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Accuracy of Traffic Detection Devices on Two- and Four-Lane Arterials

April 2002

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ABSTRACT

Accurate traffic data are critical to support various transportation analyses, including monitoring the performance of the transportation system, planning future services and facilities, developing operational strategies, and designing new facilities. Several types of traffic counting technologies are available; however, there is limited information available that compares the accuracy of the devices in terms of volume and vehicle classification.

This study was performed to provide information that can be helpful to agencies that perform traffic data collection. The main purpose of this study is to evaluate the performance of commonly used traffic data collection systems within the Fargo-Moorhead metropolitan area. Two case study locations were used for the evaluation, which consisted of a two-lane arterial and a four-lane arterial. This study has two main objectives: 1) determine the accuracy of selected traffic counting devices in capturing actual vehicular flows, and 2) determine the accuracy the detection devices are at classifying observed vehicular traffic. The classification comparisons were performed by grouping the 13 FHWA vehicle classes into four categories: 1) passenger vehicles, 2) single unit trucks, 3) single combination trucks, and 4) multi-trailer tucks.

This study initially planned on evaluating five traffic collection devices, including the Traffic Tally 6 (TT-6), MetroCount 5600, Jamar's TRAX RD, HI-STAR, and AutoScope 2004-ID. However, due to erroneous data due to device defects and environmental factors, the HI-STAR and Autoscope devices were eliminated from the study.

The first test, which was performed on a two-lane arterial, determined that the Jamar and MetroCount devices were slightly more accurate in terms of traffic volume when only one lane of the two-lane arterial was monitored. The Jamar device experienced inaccuracies of 1.5% (2 lanes) and 0.0% (1 lane), while the MetroCount devices had inaccuracies of 0.0% and 0.3% (2 lanes) and 0.0% and 0.0% (1 lane). The TT-6 device was not as accurate as the other two devices, producing inaccuracies of 31.6% and 14.5%. The classification accuracy of the Jamar and MetroCount devices was also influenced by the number of lanes monitored. In terms of the total vehicles, the Jamar device incorrectly classified 12.6% (2 lanes) and 3.2% (1 lane). The MetroCount devices incorrectly classified 8.0% (2 lanes) and 1.9% (1 lane).

Both devices were very accurate in classifying passenger vehicles, while the three truck classes incurred higher inaccuracies. When comparing passenger vehicles, the Jamar device incorrectly classified 5.3% (2 lanes) and 0.7% (1 lane), while the Metrocount device incorrectly classified 1.1% (2 lanes) and 0.7% (1 lane). In terms of the truck accuracy, the Jamar device incorrectly classified 33.3% (2 lanes) and 26.6% (1 lane), while MetroCount device incorrectly classified 51.1% (two lane) and 17.8% (1 lane).

The second test site evaluated the accuracy of the devices along a four-lane arterial. According to the results, the Jamar and MetroCount devices did not perform as well compared to the first test. The volume differences for the Jamar and MetroCount devices were 9.5% and 3.0%, respectively. On the other hand, the TT-6 performed better at the second test site, recording a 7.3% volume difference.

The classification accuracy of the Jamar and MetroCount devices was also hindered due to two travel lanes. The total number of vehicles incorrectly classified with the Jamar device was 35.0%, while the MetroCount Device incorrectly classified 6.3%. Based on the net total among passenger vehicles, the Jamar and MetroCount devices incorrectly classified 25.6% and 2.4%, respectively. In terms of the three truck classes, Jamar incorrectly classified 167.3% of the vehicles, while MetroCount incorrectly classified 61.8% of the vehicles.

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1.0 INTRODUCTION

Accurate traffic data are critical to support various transportation analyses. Traffic data are used in monitoring the performance of the transportation system, planning future services and facilities, developing operational strategies, and designing new facilities. However, traffic data collection is an expensive and time intensive task. Further, several types of traffic counting technologies are available but there is little research that compares the accuracy of the devices and guide their use for specific applications. This study was developed to address these shortcomings and produce information that can be helpful to agencies that perform traffic data collection.

2.0 OBJECTIVES

The main purpose of this study is to evaluate the performance of commonly used traffic data collection systems using selected case study locations. The study has two main objectives: 1) determine the accuracy of selected traffic counting devices in capturing actual vehicular flows, and 2) determine how accurate the detection devices are at classifying observed vehicular traffic. To accomplish the objectives, this study will collect traffic data on a two-lane arterial and a four-lane arterial.

3.0 TRAFFIC DATA COLLECTION DEVICES

Devices and systems used for collecting traffic data are typically classified as intrusive or non-intrusive. Intrusive traffic collection devices can be portable or permanently installed. Among the most common types of permanent intrusive devices are continuous traffic counters (commonly referred to as ATRs) which collect traffic volume and vehicle classification data at 24-hour count locations. The main advantage of portable-intrusive devices is the ability to move the devices to various locations. However, portable-intrusive devices exhibit some disadvantages, such as disrupting traffic flow during installation and possible malfunctions due to incorrect installation procedures which will adversely affect the accuracy of the results.

Non-intrusive traffic collection devices are those devices that cause minimal disruption to normal traffic operations and can be deployed more safely than conventional methods. Non-intrusive devices do not need to be installed in or on the pavement but can be mounted overhead, to the side, or beneath the pavement by positioning the device from the shoulder (1).

3.1 Intrusive Traffic Data Collection Devices

Conventional intrusive traffic collection devices primarily consist of axle sensor counters (commonly called road tubes) and induction devices (primarily consisting of loop detectors). Road tube devices gather traffic volume based on the change in air pressure inside the tube as vehicle axles travel over it. The device counts the number of axles and uses an algorithm that converts the number of axle actuations to vehicles. Initial axle sensors used a basic conversion of two axles per vehicle, however, more recent products have advanced algorithms to determine the vehicle class prior to counting the vehicle.

Inductance loops measure changes in the magnetic flux lines as a vehicle travels over the device. The detection length is related to several factors, including loop sensitivity and vehicle characteristics. Single loops are used to gather raw traffic volume, while dual loops are used to gather traffic volume as well as determine vehicle speed and length.

Both axle sensors and loop detectors will not perform accurately during severely congestion conditions. A vehicle changing speed over the loops will cause the vehicle length to change, thus incorrectly classifying the vehicle. In addition, stop-and-go conditions will make it difficult to determine the vehicle gap, length, and speed resulting in erroneous data.

3.2 Non-Intrusive Traffic Data Detection Devices

Several non-intrusive technologies are available, including infrared (passive and active), radar, Doppler microwave, pulse ultrasonic, passive acoustic, and video detection sensors. While these technologies have been used for many years, most of them have not been used on a large scale to collect traffic data. Video detection sensors are becoming more popular due to advances in computer technology and decreases in price. In addition to collecting various types of traffic data, such as volumes, vehicle classification, and speed, video detection sensors can also provide traffic surveillance functions, such as incident detection and verification.

4.0 FEDERAL HIGHWAY ADMINISTRATION'S TRAFFIC MONITORING GUIDE

The *Traffic Monitoring Guide* (TMG) provides insight on current traffic monitoring programs and traffic detection devices (2). In addition, the TMG provides recommendations for volume and classification counts and was used an guidance for this study.

The TMG recommends using the FHWA 13-vehicle classification scheme when classifying vehicles as described in Appendix A. It should be noted that the truck axle spacing varies from state to state and could affect some of the classification results. The FHWA classification scheme for a Vehicle Class 2 (passenger car) and Vehicle Class 3 (other two-axle, four tire single unit vehicles) don't have an exact set of axle spacings. For example, passenger cars with a longer wheel base (Class 2) have an equal or longer wheel base than small trucks or sport utility vehicles (Class 3). Therefore, it is not possible to create an algorithm that distinguishes these vehicles (2).

Most of the intrusive and non-intrusive traffic data collection devices cannot use the FHWA 13-vehicle classification scheme because of device limitations. However, a classification scheme of some variation is used for classifying vehicles. Most devices are capable of classifying vehicles into three or four vehicle classes.

5.0 METHODOLOGY

This study will compare commonly used traffic counting devices within the Fargo-Moorhead metropolitan area and other devices provided from vendors. The devices were compared in terms of traffic volume and vehicle classification on a two-lane and four-lane arterial (as shown in Figure 1). Manual counts and classification were conducted using video and served as a base line for the comparisons.

Five traffic detection devices were initially chosen for this study, four intrusive and one non-intrusive. The traffic detection devices are listed below (note Appendix B contact information):

- Traffic Tally 6 (axle sensor counter)
- MetroCount 5600 Vehicle Classifier System (axle sensor counter)
- TRAX RD - Jamar Technologies (axle sensor counter)
- HI-STAR Vehicle Magnetic Imaging (magnetic counter)
- AutoScope Wide Area Video Vehicle Detection System (machine vision)

The Traffic Tally 6 and HI-STAR Vehicle Magnetic Imaging devices were chosen for this study because they are used extensively in the Fargo-Moorhead area. The vendors from MetroCount and Jamar Technologies provided comparable products that gathered several types of traffic data. Since the ATAC operates a portable AutoScope video detection system, it was also included in the study.

After reviewing the results from the first test, it was apparent that the HI-STAR VMI and AutoScope vehicle detection system did not provide accurate results. The HI-STAR VMI data showed approximately the same volume data for every recorded interval, which did not resemble the observed traffic volume. The erroneous data was probably related to a defective device.

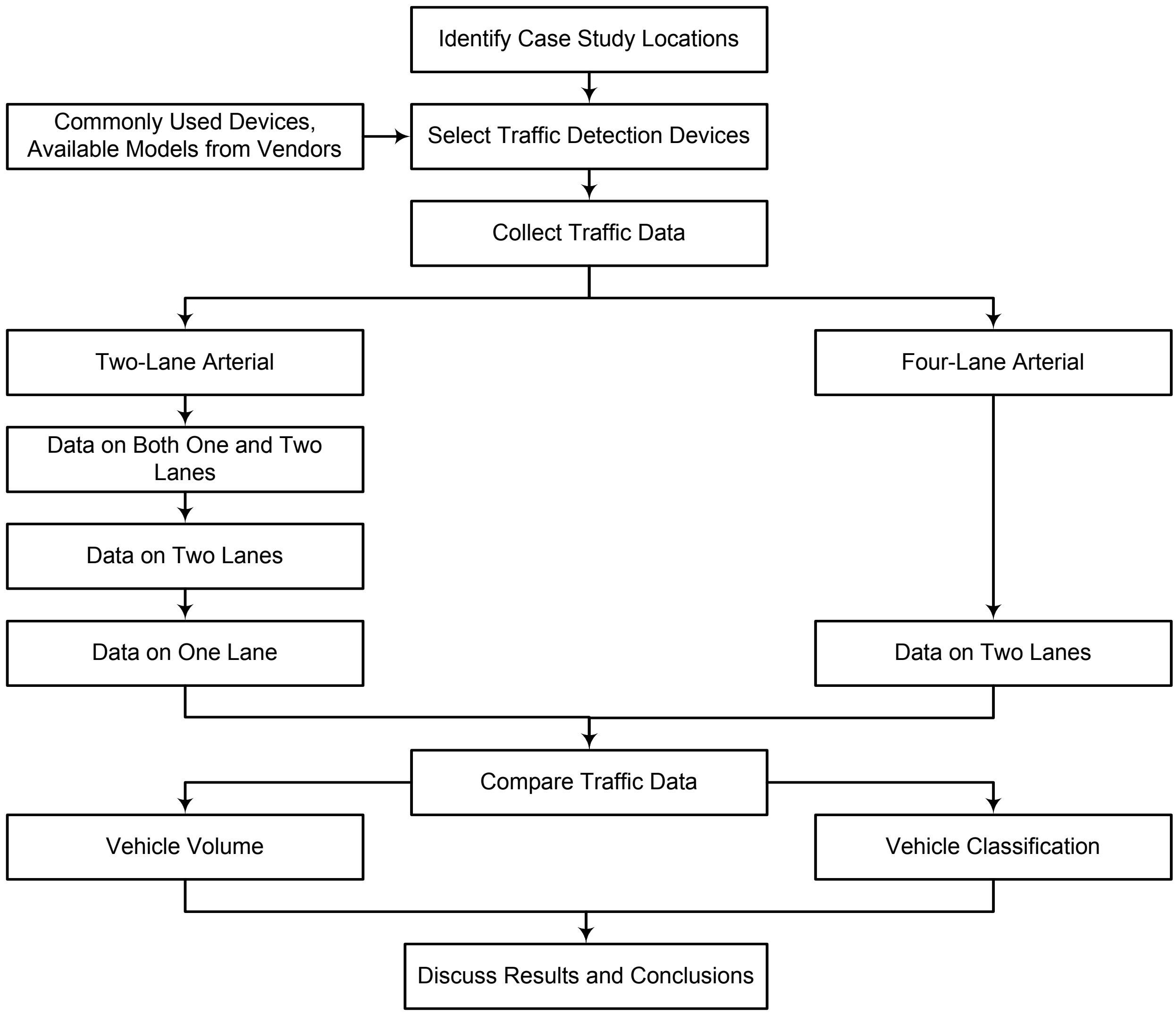

Figure 1. Methodology Flow Chart

The data from the AutoScope vehicle detection system did not provide accurate results due to environmental factors. The portable video detection system consists of two video cameras mounted on a 40-foot mast that extends from a cargo trailer. During the first test, high winds where experienced causing excessive camera movement, which significantly hindered the system's performance. Because of the errors from the first test, both the HI-STAR and AutoScope were excluded from the study.

5.1 Traffic Tally 6

Traffic Tally 6 (TT-6) from Diamond Traffic Products is a single tube traffic counter that stores up to 32 time interval counts and a grand total and is powered by a 5 year lithium battery. The vehicle count is obtained using a ratio of one count for every two sensor actuations. The main advantages of the TT-6 are related to it's relatively low cost, which allows an agency to buy a larger quantity, and it's ease of use. The data is obtained by manually recording the interval counts using a magnetic switch to scroll through the intervals.

Some disadvantages of the TT-6 device and other single tube counters are related to limitations of gathering other forms of traffic data. Single tube counters are unable to classify vehicles, measure speed, and vehicle length. In addition, single tube counters require appropriate correlation factors for adjusting actuations to vehicles.

5.2 MetroCount 5600 Vehicle Classifier System

MetroCount 5600 Vehicle Classifier System is an axle sensor counter using two road tubes that combines traffic logging hardware with traffic software. The roadside unit has two megabits of memory that can store one million individual axles and operates on replaceable alkaline battery pack with power-saving features. The roadside unit collects various types of traffic data, including volume, class, speed, gap, headway, and acceleration. The MetroCount 5600 converts the sensor actuations to vehicle counts using a proprietary algorithm.

While the software features and functions are user friendly, the main downfall of the MetroCount device is the lack of a visual display on the roadside unit. The user must setup the system (e.g., program the start time) with a computer.

5.3 Jamar's TRAX Raw Data

The TRAX Raw Data Automated Traffic Recorder from Jamar Technologies is an axle sensor counter that uses two road tubes. The device has eight megabytes of internal memory which can store more than four million axle strikes and operates using rechargeable batteries with an optional solar panel. The roadside unit collects various types of traffic data, including volume, class, speed, gap, vehicle length, following distance (headway), and acceleration.

Similar to the MetroCount 5600, Jamar's TRAX RD uses its own computer software to process the sensor actuations using a proprietary algorithm. In terms of setup, the TRAX RD has one advantage over the MetroCount 5600. The Jamar unit incorporates an LCD display allowing users to select a sensor layout, as well as check the time, date and battery life of the unit.

6.0 CASE STUDY ANALYSIS

Two tests were performed in Fargo, ND during the late fall 2001 to evaluate the performance of the traffic data collection devices on both two- and four-lane roadways. To find the accuracy of the traffic detection devices, a surveillance video was reviewed. A spreadsheet was used to analyze data for each vehicle class (using the FHWA 13-vehicle classification scheme) by plotting each vehicle against time (as shown in Figure 2). Every vehicle was observed on the video and recorded if it was missed, classified incorrectly, or if an extra vehicle was counted. It should be noted that Vehicle Class 14 was added for unknown vehicles where the device counted the vehicle but could not determine the appropriate vehicle class.

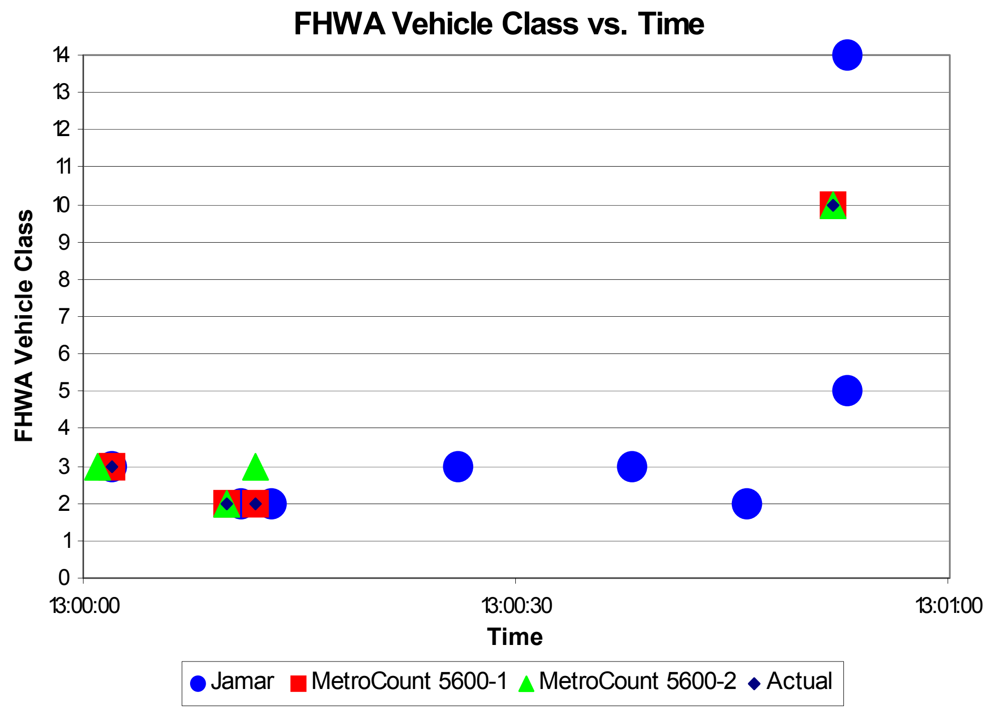

Figure 2. Example Vehicle Classification by Device

Typically, agencies develop adjustment factors for each roadway class to account for seasonal changes and heavy vehicle percentages. Currently, axle-adjustment factors are not available for either test site; therefore, this study will only compare the field data.

An agency may not always be interested in all 13 of FHWA's vehicle classes and may group the data into three or four categories. Therefore, this study will determine the differences among all of the 13 vehicle classes and summarize the data into four categories, which include the following:

- Passenger vehicles (Class 1, 2, and 3)
- Single unit trucks (Class 4, 5, 6, and 7)
- Single combination trucks (Class 8, 9, and 10)
- Multi-trailer trucks (Class 11, 12, and 13)

6.1 12th Avenue North Test Site (two-lane arterial)

This test was performed on October 18, 2001, to evaluate the performance of traffic data collection devices on a two-lane roadway (shown in Figure 3). The average temperature for the day was 46° F with no precipitation and wind gusts over 25 mph. The 12th Avenue North test was performed about a mile west of 45th Street. Given the number of detection devices that were obtained from the vendors (two from MetroCount and one from Jamar), only the westbound traffic data was compared having the following objectives:

1. Compare traffic data among MetroCount, Jamar's TRAX RD and the Traffic Tally 6.
2. Compare MetroCount-1 and MetroCount-2 (the 1 and 2 stand for the number of lanes the device is collecting data). MetroCount-1 is collecting data for only westbound traffic while MetroCount-2 is collecting traffic data for vehicles traveling both east and westbound.
3. Compare MetroCount-2 and Jamar's TRAX RD when both devices are collecting data for eastbound and westbound lanes.
4. Compare MetroCount-1 and Jamar's TRAX RD when both devices are collecting data for the westbound lane.

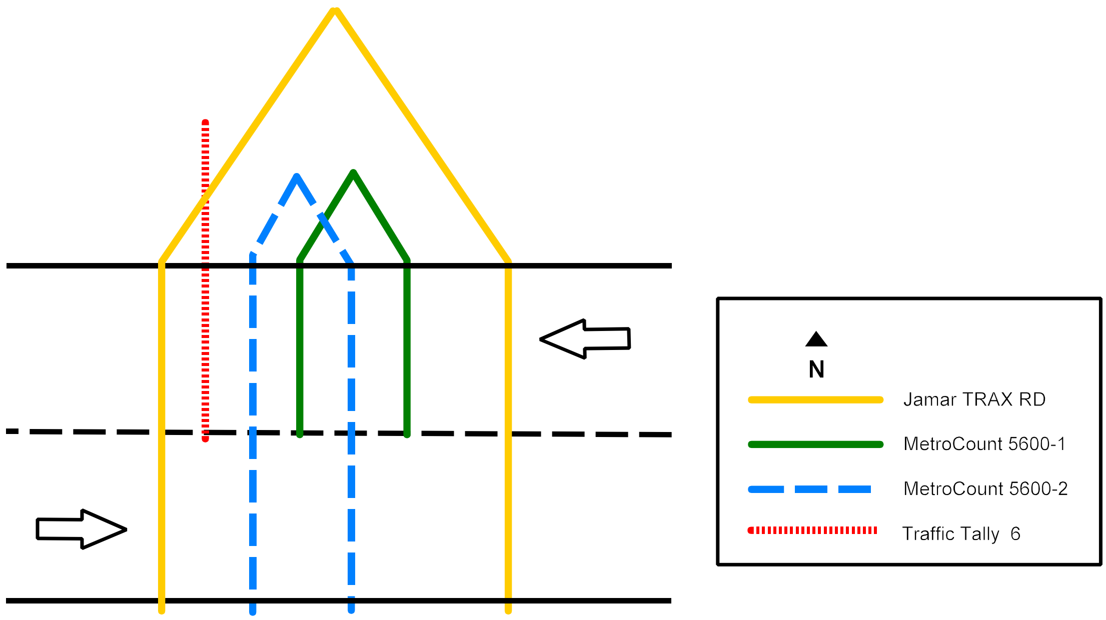

Figure 3. Traffic Detection Device Layout of 12th Avenue North

To accomplish the four objectives of this test, two periods, each two hours long, were analyzed. The first time period was used for objectives 1-3, while the second time period was used for objectives 1, 2, and 4.

6.1.1 Volume Results - Time Period 1

The surveillance video was reviewed from 11:00 a.m. to 1:00 p.m. to analyze vehicles traveling westbound on 12th Avenue. The results from the analysis are shown in Table 1.

Table 1. Two-Lane Arterial Traffic Volume Results (11:00 a.m. - 1:00 p.m.)

Traffic Detection Device	Vehicle Volume	Percent Difference
Surveillance Video	326	-
Jamar TRAX RD	331	1.5
MetroCount 5600-1	326	0.0
MetroCount 5600-2	326	0.0
Traffic Tally 6	429	31.6

Based on aggregate vehicle volume, both the Jamar and MetroCount devices produce very accurate results. The percent difference of the TRAX RD, MetroCount-1, and MetroCount-2 were 1.5%, 0.0%, and 0.0%, respectively. The TT-6 device counted 31.6% more vehicles compared to the observed volume. The large difference in traffic volume may be attributed to heavy vehicles that have several axles per vehicle.

A comparison between the two MetroCount devices was performed to determine how multiple lanes affected the volume accuracy. Compared to the surveillance video, the MetroCount-1 (one lane) and MetroCount-2 (two lanes) counted 100% of the observed volume. Therefore, placing road tubes across both lanes of travel on a two-lane road did not affect the volume accuracy.

The comparison between the Jamar TRAX RD and MetroCount-2 determined the volume accuracy of the devices when placing tubes across both lanes of travel. Both devices provided accurate results having differences of 1.5% for the Jamar device and 0.0% for the MetroCount device.

6.1.2 Classification Results - Time Period 1

Since the TT-6 device only consists of one tube, it cannot be used for the classification comparison. Therefore, the comparison consisted of the Jamar device and the two MetroCount devices. Since classification devices have difficulty distinguishing between Vehicle Class 2 and 3, the net difference between the two classes was used for the comparisons. Table 2 illustrates the differences among the four categories of vehicles. Appendix C illustrates the differences for each of the 13-vehicle classes among the three devices.

Table 2. Two-Lane Arterial Vehicle Classification Results (11:00 a.m - 1:00 p.m.)

		Jamar TRAX RD		**MetroCount 5600-1**		**MetroCount 5600-2**	
FHWA Vehicle Class	Correct Number of Vehicles	Vehicles Incorrectly classified	Percent Incorrectly Classified	Vehicles Incorrectly classified	Percent Incorrectly Classified	Vehicles Incorrectly classified	Percent Incorrectly Classified
Passenger Vehicles: Class 1, 2, and 3	281	15	5.3%	7	2.5%	3	1.1%
Single-Unit Trucks: Class 4, 5, 6, and 7	26	9	34.6%	13	50.0%	17	65.4%
Single-Combination Trucks: Class 8, 9, and 10	19	6	31.6%	4	21.1%	4	21.1%
Multi-Trailer Trucks: Class 11, 12, and 13	0	0	--	2	--	2	--
Total Vehicles	326	41*	12.6%	26	8.0%	26	8.0%

* Total includes 11 vehicles that were counted but were not classified (Class 14 in Appendix C).

Based on 326 vehicles, the Jamar, MetroCount-1, and MetroCount-2 device incorrectly classified 12.6%, 8.0%, and 8.0% of the vehicles, respectively. Most of the classification errors were related to classifying single-unit trucks.

The MetroCount devices had slightly different classification inaccuracies. MetroCount-1 had 4 more errors related to passenger vehicles, while MetroCount-2 had 4 more errors related to single-unit trucks. Based on the inaccuracies of the single-unit trucks, both devices had problems related to Class 5 vehicles (two-axle, six-tire, single-unit trucks) as shown in Appendix C.

When comparing the devices that spanned both travel lanes, the MetroCount-2 device was more accurate than the Jamar device. MetroCount-2 incorrectly classified 8.0% of the vehicles while Jamar incorrectly classified 12.6% of the vehicles (note Appendix C). The Jamar device had more passenger vehicle error (12 vehicles) but less error for trucks (6 vehicles). In addition, the Jamar unit counted 11 vehicles that were unable to be classified. When comparing the three truck categories having a total of 45 trucks, the Jamar and MetroCount-2 incorrectly classified 33.3% and 51.1%, respectively.

6.1.3 Volume Results - Time Period 2

After performing the first two-hour evaluation, a knot was tied into the Jamar road tubes and a new count was set up for the device. The knot allowed the device to collect data only for the westbound lane. The second time period gathered data from 4:00 p.m to 6:00 p.m. Time period 2 was performed to compare the traffic data among the four devices (objective 1), the differences among the MetroCount devices (objective 3), and Jamar and MetroCount devices observing only one lane of traffic (objective 4).

Table 3. Two-Lane Arterial Traffic Volume Results (4:00 p.m. - 6:00 p.m.)

Traffic Detection Device	Vehicle Volume	Percent Difference
Surveillance Video	621	-
Jamar TRAX RD	621	0.0
MetroCount 5600-1	621	0.0
MetroCount 5600-2	623	0.3
Traffic Tally 6	711	14.5

Similar to time period 1, both the Jamar and MetroCount devices produced very accurate results. Based on 621 vehicles, the volume difference of the Jamar, MetroCount-1, MetroCount-2, were 0.0%, 0.0%, and 0.3%, respectively. The TT-6 device counted 14.5% more vehicles than the actual volume. This percent difference is less than ½ of the recorded difference of time period 1, which was 31.6%. Although the volume of time period 2 (621) was approximately twice the volume of time period 1 (326), a higher percentage of trucks were observed in time period 1 resulting in more axle counts.

Similar to time period 1, the MetroCount-1 (one lane) and MetroCount-2 (two lane) devices were very accurate. MetroCount-1 had no difference (0.0%), while MetroCount-2 experienced a difference of 0.3%.

Based on the one-lane evaluation, both the Jamar and MetroCount devices performed exceptionally well. Both the Jamar and MetroCount devices did not experience any difference (0.0%) compared to the actual volumes.

6.1.4 Classification Results - Time Period 2

This section discusses the comparison between the Jamar and MetroCount devices having tubes across only one of the two lanes on the bi-directional roadway. When comparing all of the vehicle classes, the Jamar device incorrectly classified 3.2% while the MetroCount device incorrectly classified 1.9% of the vehicles (shown in Table 4). Therefore, this comparison shows that the devices are more accurate at classifying vehicles over one lane compared to two lanes on a bi-directional roadway.

Table 4. Vehicle Classification Results (4:00 p.m - 6:00 p.m.)

		Jamar TRAX RD		MetroCount 5600-1	
FHWA Vehicle Class	Correct Number of Vehicles	Vehicles Incorrectly classified	Percent Incorrectly Classified	Vehicles Incorrectly classified	Percent Incorrectly Classified
Passenger Vehicles: Class 1, 2 and 3	574	4	0.7%	4	0.7%
Single-Unit Trucks: Class 4, 5, 6, and 7	20	3	15.0%	4	20.0%
Single-Combination Trucks: Class 8, 9, and 10	23	8	34.8%	3	13.0%
Multi-Trailer Trucks: Class 11, 12, and 13	2	1	50.0%	1	50.0%
Total Vehicles	621	20*	3.2%	12	1.9%

* Total includes 4 vehicles that were counted but were not classified (Class 14 in Appendix C).

Although the Jamar and MetroCount devices incorrectly classified four of the passenger vehicles, the devices displayed slight differences in the remaining vehicle classes (Appendix C). The Jamar device had the most difficulty classifying Vehicle Class 10 (six or more axle single-trailer trucks) with 5 errors. In addition, the device counted four vehicles that it was not able to classify. The vehicle class that provided the highest amount of error for MetroCount was Class 5 (two-axle, six-tire, single-unit trucks) with 3 vehicle count errors. Overall, the inaccuracies of the three truck categories for the Jamar and MetroCount devices were 26.6% and 17.8%.

6.2 45th Street Test Site (four-lane arterial)

The second test site was located on 45th Street about one mile south of 12th Avenue North on November 2, 2001. The average temperature for the day was 46° F and the wind was out of the west at about 20 mph. 45th Street is a four-lane principal arterial with a two-way left-turn lane (TWLTL). This site was chosen to determine the accuracy of the detection devices for two lanes of traffic in the same direction during a two-hour time segment. The layout of the traffic detection devices is shown in Figure 3.

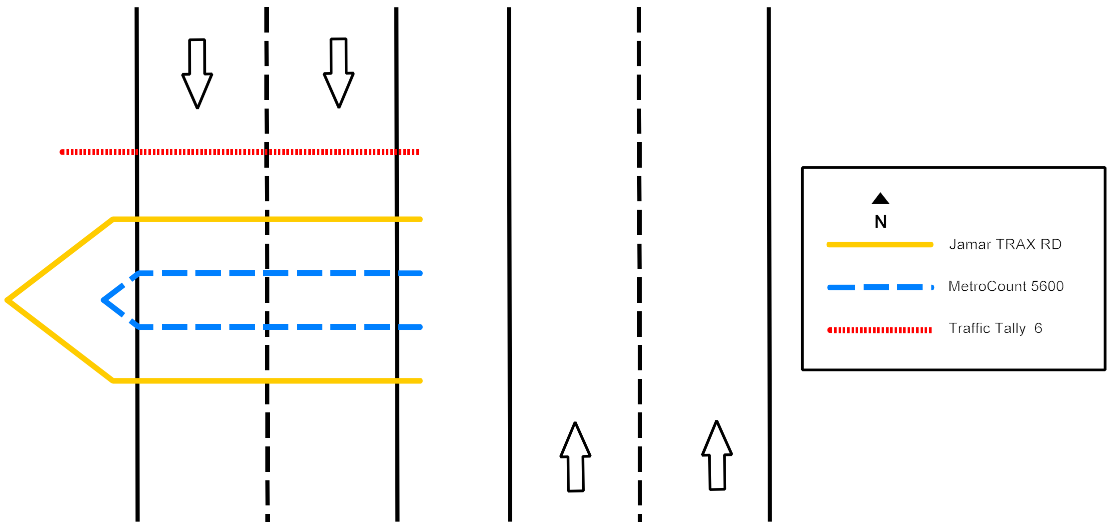

Figure 4. Traffic Detection Device Layout of 45th Street

6.2.1 Volume Results

All three detection devices counted less vehicles than the actual volume observed from the surveillance video (Table 5). Volume differences for the Jamar TRAX RD, MetroCount 5600, and the TT-6 were 9.5%, 3.0%, and 7.3%, respectively.

Table 5. Traffic Volume Results for a Four-Lane Arterial (12:00 p.m. - 2:00 p.m.)

Traffic Detection Device	Vehicle Volume	Percent Difference
Surveillance Video	835	-
Jamar TRAX RD	756	9.5
MetroCount 5600	810	3.0
Traffic Tally 6	774	7.3

The lower traffic volumes can be attributed to vehicles simultaneously traveling over the road tubes in the two lanes, causing some vehicles to get skipped. Another reason for the discrepancies between the Jamar and MetroCount devices can be attributed to vehicle platoons arriving from the intersection of 12th Ave. North and 45th St., which is approximately one mile away from the test site. During numerous instances, vehicles would exhibit small gaps, which resulted in classifying two passenger vehicles as one heavy vehicle.

An additional factor that may have affected the performance of the Jamar TRAX RD relates to a "D-Bounce" feature of the detection device. The D-Bounce setting, which is the time the device will wait to recognize another vehicle, may have not been set low enough. The D-Bounce setting for the tests were 25 milliseconds (the default value) and could have been set between 1 and 100 milliseconds.

6.2.2 Classification Results

This section compares the vehicle classification results between the Jamar TRAX RD and MetroCount 5600 devices on a roadway with two lanes of travel per direction. When comparing all of the vehicle classes, the Jamar and MetroCount units incorrectly classified 35.0% and 6.3%, respectively (as shown in Table 6).

Table 6. Four-Lane Arterial Vehicle Classification Results (12:00 p.m. - 2:00 p.m.)

		Jamar TRAX RD		MetroCount 5600	
FHWA Vehicle Class	Correct Number of Vehicles	Vehicles Incorrectly classified	Percent Incorrectly Classified	Vehicles Incorrectly classified	Percent Incorrectly Classified
Passenger Vehicles: Class 1, 2, and 3	780	200	25.6%	19	2.4%
Single-Unit Trucks: Class 4, 5, 6, and 7	43	62	144.2%	26	60.5%
Single-Combination Trucks: Class 8, 9, and 10	12	30	250.0%	5	41.7%
Multi-Trailer Trucks: Class 11, 12, and 13	0	0	--	3	--
Total Vehicles	835	292	35.0%	53	6.3%

When comparing passenger vehicles, the Jamar device incorrectly classified 200 vehicles, while MetroCount incorrectly classified 19 vehicles. The Jamar unit incorrectly classified 92 trucks (167.3%). Of the 92 trucks, Class 5 (two-axle, six-tire, single-unit trucks), Class 8 (four or fewer axle single-trailer trucks), and Class 1 (motorcycles) had vehicle differences of 53, 26, and 19 vehicles, respectively (as shown in Appendix C). The MetroCount device incorrectly classified 34 trucks (61.8%) and Class 5 provided almost half of the error with a difference of 16 vehicles.

As discussed in the previous section, potential discrepancies could be from a combination of vehicles simultaneously crossing over the road tubes and small gaps between vehicles. In addition, the classification analysis observed that both devices had difficulty distinguishing Class 5 (two-axle, six-tire single unit truck) vehicles.

7.0 SUMMARY AND CONCLUSION

Using two test locations, this study compared the vehicle volume and vehicle classification accuracy of three traffic data collection devices, including the Jamar TRAX RD, MetroCount 5600, and the TT-6. The first test, which was performed on a two-lane arterial, determined that the Jamar and MetroCount devices were slightly more accurate in terms of traffic volume when only one lane was monitored. The Jamar device experienced inaccuracies of 1.5% (2 lanes) and 0.0% (1 lane), while the MetroCount devices had inaccuracies of 0.0% and 0.3% (2 lanes) and 0.0% and 0.0% (1 lane). The TT-6 device was not as accurate as the other two devices, producing inaccuracies of 31.6% and 14.5%. Axle adjustment factors would increase the accuracy of the TT-6, however, the factors vary temporally and spatially, e.g, time of day, day, week, month, class of roadway, location of roadway, etc. Furthermore, adjustment factors may not be easily available or frequently updated.

The classification accuracy of the Jamar and MetroCount devices was also influenced by the number of lanes monitored. In terms of the total vehicles, the Jamar device incorrectly classified 12.6% (2 lanes) and 3.2% (1 lane). The MetroCount devices incorrectly classified 8.0% (2 lanes) and 1.9% (1 lane).

Both devices were very accurate in classifying passenger vehicles, while the three truck classes incurred higher inaccuracies. When comparing passenger vehicles, the Jamar device incorrectly classified 5.3% (2 lanes) and 0.7% (1 lane), while the Metrocount device incorrectly classified 1.1% (2 lanes) and 0.7% (1 lane). In terms of the truck accuracy, the Jamar device incorrectly classified 33.3% (2 lanes) and 26.6% (1 lane), while MetroCount device incorrectly classified 51.1% (two lane) and 17.8% (1 lane).

The second test site evaluated the accuracy of the devices along a four-lane arterial. According to the results, the Jamar and MetroCount devices did not perform as well compared to the first test. The volume differences for the Jamar and MetroCount devices were 9.5% and 3.0%, respectively. On the other hand, the TT-6 performed better at the second test site, recording a 7.3% volume difference. This occurrence could be explained by the fact that the device counted extra vehicles on a single lane, which is related to the percentage of trucks (Class 6-13), but missed vehicles on multiple lanes, which is related to the number of simultaneous axle actuations.

The classification accuracy of the Jamar and MetroCount devices was also hindered due to two travel lanes. The total number of vehicles incorrectly classified with the Jamar device was 35.0%, while the MetroCount Device incorrectly classified 6.3%. Based on the net total among passenger vehicles, the Jamar and MetroCount devices incorrectly classified 25.6% and 2.4%, respectively. In terms of the three truck classes, Jamar incorrectly classified 167.3% of the vehicles, while MetroCount incorrectly classified 61.8% of the vehicles.

Based on the two tests, the Jamar TRAX RD and MetroCount 5600 devices were very accurate at determining vehicle volume on two-lane and four-lane arterials. However, the classification accuracy, especially when classifying trucks, decreased as the number of lanes evaluated increased. Overall, the MetroCount 5600 was more accurate than the Jamar TRAX RD, however, an adjustment in the D-bounce feature of the TRAX RD might have created more accurate results. The Traffic Tally 6 device was not as accurate for collecting the vehicle volumes for most of the comparisons.

With any traffic data collection activity, it is important to follow the proper installation procedures to ensure the most accurate results for the particular device. For axle-based devices, it is especially important to ensure proper placement (i.e., not too close to corners and perpendicular to the road), proper spacing of road tubes, and proper tube tension.

REFERENCES

1. Federal Highway Administration, *Field Test of Monitoring of Urban Vehicle Operations Using Non-Intrusive Technologies*, prepared by Minnesota Guidestar and SRF Consulting Group, Inc., May 1997

2. United States Department of Transportation, *Traffic Monitoring Guide*, www.fhwa.dot.gov/////ohim/tmguide/index.htm, Washington, DC, May 2001.

APPENDIX A: FHWA 13-Vehicle Class Scheme
(Traffic Monitoring Guide)

FHWA Vehicle Types

The classification scheme is separated into categories depending on whether the vehicle carries passengers or commodities. Non-passenger vehicles are further subdivided by number of axles and number of units, including both power and trailer units. Note that the addition of a light trailer to a vehicle does not change the classification of the vehicle.

Automatic vehicle classifiers need an algorithm to interpret axle spacing information to correctly classify vehicles into these categories. The algorithm most commonly used is based on the “Scheme F” developed by Maine DOT in the mid-1980s. **The FHWA does not endorse “Scheme F” or any other classification algorithm.** Axle spacing characteristics for specific vehicle types are known to change from state to state. As a result, no single algorithm is best for all cases. It is up to each agency to develop, test, and refine an algorithm that meets its own needs.

FHWA Vehicle Classes with Definitions

1. **Motorcycles** (Optional) -- All two or three-wheeled motorized vehicles. Typical vehicles in this category have saddle type seats and are steered by handlebars rather than steering wheels. This category includes motorcycles, motor scooters, mopeds, motor-powered bicycles, and three-wheel motorcycles. This vehicle type may be reported at the option of the State.

2. **Passenger Cars** -- All sedans, coupes, and station wagons manufactured primarily for the purpose of carrying passengers and including those passenger cars pulling recreational or other light trailers.

3. **Other Two-Axle, Four-Tire Single Unit Vehicles** -- All two-axle, four-tire, vehicles, other than passenger cars. Included in this classification are pickups, panels, vans, and other vehicles such as campers, motor homes, ambulances, hearses, carryalls, and minibuses. Other two-axle, four-tire single-unit vehicles pulling recreational or other light trailers are included in this classification. *Because automatic vehicle classifiers have difficulty distinguishing class 3 from class 2, these two classes may be combined into class 2.*

4. **Buses** -- All vehicles manufactured as traditional passenger-carrying buses with two axles and six tires or three or more axles. This category includes only traditional buses (including school buses) functioning as passenger-carrying vehicles. Modified buses should be considered to be a truck and should be appropriately classified.

   NOTE: In reporting information on trucks the following criteria should be used:
   a. Truck tractor units traveling without a trailer will be considered single-unit trucks.
   b. A truck tractor unit pulling other such units in a "saddle mount" configuration will be considered one single-unit truck and will be defined only by the axles on the pulling unit.
   c. Vehicles are defined by the number of axles in contact with the road. Therefore, "floating" axles are counted only when in the down position.
   d. The term "trailer" includes both semi- and full trailers.

5. **Two-Axle, Six-Tire, Single-Unit Trucks** -- All vehicles on a single frame including trucks, camping and recreational vehicles, motor homes, etc., with two axles and dual rear wheels.

6. **Three-Axle Single-Unit Trucks** -- All vehicles on a single frame including trucks, camping and recreational vehicles, motor homes, etc., with three axles.

7. **Four or More Axle Single-Unit Trucks** -- All trucks on a single frame with four or more axles.

8. **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.

9. **Five-Axle Single-Trailer Trucks** -- All five-axle vehicles consisting of two units, one of which is a tractor or straight truck power unit.

10. **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.

11. **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.

12. **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.

13. **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.

APPENDIX B: Vendor Information

AutoScope Wide Area Video Vehicle Detection System (2004 ID)

Distributor: Image Sensing System
Address: 500 Spruce Tree Centre, 1600 University Avenue West, St. Paul, MN 55104
Phone: 651.603.7700
Fax: 651.603.7795
www.imagesensing.com

Traffic Tally 6

Distributor: Diamond Traffic Products
Address: P.O Box 1455, Oakridge, OR 97463
Phone: 541.782.3903
Fax: 542.782.2053
http://www.diamondtraffic.com

HI-STAR Vehicle Magnetic Imaging

Distributor: Nu-Metrics Inc.
Address: 518 University Drive, Unionown, PA 15401
Phone: 724.438.8750
Fax: 724.438.8750
http://www.nu-metrics.com

TRAX RD

Distributor: Jamar Technologies Inc.
Address: 151 Keith Valley Road, Horsham, PA 19044
Phone: 800.776.0940
Fax: 154.914.889
http://www.jamartech.com/

MetroCount 5600

Distributor: MetroCount Inc.
Full Address: 17130 Moss Side Lane, Olney, MD 20832
Phone: 800.576.5692
Fax: 301.570.1095
http://www.metrocount.com/

APPENDIX C: Device Comparisons for Every Vehicle Class

Traffic Volume and Vehicle Classification Results for a Two-Lane Arterial (11:00 a.m. - 1:00 p.m.)

Vehicle Class	1	2	3	4	5	6	7	8	9	10	11	12	13	14	Total
Actuall Vehicles/Class	0	162	119	0	14	11	1	4	14	1	0	0	0	0	326
MetroCount-1 Vehicles/Class	0	178	110	2	5	10	0	2	15	2	2	0	0	0	326
Volume Difference	0	16	-9	2	-9	-1	-1	-2	1	1	2	0	0	0	0
MetroCount-2 Vehicles/Class	0	147	137	6	7	8	0	4	12	3	2	0	0	0	326
Volume Difference	0	-15	18	6	-7	-3	-1	0	-2	2	2	0	0	0	0
Jamar Vehicles/Class	3	176	93	3	19	10	1	5	10	0	0	0	0	11	331
Volume Difference	3	14	-26	3	5	-1	0	1	-4	-1	0	0	0	11	5

Traffic Volume and Vehicle Classification Results for a Two-Lane Arterial (4:00 p.m. - 6:00 p.m.)

Vehicle Class	1	2	3	4	5	6	7	8	9	10	11	12	13	14*	Total
Actuall Vehicles/Class	4	386	186	2	8	10	0	3	14	6	0	0	2	0	621
MetroCount-1 Vehicles/Class	4	418	158	1	5	10	0	2	15	5	0	0	3	0	621
Volume Difference	0	32	-28	-1	-3	0	0	-1	1	-1	0	0	1	0	0
MetroCount-2 Vehicles/Class	3	357	221	4	6	9	0	3	13	2	0	0	5	0	623
Volume Difference	-1	-29	35	2	-2	-1	0	0	-1	-4	0	0	3	0	2
Jamar Vehicles/Class	4	425	143	1	10	10	0	6	14	1	0	0	3	4	621
Volume Difference	0	39	-43	-1	2	0	0	3	0	-5	0	0	1	4	0

* The four vehicles in Class 14 should have been in Class 10.

Traffic Volume and Vehicle Classification Results for a Four-Lane Arterial (12:00 p.m. - 2:00 p.m.)

Vehicle Class	1	2	3	4	5	6	7	8	9	10	11	12	13	Total
Actuall Vehicles/Class	0	534	246	0	21	15	7	2	8	2	0	0	0	835
MetroCount Vehicles/Class	1	547	215	6	5	17	5	4	6	1	1	0	2	810
Volume Difference	1	13	-31	6	-16	2	-2	2	-2	-1	1	0	2	-25
Jamar Vehicles/Class	19	378	221	8	74	15	8	28	4	2	0	0	0	757
Volume Difference	19	-156	-25	8	53	0	1	26	-4	0	0	0	0	-78