline standards. A failure results when any of the demand flow rates exceeds the capacity of the segment.

For major diverge areas, a model exists for computing the average density across all approaching freeway lanes within 1,500 ft of the diverge, as given in the following equation:

$$D_{MD} = 0.0175 \left(\frac{v_F}{N} \right)$$

where

- D_{MD} = density in the major diverge influence area (which includes all approaching freeway lanes) (pc/mi/ln)
- v_F = demand flow rate immediately upstream of the major diverge influence area (pc/h), and
- N = number of lanes approaching the major diverge (ln).

The result can be compared with the criteria of HCM Exhibit 14-3 to determine a LOS for the major diverge influence area. Note that the density and LOS estimates are only valid for stable cases (i.e., not in cases in which LOS F exists because of a capacity deficiency on the approaching or departing legs of the diverge).

For metric units, the calculated density in pc/mi/ln is converted to pc/km/ln

Measured Free Flow Speed

The measured free-flow speed is the FFS measured in the field and provided by the user. If the FFS is measured directly, no adjustments are applied to the measured value.

Minimum Freeway-to-Ramp Lane Changes

Minimum number of lane changes that a freeway-to-ramp weaving vehicle must make to complete the freeway-to-ramp movement successfully. This is only applicable for one-sided weaving segments. This is denoted as LC_{FR} .

Minimum Ramp-to-Freeway Lane Changes

Minimum number of lane changes that a ramp-to-freeway weaving vehicle must make to complete the ramp-to-freeway movement successfully. This is only applicable for one-sided weaving segments. This is denoted as LC_{RF} .

Minimum Ramp-to-Ramp Lane Changes

Minimum number of lane changes that must be made by one ramp-to-ramp vehicle to execute the desired maneuver successfully. This is only applicable for two-sided weaving segments. This is denoted as LC_{RR} .

Node

The endpoint of a link or a place along a facility where (a) conflicting traffic streams cross, merge, or diverge; (b) a single traffic stream is regulated by a traffic control device; or (c) there is a significant change in the segment capacity (e.g., lane drop, lane addition, narrow bridge, significant upgrade, start or end of a ramp influence area).

Number of Lanes on Freeway

This specifies the number of lanes on the freeway in the analysis direction. If there is a weaving segment, the number of auxiliary lanes is also included. When there is a managed lane, the number of lanes is the number of general purpose lanes. See also *Lane Addition* and *Lane Drop*.

Number of Lanes on Ramp

This specifies the number of lanes on the ramp roadway (on- or off-ramp). There can be 1 or 2 lanes.

Number of Maneuver Lanes

Number of lanes from which weaving maneuvers may be made with either one or no lane changes; denoted as N_{WL} .

For one-sided weaving segments, the value of N_{WL} is either 2 or 3. The determination is made by a review of the geometric design and the configuration of the segment.

For two-sided weaving segments, the value of N_{WL} is always 0 by definition.

Origin-Destination

The Network module integrates Freeways and Streets to generate travel times between specific Origin-Destination (O-D) pairs selected by the user. The applicable definition depends on the facility type located at the origin or destination:

- If the trip starts/ends in an urban street, an origin/destination is defined as a node (intersection) in the street facility.
- If the trip starts/ends in a freeway, an origin/destination is defined as a segment in the freeway facility.

Peak Hour Factor

Peak Hour Factor, or PHF, is the hourly volume during the analysis hour divided by the peak 15-min flow rate within the analysis hour. It is a measure of traffic demand fluctuation within the analysis hour.

Percent Grade

The longitudinal slope of a roadway; provided by the user as a percentage

Project Description

This field is provided for the user to document the analysis with any information for identification purposes

Proportion of CAVs

This is the proportion of CAVs in the traffic stream. CAV is a connected autonomous vehicle, defined here as a vehicle with an operating cooperative adaptive cruise control system. The range of proportion of CAVs in the traffic stream is from 0 to 100.

The proportion of CAVs is used in determining a Capacity Adjustment Factor where CAVs are present in the traffic stream (CAF_{CAV}).

Ramp Demand

This references the demand of the freeway ramp and is measured in vehicle per hour. For an on-ramp, this is the Merge Demand. For an off-ramp, this is the Diverge Demand. For a weaving on-ramp, this includes the Ramp-to-Freeway Demand and the Ramp-to-Ramp Demand. For a weaving off-ramp, this includes the Freeway-to-Ramp Demand.

Ramp Metering

Roadway metering is the storing of surges in demand at various points in the transportation network. Freeway on-ramp metering is an example of roadway metering. A checkbox is provided to indicate whether ramp metering exists for a merge or weaving segment.

Ramp Metering Rate

When ramp metering is active, the metering rate, veh/h, is required and is stored in the existing variable $RM(i,t,p)$. The maximum output flow rate $ONRO(i,t,p)$ that can enter the merge point takes into consideration the ramp metering rate as one of its possible constraints and is properly adjusted if the ramp metering becomes the restricting factor to the on-ramp discharge.

$ONRO(i,t,p)$ is the maximum output flow rate that can enter the merge point from on-ramp i during time step t in the time interval p ; it is constrained by Lane 1 (shoulder lane) flow on segment i and the segment i capacity or by a queue spillback filling the mainline segment from a bottleneck further downstream, whichever governs.

Ramp Roadway

For a freeway off-ramp, the ramp roadway is the road section connecting the deceleration lane and the downstream ramp terminal. For a freeway on-ramp, the ramp roadway is the road section connecting the upstream ramp terminal and the acceleration lane.

Ramp Roadway Length

The ramp roadway length is measured from the gore to the taper of the ramp terminal. In the case of a ramp meter, its distance must be adjusted and should measure from the on-ramp entrance to the meter instead of the distance to the merge point. Ramp roadway length is measured in feet (or meters in metric).

Ramp Terminal

Ramp terminals connecting to urban street facilities can be uncontrolled, stop-controlled, or signalized intersections. Its distance is measured from the point where additional lanes are added to the intersection approaches to the stop bar of the approach. The length of this section should be at least as long as the turn bay lengths of the approach.

Ramp Terminal Approach Volume

This references the volume of the approach specified from the ramp terminal. It is measured in vehicles per hour.

Ramp Terminal Facility Name

This field is provided to document a name for the Ramp Terminal Facility. When an external file is selected, this information will be pulled from the selected file. However, the name itself can be edited within the Network data grid.

Ramp Terminal Type

Ramp Terminal Type is automatically detected based on the external file selected. There are two different types of ramp terminals: Signal and Freeway. Abbreviations in the reports are as follows: Signal = SIG and Freeway = FRWY.

Refresh Selected Files

A 'Refresh Selected Files' button is provided on the Network page to allow reloading of files so any changes to the external file(s) will update in the data grid. Desired rows in the Network data grid must be selected before refreshing files. The external files in the rows selected will update all information in the data grid using the latest version of the file found in the same directory file path.

Remove Selected Files

A 'Remove Selected Files' button is provided on the Network page to allow removal of files that were originally selected for the external file(s). Desired rows in the Network data grid must be selected before removing files. The external files in the rows selected will be removed and any associated information within the data grid will disappear.

Right Side Clearance

The right-side clearance is the distance from the rightmost travel lane to fixed obstructions on a freeway; measured in feet (or meters in metric).

Roadway Type

Roadway types include Multilane Highways or Collector-Distributor (C-D) Roadways and Freeways. For Weavings segments, the LOS criteria changes based on the roadway type. For Merge and Diverge segments, the FFS range is somewhat lower (45-60 mi/h) and can be estimated by using the methodology in Chapter 12 if no field measurements are available. The capacity checks and the maximum desirable flow rates of the ramp influence areas also change based on the roadway type.

Segment Name

This field is provided for each segment to identify the segment or specify the start point and end point of the segment under analysis.

Segment Number

The segment number in the Network table references the segment number in the facility in the HCS Freeways program. In the case of a Weaving segment, the segment number can repeat in the Network table since the Weaving segment includes both an on-ramp and an off-ramp.

Segment Length

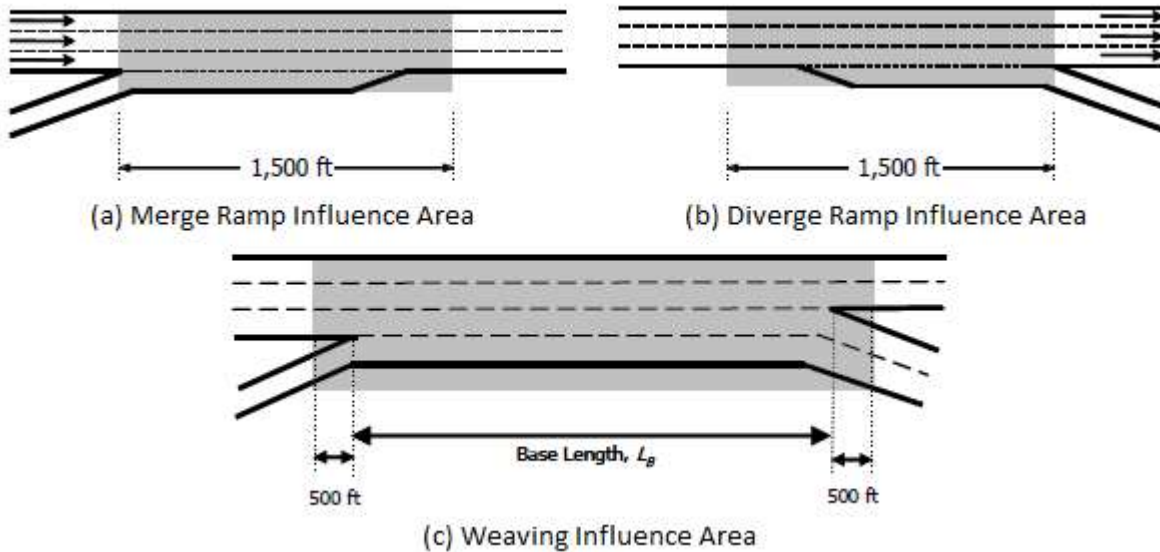
Distance in feet (or meters in metric) of each segment.

Default Segment Lengths

- Basic: 5280 ft (or 1609.3 m in metric)
- Merge: 1500 ft (or 457.2 m in metric)
- Diverge: 1500 ft (or 457.2 m in metric)
- Weaving: 3000 ft (or 914.4 m in metric)

- Overlap: 500 ft (or 152.4 m in metric)

The exhibit below illustrates the influence areas of Merge, Diverge, and Weaving segments without managed lanes. A weaving segment is usually defined as the distance between the on-ramp and off-ramp gore points. However, its influence area extends 500 ft (or 152.4 m in metric) upstream and downstream of the gore-to-gore length.



Segment Type

There are 4 possible segment types: On-Ramp, Off-Ramp, Weaving On-Ramp, and Weaving Off-Ramp. On-Ramp is associated with a Merge segment type in the Freeways methodology. Off-Ramp is associated with a Diverge segment type in the Freeways methodology. Weaving On-Ramp and Weaving Off-Ramp are associated with the entry and exit ramps of a Weaving segment type in the Freeways methodology, respectively.

Shoulder Queue Storage Length

When a shoulder is present, but its storage length is not sufficient to accommodate the unserved vehicles, this is a special case of queue spillback. In the exhibit below, the first case occurs when there is blockage of one mainline lane in addition to the shoulder. The second case occurs when there is blockage of two mainline lanes in addition to the shoulder.

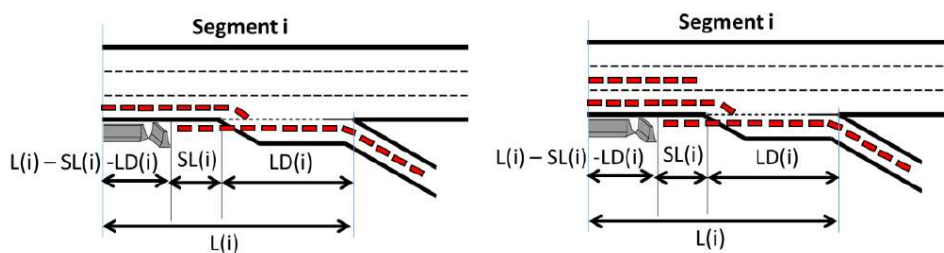


Exhibit 38-A15

Maximum Off-Ramp Queue Storage Length at Diverge Segments with Occurrence of (A) Regime 3a Queue Spillback and (B) Regime 4a Queue Spillback, when Shoulder is Available

Side of Junction

The location of the ramp(s) relative to the freeway. There are two types: *right-sided* and *left-sided*.

Single-Unit Trucks

Single-Unit Trucks are defined as one of two categories of heavy vehicles. Buses and RVs are treated as SUTs in the HCM. SUTs include the following:

- Other Two-Axle, Four-Tire Single-Unit Vehicles: Two-axle, four-tire vehicles, other than passenger cars. Generally pickup trucks, sports utility vehicles, and vans.
- Buses: All vehicles manufactured as traditional passenger-carrying buses with two axles and six tires or three or more axles. Excludes modified buses no longer capable of mass passenger transport.
- Two-Axle, Six-Tire, Single-Unit Trucks: All vehicles on a single frame with two axles and dual rear wheels. Includes some trucks, camping and recreational vehicles, and motor homes.
- Three-Axle Single-Unit Trucks: All vehicles on a single frame with three axles. Includes some trucks, camping and recreational vehicles, and motor homes.
- Four or More Axle Single-Unit Trucks. All trucks on a single frame with four or more axles.

Speed Adjustment Factor

Speed Adjustment Factor, or SAF, is a factor used to allow the user to adjust speed based on a combination of different sources, including weather and work zone effects. The SAF may also be used to calibrate the estimated FFS for local conditions or other effects that contribute to a reduction in FFS. For example, poor pavement conditions or sun glare may result in drivers reducing their speeds even under low-volume conditions.

Terrain Type

An extended length of highway containing a number of upgrades or downgrades where no single grade is long enough or steep enough to have a significant impact on the operation of the overall segment. There are three types of terrain: Level, Rolling, and Specific Grade.

See also *Level Terrain*, *Rolling Terrain*, and *Specific Grade*.

Time Analyzed

This field is provided to document the time frame of the analysis as morning peak, afternoon peak, existing conditions, future projections, etc.

Total Ramp Density

The average number of on-ramp, off-ramp, major merge, and major diverge junctions per mile (or kilometer in metric). It applies to a 6-mi (or 9.7-km in metric) segment of freeway facility, 3 mi (or 4.8 km in metric) upstream and 3 mi (or 4.8 km in metric) downstream of the midpoint of the study segment.

For segment analyses, ramp density is computed for a 6-mi (or 9.7-km in metric) section centered on the segment's midpoint; however, for facility analyses, ramp density is calculated across the entire facility (i.e., total number of ramps divided by total facility length).

Total Trucks

The percentage of trucks in the traffic stream. Trucks are heavy vehicles engaged primarily in the transport of goods and materials or in the delivery of services other than public transportation. All heavy vehicles are classified as single-unit trucks (SUTs) or tractor-trailers (TTs).

Tractor-Trailers

Tractor-Trailers are defined as one of two categories of heavy vehicles. TTs include the following:

- Four or Fewer Axle Single-Trailer Trucks: All vehicles with four or fewer axles consisting of two units, one of which is a tractor or straight truck power unit.
- Five-Axle Single-Trailer Trucks: All five-axle vehicles consisting of two units, one of which is a tractor or straight truck power unit.
- Six or More Axle Single-Trailer Trucks: All vehicles with six or more axles consisting of two units, one of which is a tractor or straight truck power unit.
- Five or Fewer Axle Multi-Trailer Trucks: All vehicles with five or fewer axles consisting of three or more units, one of which is a tractor or straight truck power unit.
- Six-Axle Multi-Trailer Trucks: All six-axle vehicles consisting of three or more units, one of which is a tractor or straight truck power unit.
- Seven or More Axle Multi-Trailer Trucks: All vehicles with seven or more axles consisting of three or more units, one of which is a tractor or straight truck power unit. Includes triple-trailer combinations.

Weather Type

There are different types of weather conditions. The HCM categorizes weather into 11 different types. These include: Medium rain, Heavy rain, Light snow, Light-medium snow, Medium-heavy snow, Severe cold, Low visibility, Very low visibility, Minimal visibility, and Non-severe weather.

The tables below provide default CAFs and SAFs by weather type and facility free-flow speed. Note that the changes in CAFs and SAFs for decreasing visibility shown in the exhibit may be counterintuitive, since they are based on a single site.

The SAF is applied to the base free-flow speed, and CAF is applied to the base capacity, both of which are calculated in the respective methodological chapters for the various freeway segment types. Both may also have been adjusted in the process of calibrating the core facility in Chapter 10 of the HCM. The adjustment factors below should be applied in addition to any prior CAF and SAF calibration.

Default CAFs by Weather Type:

Weather Type	Weather Event Definition	Capacity Adjustment Factors				
		55 mi/h	60 mi/h	65 mi/h	70 mi/h	75 mi/h
Medium rain	> 0.10-0.25 in/h	0.94	0.93	0.92	0.91	0.90
Heavy rain	> 0.25 in/h	0.89	0.88	0.86	0.84	0.82
Light snow	>0.00 – 0.05 in/h	0.97	0.96	0.96	0.95	0.95
Light-medium snow	>0.05 – 0.10 in/h	0.95	0.94	0.92	0.90	0.88
Medium-heavy snow	>0.10 – 0.50 in/h	0.93	0.91	0.90	0.88	0.87
Heavy snow	>0.50 in/h	0.80	0.78	0.76	0.74	0.72
Severe cold	<-4°F	0.93	0.92	0.92	0.91	0.90
Low visibility	0.50 – 0.99 mi	0.90	0.90	0.90	0.90	0.90
Very low visibility	0.25 – 0.49 mi	0.88	0.88	0.88	0.88	0.88
Minimal visibility	< 0.25 mi	0.90	0.90	0.90	0.90	0.90
Non-severe weather	All conditions not listed above	1.00	1.00	1.00	1.00	1.00

Source: Zegeer et al. (1).

Note: Speeds given in column heads are free-flow speeds.

Default SAFs by Weather Type:

Weather Type	Weather Event Definition	Speed Adjustment Factors				
		55 mi/h	60 mi/h	65 mi/h	70 mi/h	75 mi/h
Medium rain	> 0.10-0.25 in/h	0.96	0.95	0.94	0.93	0.93
Heavy rain	> 0.25 in/h	0.94	0.93	0.93	0.92	0.91
Light snow	>0.00 – 0.05 in/h	0.94	0.92	0.89	0.87	0.84
Light-medium snow	>0.05 – 0.10 in/h	0.92	0.90	0.88	0.86	0.83
Medium-heavy snow	>0.10 – 0.50 in/h	0.90	0.88	0.86	0.84	0.82
Heavy snow	>0.50 in/h	0.88	0.86	0.85	0.83	0.81
Severe cold	< -4°F	0.95	0.95	0.94	0.93	0.92
Low visibility	0.50 – 0.99 mi	0.96	0.95	0.94	0.94	0.93
Very low visibility	0.25 – 0.49 mi	0.95	0.94	0.93	0.92	0.91
Minimal visibility	< 0.25 mi	0.95	0.94	0.93	0.92	0.91
Non-severe weather	All conditions not listed above	1.00	1.00	1.00	1.00	1.00

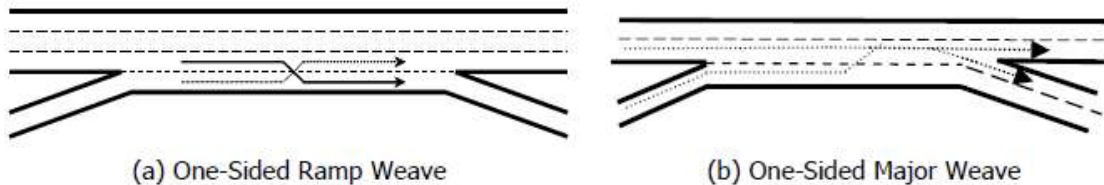
Source: Zegeer et al. (1).

Note: Speeds given in column heads are free-flow speeds.

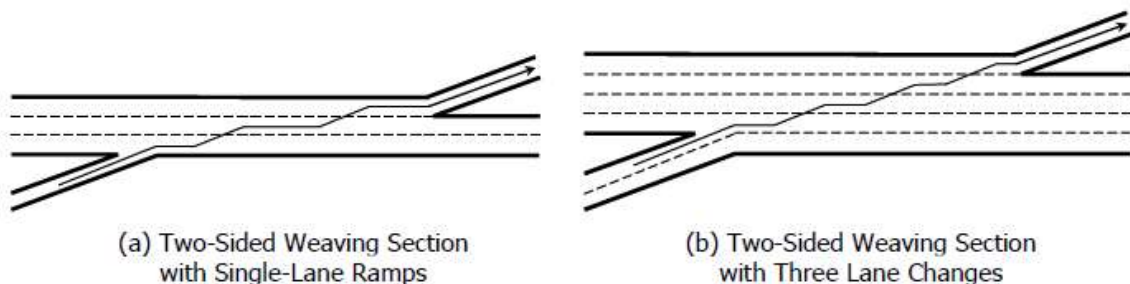
Weaving Configuration

Configuration of a weaving segment refers to the way that entry and exit lanes are linked. The configuration determines how many lane changes a weaving driver must make to complete the weaving maneuver successfully. There are two types of weaving configurations: *one-sided* and *two-sided*.

- A *one-sided weaving segment* is one in which no weaving maneuvers require more than two lane changes to be completed successfully. The following illustrates two examples of one-sided weaving segments:



- A *two-sided weaving segment* is one in which at least one weaving maneuver requires three or more lane changes to be completed successfully or in which a single-lane on-ramp is closely followed by a single-lane off-ramp on the opposite side of the freeway. The following illustrates two examples of two-sided weaving segments:

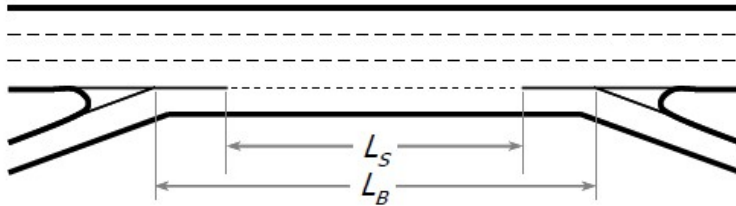


Weaving Length

The distance between the merge and diverge that form the weaving segment. There are two measures of weaving segment length: *short length* and *base length*.

- L_S = short length, the distance in feet (or meters in metric) between the end points of any barrier markings (solid white lines) that prohibit or discourage lane changing
- L_B = base length, the distance in feet (or meters in metric) between points in the respective gore areas where the left edge of the ramp-traveled way and the right edge of the freeway-traveled way meet

The following illustrates the two measures of weaving segment:



Index

A

Acknowledgements 5
Acceleration Lane Length 33
Agency 33
Analysis Period 34
Analysis Year 34
Analyst 34
Approach 34
Assign Ramp Terminal Volume to Freeway 34
Assign Ramp Terminal Volumes to All Freeways 34

B

Base Free Flow Speed 34

C

Capacity Adjustment Factor 34
Close a File 19
Connected Approach 34
Connected Intersection 34
Connected Intersection / Segment ID 35
Connected Intersection / Segment Name 35
Create a New File 12
Create Freeway Facility 35

D

Date 35
Deceleration Lane Length 35
Default Settings 8
Demand 36
Demand Adjustment Factor 37
Driver Population 37

E

Edit the Default Settings 21
Exit the Program 20
External File 37
Exit 9

F

Free Flow Speed 35

G

General Controls 8
Getting Started 7
Glossary of Terms 33
Grade Length 38

H

HCM Chapter 38 10
Help 8
How To 12

I

Incident Type 38
Interchange Density 38
Introduction 1

J

Jurisdiction 38

L

Lane Assignment 39
Lane Width 39
License Agreement 1
Load Freeway Facility 39

M

Major Diverge 39
Measured Free Flow Speed 40
Menu Items 7
Minimum Freeway-to-Ramp Lane Changes 40
Minimum Ramp-to-Freeway Lane Changes 40
Minimum Ramp-to-Ramp Lane Changes 40

N

Network Analysis 10
Network Analysis Report 11
New 8
Node 41
Number of Lanes on Freeways 41
Number of Lanes on Ramp 41
Number of Maneuver Lanes 41

O

Open 8
Open an Existing File 14
Operational Data 10
Origin-Destination 41

P

Peak Hour Factor 41
Percent Grade 41
Print 8
Print a Report 28
Print Preview 8
Project Description 41
Proportion of CAVs 41

R

Ramp Demand 42
Ramp Metering 42
Ramp Metering Rate 42
Ramp Roadway 42
Ramp Roadway Length 42
Ramp Terminal 42
Ramp Terminal Approach Volume 42
Ramp Terminal Facility Name 42
Ramp Terminal Type 43
Refresh Selected Files 43
Remove Selected Files 43
Report 8
Right Side Clearance 43
Roadway Type 43

S

Save 8
Save a File 18
Save As... 8
Segment Name 43
Segment Number 43
Segment Length 43
Segment Type 44

Shoulder Queue Storage Length 44
Side of Junction 44
Single-Unit Trucks 45
Speed Adjustment Factor 45
Steps for Starting Network Analysis 31
System Requirements 7

T

Terrain Type 45
Time Analyzed 45
Total Ramp Density 45
Total Trucks 45
Tractor-Trailers 46
Trademarks and Copyrights 6

V

View Results of the Analysis 23

W

Weather Type 46
Weaving Configuration 47
Weaving Length 48