Assessing Roadway Traffic Count Duration and Frequency Impacts on Annual Average Daily Traffic Estimation

Assessing AADT Accuracy Issues Related to Annual Factoring

Publication No. FHWA-PL-16-012

February 2016

U.S. Department of Transportation
Federal Highway Administration

Technical Report Documentation Page

1. Report No. FHWA-PL-16-012	2. Government Accession No.	3. Recipient's Catalog No.
4. Title and Subtitle Assessing Roadway Traffic Count Duration and Frequency Impacts on Annual Average Daily Traffic Estimation: Assessing Accuracy Issues Related to Annual Factoring		5. Report Date February 2016 6. Performing Organization Code
7. Author(s) Robert Krile, Fred Todt, Jeremy Schroeder (Battelle)		8. Performing Organization Report No.
9. Performing Organization Name and Address Battelle 505 King Ave. Columbus, Ohio 43201		10. Work Unit No. (TRAIS) 11. Contract or Grant No. DTFH61-13-D-00012
12. Sponsoring Agency Name and Address Federal Highway Administration Office of Highway Policy Information 1200 New Jersey Avenue SE Washington, DC 20590		13. Type of Report and Period Covered 14. Sponsoring Agency Code
15. Supplementary Notes Project performed in cooperation with the U.S. Department of Transportation, Federal Highway Administration and a Technical Advisory Committee (TAC) consisting of Alaska Department of Transportation (DOT) & Public Facilities, Georgia DOT, Illinois DOT, Minnesota DOT, Pennsylvania DOT, Texas DOT, and Wisconsin DOT. Steven Jessberger (Task Manager)		

16. Abstract

Annual average daily traffic (AADT) for many roadways is estimated through a temporary count obtained over anywhere from a few hours to one week, and subsequently expanded to a full year using factors derived from permanent count stations with similar characteristics. Many organizations perform these counts less than annually and therefore must further adjust counts from a prior year (typically 1, 2, or 5 years prior, depending on the roadway type) to the current year. This task quantifies the relative accuracy and precision associated with different annual count cycles for 24- and 48-hour count durations. Results are evaluated at the national level, as well as by functional classification of sites, and at the individual state level.

The FHWA Travel Monitoring Analysis System (TMAS) volume data from 14 years consisting of hourly counts by day from nearly 6,000 continuous permanent volume traffic data sites/years in the United States comprised the reference dataset for this research. A subset of 320 of these were utilized which include complete data for all 24 hours of every day of the year. These sites collectively represented a wide range of AADT volumes, 9 functional classes, 32 states, and years 2000 through 2012. This report is a final task report that summarizes accuracy and precision of expanding short-term counts' Average Daily Traffic (ADT) to AADT, depending on the frequency with which the counts are obtained (yearly, every two years, every three years, or every six years), and includes the analysis methodology and summary statistics findings.

17. Key Words Annual average daily traffic, AADT, continuous traffic monitoring	18. Distribution Statement No restrictions. This document is available to the public.		
19. Security Classif.(of this report) Unclassified	20. Security Classif. (of this page) Unclassified	21. No. of Pages 25	22. Price

Form DOT F 1700.7 (8-72) Reproduction of completed page authorized

Preface

We would like to acknowledge the following Technical Advisory Committee members for their contributions, support and technical guidance during this project.

Steven Jessberger	Federal Highway Administration
Jennifer Anderson	Alaska DOT & Public Facilities
Scott Susten	Georgia DOT
William Morgan	Illinois DOT
Gene Hicks, Thomas Nelson, Mark Flinner	Minnesota DOT
Jeremy Freeland, Joseph Pipe	Pennsylvania DOT
William Knowles	Texas DOT
Rhonda McDonald	Wisconsin DOT

Table of Contents

List of Tables

Executive Summary

Annual average daily traffic volume (AADT) for many roadways is estimated through a temporary count obtained over anywhere from a few hours to one week, and subsequently expanded to a full year using factors derived from permanent count stations with similar characteristics. The frequency of this count may be annually, once every two years, once every three years, or once every six years. When taken less than annually, the AADT for a current year is found by taking the AADT estimate from the year in which the count was completed, and applying as many year-over-year adjustment factors as necessary to project the count to the current year. This research, Task 4 of a larger evaluation project entitled "Assessing Roadway Traffic Count Duration and Frequency Impacts on Annual Average Daily Traffic Estimation", examined the inherent accuracy and precision of expanding short-term counts' Average Daily Traffic (ADT) to AADT, depending on the frequency with which the counts are obtained (yearly, every two years, every three years, or every six years). The Federal Highway Administration (FHWA) Travel Monitoring Analysis System (TMAS) data from 14 years consisting of 24 hours of the day and seven days of the week volume data from nearly 6000 continuous permanent volume traffic data sites in the United States comprised the reference dataset for this research.

This task was completed using a methodology that leveraged the known traffic volumes of a national cross-section of permanent traffic count stations, treating these permanent stations as surrogates for temporary count stations, and then comparing the estimated AADT from short-term counts extracted from the permanent count stations to the true known AADT for each permanent count station. This method permitted a comparison of AADT estimation accuracy (i.e., on average, how close the estimated AADT is to the true AADT) and precision (i.e., how variable are the estimated AADT results from one short-term count instance to another) as a function of short-term count durations of 24 hours or 48 hours, as well as the frequency with which such a short-term count was obtained, at yearly, every other year, every third year, or every sixth year. This is a final task report that includes the analysis methodology, summary statistics findings, and supplemental appendix documentation.

Introduction

Annual Average Daily Traffic (AADT) volume is an important measure of road use. For a set of locations nationally known as permanent traffic count stations, AADT can be measured quite accurately and precisely, even if some limited periods of time are missing or unavailable. For most roads, it is not economically or logistically practical to maintain a permanent traffic count station, but an accurate AADT is still needed. To determine AADT for such roads, the typical practice is to deploy a temporary counter for anywhere from a few hours to as many as seven days. After the counter is retrieved, the hourly traffic volume is extracted, processed and then converted to an expected annual average daily value based on the characteristics of the roadway and of the period sampled. This conversion, or factoring, is based on the same period (e.g., Tuesday, or Tuesday in November) and for a set of sites with permanent count stations that are considered similar to the location of the temporary count. In many areas, the temporary counts are not obtained for a particular site every year, and additional factoring is required to bring the last counted volume for a site up to the current year. Typical non-annual frequencies for counts include every other year, every third year, and every sixth year.

The expected error in the process of using a temporary count to develop an AADT has been an issue of significant study over many years. While it is possible to use statistical methods to simulate the impact of varying practices in temporary counts (ADT) and then to assess how they project to an AADT, these methods have difficulty in adequately capturing the complex dynamics of variability that exist in true count data over time and across sites.

An overall research effort was begun in 2014 in which the Federal Highway Administration (FHWA) Travel Monitoring Analysis System (TMAS) data from 14 years (2000-2013) were the source data. From nearly 43,000 continuous permanent volume traffic data sites (25 million records) in the entire dataset, approximately 6,000 of them had 24 hourly volumes for all days of the year, and a subset of these were used for the report, "Assessing Roadway Traffic Count Duration and Frequency Impacts on Annual Average Daily Traffic (AADT) Estimation: Assessing Accuracy Issues with Current Known Methods in AADT Estimation from Continuous Traffic Monitoring Data,"[1] the expected bias and precision associated with AADT estimation of permanent traffic count stations were established under different analytical methods to account for daily weighting and missing data. A subsequent task, documented in the report, "Assessing Roadway Traffic Count Duration and Frequency Impacts on Annual Average Daily Traffic Estimation: Assessing AADT Accuracy Issues Related to Short-Term Count Durations,"[2] extended this research to determine the relative accuracy associated with different durations of short-term counts, extending from as short as six hours to as long as one week. This task focuses on the most commonly encountered short-term count durations of 24 hours and 48 hours, and evaluates the further impact on accuracy and precision for counts taken less than annually. Specific evaluation is provided for counts taken every other year, every third year, and every sixth year. The evaluation considers the impact of such frequency at an aggregate national level, as well as by functional classification, year, state, and individual site.

This evaluation samples from existing permanent count station data where AADT is fully measured as if these stations were temporary count locations. In this method, a slice of traffic volume data within the reference dataset is removed from a permanent count site (e.g., 24 hours) to simulate a short duration count. The simulated short-term count then has day-of-week and monthly correction factors applied to generate an estimated AADT. The adjustment factors would be those typical for the evaluated site had it truly been a temporary count location. For the current task, one or more year-over-year factors are applied to the preliminary year's AADT based on other permanent count stations of a similar type (i.e., same state and functional classification grouping). This estimated AADT from a simulated short-term count is compared to the true AADT for the site in the terminal year since it is truly a permanent count station with a definitively known AADT. The difference between the estimated and true AADT value is the bias in using that particular short-term count to estimate AADT.

The basic methodology described was ultimately applied to a set of 202 permanent count stations. By applying this across such a broad number of sites, summary statistics were generated that both characterize the overall bias inherent in short-term count use to estimate AADT, and could be utilized to compare the error under different short-term count durations and frequencies. Of particular research interest was to compare the error distribution under a range of different short-term durations and frequencies to include:

- 24 hours obtained every year, every other year, every third year, or every sixth year; and
- 48 hours obtained every year, every other year, every third year, or every sixth year.

Additionally, with the robust nature of this evaluation, it is possible to examine whether factors such as functional classification (FC), year, or state influence the comparisons.

The following sections of this report begin by discussing methods employed to select the sites for evaluation, to simulate short-term counts from those sites and appropriately factor them up to AADT for the terminal year of interest (i.e., same year, 2nd year, 3rd year, or 6th year), to determine the AADT estimation error, and then to calculate and characterize the subsequent bias (accuracy) and precision of the results for a number of different reporting levels. The Methods section is followed by the Results section, which presents the summary results and discusses how they address the key research objectives of the task. This is followed by Conclusions of the key findings of the research. An Appendix and a Supplemental Set of Tables complete the report.

Methods

Traffic Monitoring Site Data

For this evaluation, FHWA TMAS traffic volume data were used as the input data. Following a series of data processing steps, which are discussed in more detail in the report, "Assessing Roadway Traffic Count Duration and Frequency Impacts on Annual Average Daily Traffic (AADT) Estimation: Assessing

[1] Publication No. FHWA-PL-015-008, November 2014.
[2] Publication No. FHWA-PL-016-008, October 2015.

Accuracy Issues with Current Known Methods in AADT Estimation from Continuous Traffic Monitoring Data,"[1] a complete dataset of available sites with corresponding hourly traffic volumes was generated. This dataset consisted of 42,876 site and year combinations for which adequate hourly data existed to determine an AADT using the American Association of State Highway and Transportation Officials (AASHTO) method. The AASHTO method was used in this evaluation even though improvements to accuracy and precision of AADT estimation were identified, notably the Highway Policy Steven Jessberger Battelle (HPSJB) Method[1]. The advantage of the HPSJB method is most apparent for data with some hourly volumes but not all hours on a day. This scenario is not common in current TMAS data, since the AASHTO method excludes all such partial days and therefore there is no benefit to submitting partial daily data to TMAS. Additionally, the currently utilized AASHTO method is more familiar to the audience, and since this evaluation looks at comparative accuracy and precision for different subsets of count duration and frequency, rather than absolute accuracy and precision, the estimation of AADT with the AASHTO method was judged to be acceptable. For 5,681 of the site and year combinations, data were available for every hour of the year. It was this latter set of data which constitutes the core of this task, since an exact AADT is known for each of these sites (i.e., no missing data). By sub-setting portions of the complete data for these sites to simulate a temporary count and then applying appropriate weighting factors, simulated short-term count duration estimates of AADT are produced, which can be compared against the true value for the site.

In the portion of the methodology that features the application of weighting factors, there are a number of candidate methods that could have been employed. Each method has some basis in use either through the Highway Performance Monitoring System (HPMS) or in practice. Development of weights requires a set of site data separate from the sites to be evaluated directly as temporary count stations. For these sites, having complete hourly data for the entire year is not strictly necessary, but they must support calculation of weighting factors at the most detailed level desired. As such, the sites that established the weighting factors could be part of the 5681 complete data sites, or they could simply be within the 42,876 sites where an AASHTO AADT calculation was possible. Additionally, the minimum number of sites that formed a weighting group is an important consideration. Following the Traffic Monitoring Guide[3] (TMG), a minimum of six sites would be required for developing factor groupings, which would then produce factors that could be applied to a seventh site with complete data that was being used as the proxy for the temporary count station. For computer programming efficiency, the maximum number of sites for a particular factor grouping was 15.

For the evaluation of AADT at sites counted less frequently than annually, an additional dimension was required for the data. Permanent traffic count stations used as proxies for temporary counts stations could be evaluated for AADT accuracy and precision based on the same year in which the counts were taken, or based on AADT that had been projected to one, two, or five years later. For maximum accuracy, this process required both the initial and final years in the sequence to have complete, hourly data for a particular site for the year, and for there to be valid year-over-year factors that could be applied to the estimated AADT in the base year. These year-over-year factors had to be based on at least six sites of the same state and functional classification as the site being used as the proxy temporary count station.

A number of other criteria for selection of sites were provided by FHWA to assure that the aggregate results would be representative of traffic count patterns as a whole across the United States:

- A minimum of 200 sites;
- To the extent possible, all states and roadway functional classifications; and
- All years from 2000 through 2013.

Site Selection

Choosing which sites to include in this analysis started with the list produced in the Task 3 analysis of this evaluation. [2] The need to evaluate the frequency of counts as either annually, every second year, every third year, or every sixth year limited the number of potential sites greatly. A total of 202 sites were ultimately identified that could meet the full requirements to produce AADT estimation error for the current year, the next year, and the third year. However, when expanding to a sixth year, only 58 of the 202 sites

[3] Publication No. FHWA-PL-013-015, September 2013

could also be used to evaluate a five year factoring. Therefore, the primary results for this analysis are produced with the set of 202 sites shown in Table 1. These sites represent seven of the 14 functional classifications and 15 states. The sites included starting years of 2000 through 2011. To permit calculation of two year factoring, 2011 was the latest starting year that could be included since 2013 was the final year of data for the overall analysis.

Table 1. Summary of Sites Selected for 1-3 Year Frequency Analysis

Functional Class	State	Starting Year 2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	Total
1R	Idaho				1									1
	Iowa				14									14
	Pennsylvania				2	1								3
1R Total					17	1								18
1U	Iowa	8												8
	Minnesota								8	6	6			20
	Pennsylvania			4										4
1U Total		8		4					8	6	6			32
3R	Idaho					3								3
	Kansas					1								1
	Maine									14				14
	Nebraska									3				3
	New Mexico						1							1
	South Dakota	13												13
	Vermont											1		1
3R Total		13				4	1			17		1		36
3U	Iowa		15			15								30
	Utah						3							3
3U Total			15			15	3							33
4R	Idaho							1						1
	Kansas			1										1
	Minnesota								7					7
	Montana							1						1
	New Hampshire												5	5
	Oregon						1							1
	Pennsylvania												3	3
	Vermont												1	1
4R Total				1			1	2	7				9	20
4U	Alaska											2		2
	Iowa	7				7								14
4U Total		7				7						2		16
5R	Iowa				10									10
	Kansas		1								2			3
	Maine									12			12	24
	Minnesota								4					4
	Pennsylvania							5						5
	Vermont											1		1
5R Total			1		10			5	4	12	2	1	12	47
Total		28	16	5	27	27	5	7	19	35	8	4	21	202

Source: Battelle

The sites selected to evaluate five-year factoring (counts once every sixth year) are shown in Table 2, representing seven of the 14 functional classifications and five states. The starting years were limited to no later than 2008 to allow for the five-year factoring. Additionally, there were no sites that had a starting year of 2002, 2005, or 2006 and the ability to factor over five subsequent years, so ultimately the every 6th year data collection is based on only six unique starting years.

Table 2. Summary of Sites Selected for 6-Year Frequency Analysis

Functional Class	State	Starting Year						Total
		2000	2001	2003	2004	2007	2008	
1R	Pennsylvania			2	1			3
1R Total				2	1			3
1U	Minnesota					7	5	12
1U Total						7	5	12
3R	Maine						12	12
	Nebraska						1	1
3R Total							13	13
3U	Iowa		14					14
3U Total			14					14
4R	Minnesota					4		4
4R Total						4		4
4U	Iowa	7						7
4U Total		7						7
5R	Maine						5	5
5R Total							5	5
Total		7	14	2	1	11	23	58

Source: Battelle

Methodology for estimating AADT from short-term counts at different frequencies

The basic approach to the evaluation was to select a site with complete hourly data for a year, and hence a known AADT (assumed to be calculated using the AASHTO method). The site must also have complete hourly data for one or more of one year, two years, or five years later than the initial year. From this site, the generation of a temporary traffic count is simulated using a subset of time, either 24 hours or 48 hours in this evaluation. An appropriate weighting factor is then applied to this temporary count to produce an estimated AADT for the current year. Factors that reflect the change in yearly traffic volumes are also produced from sites of the same functional classification in the same state. These yearly factors are then applied serially to the originally estimated AADT to determine an estimated AADT for any or all of the second, third, and sixth years in the series after the original year. We then calculate the difference between each yearly AADT based on a simulated short-term count with the true AADT for the site in the same year to determine the bias, or accuracy. These bias statistics are summarized over time periods or site geographies to determine the potential error that could be observed in practice with short-term counts expanded to AADT, and by the frequency (and hence delay) between a short-term count and the corresponding year(s) it must be adjusted to represent.

To execute the basic methodology, there are some important considerations that include:

- What are the weighting factors applied to the temporary counts to determine an estimated AADT?
- What yearly factors are applied to expand a starting year AADT to a two-, three-, or six-year future count?
- What short-term count durations should be evaluated?

Each of these topics is covered in greater detail below.

Weighting Factors

For a particular factor group, assume that there are k total sites. Of this total, k_c sites have 100 percent complete data for the entire year (i.e., 24 hours of reported volumes every day for all 365 (or 366) days in the year). The remaining $(k-k_c)$ sites have adequate data to determine the AADT using the AASHTO method (i.e., at least one complete day of each day of week in each of the twelve months of the year).

Separate monthly and day of week factors

The following weighting factor method was used within this evaluation. It is comparable to what is presented in Section 3.4.2 and 3.4.3 of the Traffic Monitoring Guide[3] (p. 3-78 through 3-80).

Develop monthly factors:

1. Use the AASHTO method to calculate AADT for each of k site and year combination.
2. For a particular one, i, of the k_c site and year combinations, calculate monthly average daily traffic (MADT) for the k-1 site and year combinations excluding the i^{th} site. Specifically, first get average traffic volume for each day of week within each month. Then average day of week traffic volume within every month.
3. Calculate 12 monthly factors for each of k-1 site and year combinations as AADT divided by corresponding MADT.
4. Average monthly factors across the k-1 site and year combinations to get monthly factors (one for each month) for the overall group.
5. Repeat steps 2 through 4 for $i=2,\ldots,k_c$. In this manner, a separate set of monthly factors are generated for each of the sites that has 100 percent complete data.

Develop day of week factors:

1. Treat Monday, Tuesday through Thursday, Friday, Saturday, and Sunday as five separate groups.
2. For a particular one, i, of the k_c site and year combinations, average all the day of week averages from the AASHTO AADT calculation to generate five day of week averages (i.e., one for Fridays, one for Saturdays, one for Sundays, one for Mondays, and one that includes all Tuesdays through Thursdays.) Exclude the i^{th} site and year in this calculation.
3. For each of the k-1 site and year combinations, divide its AADT by the average traffic volume for each day of week group to get day of week factors.
4. Average day of week factor across the k-1 site and year combinations to get day of week factors for the group. There will be 5 day of week factors (one for Tuesday through Thursday, and one each for Monday, Friday, Saturday, and Sunday).

From the factors generated above, a short-term count is expanded to an AADT by multiplying both the monthly and day of week factors that apply to that short-term count.

Hour of day factors

In addition to the factoring above, the short-term count methods will result in data with counts split across more than one calendar day. For this reason, a single set of hour of day factors are generated that apply to the higher level factoring method.

1. Treat Tuesday, Wednesday and Thursday as a group. Monday, Friday, Saturday, and Sunday are each treated individually.
2. For each of the k-1 site and year combinations, calculate the percentage of traffic volume for each hour within every day where all hourly volumes are available for that day.
3. For each of the k-1 site and year combinations, average the percentages by each hour and day of week group.
4. Average the percentages across the k-1 sites in the group. There will be 120 hour of day factors (i.e., 24 hours of the day x 5 day of week groups).

Short-term Count Duration

To examine the impact of different short-term count scenarios, a total of ten different durations were selected in Task 3, ranging from just a few hours to as many as 7 days. This range effectively bounds the shortest to longest count durations employed in practice for temporary traffic counts. For the combined duration and frequency evaluation, the ten durations were reduced to just the two most frequently used in practice:

1) 24 hours to include a random start time on one day and through 24 subsequent hours;
2) 48 hours to include a random start time on one day and through 48 subsequent hours;

For a particular site and year, each duration can be evaluated by its starting date. For instance, in a year with 365 days, there are 364 unique scenarios for evaluating the short-term count of 24 hours. For the durations that span two or three days, the number of unique scenarios was limited because of the restriction of keeping the evaluation within a calendar year. For instance, the 24-hour evaluation could be evaluated from January 1 through December 30, but not for December 31, as this would require extending into another calendar year. Additionally, as these scenarios involved a randomly assigned starting time to each day, up to 24 different values could have applied to any particular starting day. For these evaluations, only one randomly determined starting time was applied to each day.

Short-term Count Frequency

Some traffic counting applications feature a short-term count at a location annually, but many others only perform the short-term count every two years, three years, or six years. To determine overall traffic volumes in the years where no count was conducted, an expansion factor is calculated that takes AADT from the year in which the count was performed and projects it to the current year based on average change in year-over-year traffic volumes for permanent count stations of similar type (e.g., functional classification) to the temporary count station. For this evaluation, this process was replicated by calculating a yearly expansion factor of at least six other sites in the same functional classification grouping as the short-term count site, averaging these year-over-year expansion factors, and multiplying them by the AADT from the base year. To simulate a count taken every two years, the base year AADT was multiplied by a single year-over-year factor for the second year relative to the first. To simulate a count taken every three years, the base year AADT was multiplied first by the second year to the first-year factor and then by the third year to the second-year factor. To simulate the count taken every six years, the base year AADT was serially multiplied by all five year-over-year factors.

Table 3. Determining Year-Over-Year Factoring for Less Than Annual Counts - Alaska, Functional Classification 4U

Station	2010 Full	2010 AADT	2011 Full	2011 AADT	2012 Full	2012 AADT	2010-2011 Year Over Year AADT by Site	2010-2011 Year Over Year Factor (A)	2011-2012 Year Over Year AADT by Site	2011-2012 Year Over Year Factor (B)	2010 Same Year Factor 1.0	2010-11 2-Year Factor A	2010-12 3-Year Factor A*B	Site
114	0	5184.91	0	5199.45	0	5144.37	1.002804		0.989407					
242	0	8046.44	0	8052.28	0	8145.11	1.000726		1.011528					
507	0	14782.11	0	14270.37	0	15971.43	0.965381		1.119202					
523	0	14972.86	0	14904.82	0	15597.44	0.995456		1.046470					
524	0	13305.84	0	14044.41	.	.	1.055507							
527	0	8838.28	0	8792.31	0	8882.79	0.994799		1.010291					
805	1	2117.62	0	2030.55	1	2086.38	0.958883	0.994798	1.027495	1.013184	1.000000		1.007914	805
808	1	9881.37	1	9930.87	1	9581.52	1.005009	0.990186	0.964822	1.019451	1.000000	0.990186	1.009446	808
936	1	8855.05	1	8711.8	1	8621.83	0.983823	0.992304	0.989673	1.016966	1.000000	0.992304	1.009140	936
937	1	9424.63	0	9293.02	0	9357.4	0.986036		1.006928		1.000000			937
938	.	.	0	5866.07	0	5993.18			1.021669					
942	0	4393.58	0	4211	0	4092.47	0.958444		0.971852					

Each year-over-year factor is an average of year-over-year AADT ratios for all other site

Source: Battelle

This process is illustrated for Alaska, Functional Classification 4U in Table 3 above. An initial set of 12, 4U sites are identified here. For sites 805, 808, 936, and 937, the "2010 Full" column indicator of a "1" means that the FHWA TMAS data included every hour of every day for that site in 2010. As such, the site becomes a candidate to be used as a short-term count location in the analysis since it is possible to compare the final estimated AADT from any duration of each of these sites to the overall true, known AADT for the site. This is the same process detailed in the Task 3 report and is not repeated here. What is differentiated in this task is the further adjustment of a calculated AADT by year-over-year factors to simulate the need to have a current year AADT when the site was not counted in the current year.

If the current year were 2011 and it was desired to estimate AADT for a 24-hour count taken at Site 808 in 2010, Table 3 shows how that would be done. For functional classification 4U, there were 10 sites (excluding Site 808 which is now thought of as a temporary count station) that had TMAS data for AADT in both 2010 and 2011. In all 10 cases, we calculate the ratio of AADT in 2011 to that of 2010, as shown in the “2010-2011 Year-Over-Year AADT by Site” column. We then average all 10 of these values to obtain the value 0.990186 in the “2010-2011 Year-Over-Year Factor (A)” column. This factor is then available as a multiplier on estimated AADT in 2010 to project corresponding AADT in 2011. Since the “2011 Full” column indicator is a value of “1”, the true AADT for site 808 in 2011 is available, and the AADT estimated in 2010 with the 2011/2010 factor applied can be compared to the true value in 2011.

In order to get a valid, less than annual, count projection of AADT, we require the following:

a) The first year and the last year of the sequence must have complete, daily data. This is important for the last year so that the true AADT is known. It is important for the first year so that estimated AADT from every day of that year can be obtained.
b) There must be at least six sites (excluding the site being treated as a temporary count site) with AADT on both the first and second years so that a legitimately robust year-over-year factor can be obtained.
c) If three-year factoring is employed, the three-year factor is the product of each two consecutive year-over-year factors. Note that the sites that make up each year-over-year factor need not be the same, so long as the factor is based on at least six sites. The six-year factoring is simply an extension of the three-year factoring but requires five consecutive year-over-year factors. It is not shown in the example above because it would have required data beyond the time span used in this analysis.

From the sites in Table 3 above, it was possible to estimate the following:

- Error in estimating AADT from each day in 2010 with Site 805 as a simulated short-term count station both for 2010 (same methodology as Task 3) and for 2012 (three-year factoring).
- Error in estimating AADT from each day in 2010 with Site 808 as a simulated short-term count station for 2010 (same methodology as Task 3), for 2011 (two-year factoring) and for 2012 (three-year factoring).
- Error in estimating AADT from each day in 2010 with Site 936 as a simulated short-term count station for 2010 (same methodology as Task 3), for 2011 (two-year factoring) and for 2012 (three-year factoring).
- Error in estimating AADT from each day in 2010 with Site 937 as a simulated short-term count station for 2010 (same methodology as Task 3). Since the purpose of Task 4 was to compare AADT estimation error for different count frequencies (i.e., every second, third, or sixth years), this site does not contribute to that evaluation. However, it was included for the functional classification grouping factors, so its results are provided.

Although the estimates above were all possible for evaluating less than annual counts, the final set of 202 sites selected for Alaska, functional classification 4U, starting in 2010, included only Site 808 and Site 936. This is due to the desire to be able to make a comparison of AADT estimation accuracy and precision for same-year, two year, and three-year factoring that is based on the exact same set of sites. This reduces the possibility that observed differences in same-year, two-year, and three-year factoring could be attributable to the sites selected rather than the inherent error in the process.

Calculation and Characterization of Bias (Accuracy) and Precision

The bias incurred by each short-term count duration and frequency was calculated as a simple percent change:

$Bias_i = 100*(AADT_i – AADT_{true})/AADT_{true}$

Where i is a short-term count for a site within a factor group

The distribution of the $Bias_i$ terms was then characterized with a set of descriptive statistics. Both the mean and standard deviation of the bias terms were calculated and reported. However, due to the potential for the bias distribution to show some skewness, the median and the 2.5^{th} and 97.5^{th} percentiles of the distribution were the statistics selected for graphical presentation. The median is a measure of the central tendency of the bias results and is not sensitive to a small number of possibly extreme values as the mean. A median bias less than zero indicates a scenario that prevalently underestimates AADT, while a median greater than zero indicates a scenario that prevalently overestimates AADT. The bias estimates will vary from day to day throughout a year. To characterize the magnitude of this variability, the difference between the 97.5^{th} and 2.5^{th} percentile estimates is a useful statistic. This range provides the observer with 95 percent probabilistic confidence of bracketing the bias that exists for a particular short-term count duration scenario. A narrow range for this statistic provides better assurance that the short duration count expanded to an AADT is likely to estimate that AADT closely for the condition.

Sub-setting the Data

Weighting factors were calculated for all days in a year, and subsequent short-term duration counts expanded to estimated AADT were produced for every day of the year possible. However, many of these simulated AADT values would never be produced in practice. For instance, it is highly unlikely that a state department of transportation (DOT) would take a temporary count at a location on Christmas Day. To prevent the introduction of bias into the results for the analysis, certain days were removed from the tabulation of summary results. The list for the removals is provided as Appendix A, and is comprised of the Federal holidays from the years 2000 through 2013. It is noted that certain Federal holidays are not recognized in some states (e.g., Columbus Day). Additionally, local holidays (e.g., Mardi Gras in New Orleans) or non-Federal holidays (e.g., Easter) may impact decisions for whether to perform short-term counts. However, adjustment of results at this level was determined to be beyond the scope of the analysis, so the Federal holiday adjustment is the only removal from the results.

Beyond the holiday removal, the results are further restricted to cases where temporary counts included only weekdays Monday-Thursday, and assuming no holidays within the time span. For the 24-hour estimates, the 24 hours will usually span two calendar days, so the results are only provided where the two days spanned are Monday-Tuesday, Tuesday-Wednesday, and Wednesday-Thursday. Hence, 24-hour results for Sunday-Monday and Thursday-Friday, while partially falling within the period of interest, are not included. For the 48-hour estimates, results are produced only where the starting day is Monday and ending day is Wednesday, or where the starting day is Tuesday and the ending day is Thursday. This particular reporting division was selected based on a group consensus within the project Technical Advisory Committee (TAC) that it was most representative of actual DOT field practices (though not necessarily universally representative).

Results

The complete results for this evaluation are made up of a percentage bias in AADT between the short-term count and the true AADT for the following sets of conditions:

- 202 sites with complete hourly data, grouping factors based on functional classification, restricted to Monday-Thursday excluding holidays, and evaluated for same-year, two-year, and three-year factoring; and
- 58 sites with complete hourly data, grouping factors based on functional classification, restricted to Monday-Thursday excluding holidays, and evaluated for same-year, two-year, three-year, four-year, and five-year factoring.

Each of the above is evaluated for both 24- and 48-hour short-term count durations, extending from the first day of the calendar year to the last one for which the duration fits into the year, and under separate day of week and month of year weighting factors.

The aggregate number of records estimated above is large. These data have been provided to FHWA as a separate SAS dataset. Several important summaries of these records will be discussed here and provide the basis for examining the research questions of interest in this task.

National Summary: Accuracy and Precision of AADT Estimation by Count Duration and Frequency

For the 202 sites (within a particular starting year) where it was possible to evaluate accuracy and precision of AADT estimation for same-year, two-year, and three-year factoring, the national-level results are summarized in Table 4. For 24-hour counts, the results are based on 29,610 site x day estimates, which overestimate true AADT, on median, for the same year by 0.29 percent, and by 0.17 percent and 0.50 percent, respectively, for two- and three-year factoring. The same-year, two-year, and three-year factoring for 48-hour counts yields AADT values which on median are bias low by 0.02 percent, low by 0.16 percent, and high by 0.14 percent, respectively. These values are so close to zero that loss of accuracy for estimating AADT in two- and three-year factoring can be considered minimal.

Precision is presented across all duration and frequency combinations as a 95 percent confidence interval on the AADT error for any particular site and day as the difference between the 97.5th percentile largest such difference and 2.5th percentile smallest such difference. For 24-hour counts in the same year, the 29,610 day and site combinations produce an estimated AADT within -24.48 percent to +28.08 percent of the true value 95 percent of the time. To determine the gain or loss of precision, the total width of these 95 percent confidence intervals are compared. For 24-hour short-term counts expanded to the second year, the 95 percent confidence interval for precision (-24.76, 29.54) is 3.30 percent wider than that of the same year estimate. For the same set of sites projected to three years, the precision range is 5.56 percent larger. The same pattern holds for 48-hour short-term counts with the two-year factoring 2.84 percent less precise and the three-year factoring 6.48 percent less precise. However, it should be noted that 48-hour short-term counts for same year are more precise to begin with when compared to 24-hour counts (9.53 percent reduction in width of interval for 48 hours compared to 24 hours). Hence, the loss of precision for 48-hour counts at two- and three-year factoring may still result in intervals more precise than the same year for 24-hour short-term counts.

Illustrated Example: Suppose a site has an AADT of 10,000. Table 4 shows 24-hour counts expanded to AADT would produce estimates (with 95 percent probability) that range from 7,552 to 12,808 for same-year factoring (based on a 95 percent confidence interval of -24.48 to 28.08). When extending this first-year 24-hour count by a year-over-year factor, the second-year AADT estimates would range from 7,524 to 12,954 (assuming true AADT still at 10,000). This is a 174 count wider range and corresponds to the 3.3 percent loss of precision reported in Table 4. For three-year factoring (with same 10,000 AADT), the estimated range is 7,513 to 13,062. This 293 count wider range is the 5.56 percent loss in precision shown in the table. The 95 percent confidence interval converted to a vehicle count range for 48-hour counts (7,753 to 12,509) is 500 vehicles smaller than for 24-hour counts (and this is the source of the -9.53 percent value in the table). The 48-hour counts projected to a second year are 2.84 percent less precise (7,751 to 12,642 – 135 vehicle larger range) at 2 years and 6.48 percent less precise (7,719 to 12,783 – 308 vehicle larger range) at 3 years.

Table 5 replicates the structure of Table 4, but addresses the 58 sites for which it was possible to evaluate AADT accuracy and precision over a six-year period. With the much smaller number of sites, the same-year factoring results for 24-hour counts produced a median 0.49 percent bias and 95 percent confidence interval for precision as (-20.50,21.27). (These values are different than the same statistics in Table 4, due to being based on a different subset of sites.) At six years, the 24-hour counts adjusted for five sequential year-over-year factors, had moved to a median 0.18 percent undercount and the 95 percent confidence interval for precision was 21.77 percent larger than for the starting year. The 48-hour short-term counts showed the same pattern with same-year median AADT overestimation of 0.16 percent, turning to a median -0.83 percent underestimation in the sixth year. While still below one percent in all cases, these results did show a median move toward undercounting at six years. The AADT precision based on 48-hour short-term counts was 32.34 percent poorer (i.e., wider 95 percent confidence interval) at six years than for the same year. As with the one, two, and three-year factoring, the 48-hour short-term counts produced better precision (13.67 percent) than the 24-hour counts.

Table 4. Comparison of Median and 95% CI Error on AADT Estimation for 24- and 48-Hour Short-Term Counts at Same-Year, Two-Year, and Three-Year Factoring; National Level, Functional Classification Factoring, Monday-Thursday Counts, Excluding Holidays

Duration	Site x Days	Same-Year Factoring		Two-Year Factoring		Three-Year Factoring	
		Median	95% CI	Median	95% CI	Median	95% CI
24 Hours	29,610	0.29	(- 24.48, 28.08)	0.17	(- 24.76, 29.54)	0.50	(- 24.87, 30.62)
48 Hours	19,066	-0.02	(- 22.47, 25.09)	-0.16	(- 22.49, 26.42)	0.14	(- 22.81, 27.83)
		Change in 95% Confidence Interval (CI) Width					
		48 Hours vs. 24 Hours Same-Year		Two-Year vs. Same-Year		Three-Year vs. Same-Year	
				24 Hours	3.30	24 Hours	5.56
			-9.53	48 Hours	2.84	48 Hours	6.48

Source: Battelle

Table 5. Comparison of Median and 95% CI Error on AADT Estimation for 24- and 48-Hour Short-Term Counts at Same-Year, and 6-Year Factoring; National Level, Functional Classification Factoring, Monday-Thursday Counts, Excluding Holidays

Duration	Site x Days	Same-Year Factoring		Six-Year Factoring	
		Median	95% CI	Median	95% CI
24 Hours	8,450	0.49	(- 20.50, 21.27)	-0.18	(- 20.87, 29.98)
48 Hours	5,411	0.16	(- 18.00, 18.06)	-0.83	(- 18.77, 28.95)
		Change in 95% Confidence Interval (CI) Width			
		48 Hours vs. 24 Hours Same-Year		Six-Year vs. Same-Year	
				24 Hours	21.77
			-13.67	48 Hours	32.34

Source: Battelle

The results in Table 4 provide a measure of uncertainty for each of same-year, two-year, and three-year factoring separately. However, standard practice in the states is often to estimate AADT using short-term counts on two- or three-year cycles, where any AADT from a site in a previous year is brought up to the current year using the appropriate year-over-year factoring. It was desired to examine the impact of this practice from the results produced in this task. To complete the evaluation, the 202 sites with same-year, two-year, and three-year differences from AADT were utilized to evaluate common one-, two- and three-year factoring procedures. The result of the site counted every year is already reported in Table 4. To simulate sites that are counted every two years, the 202 sites were randomly split into two groups with one-half counted as same-year results and the other half counted as the two-year factoring results. To simulate sites that are counted every three years, the 202 sites were randomly split into three groups with one-third counted as same-year results, one-third counted as the two-year factoring results, and the final one-third counted as the three-year factoring results. This process was completed 1,000 times in a Monte Carlo simulation. The set of 1,000 results for median, 2.5th, and 97.5th percentile differences was evaluated for the median of each statistic to determine the impact of each of the strategies for short-term counting, and then these are tabulated similarly to each individual yearly factoring.

Table 6 shows that 24-hour counts taken yearly, half taken every other year, or one-third taken each year in a three-year cycle result in a very similar median AADT overcount of 0.29, 0.23, or 0.32 percent respectively. The 48-hour counts similarly taken yearly, half taken every other year, or one-third taken each year in a three-year cycle result in a very similar median AADT undercount of 0.02, 0.10, or 0.03 percent, respectively. The impact of counting sites on a biannual basis is 1.35 percent poorer precision for 24-hour counts and 1.18 percent poorer precision for 48-hour counts. For sites counted once every three years, the overall impact in precision is an increase of 2.93 percent for 24-hour counts and 3.12 percent for 48-hour counts.

Table 6. Comparison of Median and 95% CI Error on AADT Estimation for 24- and 48-Hour Short-Term Counts On Annual, Two-Year, and Three-Year Count Cycles; National Level, Functional Classification Factoring, Monday-Thursday Counts, Excluding Holidays

Duration	Site x Days	Every Year		Sites Counted Every 2nd Year		Sites Counted Every 3rd Year	
		Median	95% CI	Median	95% CI	Median	95% CI
24 Hours	29,610	0.29	(- 24.48, 28.08)	0.23	(- 24.63, 28.65)	0.32	(- 24.67, 29.43)
48 Hours	19,066	-0.02	(- 22.47, 25.09)	-0.10	(- 22.49, 25.63)	-0.03	(- 22.58, 26.46)
		Change in 95% CI Width		1/2 Sites Counted Each Year vs. All Sites Every Year		1/3 Sites Counted Each Year vs. All Sites Every Year	
		48 Hour vs. 24 Hour Same-Year			1.35		2.93
			-9.53		1.18		3.12

Source: Battelle

The process described for the sites with one-, two-, and three-year AADT estimation was also performed for the 58 sites that had six-year factoring. The results are shown in Table 7. In this case, the counting of one-sixth of all sites in each year has the effect of reducing the median error from 0.49 percent to 0.44 percent for 24-hour counts, and from 0.16 percent to -0.07 percent for 48-hour counts. From a precision perspective, the practice of counting one-sixth of sites each year generates precision 8.38 percent higher than yearly counting for 24-hour short-term counts and 11.56 percent higher than yearly counting for 48-hour short-term counts.

Table 7. Comparison of Median and 95% CI Error on AADT Estimation for 24- and 48-Hour Short-Term Counts On Annual and Six-Year Count Cycles; National Level, Functional Classification Factoring, Monday-Thursday Counts, Excluding Holidays

Duration	Site x Days	Every Year		Sites Counted Every 6th Year	
		Median	95% CI	Median	95% CI
24 Hours	8,450	0.49	(- 20.50, 21.27)	0.44	(- 19.76, 25.50)
48 Hours	5,411	0.16	(- 18.00, 18.06)	-0.07	(- 17.59, 22.63)
		Change in 95% CI Width		1/6 Sites Counted Each Year vs. All Sites Every Year	
		48 Hour vs. 24 Hour Same-Year			8.38
			-13.67		11.56

Source: Battelle

Functional Classification Summary: Accuracy and Precision of AADT Estimation by Count Duration and Frequency

The preceding national summaries for same-year, two-year, and three-year factoring can also be evaluated for subsets of sites corresponding to the seven functional classification represented in the original data. In comparison to the national results, Table 8 shows a much broader range of results. The basic direction of two-year and three-year factoring leading to a loss of precision is still apparent, but some functional classifications seem to produce a greater difference than others. Additionally, the clearly greater loss of precision for three-year factoring compared to two-year factoring seen in the national level results does not necessarily follow for all functional classifications (e.g., 3R for 48-hour counts, and 4R and 5R for both 24- and 48-hour counts).

Table 8. Comparison of Median and 95% CI Error on AADT Estimation for 24- and 48-Hour Short-Term Counts at Same-Year, Two-Year, and Three-Year Factoring; Functional Classification Level, Functional Classification Factoring, Monday-Thursday Counts, Excluding Holidays

FC	Site x Days	Same-Year Factoring		Two-Year Factoring		Three-Year Factoring		Change in Precision	Compared to Same-Year	
		Median, 95% CI		Median, 95% CI		Median, 95% CI		vs. 24 hour	2-Year	3-Year
24-Hour Counts										
1R	2630	-1.80	(- 17.40, 25.57)	-1.68	(- 19.02, 26.65)	-1.70	(- 19.03, 27.59)		6.27	8.48
1U	4678	0.85	(- 12.37, 14.60)	1.00	(- 15.40, 15.34)	1.37	(- 15.45, 17.42)		13.97	21.86
3R	5298	1.27	(- 34.12, 34.71)	1.01	(- 32.72, 42.74)	1.36	(- 34.04, 42.30)		9.63	10.91
3U	4824	0.19	(- 13.38, 14.94)	-0.16	(- 15.74, 15.37)	0.44	(- 15.92, 15.95)		9.82	12.53
4R	2925	-1.77	(- 27.42, 31.79)	-1.45	(- 26.72, 33.52)	-0.37	(- 27.84, 31.72)		1.74	0.60
4U	2361	0.92	(- 22.32, 24.42)	0.48	(- 22.97, 24.83)	0.69	(- 21.01, 28.40)		2.27	5.73
5R	6894	0.53	(- 29.81, 36.79)	0.25	(- 30.52, 38.97)	0.38	(- 30.28, 37.12)		4.33	1.19
48-Hour Counts										
1R	1694	-2.35	(- 18.59, 21.70)	-2.23	(- 19.42, 22.30)	-2.28	(- 19.68, 23.74)	-6.26	3.56	7.80
1U	3004	0.48	(- 10.74, 13.63)	0.74	(- 14.10, 14.11)	1.08	(- 14.40, 16.06)	-9.68	15.78	25.05
3R	3409	0.74	(- 33.82, 32.78)	0.61	(- 32.78, 42.78)	0.64	(- 33.22, 41.51)	-3.23	13.45	12.20
3U	3108	0.15	(- 11.28, 13.10)	-0.16	(- 13.72, 13.91)	0.43	(- 14.58, 15.03)	-13.92	13.32	21.45
4R	1884	-2.15	(- 26.20, 28.79)	-1.70	(- 25.51, 30.21)	-0.81	(- 26.36, 29.13)	-7.14	1.33	0.93
4U	1529	0.89	(- 21.49, 21.84)	0.39	(- 22.69, 23.45)	0.92	(- 19.82, 27.29)	-7.28	6.49	8.72
5R	4438	0.00	(- 26.70, 32.04)	-0.37	(- 27.07, 34.56)	-0.19	(- 27.49, 31.39)	-11.81	4.92	0.24

Source: Battelle

Starting Year Summary: Accuracy and Precision of AADT Estimation by Count Duration and Frequency

The preceding national summaries can also be evaluated for subsets of sites corresponding to the 12 starting years from 2000 through 2011 (Table 9). The error of two-year and three-year factoring leading to a loss of precision is still apparent, but some years produce a greater difference than others, and some are even negative. Additionally, the clearly greater loss of precision for three-year factoring compared to two-year factoring seen in the national level results does not necessarily follow for all years. Three-year factoring of 2000 counts are actually more precise than two-year factoring. Three-year factoring of 2007 counts is not only more precise than two-year factoring, but it is more precise than the same-year estimation of 2007 AADT.

Table 9. Comparison of Median and 95% CI Error on AADT Estimation for 24- and 48-Hour Short-Term Counts at Same-Year, Two-Year, and Three-Year Factoring; By Year, Functional Classification Factoring, Monday-Thursday Counts, Excluding Holidays

Year	Site x Days	Same-Year Factoring: Median and 95% Confidence Interval		Two-Year Factoring: Median and 95% Confidence Interval		Three-Year Factoring: Median and 95% Confidence Interval		Change in Precision[1] vs. 24 hour	Compared to Same-Year: 2-Year	Compared to Same-Year: 3-Year
24-Hour Counts										
2000	4116	1.71	(- 35.44, 37.58)	1.40	(- 35.68, 54.32)	1.25	(- 37.08, 45.28)		23.26	12.77
2001	2304	0.48	(- 15.06, 17.92)	0.59	(- 16.89, 18.56)	0.65	(- 17.96, 19.09)		7.50	12.35
2002	725	-1.47	(- 14.90, 13.62)	-0.11	(- 15.86, 14.80)	0.32	(- 16.45, 16.79)		7.50	16.53
2003	3942	-0.42	(- 18.56, 28.36)	-0.18	(- 19.75, 29.12)	0.21	(- 19.57, 31.06)		4.19	7.92
2004	3996	0.41	(- 22.26, 21.22)	-0.18	(- 20.08, 24.36)	0.39	(- 19.33, 26.53)		2.22	5.49
2005	740	-2.43	(- 20.31, 14.22)	-2.61	(- 18.68, 16.17)	-1.23	(- 20.18, 15.39)		0.92	3.00
2006	1022	0.65	(- 21.80, 26.93)	1.49	(- 23.25, 26.76)	0.70	(- 24.10, 31.44)		2.63	13.98
2007	2736	1.25	(- 33.71, 38.59)	0.29	(- 33.98, 47.96)	1.82	(- 31.55, 34.83)		13.34	-8.19
2008	5145	0.45	(- 24.57, 24.93)	0.88	(- 23.77, 25.06)	0.47	(- 24.71, 25.92)		-1.37	2.27
2009	1184	1.12	(- 22.14, 18.73)	-0.48	(- 25.89, 17.49)	1.65	(- 24.35, 20.82)		6.13	10.51
2010	592	3.51	(- 18.10, 81.21)	2.65	(- 18.38, 80.59)	5.71	(- 17.49, 82.55)		-0.34	0.74
2011	3108	-1.85	(- 25.77, 25.16)	-2.36	(- 25.75, 25.01)	-2.38	(- 26.59, 25.96)		-0.33	3.18
48-Hour Counts										
2000	2660	1.34	(- 33.96, 36.57)	1.16	(- 33.34, 54.13)	0.64	(- 36.41, 44.33)	-3.42	24.01	14.47
2001	1472	0.53	(- 12.00, 15.20)	0.37	(- 15.05, 16.05)	0.58	(- 15.77, 16.07)	-17.53	14.32	17.08
2002	460	-1.24	(- 16.30, 12.51)	-0.39	(- 17.67, 12.06)	0.30	(- 15.18, 15.24)	1.03	3.17	5.58
2003	2538	-0.83	(- 18.67, 23.29)	-0.64	(- 19.24, 24.71)	-0.43	(- 19.46, 25.54)	-10.55	4.75	7.24
2004	2592	0.29	(- 20.60, 19.74)	-0.17	(- 18.50, 22.86)	0.34	(- 18.37, 24.97)	-7.22	2.53	7.44
2005	480	-1.98	(- 20.02, 12.72)	-1.85	(- 16.61, 14.11)	-0.56	(- 19.31, 14.08)	-5.18	-6.18	2.00
2006	658	0.15	(- 19.52, 24.95)	1.12	(- 20.05, 24.49)	0.38	(- 22.60, 30.52)	-8.74	0.16	19.46
2007	1748	0.97	(- 31.95, 35.33)	-0.12	(- 31.25, 46.55)	1.65	(- 31.40, 31.43)	-6.95	15.64	-6.61
2008	3290	-0.14	(- 21.76, 19.95)	0.31	(- 21.53, 19.79)	-0.31	(- 22.24, 20.68)	-15.73	-0.97	2.90
2009	768	0.76	(- 19.24, 17.27)	-0.50	(- 22.90, 15.73)	1.48	(- 20.70, 17.86)	-10.68	5.81	5.62
2010	384	3.65	(- 19.30, 77.07)	2.66	(- 19.57, 76.47)	5.57	(- 18.70, 78.38)	-2.96	-0.34	0.74
2011	2016	-2.56	(- 24.42, 20.06)	-3.01	(- 25.08, 20.88)	-3.24	(- 25.63, 23.03)	-12.67	3.34	9.39

[1] Defined as 100*[(width of comparison confidence interval)/(width of reference confidence interval) – 1]
Source: Battelle

Conclusions

Several important conclusions can be derived from this evaluation:

1. When looking at different yearly frequencies of obtaining short duration counts (24 or 48 hours) and projecting them to a current year AADT (one to two years of functional classification factoring applied), the bias in the error remains small for counts obtained as many as two years earlier (median bias of 0.50 percent overcount for 24-hour counts, and 0.14 percent for 48-hour counts, compared to a median 0.29 percent overcount for 24 hours and 0.02 percent undercount for same-year factoring).
2. The precision of AADT estimates, as measured by the width of the 95 percent confidence interval on errors, systematically degrade as actual count year vs. the original count year increases. For example; when utilizing two-year factoring, AADT precision degrades by about three percent, and for three-year factoring precision degrades by about six percent. This is true of both 24- and 48-hour counts, although 48-hour counts show better precision to begin with than 24-hour counts. (see Table 4 for detailed results)
3. For six-year counts (five-year factoring), the accuracy actually improved for 24-hour counts as median bias dropped from 0.49 percent overcount at same year to a 0.18 percent undercount at six years. The 48-hour count accuracy degraded from a median 0.16 percent overcount in the same year to a 0.83 percent undercount at six years. Precision loss was 22 percent for 24-hour counts and 32 percent for 48-hour counts, though again the precision is better for the 48-hour counts in the base year.
4. When evaluating these results for both the duration and frequency of the short-term counts, scenarios were evaluated for sites counted every year, one-half of the sites counted each year, one-third of the sites counted each year, and one-sixth of the sites counted each year. The results show that the AADT bias error is very consistent and small (0.29, 0.23, 0.32, and 0.44 percent overcount, respectively, for 24-hour counts obtained every year, half of sites counted each year, one-third of sites counted each year, and one-sixth of sites counted each year; 0.02, 0.10, 0.03, and 0.07 percent undercount, respectively, for 48-hour counts). Precision degraded about one percent for one-half of sites counted each year, three percent for one-third of sites counted each year, and eight or 12 percent (24- and 48-hour counts, respectively) for one-sixth of sites counted each year. (see Table 6 and Table 7for detailed results)

The national level results also generalize to functional classification and year, but these divisions show more variability, and in some cases the overall national pattern does not hold for a specific functional classification or year.

Appendix: Federal Holidays

Table A-1: Federal Holidays Excluded from Summarized Results

Holiday	Year													
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
New Year's Day	Saturday 01 Jan	Monday 01 Jan	Tuesday 01 Jan	Wednesday 01 Jan	Thursday 01 Jan	Saturday 01 Jan	Sunday 01 Jan	Monday 01 Jan	Tuesday 01 Jan	Thursday 01 Jan	Friday 01 Jan	Saturday 01 Jan	Sunday 01 Jan	Tuesday 01 Jan
New Year's Day observed							Monday 02 Jan						Monday 02 Jan	
Martin Luther King Day	Monday 17 Jan	Monday 15 Jan	Monday 21 Jan	Monday 20 Jan	Monday 19 Jan	Monday 17 Jan	Monday 16 Jan	Monday 15 Jan	Monday 21 Jan	Monday 19 Jan	Monday 18 Jan	Monday 17 Jan	Monday 16 Jan	Monday 21 Jan
Presidents' Day (Washington's Birthday)	Monday 21 Feb	Monday 19 Feb	Monday 18 Feb	Monday 17 Feb	Monday 16 Feb	Monday 21 Feb	Monday 20 Feb	Monday 19 Feb	Monday 18 Feb	Monday 16 Feb	Monday 15 Feb	Monday 21 Feb	Monday 20 Feb	Monday 18 Feb
Memorial Day	Monday 29 May	Monday 28 May	Monday 27 May	Monday 26 May	Monday 31 May	Monday 30 May	Monday 29 May	Monday 28 May	Monday 26 May	Monday 25 May	Monday 31 May	Monday 30 May	Monday 28 May	Monday 27 May
Independence Day observed										Friday 03 Jul				
Independence Day	Tuesday 04 Jul	Wednesday 04 Jul	Thursday 04 Jul	Friday 04 Jul	Sunday 04 Jul	Monday 04 Jul	Tuesday 04 Jul	Wednesday 04 Jul	Friday 04 Jul	Saturday 04 Jul	Sunday 04 Jul	Monday 04 Jul	Wednesday 04 Jul	Thursday 04 Jul
Independence Day observed					Monday 05 Jul						Monday 05 Jul			
Labor Day	Monday 04 Sep	Monday 03 Sep	Monday 02 Sep	Monday 01 Sep	Monday 06 Sep	Monday 05 Sep	Monday 04 Sep	Monday 03 Sep	Monday 01 Sep	Monday 07 Sep	Monday 06 Sep	Monday 05 Sep	Monday 03 Sep	Monday 02 Sep
Columbus Day	Monday 09 Oct	Monday 08 Oct	Monday 14 Oct	Monday 13 Oct	Monday 11 Oct	Monday 10 Oct	Monday 09 Oct	Monday 08 Oct	Monday 13 Oct	Monday 12 Oct	Monday 11 Oct	Monday 10 Oct	Monday 08 Oct	Monday 14 Oct
Veterans Day observed	Friday 10 Nov						Friday 10 Nov							
Veterans Day	Saturday 11 Nov	Sunday 11 Nov	Monday 11 Nov	Tuesday 11 Nov	Thursday 11 Nov	Friday 11 Nov	Saturday 11 Nov	Sunday 11 Nov	Tuesday 11 Nov	Wednesday 11 Nov	Thursday 11 Nov	Friday 11 Nov	Sunday 11 Nov	Monday 11 Nov
Veterans Day observed		Monday 12 Nov						Monday 12 Nov					Monday 12 Nov	
Thanksgiving Day	Thursday 23 Nov	Thursday 22 Nov	Thursday 28 Nov	Thursday 27 Nov	Thursday 25 Nov	Thursday 24 Nov	Thursday 23 Nov	Thursday 22 Nov	Thursday 27 Nov	Thursday 26 Nov	Thursday 25 Nov	Thursday 24 Nov	Thursday 22 Nov	Thursday 28 Nov
Christmas Day observed					Friday 24 Dec						Friday 24 Dec			
Christmas Day	Monday 25 Dec	Tuesday 25 Dec	Wednesday 25 Dec	Thursday 25 Dec	Saturday 25 Dec	Sunday 25 Dec	Monday 25 Dec	Tuesday 25 Dec	Thursday 25 Dec	Friday 25 Dec	Saturday 25 Dec	Sunday 25 Dec	Tuesday 25 Dec	Wednesday 25 Dec
Christmas Day observed						Monday 26 Dec						Monday 26 Dec		
New Year's Day observed					Friday 31 Dec						Friday 31 Dec			

Source: Battelle

U.S. Department of Transportation
Federal Highway Administration

U.S. Department of Transportation
Federal Highway Administration
Office of Highway Policy Information
1200 New Jersey Ave., SE
Washington, D.C. 20590
https://www.fhwa.dot.gov/policyinformation
February 2016
FHWA-PL-16-012