2018

GDOT
Georgia Department of Transportation

Georgia's Traffic Monitoring Guide

Office of Transportation Data
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1.0 PURPOSE

Federal Regulation 23 CFR 500.202 (*1*) states, *"Traffic monitoring system* means a systematic process for the collection, analysis, summary, and retention of highway and transit related person and vehicular traffic data." Federal Regulation 23 CFR 500.203 (*1*) mandates, "Each state shall develop, establish, and implement, on a continuing basis, a TMS to be used for obtaining highway traffic data…" This document records the current procedures and practices of the Georgia Department of Transportation's traffic monitoring system and provides a comprehensive analysis that fulfills the Federal regulation stated above. The study of traffic data procedures and monitoring is an extensive and very detailed subject with numerous publications and publicly available documentation.

The focus of this document is current management and practices of the Office of Transportation Data in the traffic collection program including the collection of traffic data; quality control and assurance; data processing and statistics; and reporting. This document is not intended to be used for guidance on policy or traffic studies. The authoritative source on traffic monitoring is the Federal Highway Administration (FHWA)'s Traffic Monitoring Guide: https://www.fhwa.dot.gov/policyinformation/tmguide/.

2.0 BACKGROUND

The FHWA requires every state to submit an annual Highway Performance Monitoring System (HPMS) report containing traffic count data, physical characteristics and other pertinent road data. Congress uses the submittal data to determine Federal transportation funding apportionment allocated to the states and for legislative decision-making. According to the HPMS Field Manual (*2*), "State Maintenance of a comprehensive traffic monitoring data program to provide quality, timely, and complete traffic volume and vehicle classification data is important for meeting HPMS requirements."

The Office of Transportation Data (OTD) collects traffic data for many reasons for internal departments, including the Office of Planning, the Office of Roadway Design, the Office of Bridge Design, the Office of Materials and Testing, and the Traffic Operations Office. The Office of Planning uses traffic counts to determine traffic patterns and flows for modeling purposes. The Office of Roadway Design uses traffic counts to construct new routes or alternate designs to alleviate congestion. The Office of Bridge Design uses Annual Average Daily Traffic (AADT) data to determine the Bridge Sufficiency Rating. Additionally, the Office of Materials and Testing uses a combination of truck percentages and AADT data to develop factors that assess the deterioration of pavement. The Traffic Operations Office uses the traffic volume data for safety related purposes (e.g., calculating crash rates).

OTD provides data to a large variety of external customers. Customers of the data include transportation planning professionals, educational institutions, design engineers, contractors, real estate agencies, private companies, and other government agencies. Traffic data is important in determining which routes citizens are using for their daily commutes and leisure travel. The U.S. Department of Transportation and other customers, on both a state and national level, use the data for a variety of decision-making and policy processes including planning, modeling, allocation of funding, and informational purposes. During emergency evacuations in inclement weather, OTD provides near real-time, critical traffic data to the Georgia Emergency Management Agency and surrounding states.

3.0 TRAFFIC DATA COLLECTION PROGRAM OVERVIEW

The Georgia Department of Transportation's Office of Transportation Data has an extensive, quality driven traffic count program in compliance with all Federal regulations and guidelines. The Statistics Management Group within OTD is responsible for the management of the traffic monitoring program. Traffic count data is collected using continuous count station sites (CCS), short-term counts, portable weigh-in-motion sites (portable WIM sites), and continuous weigh-in-motion sites (WIM sites). OTD processes all incoming data with defined and established quality assurance and control measures.

FHWA requires that all states collect traffic data on the Federal-aid system and provide Vehicle Miles Traveled (VMT) estimates for the local functional classification (FC) systems as directed by Federal regulations. OTD designed the traffic collection program to provide statistically valid data for the HPMS report, required by FHWA on an annual basis, following the guidelines of the FHWA's *Traffic Monitoring Guide* (TMG) (*3*). The following is a list of the road systems included in the traffic collection program:

- State Routes
  - Interstates
  - U.S. Routes
- County Roads
- City Streets
- Ramps

4.0 TRAFFIC DATA SOURCES

OTD publishes traffic data for the public through an online, interactive map application. The website displays AADT counts collected by permanent traffic collection, portable traffic collection, and weigh-in-motion devices across Georgia's Public Road System. Other published information includes historical traffic counts, truck percentages, and vehicle classification data where available. The *Traffic Counts in Georgia* website is as follows: www.dot.ga.gov/TrafficCounts.

OTD also publishes traffic data for customers interested in a high amount of detail and frequency. A variety of data products, including statewide hourly traffic counts by site by lane by month, GIS shapefiles, and yearly traffic data, are available. The data is published on GDOT's public download website at the following link: http://mydocs.dot.ga.gov/info/publicdownloads/Downloads/Forms/AllItems.aspx. Customers can navigate to the data as shown in Figure 1.0. The available data is underlined in yellow.

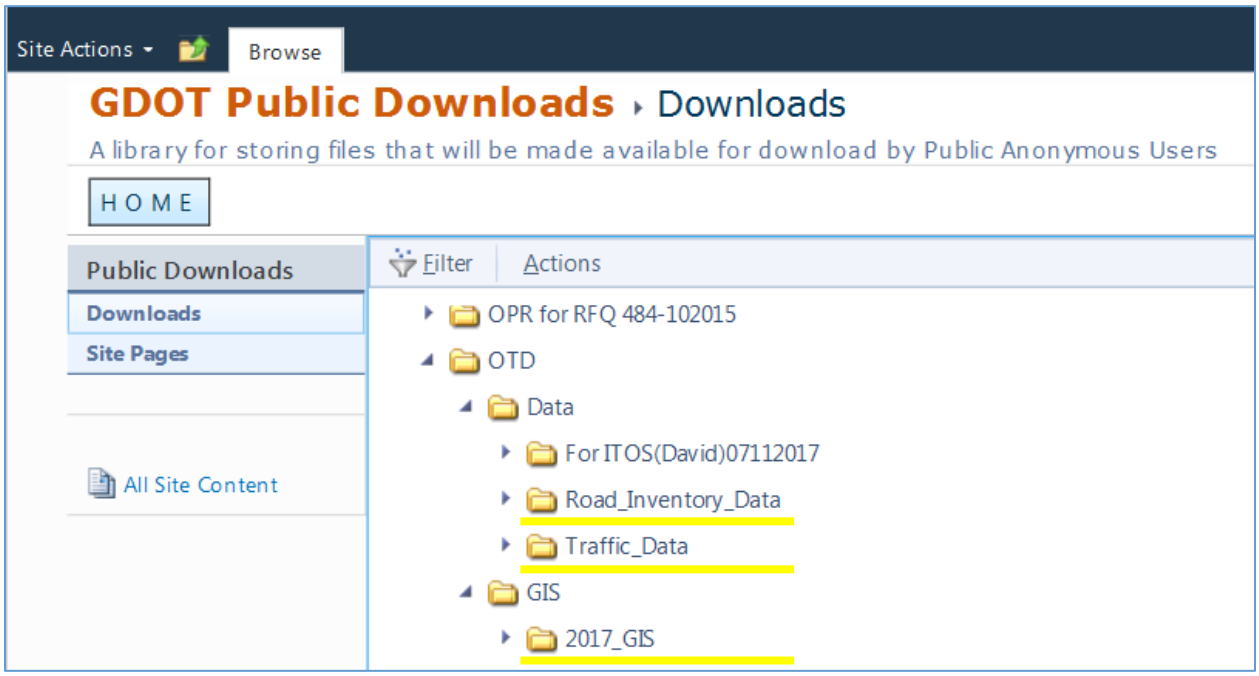

FIGURE 1: GDOT PUBLIC DOWNLOAD SITE

5.0 TRAFFIC DATA COLLECTION

The foundation of the traffic monitoring program is the collection of traffic data. Data can be collected using continuous counters, short-term counters, or portable and continuous weigh-in-motion. Internal GDOT offices only can request different types of traffic collection at specific sites through the Office of Planning. Other potential future sources of traffic data include Intelligent Transportation System (ITS) data and data sharing partnerships.

5.1 Continuous Counts

As of July 2017, OTD has 256 operational, permanent Continuous Count Stations (CCS) located on road systems throughout the state. These sites are operational 24 hours per day, seven days per week, 365 days per year excluding any necessary maintenance periods. Permanent sites are polled on a daily basis. Vehicle classification data and traffic volume data is collected. Vehicle classification can also be referred to as classification or class data.

5.2 Short-Term Counts

Short-term (also known as portable) collection devices consist of one or more pneumatic tubes stretched across a road secured on both sides by a field technician, connected to a counter on one side of the road. OTD collects traffic data for a 48-hour period. Field technicians can program the devices to collect vehicle classification counts as well as volume counts. OTD collects short-term volume counts at approximately 7,000 locations statewide annually, including approximately 2,000 vehicle classification data.

5.3 Portable and Permanent Weigh-In-Motion (WIM)

Portable and permanent Weigh-In-Motion (WIM) sensors and the related data collection equipment are utilized to collect truck weight data statewide. OTD collected data from 35 portable WIM sites located across the state in 2017 Additionally, OTD has 14 permanent CCSs configured to collect WIM data 24 hours per day, 7 days per week, 365 days per year excluding any necessary maintenance periods. The permanent WIM sites also provide volume and vehicle classification data.

5.4 Special Requests

The Office of Planning employs a traffic data collection consultant to collect specifically requested traffic data or *special requests* at site specific and project specific locations statewide. Primarily GDOT internal offices request traffic data for project specific studies, which may include short-term vehicle classification, volume counts or turning movements at an intersection.

6.0 CONTINUOUS MONITORING PROGRAM

OTD installs Continuous Count Stations (CCSs) on all types of roadways (State Routes, County Roads, and City Streets) in both asphalt and concrete. The CCSs provide volume and vehicle classification data. The stations are continuously operational (24 hours per day, 7 days per week, 365 days per year) except during any necessary maintenance periods. The data is stored onsite in a CCS Controller Cabinet, prior to being automatically polled every night using landline or cellular modems located at each CCS site.

FIGURE 2: CCS CONTROLLER CABINET

In Georgia, all CCSs have equipment configurations that are capable of collecting vehicle classification in addition to volume counts. The CCSs utilize two Inductive Loop Sensors and one Class II Piezoelectric Sensor embedded in each lane that operates according to the manufacturer's specifications. The system may require one of more of the following items as part of the system: controller cabinet, lightning suppressors, pull boxes, conduits, grounding electrodes, poles, concrete aprons, batteries and a solar panel. OTD's contractor furnishes, installs, tests, calibrates and makes ready for operation the piezoelectric sensors, equipment cabinet, inductive loops, cables, leads, and electronic hardware and software. The contractor adheres to stringent calibration and set-up routines for equipment to ensure a high level of traffic data accuracy.

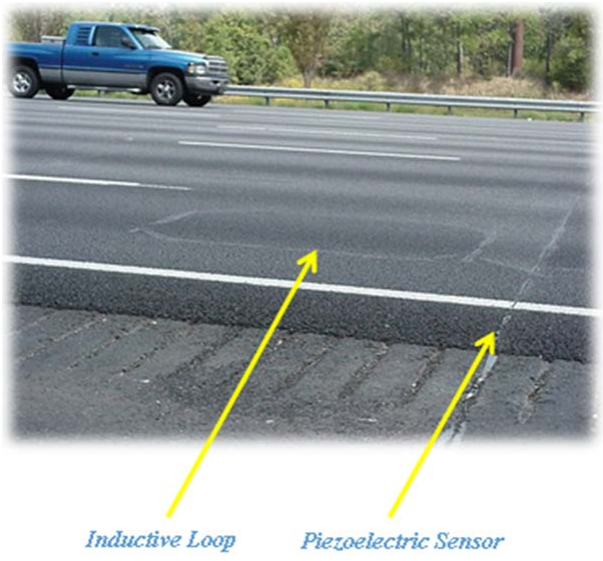

FIGURE 3: CONTINUOUS COUNT STATION

As of July 2017 OTD has 256 operational sites managed by the OTD's Statistics Management Group. This number fluctuates due to road construction and equipment failures. Traffic software transmits data electronically from permanent sites automatically on a regular basis. Office personnel process incoming data through quality control checks. Refer to *Appendix A: 13-Bin FHWA Vehicle Classification Scheme* (page 30) for detailed illustration on vehicle classification. CCSs provide valuable data statistics, such as:

- AADT, vehicle classification, and truck percentages
- Accurate traffic volume data used to calculate high volume Interstate and other freeway traffic (page 21-22)
- Daily, monthly, and axle adjustment factors by traffic pattern group (page 23)
- Design hour factors - peak hour and 30th highest hour (page 35)
- Traffic growth and patterns

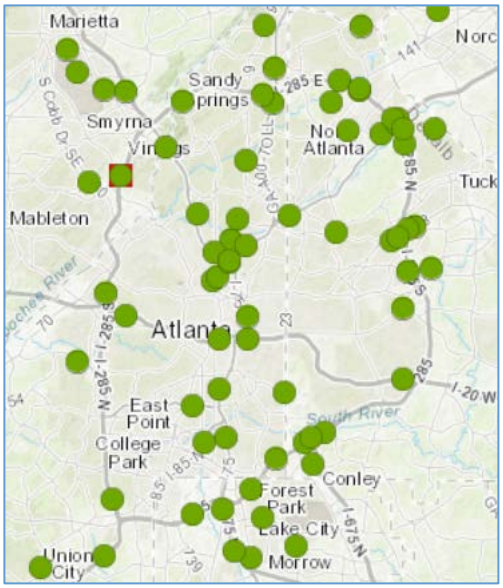

FIGURE 4: ATLANTA CCS LOCATIONS

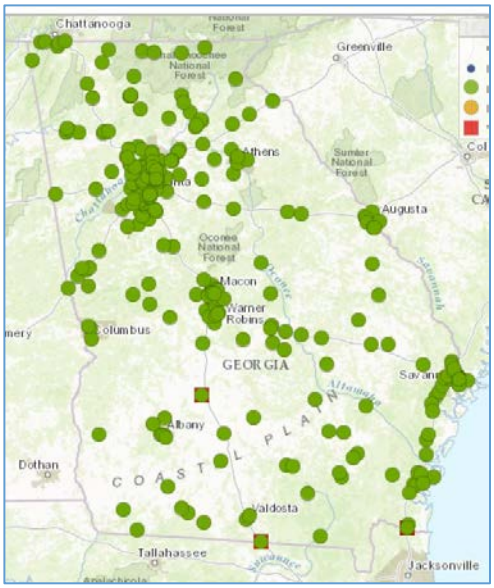

FIGURE 5: GEORGIA CCS LOCATIONS

6.1 Selection Criteria for Installation of a New CCS Site

When funding allows for the installation of a new CCS, the Statistics Management Group recommends a potential new CCS location based upon defined selection criteria (below). OTD's contractor performs a field inspection of any potential new CCS location to ensure site feasibility and optimal placement for the physical installation of the CCS equipment within the traffic count segment. The Statistics Management Group reviews the results of the field inspection, and approves or rejects the installation. The TMG (*3*) states, "The main objectives of installing and operating CCSs are to provide highly accurate vehicle classification, track changes in volume over time, determine travel patterns, and create adjustment factors and factor groups."

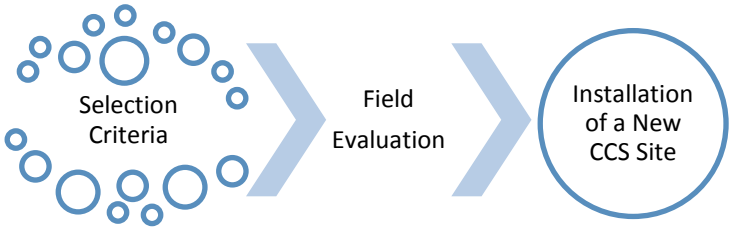

FIGURE 6: SITE SELECTION FOR A NEW CCS

The following is a list of the selection criteria:

1. Primary Selection Criteria

a. Minimum of five to eight CCSs per Traffic Factor Group depending upon the traffic patterns and precision desired (page 23).

2. Secondary Selection Criteria

a. Critical nodes on high volume roads that are used in the Step Down Method
b. Replacement of CCSs that were eliminated due to construction
c. Adequate coverage in each of the seven GDOT Districts to ensure geographic differences in travel trends are captured
d. Minimum of one operational CCS site per Interstate route
e. Minimum of one operational CCS site on other major arterials (e.g., SR-400 and SR-316)
f. Area of particular interest to GDOT management for planning purposes or to meet specific Federal requirements [e.g., the *Mechanistic-Empirical Design Pavement Guide of New and Rehabilitated Pavement Structures (5)*]

7.0 SHORT-TERM MONITORING PROGRAM

The short-term program (also known as the portable collection or the coverage program) collects roadway segment-specific traffic count information on a scheduled cycle for a 48-hour period. Field technicians can configure portable collection devices to collect vehicle classification counts as well as volume counts. OTD collects short-term volume counts at approximately 7,000 locations annually located across the state.

FIGURE 7: PORTABLE TRAFFIC DATA COLLECTION

A field technician stretches pneumatic tubes across a road and secures it on both sides. Then, the field technician connects the pneumatic tubes to a counter on one side of the road where the data is stored. The counter records and processes the pulse of air created by a vehicle's axles crossing the tubes. Depending upon the type of count needed, the field technician may set-up of one of several different tube configurations in the roadway (*6*).

7.1 Number of Counts, Period of Monitoring, and the Cycle of Monitoring

The *Roads and Highways* software system houses the Road Characteristics (RC) data, including AADT data, used in the development of the HPMS Report. OTD defines a beginning and ending mile point for each route in the Roads and Highways system. OTD divides routes into smaller sections designated with Traffic Count (TC) numbers and assigns an AADT volume to each TC number.

Georgia has approximately 27,000 TC numbers or segments. OTD cannot collect traffic counts on every road segment in Georgia every year due to practical limitations. Therefore, OTD collects portable traffic counts on a defined section of roadway (TC segment) on an annual or cyclical basis depending upon various internal and external reporting requirements and unit needs. Collection intervals range one, two, or four years. OTD collects traffic counts on a cyclical basis and adjusts the traffic counts with growth factors in years when they are not counted. AADT data is marked as either *Estimated* or *Actual* for each collection year for each TC number.

Federal Regulation 23 CFR 500.204 (*1*) states, "Documentation of field operations shall include the number of counts, the period of monitoring, the cycle of monitoring, and the spatial and temporal distribution of count sites." The Statistics Management Group re-evaluates the plan each year for the portable traffic collection program, including the number of counts and the cycle of monitoring. The period of monitoring is a 48-hour interval with data recorded for every hour of each day (a typical collection time for many state Department of Transportations), usually collected Tuesday through Thursday.

7.2 Spatial and Temporal Distribution of Traffic Counts

Submitted portable traffic data includes details such as the time, date and location of collection. Field Technicians use Global Positioning System (GPS) units during traffic data collection to record the physical location of the collected traffic count. OTD uses the GPS data to create digital maps of the collected traffic count sites to compare actual versus planned sites and review for quality control.

8.0 WEIGH-IN-MOTION PROGRAM

Each year, OTD collects weigh-in-motion (WIM) data at 14 permanent CCS sites and approximately 35 portable sites located throughout Georgia. The WIM data is transmitted electronically daily from the permanent sites. WIM technology measures vehicle counts, axle and gross weight, and vehicle classification data. GDOT and our data customers use WIM data for pavement and capacity studies, enforcement and inspection purposes, and for analysis of truck transport practices.

The Statistic Management Group provides the data from these sites to FHWA each year. FHWA runs the data through their software and produces summary W-table reports, viewed at the following website (*7*): https://fhwaapps.fhwa.dot.gov/vtris-wp/. Refer to *Appendix B: Permanent Weigh-In-Motion Sites* (page 31) and *C: Portable Weigh-In-Motion Sites* (page 32) for a complete list of permanent and portable WIM sites, respectively.

9.0 QUALITY CONTROL AND ASSURANCE

One of OTD's main goals for the traffic collection program is to provide an accurate portrayal of statewide traffic data and trends. With very few exceptions, OTD's collection program covers the complete State Highway System (approximately 18,000 miles) and samples traffic data during typical travel conditions (excluding holidays or weekends). A one-time event, such as a county fair, is not an accurate representation of an 'average day' and is not a long-term traffic trend. On the other hand, there are conditions that do influence long-term changes in traffic characteristics such as the addition of lanes, new intersections/interchanges, new roads, new business or residential developments, changes in the economy, and changes in land use.

For quality assurance, OTD has documented procedures and staff training for the installation and calibration for all types of equipment. OTD employs the following approaches for data quality assurance: 1) staff training and use of guidelines, 2) data processing rules and checklists, 3) proven software and data processing methods, 4) tight control on vendors' compliance with guidelines, 4) quality control checks with proven algorithms, and 5) stringent adherence to calibration and set-up routines for equipment. Additionally, the Statistics Management Group closely reviews all contractor-installed equipment for adherence to guidelines.

According to the TMG (*3*), "Each highway agency should have formal, documented rules and procedures for their quality control efforts." OTD has established quality control (QC) rules and procedures that evolve in conjunction with new technologies and software enhancements that ensure accurate statewide traffic data. OTD and the FHWA perform many quality control checks on the traffic data. For example, each month OTD submits the CCSs data to the FHWA online through the Travel Monitoring Analysis System (TMAS) that has built-in quality control checks. The Statistics Management Group performs quality control reviews on a daily or weekly basis and conducts a comprehensive review as part of the annual data processing.

10.0 DATA PROCESSING

The Statistics Management Group manages the data processing of incoming CCS data and portable collection data through a data management system (software). The traffic software system either rejects immediately or *flags* any data that does not meet the standards of the established quality control rules. OTD uses proven software and data processing methods to process all data with a high level of quality. Figure 7 below shows a *High Level Overview of the QC Process*:

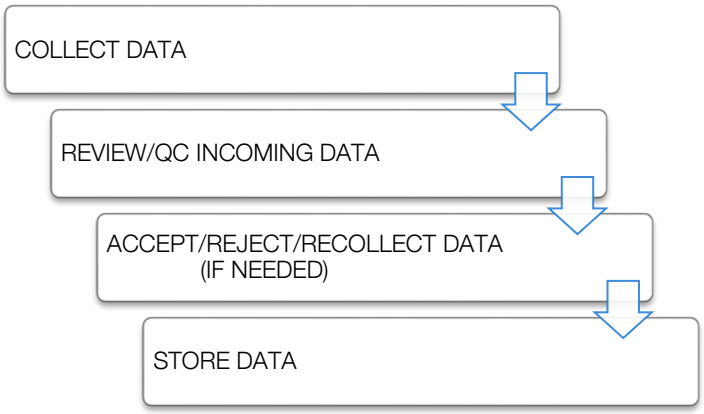

FIGURE 8: HIGH LEVEL OVERVIEW OF THE QC PROCESS

The Statistics Management Group categorizes CCSs into groups, such as Interstates or low volume, which apply specific quality control rules. The traffic software system also has adjustable thresholds for quality control rules, when applicable. The QC rules check for various issues, such as incoming data format, volume minimums/maximums, vehicle classification comparisons, etc. In addition, the system checks the double-sided CCS stations to ensure that both sides of the roadway are operational. Table 1 (page 15) contains a list of the *Quality Control Rules for Continuous Monitoring Sites*.

OTD personnel process, track, and monitor portable traffic data collected by field technicians on a daily or weekly basis. As discussed in section *V. Short-Term Monitoring Program*, GPS data and Field Notes collected at every portable data collection site assist with the quality control of the traffic count. Regarding GPS, office personnel compare the offset measured in meters between the current year and the last year of data collection. Recorded GPS data coordinates need to be within the assigned TC segment. If incoming traffic data is flagged, office personnel perform further analysis, such as evaluate GPS data coordinates, review the QC rule that the count has failed, view historical comparison for site, study trend analysis graphs, and compare traffic count data from adjacent sites. Table 2 (page 17) provides a list of the *Quality Control Rules for Short-term Monitoring Sites*.

TABLE 1: QUALITY CONTROL RULES FOR CONTINUOUS COUNT STATIONS

Quality Control Rule	Description	Data Type
Error Ratio	The system will reject the day(s) that have vehicles in class 15 (the error bin) greater than X percent of the total volume.	Class
Minimum Class Hours	The system will reject data that does not provide a complete 24 hours of truck data.	Class
No Truck Data	The system will reject the day(s) if no truck data exists for the day.	Class
No Trucks Lane	The system will reject the data if all there is no truck traffic in one lane for the day.	Class
Ratio of Class 1 to Class 2	The system will flag any day(s) where the volume in vehicle class 1 (motorcycles) exceeds the volume in vehicle class 2 (cars).	Class
Ratio of Class 13 to Class 9	The system will flag any day(s) where the volume in vehicle class 13 exceeds the volume in vehicle class 9.	Class
Ratio of Long Class to Short Class	The system will flag any day(s), where the total of the volumes in vehicle classes, 11, 12, and 13 (long class) exceeds the volume in vehicle class 8, 9, and 10 (short class).	Class
Trucks Last Year	The system will reject any daily truck traffic volumes that are substantially different from the previous year.	Class
Zero Long Class	The system will reject day(s) where the long truck classes had a zero volume.	Class
Zero Short Class	The system will reject day(s) where the short truck classes had a zero volume.	Class
Minimum Hours	The system will reject any day that does not have data for every hour	Volume
No Data	The system will reject a day if there is no data.	Volume
Volume Last Year	The system will reject any daily traffic volumes that are substantially different from the previous year.	Volume
Volume Split	The system will flag the entire set of counts if volume in one direction is over X percent of the total volume. This check is not applied to non- directional data.	Volume
Volume Step	The system will reject the day(s) that show a sudden dramatic change in hourly volumes.	Volume

Quality Control Rule	Description	Data Type
Volume Step Lane	The system will flag the day(s) where there is a sudden dramatic change in hourly lane volumes.	Volume
Zero Hours All Day	The system will reject any day where there are consecutive zero volumes for the entire day.	Volume
Zero Hours During Day	The system will reject any day where there are consecutive zero volumes at any time during the day.	Volume
Zero Hours During the Night	The system will reject any day where there are consecutive zero volumes at any time during the night.	Volume
Class 9 Average Steer Weight	The system will reject any day where the Class 9 average steer weight is outside the parameters.	WIM
Class 9 BC Spacing	The system will reject any day where the Class 9 average B-C axle spacing is outside the parameters.	WIM
Maximum Axle Count	The system will reject any day where the ratio of vehicles to axles is more than X.	WIM
Maximum Wheel Base	The system will reject any day where the wheel base is more than X.	WIM
Minimum Axle Count	The system will reject any day where the ratio of vehicles to axles is less than X.	WIM

TABLE 2: QUALITY CONTROL RULES FOR SHORT-TERM MONITORING SITES

Quality Control Rule	Description	Minimum Threshold	Maximum Threshold
Blank (No Data) Check	The system will reject any blank volume in one direction.	--	--
Class 14	The system will flag the day(s) that have vehicles in vehicle class bin 14 greater than X percent of the total daily volume.	--	5%
Class 15	The system will flag the day(s) that have vehicles in vehicle class bin 15 greater than X percent of the total daily volume.	--	1%
Class 3 greater than Class 2	The system will flag any day where the volume in vehicle class bin 3 exceeds the volume in vehicle class bin 2.	--	--
Daily Directional Volume Check	The system will calculate the directional distribution (D Factor) of the traffic. If the D Factor is greater than X percent, the counts are flagged.	--	70%
Daily Ratio of Class 1 to 2	The system will compare the ratio of vehicle class 1 bin data to vehicle class 2 bin data. If class 1 is higher, the data for the day will be flagged.	--	--
Direction Check	The system will check that the direction for the site is correct. The system should PASS a 0 (non-directional) OR a pair (1:3 OR 2:4) at every TC Number. It would NOT accept a lone direction or an incorrectly matched directional pair (example: North-1 and East-2).	--	--
Factor AADT Outside Range	The system calculates the AADT based on the factor groups using daily, monthly, and axle factors. Then, the system compares the computed hourly AADT to the historical AADT and flags sites that are outside the established volume group tolerances limits.	Variable	Variable

Quality Control Rule	Description	Minimum Threshold	Maximum Threshold
Historical Volume Check for Portable	The system averages the last 3 years of the AADT history. If 3 years of data is not available, the system will average the last 2 years of the AADT history. If 2 years is not available, the system will use one year of AADT history. The data is flagged, if it is outside the volume group tolerance limits.	Variable	Variable
Hourly Zero Volume Check	The system will reject any hour with zero volume in one direction when the current AADT for the site is greater than 10,000.	--	10,000
Less Than 48 Hours of Data	The system should reject the entire set of counts if there are not at least 48 hours of data. This means one or more row(s) in a PRN file is missing. If a row has a blank PRN file, the system still counts the row.	--	--
Max Hourly Volume	The system will reject the entire set of counts with an hourly volume count of greater than X	--	5,000
Midnight/ Noon Check	The system will reject the entire set of counts, if the midnight count is higher than the noon count.	--	--
Peak Hours (6-9 a.m.) (3-6p.m.)	The system will reject the entire set of counts with an hourly volume count of zero between the hours of 6 a.m. – 9 a.m. and 3 p.m. – 6 p.m. when the functional class is not equal to 9 or 19.	--	--
Portable Truck Percent	The system will calculate the truck percent by adding vehicle class bins 4 - 14 for the day and dividing by the total daily traffic count. Incoming data will be flagged, if the truck traffic is greater than X percent.	--	40%
Sum of Combination Vehicles Exceeds Class 9	The system will flag any day, where the total of the volumes in vehicle class bins 11, 12 and 13 exceeds the volume in vehicle class bin 9.	--	--
Volume Check	The system will flag any incoming data if there is an hourly volume count of greater than 9999. Allowable volumes are from 0 to 9999.	0	9,999

11.0 ANNUAL DATA PROCESSING

Annual data processing is a cycle that involves planning, traffic data collection, quality control, traffic calculations, reporting and publishing. Refer to *Appendix E: Traffic Calculations* (page 35) for further detail on traffic calculations. The Statistics Management Group performs the following list of tasks during annual data processing:

1. Establish the Plan (November)
   a. Review TC segmentation
   b. Review collection cycle for portable data
   c. Add/delete TC sites, as needed

2. Implement the Plan (December)
   a. Create lists of portable traffic count locations for field technicians and consultants
   b. New lists are provided to field technicians and consultants quarterly

3. Collect Traffic (January-December)
   a. Collect and review (QC) portable data, including GPS Data and Traffic Data Files
   b. Poll and review(QC) CCS data

4. Review Annual Traffic (January-February)
   a. Ensure all portable and continuous traffic has been collected and has passed quality control standards

FIGURE 9: OVERVIEW OF ANNUAL DATA PROCESSING

5. Calculate Estimates/ Factors (February)
   a. Calculate traffic adjustment factors
   b. Estimate AADTs at uncounted TC sites based upon historical data and current year CCS data
   c. Calculate traffic on high volume roads (Step Down Method)
   d. Estimate traffic on local roads
   e. Calculate peak hour traffic data and K-factors

6. Update Systems and Report Traffic (March)
   a. Populate the Federal Reporting Enhanced Database with traffic data
   b. Provide traffic data for external public viewing (www.dot.ga.gov/TrafficCounts)
   c. Report traffic data to the FHWA in the HPMS submittal

11.1 Management of Traffic Count Segments

According to the HPMS Field Manual (*2*), "Selection of count station locations should be based on previous count experience, recent land developments, and the existence of uncounted sections along the routes." A traffic count (TC) segment is defined as a section of roadway with homogenous (i.e., similar traffic for the entire segment) traffic volume. TC segments have a fluid dynamic and, as such, updates must be made annually in order to maintain the integrity of the segments. Office personnel add, delete, or move break points to reflect changes reported in the road inventory and actual field conditions.

OTD evaluation criteria for adding and spacing TC segments:

- TC segments must meet Federal-aid eligibility requirements. Federal-aid roadways are any public road with a functional classification higher than a local road in an urban area or a minor collector in a rural area. All local roads and rural minor collectors are sampled randomly for traffic data reporting; meaning only select locations on those local roads have TC numbers.

- Typically, and wherever possible, segments should span *from major intersection to a major intersection or a major traffic generator*. The Statistics Group defines a major intersection as an arterial roadway and a major traffic generator as an entrance/exit to a major retail store, such as a Super Wal-Mart.

- The Statistics Management Group's office personnel evaluate a road's segmentation if adjacent AADT volumes are varying by 20% or more. In connection with this effort, the last three or more years of traffic history is considered during the analysis.

OTD evaluation criteria for retiring a TC segment:

- OTD reviews and evaluates TC segments if adjacent segments have less than 5% difference in the AADT volumes. If the evaluation process supports a modification, OTD will delete a TC segment and expand the terminus of the adjacent TC segment.

- Changes in Federal requirements or funding levels may affect TC segments.

- OTD may remove TC segments in cases where it is not safe or feasible for a field technician to collect the data.

11.2 Calculation of Traffic on High Volume Roads (Step Down Method)

GDOT uses a ramp counting procedure referred to as the Step Down Method, also known in some states as Ramp Balancing, described in FHWA's TMG (*3*) to estimate AADT volumes for Interstates and freeways. Interstates and freeways have many lanes and high traffic volumes, which make them impossible to collect with a portable collection device due to safety concerns of the field crew and the traveling public.

The Step Down Method involves counting all entrance and exit ramps between two established mainline anchor points (or nodes) and then reconciling the count data to calculate the mainline AADT. As shown in *Figure 10: Example of Step Down Method* (Page 22), the calculated AADTs reduce in volume or 'step down' from TC0927 to TC0446. The ramps are counted using either portable collection devices or, in a few locations. OTD makes every effort to use CCSs as nodes.

OTD's traffic software calculates an AADT for each uncounted mainline link by adding or subtracting ramp AADTs (multiplied by an adjustment factor) to or from mainline AADTs, starting from one anchor point/node. The allocation of the volume difference to the ramps (and subsequently to the mainline volume estimates) is carried out by proportionally distributing the volume difference remaining at the ending control point to each of the ramps. The adjustment to each ramp is computed as the ratio of the difference in volume (remaining at the end of the reconcilement) to the sum of the ramp volumes.

In the past, the process was time-consuming and labor intensive, because office personnel calculated the numbers manually. Currently, the traffic software calculates the volumes using the Step Down Method after the AADTs have been determined for the CCSs and the ramps. OTD does not calculate the AADT volumes derived by the Step Down Method by direction of travel.

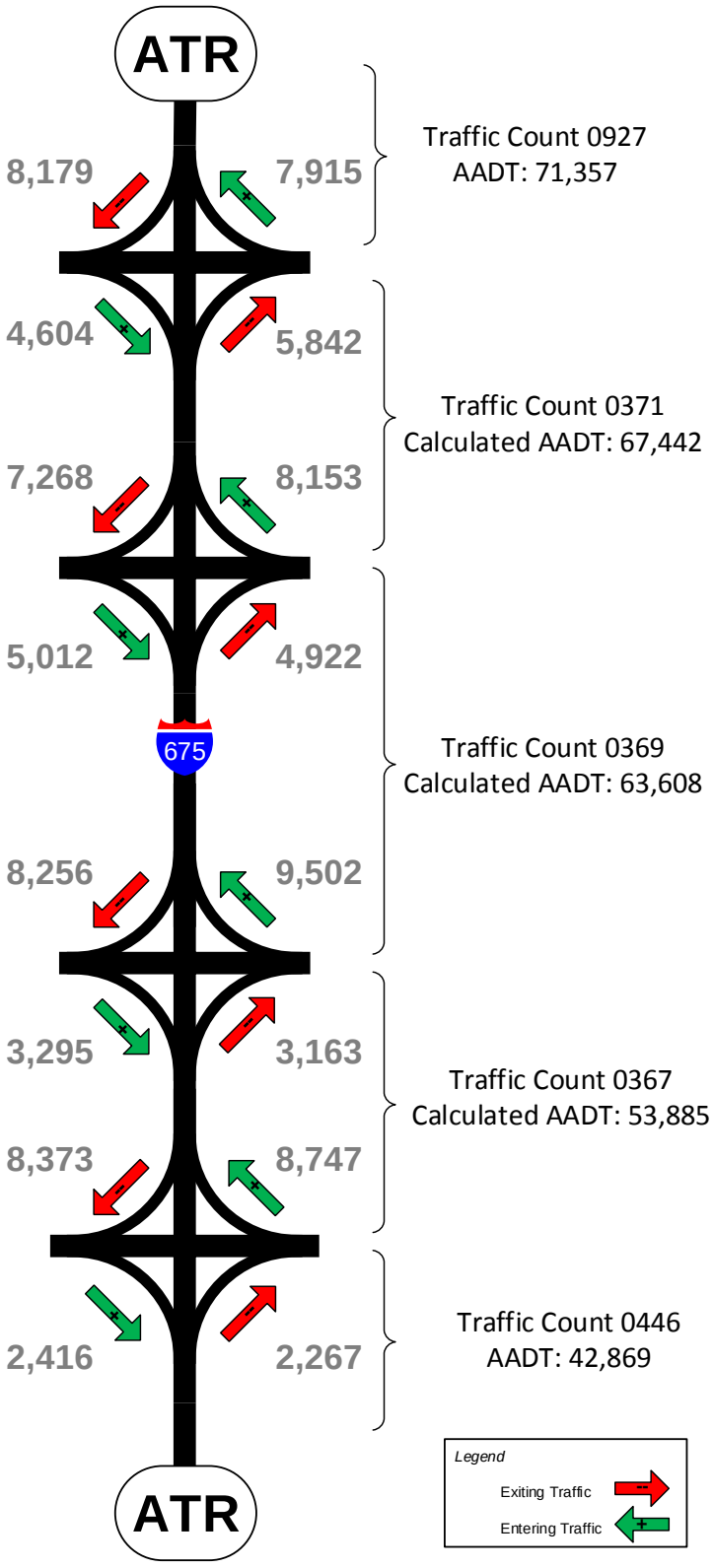

FIGURE 10: EXAMPLE OF THE STEP DOWN METHOD

11.3 Traffic Count Collection and Estimation on Local Roads

According to the FHWA (*2*), "States are required to report annually to the Federal Highway Administration (FHWA) aggregate estimates of VMT on the rural minor collector and local functional systems in rural, small urban and urbanized areas." Collectively, the FHWA refers to these roads as *local roads*, which have similar travel characteristics such as providing direct access to adjacent land, providing service to travel over short distances as compared to higher classification categories, linking locally important traffic generators with their rural hinterlands, etc. Examples of local roads are a subdivision road or an unpaved country road. Generally, except for the local roads, OTD collects traffic data on all types of roads in Georgia at regular intervals.

On local roads, OTD collect a small number of samples to derive and compute VMT statistics for Federal reporting purposes. The total local road mileage is approximately 93,288 miles, as December 2015. OTD has exceeded the HPMS sampling requirements with the total number of collected local traffic counts ranging from 800-1600 for the past several years.

According to the HPMS Field Manual (*2*), "Statistically speaking, a universe is a population from which a sample is taken. A population can be any set of sampling units, such as objects that can be observed or people who can be surveyed. A sampling frame is a list of all the sampling units in a universe." In our case, the universe for local roads is the total local road mileage. The sampling unit is a collection of local road segments, which are collected on an equally distributed cycle. OTD collects vehicle classification data on every local roadway with a bridge at a minimum of every four years.

11.4 Traffic Adjustment Factors

Federal Regulation 23 CFR 500.204 (*1*) states, "The procedures used by a state to edit and adjust highway traffic data collected from short-term counts at field locations to estimates of average traffic volume shall be documented." The raw hourly counts from portable traffic collection devices for a 48-hour period are adjusted by monthly, daily and axle factors to determine the AADT. Factors are used to estimate 'average' conditions and to account for variability in the traffic stream. They are based on data provided by the CCSs and are currently calculated annually as part of the traffic monitoring program.

Monthly factors are calculated by dividing the AADT by the monthly average daily traffic (MADT) for each location. In Georgia, January is usually the month with the lowest traffic volumes. Therefore, portable traffic collected in January would have the highest monthly factors.

Daily or day-of-the-week factors are calculated by dividing the AADT by the average daily traffic (ADT). Typically, the day of the week with the lowest traffic volumes is Sunday, which consequently has the highest daily factors.

Axle correction factors are developed based on data that represents all seasons of the year. The axle correction factors are applied to raw counts taken with portable traffic counters, which register two axle impacts as one vehicle. The axle factors are used to account for vehicles with more than two axles, typically trucks with three or more axles, in the traffic stream on a particular type of road. The axle factors should be applied to all counts

that are based on axle sensors (i.e., volume counts). Rural Interstates have the lowest axle factors, because they have the highest percentage of truck traffic in Georgia.

Growth factors are calculated for each factor group by using historical data and linear regression analysis. The growth factors are used to estimate traffic data at locations that were not collected in the current year.

OTD plans to review our factoring approach every year based upon a variety of factors: newly installed CCSs, traffic trends/patterns, high growth areas, truck traffic patterns, etc. OTD groups the CCSs into 9 Traffic Factor Groups (page 27) in accordance with the guidelines provided in the FHWA's Traffic Monitoring Guide. As expected, Atlanta has significantly different traffic patterns compared to the rural areas of the state. The 2016 factors are shown in the following tables:

TABLE 3: 2016 DAILY FACTORS

Factor Group*	Sun	Mon	Tue	Wed	Thu	Fri	Sat
1	1.22	1.01	0.98	0.98	0.94	0.89	1.04
2	1.22	1.01	0.99	0.98	0.94	0.88	1.05
3	0.92	1.08	1.15	1.10	1.01	0.85	0.97
4	1.37	0.97	0.92	0.92	0.91	0.90	1.17
5	1.26	1.00	0.99	0.98	0.94	0.87	1.04
6	1.16	1.02	1.01	0.99	0.95	0.88	1.04
7	1.43	0.98	0.93	0.92	0.92	0.88	1.13
8	1.36	0.99	0.94	0.93	0.92	0.90	1.10
9	1.19	1.01	0.98	0.97	0.95	0.91	1.04

TABLE 4: 2016 MONTHLY FACTORS

Factor Group*	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	1.10	1.09	0.99	0.99	0.96	0.98	0.97	0.96	0.97	0.90	1.07	1.07
2	1.11	1.03	0.99	0.98	0.97	0.98	0.99	1.00	0.99	0.92	1.01	1.05
3	1.17	1.12	0.97	0.98	0.96	0.92	0.88	1.02	1.03	0.99	1.00	1.04
4	1.08	1.01	0.96	0.97	0.96	1.00	1.02	0.95	0.98	0.98	1.06	1.06
5	1.10	1.01	0.98	0.98	0.96	0.98	0.99	0.97	1.00	0.96	1.04	1.05
6	1.10	1.04	0.96	0.97	0.97	0.96	0.94	1.00	1.02	1.01	1.03	1.03
7	1.07	0.98	0.96	0.96	0.97	1.00	1.01	0.98	1.00	1.00	1.04	1.05
8	1.07	1.00	0.97	0.98	0.97	0.99	1.02	0.97	0.98	0.96	1.05	1.06
9	1.07	1.02	0.98	0.98	0.97	0.97	0.99	0.99	1.00	0.99	1.04	1.03

**Factor Groups are described in Table 7: Factor Groups.*

TABLE 5: 2016 AXLE FACTORS

Factor Group*	Axle Factors
1	0.94
2	0.89
3	0.78
4	0.96
5	0.93
6	0.89
7	0.97
8	0.98
9	0.95

TABLE 6: 2016 GROWTH FACTORS

Factor Group*	Growth Factors
1	1.05
2	1.04
3	1.05
4	1.02
5	1.03
6	1.04
7	1.03
8	1.03
9	1.04

**Factor Groups are described in Table 7: Factor Groups.*

TABLE 7: FACTOR GROUPS

No.	Factor Group	Rural/Urban	Functional Classification
1	Rural – Major Collectors, Minor Collectors, and Locals	Rural	5, 6, and 7
2	Rural – Other Major Arterials and Minor Arterials	Rural	3 and 4
3	Rural - Interstates	Rural	1
4	Urban/Small Urban – Major Collectors, Minor Collectors, and Locals	Small Urban and Urban	5, 6 and 7
5	Small Urban – Other Major Arterials and Minor Arterials	Small Urban	3 and 4
6	Urban/Small Urban (Non-Atlanta) – Interstates and Freeways	Small Urban and Urban	1 and 2
7	Urban (Non-Atlanta) – Other Major Arterials and Minor Arterials	Urban	3 and 4
8	Urban (Atlanta) – Other Major Arterials and Minor Arterials	Urban	3 and 4
9	Urban (Atlanta) – Interstates and Freeways	Urban	1 and 2

12.0 OTHER CONSIDERATIONS

A complete analysis of any program identifies and considers all relevant issues and challenges. The main program management challenge is balancing costs, resources, and statistical data needs. In a world not constrained by funding or other resources, every TC segment on every road would have actual traffic data count available every year. Perhaps, in a small geographical area with a large budget this is an actual possibility. However, most state Department of Transportations must continually balance budget constraints with resources (time and available staff) and needs (quantity and quality of traffic counts collected). It is the classic paradox of project management.

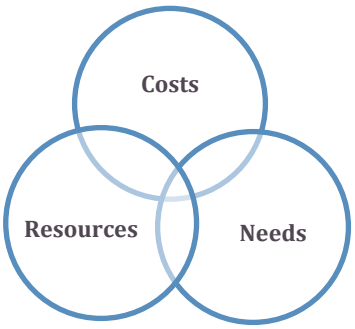

FIGURE 11: PROJECT MANAGEMENT

Despite budget constraints, the demand for traffic data in all formats has not been reduced. For example, FHWA's most recent HPMS reassessment requires additional traffic data to be collected on ramps. Special requests for traffic counts are also a competing factor with the portable traffic count program. Often, these traffic counts revolve around a special event and are not valid for use in an AADT calculation. As previously mentioned, OTD has also added traffic counts specifically located near bridges to meet internal data needs.

Other challenges include relational database struggles, software integration, staffing issues, and making traffic data accessible to the public in an easy-to-use interface. Most of the traffic data customers want an easy-to-use, simple interface that provides traffic counts. Other customers want all types of traffic data in detail as soon as it is available to them. OTD has made significant strides towards making data more accessible to the public and is continually exploring how to better serve customers' needs.

In regards to traffic data collection, OTD's primary concern is the safety of the traffic data collection crew while collecting data on high-volume routes. Due to equipment failures, collecting traffic data in stop-and-go traffic conditions is a challenge. Increased traffic congestion increases the difficulty in obtaining reliable vehicle classification counts. Construction and incidents also affect traffic data collection activities. Data processing, and quality control and assurance are challenges especially for high traffic-volume routes. Atlanta, in particular, as a metropolitan area with approximately five million people has significant traffic congestion, construction, and traffic incidents.

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Appendix A: FHWA 13-Bin Vehicle Classification Scheme

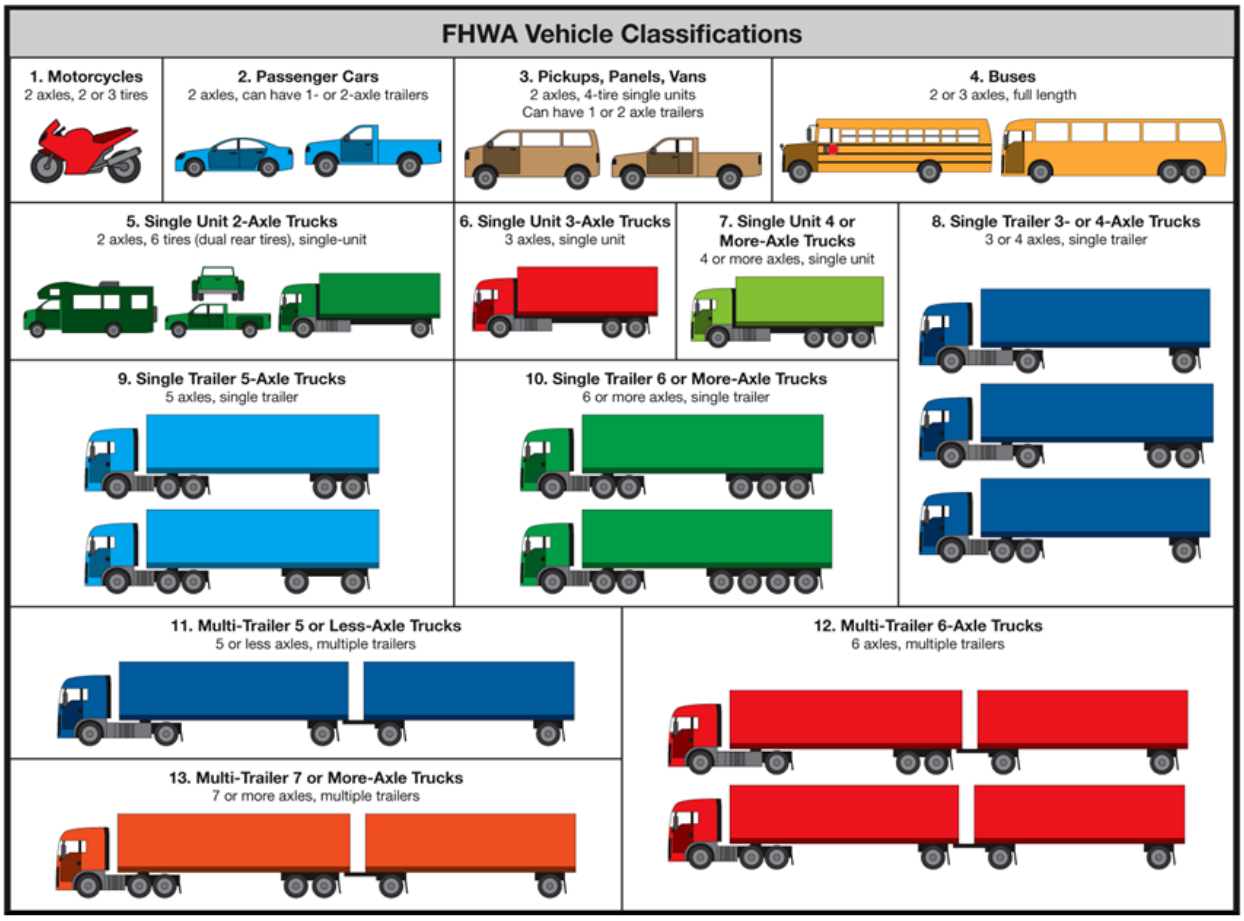

FIGURE A: FHWA 13-BIN VEHICLE CLASSIFICATION SCHEME

Source: Texas Department of Transportation's illustration of the FHWA 13-Bin Vehicle Classification Scheme (8)

Appendix B: Permanent Weigh-In-Motion Sites

TABLE B: Permanent Weigh-In-Motion Sites

No.	Site ID	WIM Lanes	Location
1	021-0334	1N	I-75/SR 401 between I-475 and SR 247
2	021-0334	1S	I-75/SR 401 between I-475 and SR 247
3	021-0378	2N/2S	I-475/SR408 south of SR-22 (NHS) between mile post 0 and 1
4	039-0218	1N	I-95/SR 405 between the Florida State Line and St. Marys Road (Camden County)
5	039-0218	1S	I-95/SR 405 between the Florida State Line and St. Marys Road (Camden County)
6	051-0368	2E/2W	I-16/SR 404 0.6 miles east of SR 307 Dean Forest Road
7	051-0700	2N/2S	SR 21 Alternate/Jimmy DeLoach Parkway between Crossgrate and Grange Road
8	065-0118	1E/1W	US 84/SR 38 north of Leland Smith Road, Homerville (Clinch County)
9	067-2373	4N	I-285/SR 407 at Orchard Road between mile post 16 and 17 (Cobb County)
10	081-0347	1N/1S	SR 300 west of Culpepper Road between mile post 10 and 11, Cordele (Crisp County)
11	087-0103	2N/2S	US 27/SR 1 South of US 27BU/ SR 1BU/ E. Griffin Avenue
12	127-0312A	2N	I-95/SR 405 between SR 27 and Golden Isles Parkway (SR 25 Spur)
13	127-0312B	1S	I-95/SR 405 between SR 27 and Golden Isles Parkway (SR 25 Spur)
14	143-0126	1E/1W	I-20/SR 402 at the Alabama State Line between mile post 0 and 1 (Haralson County)
15	185-0227	1N	I-75/SR 401 between the Florida State Line and Lake Park Bellview Road (Lowndes County)
16	185-0227	1S	I-75/SR 401 between the Florida State Line and Lake Park Bellview Road (Lowndes County)
17	207-0222	2N/2S	I-75/SR 401 between Pate Road and Bibb County Line, Macon (Monroe County)
18	245-0218	1E/1W	I-20/SR 402 between SR 104 and South Carolina State Line

1. N=North, S=South, E=East, and W=West

Appendix C: Portable Weigh-In-Motion Sites

TABLE C: Portable Weigh-In-Motion Sites

District	Station ID	Location
1	059-0125	US 129 (SR-15 Alternate) just north of the Athens Perimeter between Homewood Dr. and Trinity Place (Clarke County)
1	157-0245	US 129 (SR-11) just east of I-85 Interchange (Jackson County)
1	219-0258	SR 316 just west of US 78/SR 10 Interchange near Caterpillar Plant (Oconee County)
1	241-0052	US 441 (SR-15) south of SR 246 near the state line (Rabun County)
1	297-0018	SR 10 between Youth Monroe Rd & SR10BU Alcovy River
2	107-0022	US 1/SR 4 north of Swainsboro near Hawhammock Church Road (Emanuel County)
2	189-0003	US 78/SR 10 just north of SR 43/Lincolnton Road (McDuffie County)
2	245-0132	SR 56/Mike Padgett Highway north of Hephzibah-McBean Road (Richmond County)
2	303-0001	SR 15 south of Sandersville between Montgomery Road and Harrison-Riddleville Road (Washington County)
2	319-0125	US 441 (SR-29) just east of SR 112 near Thompson-Denson Road (Wilkinson County)
3	151-0103	SR 155 just north of Bill Gardner Parkway/Hampton Locust Grove Rd (Henry County)
3	171-0127	SR 7/US 41, 2.3 mi north of town
3	199-0212	SR 109 west of Greenville between Highpoint Road and Fire Tower Road (Meriwether County)
3	255-0373	SR 16 between South McDonough Rd and High Falls Rd
3	269-0138	SR 96 west of Butler between McCall Road (CR 239) and Back Road (CR 63) (Taylor County)
3	285-0047	SR 1/US 27 just south of SR 54 north of LaGrange (Troup County)
4	027-0138	SR 38/US 84 east of Boston near Pidcock Road (CR 91) (Brooks County)
4	071-0006	SR 133 Southeast of Moultrie near Culbertson Road (Colquitt County)
4	099-0047	SR 38/US 84 west of Donalsonville and east of Jakin near Harrell Moye Road (Early County)
4	321-0145	US 82/SR 520 near Summer between of W Road and College St (Worth County)
5	031-0187	SR 73/US 301 towards town just north of SR 46(Bulloch)
5	051-0350	SR 307 just outside Garden City Terminal main gate (Chatham County)
5	179-0041	SR 38/US 84 in Walthourville just east of SR 119 (Liberty County)

District	Station ID	Location
5	229-0123	SR 38/US 84 southwest of Patterson near Aaron's Way (Pierce County)
5	305-0041	SR 27/US 341 near River Road southeast of Jesup (Wayne County)
6	057-0239	I-575 between Ridgewalk Pkwy & Towne Lake Pkwy (Cherokee County)
6	057-0240	I-575 just south of Sixes Road interchange (exit 11) (Cherokee County)
6	115-0087	US 411/SR-53 west of Cave Springs near Buttermilk Road (Floyd County)
6	223-0103	SR 6 west of Dallas near Gold Mine Road (Paulding County)
6	227-0237	SR 5/515, 0.3 mi north of SR 108 at mile post 12.85
7	089-3112	SR 42/Moreland Avenue just north of I-285 (DeKalb County)
7	089-3205	SR 155 just southeast of I-285 near Columbia Drive (DeKalb County)
7	097-0045	SR 6 north of I-20 near Oak Ridge Road (Douglas County)
7	097-0323	SR 6 south of I-20 near Factory Shoals Road (Douglas County)
7	121-5716	SR 6 just west of I-285 near Welcome All Road

Appendix D: Georgia Counties and FIPS Identification Numbers

TABLE D: Georgia Counties and FIPS Identification Numbers

County	Code	County	Code	County	Code	County	Code
APPLING	001	DADE	083	JEFFERSON	163	RICHMOND	245
ATKINSON	003	DAWSON	085	JENKINS	165	ROCKDALE	247
BACON	005	DECATUR	087	JOHNSON	167	SCHLEY	249
BAKER	007	DEKALB	089	JONES	169	SCREVEN	251
BALDWIN	009	DODGE	091	LAMAR	171	SEMINOLE	253
BANKS	011	DOOLY	093	LANIER	173	SPALDING	255
BARROW	013	DOUGHERTY	095	LAURENS	175	STEPHENS	257
BARTOW	015	DOUGLAS	097	LEE	177	STEWART	259
BEN-HILL	017	EARLY	099	LIBERTY	179	SUMTER	261
BERRIEN	019	ECHOLS	101	LINCOLN	181	TALBOT	263
BIBB	021	EFFINGHAM	103	LONG	183	TALIAFERRO	265
BLECKLEY	023	ELBERT	105	LOWNDES	185	TATTNALL	267
BRANTLEY	025	EMANUEL	107	LUMPKIN	187	TAYLOR	269
BROOKS	027	EVANS	109	MCDUFFIE	189	TELFAIR	271
BRYAN	029	FANNIN	111	MCINTOSH	191	TERRELL	273
BULLOCH	031	FAYETTE	113	MACON	193	THOMAS	275
BURKE	033	FLOYD	115	MADISON	195	TIFT	277
BUTTS	035	FORSYTH	117	MARION	197	TOOMBS	279
CALHOUN	037	FRANKLIN	119	MERIWETHER	199	TOWNS	281
CAMDEN	039	FULTON	121	MILLER	201	TREUTLEN	283
CANDLER[1]	043	GILMER	123	MITCHELL[1]	205	TROUP	285
CARROLL	045	GLASCOCK	125	MONROE	207	TURNER	287
CATOOSA	047	GLYNN	127	MONTGOMERY	209	TWIGGS	289
CHARLTON	049	GORDON	129	MORGAN	211	UNION	291
CHATHAM	051	GRADY	131	MURRAY	213	UPSON	293
CHATTAHOOCHEE	053	GREENE	133	MUSCOGEE	215	WALKER	295
CHATTOOGA	055	GWINNETT	135	NEWTON	217	WALTON	297
CHEROKEE	057	HABERSHAM	137	OCONEE	219	WARE	299
CLARKE	059	HALL	139	OGLETHORPE	221	WARREN	301
CLAY	061	HANCOCK	141	PAULDING	223	WASHINGTON	303

County	Code	County	Code	County	Code	County	Code
CLAYTON	063	HARALSON	143	PEACH	225	WAYNE	305
CLINCH	065	HARRIS	145	PICKENS	227	WEBSTER	307
COBB	067	HART	147	PIERCE	229	WHEELER	309
COFFEE	069	HEARD	149	PIKE	231	WHITE	311
COLQUITT	071	HENRY	151	POLK	233	WHITFIELD	313
COLUMBIA	073	HOUSTON	153	PULASKI	235	WILCOX	315
COOK	075	IRWIN	155	PUTNAM	237	WILKES	317
COWETA	077	JACKSON	157	QUITMAN	239	WILKINSON	319
CRAWFORD	079	JASPER	159	RABUN	241	WORTH	321
CRISP	081	JEFF-DAVIS	161	RANDOLPH	243		

1. Numbers 041 and 203 have been deliberately omitted.

Appendix E: Traffic Calculations

TABLE E: Traffic Calculations

Description	Equation
Annual Vehicle Miles Traveled (AVMT)	Daily Vehicle Miles Traveled * 365
CCS AADT	Sum of Total Yearly Traffic Volume/ Total Number of Operational Days
Axle Factors	Total Vehicle Volume / (Total Axle Strikes/ 2)
D or Directional Distribution Factor	Predominate Direction of Peak Hour Volume/ Total Peak Hour Volume
Daily Factors	AADT/ Average Daily Traffic
Daily Vehicle Miles Traveled (DVMT or VMT)	Length of Roadway Segment * AADT
K or Design Hour Factor	30th Highest Hour/ AADT
Monthly Factors	AADT/ Monthly Average Daily Traffic
Portable AADT (Classification)	24-hour Short-Term Volume * Daily Factor * Monthly Factor
Portable AADT (Volume Only)	24-hour Short-Term Volume * Daily Factor * Monthly Factor * Axle Factor
Truck Percentages	(Sum of Vehicles in Classes 4-13/ Total Sum of Vehicles) * 100

1. This is intended to be a basic list of equations. It should be noted that additional steps, such as summation or averaging, may be necessary before an equation listed above can be applied to the data.
2. Data not accepted based upon the established QC rules is omitted from any calculation.