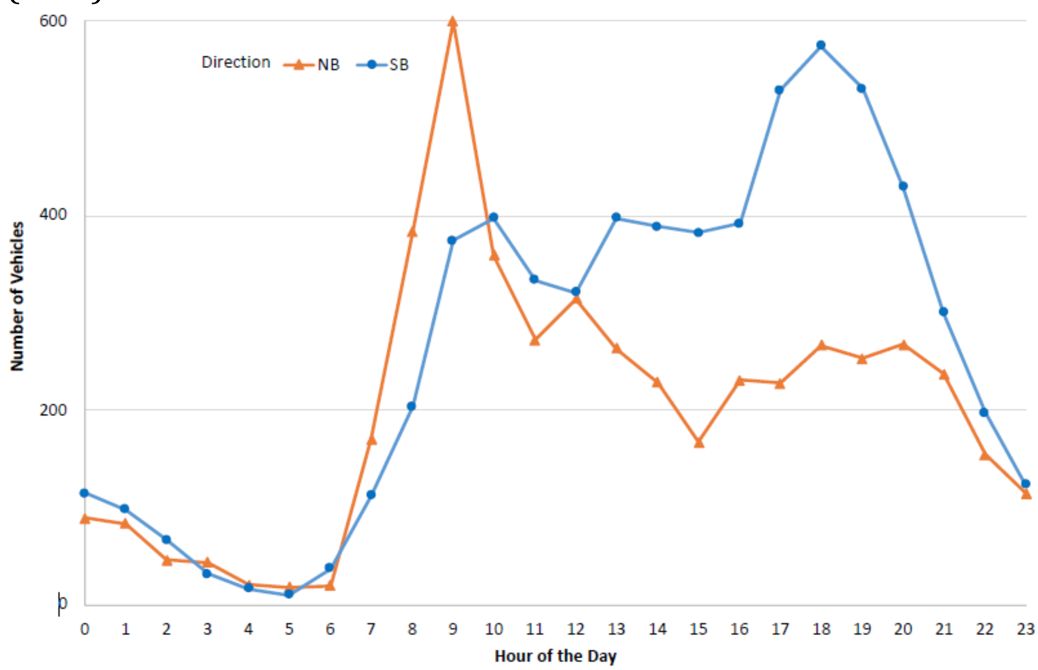
Appendix J –

Traffic Pattern Examples

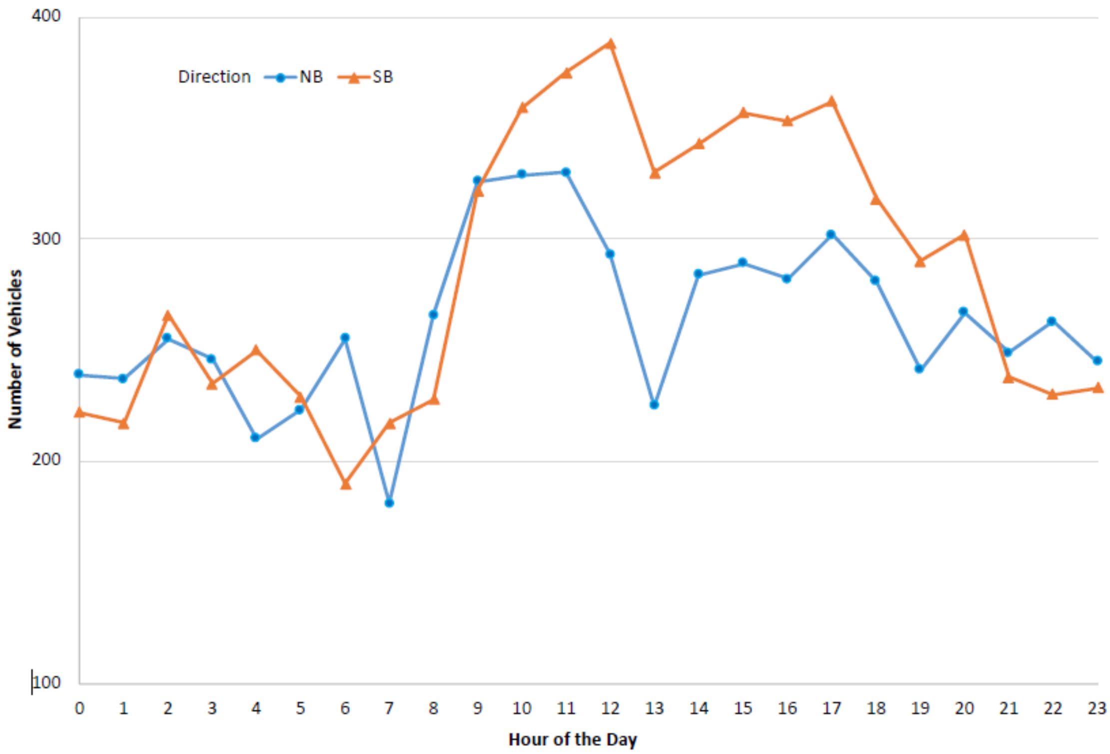
Appendix J. FHWA Traffic Pattern Examples

J.1 Micromobility And Motorized: Hour Of The Day (HOD) And Time Of Day (TOD) Examples



Source: Minnesota DOT

Figure J-1: Hour Of The Day – Passenger Vehicles, Minnesota DOT



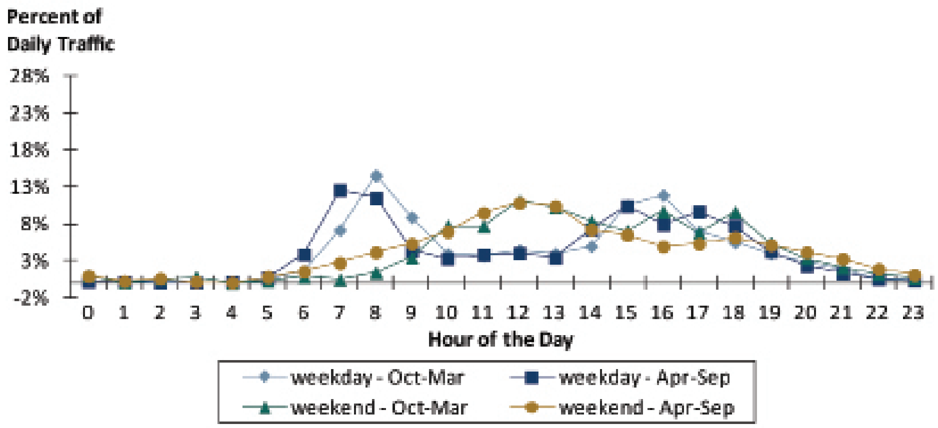
Source: Minnesota DOT

FIGURE J-2: HOUR OF THE DAY – HEAVY COMMERCIAL VEHICLES, MINNESOTA DOT

Figure J-2 has TOD for heavy commercial vehicles.

Figures J-3 shows typical traffic patterns for a permanent monitoring location that has a higher percentage of commuting-based trips:

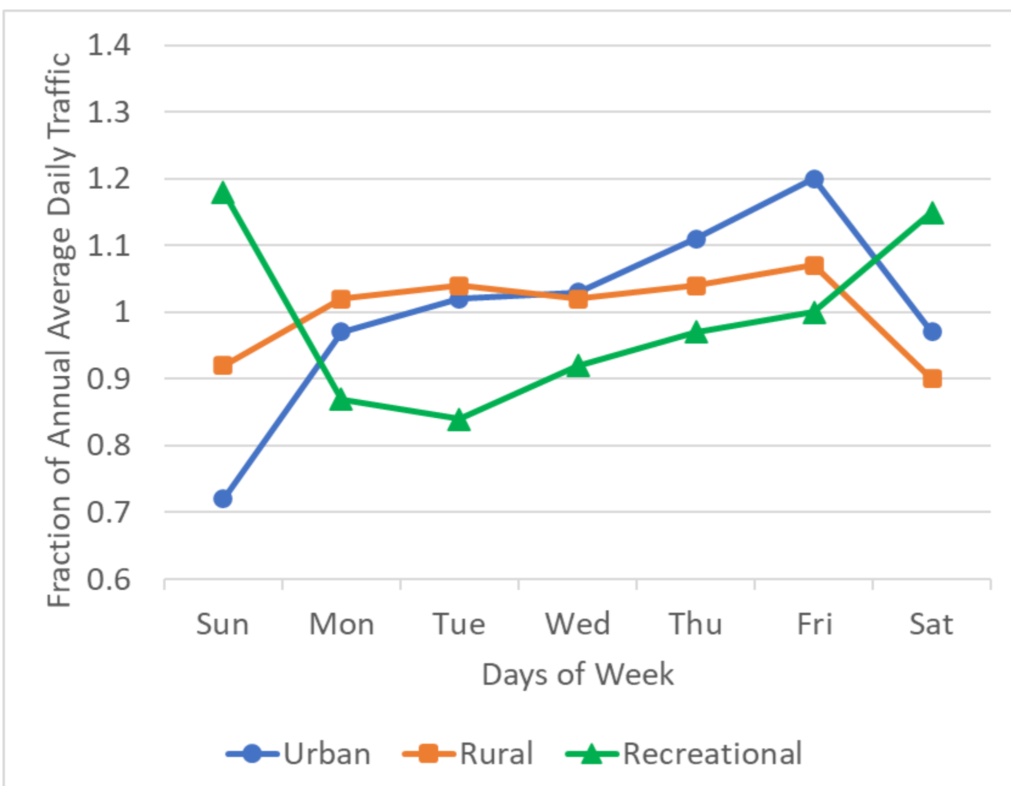
- The time-of-day patterns show strong peaks during the morning and evening, with less traffic during mid-day.
- The DOW patterns show more traffic occurring during the weekdays than the weekends, and the pattern is consistent across all months.
- The month-of-year patterns show less variation throughout the year, regardless of season or climate.



Source: Continuous Count Data, Colorado Department of Transportation, 2010-2011.

FIGURE J-3: TYPICAL TRAFFIC PATTERNS FOR LOCATIONS WITH HIGHER PERCENTAGE OF COMMUTING TRIPS; B90007 6TH AVENUE/VAUGHN STREET; 1/1/2011-12/31/2011 - HOUR OF DAY

J.2 MOTORIZED HOUR OF THE DAY EXAMPLE



Source: Federal Highway Administration. (TTI, Ioannis, Tsapakis)

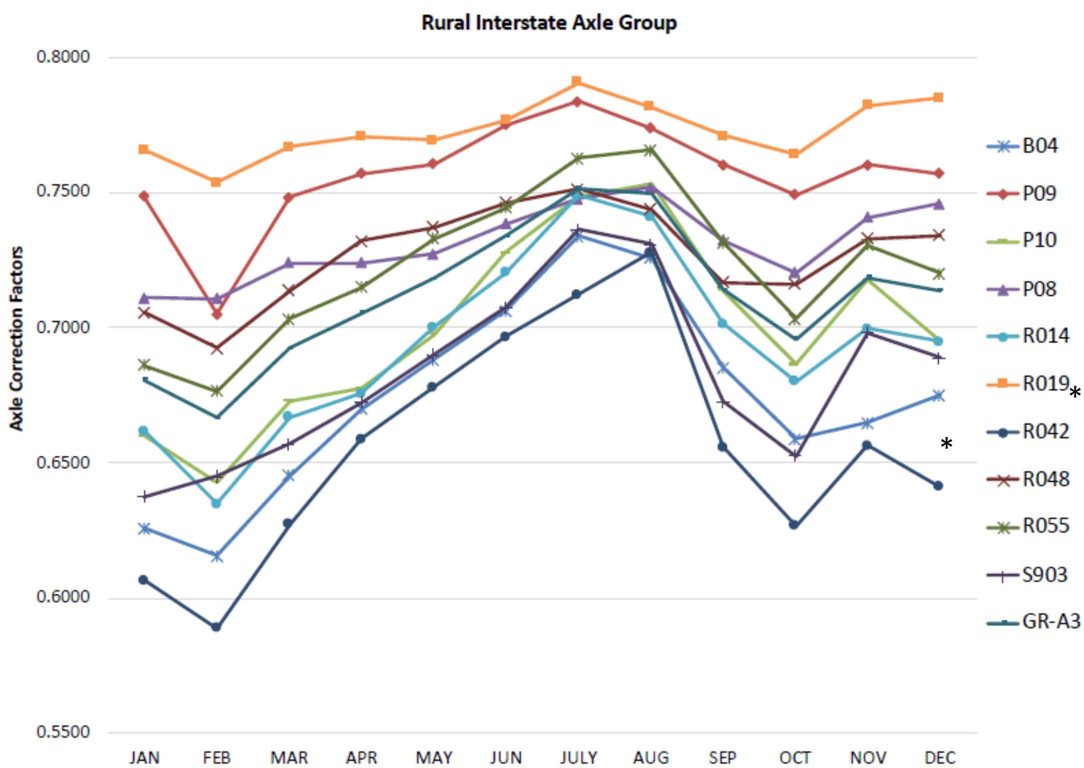
FIGURE J-4: DAY OF THE WEEK VOLUMES (FRACTION OF ANNUAL AVERAGE DAILY TRAFFIC (AVERAGE DAY OF WEEK VOLUME/AADT)) FOR URBAN, RURAL, AND RECREATIONAL SITES

J.3 MOTORIZED MONTH OF THE YEAR EXAMPLE

In the example below, the State of Washington provides an example of a Rural Interstate MOY Axle Factor Group showing data from motorized continuous counting stations.

The chart provided below represents the CY2019 average mid-week (Tue-Thur) axle correction factors by month for the permanent sites making up the Rural Interstate factor group (GR-A3). The average GR-A3 curve is also included in the chart.

This example does not utilize cluster analysis but relies on visual observation of the patterns which is simple and easy to understand and requires no statistical knowledge. As seen in the graph, some sites show an increase in axle factor correction for calculating traffic volumes during the month of June and a decrease in factor corrections in traffic volumes in the month of January.

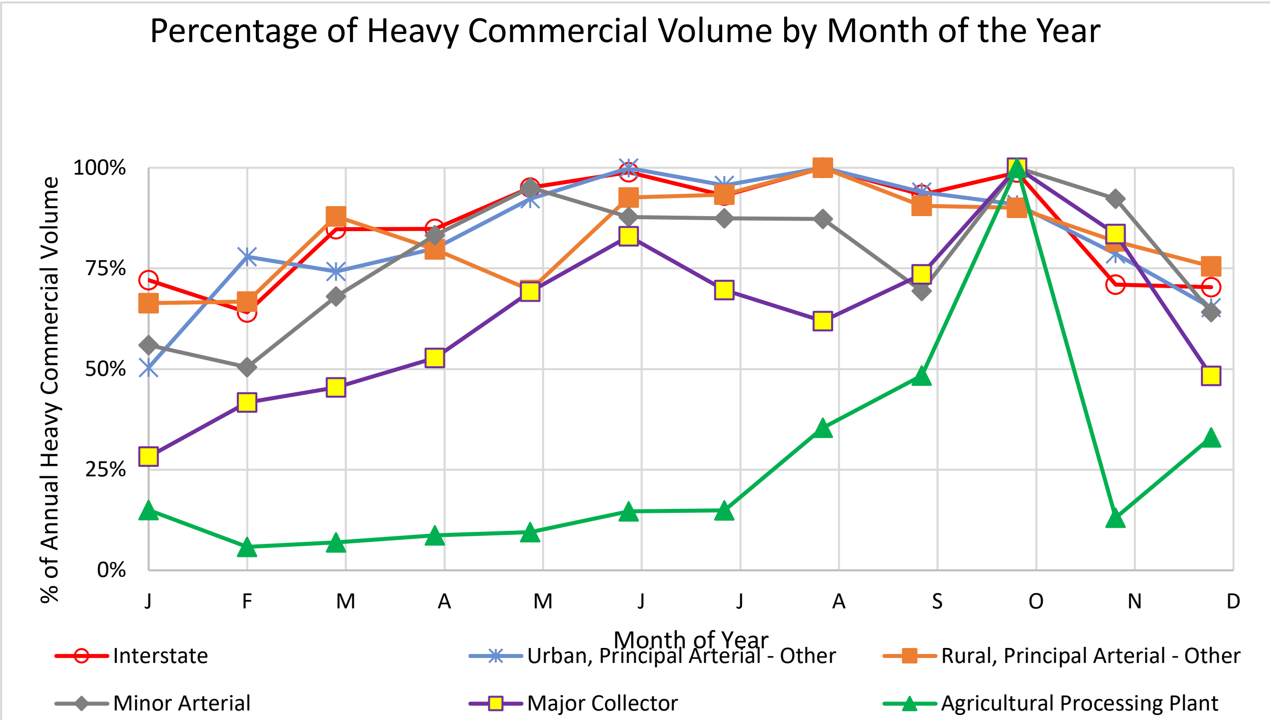


Source: Washington State DOT

FIGURE J-5: MONTH OF THE YEAR – RURAL INTERSTATE AXLE FACTOR GROUP, WASHINGTON STATE DOT

J.4 MOTORIZED WIM DATA MONTH OF THE YEAR EXAMPLE

The WIM station Graph below provided by the Minnesota DOT provides a Month of the Year look at heavy commercial volume by month of the year.

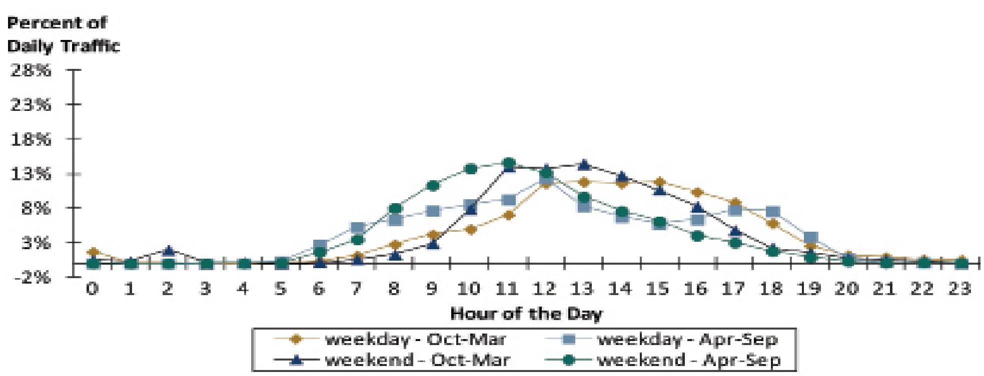


Source: Minnesota DOT

FIGURE J-6: MONTH OF THE YEAR – HEAVY COMMERCIAL VOLUME BY MONTH OF THE YEAR, MINNESOTA DOT

When working with pedestrian and micromobility data, normalizing data helps to illustrate traffic patterns. Data is normalized by taking the MADT and dividing it by the AADT. The figures below show the difference between MADTs and normalized traffic data for identifying MOY traffic patterns for pedestrian and micromobility volume data in Colorado.

J.5 MICROMOBILITY HOD, DOW AND MOY EXAMPLES



Source: Continuous Count Data, Colorado Department of Transportation, 2010-2011.

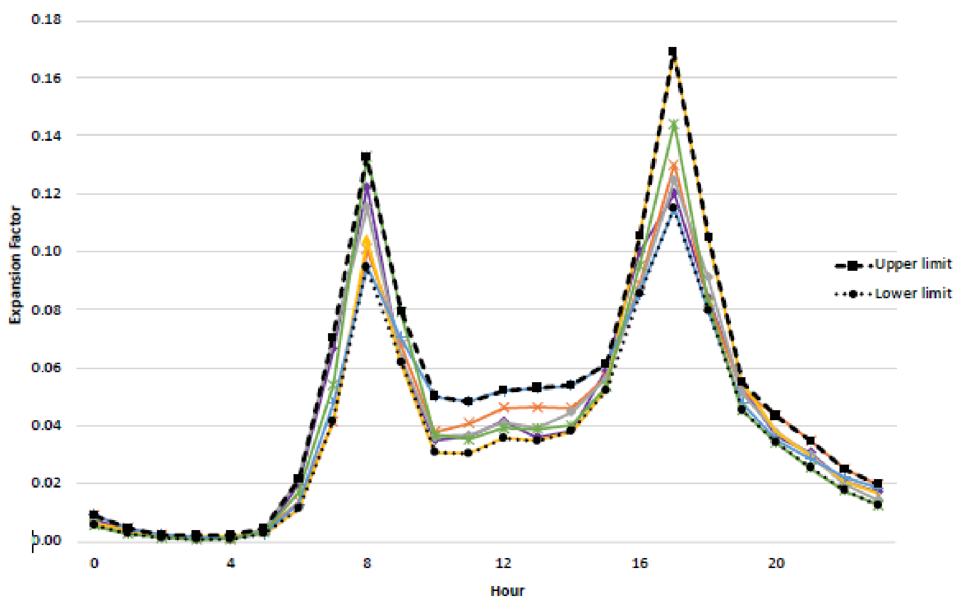
FIGURE J-7: TYPICAL TRAFFIC PATTERNS FOR LOCATIONS WITH HIGHER PERCENTAGE OF RECREATIONAL TRIPS; B90004 US36; 1/1/2011-12/31/2011 – HOUR OF DAY

J.5.1 MICROMOBILITY TRAFFIC PATTERNS

Research findings documented in the "*Monitoring Trail Traffic in the Cincinnati Metropolitan Region, Ohio*" report JPRA-2019-9179, using 78 locations along 15 trail corridors in 2017 showed most traffic patterns indicate the trails are used mostly for recreation use (cycling and walking) and less for commuting. This report also states, recreation mangers should use these results to track trends and prioritize investment in trail development, safety, and maintenance.

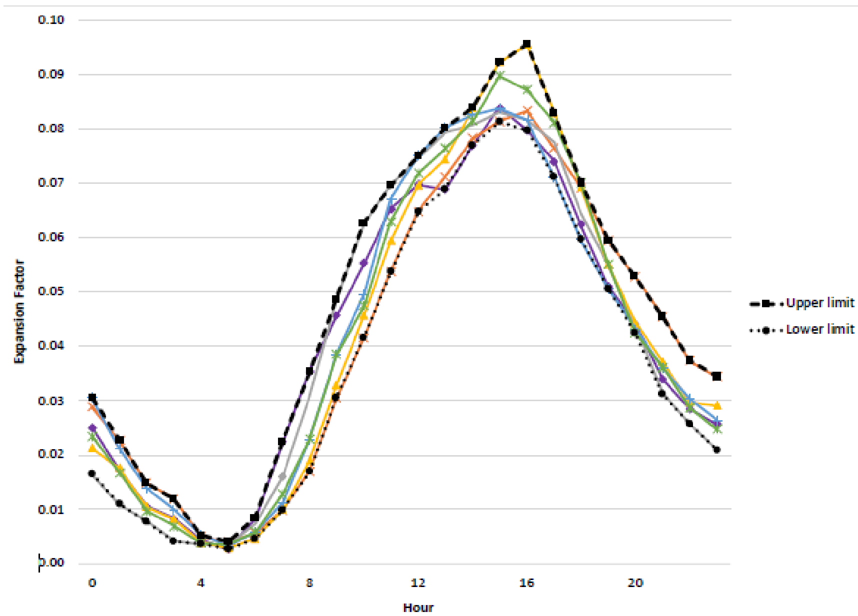
> The TMG recommends that the division responsible for data collection help data users to track trends and prioritize investments in trail development, safety, and maintenance.

Another study, "*Classification of Bicycle Traffic Patterns in Five North American Cities*" (reference Luis F. Miranda-Moreno, Thomas Nosal, Robert J. Schneider and Frank Proulx) provides a summarized analyses results of pedestrian and micromobility data collected stating that seasonal patterns across four different categories of the study location were found to have consistent hourly and weekly traffic patterns across cities, despite considerable differences between the cities in their weather, size and urban form. The study also found that count data showed that the bicycle volume patterns at each location could be classified as utilitarian, mixed utilitarian, mixed recreational, and recreational. Figure J-8 shows data graphed by time of the day (TOD) from the data collected for the study.



Source: "Classification of Bicycle Traffic Patterns in Five North American Cities." Luis F. Miranda-Moreno, Thomas Nosal, Robert J. Schneider and Frank Proulx.

Figure J-8: Time Of The Day (TOD) - Pedestrian And Micromobility Data A

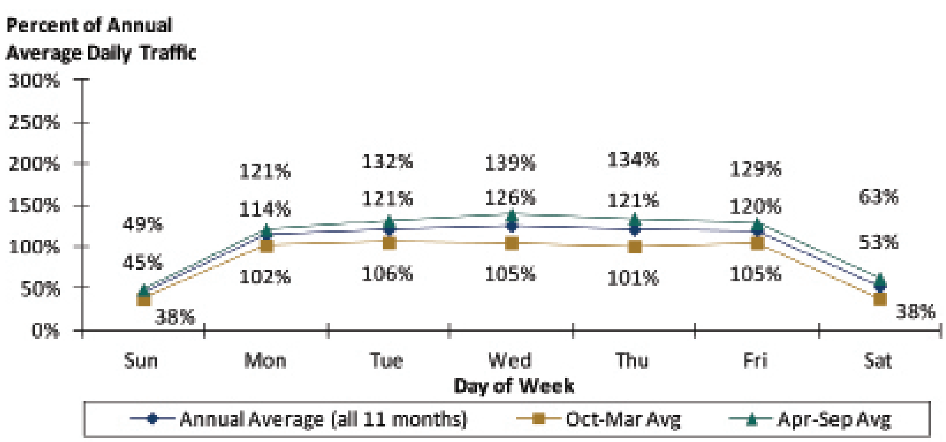


Source: "Classification of Bicycle Traffic Patterns in Five North American Cities." Luis F. Miranda-Moreno, Thomas Nosal, Robert J. Schneider and Frank Proulx.

FIGURE J-9: TIME OF THE DAY (TOD) - PEDESTRIAN AND MICROMOBILITY DATA B

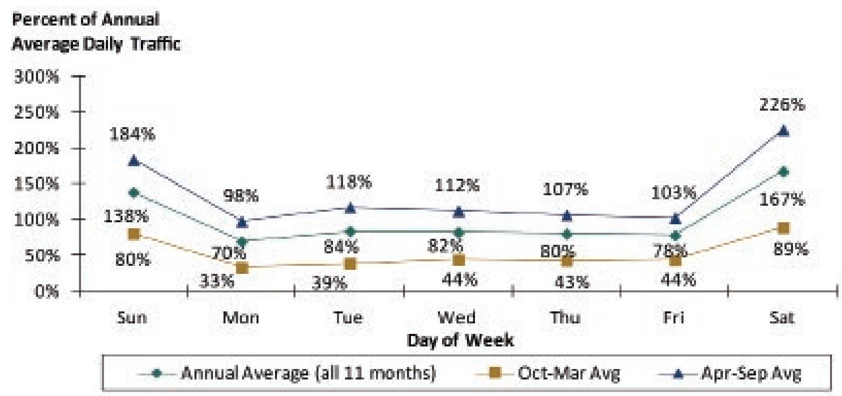
J.5.2 PEDESTRIAN AND MICROMOBILITY TIME OF DAY EXAMPLE

The time-of-day variation for mixed-mode (i.e., pedestrians and bicyclists), nonmotorized traffic at a single location is shown in Figure J-9. The time-of-day patterns for nonmotorized traffic data will vary by location and trip purposes. Diurnal peaking patterns can be seen during the weekdays for nonmotorized traffic; however, the nonmotorized peaks are less pronounced than the car and truck peaks. The weekend profiles for nonmotorized traffic have a single peak (same as rural cars), but the nonmotorized peak is mid-day (as opposed to an evening peak for rural cars) and is much more pronounced (12%-13% for nonmotorized as compared to 8% for rural cars). For this trail in Colorado, the time-of-day patterns for nonmotorized traffic do vary by season of the year.



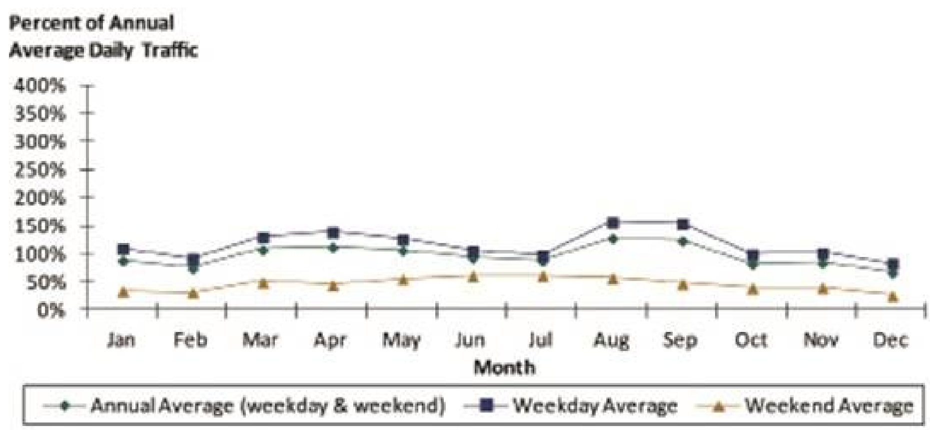
Source: Continuous Count Data, Colorado Department of Transportation, 2010-2011.

Figure J-10: TOD For Mixed-Mode Nonmotorized Traffic at Single Location



Source: Continuous Count Data, Colorado Department of Transportation, 2010-2011.

FIGURE J-11: TYPICAL TRAFFIC PATTERNS FOR LOCATIONS WITH HIGHER PERCENTAGE OF RECREATIONAL TRIPS; B90004 US36; 1/1/2011-12/31/2011 – DAY OF WEEK



Source: Continuous Count Data, Colorado Department of Transportation, 2010-2011.

FIGURE J-12: TYPICAL TRAFFIC PATTERNS FOR LOCATIONS WITH HIGHER PERCENTAGE OF COMMUTING TRIPS; B90007 6TH AVENUE/VAUGHN STREET; 1/1/2011-12/31/2011 – MONTH OF YEAR

Figure J-12 shows typical traffic patterns for a permanent monitoring location that has a higher percentage of recreation-based trips:

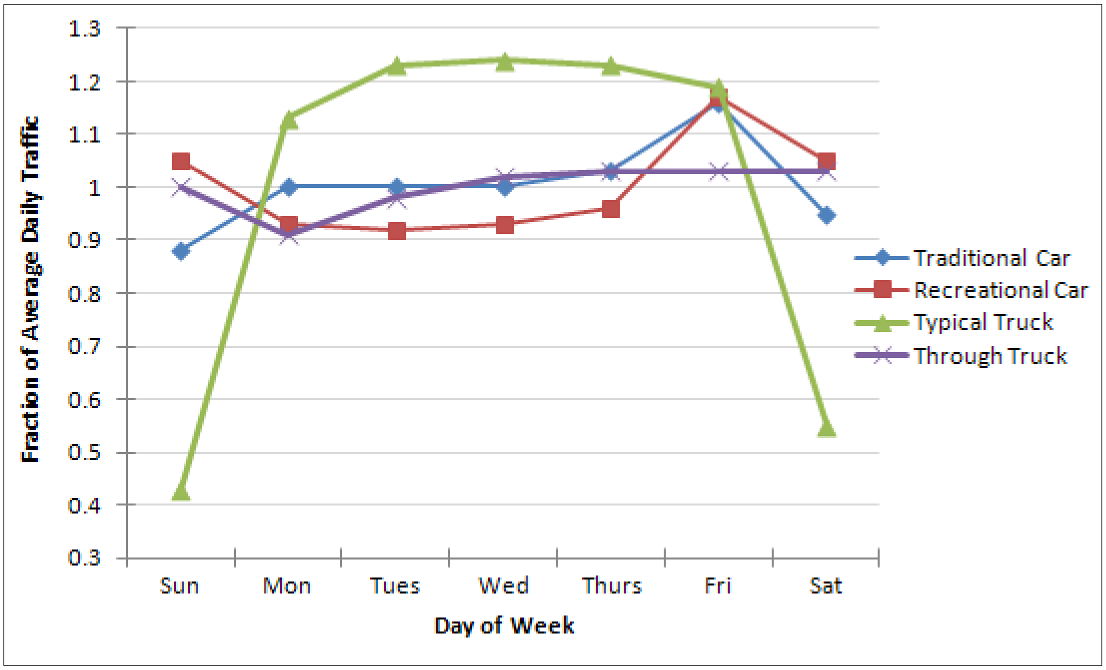
- The time-of-day patterns (Figure J-7) show a single strong peak during the middle of the day, with little or no morning and evening peaks.
- The DOW patterns (Figure J-11) show more traffic occurring during the weekends than the weekdays, and the levels vary by season.

J.6 TRUCK DAY OF THE WEEK VARIATION EXAMPLE:

J.6.1 DAY-OF-WEEK VARIATION

Time-of-day patterns are not the only way car and truck patterns differ. DOW patterns also differ in large part because of the use of cars for a variety of non-business-related traffic, whereas for the most part, trucks travel only when business needs require.

Similar to the time-of-day patterns, DOW patterns for cars fall into one of two basic patterns as shown in Figure J-13. In the first pattern (traditional urban), volumes are fairly constant during weekdays and then decline slightly on the weekends, with Sunday volumes usually being lower than Saturday volumes. This pattern also exists on many rural roads. The alternate pattern, usually found on roads that contain recreational travel, shows constant weekday volumes followed by an increase in traffic on the weekends.



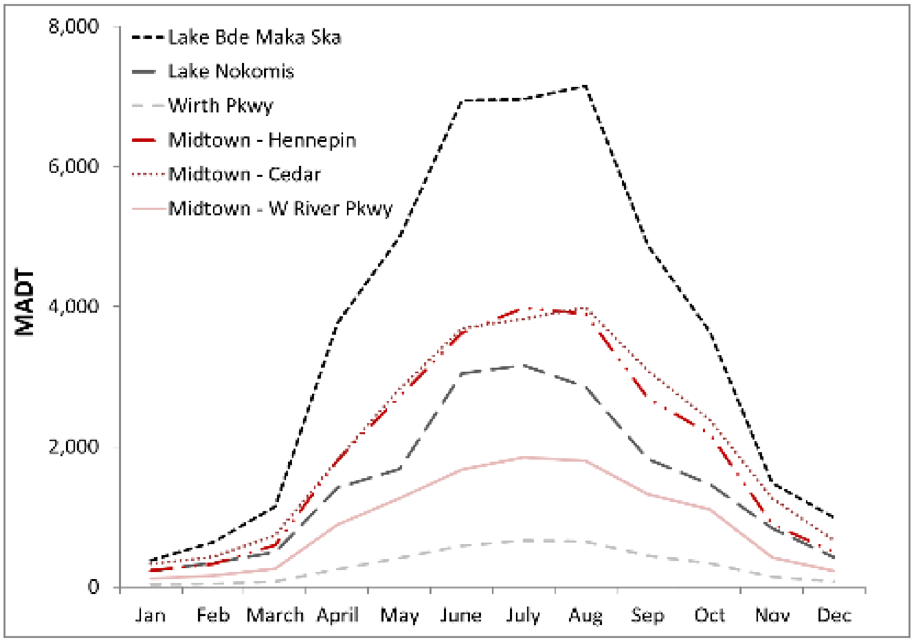
Source: *Hallenbeck, et al.,* Vehicle Volume Distributions by Classification, *1997.*

FIGURE J-13: TYPICAL DAY-OF-WEEK TRAFFIC PATTERNS

Trucks also have two patterns that are both driven by the needs of businesses. Most trucks follow an exaggerated version of the traditional urban car pattern. That is, weekday truck volumes are constant, but on weekends, truck volumes decline considerably more than car volumes (unlike cars, the decline in truck travel caused by lower weekend business activity is usually not balanced by an increase in truck travel for other purposes). However, as with the time-of-day pattern, long haul through trucks often show a vastly different DOW pattern. Since long-haul trucks are not concerned with the business day (they travel as often as the driver is allowed), they travel equally on all seven days of the week. Thus, roads with high percentages of through-truck traffic often maintain high truck volumes during the weekends, even though the local truck traffic declines. Note that through-truck traffic is still normally generated during normal business hours. Thus, through-traffic generated from any one geographic location has the same 5-day on, 2-day off pattern seen in the local truck pattern. Where a road carries through-truck traffic from a single dominant area, the two-day lag in truck volumes is often apparent. However, the lag appears at some other time in the week. This pattern is visible in truck volume counts only when through-truck traffic is a high percentage of total truck volume. What happens more commonly is that weekend truck volumes do not drop as precipitously as they do at sites where little through-truck traffic exists.

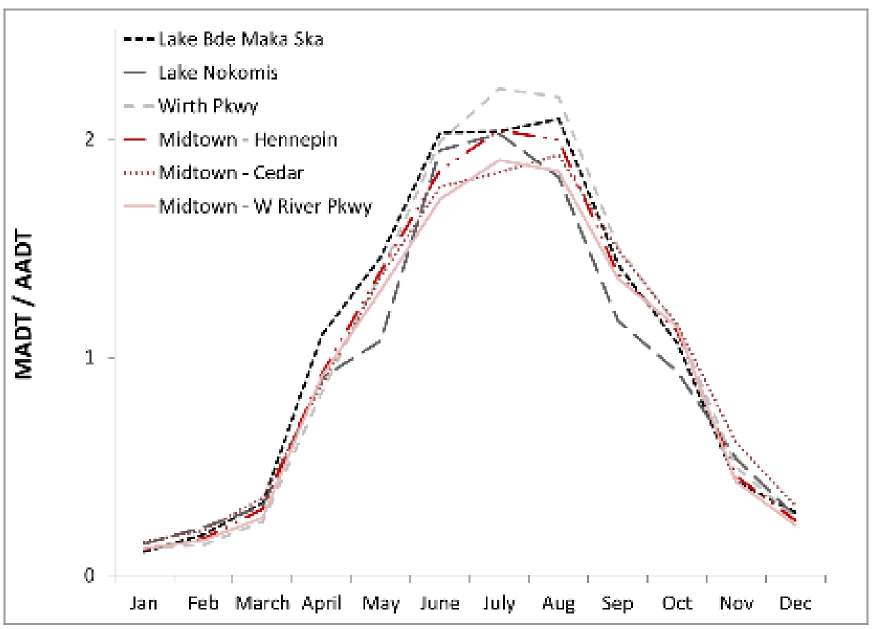
These significant changes in traffic volumes during the week have several effects on the traffic monitoring program. Most importantly, the monitoring program should collect data that allow a State to describe these variations. Second, the monitoring program should allow this knowledge to be shared with the users of the traffic data and applied to individual locations. Without these two steps, many of the analyses performed with traffic monitoring data will be inaccurate. Pavement designers need to account for reductions in truck traffic on the weekends if they are to accurately predict annual loading rates. Likewise, accident rate comparisons for different vehicle classifications are not realistic unless these differences are accounted for in estimates of vehicle miles traveled by class.

J.7 Micromobility Month Of The Year Example:



Source: Hankey, S., Lindsey, G., & Marshall, J. (2014). Day-of-year scaling factors and design considerations for nonmotorized traffic monitoring programs. Transportation Research Record, 2468(1), 64-73

Figure J-14: Monthly Average Daily Traffic (MADT) By Month Of The Year At Six Locations



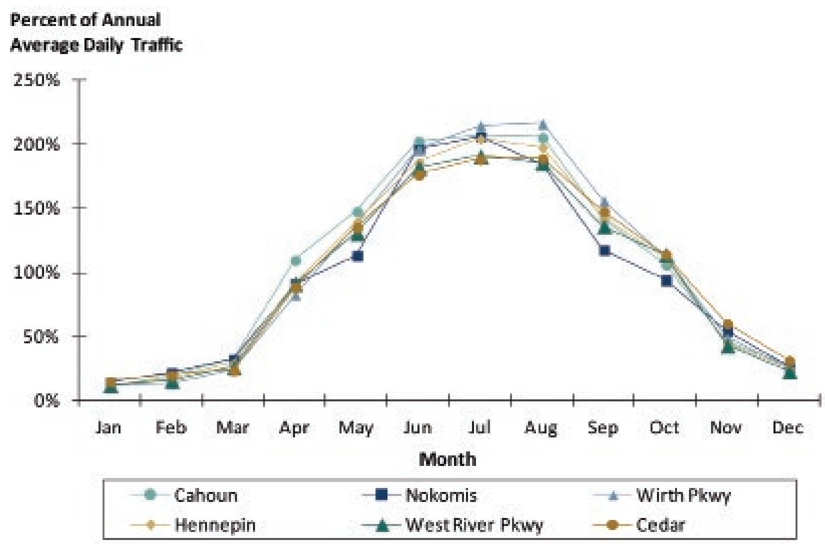
Source: Hankey, S., Lindsey, G., & Marshall, J. (2014). Day-of-year scaling factors and design considerations for nonmotorized traffic monitoring programs. Transportation Research Record, 2468(1), 64-73

Figure J-15: MADT/AADT (Annual Average Daily Traffic) Ratios For Mixed Mode Traffic At Six Locations

Monthly Average Daily Traffic (MADT; Figure J-14) and MADT normalized (Figure J-15) by Annual Average Daily Traffic (AADT) for 6 urban trail locations in Minneapolis, MN. Grey scale lines are for predominantly recreational trails around waterways; red scale lines are for locations on the Midtown Greenway. Although total traffic volumes vary greatly among locations, when normalized by AADT, all locations demonstrate similar seasonal patterns.

Figure J-14 shows an example of a typical TOD distribution for total traffic volume from a monitoring site in Minnesota that collects traffic data in different directions for the same roadway. The typical morning and evening peak hours are evident for urban routes on weekdays. The evening peak generally has somewhat higher volumes than the morning peak. Rural routes do not show two prominent peaks, while recreational routes show a single daily peak (as travelers go to and from their recreational destination). TOD factors for trucks are typically different than those observed for cars or for total volume. Temporal TOD distributions can be obtained from data collected at both short-term and permanent count sites. TOD factors obtained from permanent count sites provide insights into how travel by TOD changes by day of week, and for specific times of year—such as summer weekend traffic patterns.

Below are some examples showing TOD traffic monitoring patterns provided by the Minnesota DOT. These graphs show the TOD for passenger vehicles and for heavy commercial vehicles. WIM equipment is installed between a staging area for sugar beets and processing plants that are generally in operation 24 hours a day during the harvest season.



Source: Greg Lindsey, University of Minnesota.

FIGURE J-16: MONTHLY PATTERNS FOR SIX SHARED USE PATH LOCATIONS IN MINNEAPOLIS, MINNESOTA

J.7.1 PEDESTRIAN AND MICROMOBILITY MONTHLY VARIATION EXAMPLES

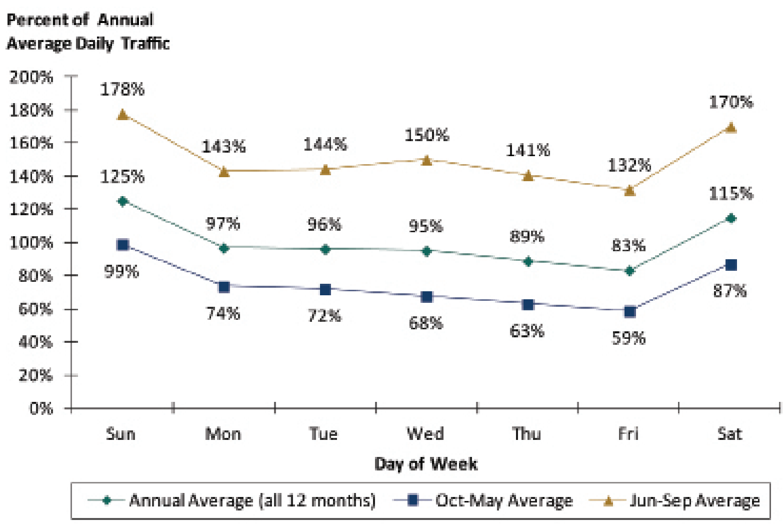
The monthly variation for mixed-mode, nonmotorized traffic at a single location in Colorado is shown in Figure J-17. The overall monthly patterns are like the rural car and truck patterns; however, the monthly patterns over time (seasonality) for pedestrian and micromobility traffic is much more pronounced. For example, the peak summer pedestrian and micromobility traffic during July is about 200%, or nearly twice the annual average. The winter pedestrian and micromobility traffic (November through February) is about 50%, or one-half of the annual average. Figure J-17 clearly demonstrates the monthly (seasonal) effects on nonmotorized traffic at this Colorado location.

Source: Cherry Creek Trail continuous count data, Colorado Department of Transportation, 2010.

FIGURE J-17: MONTHLY PATTERNS FOR A COLORADO SHARED USE PATH

J.7.2 PEDESTRIAN AND MICROMOBILITY DAY OF WEEK EXAMPLE

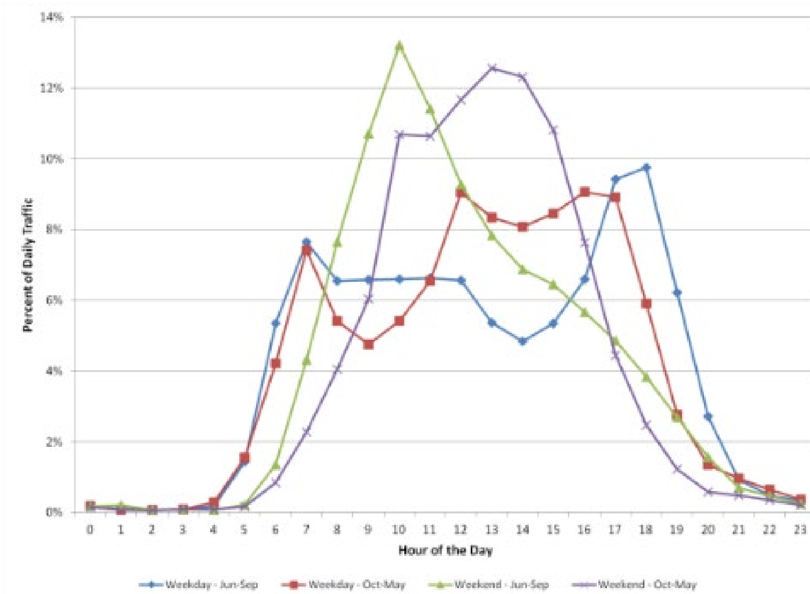
The DOW variation for mixed-mode nonmotorized traffic at a single location is shown in Figure J-18. The overall profile of the nonmotorized traffic is similar to the recreational car or through truck as shown in Figure J-13. However, the weekend traffic is more pronounced for the nonmotorized trail traffic. The other significant difference is how the magnitude varies by season of the year.



Source: Cherry Creek Trail continuous count data, Colorado Department of Transportation, 2010.

FIGURE J-18: DOW PATTERNS FOR A COLORADO SHARED USE PATH

The DOW patterns shown in Figure J-18 are averaged over a full year. The actual day-to-day variation of nonmotorized traffic volumes will be substantially greater than shown in this figure. Adverse weather (e.g., heavy rain, extreme hot or cold temperatures) has a significant impact on bicycling and walking traffic levels. In fact, even forecasts of adverse weather may also have an impact on nonmotorized traffic.



Source: Cherry Creek Trail continuous count data, Colorado Department of Transportation, 2010.

Figure J-19: Time-Of-Day Patterns For A Colorado Shared Use Path