

Traffic Monitoring in Recreational Areas



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16. Abstract <p>Traffic monitoring in recreational areas is often challenged by distinct traffic and roadway characteristics and the multitude of agencies responsible for the management of Federal lands and/or the collection of supporting traffic data. These challenges are exacerbated by a lack of consistent procedural guidance; existing national traffic monitoring guidelines lack sufficient direction and detail for recreational travel.</p> <p>In an effort to improve/lend consistency to traffic monitoring in recreational areas, the Coordinated Technology Implementation Program tasked the Office of Federal Lands Highway-Federal Highway Administration (FHWA) with conducting an assessment of the nationwide practices for recreational traffic data collection. A review of pertinent literature related to recreational traffic data collection was conducted. A targeted survey of various State and local agencies responsible for traffic monitoring was administered. A workshop focused on traffic monitoring in recreational areas was also conducted. Key findings from these activities are briefly described herein.</p>			
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Traffic Monitoring In Recreational Areas

Technology Deployment Program
Western Federal Lands Highway Division
Federal Highway Administration
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Vancouver, WA 98661



SI* (MODERN METRIC) CONVERSION FACTORS

APPROXIMATE CONVERSIONS TO SI UNITS

Symbol	When You Know	Multiply By	To Find	Symbol
LENGTH				
in	inches	25.4	millimeters	mm
ft	feet	0.305	meters	m
yd	yards	0.914	meters	m
mi	miles	1.61	kilometers	km
AREA				
in ²	square inches	645.2	square millimeters	mm ²
ft ²	square feet	0.093	square meters	m ²
yd ²	square yard	0.836	square meters	m ²
ac	acres	0.405	hectares	ha
mi ²	square miles	2.59	square kilometers	km ²
VOLUME				
fl oz	fluid ounces	29.57	milliliters	mL
gal	gallons	3.785	liters	L
ft ³	cubic feet	0.028	cubic meters	m ³
yd ³	cubic yards	0.765	cubic meters	m ³
NOTE: volumes greater than 1000 L shall be shown in m ³				
MASS				
oz	ounces	28.35	grams	g
lb	pounds	0.454	kilograms	kg
T	short tons (2000 lb)	0.907	megagrams (or "metric ton")	Mg (or "t")
TEMPERATURE (exact degrees)				
°F	Fahrenheit	5 (F-32)/9 or (F-32)/1.8	Celsius	°C
ILLUMINATION				
fc	foot-candles	10.76	lux	lx
fl	foot-Lamberts	3.426	candela/m ²	cd/m ²
FORCE and PRESSURE or STRESS				
lbf	poundforce	4.45	newtons	N
lbf/in ²	poundforce per square inch	6.89	kilopascals	kPa
APPROXIMATE CONVERSIONS FROM SI UNITS				
Symbol	When You Know	Multiply By	To Find	Symbol
LENGTH				
mm	millimeters	0.039	inches	in
m	meters	3.28	feet	ft
m	meters	1.09	yards	yd
km	kilometers	0.621	miles	mi
AREA				
mm ²	square millimeters	0.0016	square inches	in ²
m ²	square meters	10.764	square feet	ft ²
m ²	square meters	1.195	square yards	yd ²
ha	hectares	2.47	acres	ac
km ²	square kilometers	0.386	square miles	mi ²
VOLUME				
mL	milliliters	0.034	fluid ounces	fl oz
L	liters	0.264	gallons	gal
m ³	cubic meters	35.314	cubic feet	ft ³
m ³	cubic meters	1.307	cubic yards	yd ³
MASS				
g	grams	0.035	ounces	oz
kg	kilograms	2.202	pounds	lb
Mg (or "t")	megagrams (or "metric ton")	1.103	short tons (2000 lb)	T
TEMPERATURE (exact degrees)				
°C	Celsius	1.8C+32	Fahrenheit	°F
ILLUMINATION				
lx	lux	0.0929	foot-candles	fc
cd/m ²	candela/m ²	0.2919	foot-Lamberts	fl
FORCE and PRESSURE or STRESS				
N	newtons	0.225	poundforce	lbf
kPa	kilopascals	0.145	poundforce per square inch	lbf/in ²

*SI is the symbol for the International System of Units. Appropriate rounding should be made to comply with Section 4 of ASTM E380.

(Revised March 2003)

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LIST OF ACRONYMS

AASHTO	American Association of State Highway and Transportation Officials
AADT	Annual Average Daily Traffic
ADT	Average Daily Traffic
ATR	Automatic Traffic Recorder
AVC	Automatic Vehicle Classifier
AWDT	Average Weekday Traffic
BLM	Bureau of Land Management
BMS	Bridge Management System
CMS	Congestion Management System
CV	Coefficient of Variation
DOT	Department of Transportation
FARS	Fatal Accident Reporting System
FDOT	Florida Department of Transportation
FHWA	Federal Highway Administration
FLH	Office of Federal Lands Highway
FLHP	Federal Lands Highway Program
FLMA	Federal Land Management Agency
GIS	Geographic Information System
HPMS	Highway Performance Monitoring System
LTPP	Long-Term Pavement Performance
MPO	Metropolitan Planning Organization
MTC	Metropolitan Transportation Commission
NATMEC	North American Travel Monitoring Exhibition and Conference
NPS	National Park Service
PMS	Pavement Management System
PRPTIP	Park Road Program, Transportation Improvement Program
RIP	Road Inventory Program
RV	Recreational Vehicle
SMCOG	Southwest Missouri Council of Governments
SMS	Safety Management System
TMG	Traffic Monitoring Guide
TMS	Traffic Management System
TRIS	Transportation Research Information System
TTI	Texas Transportation Institute
U.S. DOT	U.S. Department of Transportation
USDA-FS	U.S. Department of Agriculture, Forest Service
USFWS	Fish and Wildlife Service
VMT	Vehicle-Miles Traveled
WIM	Weigh-in-Motion

EXECUTIVE SUMMARY

Traffic monitoring in recreational areas is often challenged by distinct traffic and roadway characteristics and the multitude of agencies responsible for the management of Federal lands and/or the collection of supporting traffic data. These challenges are exacerbated by a lack of consistent procedural guidance; existing national traffic monitoring guidelines lack sufficient direction and detail for recreational travel.

In an effort to improve/lend consistency to traffic monitoring in recreational areas, the Coordinated Technology Implementation Program tasked the Office of Federal Lands Highway-Federal Highway Administration (FHWA) with conducting an assessment of the nationwide practices for recreational traffic data collection. This work was performed by the Texas Transportation Institute and Chaparral Systems, Inc., under contract to Battelle.

There were three primary tasks:

- (1) a review of pertinent literature related to recreational traffic data collection
- (2) a targeted survey of various State and local agencies responsible for traffic monitoring
- (3) the conduct of a workshop focused on traffic monitoring in recreational areas.

Key findings from these activities are briefly described below and are related to: national guidance for traffic monitoring in recreational areas, vehicle classification, recreational traffic monitoring as described in the literature, and recreational traffic monitoring as observed in practice.

National Guidance for Traffic Monitoring in Recreational Areas

Current national traffic monitoring guidance documents—including the

Traffic Monitoring Guide,¹ *Guidelines for Traffic Data Programs*,² and the *Highway Performance Monitoring System Field Manual for the Continuing Analytical and Statistical Database*³—recommend a traffic monitoring framework that comprises: (1) a modest number of permanent continuous monitoring locations that adequately characterize the variation of traffic by day of the week and month/season of the year, and (2) a large number of portable short-term (typically 24 to 72 hours) monitoring locations that can support determination of “annualized” estimates using monthly/seasonal and day-of-week adjustment factors derived from the permanent continuous monitoring locations.

Recreational traffic can vary greatly by day of the week and month of the year, challenging the calculation of seasonal and day-of-week adjustment factors. National guidance documents recognize recreational traffic monitoring challenges but provide little substantial guidance to address them. Existing national guidance documents focus attention on major commuting and through-traffic routes because: (1) recreational traffic has greater variability and specific procedures for monitoring it are less formulaic on a national basis, and (2) recreational traffic comprises a small percentage of the total vehicle-miles traveled that must be monitored by resource-constrained State agencies. Consequently, most State Departments of Transportation (DOTs) focus traffic monitoring efforts on high-volume, high-mileage roadway classes that more significantly impact Federal-aid apportionment.

1 *Traffic Monitoring Guide*. FHWA-PL-01-021. Office of Highway Policy Information, Federal Highway Administration, U.S. Department of Transportation. Washington D.C. May 2001.

2 *Guidelines for Traffic Data Programs*. American Association of State highway and Transportation Officials. Washington D.C. 1992.

3 *Highway Performance Monitoring System Field Manual for the Continuing Analytical and Statistical Database*. Office of Highway Policy Information, Federal Highway Administration, U.S. Department of Transportation. Washington D.C. May 2005.

For these documents to have utility for traffic monitoring in recreational areas, additional detail and direction is required. This amendment process is not uncommon for Federal lands; distinct roadway design criteria and aesthetic guidelines have been previously developed in place of or as a supplement to more generalized national guidance.

Vehicle Classification

Recreational traffic is distinct with respect to the types of vehicles in the traffic stream; recreational traffic generally comprises a higher proportion of recreational vehicles (RVs), buses, and vehicles pulling trailers. The proliferation of various vehicle classes (the variety of which depends on the season and Federal Land unit) suggests that the commonly used FHWA vehicle classification scheme is insufficient in adequately characterizing recreational traffic. Under the FHWA vehicle classification scheme, the types of vehicles and vehicle combinations that frequent recreational areas are aggregated with other passenger cars, buses, and trucks across 6 of the 13 possible vehicle classifications.

Alternative vehicle classification schemes better distinguish the types of vehicles and vehicle combinations that frequent recreational areas from the general traffic. For example, the American Association of State Highway and Transportation Officials (AASHTO) defines 19 different vehicle classes for calculating design dimensions for the geometric design of roadways, intersections, and interchanges.⁴ Similarly, the *Highway Capacity Manual* distinguishes passenger cars, trucks, buses, and recreational vehicles when calculating the effect of various vehicle types on the capacity of roadways, intersections,

and interchanges.⁵ National safety databases, such as the Fatal Accident Reporting System, include van-based or pickup-based motor home, medium/heavy truck based motor home, and camper or motor home-unknown truck type among other vehicle types.⁶ Looking outside the United States, the Province of Alberta in Canada uses a vehicle classification system consisting of five classes including recreational vehicles.⁷ Most directly reflecting the types of vehicles and vehicle combinations that frequent recreational areas, the National Park Service (NPS) developed a unique vehicle classification scheme that consists of eight vehicle types: motorcycles, passenger cars, RVs, vehicles pulling trailers (including RVs), transit/shuttle buses, tour buses, light-duty trucks, and heavy-duty trucks.⁸

Automated methods for data capture have been developed largely around the FHWA vehicle classification scheme. A noted challenge is the accurate classification of individual vehicles across the 13 categories when similarities exist in the number of axles (i.e., a passenger car pulling a camper trailer may be misclassified as a four-axle single-unit or single trailer truck). Alternatives to axle-based data capture mechanisms are currently focused on vehicle length and vehicle profile. The Minnesota DOT has initiated a pooled-fund study that will investigate issues related to length-based vehicle classification.⁹ The Province of British Columbia in Canada uses a length-based vehicle classification system similar to the one proposed here. Perhaps more appropriate for distinguishing the types

4 *AASHTO Green Book - A Policy on Geometric Design of Highways and Streets*, 5th Edition. American Association of State and Highway Transportation Officials. November 2004.

5 *Highway Capacity Manual*. Transportation Research Board, National Research Council. Washington D.C. 2000.

6 <http://www-fars.nhtsa.dot.gov/Vehicles/VehiclesAllVehicles.aspx>, accessed December 17, 2008.

7 Clayton, Alan, Jeannette Montufar, Dan Middleton, and Bill McCauley. *Feasibility of a New Vehicle Classification System for Canada*. North American Travel Monitoring Exhibition and Conference (NATMEC). August 2000.

8 National Park Service. *Traffic Data Report*. 2004.

9 <http://www.pooledfund.org/projectdetails.asp?id=416&status=4>, accessed December 18, 2008.

of vehicles and vehicle combinations that frequent recreational areas are automated systems that capture the full vehicle profile. A variety of profiler systems are available commercially. Technology costs increase with sophistication and performance; traffic monitoring agencies must reconcile these added costs with the perceived value of accurate vehicle classification data for recreational areas.

Recreational Traffic Monitoring as Described in the Literature

Not surprisingly, researchers observed a disproportionate focus on traffic monitoring in urban rather than recreational areas in the published literature. Publications that did address recreational traffic monitoring generally considered: (1) the use of recreational and/or seasonal factor groups, (2) methods to support determination of recreational and/or seasonal factor groups, and (3) the likely errors associated with factoring or annualizing short-term counts on roads with high-variability traffic.

In general, a review of the literature confirmed that a number of traffic monitoring agencies in the United States and Canada are currently using one or more recreational factor groups. Recommended methods to improve upon factor group determination considered the use of the coefficient of variation, cluster analysis, plots of monthly traffic factors, and geographic mapping of continuous count sites. In one study, traffic monitoring agencies were encouraged to focus on accurately assigning short-term counts to factor groups, rather than on conducting longer duration counts (e.g., 72-hour counts). Based upon observed estimation errors, proposed alternatives to the traditional factor approach included regression analysis and artificial neural networks; however, mixed results in improving average annual daily traffic estimates were reported.

Recreational Traffic Monitoring as Observed in Practice

Additional information regarding traffic monitoring in recreation lands at Federal, State, and local levels was gathered through a targeted survey of State and local agencies and the conduct of a recreational traffic monitoring workshop.

Targeted Survey of State and Local Agencies

A targeted survey of ten State DOTs (Colorado, Florida, Idaho, Indiana, Missouri, Nevada, New Jersey, Utah, Wisconsin, and Wyoming) and three metropolitan planning organizations (Metropolitan Transportation Commission—San Francisco Bay Area, Metroplan Orlando, and Southwest Missouri Council of Governments) was conducted as part of this investigation. Survey participants were asked to respond to a series of questions related to: their agency's conduct of continuous traffic counts; the number of automatic traffic recorders (ATRs) and automatic vehicle classifiers used for recreational and non-recreational traffic data collection; the nature and extent of any recreational, seasonal, or daily factor groups in use; and the nature and extent of roadway mileage under the agency's jurisdiction.

Nearly all of the participating State DOTs maintain one or more seasonal factor groups for recreational traffic monitoring. Several States that have distinct winter and summer recreational traffic maintain two factor groups. The Florida DOT reported using more than two recreational traffic factor groups while the Indiana DOT reported using no factor group for recreational traffic.

None of the planning agencies that were contacted indicated that they routinely monitor recreational traffic; instead, planning agencies rely upon their respective State DOTs to collect this data. Planning agencies may occasionally collect data in recreational areas

to support planning uses, but this is done as part of a “special studies” process.

Recreational Traffic Monitoring Workshop

The purpose of the workshop was to bring together State and Federal land agencies to discuss current and preferred practices for monitoring traffic in recreational areas and to identify opportunities for improving traffic monitoring to and within Federal lands. Representatives from each of the participating Federal, State, and Provincial agencies described specific traffic monitoring practices related to: the use of supporting traffic data collection technologies; the conduct of short-duration counts; the use and characteristics of recreational or seasonal factor groups; vehicle classification; and traffic data use, quality, reporting, and sharing. In addition, participants collectively identified broader challenges related to traffic monitoring in recreational areas. Key findings are summarized below:

- Use of combined permanent and portable counters for data collection was generally reported, but differences in the number of sites used, the subsequent geographic coverage, and the types of technologies were observed.
- Vehicle classification data is not routinely collected; participants cited challenges related to technological limitations, inadequate recreational road geometry/structure, difficulties in annualizing vehicle classification counts based on short-duration counts, and a lack of consensus among State and Federal agencies regarding the value of vehicle classification data compared to the additional costs of equipment, installation, and data processing.
- Short-duration counts are commonly conducted: in 48-hour durations, on Tuesday through Thursday, once every 2 or 3 years. They are often scheduled: in the same month each year at a given site; during different months per site annually by design to account for seasonal variability and/or to verify and refine factor groups; or as scheduling or weather permits. Exceptions include the Nevada DOT, which conducts 7-day counts on an annual basis to account for unique recreational traffic patterns, and the Washington State DOT and Manitoba Infrastructure and Transportation, which conduct 48-hour counts twice per year in recreational areas.
- Factor groups in use by participating agencies—differing in both number and characteristics—are often assigned on the basis of: roadway functional class, traffic composition, travel patterns, proximate/destination land use, climatic region, relative importance for capturing recreational trips, and/or resources/costs. Resources/costs are supported by (in order of preference): data from proximate ATRs, cluster analysis, and/or knowledge of the area/professional judgment.
- The motivation for collecting traffic data was to: meet ongoing Federal reporting requirements; support decision-making related to safety concerns; obtain estimates of demand (i.e., visitation) for comparison with supply inventories, economic assessment and/or determination of resource impact; support decision-making related to system design, maintenance, and management; and/or support determination of cost allocations under cost sharing arrangements.
- Neither existing data quality nor the data quality requirements were able to be effectively described for participating agencies.
- Over time, the reporting of traffic data has migrated from published annual

reports to the Internet, providing timely on-line access to data; however, associated modest concerns over the potential for liability have been raised.

- Data sharing is variable but generally limited among participating agencies. Data sharing opportunities between the FHWA Office of Highway Policy Information and the Office of Federal Lands Highway were identified and appear promising.

Broader Traffic Monitoring Challenges

In addition to these practice-specific observations, a number of overarching challenges to traffic monitoring in recreational areas were identified. These challenges generally relate to: differing organizational structures and priorities among agencies related to the importance placed on recreational areas and the traffic monitoring function; funding and resource constraints and associated difficulties in replacing staff and technology assets; and the unique aesthetic, cultural, and environmental considerations in recreational areas.

Next Steps

Two fundamental opportunities emerged as a result of this investigation related to:

- (1) resource and data sharing
- (2) the pivotal role of FHWA's Office of Federal Lands Highway in improving/lending consistency to traffic monitoring in recreational lands.

In the short-term, opportunities exist to share both resources and data among agencies responsible for recreational traffic monitoring. For longer-term efforts, FHWA's Office of Federal Lands Highway should play a key role in facilitating and supporting improvements to recreational traffic monitoring among diverse partners.

Through this investigation, the unique

characteristics of participating agencies and the respective lands under their jurisdiction became evident. Despite the motivation towards more consistent recreational traffic monitoring, any proposed changes to existing practices cannot be a "one size fits all" approach. It must remain flexible to address the respective differences in underlying mission and priorities and the nature and extent of their jurisdictional land areas and associated roadway network among agencies tasked with managing recreational areas.

INTRODUCTION

Approximately 70,000 miles of federally-owned public roads serving recreational traffic fall under the purview of the Federal Highway Administration (FHWA) Federal Lands Highway Program (i.e., Park Roads and Parkways, Forest Highways, Public Lands Highways, and Refuge Roads). To adequately support planning and management efforts for the preservation and use of Federal lands, land managers must have a clear understanding of the transportation and visitor circulation patterns within their jurisdiction. Traffic data is often collected to support decision-making; however, distinct recreational traffic and roadway characteristics and the multitude of responsible agencies often challenge these efforts. The challenge of collecting recreational traffic data is exacerbated by a lack of consistent guidance. Existing national guidelines for traffic monitoring practices lack sufficient direction and detail for recreational travel.

Investigation Purpose and Methodology

In an effort to improve/lend consistency to traffic monitoring in recreational areas, the Coordinated Technology Implementation Program tasked the Office of Federal Lands Highway-Federal Highway Administration (FHWA), with conducting an assessment of the nationwide practices for recreational traffic data collection. This work was performed by the Texas Transportation Institute (TTI) and Chaparral Systems, Inc., under contract to Battelle, through three primary tasks:

1. A review of pertinent literature related to recreational traffic data collection;
2. A targeted survey of various State and local agencies responsible for traffic monitoring; and
3. The conduct of a workshop focused on traffic monitoring in recreational areas.

Literature Review

A comprehensive literature review was conducted at the onset of this investigation with a focus on traffic data collection in recreational areas. Primary sources of literature included the online Transportation Research Information System (TRIS); other related Internet sites; various conference compendiums (e.g., Transportation Research Board's Annual Meeting); and the TTI and Texas A&M University library collections.

Not surprisingly, researchers observed a disproportionate focus on traffic monitoring in urban rather than recreational areas in the published literature. Much of the literature found to address recreational traffic monitoring considered: (1) the use of recreational and/or seasonal factor groups, (2) methods to support determination of recreational and/or seasonal factor groups, and (3) the likely errors associated with factoring or annualizing short-term counts on roadways with high-variability traffic.

Targeted Survey of Traffic Monitoring in Recreational Areas

As a second task in this investigation, a targeted survey of 10 State Departments of Transportation (DOTs) (Colorado, Florida, Idaho, Indiana, Missouri, Nevada, New Jersey, Utah, Wisconsin, and Wyoming) and three metropolitan planning organizations (Metropolitan Transportation Commission—San Francisco Bay Area, Metroplan Orlando, and Southwest Missouri Council of Governments) was conducted to identify current practices in collecting traffic data at and near recreational areas. Survey participants were selected based on: (1) the ability to provide geographic diversity, (2) the likely presence of recreational travel, and (3) the research team's familiarity with State and local agency staff.

Survey participants were asked to respond to the following series of questions:

(1) Does your agency have seasonal or daily factor groups for your recreational areas? If Yes:

(a) How many seasonal or daily factor groups does your agency have?

(b) For each seasonal or daily factor group:

- Can you provide a brief description of the factor group (i.e., summer recreational, regional recreational, summer and winter recreational—town highways)
- How many automatic traffic recorders (ATRs) are used to support the factor group?
- How many automatic vehicle classifiers (AVCs) are used to support the factor group?
- Approximately how many road-miles are included in each factor group?

(c) How many total ATRs does your agency operate?

(d) How many total AVCs does your agency operate?

(e) Approximately how many total road-miles are included in the network?

(f) On a scale of 1 to 5 (with 1=very low, 2=low, 3=moderate, 4=high, and 5=very high), what priority does your agency give to data collection in recreational areas?

(2) If your agency does not conduct continuous traffic counts, can you describe your traffic data collection efforts to capture recreational traffic trends?

Recreational Traffic Monitoring Workshop

To supplement information gathered through the literature review and targeted survey, a recreational traffic monitoring workshop was conducted. The purpose of the workshop was to bring together State and Federal agencies to discuss current and preferred practices for monitoring

traffic in recreational areas and to identify opportunities for improving traffic monitoring to and within Federal lands. The same information was originally intended to be collected as part of a domestic scan tour to various States, but a gathering under a workshop proved to be a more efficient opportunity for information exchange.

The workshop was held on June 3, 2009, in Lakewood, Colorado with 27 on-site and 3 remote participants. The workshop's agenda was comprised of presentations regarding traffic monitoring in recreational areas as performed by five distinct Federal land agencies (Office of Federal Lands, Bureau of Land Management, Forest Service, Fish and Wildlife Service, and National Park Service), six State agencies (Colorado, Florida, Nevada, Utah, Washington, and Wyoming DOTs), and one Provincial agency (Manitoba Infrastructure and Transportation). Opportunities for general questions and discussion were provided following the presentations made by representatives from the various agencies. A smaller group of approximately 15 workshop attendees was convened for an additional half day on June 4, 2009, to discuss workshop outcomes and brainstorm future directives.

BACKGROUND

To provide a better understanding of the current state of traffic monitoring in recreational areas, background information is provided related to:

- Recreational traffic and roadway characteristics;
- Agencies responsible for recreational traffic monitoring;
- National guidance for traffic monitoring in recreational areas;
- Vehicle classification; and
- Recreational traffic monitoring as described in the literature.

Recreational Traffic and Roadway Characteristics

Recreational traffic is distinct with respect to the types of vehicles in the traffic stream and the corresponding average vehicle occupancy. In general, recreational traffic comprises a higher proportion of recreational vehicles (RVs), buses, and vehicles pulling trailers. Alternative transportation initiatives, such as the Paul S. Sarbanes Transit in the Parks Program, may increase the volume of buses in certain recreational areas. The average vehicle occupancy tends to be higher than that of commuter or local traffic.

Recreational trips can be either destination-focused or for leisure, where much of the drive time is considered to be recreation. Trip routing is directly influenced by its purpose. Recreational trips also have a high temporal variability (e.g., by time of day, day of week, season) depending upon the nature of recreational activities available. Unlike commuter or local traffic where the mean time between trips is both minimal and somewhat predictable, the mean time between recreational trips can range from several days to one week to one year or more. Recreational trips are discretionary, and as such, are readily influenced by factors such as weather, gas prices, etc.

The roadways that support recreational travel differ significantly from roads that are primarily commuter or industrial. Roadways that predominantly support recreational travel are generally of lower functional class, have constrained geometric design features, and may be paved, gravel, or native surfacing. Many are low or extremely low volume roads.

Agencies Responsible for Recreational Traffic Monitoring

At the Federal level, primary agencies that are directly responsible planning and managing the preservation and use of recreational areas include:

- U.S. Department of the Interior, Bureau of Land Management (BLM);
- U.S. Department of the Interior, Fish and Wildlife Service (USFWS);
- U.S. Department of Agriculture, Forest Service (USDA-FS); and
- U.S. Department of the Interior, National Park Service (NPS).

These agencies differ in their underlying mission and priorities and the nature and extent of their jurisdictional land areas and associated roadway network.

Bureau of Land Management

The BLM administers a variety of programs for the management and conservation of resources on 256 million surface acres as well as 700 million subsurface mineral acres of land in the United States. These public lands comprise approximately 13% of the total land surface of the United States and more than 40% of all land managed by the Federal Government. Most of the public lands are located in the Western United States (including Alaska) and are characterized by grassland, forest, mountain, arctic tundra, and desert landscapes. The BLM manages the land's resources and uses including energy, minerals, timber, recreation, wild horse and burro herds, fish and wildlife habitat, wilderness areas, and archaeological, paleontological, and historical sites.¹⁰

An estimated 600,000 miles of roadways service these public lands. Of these roads 90,000 miles are identified as "system routes" and are eligible for planning, maintenance, and funding. No formal process for managing or maintaining the remaining 510,000 miles of roadway presently exists. Visits to recreation sites on BLM lands and waters have significantly increased over the years from 51

¹⁰ http://www.blm.gov/wo/st/en/info/About_BLM.html, accessed July 15, 2009.

million in 2001, to 57 million in 2008.¹¹

Fish and Wildlife Service

The USFWS is dedicated to the conservation, protection, and enhancement of the habitats of fish, wildlife, and plants. The agency is also responsible for implementing and enforcing some of the Nation's environmental laws, including the Endangered Species Act, Migratory Bird Treaty Act, Marine Mammal Protection Act, North American Wetlands Conservation Act, and Lacey Act.

The USFWS manages the 96 million acre, 548-unit, National Wildlife Refuge System. More than 4,900 miles of roadway currently service USFWS lands. Visits to recreation sites on USFWS lands and waters are expected to significantly increase from 41 million in 2008 to 51 million in 2015. The USFWS also operates 70 National Fish Hatcheries, which, in conjunction with Fish Health Centers and Fish Technology Centers, restore native aquatic populations, mitigate for fisheries lost as a result of Federal water projects, and support recreational fisheries throughout the United States.¹²

Forest Service

The USDA-FS manages public lands in 155 national forests and 20 grasslands, encompassing 193 million acres. The USDA-FS is the largest forestry research organization in the world, and provides technical and financial assistance to State and private forestry agencies.

Access to USDA-FS lands is provided through a combination of public highways, local public roads, and classified USDA-FS roads within the National Forest System. An estimated 380,000 miles of classified USDA-FS roadways exist, with much of this roadway

network established to support timber harvest and log removal. Approximately 66,000 miles of USDA-FS roadway is maintained to support passenger car traffic; the remaining roadway network supports only high-clearance vehicles. An estimated 1.7 million vehicles use these roads each day to visit national forests.¹³

National Park Service

About 29,000 miles of State and local roads are designated as Forest Highways. As indicated in 23 U.S.C. 202, 203, and 204, the Forest Highways program, developed in cooperation with State and local agencies, provides safe and adequate transportation access to and through National Forest System (NFS) lands for visitors, recreationists, resource users, and others which is not met by other transportation programs. Forest highways assist rural and community economic development and promote tourism and travel.

The NPS manages a network of nearly 400 natural, cultural, and recreational sites across the Nation with the intent of preserving the sites for the enjoyment, education, and inspiration of current and future generations. The NPS also cooperates with partners to extend the benefits of resource conservation and outdoor recreation throughout the United States and the world.¹⁴

Approximately 8,500 miles of roadway service NPS lands; 5,456 miles of which are paved. An estimated 90 percent of the road miles exist in just 10 percent of the parks.¹⁵ The NPS roadway network also includes 1,736 bridges and 67 tunnels. Alternative transportation systems operate in 96 of the nearly 400 parks. The NPS routinely monitors the number of vehicles entering 297 parks along highways, parkways, and tour and access roads (paved and unpaved).

11 Placchi, Jack. *Bureau of Land Management Perspective*. Recreational Traffic Monitoring Workshop. June 2009.

12 *Fish and Wildlife Service Agency Overview: Conserving the Nature of America*. November 2008.

13 <http://www.fs.fed.us>, accessed July 15, 2009.

14 <http://www.nps.gov/aboutus>, accessed July 15, 2009.

15 Kathryn Gunderson. *National Park Service Practices and Perspectives*. Recreational Traffic Monitoring Workshop. June 2009.

Approximately 110 million vehicles or 218 million visitors enter the NPS lands for recreational purposes each year. An additional 218 million vehicles are estimated to access NPS lands for non-recreational purposes (e.g., NPS employees or contracted services, through traffic, etc.).¹⁶

State Departments of Transportation

At the State level, DOTs collect traffic data to meet Federal reporting requirements and to support decision-making needs within the State. Each State DOT must comply with the reporting requirements of the Highway Performance Monitoring System (HPMS). These data—focused on traffic volumes for a subset of roadways in a State—are used to produce statewide estimates of total vehicle-miles traveled (VMT) and the subsequent apportionment of Federal-aid funds. Additional data collected to support State-level decision-making varies widely depending on each State DOT's traffic counting needs, priorities, budgets, geography, and organizational constraints.

Differences in the nature and extent of recreational activity in each State and its relationship to the roadway network exacerbate differences in recreational traffic monitoring. For example, recreational areas and activities are highly concentrated in Florida; as a result, a high proportion of the system and secondary roadways carry recreational trips. The State's traffic monitoring activities are designed to account for this. Comparatively, Colorado's system roadways also carry recreational trips but this segment of travelers is likely considered to be secondary when planning and designing traffic monitoring activities. In Wyoming, many of the major system routes currently monitored directly feed recreational areas in the State.

¹⁶ Butch Street. *National Park Service Practices and Perspectives*. Recreational Traffic Monitoring Workshop. June 2009.

Federal Lands Highway Program

The Office of Federal Lands Highway (FLH) FHWA, under the U.S. Department of Transportation, provides funding for public roads and highways within federally owned lands and tribal lands that are not a State or local government responsibility. The FLH has close partnerships with State and local governments and works with numerous Federal land management agencies including the Bureau of Land Management, Fish and Wildlife Service, Forest Service, National Park Service, Bureau of Indian Affairs, Bureau of Reclamation, Surface Deployment and Distribution Command, and the U.S. Army Corps of Engineers.

National Guidance for Traffic Monitoring in Recreational Areas

The challenge of collecting recreational traffic data is also complicated by a lack of consistent guidance; existing national guidelines for traffic monitoring practices lack sufficient direction and detail for recreational travel.

Current national guidance documents related to traffic monitoring include the following:

- *Traffic Monitoring Guide (TMG)*,¹⁷ published by FHWA;
- *Guidelines for Traffic Data Programs*,¹⁸ published by the American Association of State Highway Transportation Officials (AASHTO); and
- *Highway Performance Monitoring System (HPMS) Field Manual for the Continuing*

¹⁷ *Traffic Monitoring Guide*. FHWA-PL-01-021. Office of Highway Policy Information, Federal Highway Administration, U.S. Department of Transportation. Washington D.C. May 2001.

¹⁸ *Guidelines for Traffic Data Programs*. American Association of State highway and Transportation Officials. Washington D.C. 1992.

Analytical and Statistical Database,¹⁹
published by FHWA.

In general, these documents recommend a traffic monitoring framework with two basic elements:

1. A modest number of permanent continuous monitoring locations that adequately characterize the variation of traffic by day of the week and month/season of the year; and
2. A large number of portable short-term (typically 24 to 72 hours) monitoring locations that can support determination of “annualized” estimates using monthly/seasonal and day-of-week adjustment factors derived from the permanent continuous monitoring locations.

The calculation of seasonal and day-of-week adjustment factors is typically straightforward, particularly on major highways in urban and rural areas carrying significant commuter or through-traffic that does not vary much by season or during the work week. However, recreational traffic can vary greatly by day of the week and month/season of the year. Because recreational traffic has greater variability than urban commuter traffic, special consideration should be given in designating permanent monitoring locations for one or more recreational traffic seasonal factor groups.

Traffic Monitoring Guide

The TMG, last updated in 2001 (previous editions were published in 1995, 1992, and 1985), is intended for use by State and local highway agencies with an emphasis on knowing what data to collect. The TMG also addresses the national data requirements for the HPMS. The 2001 TMG recognizes

the variability of recreational traffic and development of seasonal factor groups through the following statements:

- “Statistics and the desire to have factors that yield [annual average daily traffic] AADT estimates with ± 10 percent accuracy with 95 percent confidence tend to require a factor group size of between 5 to 8 counters. ... Recreational or special groups often have only a single continuous counter” (pp. 2-45–2-46).
- “Urban roads tend to have a much lower level of daily traffic variability than rural roads. Recreational areas have much higher levels of variability than non-recreational areas” (p. 3-12).
- “...recreational roads usually experience major traffic peaking at specific times necessitating frequent information” (p. 3-18).
- “Typical monthly variation patterns for urban areas have a coefficient of variation under 10 percent, while those of rural areas range between 10 and 25 percent. Values higher than 25 percent are indicative of highly variable travel patterns, which reflect ‘recreational’ patterns but which may be due to reasons other than recreational travel” (p. 3-34).
- “The reliability levels recommended are 10 percent precision with 95 percent confidence, 95-10, for each individual seasonal group, excluding recreational groups where no precision requirement is specified” (p. 3-35).
- “Recreational factor groups usually are monitored with a smaller number of ATRs, simply because recreational patterns tend to cover a small number of roads, and it is not economically justifiable to maintain five to eight ATRs to track a small number of roads. The number of stations assigned to the

¹⁹ *Highway Performance Monitoring System Field Manual for the Continuing Analytical and Statistical Database*. Office of Highway Policy Information, Federal Highway Administration, U.S. Department of Transportation. Washington D.C. May 2005.

recreational groups depends on the importance assigned by the planning agency to the monitoring of recreational travel, the importance of recreational travel in the State, and the different recreational patterns identified” (p. 3-35).

- “Roughly six ATRs are needed for each “factor group” in order to develop stable, representative factors. ... The major exception to this rule of thumb is for recreational routes and other “unusual” roads which experience unique travel patterns. In these cases, a single ATR may be all that is necessary to monitor each unique pattern” (p. 3-39).

The TMG was written to accommodate the diverse traffic monitoring needs of 50 States, acknowledging that “[a]ctual implementation will vary from agency to agency” (p. E-1). In addition, the TMG focuses attention on major commuting and through-traffic routes because: (1) recreational traffic has greater variability and specific procedures for monitoring it are less formulaic on a national basis, and (2) recreational traffic comprises a small percentage of the total VMT that must be monitored by resource-constrained State agencies.

Guidelines for Traffic Data Programs

The *Guidelines for Traffic Data Programs* is similarly lacking in addressing the unique challenges of recreational traffic monitoring. Unlike the TMG which focuses on what data to collect, AASHTO’s *Guidelines for Traffic Data Programs* primarily focus on how to collect, process, and store traffic data. Little detail is provided on sampling designs and establishing factor groups for traffic monitoring in recreational areas. The planned 2009 update provides additional detail compared to the content in the 1992 edition, but still falls short in providing definitive guidance for low-volume roads with heavy recreational traffic patterns.

HPMS Field Manual for the Continuing Analytical and Statistical Database

The *HPMS Field Manual* provides guidance to State and local agencies for the reporting of traffic and roadway inventory data for compilation in the national HPMS—a nationwide inventory for all of the Nation’s public road mileage. The HPMS is used to identify the condition, performance, and investment needs for legislation and apportionment for Federal-aid. The HPMS includes both universe data elements (data that are reported for all public roads [e.g., length]) and sample data elements (data that are measured on a statistical sample of public roads and “expanded” to other non-sampled roads [e.g., traffic counts and road characteristics]).

Each State DOT is responsible for submission of State-level HPMS data on State- and federally-owned roads to FHWA. The HPMS database should reflect the mileage of all public roads in Federal lands. However, few samples may be collected on Federal lands depending upon the location of the random statistical samples; traffic volumes on certain Federal lands roadways may instead be estimated from similarly classified rural roads within the State.

In Appendix C of the *HPMS Field Manual*, precision levels for various functional classes in both rural and urban areas are specified. Table 1 below summarizes the volume groups and precision levels for rural areas. Note that the previously described TMG does not prescribe precision levels for recreational factor groups. Lower traffic volumes that are variable in nature lead to higher error tolerances for factoring low volume traffic counts. On such routes, it may be sufficient to determine that the road has low volume (250 to 400 vehicles per day as defined by AASHTO) or very low traffic (less than 250 vehicles per day as defined by AASHTO).

Sample size estimation procedures

Table 1. Standard Sample Volume Groups and Precision Levels for Rural Areas (FHWA, 2005 p. C-1)

AADT Volume Group	Interstate	Other Principal Arterial	Minor Arterial	Major Collector
	90% confidence, 5% error	90% confidence, 5% error	90% confidence, 10% error	80% confidence, 10% error
01	0- 9,999	0- 4,999	0- 2,499	0- 2,499
02	10,000- 19,999	5,000- 9,999	2,500- 4,999	2,500- 4,999
03	20,000- 29,999	10,000- 14,999	5,000- 9,999	5,000- 9,999
04	30,000- 39,999	15,000- 19,999	10,000- 19,999	10,000- 19,999
05	40,000- 49,999	20,000- 29,999	20,000- 29,999	20,000- 29,999
06	50,000- 59,999	30,000- 39,999	30,000- 39,999	30,000- 39,999
07	60,000- 69,999	40,000- 49,999	40,000- 49,999	40,000- 49,999
08	70,000- 79,999	50,000- 59,999	50,000- 59,999	50,000- 59,999
09	80,000- 89,999	60,000- 69,999	60,000- 69,999	60,000- 69,999
10	90,000-104,999	70,000- 84,999	70,000- 79,999	70,000- 79,999
11	105,000-119,999	85,000- 99,999	80,000- 89,999	80,000- 89,999
12	120,000-134,999	100,000-114,999	90,000- 99,999	90,000- 99,999
13	> or = 135,000	> or = 115,000	> or = 100,000	> or = 100,000

are provided in Appendix D of the *HPMS Field Manual*. However, these sample size procedures require an estimate of the variability in the AADT data. The variability observed by each State DOT may be different and may not account for the true variability among State- and Federal-owned roadways.

The HPMS is currently being reassessed, which is likely to provide some enhancement and improvements to the database. However, the main purpose of HPMS will continue to be the apportionment of Federal-aid funds, which is based on length, lane-mile, and VMT information. Most State DOTs will likely continue to focus their efforts on high-volume, high-mileage road classes that provide the most impact on their Federal-aid apportionment.

Vehicle Classification

As noted previously, recreational traffic is distinct with respect to the types of vehicles in the traffic stream; recreational traffic generally comprises a higher proportion of recreational

vehicles (RVs), buses, and vehicles pulling trailers. The adequacy of existing vehicle classification schemes to accurately describe recreational traffic is considered below.

The predominant vehicle classification scheme used for traffic monitoring in the United States was developed by FHWA nearly two decades ago and consists of 13 vehicle classes:

1. Motorcycles;
2. Passenger cars;
3. Other two-axle, four-tire single unit vehicles;
4. Buses;
5. Two-axle, six-tire, single-unit trucks;
6. Three-axle single-unit trucks;
7. Four or more axle single-unit trucks;
8. Four or fewer axle single-trailer trucks;

9. Five-axle single-trailer trucks;
10. Six or more axle single-trailer trucks;
11. Five or fewer axle multi-trailer trucks;
12. Six-axle multi-trailer trucks; and
13. Seven or more axle multi-trailer trucks.²⁰

The process that led to the development of the FHWA vehicle classification scheme was based on a review of classifications then in use, anticipated data types that would be needed to address then-emerging issues, current data needs expressed by major data users, and recommendations of the States. The use of the FHWA vehicle classification scheme in the original TMG led to its adoption in various national efforts such as the HPMS and the Long-Term Pavement Performance (LTPP) Program as well as being adopted for use by various States.²¹

A shortcoming of the FHWA vehicle classification scheme as applied to the monitoring of recreational traffic is that it does not support the capture of disaggregate recreational vehicle types such as motor homes, RVs, tourism motor coaches, and vehicles towing camper or boat trailers. Under the FHWA vehicle classification scheme, the types of vehicles and vehicle combinations that frequent recreational areas are aggregated with other passenger cars, buses, and trucks across 5 of the 13 possible vehicle classifications:

- **“Passenger Cars:** All sedans, coupes, and station wagons manufactured primarily for the purpose of carrying passengers and *including those passenger cars pulling recreational or other light trailers.*
- **Other Two-Axle, Four-Tire Single Unit**

Vehicles: All two-axle, four-tire vehicles other than passenger cars. Included in this classification are pickups, panels, vans, and *other vehicles such as campers, motor homes, ambulances, hearses, carryalls, and minibuses. Other two-axle, four-tire single-unit vehicles pulling recreational or other light trailers are included* in this classification.

- **Buses:** All vehicles manufactured as *traditional passenger-carrying buses* with two axles and six tires or three or more axles. This category includes only traditional buses (including school buses) functioning as passenger-carrying vehicles. Modified buses should be considered to be a truck and should be appropriately classified.
- **Two-Axle, Six-Tire, Single-Unit Trucks:** All vehicles on a single frame including trucks, *camping and recreational vehicles, motor homes, etc., with two axles and dual rear wheels.*
- **Three-Axle Single-Unit Trucks:** All vehicles on a single frame including trucks, *camping and recreational vehicles, motor homes, etc., with three axles”* (emphasis added).²²

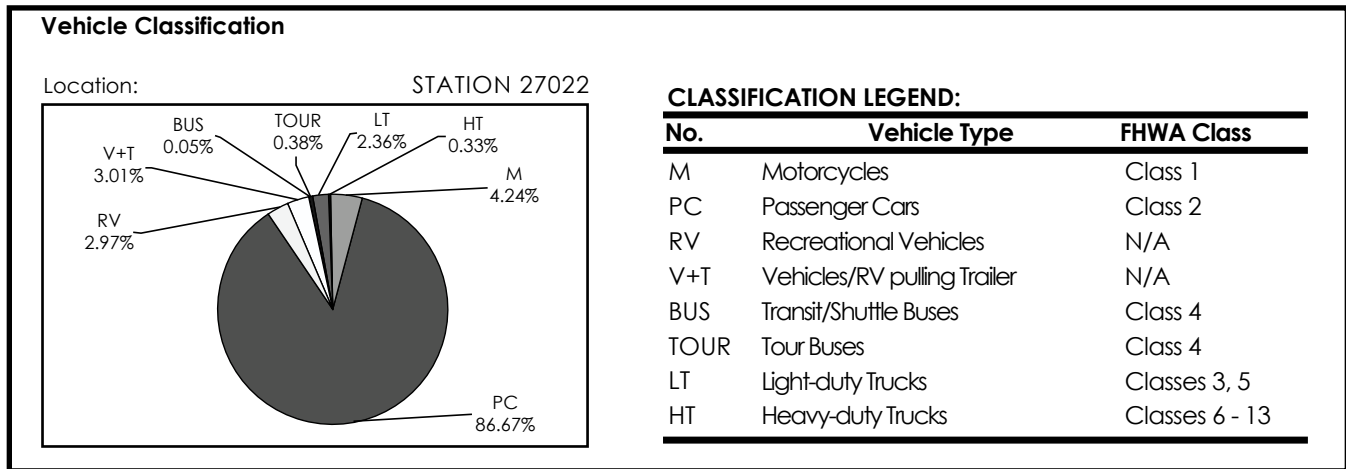
Alternative vehicle classification schemes included in other national guidance documents or reporting systems better distinguish the types of vehicles and vehicle combinations that frequent recreational areas from the general traffic. For example, AASHTO defines 19 different vehicle classes for calculating dimensions for the geometric design of roadways, intersections, and interchanges. Vehicle classes include motor home, passenger car with camper trailer, passenger car with boat trailer, and motor home and boat trailer. Six different classes of buses are also delineated, including intercity bus (40 ft. length) and intercity bus (45 ft.

²⁰ <http://www.fhwa.dot.gov/policy/ohpi/vehclass.htm>, accessed December 17, 2008.

²¹ Kashuba, Ed. *Vehicle Classification System: FHWA Perspective*. North American Travel Monitoring Exposition and Conference (NATMEC). August 2000.

²² <http://www.fhwa.dot.gov/policy/ohpi/vehclass.htm>, accessed December 17, 2008.

Figure 1. Example of Existing NPS Vehicle Classification Scheme



length).²³ Similarly, the *Highway Capacity Manual* distinguishes passenger cars, trucks, buses, and recreational vehicles when calculating the effect of various vehicle types on the capacity of roadways, intersections, and interchanges. Recreational vehicles include motor homes, cars with camper trailers, cars with boat trailers, motor homes with boat trailers, and motor homes pulling cars. Buses include intercity (motor coaches), city transit, school, and articulated buses.²⁴ National safety databases, such as the Fatal Accident Reporting System (FARS), include van-based or pickup-based motor home, medium/heavy truck based motor home, and camper or motor home with unknown truck type.²⁵ The Province of Alberta in Canada uses a vehicle classification system consisting of five classes: passenger cars, recreational vehicles, buses (including school buses and intercity buses), single unit trucks, and tractor trailer combination trucks.²⁶

To better reflect the types of vehicles

²³ AASHTO Green Book - A Policy on Geometric Design of Highways and Streets, 5th Edition. American Association of State and Highway Transportation Officials. November 2004.

²⁴ *Highway Capacity Manual*. Transportation Research Board, National Research Council. Washington D.C. 2000.

²⁵ <http://www-fars.nhtsa.dot.gov/Vehicles/VehiclesAllVehicles.aspx>, accessed December 17, 2008.






²⁶ Clayton, Alan, Jeannette Montufar, Dan Middleton, and Bill McCauley. *Feasibility of a New Vehicle Classification System for Canada*. North American Travel Monitoring Exhibition and Conference (NATMEC). August 2000.

and vehicle combinations that frequent recreational areas, the NPS developed a unique vehicle classification scheme to support their traffic database. The NPS vehicle classification scheme consists of eight vehicle types:

- Motorcycles;
- Passenger cars;
- RVs;
- Vehicles pulling trailers (including RVs);
- Transit/shuttle buses;
- Tour buses;
- Light-duty trucks; and
- Heavy-duty trucks.

The NPS Traffic Database was designed to provide a means for linking with other NPS and FHWA databases, such as the Road Inventory Program (RIP) and Geographic Information System (GIS) databases. In Traffic Data Reports produced periodically for NPS units, the relationship between the NPS vehicle classification scheme and the FHWA vehicle classification scheme is indicated. An example is provided (figure 1) from the "Yellowstone National Park Traffic Package" within the *NPS 2004 Traffic Data Report*. It should be noted, however, that the current NPS traffic data program only

Table 2. Length-Based Vehicle Classification in British Columbia

Bin	Vehicle Type	FHWA Equivalent
0 - 6 m		Motorcycles (1); passenger cars (2); light single unit trucks (3)
6 - 12.5 m		Buses (4); two axle, 6 tire single unit trucks (5); three axle single unit trucks (6); four axle single unit trucks (7)
12.5 - 22.5 m		4 axles or fewer, single trailer truck (8); five axle single trailer truck (9); six or more axle single trailer truck (10)
22.5 - 35 m		B-trains (8, 9, 10); five axle, multi-trailer truck (11); six axle, multi-trailer truck (12); seven axle, multi-trailer truck (13)
> 35 m		Multi-trailer (13)

calls for an 8-hour sample in one or two locations per monitored park. This may not be sufficiently representative in certain parks and conditions.²⁷

The FHWA vehicle classification scheme relies upon the identification of both the number of axles and the number of trailers in each vehicle. Automated methods for data capture (such as in-road sensors and supporting software) have been developed with these information needs in mind. A noted challenge for existing automated vehicle classification systems is the accurate classification of individual vehicles across the 13 categories when similarities exist in the number of axles. For example, a passenger car pulling a camper trailer may be misclassified as a four-axle single-unit or a single trailer truck.

Driven largely by the proliferation of electronic tolling systems in the United States (where vehicle type determines toll rates, which differ for commercial and non-commercial traffic), alternative technologies are in use and under development that can improve the accuracy of individual vehicle

classification and support development of a wider range of vehicle classification schemes. Alternatives to axle-based data capture mechanisms are currently focused on vehicle length and vehicle profile. In-road or off-road non-intrusive sensors are used to detect vehicle length; vehicle lengths are then correlated with various vehicle classes such as car, single-unit truck, and combination truck.

The Minnesota DOT has initiated a pooled-fund study that will investigate issues related to length-based vehicle classification. The study objectives are to develop field test installation methods for loops to determine the most cost effective and best performing procedures and materials; determine the number of bins and the length spacing for each of those bins for uniform collection of length based classification data; and establish calibration standards for vehicle length based measurements.²⁸

The Province of British Columbia in Canada uses a length-based vehicle classification system. The relationship of British Columbia's vehicle classification scheme to FHWA's

27 National Park Service. 2004 *Traffic Data Report*. 2005.

28 <http://www.pooledfund.org/projectdetails.asp?id=416&status=4>, accessed December 18, 2008.

vehicle classification scheme is depicted in table 2.²⁹

Perhaps more appropriate for distinguishing the types of vehicles and vehicle combinations that frequent recreational areas are automated systems that capture the full vehicle profile. A variety of profiler systems are available commercially. The most advanced utilize Doppler radar, laser scanner, infrared light curtain and/or machine vision technologies to provide a two- or three-dimensional image of a vehicle that can then be appropriately categorized in a pre-defined classification scheme.

Recreational Traffic Monitoring as Described in the Literature

When conducting a review of literature related to traffic monitoring in recreational areas, researchers originally sought information on applied research and statistical methods that address traffic monitoring system coverage, data content, and data quality issues related to the composition and variability of recreational traffic. Not surprisingly, researchers observed a disproportionate focus on traffic monitoring in urban rather than recreational areas. Much of the literature found to address recreational traffic monitoring considered: the use of recreational and/or seasonal factor groups, methods to support determination of recreational and/or seasonal factor groups, and the likely errors associated with factoring or annualizing short-term counts on roads with high-variability traffic.

Recreational and/or Seasonal Factor Groups

The observed published literature served to define and characterize select recreational and/or seasonal factor groups currently in use at the State level. Most recently (2007), Byrne described the use of six seasonal factor groups

in Vermont, three of which are devoted to recreational traffic:

- Summer recreational—8 permanent counters;
- Summer and winter recreational, US and Vermont routes—7 permanent counters; and
- Summer and winter recreational, town highways—7 permanent counters.³⁰

In a report published in 2007, the New York State DOT described the use of three basic seasonal factor groups:

- Urban traffic patterns—seasonal coefficient of variation less than 10 percent;
- Suburban traffic patterns—seasonal coefficient of variation between 10 and 25 percent; and
- Recreational traffic patterns—seasonal coefficient of variation greater than 25 percent.

Within each of these main factor groups, two additional “minor” factor groups are provided to slightly increase or decrease the seasonal peaking characteristics.³¹

In a related study published in 2000, Lingras et al. enumerates the seasonal factor groups that are used in the province of Alberta, Canada:

- Group 1: Highly recreational;
- Group 2: Regional recreational;
- Group 3: Long distance;
- Group 4: Urban commuter; and

²⁹ <http://www.th.gov.bc.ca/trafficData/vcc>, accessed December 18, 2008.

³⁰ Bernard F. Byrne. Revised Method for Estimating Design Hourly Volumes in Vermont. *Transportation Research Record 1993*, Transportation Research Board of the National Academies, Washington, D.C., 2007, pp. 23–29.

³¹ 2007 *Traffic Data Report for New York State*, New York State Department of Transportation, available at <https://www.nysdot.gov/divisions/engineering/technical-services/highway-data-services/traffic-data>.

Table 3. Seasonal Factor Group Analysis in Delaware

Factor Group	Monthly CV	Existing Permanent Count Stations	Permanent Count Stations Based on Variability	Recommended Permanent Count Stations
Urban	7%	24	4	27
Rural	16%	16	13	19
Recreational	29%	6	35	12
Predominantly Recreational	20%	7	75	11

- Group 5: Regional commuter.³²

Methods to Support Determination of Recreational and/or Seasonal Factor Groups

Shifting focus to the methods to support determination of recreational and/or seasonal factor groups, Faghri et al. reported recommendations for an integrated traffic monitoring system for Delaware in 1996. The authors recommended the use of four seasonal factor groups based on the monthly coefficient of variation (CV). Statistical analysis of the within-group variability was used to determine the required number of permanent count stations for an 80 percent confidence level and 10 percent error. The statistical analysis indicated that very few permanent count stations were required for urban and rural factor groups; the variability for the remaining two recreational factor groups indicated large required sample sizes, more than were possible given available resources. Taking these resource limitations into account, the authors provided final recommendations for the seasonal factor groups and number of permanent count stations (table 3).³³

One year later, Stamatiadis and Allen

developed seasonal adjustment factors for vehicle classification counts for the State of Kentucky. Their research indicated that many States do not use seasonal adjustment factors for short-term vehicle classification counts. In this study, the authors used two years of vehicle classification data from Kentucky to develop class count factor groups. In their conclusions, the authors emphasized the importance of seasonal adjustment factors for accurate annual estimates.³⁴

In 2000, Aunet described the Wisconsin Department of Transportation's efforts to address traffic variability when developing seasonal factor groups. He emphasized that traffic data inherently has variability, both spatially and temporally, and recommended focusing traffic data analysis efforts on measuring or quantifying this variation and developing methods to account for it. He suggested a combination of approaches to develop seasonal factor groups and adjustment factors:

- Statistical measures such as coefficient of variation;
- Cluster analysis;
- Plots of monthly traffic factors; and
- Geographic mapping of continuous count sites.³⁵

³² Pawan Lingras, Satish C. Sharma, Phil Osborne, and Iftekhar Kalyar. Traffic Volume Time-Series Analysis According to the Type of Road Use. *Computer-Aided Civil and Infrastructure Engineering*, Volume 15, 2000, pp. 365–373.

³³ Ardeshir Faghri, Martin Glaubitz, and Janaki Parameswaran. Development of Integrated Traffic Monitoring System for Delaware. Transportation Research Record 1536, Transportation Research Board, National Academies, Washington, D.C., 1996, pp. 40–44.

³⁴ Nikiforos Stamatiadis and David L. Allen. Seasonal Factors Using Vehicle Classification Data. Transportation Research Record 1593, Transportation Research Board, National Academies, Washington, D.C., 1997, pp. 23–28.

³⁵ Bruce Aunet. *Wisconsin's Approach to Variation in Traffic Data*. Paper presented at NATMEC 2000 Conference, 14 pages.

In 2003, Robichaud and Gordon reviewed traffic monitoring procedures for several Canadian provinces to provide recommendations to the British Columbia Ministry of Transportation. The authors reported on the results of studies in New Brunswick and Prince Edward Island that showed the use of regression was consistently more accurate for expanding short-term counts to annual estimates than the factoring method. However, the analysis of British Columbia data showed that factoring could be more accurate than regression if longer-duration short-term counts are used (on the order of 7 days once per year).³⁶

More recently (2004), Li et al. conducted a regression analysis to identify factors that most strongly affected seasonal traffic fluctuations in Florida. Currently the Florida DOT assigns short-term counts to a seasonal factor group based largely on spatial proximity to the permanent monitoring locations. The results of the analysis indicated that roadway functional class was not a significant factor, but the following were significant factors for seasonal traffic fluctuation:

- Density of hotels and motels for tourism;
- Number of retired people between the ages of 65 and 75 with high income; and
- Extent of retail employment.³⁷

These land use variables could be obtained from the planning departments and/or agencies.

36 Karen Robichaud and Martin Gordon. Assessment of Data-Collection Techniques for Highway Agencies. *Transportation Research Record 1855*, Transportation Research Board of the National Academies, Washington, D.C., 2003, pp. 129–135.

37 Min-Tang Li, Fang Zhao, and Yifei Wu. Application of Regression Analysis for Identifying Factors That Affect Seasonal Traffic Fluctuations in Southeast Florida. *Transportation Research Record 1870*, Transportation Research Board of the National Academies, Washington, D.C., 2004, pp. 153–161.

Errors Associated with Factoring Short-term Traffic Counts

A significant body of work related to the potential for errors when factoring short-term traffic counts, spanning nearly a decade, was authored by Satish C. Sharma. In 1993, Sharma and Allipuram used data from 61 permanent traffic monitoring locations in Alberta, Canada to analyze the frequency and duration of seasonal traffic counts. According to the authors, there is wide variation in how long and often seasonal counts are taken in the Canadian provinces. The researchers developed an algorithm that could be used to optimize the seasonal traffic count schedule based on three road types (i.e., commuter, average rural, recreational).³⁸

In 1996, Sharma et al. analyzed the tradeoffs in precision of annual traffic counts when using seasonal traffic counts. In this study, researchers examined the collection of counts for two, three, and four noncontiguous months. Seasonal traffic counts, or several short-term counts spread throughout the year, are sometimes used as an alternative to a single short-term count when there are significant or unknown seasonal fluctuations. The study found the following errors at a 95% confidence level:

- 8% error for two noncontiguous months;
- 6% error for three noncontiguous months; and
- 4% error for four noncontiguous months.³⁹

During the same year, Sharma et al. analyzed data from several permanent count stations in Minnesota to determine the effects of various factors on the statistical precision

38 Satish C. Sharma and Reddy. R. Allipuram. Duration and Frequency of Seasonal Traffic Counts. *Journal of Transportation Engineering*. Volume 119, No. 3, May/June 1993, pp. 344–359.

39 Satish C. Sharma, Peter Kilburn, and Yongquiang Wu. The precision of average annual daily traffic volume estimates from seasonal counts: Alberta example. *Canadian Journal of Civil Engineering*, Volume 23, 1996, pp. 302–304.

of AADT estimates. Consistent with other studies, researchers found that the AADT estimation errors are very sensitive to the assignment effectiveness (i.e., the correctness with which a sample site has been assigned to a factor group). Additionally, the authors indicated that traffic monitoring agencies should place more emphasis on accurately assigning short-term counts to factor groups, rather than on conducting longer duration counts (e.g., 72-hour counts). The study findings from Minnesota were confirmed with permanent count data from Alberta and Saskatchewan analyzed in the same year.⁴⁰

In two related reports published in 2000 and 2001, Sharma et al. reported results of various analysis techniques to estimate annual average traffic counts on low-volume roads. Researchers found that artificial neural networks were more favorable for AADT estimation than the traditional factor approach. In particular, one advantage of the neural network approach is that the definition and designation of seasonal factor groups is not necessary. Results also indicated a clear preference for two 48-hour short-term counts as compared to other frequencies (one or three) or durations (24- or 72-hour).^{41 42}

In 1997, Davis reviewed the procedures used to estimate the accuracy of “annualized” short-term counts and found that many attempts failed to include the error from using incorrect seasonal or day-of-week adjustment factors. Based on his research, Davis recommended the use of seasonal counts

(i.e., short-term counts taken during several seasons of the year) to provide solid prior information for assigning short-term counts to a seasonal factor group.⁴³

Most recently (2007), Lewis and Albright described the errors associated with the application of default traffic count adjustment factors. In this case, city engineers were using default national factors in the *Highway Capacity Manual* to adjust average weekday traffic counts (AWDT) to AADT counts. The authors indicated that the default national factors were different than those provided by the State’s traffic monitoring agency. Further, the authors suggested improvements to the States’ seasonal factor groups which are currently based on area type and roadway functional class.⁴⁴

Other Related Literature

Two additional publications are worthy of note. In 1980, Erickson et al. considered automatic time-interval counts for use in the planning and management of recreational areas. The authors collected hourly directional counts in the Daniel Boone National Forest using punch cards over a 4-month period. An interesting finding from this effort was that, at several locations, the entering traffic had much different traffic peaking patterns than exiting traffic. The authors also highlighted the variability throughout the data collection period that was presumably due to adverse weather conditions.⁴⁵

40 Satish C. Sharma, Brij M. Gulati, and Samantha N. Rizak. Statewide Traffic Volume Studies and Precision of AADT Estimates. *Journal of Transportation Engineering*, Volume 122, No.6, November/December 1996, pp. 430-439.

41 Satish Sharma, Pawan Lingras, Fei Xu, and Peter Kilburn. Application of Neural Networks to Estimate AADT on Low-Volume Roads. *Journal of Transportation Engineering*, Volume 127, No. 5, September/October 2001, pp. 426-432.

42 Satish C. Sharma, Pawan Lingras, Guo X. Liu, and Fei Xu. Estimation of Annual Average Daily Traffic on Low-Volume Roads: Factor Approach Versus Neural Networks. *Transportation Research Record 1719*, Transportation Research Board of the National Academies, Washington, D.C., 2000, pp. 103–111.

43 Gary A. Davis. Accuracy of Estimates of Mean Daily Traffic: A Review. *Transportation Research Record 1593*, Transportation Research Board of the National Academies, Washington, D.C., 1997, pp. 12–16.

44 Martin Lewis and David Albright. Evaluating the Highway Capacity Manual’s Adjustment Factor for Annual Weekday to Annual Average Daily Traffic: Applying a Consistent Traffic Data Methodology. *Transportation Research Record 1993*, Transportation Research Board of the National Academies, Washington, D.C., 2007, pp. 117–123.

45 D.L. Erickson, C.J. Liu, and H.K. Cordell. *Automatic, Time-Interval Traffic Counts for Recreation Area Management Planning*. Paper presented at the National Outdoor Recreation Trends Symposium, Durham, NH, April 20-23, 1980, 10 pages.

In 2005, Dunning documented the impacts of transit service on traffic conditions in national parks and gateway communities. Dunning described the difficulties of monitoring changes in visitation due to management actions, such as the introduction of transit services. She indicated that changing methods for monitoring visitation traffic can confound an accurate before-after comparison. Additionally, she noted that in parks where traffic counts and a vehicle occupancy multiplier are used to estimate visitation, the assumed vehicle occupancy may also change in the “after” evaluation period. She concluded that visitation counts could give general insights but could not fully describe the impacts of transit service.⁴⁶

INTERPRETATION OF DATA

REQUIREMENTS FOR FEDERAL LANDS

MANAGEMENT AGENCIES

This section summarizes key Federal data requirements and presents an interpretation of these requirements with respect to traffic monitoring.

Summary of Federal Data Requirements

There are numerous Federal regulations that prescribe or imply data system requirements for Federal lands:

- 23 USC 204: Federal Lands Highways Program;
- 23 USC 303: Management Systems;
- 23 USC 402: Highway Safety Programs;
- 23 CFR 660: Special Programs (Direct Federal), Subpart A–Forest Highways;
- 23 CFR 500: Management and Monitoring Systems;

- 23 CFR 970: National Park Service Management Systems;
- 23 CFR 971: Forest Service Management Systems (Forest Highway Program Management Systems);
- 23 CFR 972: Fish and Wildlife Service Management Systems;
- 23 CFR 924: Highway Safety Improvement Program;
- 16 USC 1a-7: National Park System Development Program;
- NPS Director’s Order #82: Public Use Reporting;
- Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy For Users (SAFETEA-LU), Public Law 109-59, August 10, 2005; and
- Transportation Equity Act for the 21st Century (TEA-21), Public Law 105-178, June 9, 1998.

Relevant sections of these Federal regulations are outlined and discussed in the following sections.

23 CFR 500: Management and Monitoring Systems

Subpart A of this section requires the development and implementation of pavement, bridge, safety, congestion, public transportation, and intermodal management systems in each State. Subpart A also requires the development of a traffic monitoring system for highways and public transportation facilities and equipment. A traffic monitoring system is defined as “... a systematic process for the collection, analysis, summary, and retention of highway and transit related person and vehicular traffic data” (§ 500.202, p. 142). Later sections indicate that these traffic monitoring systems should conform to standard industry practices as indicated in several national traffic monitoring guidelines.

Oddly, § 500.104 indicates that a State may elect not to implement any of these systems

⁴⁶ Anne E. Dunning. Impacts of Transit in National Parks and Gateway Communities. *Transportation Research Record 1931*, Transportation Research Board of the National Academies, Washington, D.C., 2005, pp. 129–136.

except for the congestion management system and the traffic monitoring system.

Subpart B of this section details the requirements for the development and implementation of a traffic monitoring system. In § 500.203, the requirements indicate that the “coverage of federally owned public roads shall be determined cooperatively by the State, FHWA, and the agencies that own the roads” (p. 143). The full text of this section is included as appendix A because of its importance.

23 CFR 970: National Park Service Management Systems

This section requires the development and implementation of safety, bridge, pavement, and congestion management systems for roads funded under the Federal Lands Highway Program (FLHP). The management systems are intended for use in developing transportation plans and making resource allocation decisions in the Park Road Program transportation improvement program (PRPTIP). The relevant sections of this regulation are included below:

- “The NPS may tailor all management systems to meet the NPS goals, policies, and needs using professional engineering and planning judgment to determine the required nature and extent of systems coverage consistent with the intent and requirements of this rule” (§ 970.204, p. 470).
- “Existing data sources may be used by the NPS to the maximum extent possible to meet the management system requirements” (§ 970.204, p. 470).
- “The minimum PMS [pavement management system] database shall include: ...Traffic information including volumes and vehicle classification (as appropriate)” (§ 970.208, p. 471).
- “The minimum BMS [bridge management system] database

shall include: ... Traffic information including volumes and other pertinent information” (§ 970.210, p. 471).

- “The SMS [safety management system] shall be designed to fit the NPS goals, policies, criteria, and needs and shall contain the following components: (1) An ongoing program for the collection, maintenance and reporting of a data base that includes: ... Traffic information including volume, speed, and vehicle classification, as appropriate” (§ 970.212, p. 472).
- “A CMS [congestion management system] will: (i) Identify and document measures for congestion (e.g., level of service); (ii) Identify the causes of congestion” (§ 970.214, p. 473).

23 CFR 971: Forest Service Management Systems

This section establishes the policy for various management systems on Forest Highways, and indicates that the Forest Service, the Federal Highway Administration, and the respective state DOTs are responsible for implementing these management systems. The management systems include pavement, bridge, safety, and congestion. Traffic information is noted throughout the requirements as an essential element of these management systems.

23 CFR 972: Fish and Wildlife Service Management Systems

This section establishes the policy for various management systems on Refuge Roads, and indicates that the Fish and Wildlife Service and the Federal Highway Administration are responsible for implementing these management systems. The management systems include pavement, bridge, safety, and congestion. Traffic information is noted throughout the requirements as an essential element of these management systems.

23 CFR 924: Highway Safety Improvement Program

This section establishes the policy for the development and implementation of a comprehensive highway safety improvement program in each State. This section does not specifically mention whether federally-owned roads are to be considered in the highway safety improvement program.

“The HSIP [highway safety improvement program] planning process shall incorporate: (1) A process for collecting and maintaining a record of crash, roadway, traffic and vehicle data on all public roads including for railway-highway grade crossings inventory data that includes, but is not limited to, the characteristics of both highway and train traffic” (§ 924.9, p. 461).

23 CFR 660: Special Programs (Direct Federal), Subpart A—Forest Highways

This section establishes the Forest Highway Program within the Federal Lands Highway Program. It also establishes the same requirements for a pavement, bridge, and safety management system.

23 USC 204: Federal Lands Highways Program

Included here is an excerpt of 23 USC 204 which outlines the responsibilities of the Federal Lands Highways Program:

“(a) ESTABLISHMENT.—

(1) IN GENERAL.—Recognizing the need for all Federal roads that are public roads to be treated under uniform policies similar to the policies that apply to Federal-aid highways, there is established a coordinated Federal lands highways program that shall apply to public lands highways, park roads and parkways, refuge roads, and Indian reservation roads and

bridges.

(2) TRANSPORTATION PLANNING PROCEDURES.— In consultation with the Secretary of each appropriate Federal land management agency, the Secretary shall develop, by rule, transportation planning procedures that are consistent with the metropolitan and statewide planning processes required under sections 134 and 135.

(3) APPROVAL OF TRANSPORTATION IMPROVEMENT PROGRAM.—The transportation improvement program developed as a part of the transportation planning process under this section shall be approved by the Secretary.

(4) INCLUSION IN OTHER PLANS.—All regionally significant Federal lands highways program projects—

(A) shall be developed in cooperation with States and metropolitan planning organizations; and

(B) shall be included in appropriate Federal lands highways program, State, and metropolitan plans and transportation improvement programs.

(5) INCLUSION IN STATE PROGRAMS.—The approved Federal lands highways program transportation improvement program shall be included in appropriate State and metropolitan planning organization plans and programs without further action on the transportation improvement program.

(6) DEVELOPMENT OF SYSTEMS.—The Secretary and the Secretary of each appropriate Federal land management agency shall, to the extent appropriate, develop by rule safety, bridge, pavement, and congestion management systems for roads funded under the Federal lands highways

program” (pp. 148-149).

Interpretation of Requirements

This section contains the contractor’s interpretation of these requirements as well as a discussion of how these requirements could be implemented. The Federal regulations listed in this section are written so general and vague that they are open to widely varying degrees of interpretation. Different stakeholders (e.g., different groups within FHWA, the federal lands management agencies [FLMAs], State DOTs, and regional transportation planning agencies) may interpret these regulations to mean different things, based mostly on their own role in the transportation development process. Therefore, as a general strategy to improve traffic monitoring on Federal lands, the contractor recommends against trying to discern extensive implementation details from these Federal regulations among the many stakeholders.

Instead, the contractor recommends that FHWA FLHD proceed with the recognition that:

- Federal regulations clearly call for management and monitoring systems;
- Implementation details for these management and monitoring systems cannot be clearly discerned from the Federal regulations; and
- Implementation details on these management and monitoring systems will have to be a negotiated consensus among stakeholders based on:
 - o A common-sense approach to making informed decisions using data;
 - o A recognition of severe resource constraints among the FLMAs;
 - o A long-term goal of matching the current state of the practice (as evidenced in State DOTs) in traffic monitoring; and

- o Recognition that small, evolutionary improvements represent the most likely implementation path to this long-term goal.

23 CFR 500: Management and Monitoring Systems

23 CFR 500 outlines the requirements for management and monitoring systems within each State. It is implicit within this section that this requirement is for each State DOT, since the State DOT is responsible for the maintenance and management of major highways within the State. In Section 500.203, the regulations indicate that “[c]overage of federally owned public roads shall be determined cooperatively by the State, the FHWA, and the agencies that own the roads” (p. 143). Therefore, this is interpreted to mean that the coverage of federally owned public roads in a State traffic monitoring system is to be determined on a State-by-State basis and must be agreed upon by the State, FHWA, and the applicable FLMAs. In certain States, State DOTs may strongly desire the coverage of federally-owned public roads because these roads could have a significant impact on their statewide transportation system. In other States, State DOTs may not have the interest or resources to include federally-owned public roads because they do not feel this impacts their decisions or planning process.

This section does not specify who must initiate the cooperation, only that the decision must be made cooperatively. My interpretation is that the State and the FLMA are the two primary stakeholders, with FHWA (the Federal Lands Division) playing an intermediary/overseer role. Further, it is my opinion that this intermediary/overseer role should be invoked when FHWA has supporting evidence that highway decision-making could be significantly improved if the State DOT included federally-owned public roads in their management and monitoring systems. For example, if a State DOT is making

funding decisions that would be dramatically different if federally-owned public roads were included in the DOT's management system, then FHWA has an obligation to encourage cooperation between the State DOT and FLMAs. However, if the State DOT and Federal land management agencies do not believe that coverage of federally-owned public roads in the State management system will affect decision-making, and FHWA does not have supporting evidence to the contrary, then all agencies should agree that there is little benefit to forcing data sharing where it does not affect decisions.

23 CFR 970: National Park Service Management Systems

23 CFR 970 requires the development of several management systems for roads funded under the Federal Lands Highway Program (FLHP). It is clear from the regulations that traffic data (e.g., traffic volumes, vehicle classification, vehicle speeds) play a foundational role in several of the management systems. The regulations indicate that existing data sources may be used. Each of the management systems is defined differently, but the common element is that these management systems are "a systematic process" for making transportation decisions.

Section 970.204 outlines general requirements for the management systems. As with many Federal regulations, these requirements can be interpreted to mean different things to different people. When regulations like these are open to interpretation, my recommendation is to look at common industry practices as a benchmark for what should be implemented. For example, how are other agencies implementing requirements for management systems? How integrated and accessible are these agencies' databases? What level of resources has been provided for data collection, management, and analysis? In

this example, one could benchmark the National Park Service management systems against State DOT and metropolitan planning organization (MPO) management system practices.

It is interesting to note that 23 CFR 970 does not explicitly require a traffic monitoring system that supports these management systems. However, in the author's interpretation, the requirement for a NPS traffic monitoring system is implicit since all of these management systems require traffic data as an input.

23 CFR 660: Special Programs (Direct Federal), Subpart A—Forest Highways

23 CFR 660 establishes the Forest Highway Program within the Federal Lands Highway Program. It also establishes the same requirements for a pavement, bridge, and safety management system. Similar to 23 CFR 970, 971, and 972, this section, this section does not explicitly require a traffic monitoring system that supports these management systems. However, in the author's interpretation, the requirement for a Forest Highways traffic monitoring system is implicit since all of these management systems require traffic data as an input.

SAFETEA-LU Public Law 109-59, August 10, 2005

Section 204 of SAFETEA-LU, "Federal Lands Highways Program," indicates that "the Secretary [of Transportation] and the Secretary of each appropriate Federal land management agency shall, to the extent appropriate, develop by rule safety, bridge, pavement, and congestion management systems for roads funded under the Federal lands highways program." My interpretation of this language is that there is more discretion in the rigor of management systems implemented within the FLMAs that do not already have specific Federal regulations (like NPS). The key phrase is "to the extent

appropriate.” For example, a full-blown congestion management system with rigorous data collection may not be appropriate for Federal lands that do not routinely experience congestion. Ultimately, however, the details are left up to the FLMAs and FHWA.

RECREATIONAL TRAFFIC MONITORING AS OBSERVED IN PRACTICE

Building upon the information gathered during the review of published literature, additional information regarding traffic monitoring in recreation lands at Federal, State, and local levels was gathered through a targeted survey of State and local agencies and the conduct of a recreational traffic monitoring workshop.

Targeted Survey of State and Local Agencies

A targeted survey of ten State DOTs (Colorado, Florida, Idaho, Indiana, Missouri, Nevada, New Jersey, Utah, Wisconsin, and Wyoming) and three metropolitan planning organizations (Metropolitan Transportation

Commission—San Francisco Bay Area, Metroplan Orlando, and Southwest Missouri Council of Governments) was conducted to identify current practices in collecting traffic data at and near recreational areas. Survey participants were selected based on the ability to provide geographic diversity, the likely presence of recreational travel, and the research team’s familiarity with State and local agency staff.

Survey participants were asked to respond to a series of questions related to: their agency’s conduct of continuous traffic counts; the number of ATRs and AVCs used for recreational and non-recreational traffic data collection; the nature and extent of any recreational, seasonal, or daily factor groups in use; and the nature and extent of roadway mileage under the agency’s jurisdiction.

State Departments of Transportation

Key responses from the ten participating State DOTs are summarized in table 4. Nearly all of the participating State DOTs maintain one or more seasonal factor group for

Table 4. Recreational Factor Groups in Selected State Traffic Monitoring Programs

State DOT	ATRs Statewide	Recreational Factor Groups	ATRs per Recreational Factor Group
Colorado	100	Recreational: Ski Traffic	14
		Special Case: Non-Ski Traffic, Casino Traffic	25
Florida	274	Many Different Recreational Factor Groups	NA
Idaho	209	Recreational Traffic	
Indiana	103	No Recreational Factor Groups	NA
Missouri	95	SFG004: All Recreational Traffic	14
Nevada	93	Recreational: Northern State Recreational–Tahoe	3
New Jersey	65	Recreational Traffic	10
Utah	97	Northern Recreational	11
		Southern Recreational	11
Wisconsin	150	Urban Tourist Recreational	5
		Rural Tourist Recreational	35
Wyoming	162	Recreational Traffic	6

recreational traffic monitoring. Several States that have distinct winter and summer recreational traffic maintain two factor groups. The Florida DOT reported using more than two recreational traffic factor groups while the Indiana DOT reported using no factor group for recreational traffic.

Metropolitan Planning Organizations

None of the planning agencies that were contacted indicated that they routinely monitor recreational traffic; instead, planning agencies rely upon their respective State DOTs to collect this data. Planning agencies may occasionally collect data in recreational areas to support planning uses, but this is done as part of a "special studies" process. Responses from the three metropolitan planning organizations are summarized below.

The Metropolitan Transportation Commission (MTC) is the transportation planning, coordinating, and financing agency for the nine-county San Francisco Bay Area. MTC staff analyze and report on State highway system traffic count data collected by the California State Department of Transportation. Technical summaries, available for years 1989 through 2007, include information on:

- Route number, post mile, direction, and location description;
- Minimum, maximum, mean, and standard deviation of traffic volumes;
- Number of traffic counts at location;
- Volumes for a.m. peak period hours (0600-0700, 0700-0800, 0800-0900);
- Volumes for p.m. peak period hours (1500-1600, 1600-1700, 1700-1800); and
- 24-hour daily directional volumes.

Persons interested in AADT counts or congestion and vehicle hours of delay estimates are directed to the California Department of Transportation databases.

No information was uncovered related to the distinct consideration of recreational traffic.

Metroplan Orlando is the MPO for Orange, Osceola, and Seminole Counties. The metropolitan area of Orlando has one of the fastest growing populations in the country, and, as a result, the number of new motor vehicles coming into the area is growing rapidly. Due to this growth, and the fact that the private automobile is the predominant mode of transportation, the area's highway system is becoming increasingly congested.

One of the main methods for measuring the level of activity on an area's highway system is the collection of traffic counts on major roadways. More than 300 traffic counts for various locations in Orange, Seminole, and Osceola Counties are obtained each year by the Metroplan Orlando staff from the Florida Department of Transportation (FDOT), the three counties, and from the City of Orlando. This information is published in a traffic count report that provides FDOT's daily (24-hour) bi-directional traffic counts averaged annually on major roadways.

No information was uncovered related to the distinct consideration of recreational traffic.

The Southwest Missouri Council of Governments (SMCOG) is a voluntary association of local governments in the ten-county area of southwest Missouri in the Springfield area. These include Barry, Christian, Dade, Dallas, Greene, Lawrence, Polk, Stone, Taney, and Webster counties. Branson is located in Taney County. SMCOG is administered and operated through the Center for Resource Planning and Management at Missouri State University. SMCOG is the only regional council in Missouri affiliated with a university. Through this unique partnership, SMCOG has access to a wide variety of resources and technical assistance at the university.

No information was uncovered related to traffic counts conducted by SMCOG or the distinct consideration of recreational traffic.

Recreational Traffic Monitoring Workshop

To supplement information gathered through the literature review and targeted survey, a recreational traffic monitoring workshop was conducted. The purpose of the workshop was to bring together State and Federal Land agencies to discuss current and preferred practices for monitoring traffic in recreational areas and to identify opportunities for improving traffic monitoring to and within Federal lands. A desired outcome of the workshop was sufficient information exchange leading to the development of guiding principles of traffic monitoring for recreational areas.

The workshop's agenda comprised presentations regarding traffic monitoring in recreational areas as performed by Federal, State, and Provincial agencies. Specific traffic monitoring practices that were described related to:

- The use of supporting traffic data collection technologies;
- The conduct of short-duration counts;
- The use and characteristics of recreational or seasonal factor groups;
- Vehicle classification; and
- Traffic data use, quality, reporting, and sharing.

In addition, participants collectively identified broader challenges related to traffic monitoring in recreational areas.

Traffic Data Collection Technologies

Use of combined permanent and portable counters for data collection was generally reported; but differences in the quantity of count sites used (i.e., the number of units available), the subsequent geographic

coverage, and the types of technologies (i.e., simplistic to advanced) were observed.

Regarding the use of technology in recreational areas, a number of field-related challenges were identified:

- The geographic expanse and remoteness on recreational areas limit the accessibility for site visits and preventative or routine maintenance of technology or equipment;
- Availability of power and telephone line utilities;
- Wireless communications may be limited (e.g., cellular coverage);
- Traffic is operating in a low speed environment, challenging the accuracy of automated technologies; and
- Traffic on recreational roadways does not consistently lane track (travel ways may be narrow, no lanes may be defined, or drivers may be more casual at lower speeds), again challenging the accuracy of automated technologies.

Representatives from the Wyoming DOT reported using satellite as alternative to cellular to overcome challenges related to communications coverage. Despite its perceived high cost, the use of satellite communications in Wyoming suggests that this technology is or is becoming a viable option where cellular coverage is unavailable or unreliable and where line-of-sight technologies are too costly or visually intrusive in sensitive areas.

Participants from NPS noted success in using:

- A long-term product vendor;
- Simplistic technologies that require less maintenance; and
- "Ranger-proof" data collection systems that had fewer features but a very simple interface.

Vehicle Classification

Vehicle classification data is not routinely collected despite its noted value for decision-making. Cited limitations that currently prevent its collection include the following:

- Existing/new technologies intended to automatically classify vehicles are challenged to accurately characterize recreational vehicle types;
- Length-based classification technologies are not routinely calibrated, which affects the underlying accuracy of the data and perceived performance of the technology;
- Recreational road geometry/structure may not adequately support vehicle classification equipment;
- The additional equipment, installation, and data processing resources required may not be available;
- A lack of consensus and differing priorities among State and Federal land agencies regarding the value of vehicle classification data, particularly when compared to the additional costs for data capture; and
- Short-duration classification counts are particularly difficult to translate to an annualized estimate of vehicle class.

Weigh-in-motion (WIM) systems have been used to reduce misclassification errors associated with recreational vehicle types. However, the previously reported challenges related to the potentially high cost of permanently installed WIM systems and/or the low reported accuracies of less costly portable WIM systems limit this application.

On a related note, the representative from the Wyoming DOT presented a novel “virtual lane” equipment installation for distinguishing tandem motorcycle traffic from passenger car traffic. Each year in late July and early August, Wyoming DOT observes a significant spike in motorcycle traffic as motorcyclists travel

through Wyoming on the way to the Annual Sturgis Motorcycle Rally in South Dakota. Motorcycles traveling in tandem are often erroneously classified as passenger cars using automated methods. This innovative practice was developed to more accurately explain and characterize traffic patterns during this time of year.

Short-Duration Counts

Short-duration counts are commonly conducted:

- In 48-hour durations;
- On Tuesday through Thursday; and
- Once every 2 or 3 years.

However, there were a few special practices for handling recreational traffic that were noted that did not conform to this pattern. The Nevada DOT conducts 7-day counts on an annual basis to account for their unique recreational traffic patterns related to casinos, and for consideration of weekend trips. No other participants reported conducting short duration counts on Friday, Saturday, Sunday, or Monday when recreational traffic may be more predominant. Instead, traditional traffic monitoring scheduling practices, better suited to reflect commuter traffic, are more often followed. The Washington State DOT conducts 48-hour counts twice per year in recreational areas to better capture seasonal variability. In Manitoba, Canada, 48-hour counts are also conducted twice per year, but this is not limited to only recreational areas.

When short-duration counts are scheduled, a portion of participants reported scheduling site counts:

- In the same month each year (i.e., traffic counts are typically conducted during the same month each year at a given site);
- During different months per site annually by design to account for

seasonal variability and/or to verify and refine factor groups (i.e., if counts taken in different months of the year do not produce similar AADTs, the assigned factor group is likely not appropriate); or

- As scheduling or weather permits.

Estimates of AADT may be seasonally adjusted using high volume average daily traffic (ADT) months. In Washington State, significant variation between different weeks in the same month necessitated the creation and use of week-specific instead of monthly factors.

Recreational or Seasonal Factor Groups

Factor groups in use by participating agencies differed in both number and characteristics. Several of the participating agencies do not have defined “recreational” factor group(s). Factor groups are often assigned on the basis of:

- Roadway functional class;
- Traffic composition;
- Travel patterns (e.g., high weekend, seasonal volumes);
- Proximate/destination land use;
- Climatic region (i.e., climate conditions that affect travel patterns);
- Relative importance for capturing recreational trips; and/or
- Resources/cost.

Factor group assignment is generally supported by, in order of preference:

- Data from proximate ATRs;
- Cluster analysis; and/or
- Knowledge of the area/professional judgment.

In Manitoba, Canada, traffic analysts use a factor group assignment algorithm that utilizes a series of questions that lend consistency to the decision-making process. While consistent questions are posed, this

process does allow for some subjectivity in response.

For mixed-traffic facilities, consideration of traffic volumes on adverse weather days may distinguish recreational and “other” traffic. When the necessity of this information was questioned, participants indicated that there was value in determining the proportion of recreational traffic to support economic development considerations.

Traffic Data Use, Quality, Reporting, and Sharing

While traffic volumes are consistently captured, other traffic characteristics are less frequently captured despite their perceived value to enhance data quality and decision-making, such as:

- Classification;
- Weight;
- Speeds;
- Occupancies; and
- Origin/destination.

As mentioned earlier, the capture of vehicle weight, in particular, is challenged by the potentially high cost of permanently installed WIM technology and/or the low reported accuracies of less costly portable WIM systems.

Among participating agencies, the motivation for collecting traffic data varied but generally included the following:

- To meet ongoing Federal reporting requirements;
- To support decision-making related to safety concerns;
- To obtain estimates of demand (i.e., visitation) for comparison with supply inventories, economic assessment, and/or resource impact;
- To support decision-making related to system design, maintenance, and

management; and/or

- To support determination of cost allocations under cost sharing arrangements.

In general, Federal agencies tasked with managing recreational areas are primarily concerned with visitation and resource protection while State DOTs are more interested in roadway use and infrastructure preservation.

Ongoing development of and reliance upon management systems—particularly pavement/bridge, safety, and congestion management systems—will increase the importance for traffic data. The level of data detail required to support planning-level decisions and operations/maintenance-level decision differs. In addition, the sensitivity of decision-making outcomes to the nature and characteristics of input data varies by application and the level of sophistication of supporting computer models (e.g., some models provide less precise, qualitative outcomes and hence, require less precision from the input data).

Private industry also relies upon traffic data to support development/business decisions. Two examples provided by the NPS related to the production of Coleman™ camp stoves based on observed increasing or decreasing recreational travel trends and the site selection for new IMAX™ theatres that requires a minimum passing traffic volume (market) for development.

Data quality was reported to be dependent upon available costs and resources. Participating agencies reported the use of automated data validity checks prior to its use and distribution. The participant from the Utah DOT also noted that GIS programs provide convenient graphical displays for visually detecting problems with the data.

Missing data was generally reported directly as such by participating Federal land

management agencies. State DOTs reportedly utilize formal procedures (AASHTO methods) for extrapolating data across missing time periods.

Data quality was thought to be often taken for granted. In a special study conducted to determine the adequacy of planned coverage counts and factoring processes for NPS lands, estimated AADT errors of nearly 50 percent were observed. For Forest lands, a pilot traffic data project, which attempted to factor sample counts using various surrogate information, concluded that reliability of traffic estimates cannot be determined without continuous traffic count (reference) data. This outcome not only suggests a high variability in recreational traffic but also raises questions as to the adequacy of “percent error” as a metric on highly variable and/or low volume roads. For lower volume roads, instead of characterizing data quality solely in terms of percent error, perhaps a combination of percent and absolute error could be reported. One participant reported that the Ohio DOT reports absolute error when traffic volumes are below a specified threshold and percent error when traffic volumes exceed the same threshold. For recreational roads with considerable and varying levels of traffic and/or peak surge periods, it may be most appropriate to set a realistic data value target that meets specific requirements of the users instead of attempting to comply with an unrealistic standard precision requirement common to other roads.

None of the workshop participants provided a clear indication of data quality requirements, either in general or for specific data applications. As such, few workshop participants reported having a clear and comprehensive understanding of their existing data quality (i.e., without defined data quality requirements, scarce resources will be directed to activities other than determining data quality). A systems engineering approach was recommended to define data

needs, verify that the requirements are met, and validate that the requirements are appropriate.

An underlying challenge to this effort is that quality improvements may not be viewed as necessary by all participating agencies. While general consensus indicated that data shortcomings currently exist, improving traffic data extent or quality may not be a priority and/or may not be supported by existing resources.

Over time, the reporting of traffic data has migrated from published annual (or more frequent) reports to CDs, DVDs, and most recently, the Internet, providing timely on-line access to data. The level of reporting detail and frequency was observed to vary among participating agencies. A number of participating agencies reported including caveats regarding data quality to limit the potential for liability.

Data sharing is variable but generally limited among participating agencies. Some examples of successful data sharing partnerships include the following:

- NPS Public Use Statistics Office (focused on visitation) utilizes data from NPS Field Operation Technical Support Center (focused on roadways) to support decision-making. Unfortunately, traffic data collected by NPS Public Use Statistics Office is not routinely shared with the NPS Field Operation Technical Support Center.
- The Forest Service, Montana DOT, and a local county cooperatively participate in a pavement management system.
- Wyoming DOT utilizes data from NPS Public Use Statistics Office.
- NPS and various State DOTs partner to install permanent traffic counters in park jurisdiction and share data across both agencies.

Opportunities to include FLMA in the

existing FHWA Traffic Management System (TMS) traffic data repository were discussed and appear promising. The FHWA Office of Highway Policy Information also offered to make the HPMS traffic data currently reported by States available to participating agencies through the FHWA Federal Lands Highway Division to support related decision-making.

At the State level, participants from the Colorado DOT described their successes in developing a comprehensive integrated database using multiple traffic count data sources, noting a 35 percent increase in traffic count data available to the Colorado DOT valued at \$87,000. The Colorado DOT also noted that the development of such a database requires the use of common terminology and a common attribute of interest (e.g., traffic volumes) among all contributors. A common traffic monitoring database such as this must also recognize and account for different quality levels when various data sources are being integrated/combined.

Broader Traffic Monitoring Challenges

A number of broader, overarching challenges to traffic monitoring in recreational areas were identified. These include the following:

- Recreational travel may be perceived to be less important.
- The lack of perceived importance is exacerbated when the responsibilities for traffic monitoring/roadway management and commerce/tourism are maintained in distinct agencies.
- The traffic monitoring function was observed to vary in priority among participating agencies.
- Contrary to needs for roadway infrastructure/management, recreational traffic is sometimes more difficult and costly to monitor than less variable traffic, is often limited in

geographically, and represents a small proportion of vehicle-miles traveled.

- Monitoring of recreational traffic is more effective/reliable if the recreational route coincides with roadways that require monitoring under FHWA requirements or other dual-purpose applications.
- Participating agencies differ in their organizational approaches; the NPS and USDA-FS are generally centralized with agency-wide guidance while the USFWS and BLM are generally decentralized, allowing for more discretion at the regional and local level.
- Each participating agency noted challenges resulting from limited funding and resources that often resulted in a reduction in traffic monitoring program size.
- Staffing reductions and turnovers challenge the performance of collecting, processing, and maintaining functions, resulting in a loss of expertise, institutional knowledge, and momentum.
- Road instrumentation in recreational areas is often not directly identified as a road asset and as such, may not be replaced if damaged.
- The unique aesthetic, cultural, and environmental considerations in Federal and other protected lands serving recreational travel introduce additional implementation constraints.
- Existing national guidance for traffic monitoring practices lacks sufficient direction and detail for recreational travel—additional guidance may be available through the Forest Service’s National Visitor Use Monitor Program which standardizes sampling approach, data collected, and data definitions and the Fish and Wildlife Service’s *Visitor Estimation Handbook* that includes

methods for traffic monitoring.

NEXT STEPS

Two fundamental opportunities emerged as a result of this investigation related to resource/data sharing and the pivotal role of FHWA’s Office of Federal Lands Highway in improving/lending consistency to traffic monitoring in recreational lands.

In the near term, opportunities exist to share both resources and data among agencies responsible for recreational traffic monitoring. Interagency agreements may help to facilitate the joint installation and maintenance of traffic monitoring equipment (e.g., if a counter fails, the agency responsible for maintenance must respond in a timely manner to minimize the impact to all agencies reliant upon the data). Dual derivation methods were proposed to increase data quantity for both traffic and visitation applications. For example traffic monitoring data could be more widely used to estimate visitation based on assumed vehicle occupancies, and visitation data that is derived from sources other than traffic counts (e.g., surveys, turn-styles, etc.) can be used to estimate traffic volumes, again assuming average vehicle occupancy. Attaching a quality report to data would allow data users to determine whether the data is sufficient for their intended application; the challenge lies in accurately determining the data quality.

For longer-term efforts, FHWA’s Office of Federal Lands Highway should play a key role in facilitating and supporting improvements to recreational traffic monitoring among diverse partners. Agencies tasked with managing recreational areas differ in their underlying mission, priorities, and the nature and extent of their jurisdictional land areas and associated roadway network. A lack of understanding of and possible inconsistencies within each agency’s mission results in uncertainties regarding what data needs to be collected and reported. FHWA’s Office

of Federal Lands Highway can facilitate and encourage improved understanding and awareness within and among partner agencies, leading to improvements and greater consistency in recreational traffic monitoring. A four-stage approach was recommended to initiate improvements to existing traffic monitoring in recreational lands:

- **Stage 1-Continuous Counts.** Develop guidelines that support the selection of continuous count locations based on the number of access points, distance to nearest ATR, etc. and determine when the installation of a new continuous count station may be warranted (i.e., instead of “massaging” data from distant ATR).
- **Stage 2-Coverage Counts.** Develop guidelines that describe the location, scheduling, and duration of short-duration coverage counts.
- **Stage 3-Data Analysis.** Consider the development/use of predictive models that distribute traffic over the network to minimize required traffic data collection, as well as opportunities for data sharing/integration.
- **Stage 4-Special Spot Studies.** Develop guidelines that describe when isolated special studies are appropriate.
- **Stage 5-Store Traffic Data.** Store traffic data in an easily-accessible database that can easily be integrated with other management systems.

In addition to facilitating longer-term development efforts, FHWA’s Office of Federal Lands Highway should support these efforts financially. Under traditional scenarios, the Federal Government is able to allocate Federal funds to the States for performance of certain duties under specified guidelines, with access to Federal funds being the “carrot” through which States participate. For the management of recreational lands, no such hierarchy

exists—Federal agencies must find ways to cooperate with other Federal agencies. FHWA’s Office of Federal Lands Highway can act as a catalyst for identifying and securing funds to support multi-agency efforts focused on improving/lending consistency to traffic monitoring in recreational areas.

Through this investigation, the unique characteristics of participating agencies and the lands under their jurisdiction became evident. Despite the motivation towards more consistent recreational traffic monitoring, any proposed changes to existing practices cannot be a “one size fits all” approach. It must remain flexible to address the respective differences in underlying mission, priorities, and jurisdictional nature and extent of the land areas among the agencies tasked with managing recreational areas.

APPENDIX A: 23 CFR 500: **MANAGEMENT AND MONITORING** **SYSTEMS, SUBPART B—TRAFFIC** **MONITORING SYSTEM**

Subpart B—Traffic Monitoring System

§ 500.201 Purpose.

The purpose of this subpart is to set forth requirements for development, establishment, implementation, and continued operation of a traffic monitoring system for highways and public transportation facilities and equipment (TMS) in each State in accordance with the provisions of 23 U.S.C. 303 and subpart A of this part.

§ 500.202 TMS definitions.

Unless otherwise specified in this part, the definitions in 23 U.S.C. 101(a) and § 500.103 are applicable to this subpart. As used in this part:

Highway traffic data means data used to develop estimates of the amount of person or vehicular travel, vehicle usage, or vehicle characteristics associated with a system of highways or with a particular location on a highway. These types of data support the estimation of the number of vehicles traversing a section of highway or system of highways during a prescribed time period (traffic volume), the portion of such vehicles that may be of a particular type (vehicle classification), the weights of such vehicles including the weight of each axle and associated distances between axles on a vehicle (vehicle weight), or the average number of persons being transported in a vehicle (vehicle occupancy).

Traffic monitoring system means a systematic process for the collection, analysis, summary, and retention of highway and transit related person and vehicular traffic data.

Transit traffic data means person and

vehicular data for public transportation on public highways and streets and the number of vehicles and ridership for dedicated transit rights-of-way (e.g., rail and busways), at the maximum load points for the peak period in the peak direction and for the daily time period.

§ 500.203 TMS general requirements.

(a) Each State shall develop, establish, and implement, on a continuing basis, a TMS to be used for obtaining highway traffic data when:

- (1) The data are supplied to the U.S. Department of Transportation (U.S. DOT);
- (2) The data are used in support of transportation management systems;
- (3) The data are used in support of studies or systems which are the responsibility of the U.S. DOT;
- (4) The collection of the data is supported by the use of Federal funds provided from programs of the U.S. DOT;
- (5) The data are used in the apportionment or allocation of Federal funds by the U.S. DOT;
- (6) The data are used in the design or construction of an FHWA funded project; or
- (7) The data are required as part of a federally mandated program of the U.S. DOT.

(b) The TMS for highway traffic data should be based on the concepts described in the American Association of State Highway and Transportation Officials (AASHTO) "AASHTO Guidelines for Traffic Data Programs"⁴ and the FHWA "Traffic Monitoring Guide (TMG),"⁵ and shall be consistent with the FHWA "Highway

4 AASHTO Guidelines for Traffic Data Programs, 1992, ISBN 1-56051-054-4, can be purchased from the American Association of State Highway and Transportation Officials, 444 N. Capitol Street, NW., Suite 249, Washington, D.C. 20001. Available for inspection as prescribed in 49 CFR part 7, appendix D.

5 Traffic Monitoring Guide, DOT/FHWA, Publication No. FHWA-PL-95-031, February 1995. Available for inspection and copying as prescribed in 49 CFR part 7, appendix D.

Performance Monitoring System Field Manual.”⁶

(c) The TMS shall cover all public roads except those functionally classified as local or rural minor collector or those that are federally owned. Coverage of federally owned public roads shall be determined cooperatively by the State, the FHWA, and the agencies that own the roads.

(d) The State’s TMS shall apply to the activities of local governments and other public or private non-State government entities collecting highway traffic data within the State if the collected data are to be used for any of the purposes enumerated in § 500.203(a) of this subpart.

(e) Procedures other than those referenced in this subpart may be used if the alternative procedures are documented by the State to furnish the precision levels as defined for the various purposes enumerated in § 500.203(a) of this subpart and are found acceptable by the FHWA.

(f) Nothing in this subpart shall prohibit the collection of additional highway traffic data if such data are needed in the administration or management of a highway activity or are needed in the design of a highway project.

(g) Transit traffic data shall be collected in cooperation with MPOs and transit operators.

(h) The TMS for highways and public transportation facilities and equipment shall be fully operational and in use by October 1, 1997.

§ 500.204 TMS components for highway traffic data.

(a) *General.* Each State’s TMS, including those using alternative procedures, shall address the components in paragraphs (b)

through (h) of this section.

(b) *Precision of reported data.* Traffic data supplied for the purposes identified in § 500.203(a) of this subpart shall be to the statistical precision applicable at the time of the data’s collection as specified by the data users at various levels of government. A State’s TMS shall meet the statistical precisions established by FHWA for the HPMS.

(c) *Continuous counter operations.* Within each State, there shall be sufficient continuous counters of traffic volumes, vehicle classification, and vehicle weight to provide estimates of changes in highway travel patterns and to provide for the development of day-of-week, seasonal, axle correction, growth factors, or other comparable factors approved by the FHWA that support the development of traffic estimates to meet the statistical precision requirements of the data uses identified in § 500.203(a) of this subpart. As appropriate, sufficient continuous counts of vehicle classification and vehicle weight should be available to address traffic data program needs.

(d) *Short term traffic monitoring.*

(1) Count data for traffic volumes collected in the field shall be adjusted to reflect annual average conditions. The estimation of annual average daily traffic will be through the appropriate application of only the following: Seasonal factors, day-of-week factors, and, when necessary, axle correction and growth factors or other comparable factors approved by the FHWA. Count data that have not been adjusted to represent annual average conditions will be noted as being unadjusted when they are reported. The duration and frequency of such monitoring shall comply to the data needs identified in § 500.203(a) of this subpart.

(2) Vehicle classification activities on the National Highway System (NHS), shall be sufficient to assure that, on a cycle of no greater than three years, every major system segment (i.e., segments between interchanges

⁶ Highway Performance Monitoring System (HPMS) Field Manual for the Continuing Analytical and Statistical Data Base, DOT/FHWA, August 30, 1993 (FHWA Order M5600.1B). Available for inspection and copying as prescribed in 49 CFR part 7, appendix D.

or intersections of principal arterials of the NHS with other principal arterials of the NHS) will be monitored to provide information on the numbers of single-trailer combination trucks, multiple-trailer combination trucks, two-axle four-tire vehicles, buses and the total number of vehicles operating on an average day. If it is determined that two or more continuous major system segments have both similar traffic volumes and distributions of the vehicle types identified above, a single monitoring session will be sufficient to monitor these segments.

(e) *Vehicle occupancy monitoring.* As deemed appropriate to support the data uses identified in § 500.203(a) of this subpart, data will be collected on the average number of persons per automobile, light two-axle truck, and bus. The duration, geographic extent, and level of detail shall be consistent with the intended use of the data, as cooperatively agreed to by the organizations that will use the data and the organizations that will collect the data. Such vehicle occupancy data shall be reviewed at least every three years and updated as necessary. Acceptable data collection methods include roadside monitoring, traveler surveys, the use of administrative records (e.g., accident reports or reports developed in support of public transportation programs), or any other method mutually acceptable to the responsible organizations and the FHWA.

(f) *Field operations.*

(1) Each State's TMS for highway traffic data shall include the testing of equipment used in the collection of the data. This testing shall be based on documented procedures developed by the State. This documentation will describe the test procedure as well as the frequency of testing. Standards of the American Society for Testing and Materials or guidance from the AASHTO may be used. Only equipment passing the test procedures will be used for the collection of data for the purposes identified in § 500.203(a) of this subpart.

(2) Documentation of field operations shall include the number of counts, the period of monitoring, the cycle of monitoring, and the spatial and temporal distribution of count sites. Copies of the State's documentation shall be provided to the FHWA Division Administrator when it is initially developed and after each revision.

(g) *Source data retention.* For estimates of traffic or travel, the value or values collected during a monitoring session, as well as information on the date(s) and hour(s) of monitoring, will remain available until the traffic or travel estimates based on the count session are updated. Data shall be available in formats that conform to those in the version of the TMG current at the time of data collection or as then amended by the FHWA.

(h) *Office factoring procedures.*

(1) Factors to adjust data from short term monitoring sessions to estimates of average daily conditions shall be used to adjust for month, day of week, axle correction, and growth or other comparable factors approved by the FHWA. These factors will be reviewed annually and updated at least every three years.

(2) The procedures used by a State to edit and adjust highway traffic data collected from short term counts at field locations to estimates of average traffic volume shall be documented. The documentation shall include the factors discussed in paragraph (d) (1) of this section. The documentation shall remain available as long as the traffic or travel estimates discussed in paragraph (g) of this section remain current. Copies of the State's documentation shall be provided to the FHWA Division Administrator when it is initially developed and after each revision.

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