

*Two-Axle Commercial Vehicle Composition
and Occupancy in Western North Dakota*

White Paper

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INTRODUCTION

The Office of Highway Policy Information of Federal Highway Administration (FHWA) publishes statistical data about motor vehicle registrations reported by the 50 states and District of Columbia. According to its 2020 publication, the 97.94% of vehicles in the State of North Dakota are registered as either private or commercial. The remaining 2.06% are publicly owned. The national averages are 98.51% private or commercial and 1.49% publicly owned.

The actual composition of vehicles plying on the state highways in terms of commercial versus non-commercial (private) is not known. Among other factors, this composition may vary within parts of the state given the nature of land use and level of urbanization. The North Dakota Department of Transportation (NDDOT) is interested in estimating the percentage of commercial vehicles using the state's infrastructure, especially in the western region.

The estimation process is complicated by the large number of companies and workers in the Bakken oil-producing region of North Dakota that come from other states. Therefore, even if the commercial versus non-commercial breakdown of percentages of vehicle types such as passenger cars, pickup trucks etc. within North Dakota were known, they may not represent the true usage of the state's infrastructure by category of vehicles. Additionally, NDDOT is interested in estimating the vehicle occupancy of the non-commercial vehicles.

METHODOLOGY

For this white paper, six locations in western North Dakota were selected for data collection. The locations are listed in Table 1. Data was collected during the week of September 19, 2022.

Table 1. Study locations

#	Location	Milepost	Camera type
1	US 85 north of I-94	108.25	Video
2	US 85 north of ND 200	78.68	Video
3	US 85 west of ND 23	76.65	Video
4	ND 22 north of Dickinson	146.59	Video
5	ND 23 east of Watford City	6.01	Still-image
6	ND 200 near Killdeer	95.02	Still-image

Cameras were set up at the six locations to record approximately 24 hours of video or static images (depending on camera type). An example of camera placement is shown in figure 1 below.

Snapshots at a once-per-second frequency were extracted from the video and then processed to eliminate those where no vehicle was found in the camera view. The residual images were then manually processed to categorize them as commercial or non-commercial. Only vehicles with two axles, including those with dual rear wheels, were considered for this paper.



Figure 1. Example of a camera setup

A vehicle was categorized as commercial if it met at least one of the following conditions:

1. A logo/decal/sticker other than those deemed factory installed was visible on the side of the vehicle including:
 - a. Company logo/name
 - b. Federal Motor Carrier Safety Administration issued USDOT#
 - c. Vehicle ID numbers
 - d. Reflective markers
2. A non-factory or customized equipment was observed (especially in case of pickup trucks) such as:
 - a. Work truck beds
 - b. Utility body
 - c. Flat bed
 - d. Other specialized equipment
 - e. More than one permanently mounted toolbox
 - f. Auxiliary fuel tank
 - g. Flashing beacons
3. A vehicle with none of the distinctive features listed above towing a trailer with features such as company logo etc.
4. Vehicles towing livestock trailers

The following vehicles were not categorized as commercial:

1. Publicly owned vehicles such as government vehicles
2. Ambulances
3. Fire department volunteer vehicles
4. Transit agency vehicles

5. Police department vehicles
6. Sherriff department vehicles
7. Highway patrol vehicles
8. Vehicles with only 1 light bar
9. Vehicles with only 1 permanently mounted tool box

The commercial vehicles were then scrutinized further to determine front-seat passenger occupancy. Figures 2 through 12 below show examples abovementioned categories.



Figure 2. Example of a vehicle with company decals on the side



Figure 3. Example of a vehicle categorized as non-commercial



Figure 4. Example of a commercial vehicle with auxiliary fuel tank towing specialized trailer



Figure 5. Example of a commercial vehicle with non-factory reflective marker



Figure 6. Example of a commercial vehicle with decals on the side



Figure 7. Example of a commercial vehicle with company logo towing utility trailer



Figure 8. Example of a commercial vehicle with decals



Figure 9. Example of a commercial vehicle with utility body

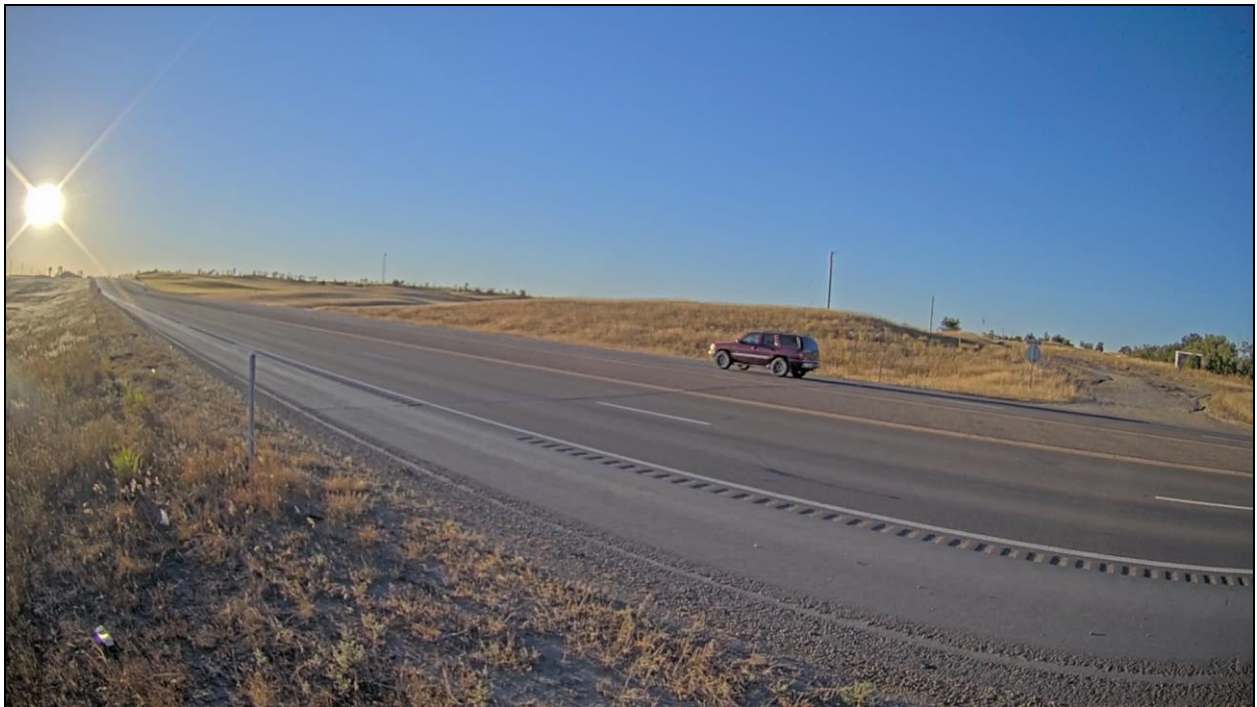


Figure 10. Example of a non-commercial vehicle

OBSERVATIONS

The table below shows the number of commercial and non-commercial vehicles observed at the six locations. Note that identifiable publicly owned vehicles were not included in either of the categories.

Table 2. Number of commercial and non-commercial vehicles observed by location

#	Location	Non-Commercial	Commercial	Total	Commercial (%)
1	US 85 north of I-94	230	84	314	27%
2	US 85 north of ND 200	160	85	245	35%
3	US 85 west of ND 23	169	69	238	29%
4	ND 22 north of Dickinson	1,788	609	2,397	25%
5	ND 200 near Killdeer	373	436	809	54%
6	ND 23 east of Watford City	69	37	106	35%
All Locations		2,789	1,320	4,109	32%

The average percentage of commercial vehicles was observed to be 32%. Outside of the outlier of 54% at location #5, ND 200 near Killdeer, the commercial vehicle percentages ranged from 25% to 35%. Note that not every vehicle being used for commercial purposes may fall under the criteria used in this study and therefore these percentages are likely to be conservative estimates. The reasons for vehicles to not fall under the criteria are discussed below.

- The Internal Revenue Service allows for deductions when a personal vehicle is even partially used for business (commercial) purposes. Such business owners may not install company logos or decals on their otherwise non-commercial vehicle thereby rendering it as an ‘unmarked’ commercial vehicle.
- Other business owners may not feel the need to “advertise” their company by marking their vehicle even when the vehicle is being used for commercial purposes 100% of the time.
- The speed and motion of vehicles introduced blur at some of the locations, especially during inclement weather and non-ideal lighting conditions. As a result, some commercial vehicles may have not been included in the observations.

The overnight/low-light images, even those from cameras equipped with infrared capabilities, were not found to be useful for commercial vehicle observation. In addition, the battery pack of the camera used at locations 5 & 6 depleted sooner than expected due to low overnight temperatures. Consequently, there were far fewer images collected and subsequently processed from these locations as compared to the other five locations.

The occupancy could only be observed at locations 5 & 6. Passengers observed in the back seat of commercial vehicles (such as crew-cab pickup trucks) were considered to be double occupancy. The number of single- and double-occupancy vehicles is presented in table 3 below.

Table 3. Number of single- and double-occupancy vehicles at locations 5 & 6

#	Location	Single-Occupancy	Double-Occupancy	Total	Double-Occupancy (%)
5	ND 200 near Killdeer	274	29	303	10
6	ND 23 east of Watford City	3	2	5	60
Both Locations		277	31	308	10

The average percentage of double-occupancy vehicles was observed to be 10%. It is worth mentioning that a motion-triggered still-image camera was used at both locations. In addition, location #5, ND 200 near Killdeer, had the lowest posted speed limit thereby making most of the images blur-free due to slower vehicles. The signpost on which the camera was mounted also appeared to be closest to the edge of the travelled lanes thereby effectively “zooming in” on the vehicles for better images. The background at this location was also consistent in color thereby providing a nice contrast for observations through driver-side and passenger-side windows.

Similar to commercial vehicle determinations, overnight/low-light images were not found to be useful for occupancy observation. Because of the single-angle images (as opposed to the potential multiple observable angles provided by a video), and varying lighting conditions it is possible that some double-occupancies were not observed thereby making the percentages a conservative estimate. The battery depletion at location #6 most adversely affected the occupancy observations as indicated by the very low number of total observations.

RECOMMENDATIONS/NEXT STEPS

ATAC has the following recommendations with respect to the determination of 2-axle commercial vehicle composition of traffic:

1. Such studies should be expanded to other parts of the state to understand how varied the vehicle mixes are within different regions of the state. As mentioned earlier, differences may arise related to unique land-use as well as other factors that may become apparent once more observations and data points are collected.
2. More studies should be conducted during different seasons of the year to account for any seasonal bias. For instance, there may be a likelihood of higher commercial activity during a particular season of the year as compared to the others, which may be based on business type and commercial vehicle category (e.g., pickup-truck based snowplows).
3. In-person observations are recommended as some commercial vehicles may not have signage indicating commercial use on the side of the vehicle but may have signage on the front or back. This placement was not clearly observable in video or image captures. Alternatively, different camera angles may also be tested to determine optimal camera angles and placement.
4. Other data sources, such as recorded or streamed images from pan-tilt-zoom surveillance camera video, could also be used.

With respect to determining the occupancy of 2-axle commercial vehicles, ATAC has the following recommendations:

1. Similar to commercial vehicle studies, occupancy studies also should be conducted in other parts of the state to understand how occupancy rates may vary within different regions.
2. In addition, data collection/observations should be conducted during different seasons of the year to better understand seasonal effects on occupancy.
3. In-person observations for occupancy are highly recommended as:
 - a. Many more observations would be able to be made, making the sample size larger and the resulting statistics more reliable, and,
 - b. Similar to seat belt use observations, different angles of the same vehicle may be observed as they travel past the observer, resulting in more observations and a higher degree of accuracy.