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Traffic Monitoring Data

Successful Strategies in Collection and Analysis

A Workshop

May 2, 2007

Washington, D.C.

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OF THE NATIONAL ACADEMIES

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Traffic Monitoring Data
Successful Strategies in Collection and Analysis

A Workshop

Organized by the
Transportation Research Board

Cosponsored by
Federal Highway Administration

May 2, 2007
National Academies Keck Center
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Contents

Introduction

On May 2, 2007, the Transportation Research Board (TRB) sponsored a 1-day workshop entitled Traffic Monitoring Data: Successful Strategies in Collection and Analysis. This workshop was held for data producers and data users who were interested in better traffic data in the mid-Atlantic region of the United States. A committee was formed to plan the agenda for this workshop. The planning committee consisted of the following individuals from departments of transportation (DOTs) and other interested agencies:

- Laine Heltebridle, Pennsylvania DOT, Committee Chair;
- Ralph Gilman, FHWA;
- Karl Hess, Maryland State Highway Administration (SHA);
- Jianming Ma, District DOT (DDOT);
- Catherine C. McGhee, Virginia Transportation Research Council;
- William McGuirk, DDOT;
- Thomas Schinkel, Virginia DOT;
- David Gardner, Ohio DOT;
- Thomas Palmerlee, TRB; and
- David Floyd, TRB.

The intent of the workshop was to have an interactive forum to exchange knowledge about successful strategies in the collection and the analysis of traffic data. To find out about the success and challenges states were experiencing in the collection and analysis of traffic data and to help determine possible workshop sessions, the committee decided to send a survey to the following DOTs: Delaware, District of Columbia, Maryland, Pennsylvania, and Virginia. The summary of survey responses helped to guide the committee in its determination of topics that should be addressed at this workshop.

In addition to the exchange of ideas and information, an important product of this workshop was the generation of potential topics and sessions at the North American Travel Monitoring Conference and Exposition, to be held in Washington, D.C., August 6–8, 2008. Since this was the first regional workshop TRB had sponsored on the topic of traffic monitoring data, the committee was hoping to have about 40 attendees from DOTs, metropolitan planning organizations (MPOs), and private companies. Attendance exceeded all expectations, with twice the expected number.

—Laine Heltebridle
Pennsylvania Department of Transportation
Planning Committee Chair

Virginia Department of Transportation
Successes and Challenges in Traffic Monitoring

TOM SCHINKEL
Virginia Department of Transportation

The Virginia DOT (VDOT) program includes more than 100,000 traffic roadway segments where data are collected and traffic estimates produced. Three hundred and twenty-two of these links have 322 continuous traffic count station data, with 140 of the stations being on the Interstate system. The program is heavily influenced by a need for continuous data for factor creation on the National Highway System (NHS), and over 250 of the continuous count stations are on the NHS. Seven of the continuous stations have weigh-in-motion (WIM) capability.

The program also includes 17,000 traffic links on the higher functionally classified roads, or collectors and above. These traffic links are divided into a 3-year count cycle, by jurisdiction—meaning each city's or county's roads are counted once every 3 years. The counts are evenly divided over the 3-year period and about 5,600 are collected each year. Counts are taken during periods of normal traffic on Monday through Thursday. Counts last for 48 h. Factors from continuous count sites are applied to each count to produce annual average daily traffic (AADT) estimate for each traffic link. During years when the traffic links are not being counted, they are growth factored using continuous count station data.

The 85,000 local counts are counted on a 3-, 6-, or 12-year cycle based on pavement type and land use. The 3-year cycle is for local unpaved roads. Data are collected more frequently on these local roads than others because the traffic volume is part of the decision matrix regarding which unpaved roads are paved. The 6-year cycle counts are for local roads that have growth potential. The 12-year cycle is for fully developed or built-out subdivisions where no additional growth is expected. The once-every-12-years count in a no growth area is intend to capture traffic volume changes due to changing demographics of the neighborhood. About 14,000 24-h counts are collected each year to meet the requirements of this schedule.

Since 1997, VDOT has stored traffic count data in an Oracle database, the year the current edition of the traffic program was started. As of March 1, 2007, there were more than 675,000 days of vehicle classification data, more than 400,000 days of vehicle volume data, more than 360,000 days of vehicle speed data, and more than 2,000 days of vehicle WIM data available for review and customer use.

Per-vehicle records are maintained for WIM data sites, and as of March 1, 2007, there were 37 million vehicle records available and we are adding 1.5 million a month.

Vehicle speed data has been saved from our continuous count stations since 2003; not because there was a need, but just because storage was cheap and we could. Today that data is being used for performance measures and probably most notably within Virginia for producing holiday travel forecasts of where and when travelers can expect delay.

CHALLENGES

There are many challenges to collecting quality traffic data. A few of those included in the Virginia presentation are:

1. Counting traffic in high-volume urban locations is difficult from a data quality as well as from a safety standpoint due mostly to technology limitations. Improvements in nonintrusive technologies has helped from a safety standpoint, but data collection in stop-and-go traffic remains problematic due to the type of sensors and equipment currently available on the market.
2. Two-axle vehicles in the FHWA Class 2, 3, 4, and 5 categories have crossover issues. Vehicle classification is based on axle spacing. The point was emphasized that the traffic counter cannot see that big yellow bus. It only detects the tires and classifies the vehicle based on a set of rules maintained in the traffic counter that are designed to get as many as possible correctly classified. Sport utility vehicles are particularly troublesome due to the high level of interest in them, and the wide range of axle spacing of the various models.
3. Dual use is made of traffic data from some traffic monitoring continuous count stations. Operations polls the data every 5 min, downloading the most volume, average speed, and occupancy data in near real time. Data can be used to detect incidents. The durability of grout materials used for in-road installed sensors was discussed as a problem adversely impacting the longevity of sensors. With premature failure of sensors due to grout problems, states lose valuable data as a resource.
4. In Virginia, there seems to be a large number of operations sensor—both public and private. For various reasons such as data quality, format, and lack of data sharing agreements, to list a few, the operations data has been difficult to obtain and use for the traffic monitoring program.

SUCCESSES

1. Inductance loops sometimes get a bad reputation due to poor installation practices or horror stories of operations groups that installed them every ½ mi only to have them all milled out by one project. In Virginia, we've had excellent results by following a standard practice for installation.
   - By ensuring that loops are at a 4-in. depth and by using a loop grout that breaks rather than pulls out, the majority of our loops survive milling operations.
   - The failure point for loops is often due to the splice utilized when installing the loop. To take an improperly performed splice out of the equation as a failure point, Virginia's traffic monitoring system (TMS) has a "no splice" policy for newly installed loops.
   - Use an encased wire that provides added protection.
   - Pay contractor for data. It is in their best interest to install a loop so that it meets our specification and produces quality and quantity data.
2. VDOT uses a classification table that helps extend the life of piezoelectric sensors and also is used as a "maintenance needed" indicator. The class table is called the 21 bin locally and uses a loop logic function to classify smaller and lighter vehicles (class 2 and 3) when the sensor degrades to the point that these lighter axles are sometimes missed by the sensor. The

numbers of vehicles that classify based on the loop logic function are binned separately from those with two good axle hits, using bins 16 through 19. As the number of vehicles in these bins grows, it is an indicator to operators that the sensor is starting to fail and will need maintenance soon. When the heavier vehicles start to have missed axle problems, they are recorded in a separate bin also, but are treated as unclassified vehicles. When these vehicles occur at a rate of 0.5% of the traffic, the data is quality coded as not useable for truck factor creation, and sensor replacement will be scheduled.

3. VDOT follows a number of items that it defines as "best practices" for the coverage count program within the state. There are many of these, but some of the key, more critical ones include the following.

- Using a traffic counter with a "tailgating logic" feature that allows it to look at two vehicles traveling closely together and record them as two separate vehicles if the axle configurations do not match those within the classification tree for a truck. This requires a tightly defined classification table for trucks, but allows the state to collect quality classification data in urban and peak hour conditions.
- Ensuring that standard proven road tube set-ups are used for collecting data in similar conditions. All road tube lengths and distances are measured, recorded and submitted on a field worksheet.
- All data are collected by lane.
- In urban conditions with traffic signals, traffic counter locations are split by direction to avoid queuing and stopping on road tubes.
- An active inspection program of contract data collection is maintained. Contractors are required to "self-inspect" a number of counts by videotaping the set-up and submitting a synchronized with the traffic counter time interval of data for comparison to the machine count.

4. Dual use is made of traffic data from some traffic monitoring continuous count stations. Operations polls the data every 5 min, downloading the most volume, average speed, and occupancy data in near real time. Data can be used to detect incidents.

5. For WIM site selection, traffic monitoring personnel coordinate with pavement engineers around the state to collect their recommendations for new paving jobs with smooth pavement. A road profile van collects data from those locations and those that meet the 95% confidence level that smoothness will not be an issue for WIM data collection are used for new site installations.

Questions on any of the information found within this summary of Virginia's presentation may be directed to the Traffic Monitoring Program Manager, Tom Schinkel, at 804-225-3123 or Tom.Schinkel@VDOT.Virginia.Gov.

Pennsylvania's Successes and Challenges in Traffic Monitoring

LAINE HELTEBRIDLE
Pennsylvania Department of Transportation

Pennsylvania has 120,667 linear miles of public road of which 43,200 linear miles are included in its short-term traffic counting program. There are over 30,000 traffic counting sites statewide. Approximately 6,500 short-term counts are conducted annually. Traffic counts are scheduled on a 1-, 3-, or 5-year cycle. For the short term traffic counting program, the Pennsylvania DOT (PennDOT) partners with its metropolitan planning organizations (MPOs), rural planning organizations (RPOs), and District Engineering Office to take short-term traffic counts. PennDOT also contracts with three vendors and has three staff members who take traffic counts.

Pennsylvania has 78 permanent traffic counting sites. These permanent sites include 61 automatic traffic recorders (ATR), 13 WIM, and four continuous automatic vehicle classifiers (CAVC). Pennsylvania also has 200 short-term in-pavement (STIP) sites. These sites have inductive loops in the pavement but do not contain permanent counters. Counters are placed in the cabinets at these sites when traffic counts are needed. Many of the STIP sites are in urban areas where setting tube counts is difficult.

Pennsylvania's successes in traffic monitoring include:

- MPO–RPO partnerships;
- The Traffic Information System;
- The TMS;
- The Internet TMS (iTMS);
- The Internet Traffic Data Upload System (iTDUS);
- Statewide Traffic Counting Supplies and Traffic Counting Services Contracts;
- Non-intrusive traffic data collection research; and
- ATR quality assurance (QA) program.

PennDOT's partnership with the MPOs and RPOs began in the 1980s. The traffic data collection task is included in the Unified Planning and Work Program (UPWP) that PennDOT has with each MPO and RPO. The MPOs and RPOs collect 38% of the short-term traffic data each year for PennDOT. The UPWP also contains a task for the MPOs to collect Highway Performance Monitoring System (HPMS) data for PennDOT. These data collection partnerships have proven to be beneficial for Pennsylvania.

The traffic information system is a PC based system developed for Pennsylvania. It serves as the permanent traffic counting data system module manager providing for the integration of traffic counting, asset management, traffic count processing and editing, count analysis, traffic factor development, and traffic data reporting. This system also provides a portal to PennDOT's geographic information system (GIS), TMS, and Roadway Management System.

The TMS is a PC-based system developed for Pennsylvania. It allows PennDOT to manage short-term traffic data collection activities. TMS allows PennDOT's traffic analysts to add, change, or delete traffic site data, schedule and assign traffic counts, and produce maps and reports of short-term traffic counting sites.

The iTMS is an Internet-based system that allows the public to search for traffic data. Search criteria include place name, zip code, municipality, street name, PennDOT route number, street address, and intersection. The iTDUS is a web-based application that allows PennDOT's traffic data partners and vendors to upload traffic data for processing.

PennDOT has two statewide contracts. One contract is for purchasing traffic counting equipment and supplies and the other contract is for purchasing traffic counting services. Each contract is multiaward and can be used by state and local government agencies. The contracts also contain prices vendors cannot exceed. However, vendors do have the opportunity to offer prices lower than what is quoted on the contract. Links to the contracts are available on the Traffic Partners page of PennDOT's Bureau of Planning and Research website.

PennDOT conducted a research project on the use of nonintrusive devices to collect traffic data. French Engineering of Smithfield, Pennsylvania, conducted the research. Four nonintrusive technologies were evaluated. These technologies were the Wavetronix Smart Sensor, Remote Traffic Microwave Sensor (RTMS) by Electronic Integrated Systems, SAS-1 by SmartTek, and The Infra-Red Traffic Logger (TIRTL) by Control Specialist Company. Traffic counts were taken on a four-lane urban expressway, a two-lane rural principal arterial, and a four-ane urban principal arterial with a center turn lane. Each company set up its own nonintrusive equipment. Data collected by the nonintrusive equipment was compared to data collected manually, by video, and by an ATR or STIP. Results showed that the Smart Sensor was the most accurate on volume counts and the TIRTL was the most accurate on class counts. A copy of the results of this research project is available on PennDOT's website.

Pennsylvania is currently in the process of automating its ATR QA Program. This program compares the data from a manual and tube count with the data collected by the ATR to determine if the data being collected by the ATR is accurate. Data from the ATR must be within 2% of the manual and tube count data to be considered accurate. An application is being developed to provide automated count entry, retrieval of the ATR data, historical data archiving, and report generation. This new application should be completed by the summer of 2007.

Challenges for Pennsylvania's traffic monitoring program include:

- The collection of motorcycle data,
- The collection of traffic data on ramps,
- The collection of traffic data on municipal-owned roads, and
- The collection of 13 classes of vehicles with nonintrusive equipment.

Currently Pennsylvania does not collect motorcycle data. However, FHWA will start to require motorcycle data be included in the state's HPMS submittal in 2008. As a result of this requirement, PennDOT is working on determining how to collect and store this data.

FHWA is considering having states include ramp information in their annual HPMS submittal. This ramp information would include traffic data. Ramps are currently not included in Pennsylvania's short-term traffic counting program. If traffic data on ramps becomes a FHWA requirement, Pennsylvania would have 888 mi of ramps on which to collect data in addition to determining how to process and factors these traffic counts.

The only municipally owned roads that are included in Pennsylvania's traffic counting program are those roads that are on the Federal Aid system. As a result, almost 73,000 linear miles of roadway are not counted. Pennsylvania’s current resources for traffic counting do not allow including all 73,000 linear miles of municipally owned roads. PennDOT recently completed a research project on the development of a stratification procedure to count traffic on these roads. It was determined from the research that the municipally owned roads could be stratified by county and HPMS rural–urban code. Based on the rural–urban mileage in each county, a count would be assigned for every 10 mi of rural road and every 7 mi of urban road. The contractor conducting the research randomly assigned the traffic count locations. An additional 7,200 traffic counts would be added to Pennsylvania’s current short-term counting program. Pennsylvania plans to add these additional counts in 2008.

One of the challenges Pennsylvania has seen with the use of nonintrusive equipment is collecting the current FHWA 13 vehicle class scheme. While length by class can be collected using this technology, it does not appear that this equipment is able to collect class data in FHWA’s 13 class schema.

Maryland Traffic Monitoring

JERRY EINOLF
Maryland State Highway Administration

In 1995, the SHA of the Maryland DOT transferred responsibility for traffic data collection to its Highway Information Services Division (HISD). The original project had several goals:

1. Improving data quality;
2. Improving traffic data availability by placing the data on the SHA network;
3. Improving turn-around time from requests to counts;
4. Reducing SHA data collection staff;
5. Privatizing traffic data collection; and
6. Developing an automated system to expedite these efforts. This new system went live in late 1997.

At present, HISD monitors traffic by using 79 ATRs, with 69 ATRs currently online, producing data throughout Maryland. In addition, there are over 3,700 short-term (48-h) program (coverage) count locations. HISD also coordinates approximately 1,200 special project counts annually as needed.

SUCCESS STORIES IN TRAFFIC MONITORING

Data Collection

The most significant success story involved the decision to privatize data collection efforts by using multiple consultant contracts. Consultants now provide program counts and all special project counts, including portable machine traffic counts, manual traffic counts, high-occupancy vehicle (HOV) counts, origin and destination (O-D) studies, and on-site traffic engineering assistance. The consultants use innovative products, such as Road Ramp and TIRTL, to collect classification data on high-speed roadways. HISD also has consultant contracts in place for the preventative maintenance on the ATRs.

Applications

HISD developed several applications that were crucial to automating processes. HISD members developed an intranet-based user interface that SHA traffic sngineers in Maryland’s seven engineering districts and Baltimore City can use to request special project counts and view existing count data. They also developed a database that stores the traffic count data; this database currently offers users 17 years’ worth of data. HISD members developed a GIS module that allows users to request counts, select reports, and display count locations using the GIS-based map. In addition, they developed a web-based reporting module that provides access to all validated traffic count data through a series of predefined reports. These reports are made available to the public on SHA’s website; users can search data by date, day of week, count type, functional classification, and location.

Data Analysis

Another success story involved improving the data validation process. The following validations are performed during ATR loads: standard deviation, repeating values, directional distribution, and 24 h of data. HISD members also review ATR data on a monthly basis with traffic engineers from the Travel Forecasting Team. Short-term counts now require digital images of each count site, consultant principal engineer review and sign-off, and Travel Forecasting Team traffic engineer review. HISD also entered into data-sharing agreements with the following: Baltimore Metropolitan Council of Governments (BMC), Washington Council of Governments (WashCOG), Baltimore City Office of Transportation, Maryland Transportation Authority, and other local government agencies by request.

Reporting

The aforementioned web-based reporting module, shown in Figure 1, makes standard sets of reports available to the public on SHA’s website.

In addition, HISD publishes an annual Traffic Trends Report and an annual Traffic Volume Map (see Figure 2).

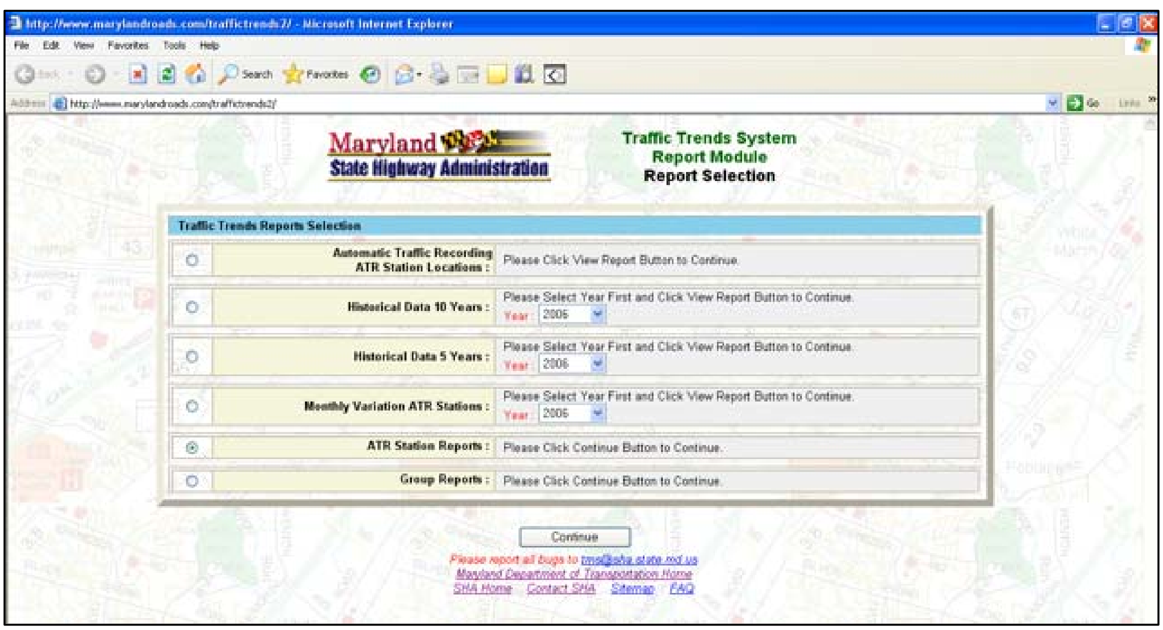


FIGURE 1 Traffic trends system report module.

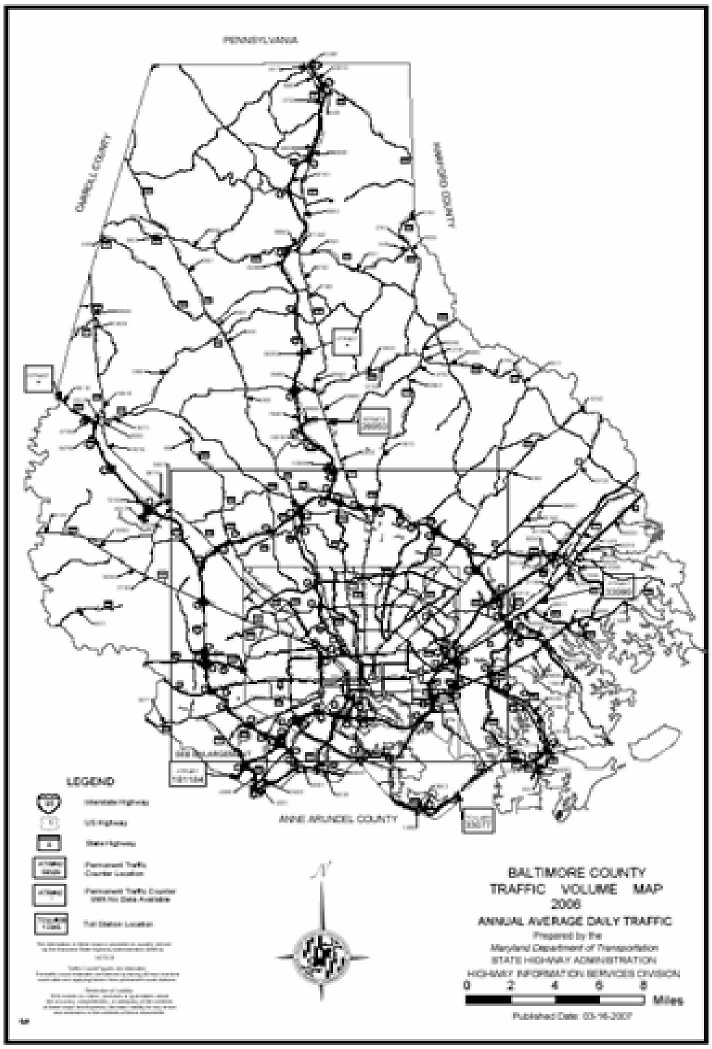


FIGURE 2 Traffic volume map.

Overall

By far the most important element in this initiative was having the support of upper management at SHA. This is especially critical when purchasing new hardware and software, budgeting for consultant contracts, using on-site consultants, and securing funding.

CHALLENGES IN TRAFFIC MONITORING

Data Collection

HISD has had to hurdle many obstacles in this area. Scheduling and coordinating counts with only a limited number of consultants are difficult. Traffic volume threatens the safety of the consultants, who in turn experience delays from having to set up temporary traffic control. The security of the ATR equipment, as well as the consultants' portable equipment, remains a constant concern. Adding to that, road construction, traffic accidents, and vandalism often take the ATRs offline. HISD also faces the challenge of ensuring that ATRs are taken into consideration during the early planning phase of construction projects.

Data Analysis Challenges: Factoring–Group Factors

Sufficient number of ATRs in each group to calculate day of week factors:

- Truck AADT: factors to estimate truck AADT based on limited number of ATRs.
- Motorcycle AADT: calculating factors to estimate motorcycle AADT.
- Assigning short-term counts to proper groups for factoring.
- Ensuring the accuracy of data on roads with numerous traffic signals where queuing occurs and also on high-volume Interstates and freeways.

Other Challenges and Lessons Learned

During an initiative like HISD's, it is imperative to have sufficient information technology (IT) support in order to "keep up with the Joneses" in regards to current technology. HISD members also learned that privatizing requires sufficient staff; not only is staff needed to manage the consultants and their contracts, but additional staff is also needed to manage the day-to-day operations. It is also important to use standard data collection templates and validation procedures when privatizing. In addition, getting appropriate support and funding from upper management is crucial to the overall success.

LOOKING TO THE FUTURE

Looking forward, HISD plans to extend the periods of performance on contracts to eliminate the need for an annual rebidding process. The division is also in the process of converting to an all-.NET environment, as well as integrating with other systems like HMIS and GIS. In addition, HISD seeks to change its image from just a data warehouse to one that also provides analytical services. And, of course, HISD members will continue to fine-tune the processes and systems along the way.

District of Columbia's Successes and Challenges in Traffic Monitoring

WILLIAM MCGUIRK
JIANMING MA
District Department of Transportation

DDOT designated 402 locations to collect traffic data for HPMS in the city. Due to budget constraints, only traffic count data collection is conducted at about one third of those locations, i.e., 140 HPMS sites. DDOT collects 48-h coverage counts on the 140 HPMS sites. Data is collected and reported for all of 13 FHWA classes.

In order to estimate traffic volume information on other locations, monthly and day-of-week factors are developed at 263 locations. Seventeen RTMS units continuously capture volume, speed, classification (four classes), and occupancy data for entire freeway system in the District.

In August 2006, one virtual WIM station was successfully installed to collect weight, axle spacing, speed, volume, and classification data on Interstate 295. Overweight warning messages are transmitted to police patrol vehicles nearby for weight enforcement and safety inspection. In addition, three old WIM stations collect real-time weight, axle spacing, speed, volume, and classification data on arterials.

There have been no functioning permanent count stations due to lack of maintenance since late 1990s. Because of insufficient permanent count stations and other reasons, DDOT traffic volume map has not been formally updated since 2002.

Additionally, DDOT in-house staff collects manual and machine count data, such as, 10-h turning movement counts, pedestrian counts, speed studies, smart machine deployment, and 48-h machine counts based on special requests. Traffic Records Strategic Plan covering traffic crash and citation data is to be finalized in June, 2007

SUCCESSES

DDOT has achieved the following successes through numerous efforts put in traffic monitoring activities:

- I-295 virtual WIM station was inaugurated;
- Partnered with mobility technologies to deploy RTMS units on freeway system;
- Partnering with Metropolitan WashCOG to produce annual HPMS volume counts;
- Partnering with MDOT and VDOT to reflect continuity of annual volume data across jurisdictional lines and develop monthly–day of week factors;
- Contract to construct permanent count stations at 30 citywide locations to be awarded summer 2007;
- Transmission of data from signal controller to traffic management venter via signal system twisted pair communication cable;

- Modular design capable of supporting multiple technologies;
- Count station cabinet to be identical to current signal controller cabinet;
- Contractor responsible for 36 months of maintenance on all equipment;
- TMS for Highways (TMS-H) final report documents area where improvement is needed; and
- DDOT collected and plotted vehicular speed data at 446 locations covering all arterial and collector roads.

CHALLENGES

However, there is still much room for improvement in terms of accuracy, timeliness, integrity, efficiency, and comprehensiveness. Below is a list of challenges facing DDOT traffic monitoring professionals:

- Implement permanent count stations at 30 citywide locations.
- Work with FHWA to fund and implement TMS-H recommendations.
- Understand and collect motorcycle volume data.
- Implement the plan to annually update traffic volume map.
- Enhance web-based data availability for all data users.
- Recognize that volume, speed, roadway, and crash data are uniquely related. A common database drawing upon success of the Traffic Records Strategic Plan is a worthwhile goal.
- Implement permanent count stations to capture nontraditional peaks (weekends, special events, and nighttime).

For additional information about traffic monitoring efforts in the city, please contact William McGuirk at 202-671-1493 or e-mail: William.McGuirk@dc.gov.

Session Summary Comments

LANCE DOUGALD
Virginia Transportation Research Council

The first session of the workshop described the types of data that Virginia, Pennsylvania, Maryland, and District of Columbia collect including the challenges that each DOT faces in light of the Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (SAFETEA-LU) and other federal bills and policies. The second session titled Improving Organizational Decisions: Adding Value to Traffic Data provided insight on the importance of the quality of data, how data can be used to accomplish goals and objectives, what can be done to improve data for the purposes of making more sound decisions, and how data is captured and presented on websites in the mid-Atlantic region. The four topics of this session were:

1. The Importance of Traffic Data for Metropolitan Washington Council of Governments and Potential Benefits from Data Improvements. Presented by Ronald F. Kirby, Director of Transportation Planning, Metropolitan Washington Council of Governments.
2. MacArthur Traffic Impact Analysis. Presented by Rob Hranac, Berkeley Transportation Systems.
3. Discussion of Impacts of Decisions Supported by Traffic Data and Potential Data Improvement: The Analyst's Perspective. Presented by Michael Baxter, Maryland SHA.
4. Comparing Traffic Data Websites in the Mid-Atlantic Region. Presented by Praveen Edara, Virginia Transportation Research Council.

The Importance of Traffic Data for Metropolitan Washington Council of Governments and Potential Benefits from Data Improvements

RONALD F. KIRBY
Metropolitan Washington Council of Governments

Ronald Kirby's presentation titled It's Not the Model! The Problem with Counts addressed issues relating to the quality of data for modeling purposes. In particular, model performance, accuracy, and certainty are relative to the quality of the input data. Poor data can further complicate the model validation process. For air quality and traffic forecasting models, as well as obtaining regional vehicle miles traveled (VMT) data, AADT, annual average weekday traffic (AAWT), vehicle classifications, occupancy, etc., WashCOG obtains HPMS data from DDOT, Maryland SHA, VDOT, and other local jurisdictions. HPMS data, however, is an annualized traffic volume estimate based on a statewide sample of locations and data noise is a potential issue when using statewide HPMS data for a specific metropolitan area because statewide collection programs vary. Estimates are made on annualized traffic volumes because of the limited number of permanent count stations and variations in data collection cycles. The inconsistencies between state HPMS programs results in varying VMTs and annualized growth rates over a multiyear period and this variation promotes concern over the accuracy of count data.

In updating the traffic volume estimates for the Washington, D.C., region, WashCOG conducted model performance tests using actual and factored daily traffic volume estimates from program and permanent count stations. In conducting these tests it was noticed that there were systemic volume problems due to biased estimates on freeway segments. To address this problem, estimated counts were eliminated; by doing so, it was found that the systemic bias disappeared. The finding of this analysis was that model performance improved using counts of higher quality and certainty even though the number of actual count data locations was far less.

In conclusion, model performance is important for regional travel forecasting models. If the model is not matching observed data, the data should be scrutinized. WashCOG is currently working with Virginia, Maryland, and Washington, D.C., to verify the data used for such models.

DISCUSSION

It is easy to get the media to write about data, but they are less willing to write articles about forecast results. For example, a spike in emissions in the D.C. area was noticed by the media based on a 2-year trend starting in 2001. They compared this data to 2005 data and found that VMT was declining. The reporter's conclusion was that traffic is decreasing and thus people must be walking, biking, or taking transit more often. The lesson learned is that as a provider of data you are the victims of your own success and that people (especially the media) are not always using data for the purposes that data was intended for.

MacArthur Traffic Impact Analysis

ROB HRANAC
Berkeley Transportation Systems

The MacArthur Maze is a series of freeway connectors on the east side of the Bay Bridge in Oakland, California. As the feeder to the Bay Bridge and San Francisco from the East Bay, it is part of one of the most traveled freeway systems in the country. On April 29, a gasoline tanker fire caused a section of the maze to collapse. This collapse closed two freeway connectors in the Maze: 80E–580E and 80W–880S, as shown in the map of the San Francisco Bay Area (Figure 1). On May 7, the 80W–880S connector reopened. On May 24, the 80E–580E connector reopened.

The maps in Figure 2 show the detour routes for the closed sections. The 80W–880S section detour utilized an alternate—and equidistant—freeway. The 80E–580E detour route used arterial roads through West Oakland.

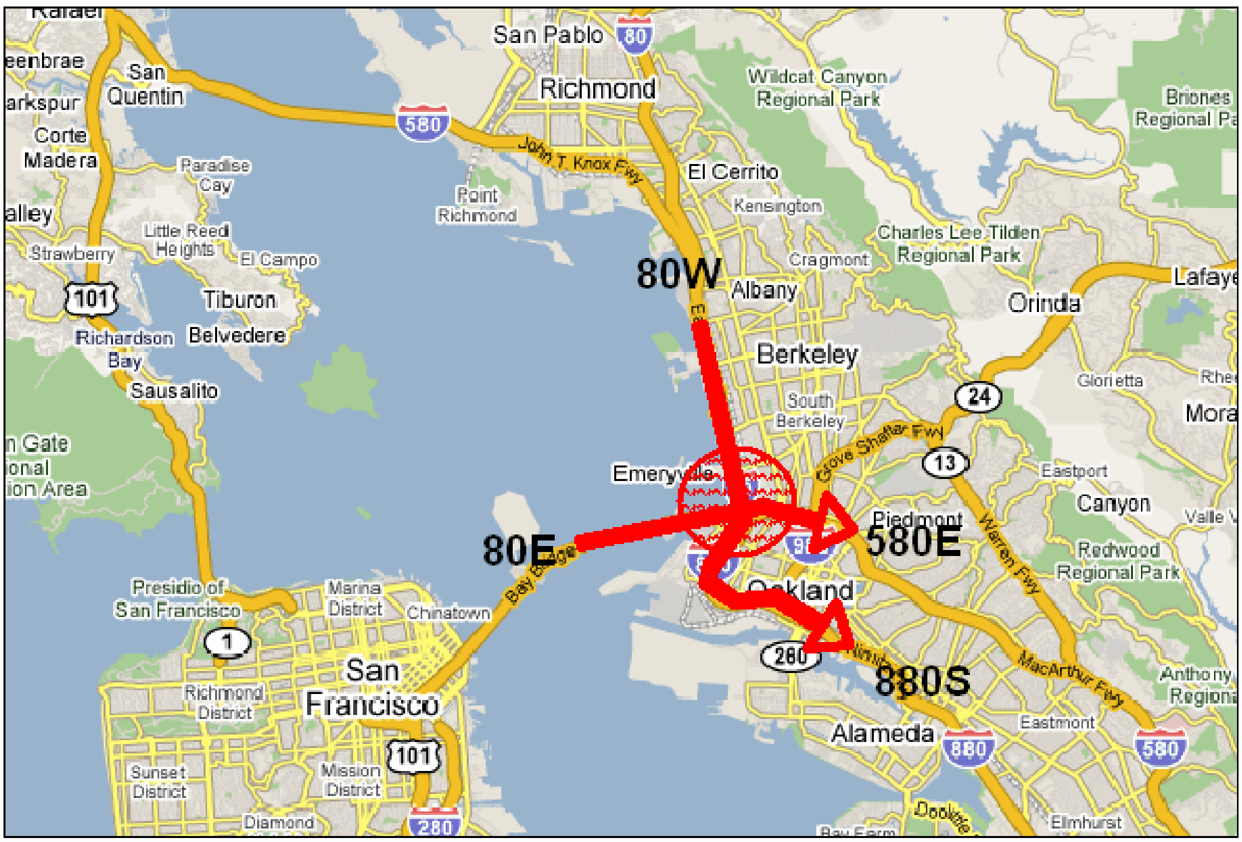
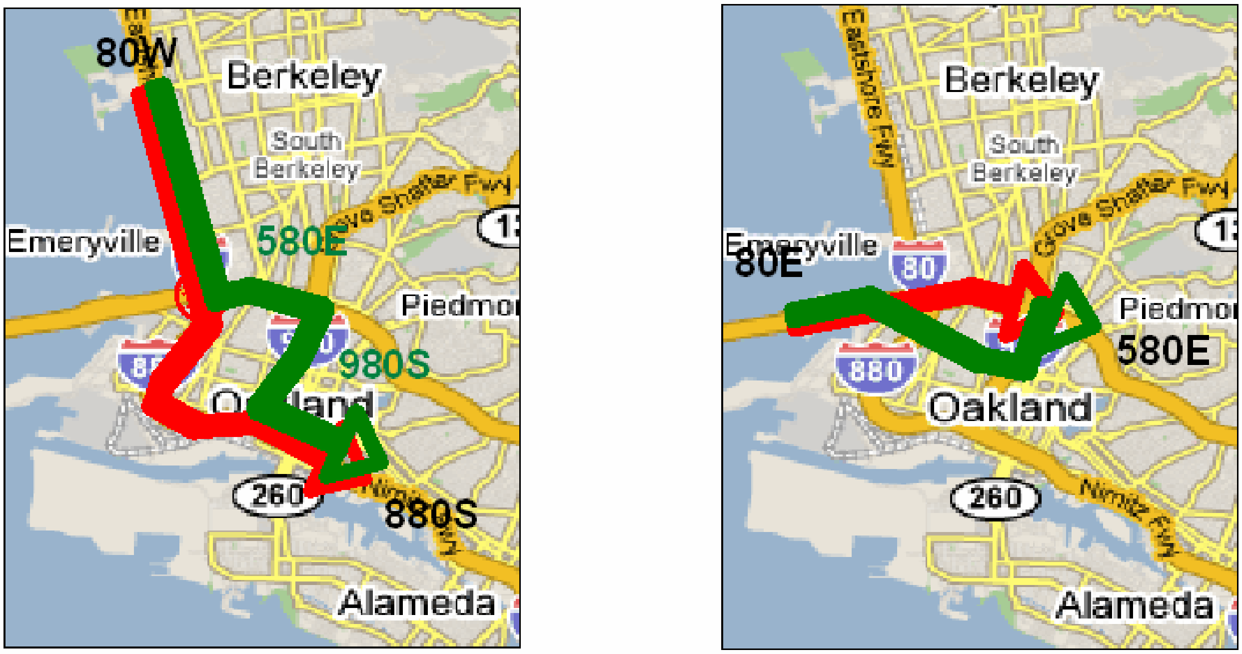


FIGURE 1 Map of San Francisco Bay Area.



(a) **(b)**

FIGURE 2 Detour routes for the closed sections:
(*a*) 80W–880S detour and (*b*) 80E–580E detour.

What happened to traffic in the San Francisco Bay Area during the month that the system was disrupted? To answer this question, California DOT (Caltrans) engineers and Metropolitan Transportation Commission planners used the Performance Measurement System (PeMS), a web-based software system that takes in automated data streams, saves them in a data warehouse, and build performance measures on top of them. PeMS is online at http://pems.eecs.berkeley.edu. Using PeMS, area transportation agencies were able to conduct instant analysis on the localized impacts of the collapse around the maze area, as well as the wider regional impacts.

The regional freeway system impacts during the first week following the collapse were somewhat counterintuitive. Regional traffic congestion actually decreased slightly, likely due to mode and time shifting by commuters. The collapse occurred during the early morning hours on Sunday and was well covered by both the local and national media. Most media reports predicted a chaotic commute and—likely because of this—volumes through the maze area were much lower than average on the first weekday after the collapse. Figure 3 shows the top 10 Caltrans District 4 morning bottlenecks on an average weekday (in yellow), along with the top 10 bottlenecks on first weekday after collapse (in red). This image demonstrates that the bottlenecks that normally exist in the collapse area were much smaller than normal.

Also of interest to engineers were localized impacts, on commute routes diverted by the collapse. The most impacted route extended from the Bay Bridge to the Caldecott Tunnel toward Walnut Creek and Pleasanton. On this route, freeway commuters were diverted onto local Oakland arterial streets during the maze reconstruction. The chart below (Figure 4) shows the difference between travel times by time of day before and during maze reconstruction. The shaded gray band represents the minimum and maximum average travel times on weekday

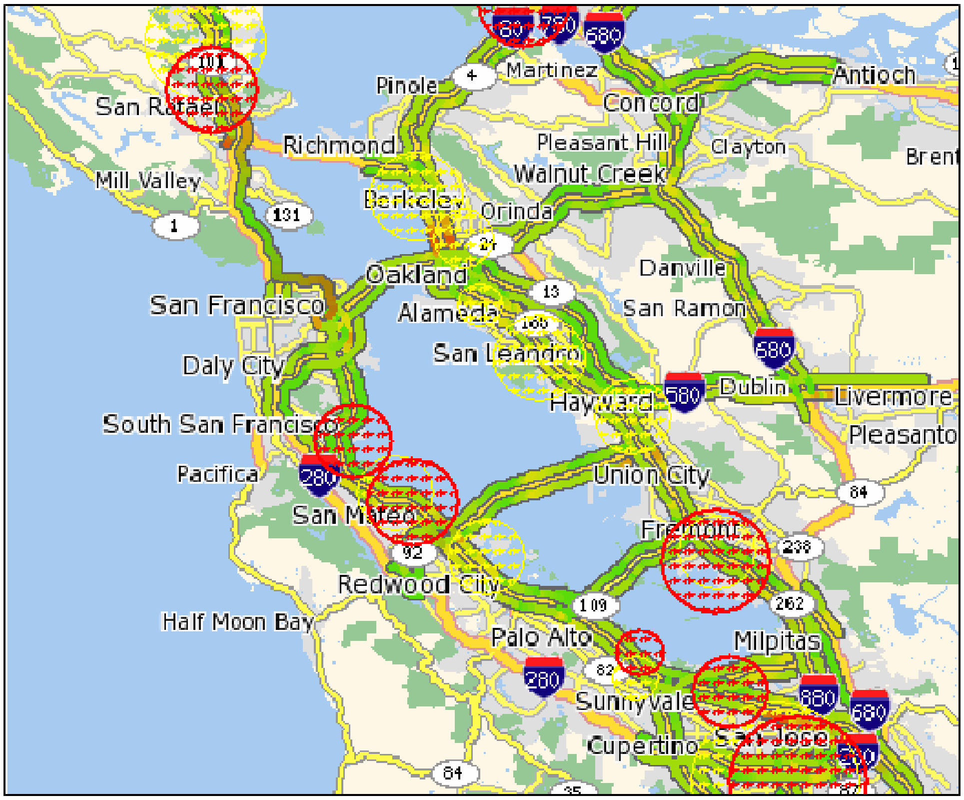


FIGURE 3 Top 10 Caltrans District 4 morning bottlenecks on an average weekday (in yellow), along with the top 10 bottlenecks on first weekday after collapse (in red).

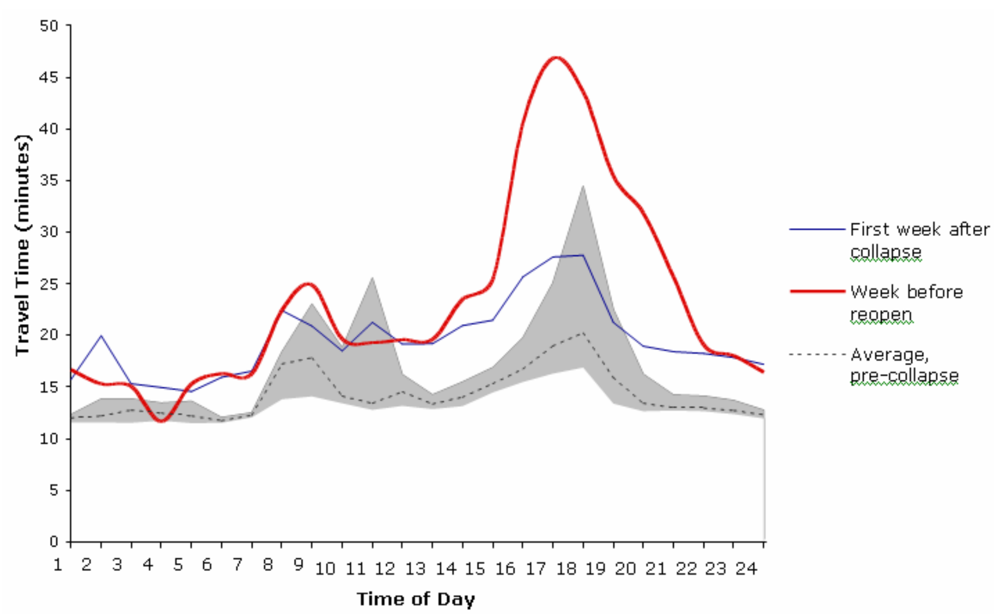


FIGURE 4 Travel times 80E at Bay Bridge to 24E at Caldecott.

before the collapse. The peak travel time for this commute occurs during the p.m. period and varies quite a bit: this route frequently suffers from non-recurrent, mostly incident-based congestion. The dotted line represents the average condition. During the week after the collapse (shown by the blue line), travel times were higher during all times of the day, but still fell below some of the worst pre-collapse travel times during the p.m. peak period. However, a few weeks later—just before Caltrans reopened the section—commuters had adjusted their behavior and volumes along the route were trending back to the precollapse norm. As a result, average travel times (represented by the red line) had worsened considerably, especially during the p.m. peak period. During the p.m. peak, travel times were nearly triple the average, precollapse times.

This analysis shows how useful real-time traffic data archives can be in helping agencies understand system impacts during times of crisis and adjustment. Because Caltrans has invested heavily in both its data infrastructure and the back-end software systems to make sense of the data that infrastructure gathers, it was able to quickly and efficiently inform its partner agencies of the transportation system impacts to commuters affected directly and indirectly by the MacArthur Maze collapse.

Discussion of Impacts of Decisions Supported by Traffic Data and Potential Data Improvement

The Analyst's Perspective

MICHAEL BAXTER
Maryland State Highway Administration

This article explores the impact that traffic data has had on decision making at the SHA of the Maryland DOT (MDOT). In addition, the article suggests ideas for improving traffic data from the perspective of the data analysts.

TRAFFIC MONITORING SYSTEM

In 1995, the SHA transferred responsibility for traffic data collection to its Highway Information Services Division (HISD). HISD uses the Traffic Monitoring System (TMS) for collecting traffic count data. The system has 79 automated traffic recorders (ATRs), with 69 ATRs currently online, producing data throughout the state. In addition, there are more than 3,700 short-term (48-h) program (coverage) count locations over a 3-year cycle. HISD also coordinates approximately 1,200 special project counts annually as needed.

Crucial to the success of TMS was the decision to privatize data collection efforts by using multiple consultant contracts. Consultants now provide program counts and all special project counts, including portable machine traffic counts, manual traffic counts, HOV counts, O-D studies, and on-site traffic engineering assistance. HISD members also meet on a monthly basis with traffic engineers from the travel forecasting team to review the ATR data. Short-term counts now require digital images of each count site, consultant professional engineer review and approval, and travel forecasting team traffic engineer review. In addition, the data is validated before it is uploaded to TMS.

SYSTEM MAINTENANCE AND PRESERVATION

Regarding system preservation, approximately half of the Consolidated Transportation Program is focused on system preservation and is formulated based on some level of traffic count, level of service, or travel data. For safety issues, traffic count information is the second most important component. There are also various funds for specific areas of highway maintenance such as spot resurfacing that use traffic count data as an important input.

CONSTRUCTION PROJECTS

For work on new or relocated facilities or major reconstructions, traffic count data is used to determine the type of facility, such as divided or nondivided, number of lanes, at-grade or gradeseparated intersections, and is also used to determine the pavement profile. Classification counts are necessary to capture the vehicle mix for the proposed area of work in order to calculate the projected axle loadings for the projected life of the pavement being designed. Count data is also used to formulate maintenance of traffic strategies.

HIGHWAY NEEDS INVENTORY

The Highway Needs Inventory (HNI) is a long-term, financially unconstrained technical reference and planning document that identifies highway improvements to serve existing and projected population and economic activity in the state. It also addresses safety and structural problems that warrant major construction or reconstruction. The HNI serves as the source document for SHA's portion of MDOT's Consolidated Transportation Program, the state's 6-year capital budget for transportation projects.

HIGHWAY PERFORMANCE MONITORING SYSTEM

Traffic count data, both volume and classification counts, are used to develop HPMS data items such as AADT, K-factor, D-factor, and percent trucks. ATR data is especially critical for the K-factor and D-factor items. HPMS data is used in allocating I4R funds, in the biennial report to Congress on the state of the nation's highways, and as input into various transportation models, such as Highway Economic Requirements System–State Version; and in transportation industry analyses such as those from The Road Information Program and the Texas Transportation Institute.

POSSIBLE IMPROVEMENTS

From the perspective of SHA's data analysts, the data might possibly improve with increased management support in relation to funding, staff, equipment, cross-organizational cooperation, and consultant resources. The data analysts also believe the data quality might possibly increase with the collection of more data in a timelier manner, improved validation techniques, better equipment, and a more accurate selection process when using statistical sampling.

CONGESTION ASSESSMENT PROGRAM INITIATIVE

This six-step process, wherein analysts use existing data to pinpoint congested corridors–hotspots, is illustrated in Figure 1. The analysts then use Skycomp[1] data for detailed section–corridor data. Next, they determine whether the congestion is recurring versus nonrecurring. Finally, the analysts provide feedback on the project planning and safety processes so that transportation funds can be used as efficiently as possible.

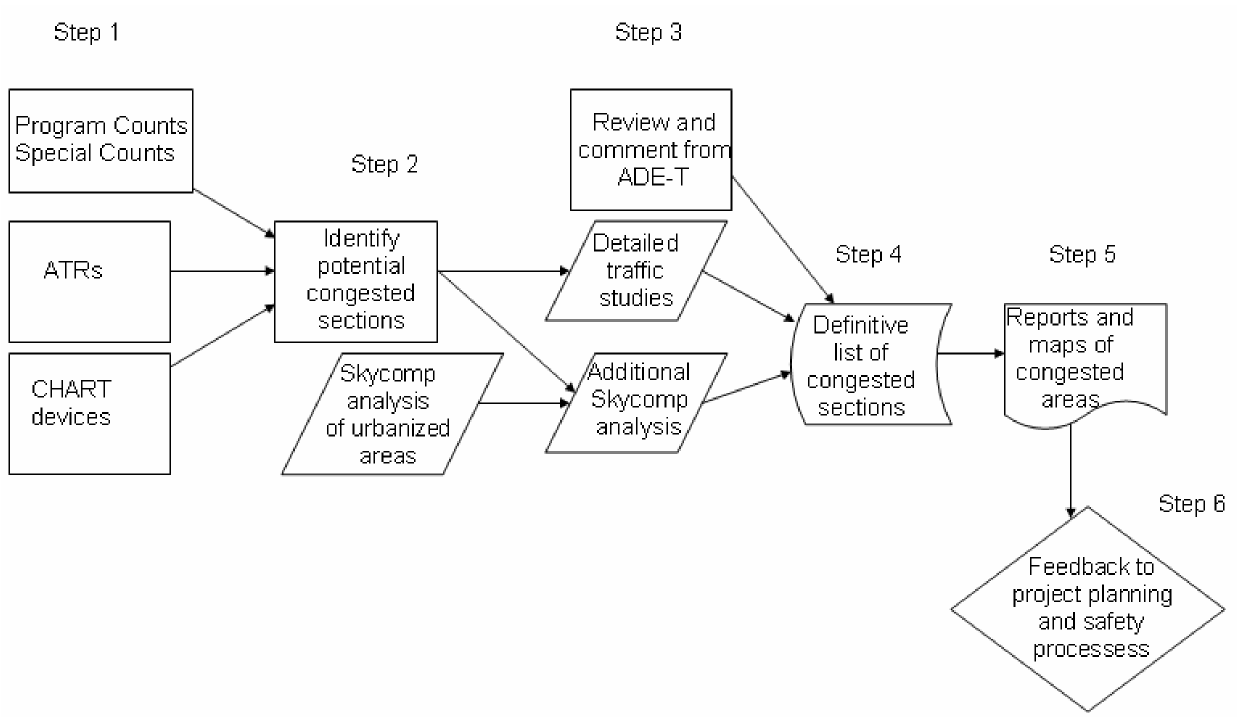


FIGURE 1 Proposed congestion assessment system process.

CONCLUSION

SHA's mission is to "Efficiently provide mobility for our customers through a safe, well-maintained and attractive highway system that enhances Maryland's communities, economy and environment."

In order to successfully address this mission, it is critical that we be able to determine what the demand is for our product, which is a safe and efficient highway system. Traffic data is a crucial input into many aspects of SHA's mission, from the high-level strategic documents to the every-day demands that need to be met in order to successfully accomplish this mission.

NOTE

1. Photodensity surveys by Skycomp Mobility Measurement.

A Review of the Traffic Data Websites of Four State DOTs
Washington, D.C., Pennsylvania, Maryland, and Virginia

PRAVEEN EDARA
Virginia Transportation Research Council

JINGXIN XIA
University of Virginia

State DOTs provide traffic-related information to the public via highway advisory radio, 511, and through the Internet. In this presentation, the Internet medium of sharing information is discussed. A review of the Internet websites hosted by four state DOTs—DDOT, PennDOT, MDSHA, and VDOT—was conducted and the results summarized in this presentation.

Traffic data websites can be broadly categorized into three categories: (*a*) websites that provide planning-level data, (*b*) websites that display real-time data and information, and (*c*) websites that provide traffic operations data.

WEBSITES THAT PROVIDE PLANNING-LEVEL DATA

DDOT provides a map of the city (and downtown) traffic links labeled with AAWT. PennDOT and MDSHA also provide similar maps with AADT information on the links.

MDSHA website provides information on traffic trends using ATR station data. Hourly, monthly, and seasonal fluctuations in traffic volumes at the individual ATR stations can be downloaded. Traffic volume counts by count type (e.g., vehicle occupancy, turning movements), day of week, county, route, etc., are also provided. Vehicle classification by functional class, annual highway mileage, VMT, etc., can also be downloaded from the website.

PennDOT website provides traffic data report that include traffic expansion factors and highway statistics report that include mileage and travel by system, functional class, county, and district.

VDOT, other than providing AADT and VMT data in excel format, offers an interactive GIS-based map with several data layers including traffic, rest areas, aerial photography, airports, Amtrak and bus stations, park-and-ride lots, ports, weigh stations, etc.

WEBSITES THAT DISPLAY REAL-TIME DATA AND INFORMATION

MDSHA offers an interactive GIS mapping application that reports live traffic conditions to the public. Currently, the provided information includes incident reports, weather-related road closures, current lane closures, live traffic cameras, local weather station images, speed sensor data, and current dynamic message signs.

PennDOT developed iTMS which is also an interactive web application. Highway links are color coded based on the traffic volume levels. Additional information on ADT, truck volumes, etc., is displayed when the links are clicked. Video images are displayed when the count sites with cameras are clicked.

DDOT is currently developing a web-based GIS mapping system to provide information on live traffic conditions to the public.

Virginia Road Alerts is a web-based mapping system of VDOT that provides information on incident reports, current lane closures, and traffic cameras providing live videos of the traffic.

WEBSITES THAT PROVIDE TRAFFIC OPERATIONS LEVEL DATA

DDOT provides operations data such as directional volume, speed, occupancy, and vehicle classification at 1-min time intervals on I-395, I-295, New York Avenue, and Pennsylvania Avenue. This data is made available through the www.traffic.com website.

University of Maryland's CATT laboratory hosts a data website that provides traffic data at a 5-min aggregation interval. Temporal plots of volume, occupancy, flow, speed, and detector health can also be plotted using the user interface of the website. Incident data can also be queried through the website.

In Pennsylvania, traffic operations data for Philadelphia and Pittsburgh are provided by www.traffic.com.

VDOT's Archived Data Management System (ADMS) provides real-time directional volume, speed, occupancy, and vehicle classification on freeways in Northern Virginia and Hampton Roads. Traffic data is provided at a minimum of 1-min aggregation. Temporal and spatial plots of traffic data can be plotted in the website. Incident data can be queried by type or duration. Other features such as weather download, mobility measures of effectiveness, and HOV monitoring and evaluation are also included on the ADMS website.

RESOURCES

Washington, D.C.

1. Traffic Volume Maps: http://ddot.dc.gov/ddot/cwp/view,a,1250,q,580996,ddotNav,%7C32399%7C.asp.
2. HPMS Data Collected through RTMS: http://stakeholder.traffic.com/stakeholder/index.html.
3. Transportation Planning and Research: http://ddot.dc.gov/ddot/cwp/view,a,1250,q,637773,ddotNav,%7C32399%7C.asp.

Maryland

1. Traffic Monitoring Site link: www.marylandroads.com/SHAServices/mapsBrochures/maps/OPPE/trafficvolumemaps/tms.asp.
2. Maryland's Traffic Trends link: www.sha.state.md.us/TrafficTrends2/
3. Maryland's Annual Mileage Report link: www.marylandroads.com/SHAServices/trafficreports/oppe/hisdreports.asp.
4. Maryland's Vehicle Mileage of Travel link: www.marylandroads.com/shaservices/trafficreports/vehicle_miles_of_travel.pdf.

5. Real-time traffic data: www.cattlab.umd.edu/.

Pennsylvania

1. Planning and Research Bureau’s website: www.dot.state.pa.us/Internet/Bureaus/pdPlanRes.nsf/PlanningAndResearchHomePage?OpenFrameset.
2. iTMS: www.dot7.state.pa.us/itms/default.asp.

Virginia

1. AADT and VMT Reports, current and historical: www.virginiadot.org/info/ct-TrafficCounts.asp.
2. GIS Map with a traffic data layer: www.virginiadot.org/projects/prOTIM.asp.

Session Observations

LANCE DOUGALD
Virginia Transportation Research Council

The four presentations in this session revealed the importance of utilizing data in a more strategic manner. Collecting data is not the end of the process. How we use, share, and archive the data that we collect is crucial in forming partnerships, delivering quality assessments, and gaining a better understanding of future data collection needs. Are we collecting the right kinds of data? Are we optimizing the use of our resources when collecting data? How much data is necessary or sufficient to track and monitor trends? Are we cognizant of the quality of data and how it affects the modeling process?

Some of the common themes in the discussions were that it is difficult to know what the demand for data is, how much data to collect, who is using the data, and how are they using it.

It was pointed out that agencies and companies involved with traffic monitoring and data collection need to make sure that data collection activities can be used for multiple purposes. Some participants emphasized that particular attention should be paid to levels of data aggregation and data quality. Further, to enhance data assessments, it was suggested that there is a need to archive data to a single location. Collecting and archiving data supports a variety of purposes, such as developing operational strategies, planning for operations, long-term planning, and policy and investment decisions.

> "If you cannot tell how your system performed yesterday, you cannot hope to manage your system today."
>
> —*Pravin Varaiya*
> *University of California, Berkeley*

Data Collection Challenges and Breakthroughs
Session Summary Comments

LESLIE MCCOY
LAINE HELTEBRIDLE
Pennsylvania Department of Transportation

The first presenter of this session was Rich Taylor of FHWA. Taylor provided an update on Section 1201, the Real-Time System Management Information Program, of SAFETEA-LU. This section of SAFETEA-LU requires the Secretary of Transportation to "establish a real-time system management information program to provide, in all States, the capability to monitor, in real-time, the traffic and travel conditions of the major highways of the United States and to share that information to improve the security of the surface transportation system, to address congestion problems, to support improved response to weather events and surface transportation incidents, and to facilitate national and regional highway traveler information."

Section 1201 also requires that "not later than 2 years after the date of this Act the Secretary shall establish data exchange formats to ensure that the data provided by highway and transit monitoring systems, including statewide incident reporting systems, can readily be exchanged across jurisdictional boundaries, facilitating nationwide availability of information." FHWA is currently working with standards development organizations, and the ITS architecture team on the data exchange format.

The goals of the Real-Time System Management Information Program are the establishment of a basic real-time information system in all states; the identification of longer range real-time monitoring needs; the development of plans and strategies and to provide the capability to share data. The proposed outcomes of this program are a publicly available website, a 511 information system, regional ITS architectures, and access to data through the Internet.

FHWA published a Request for Information in the *Federal Register* on May 4, 2006. The deadline for comments was July 3, 2006. Comments received were incorporated into the rule-making activity. Many comments focused on rolling out this program with high-priority information on high-priority roadways first. FHWA's current schedule has the rule and the data exchange format being issued in late summer of 2007. Program guidance and technical assistance will follow after the issuance of the rule.

Questions can be directed to Robert Rupert of FHWA. Rupert can be contacted at 202-366-2194 or e-mail: Robert.Rupert@dot.gov.

The remainder of this session was a discussion of data collection challenges and breakthroughs experienced by the attendees. This discussion was lead by Ralph Gilman of FHWA. During this session Dave Gardner of the Ohio DOT provided an update on standards and procedures. ASTM is currently developing standards for safety, transit and freight data. NCHRP has spent approximately a year and a half on revising the AASHTO guidelines to traffic monitoring and data collection. This revised publication is in final draft form and could be published by the end of 2007.

One of the topics discussed during this session was traffic data collection and access by the public. While many states provide access to raw traffic data via the web, only Pennsylvania provides traffic data that has been factored. VDOT had problems using traffic data collected by a private firm using ITS technology due to a restrictive agreement with the firm. Due to this experience, Virginia has negotiated new less-restrictive agreements in order to make use of this traffic data.

A lengthy discussion took place on the FHWA's requirement that by June 2008 states be required to collect and report motorcycle travel data as part of their annual HPMS data submittals. NHTSA wants this data because over the past several years NHTSA has seen motorcycle crashes, fatalities, and registrations increase while motorcycle VMT has remained flat. While 44 states currently report motorcycle VMT in their annual HPMS submittal to the FHWA, there is concern about the accuracy of collecting this data. Some of the issues states have experienced trying to collect this data include: traffic counting equipment not configured to collect motorcycle data (attendees from Jamar and Gold River companies stated their equipment is configured to collect motorcycles); motorcyclists avoid riding over piezos imbedded into the pavement (costs to states could increase if larger piezos are required to ensure that motorcyclist cannot ride around piezos) and the FHWA's *Traffic Monitoring Guide* states that traffic counts should be taken during the week (trends indicate that motorcycle travel is higher during weekends). Many state participants felt road tubes were currently the most accurate technology to collect this data.

Other potential methods to collect this data that might be more accurate were discussed. These ideas included working with state licensing and registration agencies to collect and store travel information from motorcyclists during the registration process or using the FHWA's National Household Travel Survey to collect this data. Another suggestion was madeto propose a research needs statement for NCHRP a project on the collection of motorcycle travel data.

A third topic discussed during this session was classification of vehicles by length and the use of nonintrusive technology to collect traffic data. Currently nonintrusive technology can classify vehicles into four bins. FHWA will accept this data if the state can relate the four bins to the current FHWA 13-class scheme. Ohio DOT stated that length classification is working well for them. Ohio recently started reporting three bins of length classification data to the FHWA. The FHWA is in the process of organizing a pooled fund study on collecting vehicle classification data by length. One state has already committed funding for this study and the FHWA is currently looking for other states to participate.

The use of GIS to report and display traffic data was the final topic discussed during this session. The Baltimore, Maryland, MPO has been using a consultant to assist with the creation of a latitude–longitude spatial model because the current one is inaccurate. Dave Gardner of the Ohio DOT stressed that data has to be correct to be able to use GIS. Currently Ohio has GIS applications that are available but they do not use them if the data is compromised.

The Analyst's Perspective
Can't Do It Without Data, but Decisions Are What Count

TIM LOMAX
Texas Transportation Institute

The Mid-Atlantic region agencies provided a wealth of information on their current practices and the direction of their data collection programs. Participants identified data programs, data uses, data users, and data challenges. The material provided in advance of the meeting also provided a wealth of information on the states and the Washington, D.C., region. This section presents my thoughts on how those data issues affect and are affected by the analytical processes and the end users of the data.

I will use some sweeping generalities in this discussion. These observations are not true for every situation all the time. As the text message says, ymmv (your mileage may vary).

- Significant advances in data have dramatically changed the analysis capabilities but also resulted in greater expectations, as well.
- We can now tell better story about the condition and performance of the system and infrastructure elements.
- Some institutional elements, however, are still set in old ways of accomplishing the mission. Or worse, do not even recognize the importance of the service mission that transportation fulfills.
- More of the project program effects can be illustrated with direct data.
- Data is being used to power better models of alternative effects of improvement strategies
- "Data is an asset." I think this is a good way to think about the issues. Data is not an end; it is a resource like people or machines. Data needs an investment of time, staff, equipment and funding. *Transportation Research Circular E-C109: Transportation Information Assets and Impacts: An Assessment of Needs* (TRB, 2006) provides a good overview of this issue (http://onlinepubs.trb.org/onlinepubs/circulars/ec109.pdf).

USING THE DATA

How does Wal-Mart make money? Data! In general, they don't make money selling things. Many defunct merchants sold lots of things—it just cost them more to make and sell them. Wal-Mart knows the cost, manufacturing, and delivery times, inventory needs, etc., for the commodities in their stores. They have a rapid reaction time to market trends; they buy in huge quantities which gives them low wholesale prices. Wal-Mart understands market trends quicker because they analyze their sales data. And they do it at the store level, not just national trends.

You, likewise, are in the data business—it is a vital business. But it is like a business; you need to market the information, know customer needs, and be aware of competitors (although in most cases the "competitors" are really potential partners as they are collecting the same kind of information). Neil Pederson of the MDSHA said (this is my paraphrase) "decisions get made on a Tuesday, not when the data are of the highest quality." And sometimes even when the data are not sufficient quality. But if data are understood and understandable they can play a part in the decision. Most of these people are more comfortable with uncertainty than the data collectors. The guiding philosophy of data providers and analysts should not be "Hold onto the data until it's perfect." Most likely it should be "communicate the results and the uncertainty." Decision makers will "get" the issues (see Figure 1), make best decision possible and, if they're not comfortable with the possible error, invest in better data.

It is difficult to engage a conversation if there is no way to understand the concept, how the condition varies, how it affects travelers, shippers, taxpayers, voters.

LINKING DATA TO DECISIONS

If we were producing widgets we'd want to know how many widgets were being shipped and bought, what color, where? How much shipping time? Production time? How much does the travel time vary from day to day? How many get broken in shipping? And what should we change to make improvements in our products, sales, revenue and profit?

These kinds of requirements in transportation data usually look like the need for connecting several different data sets to create a comprehensive picture of conditions and performance of the system. Storing the common data sets together is one way of accomplishing this. For example, volume, speed, crash, incident, weather, special events, roadwork, price, signal timing, and operations data are all related to a variety of transportation factors and system performance aspects. Creating a complete picture of transportation information would also include a variety of inventory information, closed-circuit camera data, and other archived information. These data can be stored and used in GISs, archived datasets, operations deployments, and near-term planning activities.

Information systems that combine these various data sources are more powerful and valuable. Issues of time and geographic scale are also relevant, but the reporting requirements of the various uses are different. In some cases, continuous data from monitoring systems are available and in other cases using sample data and factors are the only ways to produce the needed statistics. In all cases, however, data collectors and analysts alike must maximize the use of data for current performance, monitoring and reporting purposes, as well as using the data to improve models and estimation techniques. As with the Wal-Mart analogy, the combination of good data used for many purposes throughout the agency is hard to beat. All the review makes the data better and the multiple uses make the data more valuable.

GISs that map the data to system, land use, and political geographies were identified by workshop participants as another subset of information use. A GIS can provide display elements

Measured Value = 15.02 ± 1.83

Interesting to Decision Makers	Interesting to Data Producers

FIGURE 1 Focus of interest (a simplistic example).

but can also be used to develop work plans, equipment deployment, and resource allocations. Mapping provides a range of uses from when and where studies are taking place and equipment is installed to illustrating results.

CHANGES IN DATA PRODUCTION METHODS

Data sharing, "data stitching," data fusion—these phrases describe one of the very important elements of future data collection operations. Data will be used for many purposes—the challenge may be to combine the data sources to provide data for a range of analyses at the least cost or most efficient use of resources. Traffic impact analyses, signal timing studies, and many daily operations use a variety of data sources and data collection studies. One problem with these, however, is that the data are often lost because they do not fit within traditional or typical dataset constructs. This might require the development of data collection and analysis techniques that satisfy a broad range of uses and users and the inclusion of special data into datasets so that they can be used more than once.

Just to continue the analogy for one more paragraph, Wal-Mart doesn't have one supplier make all the large blue shirts and another make all the extra-large red shorts; they have specifications for what is blue and red and large and extra large and they look for the best way to produce what their customers will buy. Most importantly they react really quickly. They don't make shorts that look like the ones that Magic Johnson wore in the 1980s.

Continuous count, speed, travel time, and weigh stations are even more visible now than in the past. An example of the way data collection is changing is the emphasis on real-time traffic congestion data for the 511 traveler information programs and websites. Is that our only vision for that kind of data? I'd like to see the focus on the traveler information data needs used to build awareness of what it takes to power the real-time sites and how to use it for planning, investment analysis, design, operations, maintenance, etc. One example is that the electronic toll collection tags that are used to provide speed data on all freeways in some regions cannot provide volume or classification data and because the focus is on speed, volume counts are much less important. But if that data is to be used for travel delay estimates, program evaluations, and planning purposes, volume counts are a key element along with data on weather, incidents, road work.

Partnerships—both inside and outside of the agency—can be very useful. Private-sector data collection efforts have received a lot of attention lately, but the public–public partnerships are perhaps more vital. Various groups within agencies can share data but agencies increasingly use other governmental entities as data, information, and analytical resources. State DOTs for example, call on local governments to help collect data and provide information about projects. These agencies can provide knowledge about events and system usage patterns and are also particularly well positioned to provide data quality checks. In general, getting many partners involved in collecting, reviewing, and using the data is a good practice; it allows analysts to see the data they might have access to and a variety of different expertise can examine and test the data to ensure it is reasonable.

CONCLUSION

What do we do when a reporter, commissioner, or legislator calls to ask about the data and an analysis? Or when construction activities remove data collection sites? We should take these opportunities, and any others that come along, to say something about the data and their ability to support decisions that improve our economy and quality of life. We should leverage any opportunity we get to describe the connection between data, analysis and "things you'd really like to know," to both external and internal audiences. Otherwise we might be guilty of a form of vandalism similar to the folks who destroy traffic counters (although without the risk of sheet metal cuts). If these individuals and groups do not have an appreciation for the role of data in their decisions, it will be difficult for them to justify investments in data improvements.

Thank you for your time and for the great ideas I am taking away from this workshop.

Summary from the Data Collector's Perspective

THOMAS SCHINKEL
Virginia Department of Transportation

State DOTs are facing new challenges in meeting the needs of an ever-increasing customer base for traffic data. Traditional and new customers are hungry for quality data to make practical, data-supported business decisions. The May 2, 2007, Regional Workshop provided a tremendous opportunity for Mid-Atlantic region state personnel involved in traffic monitoring data collection and analysis to come together and share successes and challenges in meeting those needs. It also provided an opportunity to meet with customers and receive reinforcing feedback about how important the data the traffic monitoring community provides is to the success they will have in their own program areas.

During the workshop, representatives from the District of Columbia, Maryland, Pennsylvania, and Virginia presented successes and challenges for their organization's traffic monitoring programs. Successes included the following:

- Privatization. A common success theme among presenting organizations was the detailing of a degree of privatization within their data collection programs. The degree of privatization ranged greatly. One state is in its 12th year of managing all maintenance and construction of the continuous station data collection program as well as all of their coverage HPMS traffic counting through contracts. Another is looking to award contracts this year to revitalize their own continuous station data collection program. In a period of declining full-time employees for many governmental organizations, the successful integration of contract workers and data collection is critical to program success. Lessons learned such as the need to retrain current staff from doers to contract managers and the need for clear contract specifications, among many others, were shared.
- Web application presentation of data. Each organization detailed successful experiences in reaching data customers through internal and external web applications. By having direct access to factored and raw traffic count data, customers are able to conduct their own data mining to meet their needs; leaving the collectors to concentrate on data acquisition issues. Direct customer access to traffic databases adds exponentially to the value of traffic data as it encourages users to research data and develop their own applications.
- Nonintrusive technology. Presenters detailed their organization's experiences with nonintrusive technology testing and deployment. Data collectors are increasingly looking to these types of technologies for safer data collection in high-volume areas. Experiences were detailed as successful, but with wide-ranging results. Those wishing to learn more detail about the individual state plans should contact the state directly. With the growing importance of nonintrusive data collection, states in the region could gain benefits from the technology quicker by sharing their experiences better.
- Sharing data with operations. In a break with traditional data sharing arrangements, Virginia detailed a program where traffic monitoring continuous count station data is shared in near real time with the state's operations sections. Operations personnel read the volume,

occupancy and average speed directly from the ATRs each 5 min. Traffic trends have been established and alerts can be provided to operators when unusual traffic conditions occur, allowing them to recognize and react to potential incidents faster. The program has been a success in Virginia and has been reviewed by FHWA with an eye towards its potential to meet data needs of the 1201 program.

- Good practices. A number of items were discussed as successes by one or more of the organizations that are grouped together here under a good practices heading. They include:
  1. Automated data review based on established criteria (directional splits, peak volume percentage, repeating values, zero interval values, percent unclassified vehicles, etc.) that assist personnel in quality reviewing of data.
  2. Requiring digital photographs of contract coverage count locations. Photographs can provide a great deal of information about the traffic count and location counted, but typically are used to provide a record of the conditions up and downstream from the traffic count sensors as well as the condition of the sensors at pick up.
  3. Deeper installation of inductance loops which results in survival through normal milling–maintenance operations and uninterrupted data flow.
  4. Using long-term pavement performance-provided software to analyze international roughness index data and select smooth pavement for WIM sensor installations, greatly increasing the chance for successful data collection with these expensive resources.
  5. The importance of contract inspection programs was discussed. Ensuring that contract specifications and good data collection practices are followed is a critical element in achieving a quality data product. While inspection by state employee staff is the norm, one state discussed a contractor videotape self-inspection program. Contractors are required to videotape their own work in setting up a traffic count. The videotape specification also includes submission of one-time interval of traffic data synchronized with the traffic counter. The videotape is reviewed in the state offices for specification compliance, with the final check for acceptance being whether the taped traffic interval matches the electronic traffic data file submitted by the contractor.

CHALLENGES

Along with the successes, each organization was asked to present challenges they faced in their data collection programs to provide the audience with a better understanding of the issues involved with collecting quality traffic data.

Traffic Counting in High-Volume Conditions

Counting traffic in high-volume conditions does present challenges to traffic data collectors. Stop-and-go traffic is particularly difficult to accurately count. There also is a safety factor associated with setting up data collection equipment in these conditions. Nonintrusive technology solutions are increasingly being tested and used to minimize safety issues, but they bring with them their own data quality issues. The good news is that improvements to nonintrusive technology are continuing to be made.

Collecting Motorcycle Data: Estimating Motorcycle VMT

A common challenge mentioned by each agency responsible for data collection was a concern over the collection and reporting of motorcycle data. Some have not been collecting the data, while others have been collecting it but have concerns about the magnifying glass they feel is about to be placed on estimates provided. Listing a just a few of the specific motorcycle-related challenges addressed during the conference:

1. Motorcycles are a small, lightweight vehicle that can be difficult to collect with some sensors.
2. Coverage counts are typically collected year round due to the size of programs and number of counts required. Motorcycle traffic can be very seasonal and VMT estimates would be affected by the month counts were collected.
3. Coverage counts are typically collected Monday through Thursday. Motorcycle traffic can be highly recreational–weekend influenced, again impacting on the VMT estimate.

Summarizing the data collectors' concern for this challenge, because of the issues related to collecting the data and the comparatively low percentage of VMT for motorcycles as a vehicle class, a subtle collection program change could result in a significant, but misleading, percentage change for motorcycle VMT.

Other challenges that were detailed by one or more of the data collection agencies included ramp counts, insufficient continuous count stations for factor creation, counts on local roads, sensor grouts failing and cutting short the useful life of count stations, program funding, and staffing.

In the sessions presented by data users, the data collection community clearly heard the importance of quality traffic data to the success of their programs. In many instances, the customers' comments mirrored the challenges detailed by the collection agencies in their presentations. The data collectors' challenge is to continue to strive to meet the ever-increasing needs of the data users, hence the importance of continually looking for opportunities for dialogue on evolving needs and understanding of data quality issues.

APPENDIX A

Advance Questions for Departments of Transportation

Traffic Monitoring Data Workshop: Successful Strategies in Collection and Analysis

KEY ISSUES

What burning issues are you facing?

Delaware

Politics, lack of funds, lack of personnel, reasons why things can't be done—nothing that can be addressed or solved at a workshop.

District of Columbia

Funding, training of staff, and how to safely get short-term counts on freeways and bridges.

Maryland

Incorporating ITS data into our traffic monitoring program is a burning issue.

Pennsylvania

HPMS reassessment and the impacts on data collection with the collection of traffic counts on ramps and motorcycle data

Virginia

An axle sensor with a longer life—we are constantly replacing failing piezo sensors to collect classification data. A safer way to collect short-term traffic count data at high-volume locations.

What topics and issues would you like to address at the workshop?

Delaware

[No response.]

District of Columbia

State of the practice software for processing data. How to integrate traffic data into GIS-based roadway inventory data.

Maryland

Nonintrusive traffic detection is always a good topic to address.

Pennsylvania

Collection of accurate motorcycle data without compromising other vehicle classes

Virginia

Both of the above issues. Also any direction or guidance available from FHWA on length based classification and use of it in state data collection programs.

Do you have any successes that you could share with others?

Delaware

No.

District of Columbia

In order to make a better coverage, we created a 3-year cycle HPMS count sites map and we are working on the 6-year cycle count sites map. Those maps clearly lay out the data collection schedule.

Maryland

Since inheriting the TMS program in 1997, we have improved the long-term down list of ATRs from approximately 22 to a recent total of eight. We currently have two field technicians assigned to the ATRs and have recently awarded an ATR maintenance contract to assist in the repair and maintenance of the ATRs.

Pennsylvania

iTMS: the Internet TMS which allows anyone with internet access to look up traffic counts on Pennsylvania state-owned roads and local roads on the functional classification system. iTDUS: a web-based system for planning partners to process traffic counts. Statewide Traffic Count Services contract which allows PennDOT and our planning partners to procure traffic counting services from vendors. Implementation of a locally owned, local functionally classified roads traffic counting program. Partnering with our MPOs to collect traffic data.

Virginia

- Sharing data from continuous count stations in near real-time with our traffic operations groups.
- VDOT best practices with road tube traffic data collection.

COLLECTION INVENTORY

How many continuous traffic monitoring sites do you have?

Delaware

75.

District of Columbia

14 RTMS sites plus three WIM sites.

Maryland

Maryland has 79 ATR sites total; 71 sites currently operating.

Pennsylvania

78 (60 ATRs).

Virginia

318 stations: (*a*) includes 6 WIM stations; (*b*) 294 volume/speed/classification stations; and (*c*) 18 volume/speed only.

How many coverage count sites do you have?

Delaware

800.

District of Columbia

1,800 sites.

Maryland

Maryland currently has 3,737 coverage count sites on a 3-year cycle which is subject to change due to HPMS requirements and roadway openings, relocations, and closings.

Pennsylvania

Approximately 32,500.

Virginia

- 17,000 48-h counts on the higher functionally classified roadways collected on a 3-year cycle (about 5,600 annually).
- 11,270 24-h counts on the local road network collected on a 3-year cycle (mostly urban samples and unpaved roads).
- 75,750, 24-h counts on the local road network collected on a 6-year cycle.
- 2,500, 24-h counts on the local road network collected on a 12-year cycle (built out subdivision roads).

How many vehicle classification sites do you have?

Delaware

23.

District of Columbia

Three WIM sites.

Maryland

Maryland has 17 ATRs equipped for vehicle classification and 1,640 portable vehicle classification sites.

Pennsylvania

Five.

Virginia

- 300 of the continuous-count locations provide vehicle classification data.
- 6,200 of the 3-year cycle 48-h counts provide vehicle classification data.

How many WIM sites do you have?

Delaware

23.

District of Columbia

DDOT also collects travel time, vehicle occupancy, speed, pedestrian counts, and turning movement counts at intersections.

Maryland

Maryland has a total of six WIMsites, but only one is currently collecting data.

Pennsylvania

13.

Virginia

We operate six stations and intend to expand the operation in 2007. We also have a data sharing agreement with the state Department of Motor Vehicles and use their information from their three stations that meet our data quality needs.

What other traffic data do you collect (travel time, vehicle occupancy, etc.)?

Delaware

None.

District of Columbia

[No response.]

Maryland

Maryland collects (through our TMS consultants) turning movements, pedestrian, manual classification, machine classification, machine speed, machine volume, delay, travel time, license plate surveys, and vehicle occupancy counts. We are just starting to get into freeway and arterial level-of-service ratings based on aerial photography of state highways.

Pennsylvania

Speed.

Virginia

We manage the special studies data collection program which is used to meet department traffic data needs not met by the regular program. In 2006 that included 149 directional turning movement studies, an additional 260 vehicle classification counts, and a smaller number of a variety of studies such as license plate surveys, time-delay studies, occupancy counts, and etc.

COLLECTING TRAFFIC DATA

Does your state use consultants for traffic data collection?

Delaware

Vendor provides coverage counts. Occasionally, we'll use a consultant for special project counts such as turning movements or intersection counts.

District of Columbia

Yes, we do.

Maryland

Yes, our office has been utilizing consultants since 1997. We currently have seven active contracts to collect traffic data.

Pennsylvania

Yes, three.

Virginia

Yes, in both our continuous count program and our short-term count program. We currently have three consultants on board.

Do you share and use traffic data from each other—state and MPO?

Delaware

State and MPO? Virtually everyone uses our count data. We do not use data from other sources.

District

Yes, we do.

Maryland

Yes, we have a good working relationship with the BMC. BMC gets traffic count data from us either from our website or by special requests from our Traffic Engineers. We allow BMC to load validated traffic counts that they perform on our website.

Pennsylvania

Yes.

Virginia

We share data with all requesting organizations. We have had limited success using data from other agencies due to coordination, format and quality issues.

How do you market your traffic data and satisfy your customers?

Delaware

We provide data to anyone via our Internet site.

District of Columbia

DDOT makes traffic volume available online, so everybody can get traffic volume data for free.

Maryland

Maryland markets its traffic data through word of mouth and through our Traffic Monitoring System internet website at: www.marylandroads.com/SHAServices/mapsBrochures/maps/OPPE/trafficvolumemaps/tms.asp. This website contains traffic volume maps with AADT counts from 1980 to the present for Maryland state roads. The site also contains traffic trends, traffic count data reports, and traffic station history. The traffic station history report reflects the AADT in Maryland for the last 5 years (presently 2001 through 2005) and the annual average weekday daily traffic (AAWDT) for 2005. It contains the county, route, mile point, station ID, description, AADT, and the AAWDT for each station. The report is sorted by county, route, and mile point in ascending order. We also have hard copy reports available to our customers.

Pennsylvania

We have iTMS a traffic data website that shows current information for every site we are responsible for collecting. We are also in the process of designing a marketing plan for the Transportation Planning Division to market what we do and our products and services to other areas within PennDOT and the public.

Virginia

- Publications with traffic estimates and reports are made available via the Internet and also can be purchased in hard copy.
- Raw traffic count data are made available departmentwide via the Intranet.
- Direct, read-only access to our Oracle database provided to “power user” internal customers.
- Traffic data is made available as a layer on department GIS applications.
- Each time a jurisdiction is to be counted those responsible for the roadways are notified of the data collection effort through a letter. The letter provides a contact name/number, and they are offered the traffic data that will result from the counts.

- Custom data reports are created for some customers to satisfy their reporting needs; VDOT environmental and nonattainment air quality reporting being an example of a major work effort.
- Many, many customers are provided with standard export sets of selected raw traffic data. MPOs and city–county government agencies being the primary customers for large data sets. A few consultants also receive large data sets; usually when working for such agencies. Many consultants receive small data exports for localized projects.
- Each Thanksgiving an Interstate system forecast of traffic conditions (telling drivers when they can expect congestion) is provided based on historical traffic conditions at continuous count stations. This report receives widespread and positive news coverage within the state.
- Staff members attend meetings and serve on committees to explain what data is available and bring customer desires back to the group. A recent success was the effort to redesign the WIM program to meet the needs of the Mechanistic–Empirical Pavement Design (2002 Pavement Design Guide) program needs.
- Attempts are made to contact potential customers, hoping to push the data to them. Sometimes successful, sometimes not.

What new traffic data initiatives are you working on?

Delaware

At the moment, none. About 2 years ago, we attempted to have our iTMS people provide us with data that they collect, but throw away. We asked our consultant to spearhead an effort to integrate their count data into our count program, but the consultant dropped the ball.

District of Columbia

DDOT is working on Traffic Records Strategic Safety plan which involves traffic data, crash data, roadway inventory data, etc.

Maryland

Currently, we are testing nonintrusive side-fire radar detectors at three sites (all sites will be adjacent to an ATR station) along the Baltimore Beltway (I-695), Capital Beltway (I-495) and on an arterial (US-29) to verify the ease of installation, accuracy of the traffic volumes, and classification counts (by length) of the detector units. Installation and testing will be performed at the three sites for a period of 6 weeks without any need to close any travel lanes at any time.

Pennsylvania

Our division has a website (iTDUS) solely for the purpose of enabling our traffic counting partners and vendors to process traffic counts and submit them to PennDOT to then upload to our mainframe. We are also in the process of developing a locally owned road database to assign, process, track, and store counts on nonstate locally owned roads. We are also testing a couple of nonintrusive data collection devices.

Virginia

- Expand use of continuous count station data by operations groups. We have found that our data quality standards are generally higher than those in operations. Meaning it usually is easier for us to operate the data collection effort and share with them rather than the other way around.
- Testing of a higher output piezo with a deeper installation—attempt is to improve longevity of the sensor.
- We'd like to test the technology using laser for vehicle classification, but are not actively working that right now.
- Possible expansion of our continuous data collection effort on the Interstate for the purpose of providing data for delay measurement and performance reporting.

What technologies are used to collect vehicle classification data?

Delaware

We use piezos. Some of us are looking into the possibility of using the Groundhog Permanent Traffic Analyzer technology at selected sites or at selected times. Unfortunately, the Groundhog seems to do everything except collect WIM data, but it's easy to install. So far, we are not getting much support.

District of Columbia

DDOT plans to make use of different technologies for 30 new permanent count stations such as inductive loops with piezoelectric sensors, microwave detection system, acoustic detection system, video detection system, and infrared detection system. The permanent count stations are expected to be under construction later this year

Maryland

Currently, a number of our ATRs with loop, piezo, loop, collect vehicle classification. The WIM sites collect class with piezo, loop, piezo, and loop. Our consultants utilize road tubes, the nonintrusive TIRTL device, and by manual classifying

Pennsylvania

We use our WIM and CAVC sites along with portable counters that field staff and the agencies use.

Virginia

- Continuous count stations use two loops and one piezoelectric sensor installed in each lane; ADR 3000+ with loop logic.
- WIM sites use two Quartz piezo sensors and one loop installed in each lane along with an ADR 3000+.

- Road tubes and ADR 1000 with tailgating feature turned on. The tailgating feature provides for two cars traveling close together to be classified as two cars and not combined into one Class-8 vehicle as many counters will do. VDOT best practices are used to setup road tubes with each lane setup separately (independent arrays), when traffic conditions warrant, to provide a quality data product.
- Length-based classification (from two loops per lane) used for speed studies to separate truck speeds from cars. This data is for internal use only and is not submitted to FHWA as classification data.
- Length-based classification data from nonintrusive technologies has not passed our data validity checks and is not used.

Do you use in-house–outsourced, client–mainframe software to process your count data? what procedures were required to obtain software?

Delaware

Count data are collected by our Traffic Section, but we use Chaparral's TRADAS software to process the data and we use their staff for support functions to develop our annual Traffic Summary Book.

District of Columbia

So far, DDOT uses Microsoft Excel software to process count data.

Maryland

Maryland uses a web-based application with an Oracle backend to process and load the count data. The application was created by consultants for Maryland SHA. Maryland owns and maintains the software.

Pennsylvania

We use an in-house mainframe to upload and store traffic counts that have been processed through the iTDUS website.

Virginia

We have been using in-house developed software since the late 1990s after a failed attempt to meet our data processing needs with an off the shelf product.

Our software consists of three main client applications that read and write all traffic data to one central Oracle database. The first application is a Microsoft Access database that serves as the main user interface. Very simplistically it provides the ability to manage/report/query the database and all its many data. This database "front-end" utilizes linked tables with Visual Basic (VB) code and stored oracle procedures to build reports/queries and to execute various processes. It is maintained/updated by in-house staff. The second application is a more typical Microsoft Windows user interface. It is written in VB and is maintained/updated by in-house staff. It is used primarily to load Binary or ASCII text files into our database and then to review and assign data quality codes to the data. These first two applications are used by only those responsible for managing VDOT traffic data. The third application is a website available to everyone on the VDOT computer network. It is used by our internal customers (planners/engineers) to query our data without having to put in a special request to one of our staff. It was developed in-house and maintained by our IT support.

How do you collect traffic data on high-volume roadways? How do you derive vehicle classification on high-volume–multilane roadways?

Delaware

We use our permanent ATRs for all roads, with the exception of I-95 where the counters have not been working for some time. For the I-95 corridor, we have been asking that the RTMS counters that we already own be used so that we get at least some data, but to date that has not happened. Our count data from I-95 comes from our toll counts at the Delaware–Maryland border and from the Delaware River Bridge Authority toll counts at the Delaware Memorial Bridge.

District of Columbia

We have 3 WIM stations and 14 RTMS sites on freeways which are high-volume roadways. We have traffic volume data with 13 classes from the 3 WIM station, and four classes from the RMTS sites.

Maryland

Maryland has a number of ATRs which use embedded loops and piezo on high-volume roadways. Our consultants also collect short-term data utilizing road tubes, the RoadRamp System, and the nonintrusive TIRTL device. The data is collected by lane and by hour following the FHWA 13-bin class scheme.

Pennsylvania

If a portable road tube count cannot be set safely, we have short-term in pavement (STIP) sites that collect volume and classification on the high-volume roadways along with some of our permanent sites. If we do not have either a STIP or permanent site located there, we would schedule an 8-h manual classification count.

Virginia

- We use nonintrusive technology (sidefire radar) in a portable application for all short-term counts on the Interstate system. These data are collected as volume counts only at this time; however, we have had success collecting speed data as well as volume in testing done this summer using the new Wavetronix HD sensor.
- We use this same nonintrusive technology off the Interstate on some very difficult high-volume locations.

- We use road tubes and independent arrays at other high-volume locations. Technicians setup equipment during nonpeak times.
- Vehicle classification data are collected using VDOT best practices. Basically, high-volume locations are set up with independent arrays, which employs blockers and other methods to separate the inputs from each other by lane.

What equipment maintenance and calibration procedures do you have in place?

Delaware

We use a combination of in-house staff and vendor support to meet our maintenance needs. However, our calibration efforts have been less than stellar. Although we've managed to calibrate most of our ATRs this year, it's not unusual for them to go uncalibrated for several years at a time.

District of Columbia

We have both manufacture technician and in-house staff in place to maintain equipment.

Maryland

Maryland has an ATR maintenance contract in place. A regular schedule of quarterly site visits is required for each of our ATRs. Preventative maintenance should decrease the severity of failures and the length of downtime, thereby providing greater assurance of quality data collection at ATR stations. We also verify speeds at our ATRs by comparing speeds with a Laser Lidar gun against the speed registering on the ATR. An in-depth maintenance record for each ATR is created and kept for review. These records are categorized and summarized to identify trends, if any. For portable and manual counts, our consultants thoroughly check and maintain their equipment and adhere to the calibration procedures that the manufacturers suggest.

Pennsylvania

For our WIM and CAVC sites, we currently have a maintenance contract in place which includes two calibrations to be conducted in the spring and fall of each year.

Calibrations are accomplished by utilizing a modified version of the ASTM Standard E1318-92: Standard Specification for Highway Weigh-In-Motion Systems—Type II WIM Systems. The modifications dictate that as a minimum, one five-axle single-trailer truck of known static weight and axle spacing will be utilized as the reference value for testing. The contractor provides the truck for calibration.

- The contractor makes all necessary arrangements for conducting a complete WIM calibration at each of the sites. The contractor notifies the department of the calibration dates. The contractor will calibrate the WIM system utilizing the referenced vehicle and the modified ASTM E 1318-92. For Kistler or Bending Plate sites the reference vehicle will make a total of nine passes consisting of three passes over the WIM system at three different speeds. A record will be made of the gross vehicle weight (GVW), axle spacing, and speed for each pass. For polymer piezo sites the reference vehicle will make a total of nine passes over the WIM system at the posted speed. A record will be made of the GVW, axle spacing, and speed for each pass.

- Utilizing the recorded GVWs, calculate the percent difference between actual and measured weights of each pass.
- Upon the completion of all passes, calculate the percent of the total number of observed values exceeding the known vehicle weight. This will show the percent of calculated differences that exceeded the specified tolerance value (±15% of GVW). If the total number of calculated difference is greater than 15%, declare the WIM system inaccurate and report that it failed the acceptance test.
- To successfully accomplish the accuracy test for vehicle classification the contractor must follow the procedure listed below:
  - A manual vehicle classification will be performed on each lane of the site for the period of 15 min.
  - The observer will make an entry for each observed vehicle and the corresponding vehicle recorded on the classifier.
  - Upon completion of the manual classification period. A separate analysis will be completed for each lane at the site.
  - The indicated % error of machine should be within ±5%. If the values fall outside of this range, the contractor must effect adjustments according to the machine's manufacturer.

For our ATR sites, we currently have a QA program in place. Our program includes:

1. At least once every 3 years: a QA test at each site involving a class count using manufactured calibrated portable counters (set for a minimum of 24 h: midnight to midnight) and also a 2-h manual count taken during counter set time. The percent error of the tests should be within ± 2%. If the values fall outside of this range, we investigate causes and make corrections.
2. If a new counter is placed at a site, a 2- to 3-h manual count is taken within 1 year to verify counter accuracy to within ± 2%.
3. Also in addition to field testing, data is compared to historical archived data on a monthly basis and large differences/variations are investigated.

Virginia

- The key to the maintenance effort is a strong data review program. Continuous count stations are downloaded and reviewed daily. All data (continuous and short term) go through an automated review against a series of data quality checks completed during the upload process. A second review, this one manual, occurs where the automated review messages are analyzed and a quality code is assigned to all data. Data that are flagged during the review process are researched in more depth. Data issues that cannot be resolved will result in a technician being dispatched to perform a service call to a location in the case of continuous data or a recount in the case of short-term data.
- Sensor installations are videotaped and photographed to document that proper installation procedures were used.

- All new in-road sensor installations are checked during acceptance testing. Sensor readings are taken. Validation checks are conducted by comparing counter data with a manual count.
- VDOT uses a loop logic, or 21 bin, classification table which aids in predicting piezo failure. The loop logic allows the shorter and lighter vehicles, which will begin to have missed axle hits first, to be classified as class 2 or 3 vehicles based on length. Vehicles with missed axles using the loop logic function to classify correctly are binned separately (class 16 thru 19) from those with two-axle hits. As the class 16 thru 19 vehicles grow in number, operators know that maintenance will be required soon. When piezo performance deteriorates to the point that heavier longer vehicles begin to miss axles, they are binned in a class 20 category. At this point the piezo sensor is failing and data is downgraded based on established program criteria.
- Sensor readings are collected at sites flagged for service calls.
- Annual checks and sensor readings are collected at locations that were not otherwise visited during the year as time allows.
- For road tube counters, air switch readings are taken twice a year to ensure equipment are in operable working condition.
- Road tubes are checked for air leaks prior to each use.
- Short-term count contractors are required to perform a videotaped verification test of their equipment and set-up procedures in all types of traffic conditions. Videotaped traffic data are compared to submitted machine data.
- For short-term counts, VDOT inspection staff review contract set-up work and record findings. Manual verifications of traffic counts are conducted.
- Calibration of WIM equipment per ASTM standards. Kistler sensors are ground flush with roadway approximately semiannually.

USING TRAFFIC DATA

List the main users of your traffic data products

Delaware

Aside from our in-house engineers, modelers, air quality, and our HSIP program, developers, real estate interest, and potential store owners/chain stores are the primary users of our data.

District of Columbia

FHWA, DDOT, MPO, consultants, public, etc.

Maryland

The main users of our traffic data products are traffic engineers, consultants, MPOs, business owners, and concerned or curious citizens.

Pennsylvania

Transportation Planning Division staff, other PennDOT bureaus, other state agencies, general public (realtors and developers, engineering and consulting firms, business owners, and entrepreneurs).

Virginia

- Other VDOT Divisions, planning, environmental, location and design, materials, and the districts (field), to list a few;
- Other state government agencies, state police, tourism, etc.;
- MPOs;
- County, city, and town government;
- Federal government;
- Private business; particularly real estate;
- Private citizens; and
- Our own section for data quality control.

How do their applications support the department's main goals

Delaware

With the exception of in-house projects, they don't.

District of Columbia

FHWA, DDOT, MPO, consultants, public, etc. [This answer is to previous question.]

Maryland

Our traffic data is instrumental in fulfilling Maryland's HPMS, pavement management, congestion management requirements. It is also essential for supporting safety projects, especially pedestrians, and bicycle level of comfort.

Pennsylvania

Traffic data is used by the Bureau of Design in the design of new roads or in the redesign of existing roads. The Bureau of Maintenance and Operations uses traffic data in its maintenance funds allocation formula. The Bureau of Highway Safety and Traffic Engineering uses traffic data to calculate the state's fatality rate, seatbelt use rate, and roadway capacity. Traffic data is included in the state's yearly HPMS data submission to FHWA. FHWA uses the traffic data reported in HPMS for the Interstate maintenance, NHS, and surface transportation program funding formulas.

Virginia

Help provide for safer more efficient transportation system.

What improvements do primary users want to see in the amount or quality of the data they receive?

Delaware

Hard question to answer. Many who are unfamiliar with the collection of data seem to think the data is not accurate if the numbers don’t reflect what they want to see. Those of us responsible for traffic data collection would like to see more data collected, but we have absolutely no support.

District of Columbia

Timeliness, consistency, and continuity.

Maryland

Our primary users are generally satisfied with the quality of the data they receive. Our TMS program utilizes multiple validations to ensure our customers receive the highest quality data.

Pennsylvania

Factored hourly data, more classification counts, motorcycle data.

Virginia

The quality of our data is generally recognized as very good within the department. More vehicle weight data and more vehicle classification data are common requests.

STAFFING AND ORGANIZATIONAL

In what area/division of the DOT is traffic monitoring located?

Delaware

Planning division.

District of Columbia

[No response.]

Maryland

Maryland's TMS program is located in the SHA's Office of Planning and Preliminary Engineering at the HISD.

Pennsylvania

Bureau of Planning and Research (Transportation Planning Division) under the Office of Planning Department.

Virginia

Traffic Engineering Division.

Do you operate your data collection program from a centralized or decentralized location?

Delaware

Decentralized, which is the crux of many of our problems.

District of Columbia

[No response.]

Maryland

Maryland's data collection program is operated from a centralized location in Baltimore.

Pennsylvania

Centralized location.

Virginia

Centralized.

How many people make up the traffic monitoring section? Office versus field?

Delaware

Two office people and two field people in different locations and different sections.

District of Columbia

[No response.]

Maryland

The Traffic Monitoring section is made up five office personnel and two field technicians.

Pennsylvania

Office: seven. The section is made up of one manager who is responsible for two transportation planning specialist supervisors who are responsible for three traffic analysts who are primarily responsible for assigning, processing, and tracking the yearly traffic count assignments and a fourth analyst who is a part time field person and data analyst with permanent site data. We have an additional transportation planning specialist who is responsible for permanent site data. In the field: three. We have a field operations section with one supervisor, one part-time field person housed in central office, and one full-time field person located in the western part of state whose main job is setting traffic counts.

Virginia

- Fifteen full-time staff assigned to section. These are divided generally as 11 office and four field, although several office staff have significant field duties.
- The program funds another nine positions assigned to the districts and who perform field data collection for us. Serious consideration is being given to contracting this function also.
- Contract staff of around 50 to collect data and perform count station maintenance. Some of these 50 are office staff members who administer the program from the contract side, but the majority is field staff.

Do you outsource any of your data collection–analysis processes?

Delaware

We only outsource the coverage count portion of our program. Except for the HSIP program, no analysis is really done.

District of Columbia

[No response.]

Maryland

As of 1997, Maryland has been utilizing consultant contracts to collect traffic data. We do our own traffic analysis.

Pennsylvania

We outsource roughly 3,300 traffic counts a year.

Virginia

- Short-term counts on the higher functionally classified roadways (the 17,000 48-h 3-year cycle counts) are entirely contracted.
- Maintenance and installation of the continuous count station program is contracted.
- Data analysis is not contracted.

Do funding issues keep you from maintaining an acceptable traffic monitoring program? If so, please explain.

Delaware

The traffic section that is responsible for the maintenance of the counters claim they do not have money in the budget to hire more maintenance people. In planning, no additional positions are allocated in the budget because senior management fails to recognize the importance of having good data.

District of Columbia

[No response.]

Maryland

Funding issues have not been a problem for maintaining an acceptable traffic monitoring program. We have been fortunate to have the support of upper management because they realize the importance of quality data as it affects all aspects of projects and products generated by the Maryland SHA.

Pennsylvania

Our current traffic monitoring program is acceptable but does limit us to the number and types of counts we can take a year. Our count program is on a 5-year cycle. Additional funding will be necessary to collect motorcycle data and ramp data, especially if we want to keep our current standards.

Virginia

No. Funding has not been a problem for the past 10 years. Prior to the mid-1990s, funding was a significant issue at various times. Because of that, the program was not as robust as a result. That does make the comparisons of data (how much VMT growth) over time that seem to be key to transportation funding issues, difficult.

APPENDIX B

Participants

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APPENDIX C

List of Acronyms

AADT	annual average daily traffic
AAWT	annual average weekday traffic
ADMS	Archived Data Management System
ATR	automated traffic recorders
BMC	Baltimore Metropolitan Council of Governments
BMS	bridge management system
CAVC	continuous automatic vehicle classifiers
CDS	coordinated data system
CORS	continuously operated reference sites
dmi	digital measurement instrument
DDOT	District Department of Transportation (Washington, D.C.)
DOT	department of transportation
ELA	Enterprise Licenses Agreement
FHWA	Federal Highway Administration
GIS	geographic information system
GPS	Global Positioning System
HISD	Highway Information Services Division
HNI	highway needs inventory
HPMS	Highway Performance Monitoring System
HSIP	Highway Safety Improvement Program
IT	information technology
iTDUS	Internet Traffic Data Upload System
iTMS	Internet Traffic Monitoring Systems
MPO	Metropolitan Planning Organization
NHS	National Highway System
NHTSA	National Highway Traffic Safety Administration
PeMS	Performance Measurement System
PennDOT	Pennsylvania Department of Transportation
RPO	Rural Planning Organization
SHA	State Highway Administration
STIP	short term in pavement
TMS	traffic monitoring system
TRB	Transportation Research Board
RTMS	Remote Traffic Microwave Sensors
TIRTL	The Infra-Red Traffic Logger
TTI	Texas Transportation Institute
UPWP	Unified Planning and Work Program
VB	Visual Basic
VDOT	Virginia Department of Transportation
VMT	vehicle miles traveled
VTRC	Virginia Transportation Research Council

WashCOG	Metropolitan Washington (D.C.) Council of Governments
WIM	weigh in motion

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