TRAFFIC MONITORING GUIDE

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TRAFFIC MONITORING GUIDE
EXECUTIVE SUMMARY

This document summarizes the recommendations in the Traffic Monitoring Guide (TMG). The complete guide should be referenced as needed to understand the technical analysis behind these recommendations.

Actual implementation will vary from agency to agency. Each State or local highway agency has its own traffic counting needs, priorities, budgets, geographic, and organizational constraints. These differences cause agencies to select different equipment for data collection, use different collection plans for obtaining traffic data, and emphasize different data reporting outputs. However, all highway agencies collect the same basic types of data, and each can benefit from using a similar basic data collection framework.

Traffic monitoring has a long tradition and each agency has an established legacy program. The TMG offers suggestions to help improve and advance current programs with a view towards the future of traffic monitoring. A basic program structure for traffic monitoring is presented. The guide provides specific examples of how statewide data collection programs should be structured, describes the analytical logic behind that structure, and provides the information highway agencies need to optimize the framework for their particular organizational, financial, and political structures.

DATA COLLECTION FRAMEWORK

The basic recommended program design consists of:

- portable short duration counts, and
- permanent continuous counts.

The short duration counts ensure geographic diversity and coverage. The continuous counts help the agency understand the time-of-day, day-of-week, and seasonal travel patterns and allow development of the mechanism needed to convert short duration counts into accurate estimates of annual conditions. Adjustments to short duration count data are normally required to remove temporal bias from data used for annual average daily traffic (AADT) computation.

The TMG recommends that the short count data collection consist of a periodic comprehensive coverage program over the entire system on a 6-year cycle. The coverage plan includes counting the Highway Performance Monitoring System (HPMS) sample and universe sections on a shorter 3-year cycle to meet the national HPMS requirement.

The coverage program is supplemented with a “special needs” element where additional counts are performed as needed to meet other more specific data needs. The

"special needs" program represents many different operations and may include the following:

- pavement design counts performed to provide data for pavement design, maintenance, repair, rehabilitation, and reconstruction
- traffic operations counts performed to provide inputs to traffic control studies (e.g., the creation of new signal timing plans)
- traffic counts for other special purpose studies.

The specific requirements (what is collected, when and where it must be collected) for these and other "special needs" studies change from agency to agency. The ways in which agencies balance these all-encompassing needs against their limited traffic counting budgets lead to the very different data collection programs that exist around the country.

The TMG recommends a coverage program structure for both volume and vehicle classification programs. Substantial amounts of classification data are needed to better understand truck travel on highways. Highway agencies should collect classification data (which also supply total volume information) in place of simple volume counts whenever possible. The TMG recommends that State highway agencies initially aim to take 25 to 30 percent of their short duration coverage counts with classification counting equipment. Agencies that can exceed this figure are encouraged to do so. The ability to meet or exceed this goal depends on agency perspective and is a function of the equipment available and the nature of the road system. Classification data are difficult to collect in many urban settings because of safety or equipment limitations. Therefore, a city may decide to collect considerably less than 30 percent of its counts as classification counts.

Access to data collected from continuous counters is necessary for all highway agencies. Considerable benefit can be obtained by sharing these data collection resources. Agencies should work together to reduce duplication in the number and location of permanent, continuous data collection devices. Agencies should share the data they collect (e.g., a State DOT should use seasonal and day-of-week information collected at permanent sites operated by a county or city as part of developing adjustment factors for a specific urban area). A single count location can supply information for many purposes (e.g., permanent, continuous weigh-in-motion scales supply weight, classification, and volume data). Opportunities to share data exist not only among agencies but within agencies. Ensuring that planning, operations, maintenance, and construction groups share the data they collect can substantially increase the availability of traffic monitoring data while reducing the overall cost of data collection.

A key source for urban traffic data will be the traffic surveillance systems used for traffic management and control. These systems, currently being installed, expanded, and improved as part of the Intelligent Transportation System (ITS) program offer highway agencies the ability to collect continuous traffic monitoring data at high volume locations. Access to these data requires proactive efforts by the traffic monitoring groups, as archiving and analysis of surveillance data are traditionally less important to the operations groups that build, operate, and maintain these ITS systems. Without proactive

efforts by the traffic monitoring groups, the benefits of ITS data can be lost because operations groups spend their scarce resources on operational improvements rather than on the archiving and analysis software needed to convert surveillance data into useful traffic statistics.

The TMG recommends that each agency improve the quality of reported traffic data by establishing quality control processes for traffic data collection and processing. Subjective editing procedures for identifying and imputing missing or invalid data are discouraged, since the effects of such data adjustments are unknown and frequently bias the results. Each highway agency should have formal rules and procedures for their quality control efforts.

VOLUME COUNTS

The measurement of traffic volumes is one of the most basic functions of highway planning and management. Traffic volume counts are the most common measure of roadway use, and they are needed as input to most traffic engineering analyses. While several traffic volume statistics are used in traffic analyses, two are of primary interest for the design of statewide traffic monitoring programs: annual average daily traffic (AADT) and average daily vehicle distance traveled (DVDT). Because DVDT is computed by multiplying the roadway segment AADT by the length of that segment, the primary goal of most traffic monitoring programs is to develop accurate AADT estimates, which can then be expanded to estimates of travel. To achieve this goal, the recommended traffic monitoring program consists of two basic components, a continuous count program and a short duration count program.

Continuous Count Program

All highway agencies should have access to data collected from continuous counters. These data are needed to understand temporal (day-of-week, month) changes in traffic volume. However, not all agencies need to operate these devices. Agencies should work together to ensure that enough data are collected and shared to allow calculation of accurate seasonal adjustment factors needed to convert short duration traffic counts into estimates of AADT. The TMG provides considerable guidance on how to structure continuous count programs, how to determine the appropriate number of counters for adjustment factor development, and how to apply those factors.

Short Duration Counts

The short count program is designed to provide roadway segment-specific traffic count information on a cyclical basis. The TMG recommends the collection of 48-hour periods with counters that record hourly data. To compute AADT, the volume data from the short counts must be adjusted to annual conditions. The adjustments include:

- axle correction (for counts taken with single axle sensors)
- day-of-week (for counts taken for less than one week)
- month (to account for volume changes from month to month).

Since AADT is desired for the current year, growth factors need to be computed and applied to counts not taken during the current year. Also, counts of less that 24-hour duration, usually taken as a last resort and not recommended in the TMG, must be adjusted to represent a full 24-hour period.

Short Count Program Design

Highway agencies perform short duration counts for a variety of purposes, including meeting federal reporting needs (HPMS), supplying information for individual projects (pavement design, planning studies, etc.), and providing broad knowledge of roadway use. The short duration counting program can be most efficient if these various data collection efforts are coordinated so that one count session meets multiple needs. To produce that efficiency, the TMG recommends the following steps to program design:

- Divide the road system into homogeneous traffic volume segments, determine the count locations needed to cover the system over a maximum cycle of six years.
- Determine the count locations required to meet the HPMS needs.
- Determine the count locations and data collection needs of specific projects that will require data in the next year or two. This entails working with the offices that will request these data to determine their data needs.
- Overlay the counts[1] on maps of the highway system including the location of functioning continuous counters.
- Determine how counts can be combined to make best use of available counting resources.
- Schedule the counts to efficiently use the available data collection crews and equipment.

This program design is intended to reduce count duplication and increase the efficiency of the data collection staff.

HPMS Counts

Of particular importance to all highway agencies is the collection of the HPMS sample and universe section traffic data. Volume data from the HPMS are used to apportion Federal-Aid funds. Significant portions of these funds are allocated by each State highway agency to lower jurisdictions, highway districts, or local agencies.

[1] Included in this effort should be all vehicle classification and WIM counts, since these counts should also provide total volume data.

Consequently, each highway agency has a direct financial interest in the validity of data submitted to the FHWA under the HPMS.

In addition, the outcome of many studies based on the HPMS data affect highway agencies. The HPMS data are used in a number of key analytical tools, including the HPMS Analytical Package, the Surface Transportation Efficiency Analysis System (STEAM), the Highway Economic Requirements System (HERS), and the ITS Deployment Analysis System (IDAS), as well as a host of State-specific planning and performance modeling systems.

The HPMS traffic data collection requirement was initially designed as a statistical sample of highway sections to meet federal data needs. The HPMS data collection system evolved into a combination of a universal count program for the National Highway System and other principal arterials (that is, every HPMS roadway section must be counted) and a statistical sample for the remaining highway systems.

Each State highway agency is responsible for reporting traffic data to the HPMS as specified in the HPMS Manual. To support the HPMS reporting requirement, each NHS, principal arterial, and sample section must be counted at least once every three years. Note that the HPMS covers roads on and off the State highway systems.

In addition, each State should maintain cyclic count coverage data on all arterial and collector roadways covered by the HPMS sample so that those sections can be accurately assigned to HPMS volume strata. This is necessary to expand the HPMS sample counts into accurate estimates of statewide VDT.

State highway agencies may not need to physically count all HPMS sample or universe locations. In some cases, States rely on local governments to collect and report these data. In other cases, procedures such as "ramp balancing" can be used to estimate traffic volumes on roads where portable counts cannot be safely performed. Regardless of how these data are collected, the State highway agency is responsible for the quality, completeness, and accuracy of all submitted HPMS traffic data.

VEHICLE CLASSIFICATION COUNTS

This edition of the TMG significantly departs from the vehicle classification recommendations in previous editions. The new recommendation follows the same basic design as the volume count program previously described. It consists of a coverage count element supported by a continuous count program.

One reason for this change is that the statistical sample previously collected met only a single objective efficiently, the estimation of the average percentage of travel by truck type by functional class of roadway. It did not meet the data collection needs of many other users and did not supply sufficiently accurate data on the percentage of trucks operating on HPMS sample sections.

This change in data collection methodology has other implications. The new approach acknowledges that many uses other than statewide travel estimates must be met. To meet these needs it is necessary to be able to estimate annual average truck travel. Therefore, the TMG recommends a strong continuous classification count program. The continuous classification count program is specifically aimed at providing users with a better understanding of time-of-day, day-of-week, and seasonal variation in truck volumes.

To apply the knowledge of truck volume variation, the TMG recommends new procedures to create and apply factors from the continuous classification count program to the short duration classification counts being collected. The TMG recommends that seasonal and day-of-week adjustment factors be developed for three or four broad vehicle classifications. These factors are similar to those currently applied to traffic volume counts, but recognize that truck travel patterns are very different from those of passenger vehicles. The factors are needed to create accurate estimates of annual truck traffic.

Short Duration Classification Counts

The objective of the short duration classification count program is to ensure that highway agencies have valid truck volume information for all highways under their jurisdiction. This means that agencies need to count truck volumes on all arterial and major collector roads. A specific emphasis is placed on the collection of classification data on the HPMS sample segments, since these data are used in many nationally significant analyses. At the same time, structuring the coverage program on the HPMS sample provides a geographically diverse set of roadway locations to address most other needs. Additional needs would be covered under the "special needs" criteria.

The basic data collection recommendations follow:

- Highway agencies should collect classification counts rather than volume counts whenever equipment and staffing limitations allow. As a rule of thumb, 25 to 30 percent of the volume counts should be classified.
- Each agency should perform at least one vehicle classification count on each route each year.
- For roads that change character and/or sustain significant truck volume changes over their length, one count should be taken on each segment of that roadway each year.[2]
- Where practical, these counts should be performed at existing HPMS standard sample sections.

The classification counts should cover a 48-hour monitoring period and, if possible, should use the standard FHWA 13 vehicle categories. In some locations, equipment limitations prevent the collection of the 13 FHWA categories. This usually

[2] This and the previous bullet are intended to ensure that sufficient measurements of truck volumes are taken on each important route with a bare minimum of a single count

occurs in high volume, multi-lane situations where vehicle speeds are highly variable, such as congested urban areas, or where traffic signal systems cause vehicles to accelerate or decelerate while being counted. At these locations, highway agencies are encouraged to use any truck classification equipment that can accurately classify trucks, even if that means using a different (usually simplified) classification scheme. If unable to classify under the 13-class scheme due to equipment limitations or safety issues, the TMG recommends the use of four (or three) classes based on total vehicle length.

To meet these guidelines, many State highway agencies will need to increase the number of classification counts they conduct. As old traffic counting equipment is replaced, the new equipment should be capable of classifying as well as counting. For statewide monitoring purposes, highway agencies should attempt to collect classification data whenever possible, given equipment limitations and the need for efficient staff and equipment utilization. The goal for every highway agency should be to collect enough data to provide a valid estimate of truck volume on each route. These estimates should be based on actual traffic counts conducted on the roadways in question.

Permanent, Continuous Classification Counts

The continuous classification count program has one major goal, the creation of factors needed to estimate annual average daily truck volume from short duration classification counts. To accomplish this goal it is necessary to measure day-of-week and seasonal variation in truck traffic and to apply the knowledge to short duration counts. Truck volumes vary significantly by time of day and day of week as illustrated by Figures 1 and 2.

Sufficient continuous counters are needed to measure each of the different truck volume patterns found in a State or region. This means that continuous counters should be placed on different functional classes of roads and in different geographic locations. It is especially important to be able to measure the differences in truck volume patterns between roads that carry primarily local truck traffic and those that serve through-traffic.

A good rule of thumb is that the continuous classification count program should be roughly the same size as the traditional continuous volume count program (the ATR program). In fact, the design of the continuous count program is very similar to the design of the ATR program. While the recommended continuous count program requires a significant number of count locations, it is important to note that continuous classifiers also serve as ATRs. Thus it is possible to use the classification counters in place of ATRs at the same time they are used to supply continuous classification data. Such a step significantly reduces the number of continuous counters an agency needs and reduces unnecessary duplication.

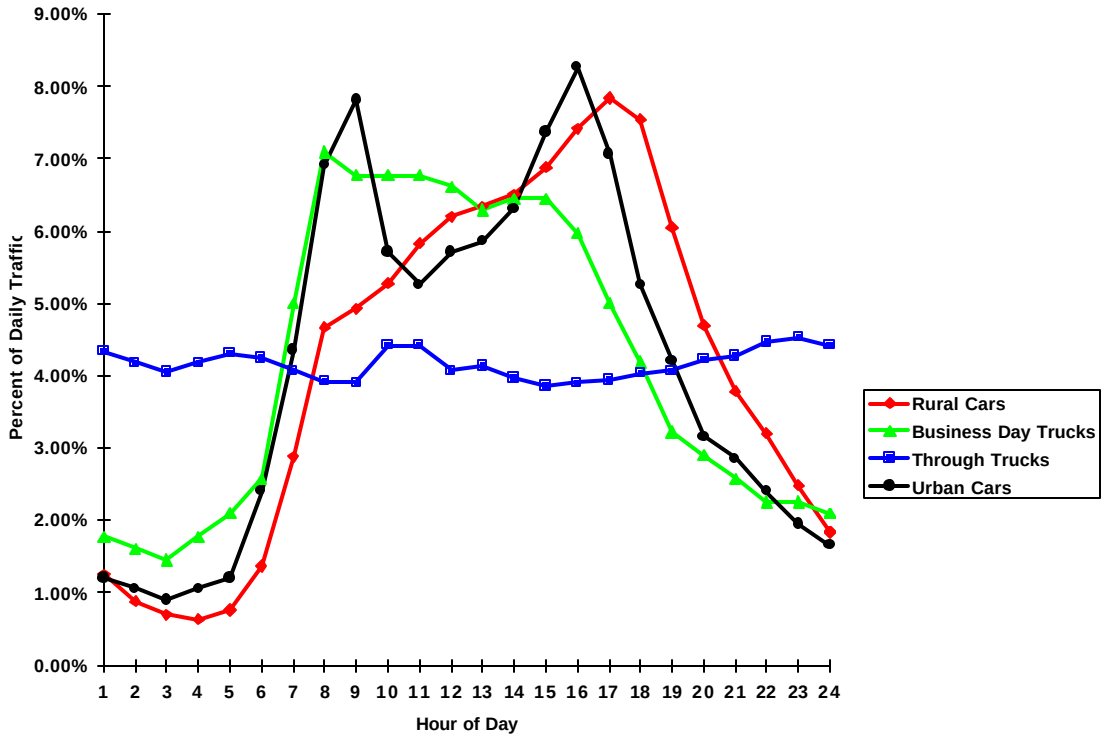

Figure 1: Basic Time of Day Patterns

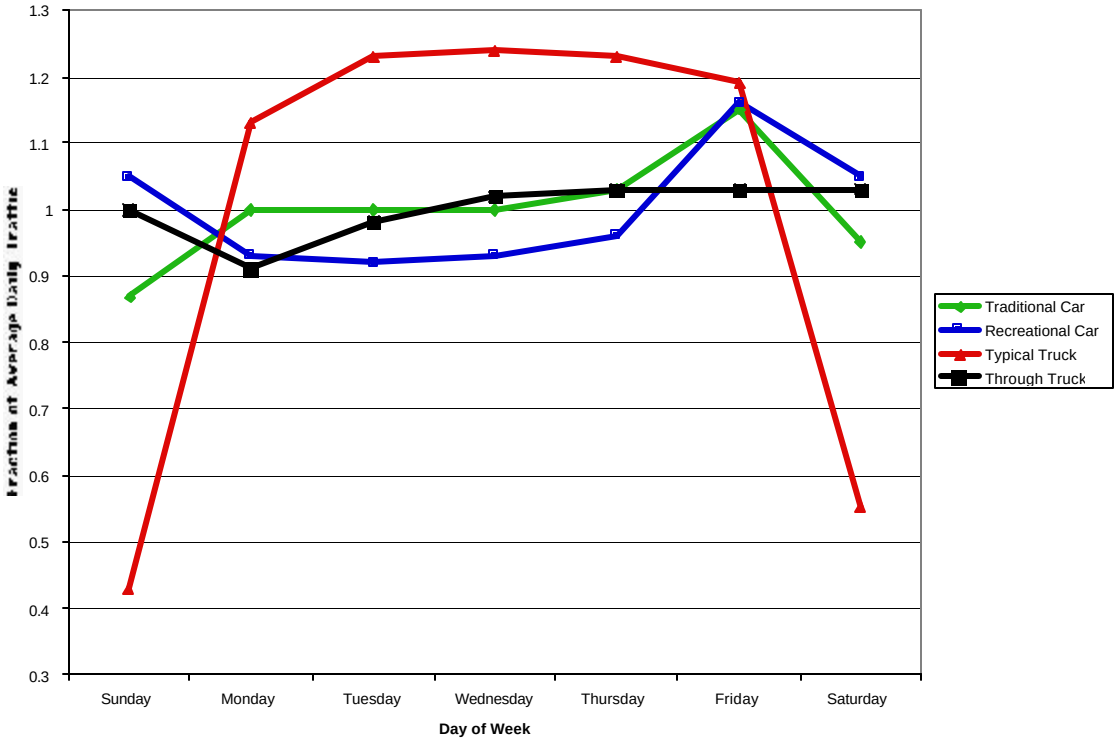

Figure 2: Typical Day of Week Travel Pattern

Factoring of Short Duration Classification Counts

For many years highway agencies have developed and applied adjustment factors to short duration volume counts in order to estimate annual average volumes. Annual average estimates of truck volumes are key inputs to pavement design analyses, trend analyses, revenue studies, accident analyses, and a variety of other studies of high importance and visibility to highway agencies. Therefore, highway agencies must develop adjustment procedures that allow accurate estimation of annual average truck volumes from short duration counts. The definition of trucks in this analysis applies to the longer wheelbase mostly cargo vehicles not to pickup trucks or vans.

Research has shown that truck volumes, like car volumes, vary by time of day, day of week, and season, but truck volumes follow patterns that are significantly different than those of passenger vehicles. Therefore, applying the adjustment factors already computed for volume induces bias in the computation of annual truck volume estimates. What each highway agency needs are adjustment factors specifically designed to convert short duration truck volume counts into estimates of annual average daily truck traffic (AADTT).

These factors and factoring procedures need to be developed by each State highway agency. The development of truck factor procedures is a new endeavor and as such it will take time to mature. The TMG suggests a factoring approach that uses the nature of the road's freight traffic and, if needed, geography to categorize roads into factor groups. The recommended roadway characterization includes identifying whether the truck traffic on that road is predominantly "locally" oriented or that road carries large "through" truck movements. Roads with mostly local truck traffic tend to have travel patterns that are heavily oriented toward business day travel (that is, few trucks at night and on weekends.) Roads that carry heavy through-movements have higher weekend and nighttime truck volumes.

Geographic stratification for the truck factor groups is suggested for States in which economic activity changes significantly from one part to another. For example, if the southern half is heavily agricultural, while the northern half is heavily oriented toward manufacturing, these two geographic areas are likely to have different seasonal trucking patterns.

Table 1 presents a suggested grouping scheme for the creation of truck factor groups. A key recommendation on the development of truck factors is to create factors for only three or four broad categories of vehicles. The suggested classes for factoring are:

- passenger vehicles
- single-unit trucks
- single combination trucks (trucks and tractors with a single trailer)
- multi-trailer trucks.

States that have few multi-trailer trucks should reduce further to three categories by consolidating the single combination and multi-trailer truck categories.

Table 1: Example Truck Factor Groups [3]

Rural	Urban
Interstates and arterial major through-truck routes	Interstate and arterial major truck routes
Other roads (e.g., regional agricultural roads) with little through-traffic	Interstates and other freeways serving primarily local truck traffic
Other non-restricted truck routes	Other non-restricted truck routes
Other rural roads (e.g., mining area)	Other roads (non-truck routes)
Special roads (e.g., recreational, ports)	

The use of urban or rural breaks may be necessary due to the differences in patterns and volumes at these locations. In many States, such a break may not be considered appropriate.

The aggregated classification scheme for factoring short duration classification counts is recommended for several reasons. In many States, the volumes in many of the FHWA 13 vehicle categories are very low and highly variable. When volumes within a vehicle class are low, the factors computed for those vehicle categories become very unstable and inaccurate. The factors and estimates can change drastically based on a few vehicles. Aggregating vehicle classes allows the factoring process to keep the majority of truck volumes (by class) high enough to provide stability to the factors produced.[4] The aggregation also reduces the computational process to create and apply the factors, since computing factors for 13 classes would become a very cumbersome process.

Other Recommendations

Calibration and Quality Control

A key component of the vehicle classification program is the establishment of quality control procedures including the calibration and testing of equipment used to

[3] These are strictly examples. Each State highway agency should select the appropriate number and definition of truck groups based on its economic and trucking characteristics.

[4] It is also possible to account for seasonal variation by counting multiple times during the year at a single location and this is appropriate for sites where a high degree of accuracy is needed or where truck adjustment factors are not considered highly reliable.

collect truck volume data. Each State must periodically calibrate, test, and validate the performance of its classification equipment to ensure that the equipment is operating as intended. This includes testing new classifiers received from the manufacturer. The quality control program should include a short field test whenever a classifier is placed in traffic to ensure that the counter is working correctly.

Use of Multiple Classification Schemes

The classification schemes that can be collected are a function of the data collection equipment used and of road conditions. Many States use different classification equipment in different operating conditions and are confronted with the task of dealing with different classification schemes at different points in their roadway network. Each State highway agency must understand the different classification schemes they use and develop conversion rules. For example, if the State uses the FHWA 13 classes but also utilizes length categories from inductance loops on urban freeways, it must develop appropriate length-based classification rules to make both schemes compatible.

To understand how different classification schemes relate to each other, the highway agency needs to periodically perform specific studies to determine the make-up of the different classification schemes. In the example above, WIM data that contain both axle spacing and overall vehicle length information can be used to determine how vehicles categorized with the FHWA 13-category scheme are placed within the vehicle length categories.

TRUCK WEIGHT DATA

The new TMG recommends changing the focus of the truck weight data collection program from collecting data at a random number of locations to adjusting the number of locations to fit the level of variability in truck weights. This is done in recognition of the major cost and difficulties involved in collecting accurate truck weight data. The objective of the new program recommendations is to ensure that each State collects accurate truck weight data to meet agency needs. This is accomplished by:

- defining truck weight roadway groups (so that each road within a group experiences truck weights per vehicle type that are similar to those of other roads within that group)
- collecting weight data from at least six sites within each group
- collecting data on the day-of-week and seasonal changes in vehicle weights that occur within each group
- paying specific attention to the calibration of the WIM equipment used for that data collection.

While structuring a truck weight program similarly to the volume and classification data programs would be preferable, (i.e., a few continuous count locations supported by a large number of geographically-dispersed short duration counts), the cost

of weight data collection and the limitations in available equipment make such a design unrealistic. Instead, the program recommends collecting data at a relatively small number of locations designed to be representative of much larger groups of roads. The truck program design is similar to the continuous count elements for volume and vehicle classification. One major difference for the truck weight data collection program is that most of the weight monitoring sites need not operate continuously. The program is designed to ensure that current operational WIM sites become the base of the program. This base can be modified as needed to form the groups.

Truck Weight Roadway Groups

The TMG recommends that each State define its roadway system into "truck weight roadway groups," so that each road within a group experiences truck loading patterns (in terms of vehicle weights per vehicle, not total tonnage using the roadway) similar to those of other roads within that group. Further, it recommends using the characteristics of the freight moved on the roads to help create the roadway groups. This can be accomplished by understanding the type of commodities carried, the vehicles used, and the freight movement function performed by each road. (For example, does the road serve primarily as a through-truck route? Does it serve as a farm to market road? Does it provide access to specific types of heavy industry or mining areas? Does it serve conventional urban/suburban development patterns?)

Small, reasonably homogenous States (e.g., Rhode Island, Vermont) may only need one or two truck weight groups. For example, they might have roads with a large percentage of through-trucks versus roads that are primarily used for local freight movements. Large, diverse States (e.g., California, Texas) may have several different truck weight groups.

States are encouraged to adopt "truck weight groups" that:

- can be easily applied within the State
- can provide a logical means for discriminating between roads that are likely to have very high load factors and roads that have lower load factors.

The truck weight groups need not be the same groups that are used to create vehicle classification factoring. However, the information developed from the vehicle classification groups will be a great help in the development of the truck weight groups. The truck weight groups should follow the vehicle classification groups as much as possible. However, since the number of WIM sites will be much lower than the number of permanent classifiers, the number of truck weight groups will be lower.

The truck route grouping process should, as much as possible, incorporate knowledge about specific types of heavy trucks, so that roads that carry those heavy trucks are grouped together, and roads that are not likely to carry those trucks are treated separately. For example, roads leading to and from major ports might be treated

separately from other roads in that same geographic area because of the high load factor that is common to port facilities. These "specialty roads" should be treated just as "recreational" routes are treated when continuous volume count information is collected (that is, as an important but "special" case).

Recommended Number, Length, and Location of Counts

Vehicle weights within each truck weight group should be measured by a number of WIM sites[5] located within the group. For most truck weight groups, a minimum of six sites should be monitored.

At least one of the WIM sites within each group should operate continuously throughout the year to measure temporal changes in the loads carried by trucks operating on those roads. Where possible, more locations within each group should be monitored continuously to provide a more reliable measure of seasonal change. The proper number of additional continuous sites is primarily a function of the State's ability to supply the resources needed to monitor those sites and the need to monitor differences in seasonal weight characteristics.[6]

The remaining WIM sites should be monitored for no less than 24 consecutive hours to account for time-of-day differences in vehicle weights. Data collection sessions of longer than 24 hours are encouraged whenever practical. In particular, when in-ground weight sensors are being used and the data collection electronics can be safely left to operate without on-site staff, a minimum of one-week counts are recommended at all measurement locations that are not being operated continuously.

Given the recommended data collection design, the size of any State's weight data collection program will be a function of the variability of the truck weights (the number of weight groups created) and the accuracy and precision desired to monitor and report on those weights (the more count locations measured within a weight group, the better the highway agency will understand the weights present on that group of roads.)

For a small State that has only two basic truck weight road groups, the basic recommendation would be for a minimum of about 12 weighing locations and two to four continuously operating weigh-in-motion sites. The number of locations can be further reduced by data-sharing agreements with neighboring States to collect "joint" vehicle weight data.

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[5] The exception would be for a specialized road. Just as "recreational" routes are often monitored with a single permanent counter location for volume factoring, a "specialty truck weight road" like that leading to a port may be monitored with a single WIM site.

[6] If the data collection shows that a group of roads has a very stable seasonal pattern, then relatively few continuous counters are needed to monitor the pattern. However, if the State has little data on seasonal weight patterns or if previous data collection has shown the pattern to be inconsistent within that group of roads, a larger number of continuous counters may be needed.

A large State with diverse trucking characteristics could have 10 or more distinct truck weight groups, and therefore 60 or more WIM sites, with a corresponding increase in the number of continuously operating WIM locations. Most States will have far fewer weight groups, at least as a starting point. The number of weighing locations in a State should fall somewhere between the extremes of 12 and 90 locations.

The truck weight monitoring locations cannot be selected in a random or even semi-random manner due to equipment and site selection considerations. Instead, the TMG recommends that each State start with its existing WIM sites and add sites as needed. A plan should be developed to establish the criteria for site selection.

When data collection at existing sites becomes inappropriate, because of pavement failure surrounding the WIM sensors or failure of the WIM equipment itself, or because weight data is no longer needed at that site, the plan should guide the decision to remove or maintain that site. At sites where data are still desired, the equipment should be reinstalled after any necessary pavement repair/rehabilitation takes place. Where a site is no longer necessary, the WIM equipment should be moved to a different site where either vehicle weights are not known or additional data are needed.

Highway agencies should collect WIM data at a variety of locations. This includes moving at least some data collection activity to new roads or new locations whenever the opportunity presents itself. In this fashion, insight can be continuously gained on the truck weight patterns found throughout the State. However, this desire for better geographic distribution of data collection sites must be balanced against equipment and resource limitations and the need to ensure that each site selected for WIM data collection has the physical attributes (flat, strong pavement in good condition with constant vehicle speeds) that allow for accurate WIM system operation.

Data Aggregation and Reporting

The collection of data without effective processing of the data and reporting of information to users reduces the value of the program. States need to improve the processing and analysis of their collected WIM data either by making use of appropriate software or developing it. The TMG contains specific recommendations for the development of load summary tables from the collected WIM data. The Vehicle Travel Information System (VTRIS) package developed by the FHWA allows easy analysis of current WIM data.

For each of the truck weight groups, State highway agencies should develop estimates of:

- average gross vehicle weights (GVW) by vehicle class
- axle load distributions by type of axle (single, tandem, tridem, etc.).

These summaries should then be made readily accessible to users so that this information gains widespread use. Widespread use will translate into more agency-wide

support for the data collection activity and better transportation decisions. Of particular interest to many highway agencies will be the need to produce these types of loading estimates for the new AASHTO Pavement Design Guide currently under development.

Need for Calibration

Heavy emphasis is placed on the calibration of WIM data collection equipment. Quality information is more important than the quantity of data collected. It is far better to collect small amounts of well-calibrated data than to collect large amounts of data from poorly calibrated scales.

All equipment at WIM sites should be carefully calibrated before the actual collection of data. In addition to periodic re-calibration of continuously operating WIM equipment, highway agencies need to perform ongoing quality control functions for the data collected and processed. When questionable data are observed, the performance of that equipment must be investigated, and, if necessary, repairs made and new calibration efforts undertaken.

ACRONYMS

Acronym	Meaning
3S2	3-axle tractor with a 2-axle semi-trailer
ADT	Average Daily Traffic
AADT	Annual Average Daily Traffic
AADTT	Annual Average Daily Truck Traffic
AASHTO	American Association of State Highway and Transportation Officials
ADUS	Archived Data User Service
ARTS	Advanced Rural Transportation Systems
ASTM	American Society for Testing and Materials
ATIS	Advanced Traveler Information System
ATMS	Advanced Traffic Management System
ATR	Automatic Continuous Traffic Recorder
AVC	Automatic Vehicle Classification
BMS	Bridge Management System
CAAA	Clean Air Act Amendments (1990)
CMS	Congestion Management System
CVC	Continuous Vehicle Classifier
CVO	Commercial Vehicle Operations
DVDT	Daily Vehicle Distance Traveled
EAL	Equivalent Axle Loading
EPA	Environmental Protection Agency
ESAL	Equivalent Single Axle Loading
FHWA	Federal Highway Administration
GIS	Geographic Information System
GPS	Global Positioning System
HPMS	Highway Performance Monitoring System
IRI	International Roughness Index
ISTEA	Intermodal Surface Transportation Efficiency Act (1991)
ITS	Intelligent Transportation Systems
LTPP	Long Term Pavement Performance
MADT	Monthly Average Daily Traffic
MPO	Metropolitan Planning Organization
NHS	National Highway System
OFE	Other Freeways and Expressways
OPA	Other Principal Arterial
PMS	Pavement Management System
PSR	Present Serviceability Rating
PTR	Permanent Traffic Recorder (another name for ATR)
SHRP	Strategic Highway Research Program
TEA21	Transportation Equity Act for the 21st Century
TMG	Traffic Monitoring Guide
TVT	Travel Volume Trends
TWS	Truck Weight Study

VDT	Vehicle Distance Traveled
VMT	Vehicle Miles Traveled
VTRIS	Vehicle Travel Information System
WIM	Weigh-in-Motion