

APPENDIX 11F RELIABILITY DATA GUIDANCE

Developing Local Demand Factors

Local demand factors (i.e., demand patterns specific to a roadway facility) can be developed from automatic traffic recorder (ATR) data, following these three steps:

Step 1: Select an Automatic Traffic Recorder

- a. Using ODOT's TransGIS¹ portal, locate ATRs located on the study freeway close to the location to be analyzed. GIS layers for ATR locations can be found under the "Equipment – Highway" section.
- b. If an ATR is located on the study facility, it should be selected. Otherwise, select one of the two nearest ATRs on the freeway, considering both proximity and location (i.e., expected to have similar traffic patterns) when making the selection.
- c. Note the unique five-digit identifier (e.g., 10-005) for the desired ATR.

Step 2: Download Automatic Traffic Recorder Data

- a. View the Automatic Traffic Recorder Summary report for the desired analysis year on ODOT's Traffic Counting² webpage. The summary report can be found under the "Permanent Automatic Traffic Recorders: Station Trends" section.
- b. Using the unique ATR identifier, navigate to the appropriate page within the summary report to obtain average weekday or daily traffic for each month of year.

Step 3: Calculate Demand Factors

- a. Determine the reference day and month for the demand factors. The reference day and month should be based on the input demands used in the core freeway methodology analysis. If the demands are based on actual 15-minute traffic counts, the reference day and month should correspond to a representative count day. If the demands are based on factoring AADTs, the reference month and day should be selected to representative of a time period when daily volumes closely match the AADT (as determined from the ATR summary report).
- b. Set the demand factor for the reference month to 1.0.
- c. Calculate the demand factor relative to the reference month for all other months of year using the Average Weekday Traffic data provided in the summary report. For example, if the reference month is March and the ADT measured for March at the ATR is 32,395, then if the ADT for June is 38,500, the demand factor for June would be $(38,500 / 32,395) = 1.188$.
- d. Set the demand factor for the reference day to 1.0.

¹ TransGIS. ODOT. <https://gis.odot.state.or.us/transgis/>

² Traffic Counting. ODOT. <https://www.oregon.gov/ODOT/Data/Pages/Traffic-Counting.aspx>

- e. Calculate the demand factor relative to the reference day for all other days of the week using the traffic counts used in the core freeway methodology analysis. If week-long traffic data are not available, the national defaults shown in Exhibit 18 may be used.

Exhibit 1: National Default Demand Factors

Area Type	Monday	Tuesday	Wednesday	Thursday	Friday
Urban	0.852	0.852	0.870	0.896	1.00
Rural	0.890	0.852	0.871	0.918	1.00

Developing Local Incident Rates

Detailed incident data are generally not available outside the Portland metropolitan area. Instead, local incident rates can be developed based on known crash rates for the study facility, following these four steps:

Step 1: Download Crash Data

- a. Identify the ODOT highway number, beginning mile point, and ending mile point of the study freeway corridor. ODOT facility information can be obtained from the Road Assets and Mileage webpage³.
- b. Download facility-specific crash data from the ODOT Crash Data System⁴ based on the ODOT highway number, beginning mile point, and ending mile point. Select the “Data Extract CDS 501” option to download raw data extracts. Note that data extracts can be downloaded for a maximum of one full year at a time.

Step 2: Parse the Data

- a. Data extracts are formatted as comma-delimited files and do not contain any headers. An Microsoft Excel spreadsheet containing column headings can be downloaded from the “CDS501 Data Extract Column Headers” hyperlink located in the ODOT Crash Data System.
- b. The following key data fields are required to generate incident rates for reliability analysis:
 - i. **Crash ID** – A unique identifier for each recorded crash. Data extracts contain multiple rows per recorded crash. The Crash ID field can be used to avoid double-counting the number of recorded crashes in a dataset.
 - ii. **Crash Month** – Month of year the recorded crash occurred.
 - iii. **Crash Year** – Calendar year the recorded crash occurred.

Step 3: Calculate Crash Rates

- a. Calculate the number of recorded crashes for each month of year by determining the number of unique Crash ID values for each Crash Month. If multiple years of data are

³ Road Assets and Mileage. ODOT. <https://www.oregon.gov/odot/data/pages/road-assets-mileage.aspx>

⁴ Crash Data System. ODOT. <https://tvc.odot.state.or.us/tvc/>

used (recommended), calculate the average number of unique Crash ID values for each Crash Month.

- b. Determine the average daily traffic for each month of year. The ATR data used for developing demand factors can be used for this analysis.
- c. Calculate crash rates for each month of year using the following formula:

$$R = \frac{100,000,000 \times C}{D \times N \times V \times L}$$

where:

R = Crash rate for the road segment expressed as crashes per 100 million vehicle-miles of travel (VMT)

C = Total number of recorded crashes in the month of year.

D = Number of days in a given month

N = Number of years of data

V = Number of vehicles per day (both directions)

L = Length of the roadway segment in miles.

Step 4: Calculate Incident Rates

- a. If the study freeway corridor is located within the Portland Metropolitan region, calculate incident rates for each month of year using an incident-to-crash ratio of 4.35 incidents per crash.
- b. If the study freeway corridor is located outside the Portland Metropolitan region, calculate incident rates for each month of year using the national default incident-to-crash ratio of 4.9 incidents per crash.
- c. Unless local data are available on the effects of incidents on freeway capacity, use the national default values provided in Exhibit 19.

Exhibit 2: Capacity Adjustment Factors (CAF)

Segment Lanes	Shoulder Closure	1 Lane Closure	2 Lane Closure	3 Lane Closure	4 Lane Closure
2	0.81	0.70			
3	0.83	0.74	0.51		
4	0.85	0.77	0.50	0.52	
5	0.87	0.81	0.67	0.50	0.50

Developing Local Weather Data

Oregon features a variety of different climates. The Oregon Coast Range produces some of the highest rainfall totals in the United States, while eastern Oregon features a relatively arid high desert climate. As a result, a freeway reliability study may need to account for these weather variations using data local to the study freeway facility. The analyst can generate a custom set of weather probability inputs

for reliability analysis using the Integrated Surface Database (ISD) available from the National Oceanic and Atmospheric Administration (NOAA) following these six steps:

Step 1: Select a Weather Station

- a. Using the Historical Observing Metadata Repository (HOMR)⁵ tool provided by NOAA, identify an appropriate weather station to generate weather probabilities for reliability analysis.
- b. A filter can be used within the HOMR tool to identify weather stations included in the ISD by enabling the Weather-Bureau-Army-Navy (WBAN) exist filter.
- c. Selected weather stations should be within a reasonable distance of, and at a similar elevation to, the study freeway facility.
- d. Note the WBAN ID for the selected weather station.

Step 2: Download Weather Data

- a. Annual weather data logs can be downloaded from NOAA's ISD File Transfer Protocol (FTP)⁶ server.
- b. Weather station data files can be identified using the WBAM ID and use the following file naming convention:

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<USAF ID>-<WBAM ID>-<Year>
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- c. To account for variations in annual weather events, it is recommended to generate weather reliability inputs using 10 years of data from the selected weather station.
- d. Data files are compressed in the gzip file format and require a software application to decompress the files before the data can be used.

Step 3: Parse the Data

- a. Weather data are stored in an ASCII file format, with each row representing one observation and consisting of 105 to 742 characters of data.
- b. The first 105 characters represent the control and mandatory data: information regarding the observation date, time, station information, and other basic meteorological information such as winds, visibility, and temperature. Data in this section can be parsed based on a fixed location within the string.
- c. Characters following the three character identifier (ADD) contain additional information of significance to the analysis, such as weather type, temperature, dew point, and precipitation. Data in this section are only reported if an observation exists during the observation period (e.g., rain occurred), and cannot be parsed based on a fixed location within the string.
- d. Exhibit 20 illustrates key variables within a sample ISD dataset observation required to generate weather probabilities and duration.

⁵ Historical Observing Metadata Repository. NOAA. <https://www.ncdc.noaa.gov/homr/>

⁶ Integrated Surface Database. NOAA. <ftp://ftp.ncdc.noaa.gov/pub/data/noaa>

- e. Data documentation on the ISD dataset is provided on the FTP server in Microsoft Word and PDF formats.

Exhibit 3: Parsing Observation Data from Integrated Surface Database

0437726985242422017092923537+...95ADDAA...3SM -RA BR FEW008 BKN040 OVC048 17/14 A3003 RMK...P0047...

<p>Observation Date Geophysical observation date in the format YYYYMMDD.</p> <p>Additional Data Identifier Denotes the beginning of additional data section with the three character identifier ADD.</p> <p>Weather Type - = Light + = Heavy DZ = Drizzle CLR = Clear Skies OVC = Overcast RA = Liquid Precipitation SN = Snow UP = Unknown Precipitation FG = Fog FZFG = Freezing Fog BR = Mist HZ = Haze SQ = Squall FC = Funnel Cloud / Tornado / Waterspout SCT = Scattered Clouds TS = Thunderstorms GR = Hail GS = Small Hail FZRA = Freezing Rain VA = Volcanic Ash</p>	<p>Observation Time Geophysical observation time recorded in Coordinated Universal Time Code (UTC) in the format HHMM.</p> <p>Visibility Measure of distance an object and/or light can be clearly discerned.</p> <p>Temperature Temperature observed in degrees Celsius. Multiply by $\frac{9}{5}$ and add 32° for conversion to Fahrenheit.</p> <p>Average Dew Point Temperature for air to be saturated with water vapor observed in degrees Celsius. Multiply by $\frac{9}{5}$ and add 32° for conversion to Fahrenheit.</p> <p>Pressure Observed atmospheric pressure. Divide by 100 for measurement in inches of Hg (mercury).</p> <p>Precipitation Observed precipitation. Divide by 100 for measurement in inches per hour.</p>
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Step 4: Identify HCM Weather Categories

- a. Using the data parsed from each observation entry, identify the corresponding HCM weather category.
- b. Exhibit 21 provides a summary of weather variables that can be used to match an observation to a HCM weather category.
 - i. If one or more of the weather types with a checkmark in Column A applies to the observation, and all parameters in Column B are true, the observation is matched to the HCM weather category for that row.
 - ii. If none of the weather types with a checkmark in Column A applies to the observation, but all of the parameters in Column B are true, the observation is matched to the HCM weather category for that row.
 - iii. Otherwise, the observation is classified as normal (i.e., non-severe) weather.

Exhibit 4: Identifying HCM Weather Categories

HCM Weather Categories	COLUMN A								COLUMN B			
	Liquid	Mist	Drizzle	Thunderstorm	Rain	Snow	Ice	Hail	Precipitation (in./hr)	Temperature (°F)	Visibility	Other
Medium Rain	✓	✓	✓	✓	✓	-	-	-	> 0.1 - 0.25	-	-	-
Heavy Rain	✓	✓	✓	✓	✓	-	-	-	> 0.25	-	-	-
Light Snow	-	-	-	-	-	✓	✓	✓	< 0.05	-	-	-
Light-Medium Snow	-	-	-	-	-	✓	✓	✓	> 0.05 - 0.10	-	-	-
Medium-Heavy Snow	-	-	-	-	-	✓	✓	✓	> 0.10 - 0.50	-	-	-
Heavy Snow	-	-	-	-	-	✓	✓	✓	> 0.50	-	-	-
Severe Cold	-	-	-	-	-	-	-	-	-	< -4	-	Not classified as a rain or snow event.
Low Visibility	-	-	-	-	-	-	-	-	-	-	> 0.50 - 1.00	Not classified as a rain, snow or severe cold event.
Very Low Visibility	-	-	-	-	-	-	-	-	-	-	> 0.25 - 0.50	Not classified as a rain, snow or severe cold event.
Minimal Visibility	-	-	-	-	-	-	-	-	-	-	< 0.25	Not classified as a rain, snow or severe cold event.
Normal	-	-	-	-	-	-	-	-	-	-	-	Not classified as any of the other weather events.

Step 5: Calculate Weather Event Durations

- a. Once all observations have been classified with a HCM weather category, calculate the overall duration of the various HCM weather events (except for “normal”) by calculating the time difference between observations.
- b. Total weather durations should be summarized for each HCM severe weather category for each month of year, and for the entire year.
- c. Weather probabilities for a given month of year can be calculated by dividing the total duration of that type of weather by the total number of hours in the particular month.
- d. Average weather durations can be calculated by dividing the total weather duration for the year by the frequency of weather events.

Step 6: Summarize Weather Information

- a. Summarize monthly weather probabilities and average weather durations in a table, as shown in Exhibit 22.

Exhibit 5: Example Weather Data for Reliability Analysis in Portland, OR

Month		Medium Rain	Heavy Rain	Light Snow	Light/ Medium Snow	Medium/ Heavy Snow	Heavy Snow	Severe Cold	Low Visibility	Very Low Visibility	Minimum Visibility	Normal Weather
Weather Probability	January	1.8%	0.8%	0.2%	0.0%	0.2%	0.0%	0.0%	0.0%	0.0%	0.5%	96.5%
	February	1.0%	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	98.8%
	March	0.6%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	99.4%
	April	0.5%	0.3%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	99.2%
	May	0.6%	0.5%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	98.9%
	June	0.3%	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	99.6%
	July	0.1%	0.3%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	99.6%
	August	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	100.0%
	September	0.7%	0.5%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	98.9%
	October	1.1%	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.2%	0.0%	0.0%	98.7%
	November	1.9%	0.9%	0.0%	0.0%	0.0%	0.0%	0.0%	0.3%	0.0%	0.7%	96.1%
December	1.6%	0.7%	1.0%	0.0%	0.0%	0.0%	0.0%	0.4%	0.0%	0.5%	95.8%	
Average Duration (minutes)		37.9	18.3	112.6	20.5	21.9	6.6	0.0	37.4	0.0	131.2	0.0