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Highway Information Services Division

Traffic Monitoring System Program

October 2010

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Chapter 1: Introduction

In 1997, as part of a major re-engineering effort, the Highway Information Services Division (HISD) was given responsibility for administering Maryland State Highway Administration's Traffic Monitoring program. This program is responsible for the collection, processing, analysis, summarization and reporting of Maryland highway traffic count data.

The re-engineering included development of a database to store traffic count data, a user interface allowing SHA Traffic engineers throughout Maryland's seven engineering districts to request special project counts as required, and an Internet based reporting system providing access to all validated traffic count data using a series of pre-defined reports.

Another major part of the re-engineering was the privatization of all short term traffic counts, which are now performed by consultants on contract to HISD. The maintenance of the permanent counters remain the responsibility of HISD

Maryland's Traffic Monitoring Program includes 79 permanent continuous Automatic Traffic Recorders (ATRs), and over 3,800 short term (48 hour) Program Count locations throughout the state. Of the 79 ATRs, 18 are presently equipped to perform vehicle classification counts based on the 13 FHWA vehicle classifications.

Program or Coverage (short term) counts are counted on a three year cycle, with one third of the locations being counted each year. Growth factors are applied to the other two thirds which are not counted during the current year.

In addition, approximately 1,200 Special counts are also performed yearly on an as-needed basis. Special counts are normally project related counts and are requested by State Highway Traffic Engineers. The counts include volume, vehicle classification counts, turning movement, delay and vehicle occupancy counts.

All valid count data is available in formatted reports on the Maryland State Highway Internet site: http://www.roads.maryland.gov/Index.aspx?PageId=251

Chapter 2: Automatic Traffic Recorders (ATRs)

Automatic Traffic Recorders (ATRs) are permanent traffic counters which count traffic continuously throughout the year.

The ATRs utilize several different sensor configurations, which determine the type of data that can be collected at the site. See chart below:

Sensor Configuration Per Lane	Volume Only	Speed	Length	Classification	Weigh-In-Motion
Loop	X				
Loop - Loop	X	X	X		
Loop-Piezo-Loop	X	X	X	X	
Piezo-Loop-Piezo	X	X	X	X	X
Radar	X	X	X		

A cabinet adjacent to the roadway contains the recording unit, surge protection, power supply, and communication device.

Maryland currently has 79 ATR locations throughout the state. Below is a list of the number of ATRs by county and the number of ATRs by functional classification:

ATRs by County

County	# of ATRs
Allegany	4
Anne Arundel	8
Baltimore	20
Calvert	1
Carroll	1
Cecil	1
Charles	2
Dorchester	1
Frederick	5
Garrett	2
Harford	3

County	# of ATRs
Howard	5
Kent	1
Montgomery	5
Prince George's	6
Queen Anne's	3
Somerset	2
Talbot	1
Washington	3
Wicomico	2
Worcester	3

ATRs by Functional Classification

Functional Classification	# of ATRs
Rural Interstate	7
Rural Other Principal Arterial (OPA)	15
Rural Minor Arterial	5
Rural Major Collector	2
Urban Interstate	28
Urban OPA Freeway/Expressways	12
Urban Other Principal Arterial	10
Total:	**79**

The ATRs are polled on a daily basis via telemetry. The data is then loaded into an Oracle database. A series of data validations are performed against the data files as part of the load process. Only data that passes validation is used in the calculation of group, growth, axle correction factors and AADTs.

ATR Validations

As the ATR data is being loaded into the database, the following validations checks are performed against each ATRs data:

- An individual lane collecting the same number of vehicles for 4 or more consecutive hours.
- The directional split of the total volume is out of range based on user supplied parameters (Default is 60% - 40%).
- Directional Volume is over the maximum volume or under the minimum volume based on the day of week for the past 12 months.
- The ATR must collect 24 hours of data.

If the data fails any of the above validation checks, it is still loaded into the database, but is marked as invalid. A member of the TMS team reviews the results of the validations on a daily basis and has the option of changing the validation status of the ATR data.

In addition, the TMS team meets with members of the Travel Forecasting and Analysis Division on a monthly basis to review a daily summary of all the previous month's ATR .The summary includes total volume, directional distribution, peak hour, peak hour volume, historical monthly ADT, whether the count is valid (V) or invalid (I). After review of the data an additional status of validated with a reason (R) is added if necessary. This status is used when there is no error in the ATR, but the traffic pattern/volume is not consistent with the norm due to external factors such

as weather related events, construction, holidays or other reasons. The data for these days is published but not used for the generation of factors. While reviewing the data, the team is looking for data anomalies, such as the total volume is consistently over the maximum or under the minimum volume based on historical volumes for the day of week, or the directional split consistently exceeds the 60/40 split on weekends, etc. In certain situations, a site visit to the ATR or a phone call to the District Traffic Engineer may explain the changes to the data.

48 hour verification counts are also performed at each ATR twice a year. The data is compared to the ATR by lane, direction and total volume by hour. If a problem with the ATR or loops is suspected, TMS field technicians will be sent to the site to investigate the problem and if required, will make the necessary repairs.

Maryland uses only data that has been marked as valid for Group Factors, Growth Factors, Axle Correction Factors and Traffic Trends reporting. A combination of the data marked as valid and valid with a reason is used for the creation of AADTs as that represents the actual traffic at that location. All publications are based on actual data collected, as Maryland does not impute data.

Chapter 3: Program (Coverage) Counts (Short-Term Counts)

Maryland's Program (Coverage) Counts consist of approximately 3,800 locations which are counted on a three or six year cycle based on HPMS requirements. Program Counts are 48 hour volume or vehicle classification counts, which are taken during the week on either Tuesday and Wednesday or Wednesday and Thursday to reflect typical weekday travel patterns. Approximately 50% of the Program Counts taken each year are vehicle classification counts, based on the FHWA 13 bin vehicle classification schema.

All Program Counts are factored with seasonal factors and axle correction factors when necessary in order to adjust to reflect annual traffic conditions.

Below is a list of the number of Program Count Locations by county and by functional classification:

Program Count Locations by County

County	# of Program Count Locations	County	# of Program Count Locations
Allegany	134	Howard	138
Anne Arundel	324	Kent	63
Baltimore	395	Montgomery	376
Calvert	67	Prince George's	352
Caroline	85	Queen Anne's	96
Carroll	146	St Mary's	79
Cecil	109	Somerset	54
Charles	94	Talbot	61
Dorchester	69	Washington	193
Frederick	234	Wicomico	126
Garrett	68	Worcester	92
Harford	190	Baltimore City	252

Program Counts by Functional Classification

Rural	# of Program Count Stations	Urban	# of Program Count Stations
Interstate	44	Interstate	189
Other Principal Arterial	161	OPA Freeway/Expressways	199
Minor Arterial	300	Other Principal Arterial	867
Major Collector	439	Minor Arterial	683
Minor Collector	228	Collector	459
Local	102	Local	126

Program Count Validations

The following validations are performed against Program Counts before they are used to calculate AADTs:

Validations Performed by Consultant Who Performed Count

- Before submitting the count to SHA, each Program Count must be reviewed and signed off by a Professional Traffic Engineer who works for the consultant firm that performed the count.

- The consultant who performed the count provides SHA with a data file containing the raw data, and a factored AADT, based on the previous year's day of week, seasonal and axle correction factors. The count is compared with the previous year's factored AADT at the location. If the new factored AADT is not within ± 5% of the previous year's factored AADT, the consultant is required to prove a valid reason explaining the difference in the AADT (such as a new mall opened causing an increase in AADT, or a new bypass road opened resulting in a decrease in the AADT).

Validations Performed by SHA before Loading the Data into the Database

- **Lane Distribution -**Number of records for each direction should be the same, unless the number of lanes is uneven.

- **Validation by Travel Forecasting and Analysis Division -** The raw data, along with a cover sheet highlighting the raw ADT, factored AADT using last year's factors, the factors used, directional percentage and additional data for the count is sent to the Travel Forecasting and Analysis Division for validation by Traffic Engineers who are familiar with the location of the count.

- **Images -** Check if all the images of the location and other digital documents accompanied with the count match the count data.

Validations Performed by SHA after Loading the Data into the Database

- **Number of Lanes and Directions -** Check if the counts have same number of lanes as in the station table and if the directions of all the counts match the inventory direction.

- **Volume Distribution -** Check if the volume distribution is uneven between the two directions, if it is not within a 60/40 split; look at the number of lanes in each direction and the historic volume distribution at the station.

- **Class Validation -** Check Class percentages by lane, for each all the stations, look for uniformity of different classes of vehicles throughout the lanes and directions.

- **End of Year Edits -** As a final edit, after all the Program Counts for the year have been completed, loaded into the database, and factored into AADTs using the current years factors, a report displaying county, route, milepoint, the new factored AADT, the previous year's AADT and the percent difference between the previous and current year AADT is reviewed by the TMS team & Travel Forecasting and Analysis Division. At this point, if a count seems out of range without a valid reason, the count will be marked invalid, a growth factor will be applied to the previous year's AADT, and the location will be re-counted the next year.

Chapter 4: Adjustment Factors

One of the primary uses of ATR data is to calculate factors which are used to adjust short term counts to reflect annual conditions. These factors include adjustment factors for each day of week by month, axle correction factors and growth factors.

Maryland uses five groups. Each ATR is assigned to one of the following groups based on the functional classification of the road where the ATR is located, with the exception of the Seasonal Group.

- Rural Interstate
- Rural Other
- Urban Interstate
- Urban Other
- Seasonal

Number of ATRs by Group Classification

ATR Group	# of ATRs
Rural Interstate	5
Rural Other	12
Urban Interstate	30
Urban Other	21
Seasonal	11
Total:	**79**

Calculating Day of Week, Month of Year Factor Factors

Maryland uses factors based on day of week for each month for each ATR group. Adjustment factors are calculated for each day of the week for each month, resulting in 84 factors for each ATR Group (7 weekdays X 12 Months = 84). Only ATRs that have at least one valid day of data for each day of the week for every month are used in the calculation. (i.e. each ATR must have at least 1 valid Monday, Tuesday, Wednesday, Thursday, Friday, Saturday and Sunday for each month).

Follow the steps below to calculate the factors:

1. For each ATR used to calculate Group Factors, calculate a median hourly volume for each day of the week each month of the year.

   Example: ATR # P0001 had four valid Wednesdays in March 2008, as shown in the example below. Calculate the median hourly volume for Wednesdays in March and insert it into a database table.

```
STATION_ID          DATE            WEEKDAY              TIME            VOLUME

   P0001         03/05/2008       Wednesday              01                31
   P0001         03/12/2008       Wednesday              01                35
   P0001         03/19/2008       Wednesday              01                19
   P0001         03/26/2008       Wednesday              01                19


                                             Median Hourly Volume:         25
```

2. Repeat this process for each ATR. After you finish, the database now contains the median hourly data for each ATR for each day of the week for each month.

3. Calculate an AADT for each of the five ATR Groups by taking the sum of median hourly volume for each day and dividing it by 84 days = Group AADT.

4. Divide the Group AADT by the total daily volume for day of week for each month for each ATR group. The result is the **Day of Week, Month of Year Factor** for each ATR Group.

   Example: Calculating the March Wednesday Factor for the group Rural Others, when:
   2007 Group AADT, Rural Others = 157,432
   and
   Total Volume, Rural Others, Wednesdays in March = 155,891

   $\dfrac{157,431 \text{ (2007 Group AADT, Rural Others)}}{155,891 \text{ (Total Volume, Rural Others, Wednesdays in March)}}$

   The factor = 1.01.

5. Apply this factor (1.01) to a 24-hour count taken on a Wednesday in March to calculate a factored AADT.

Calculating Axle-Correction Factors

Axle correction factors are used to adjust short term counts taken with single axle sensors into vehicle counts. Axle corrections factors for a year are calculated based on all vehicle classification counts taken during that year.

Follow the steps below to calculate axle-correction factors:

1. Select all vehicle classification counts taken during the previous year grouped by functional classification.

2. Add the Total Vehicles for each functional classification.

3. Add the Total Axles for each functional classification by multiplying each vehicle by the number of axles according to the FHWA Vehicle Classification Schema.

4. Axle Correction Factor = $\dfrac{\text{Total Vehicles x 2}}{\text{Total Axles}}$

5. Store the result in a database table grouped by year and functional classification.

Calculating Growth Factors

Growth factors are calculated from permanent count data by year for each ATR group. These factors are applied to Program Counts which were not counted during the current year in order to provide a current AADT estimate. Program Counts (48 hour counts) are counted on a three or six year cycle based on HPMS requirements.

Growth factors are created by calculating the yearly median percent difference in AADT for each ATR in the ATR groups. Only ATRs that have at least one valid day of data for each day of the week for every month for both the previous and current year are used to calculate growth factors.

Chapter 5: Annual Average Daily Traffic (AADT) Calculation

Maryland's SHA publishes AADT counts for all Permanent and Program Count locations on an annual basis. The AADT calculation process is described below.

Permanent Count Stations (ATRs)

Add the daily total volume for all valid days for the year and divide it by the number of valid days for the year. As a general rule, only ATRs that have a minimum of two weeks' worth of valid data for each season are used to publish AADT counts.

Program Count Stations (48-Hour Counts)

1. Add the total daily volume for each day counted. (Program Counts are 48-hour counts.)

   Example: A 48-hour Program Count was taken on a Wednesday and Thursday in May 2007 at Station # B030098, located on MD-147 in Baltimore County. This location has a functional classification of Urban Minor Arterial and is part of the Urban Other ATR Group.

   ```
   Wednesday = 14,673
   Thursday  = 14,891
   ```

2. Apply the short-term count adjustment factor based on the ATR Group and month and day of week the count was taken.

   Example:

   ```
   Wed Volume          Wed Factor
      14,673      x       0.9        = 13,206

   Thu Volume          Thu Factor
      14,891      x       0.88       = 13,104
   ```

3. Add the factored results and divide the sum by the number of days counted.

   Example:

   ```
     13,206
   + 13,104
     ──────
     26,310 / 2 = 13,155
   ```

4. Apply the Axle Correction factor based on the functional classification. (If the count is a vehicle classification count, skip this step.)

   Example: In this case, the count was a volume count, so apply the Axle Correction factor (ACF).

   ```
   Factored Volume   x   _ACF_      =   Factored AADT
        13,155       x   0.98    =         12,892
   ```

Since 2006, the TMS team has added a special numeric code to the AADT and AAWDT numbers in order to identify the years in which the counts were actually taken; the last digit represents the number of years prior to the actual count, in which:

0 = Count taken in current year (2010)
1 = Count taken in 2009
2 = Count taken in 2008
3 = Count taken in 2007, etc.

Program Count Locations Not Counted During the Current Year

Maryland counts approximately one-third of the Program Count locations each year. For the locations that were not counted during the current year, the team applies a growth factor based on the ATR Group to which the Program Count is assigned. Growth factors are calculated for each of the five ATR Groups: Urban Interstate, Urban Other, Rural Interstate, Rural Other, and Seasonal.

Chapter 6: Traffic Data Reporting

Maryland's Traffic Monitoring System is an Intranet-based application that allows authorized users on the SHA network to do the following:

- Request counts
- Schedule counts
- Check on the status of counts
- Track contracts and invoicing for contractors performing counts
- Report the count data in various standard reports

A GIS module is also available to authorized users on the SHA network, allowing them to request counts, select reports, and display count locations using the GIS-based map.

All validated traffic count data is published in formatted reports and is available online at http://shagbhisdadt.mdot.state.md.us/ITMS_Public/default.aspx, SHA's public Web site. Users can search data by date, day of week, count type (Vehicle Classification, Turning Movement, Vehicle Occupancy, and Volume), functional classification, and location (county and route).

In addition, many standard sets of reports (including all traffic trends reports) are available on SHA's public Web site. Since the majority of these reports require statistical analysis using previous years' traffic data, TMS has the capacity to store more than10 years' worth of data.

Maryland also produces the following hard-copy and online publications on an annual basis:

- The **Traffic Trends Report** is a summary of traffic volume data from the permanent ATR stations for individual stations and ATR Groups, including hourly, daily, monthly, and seasonal variations in traffic volumes and factors for converting short-term counts to AADTs. Available online at http://roads.maryland.gov/Index.aspx?PageId=253&d=35

- The **Traffic Volume Maps** display AADTs at the ATR, Program Count, and Toll locations by county. Available online at http://roads.maryland.gov/Index.aspx?PageId=792

- The **Truck Volume Maps** display the average percentages of trucks at various locations on Maryland's roadways by county. Also included at these locations is the current AADT. Available online at http://roads.maryland.gov/Index.aspx?PageId=793

- The **GIS Traffic Count Data** consists of historical Annual Average Daily Traffic (AADT) and Annual Average Daily Weekday Traffic (AAWDT), percentage single unit and combination trucks in Nad83 ft HARN in both Shapefile and KML file formats. Available online at http://roads.maryland.gov/pages/GIS.aspx?PageId=838